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التعاون الألماني
DEUTSCHE ZUSAMMENARBEIT

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Market-based study for tapping employment potential and innovation-driven business sector development in the solar value chain and promoting business association structures in Iraq

Private Sector Development & Employment Promotion (PSD)
Commissioned by the German Federal Ministry for
Economic Cooperation and Development,
co-funded by the European Union.
Deutsche Gesellschaft für
Internationale Zusammenarbeit (GIZ) GmbH
Baghdad Office | Baghdad, Iraq

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IMPRINT

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Disclaimer

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Table of Content

List of Figures & Tables

Acronyms

AC	Air Conditioning
AGF	African Guarantee Fund
APEC	Asian Pacific Economic Cooperation
BBC	Basra Businesswomen Centre
BBU	Basra Businessmen Union
BDS	Business Development Services
BMZ	German Federal Ministry for Economic Cooperation
BRESC	Baghdad Renewable Energy and Sustainability Centre
BSW	Bundesverband Solarwirtschaft / German Solar Association
CBI	Central Bank of Iraq
CCGT	Combined Cycle Gas Turbine
CSR	Corporate Social Responsibility
CV	Corporate Venturing
CVC	Corporate Venture Capital
C+I	Commercial and Investment
DFI	Development Finance Institution
DG	Distributed Generation
DSCR	Debt Service Coverage Ratio
EE	Energy Efficiency
EH	Energy House
EPC	Engineering, Procurement and Construction
EOI	Expression of Interest
ESCO	Energy Service Company
FAO	Food and Agriculture Organisation of the United Nations
FDI	Foreign Direct Investment
FDO	Foreign Direct Outflow
FIT	Feed-In-Tariff
GCF	Green Climate Fund
GHI	Global Horizontal Irradiation
GIZ	Gesellschaft für Internationale Zusammenarbeit
GTI	Global Tilted Irradiation
HCD	Human Capacity Building
ICD	Institutional Capacity Building
IEA	International Energy Agency
IEI	Iraq Energy Institute
IGCC	Iraqi General Commission of Customs
IGE	Infinity Green Energy
IIA	Iraq Innovation Alliance
INES	International Network of Engineers and Scientists for Global Responsibility
IOC	International Oil Companies
IOM	International Organisation of Migration

IPP	Independent Power Producer
IRENA	International Renewable Energy Agency
IRR	Internal Rate of Return
KRG/KRI	Kurdistan Regional Government / Kurdistan Region of Iraq
LCOE	Levelised Cost of Energy/Electricity
LCR	Local Content Regulation
LLCR	Loan Life Coverage Ratio
MENA	Middle East and North Africa
MOA	Ministry of Agriculture
MOCHMPW	Ministry of Construction and Housing and Municipalities and Public Works
MOE	Ministry of Energy
MOO	Ministry of Oil
MOWER	Ministry of Water Resources
MSME	Micro Small Medium Enterprise
NCOT	Nominal Operating Cell Temperature
NPV	Net Present Value
OECD	Organisation for Economic Cooperation and Development
O&G	Oil & Gas
PMAC	Prime Minister's Advisory Committee
PPA	Power Purchase Agreement
PSD	Private Sector Development
PUE	Productive Use of Energy
PV	Photovoltaic
RE	Renewable Energy
RET	Renewable Energy Technology
RCREEE	Regional Centre for Renewable Energy and Energy Efficiency
SAAI	Shmookh Ardh Al-Iraq
SDG	Sustainable Development Goals (of the UN Agenda 2030)
SEDA	Sustainable Energy Development Authority (Malaysia)
SEIC	Solar Energy Innovation Club
SHS	Solar Home System
SME	Small and Medium Enterprises
TBI	Trade Bank of Iraq
TOT	Training of Trainers
UNDP	United Nations Development Programme

Introduction

Iraq's difficult power supply situation has been hampering the country's economic development for many years and authorities are working for a breakthrough in providing reliable power supply to all Iraqi citizens and the economy as a whole. The current national context is marked by efforts from the government to stabilize the country politically and to finally resume economic growth. At the same time outside influences such as the pandemic, fluctuating oil markets and global economic instability exacerbate the many challenges faced by the country and its people; this puts strong budgetary constraints on government's room for manoeuvre.

Doing business in Iraq is no easy thing. This is why creating a national environment that can attract national and international investments is among the main priorities to develop the country. Current development cooperation approaches consider solar photovoltaics (PV) power as a potential game changer to support the diversification of the economy and sectoral development in Iraq. However, although PV markets display exponential growth in most countries nowadays, solar power is still in its very infancy in Iraq. The pivotal question stirring the energy and development community is therefore how to unlock economic development in the solar value chains in Iraq. The employment potential that can be activated through PV market dynamics in Iraq is the main driver of this study commissioned by GIZ to the German Solar industry Association.

Current policy and regulatory frameworks do not yet favour PV market growth: The lack of PV subsidising policies is inhibiting private investment in PV, feed-in regulations are not in place and financing is not available, to cite just a few impediments. Also, the existing power infrastructures in generation, transmission and distribution are inefficient and result in over 50% of electricity losses. This situation casts doubts on the immediate plausibility of utility scale PV investments in the range of mega- or gigawatts, and it speaks in favour of investigating more decentralised approaches of introducing distributed solar PV as a regional and local job motor to the country. The solar PV sector has been identified by GIZ's PSD program as a particularly promising field of action to trigger business growth in Iraq with a strong potential for upscaling innovative, sustainable economic activities and generating employment.

A number Iraq solar pioneers and several initiatives are already working hard today introducing solar PV to local and regional markets, but a real breakthrough allowing to tap the tremendous solar resource available still seems far from sight under current conditions. Business-as-usual energy politics based on established fossil fuel centered paradigms are still setting the tone. It is therefore to be expected that the public sector won't be able to rapidly create the environment required for a diversified PV growth, one that can bring about a country-wide, sustainable solar job creation dynamic.

The market-based study at hand focuses on the nascent solar PV sector in Iraq by assessing the corridors for building and supporting structures in the private sector. It provides SMEs, potential entrepreneurs and other actors who have ambitions to integrate or support solar PV business with the fundamental data and information about market structures and potential business cases. To achieve this, the study assesses the current situation of the national power supply system as well as the state of development of solar PV in Iraq, and then explores the economics of PV systems in their local context. Moreover, an overview of the wide range of conditions required to develop the PV markets in the country provides the basis from where comprehensive sets of recommendations are elaborated.

This report is not intended to be a comprehensive market and barriers analysis for 'governmental policy consultancy' but is rather to be understood as a 'promotion of trade and industry' measure for promoters of economic development as well as private sector actors wishing to engage into solar PV business activities.

Summary

Among the various forms of electric and thermal renewable and solar energy generation, PV-based power generation has the highest immediate market potential in Iraq due to PV's achievement in recent years of global mass market maturity, cost effectiveness and high acceptance among energy market actors. Furthermore, the global market availability of PV components and systems and the variety of application fields, ranging from small and medium capacities in the watt and kilowatt (Wp-kWp) range to largest capacities in megawatt and gigawatt scales (MWp-GWp), are strong advantages which also grant an increasingly easy accessibility of PV technologies for all customer categories. Supporting the market development of solar PV is therefore considered one of the most obvious and promising approaches to stimulate private sector development in Iraq, especially given the strong market demand for reliable sources of power supply, and also PV's particularly high potential for direct and indirect job creation along the value chain in local, regional and country-wide contexts.

Chapter 1 describes Iraq's traditional power sector which is affected by an ever-increasing gap between power demand and supply. Authorities haven't found a remedy for closing this gap effectively as yet and will struggle to do so in coming years. In 2019, the International Energy Agency (IEA) elaborated a comprehensive set of recommendations spanning technical measures to improve power generation, transmission and distribution, and also suggested to engage into renewable energy development strategies focussing notably on utility scale PV. The significant investments required for large-scale PV market introduction would have to come from abroad to a large extent, which is a challenge the Iraqi government is working on.

Despite a considerable local solar resource in the country, the demand and supply for solar PV are still rudimentary, as described in Chapter 2. Therefore it is recommendable to work on improving the fundamental market framework conditions for decentralised small and medium sized PV applications that can be adopted by SMEs and households. In chapter 3, the study therefore analysed the economics of small PV roof top systems, as well as mid-sized PV systems for agricultural water pumping and SME applications. The economic performance indicators generated suggest that PV would be competitive already if power prices in Iraq weren't subsidised to the extent they are and if affordable debt financing was available.

Concerning the ability of Iraq's private sector to spark a PV market dynamic, the report at hand differentiates between SMEs which are beginning to tackle the PV challenge and larger established companies which have remained observant so far. With upstream local manufacturing currently non-existent, market development is centred around downstream commercial activities which however require systematic professionalisation, notably in the fields of technical knowhow, marketing and management. Comprehensive capacity building efforts and systemic support measures are therefore needed which will ultimately require the intensification of international co-operation. Furthermore, established companies should begin to diversify their activities into PV business and young start-ups venturing into solar should be systematically supported by authorities by establishing conducive and reliable framework conditions. Chapter 4 of this report provides an overview of the many aspects to consider for supporting PV business growth that can have significant impact on solar job creation.

In its final chapter 5, this report provides two comprehensive sets of recommendations: The first set focusses on a generalised problem/solution analysis based on a PV market model involving the core PV value creation chain, the flanking enabling environment and the facilitation of services provision, with the goal to improve framework conditions for PV business activities. The second set of recommendations addresses more particularly possible approaches for promoting PV actors' and stakeholders' endeavours intended at facilitating the emergence of solar job creation dynamics.

1. Assessment of the traditional power sector in Iraq

The economy and population of Iraq are suffering considerably from the consequences of the recent armed conflicts. The national power supply infrastructure was partly destroyed or severely damaged due to armed conflicts in central eastern and northern regions. The fossil fuel-based power plant park is old and inefficient with some more recent modernisation investments having been ill-conceived. For many years, the Iraqi population has been confronted with a regularly failing power supply. They have consequently adopted the bad habit of not paying for their public power consumption, making tariff collection a major challenge for the state utility, whilst also resorting to decentralised local power suppliers that charge hugely overinflated prices for services. Although the public power supply system obviously finds itself in a dire situation, the prospects for reconstruction and development have improved significantly in economic and social terms since the defeat of the ISIS in Northern Iraq at the end of 2017.

1.1 Introduction to the current situation of the power sector in Iraq

1.1.1 Recent history

Iraq is slowly recovering from a long period of conflict and instability. After the invasion by coalition forces in 2003, which led to the ousting of Saddam Hussein, Iraq began fracturing along sectarian lines, ushering in a period of widespread violence. After war broke out in neighbouring Syria in 2011, ISIS took advantage of societal tensions and grievances in the Northern territories. The group captured parts of Anbar in 2013, then swept through Sinjar and Mosul in a brutal 2014 campaign that forced almost 6 million people to flee their homes. Since the military defeat of ISIS in November 2017, a transition set in towards stabilization and around 4 million people have returned to their homes, trying to rebuild their lives although many are without livelihood opportunities, proper shelter, or basic services. However, ISIS still poses a threat in parts of the country and over 1.7 million remain displaced, living in harsh conditions in camps or scattered towns, often in rural areas, with limited or no access to schools or jobs.[1]

Elections were held in 2018 and political elites began working on gaining the trust of citizens. With security much better than in the previous years, Iraq is reconnecting with the world. Oil production has nearly doubled over the past decade to an average of about 4.5 million barrels per day in January 2019. Iraq's political elites have not always overcome their sectarian and internal battles for political and sectarian interests. Systems of checks and balances are weak or non-existent. Trust in political institutions is still low and Iraq ranks 168 (out of 180) countries in the Corruption Perception Index. Protests over deteriorating economic conditions and state malpractice started in July 2018 in Baghdad and other major Iraqi cities, mainly in the central and southern provinces. These popular uprisings indicate that citizens blame authorities for poor living conditions. The discontent of populations generally flares up in summer, when temperatures rise and the lack of electricity and clean water in the governorate are less bearable.

[1] See www.rescue-uk.org, 2020

1.1.2 Actual situation in the country

The current population is estimated at close to 40 million and the Gross Domestic Product (GDP nominal) per capita is estimated at 6116 USD for the year 2019. Since 2012, the population has expanded by over 5 million and is now growing at a rate of 1 million per year with more than 40% of the population under the age of 14. The rapid growth in the working age population has not been matched by a growth in private sector job creation. Instead, Iraq has relied on the public sector to keep a lid on unemployment. Consequently, the public sector has expanded from around 1.2 million employees in 2003 to about 4 million in 2020.

Iraq's social and political landscape has changed drastically since the escalation of regional and global power competition in past years. This led to an unprecedented uprising by peaceful demonstrators against malpractice and sectarian interests in October 2019, causing the resignation of Prime Minister Abdul-Mahdi by the end of November. The current COVID-19-induced health and economic crises both hit the unstable country even harder, delaying its urgently needed recovery. All these problematic developments have exacerbated long-standing tensions, feeding public distrust in the state and tribal violence in the south. They have also detrimentally affected minority communities, especially in ISIS-affected areas, creating openings for ISIS remnants to step up attacks, contributing to continued internal displacement of over one million persons.

The formation of a new government in May 2020 ended months of political deadlock. However, fiscal pressures, political rivalries and limited institutional capacity present serious hurdles to reforms - such as strengthening governance and tackling corruption – which remain critical to long-term stability in Iraq and the region[2]. With an improving security situation many aid efforts of international initiatives are currently focusing on supporting economic development and employment perspectives.

1.1.3 Energy situation in the country

The energy sector is integral to the broader Iraqi economy. Oil and gas account for almost 60% of gross domestic product (GDP), 99% of export earnings and 90% of government revenues[3]. A changing global energy system poses critical questions for Iraq: the current general trend away from fossil fuels, particularly in the global mobility industry (further increased by the Covid-19 pandemic), technological transition towards renewable energies, the drive for greater energy efficiency and the long-term response to environmental challenges all imply sustained pressure on development models that rely heavily on hydrocarbon revenues. Iraq also faces a profound need to develop its domestic energy infrastructure, in particular in the electricity sector. The task of doing so has been greatly complicated by armed conflicts, wild fluctuations in oil prices since the year 2000, and the squeeze these factors have exerted on state capital expenditure.[4]

Iraq's long-running electricity dilemma is now a daily source of public misery. The struggle of the power generation and distribution system to keep up with relentless demand caused by almost free electricity, especially as temperatures soar to record levels of over 50°C degrees, can only get worse without reforms. Constrained budgets and damage wrought by war mean that Iraq is not producing enough electricity to satisfy demand. About 90% of the energy

[2] The current situation in Iraq – A USIP fact sheet, USIP, 2020
[3] World Bank, 2017
[4] Iraq's Energy Sector - A Roadmap to a Brighter Future, IEA 2019

consumption of Iraq is based on fuel, the rest supplied by natural gas. According to the International Energy Agency (IEA), the electricity demand in Iraq, will increase with a 6% annual growth rate by 2030 and is expected to double to around a 17.5 GW average per year. Such sharply rising demand will continue to widen the supply gap caused by ineffective production and transmission capacities. Long daily electricity shortages, especially in hot summer months, have fostered the use of diesel generators to fill the gap. Where incomes allow, local neighbourhood generators are used by many households to remedy constant power grid failures, but this is a costly stop-gap measure. The past points to what will come next if reforms are not carried out. Almost all governments since the regime change of 2003 have witnessed mass protests against the lack of services, and the burning of effigies of politicians has become a summer ritual to express people's anger. The power sector, ravaged by decades of wars, sanctions, terrorism, malpractice, and mismanagement has been a nightmare for all administrations despite the billions of dollars spent on it.[5]

Situation of the power sector in KRG:

In North Iraq, the season of maximum demand for power is in wintertime, the opposite of the centre and south of the country, where maximum power loads occur in the summer season. Similar to the rest of regions in Iraq, today's autonomous region of Kurdistan experiences regular shortages of power supply and has done since 1991. However in recent years, KRG has suffered more from power shortages than other regions because of the widespread infrastructure destruction stemming from the war with ISIS. While traditionally depending on the central Government for their power supply, their newly acquired autonomous status forced KRG to organize its own power supply. However, the power plant park installed in KRG does not operate effectively for a number of reasons, mainly due to planning flaws and malfunctions in a crisis-torn governance environment.

Since 2015, maintenance operations have been reduced as a result of state budget issues. Including the dams and small diesel generators operating in the region, the total installed nameplate capacity is of approximately 6,000 MW. However, the effective operational power generation capacity in KRG is estimated at 3,200 MW, from which residential and small consumers absorb around 2,500 MW, about 450 MW go to the Iraqi network through Mosul, while regional industrial loads represent 200-250 MW. The difference between nameplate and operational capacities is mainly due to a lack of appropriate fuels, with no natural gas available to operate relatively new gas turbines. In addition, still damaged power lines which cannot be repaired because of budget issues hamper the transmission of electricity generated in the power plant park. Consequently, public and commercial consumers tend to supply themselves autonomously with diesel generators.

1.2 Power market structure

This chapter could also have been named "Chronic supply deficits meet an exploding demand". Iraq has a dramatic electricity shortage problem and the country's power sector faces significant challenges. Grid outages are common during the country's broiling summers and remain a daily occurrence for most households because grid managers are compelled to proceed to sequenced blackouts, prioritizing certain districts and large users. Its aging and inefficient generation and transmission systems suffered $7 billion in damage at the hands of the Islamic State, but even before 2014 Iraq's electricity sector was struggling to keep up with

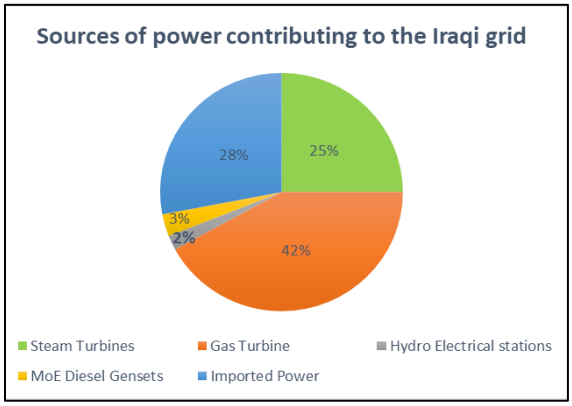
[5] Fixing Iraq's power sector, Luay al-Khatteeb, Middle East Institute, 2020

demand.[6] These chronic electricity shortages have, for many years, threatened economic development and the fragile social stability in this war-torn country, which suffers dramatically from poor living conditions, unemployment, political gridlock, malpractice, and chronic shortages of water and electricity in central and southern regions.[7]

1.2.1 Generation infrastructure: Power plant capacity installed versus power generation and power mix

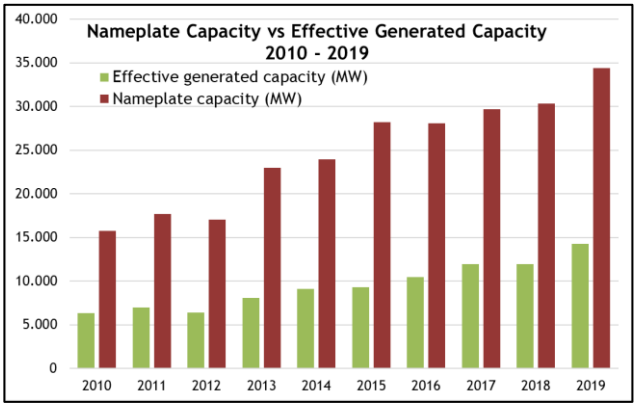
The current generation mix displayed in Figure 1 is heavily slanted in favour of gas-turbine generation (around 42% of MW generated), along with thermal plants relying on fuel oil, crude oil and refined gasoline (25%), a significant share of energy comes from imported sources (28%), mainly originating from neighbouring Iran, and the remaining 5% is provided by Ministry of Electricity (MoE) diesel generator sets (3%) and some limited hydro- electric capacities from the country's eight dams (2%).

Figure 1: Iraq's power mix in 2018



Source: Own graph based on data from MoE Baghdad, 2019-2020

Figure 2: Effective generation capacities of Iraq's power generation park, 2010-2019



Source: Ahmed M. Tabaqchali based on data from MoE Baghdad, 2019-2020

Table 1: Iraq's power mix in 2018

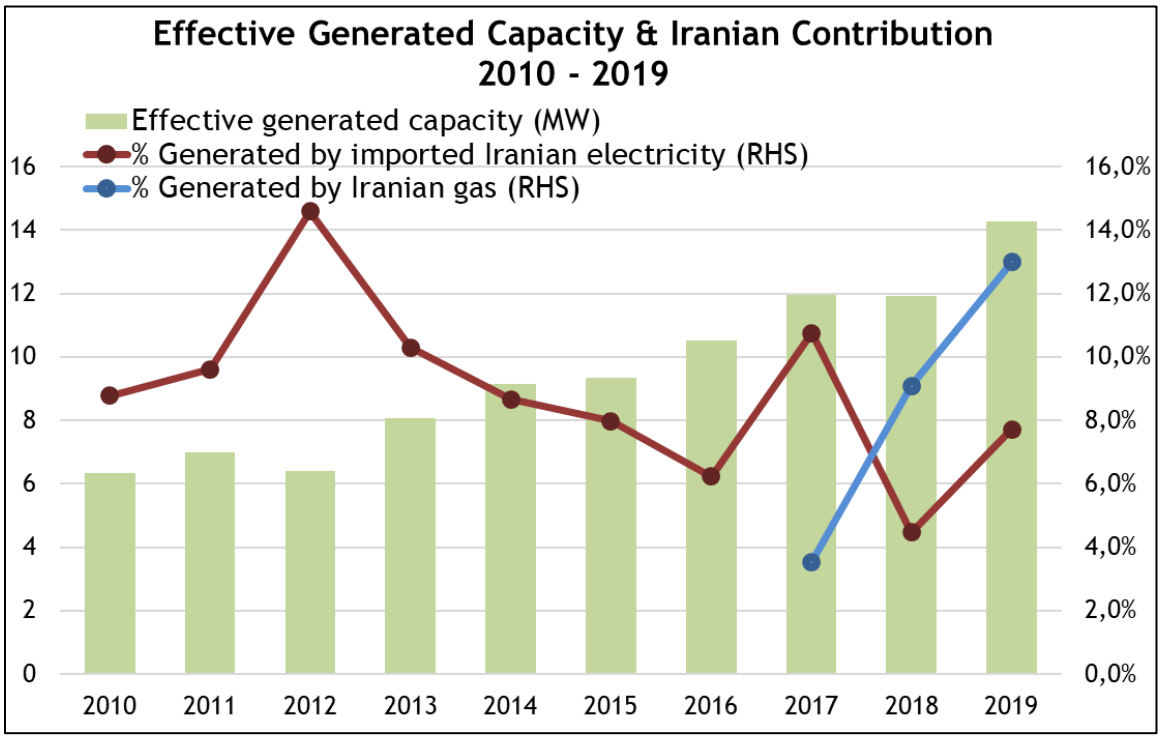
Source of power	Actual power generation in MW	Contribution to the grid
Steam Turbines	3270	25%
Gas Turbine	5521	42%
Hydro Electrical stations	208	2%
MoE Diesel Gensets	274	3%
Imported Power	3627	28%
Total	12,900	100%

Source: MoE Baghdad, 2019

[6] Iraq's Energy Sector - A Roadmap to a Brighter Future, IEA 2019

[7] Iraq's Electricity Sector at a Critical Juncture, Inside Arabia - Voice of the Arab people, Saltanat Berdikeeva, 2019

Figure 3: Effective generation capacities in Iraq and imports from Iran, 2010-2019



Source: Ahmed M. Tabaqchali based on data from MoE Baghdad, 2020 [8]

A particular problem of the power generation park is the substantial difference between effective generation capacities and installed nominal generation capacities (Nameplate capacity), which are well below 50% (see Figure 2). The primary reason for this is due to strategic planning mistakes wherein power plants generally do not use the fuel they were intended to operate with, causing widescale maintenance and other technical problems: In 2018 for instance more than 60% of operational gas turbines were running on inappropriate fossil fuels.

Based on the same power plant park, Figure 3 shows that Iraq's supply gap has been systematically complemented by power imports from Iran, playing an important part in the network given the scarcity of power in the country's power grids. Power cuts of electric capacity by Iran - which provides about 1,000 MW to Iraq - during the 2018 heat wave ignited public anger. Furthermore, to alleviate the lack of gas required for the substantial gas power plant capacities, Iran has also been supplying natural gas to Iraq since 2017.

1.2.2 Transmission & distribution infrastructure: Power grid and electrification rates

More than 25 years of war and armed conflicts have had a huge negative impact on the national power grid. Although access to electricity in Iraq was reported at 99.9 % in 2018 according to the World Bank, this official statistic does not say so much about access to reliable electricity nor whether the grid infrastructure is able to adequately supply demand.

[8] Seen in the AUISofficial webinar "Iraq's Electricity Challenges: US Sanctions, Iran, and the Future of Energy" and based on Ahmed Tabaqchali's article Iraq's Power Conundrum: How to Secure Reliable Electricity While Achieving Energy Independence | Middle East Centre (lse.ac.uk).

Between 2012 and 2019, an additional 8 gigawatts (GW) of newly installed gas power plant generation capacity expanded the national power plant park more than twofold. However, these significant capacity increments serve less than 4 GW of excess demand because they have not been matched by rehabilitations of weakened and failing power transmission and distribution infrastructures. Consequently, technical and non-technical losses of Iraq's power system are among the highest in the world. With about 20% technical losses, 20% electricity theft or unbilled consumption and another 26% of unpaid bills, the public utility's tariff collection managed to recover no more than 33% of its expenses in 2017.[9] These inefficiencies present huge potential for improvement, given that cutting losses by half would help to dramatically improve the efficiency of grid supply, effectively increasing available capacity by up to one-third.

Improving the state of the national power grid by investing systematically into the rehabilitation and maintenance of transmission and distribution networks should be a central priority to mitigate the most pressing and obvious failures of the power grid. A comprehensive maintenance programme for lines and substations would bring a continuous stream of benefits, some of which would be delivered within the first year of the initiative. Reducing losses by five percentage points from current levels would effectively raise the available capacity by more than eight percentage points, making the most of both existing and new power plants. Furthermore, to support growing demand and electricity supply in the coming years until 2030, existing transmission and distribution networks will need to be upgraded and expanded significantly. The substantial investments required represent a sustained effort over several years, yet they are essential to bring the country back to a sustainable economic growth path.[10]

1.2.3 Booming demand and rampant supply shortages

Iraq has experienced a decoupling between national demand for electricity and its public supply since the first US intervention "Desert Storm" in 1991, after which decade long UN imposed sanctions began. Demand and provision of electricity has not returned to equilibrium even since the lifting of sanctions in 2003, whilst the gap between yearly average supply and demand of electricity has risen dramatically. However, the evolving gap between peak supply and demand has been even more drastic, especially during summertime, with Basra the region most affected by resulting daily power shortages. Rising living standards under Iraq's hot and hotter ambient temperatures have resulted in high air conditioning and cooling loads which greatly contribute to supply shortages, yet are highly subsidized through low public power tariffs. These highly problematic trends amplify social tensions which regularly discharge in public demonstrations and popular uprisings.

In parallel to the aforementioned heavy investments since 2012 into gas power plants, peak demand increased by 80% until 2019, resulting in an even larger supply-demand gap than in 2012 and translating to a situation that has barely improved for the average consumer.[11] According to official MoE data for the year 2019, the average yearly power supply was around 13.5 GW and the average demand around 17 GW, leaving a yearly average gap of 3-4 GW. Peak supply reached 19 GW while peak demand topped 26 GW, further accentuating the peak gap as twice as high as the average gap. The more recent data for the summer of 2020, where ambient temperatures reached 50 degrees in the South, suggests that peak demand reached

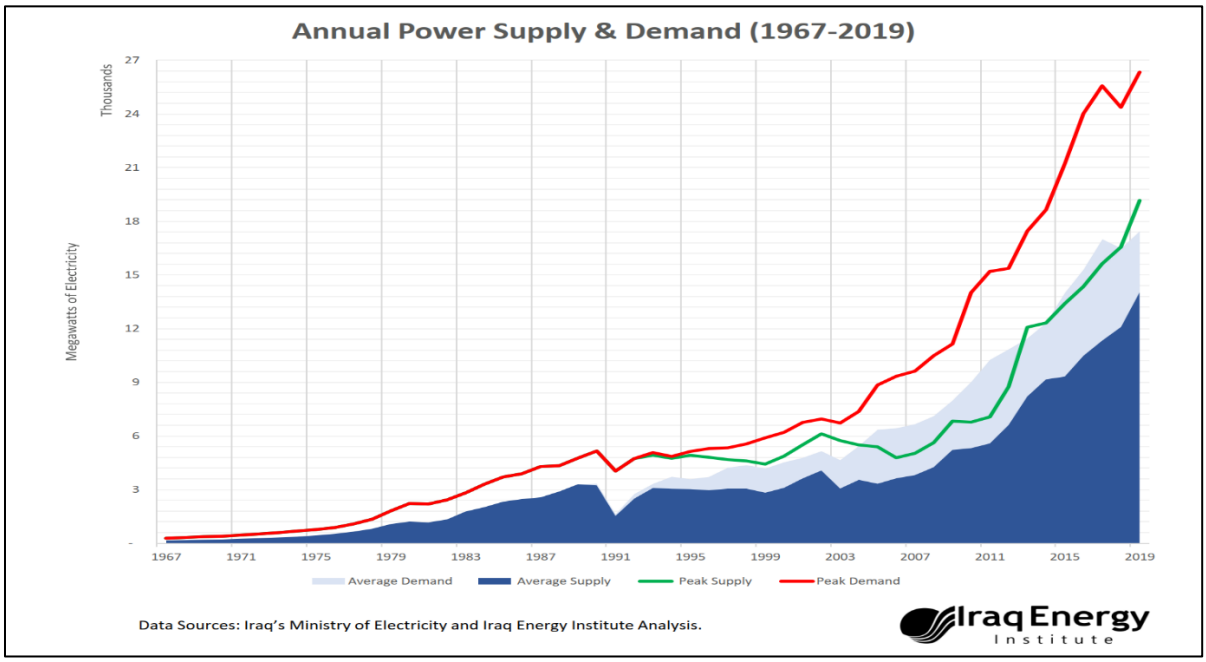
[9] Harry Istepanian, Iraq Solar energy: From Dawn to Dusk, Friedrich-Ebert-Stiftung Jordan & Iraq / Al-Bayan Center for Planning and Studies, 2020, page 10

[10] Iraq's Energy Sector - A Roadmap to a Brighter Future, IEA 2019

[11] Iraq's Energy Sector - A Roadmap to a Brighter Future, IEA 2019

as high as 32 GW, mainly because of high air-conditioning demand. These enormous supply gaps are largely filled by diesel generators, as described in section 1.2.5. To supplement its own production, the country needs to import electricity and natural gas from Iran, however this incomplete solution to its power shortages could soon end. As the United States continues its pressure campaign against Iran, Washington has demanded that Baghdad come up with a plan to wean itself off Iranian energy supplies, which constitute a significant chunk of Iraq's electricity needs[12].

Figure 4: Power supply and demand in Iraq in 1967-2019 and the evolving supply gap



Source: Iraq Energy Institute, 2020

This presents governments and public administrations in Iraq with a sizeable strategic national challenge: Find and implement a suitable energy strategy that helps establish a modern generation mix and power network which must eventually be able to supply the population with sufficient quality power. Achieving stable power supply throughout the country is a pre-requisite for any kind of broader sustainable economic development. However, constrained budgets due to low oil prices on international markets, extensive national damage wrought by military conflicts make it very difficult for Iraq to deliver enough electricity at affordable prices for a steadily increasing demand from Iraq's population (itself growing at a rate of over 1 million per year).

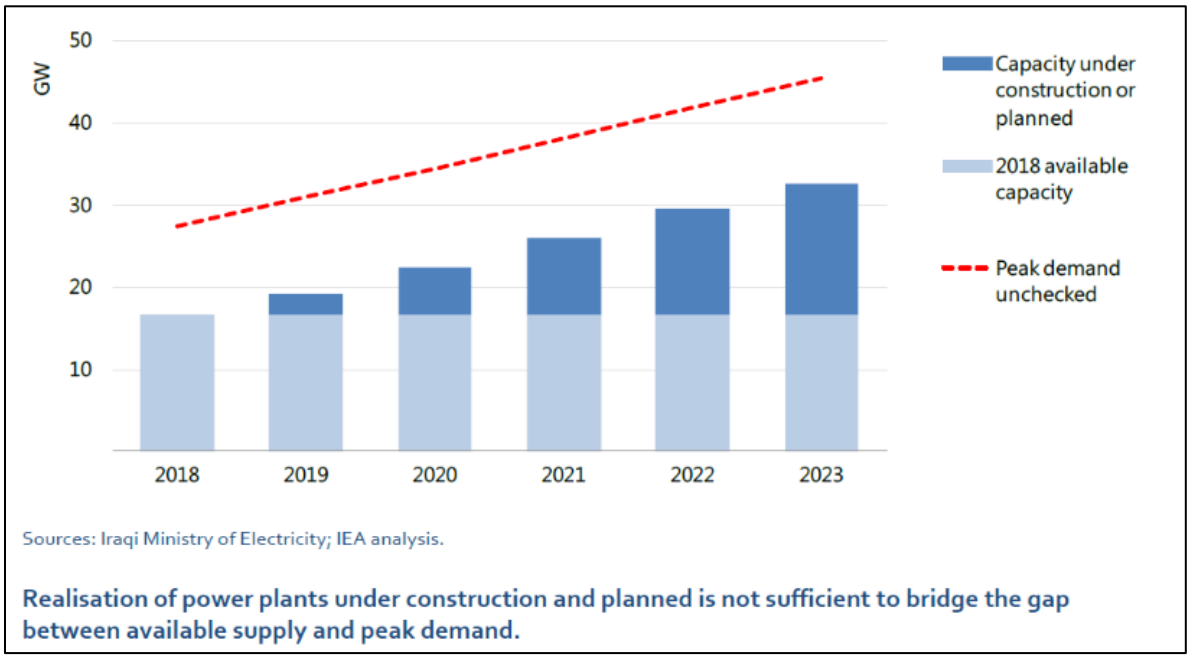
Given that poor tariff collection covers only 33% of expenses of the power produced by public utilities today, a negative cycle is created whereby lower revenues lead to lower capital investment, which in turn limits available supply and revenues.[13] This vicious circle is likely to continue as, according to the IEA, electricity demand in Iraq is forecasted to increase with a 6% annual growth rate by 2030. Closing the gap between peak demand and available supply is therefore not to be taken for granted. Without efforts to keep demand growth in check, peak demand and electricity consumption are projected to increase by 50% in the next five years

[12] Iraq's Electricity Sector Is Caught in the U.S.-Iran Power Struggle, Stratfor, Nov. 2018
[13] Iraq's Energy Sector - A Roadmap to a Brighter Future, IEA 2019

(see Figure 5) and to double by 2030 (see chapter 1.4 on power sector forecasts by 2030). Currently, there are about 20 GW of new conventional power generation capacity either under construction or planned for the medium term. Even where these are successfully completed on-time, a significant gap between power supply and demand would remain in 2023.

The International Energy Agency has carried out an in-depth analysis to identify short- and medium-term measures that can alleviate the most immediate pressures in the electricity sector. The most severe and immediate shortfalls in supply can be mitigated by: the rapid and systematic improvement of network maintenance, targeting a small number of high-impact upgrades; the rapid deployment of new mobile power units; and the upgrading of some existing power plants. In addition to efficient generation capacity increments, Iraq must urgently modernize its power transmission grid and distribution network, trying to get international technological and financial support as well as investments for urgently needed rehabilitation, replacement and extension investments. Without these additional efforts, domestic generation, imports and neighbourhood generation would need to double by 2030, for a total supply of over 250 TWh.

Figure 5: Peak demand and available power capacity in Iraq, 2018-2023



Source: IEA, 2019

1.2.4 Power user segments most affected by power shortages

The segmentation of power consumers in Iraq falls into five main groups (see Figure 6): private households consume approximately 48-50% of the power generation in Iraq, the public sector approximately 30%, the commercial and industrial sector roughly 15%, the agricultural sector 3%, and various other consumers consuming the remaining 2% or more. In general most, if not all sectors in Iraq are subject to a lack of sufficient and stable supply of quality power and are therefore obstructed in their daily activities in one way or another.

The average population or private households are seriously affected because:

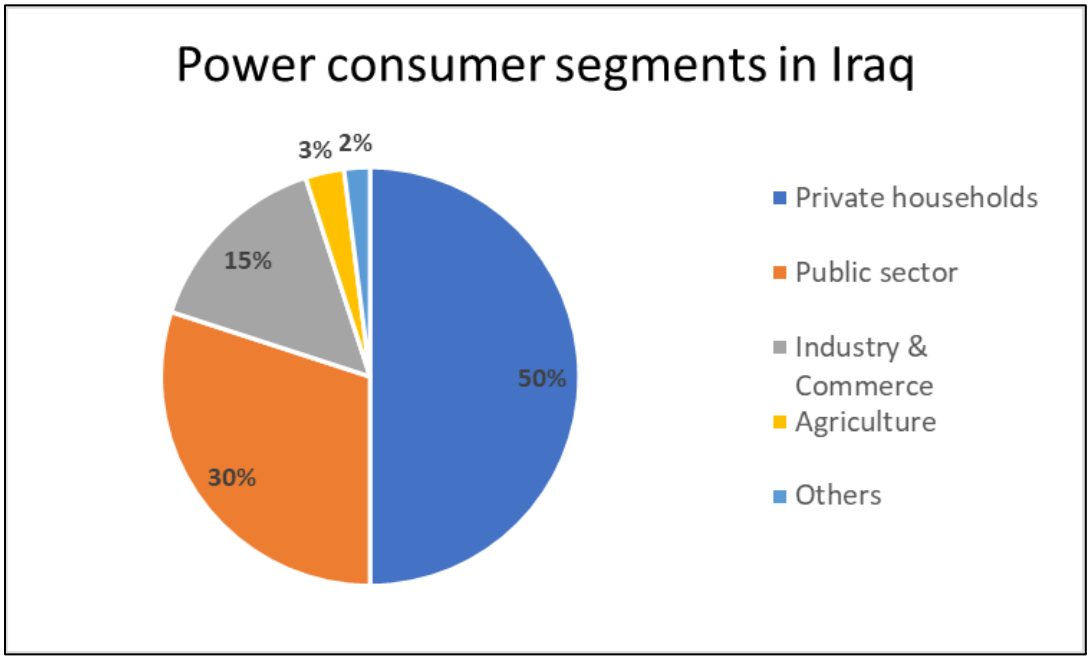
1) Their livelihood as skilled and unskilled labour depends on working economic sectors such as industries, small businesses and farming which are all directly affected by the lack of power.

2) Quality of life increasingly depends on the availability of powered appliances, such as refrigerators, ventilation fans, AC appliances. This is especially the case for lower income households which generally have fewer or no alternatives to failures of the public grid. The average Iraqi usually cannot afford a private diesel generator or does not have the means to buy the required Amps from their local neighbourhood generators.

3) Furthermore, lower income households also depend very much on public services such as education, health or clean water supplies that are not delivered properly because of energy and power shortages.

The purchase power of average Iraqi people is estimated to have decreased by more than half due to loss of employment, public service failures and general business environment degradation related to power issues. The lack of power additionally pushes people to spend more on alternative power supplies like domestic generators or expensive neighbourhood generator power supplies, which seriously stresses the budget of most households.

Figure 6: Power consumer segments in Iraq in 2019



Source: BSW estimations collected during own interviews in Iraq

In the public sector, important authorities and government agencies generally have access to power coming from their own diesel generators, while administrative subunits as well as public services available to the population, such as educational and health facilities are more likely to face precarious power supplies. Another critically affected area is municipal water treatment which compels people to spend a growing share of their income on drinking water.

Before the latest armed conflicts, the government was supplying industrial regions with unique power lines at preferential tariffs. However, those networks were seriously damaged during military operations and are yet to be rehabilitated, with power supply often being reduced to a mere 6 hours per day, generally between 08:00 and 14:00. The national upstream oil and gas

industry produces electricity on-site, in many cases to meet its own needs, as so do large public and private companies, however most SME (Small Medium Enterprises) suffer acutely from the lack of reliable public power supply. They are forced to operate expensive and often inefficient diesel generators or make other costly power supply arrangements, which smaller companies cannot even afford. Consequently, many medium sized factories and manufacturing companies had to close due to power supply related problems and excessive power costs, resulting in soaring unemployment and fewer local products being sold in domestic markets. Today, in addition to security problems identified by interviewed Iraqi experts, the main impediment to economic and industrial development is seen to be problems related to power supply.

The main source of irrigation in Iraq's agricultural sector depends on pumping surface waters and extracting groundwater from boreholes, which relies entirely on electricity. Most farmers use diesel generators whose high operational costs stresses their finances, while most have so far been unable to afford the high upfront investment of photovoltaic (PV) systems. The lack of available or affordable power for irrigation purposes in remote agricultural locations therefore restricts farmers' abilities to work throughout the year and tends to confine their agricultural activity to just one season out of necessity to save scarce energy resources.

1.2.5 Bridging the demand gap with neighbourhood generators

The years long, chronic malfunctioning of the national power system with its long daily electricity shortages has resulted in the use of diesel generators to fill the gap. Where private incomes allow, local neighbourhood generators are used by many households and small businesses to avoid power shortages; hence the neighbourhood power supply sector thrives, but this is a very costly stop-gap solution to the deep-rooted and complex problem of insufficient public power supply.

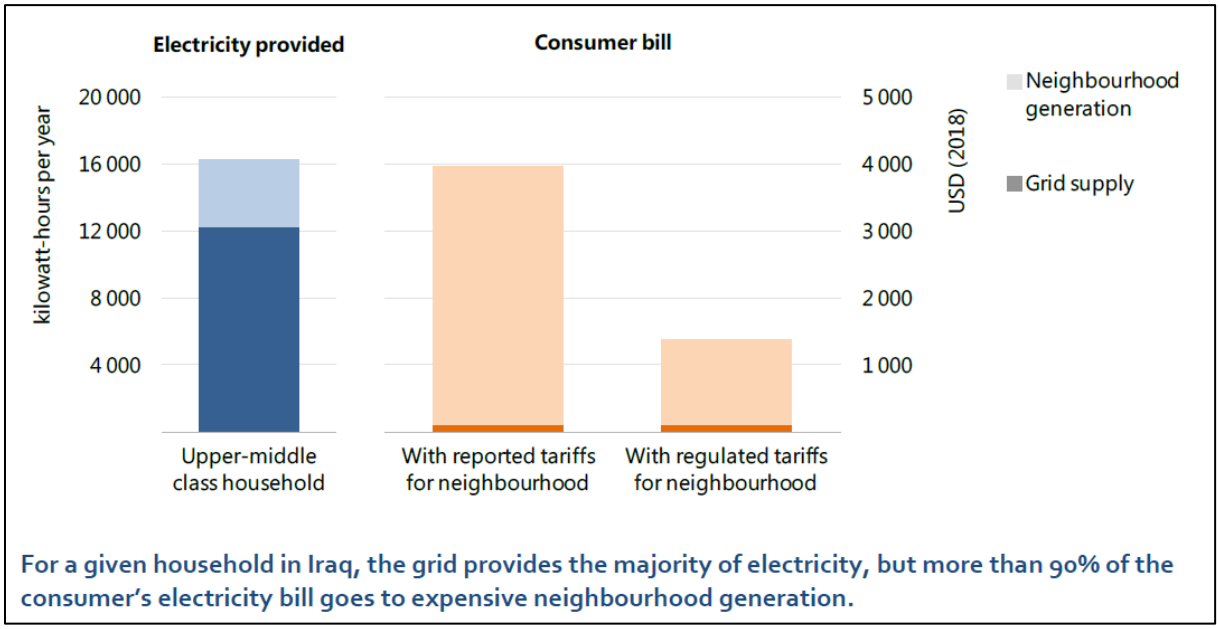
Indeed, small and mid-scale fossil fuel-based generators play a critical role in supplementing grid supply, helping to alleviate some of the most acute shortages, especially in the peak demand summer months. In 2018, the combined total of diesel generators operating was around 6 GW, with more than 10,000 diesel gensets of an average capacity of 0.5 kVA operating throughout the country. About two-thirds of the total are owned by private businesses and referred to as "neighbourhood generators", which connect paying households and businesses via their separate powerlines, often referred to as 'spiderwebs'. Privately owned neighbourhood generators are, in effect, small-scale Independent Power Producers or IPPs. They sell electricity to their customers based on generation capacity subscriptions or power equivalents expressed in Amperes. Prices vary considerably across Iraq and also according to seasons and are in the range of USD 7 to above USD 21 per ampere and month. A billing system based on kWh of power consumed is not wanted because it would require the installation of a power meter infrastructure which increases costs and more importantly improves transparency for customers.[14] About one-third of the small generators are owned by government entities, mainly to meet their own electricity needs. Together, these assets are able to close about half of the gap between peak demand and grid supply but they are an extremely expensive option for consumers. Given their high costs and limited availability, lower income households across the country are unable to rely on neighbourhood generators to fill

[14] Iraq's Energy Sector - A Roadmap to a Brighter Future, IEA 2019

the gap and have to forgo desired energy services, such as energy-intensive air conditioning systems.[15]

The grid supplied more than 80% of the electricity consumed by households in 2018[16], yet it makes up only a tiny share of consumer's paid electricity bills (see Figure 7). Consider the example of an upper-middle class household in an urban centre. Such a household might consume around 16,000 kilowatt-hours (kWh) of electricity per year, with three-quarters of it to provide cooling in summer months. The remaining 4000 kWh are for appliances, lighting, televisions and other electrical devices. Such a household could, on average, rely on the public power grid to supply around 12.000 kWh (assuming an average supply of 14 hours per day across the year), with neighbourhood generators providing the remaining 4000 kWh. Consumers' payments to neighbourhood generators rely on ampere-based annual subscription contracts, whereby the above considered household has a 'typical' power subscription equivalent to 16 amperes (Footnote: Which is equivalent to 3.5 – 3.8 Kilowatts, with 1 Amp = 0.12 kW at 120 Volts and = 0.24 kW at 240 Volts). The power supplied by neighbourhood generators is utilised to a high degree to provide cooling during the hottest 6 months of the year and much less in cooler months.

Figure 7: Consumer bill and electricity provided from the grid and neighbour generation for upper-middle class households



Source: IEA, 2019

This household's consumption would put it in the top tier of public grid supply tariffs, pegged at around IQD 120,000 (USD 100) per year. Supplementing its public grid supply with neighbourhood generators for an average of around 10 hours per day over the year, this household might expect to pay as much as USD 4000 per year to the neighbourhood generator company. This is possible because neighbourhood generator companies are able to charge

[15] Iraq's Energy Sector - A Roadmap to a Brighter Future, IEA 2019
[16] Iraq's Energy Sector - A Roadmap to a Brighter Future, IEA 2019

as much as IQD 25,000 (USD 21) per ampere and month of capacity despite regulations in place that call for lower charges of IQD 8000 (7 USD) per ampere.

These fixed charges translate to around USD 1000/MWh for the example household, putting neighbourhood generators among the most expensive sources of power worldwide. When both power sources are combined, the upper-middle class household pays an average price of USD 240/MWh for electricity delivered, which is eight-fold the average residential electricity price in the Middle East region today. The temptation to purchase power at exorbitant prices is extremely high for most Iraqi households, especially during summer months.

The phenomenon of extreme electricity prices, with over-subsidised public power on the one hand and overpriced priced neighbourhood power on the other, marks a poorly regulated market environment. It also hints at how highly Iraqi people value more clement ambient temperature conditions (e.g. for better sleep), as demonstrated by their unusually high willingness to pay for excessive prices imposed by ruthless power suppliers and often even surpassing even their ability to pay. Neighbourhood power suppliers are able to optimize their price setting on the back of inhabitants suffering to such extent from extreme ambient heat that they are willing to pay literally any price for decent, healthy temperatures.

Such exaggerated exploitation by local monopolistic power supply positions is quite typical in nascent, widely unregulated market economies and unfortunately widespread across the country. This situation is often further aggravated by malpractice in public authorities, which formally chastise illicit practices, yet tolerate them tacitly by not enforcing politically established counter-measures. Concerning the scale of prevailing malpractice, the interviews conducted in the context of this study hinted at rumours that some public power plants may sometimes even be throttled to improve the neighbourhood generation's business and revenues in cities.

1.2.6 Costs of centralised and decentralised power generation

The costs of centralised power generation using large power plants vary considerably from those of distributed or decentralised power generation involving many smaller power generation units, be they fossil fuel based gensets or solar PV generators. This is mostly due to economies of scales applicable for larger power generation units and subsidy policies in place. In the following section we differentiate between centralised and decentralised power generation systems.

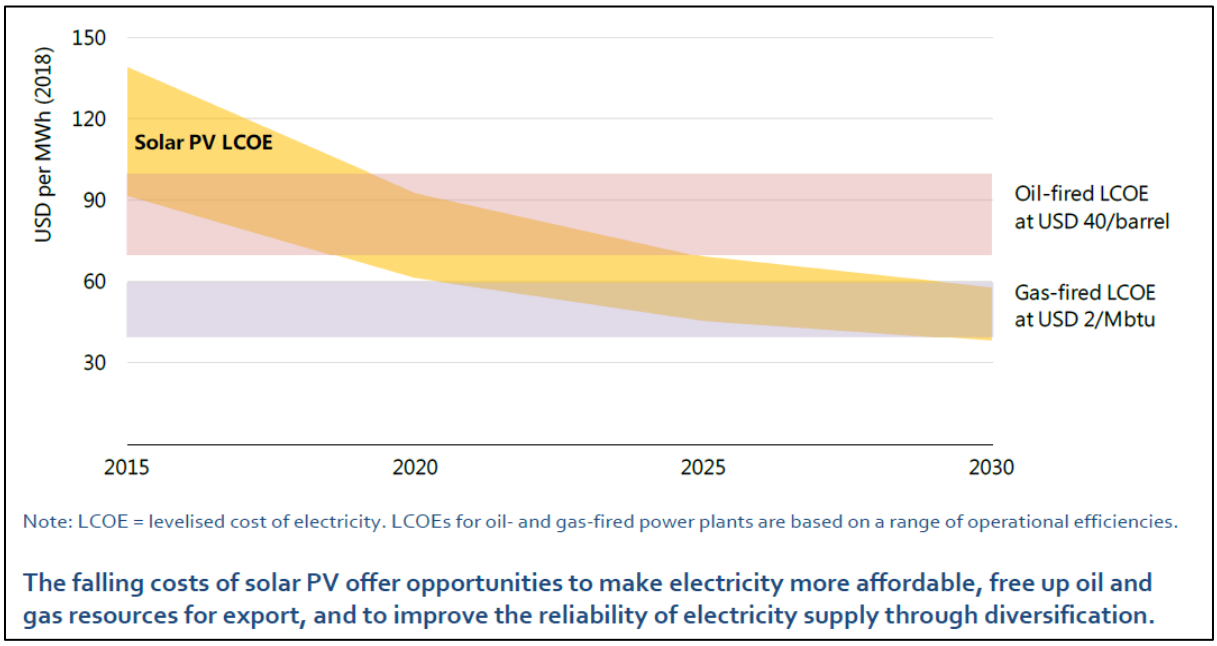
Cost of centralized, utility scale power plant park

Utility scale fossil and solar PV power plants are not the focus of this report, yet their cost degression trends have a significant incidence on the costs of small and medium scale PV installations, notably because of PV modules' sharp cost decrease. Between 2010 and 2019, the continued dramatic fall of the overall cost of solar PV systems and the increase in capacity factors[17] saw the global weighted-average Levelized Cost of Electricity Generation (LCOE) of newly commissioned utility-scale solar PV fall by 82%, from around 0.378 to 0.068 USD/kWh in 2019[18].

[17] The global weighted-average capacity factor for new, utility-scale solar PV, increased from 13.8% in 2010 to 18.0% in 2019. This was predominantly driven by the increased share of deployment in sunnier locations. IRENA, Renewable Power Generation Costs in 2020)

[18] Renewable Power Generation Costs in 2019, IRENA 2020

Figure 8: Solar PV LCOE relative to O+G-fired power generation in Iraq in the period 2015-2030

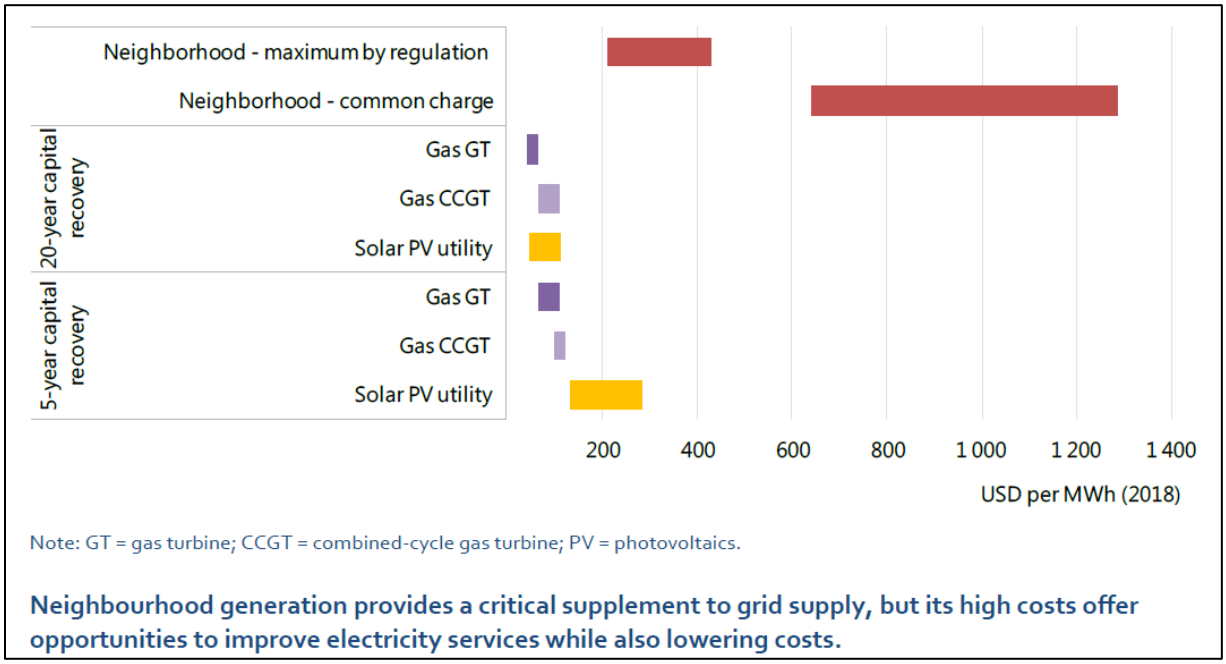


Source: IEA, 2019

Figure 8 shows how the LCOE of utility-scale PV are reaching cost parity with various fossil fuel plant categories due to a long-term cost degression: Solar PV is competitive today with the full LCOE parity band of oil-fired power plants. Also, the most competitive PV utility scale projects are just entering the LCOE parity band with gas-fired power plants. From this, it can be concluded that utility scale PV plants are already competitive with about half of Iraq's existing power plant park. This is especially true in a national context where recently built gas turbine stations are operated with liquid fuels, beyond plant specifications and are consequently operating at their lowest capacity factors and efficiency levels. PV's overall competitiveness with properly operated gas power plants is reckoned to be almost completely achieved in the coming 5 years, by around 2025.

Figure 9 compares neighbourhood generators with standard utility scale power generation plants, showing that large bulk power generation costs are significantly lower than those of much smaller decentralised power generation units. This figure also shows that, at this point in time, utility scale PV has essentially reached competitiveness with gas power plants in Iraq (especially with Combined-Cycle Gas Turbines (CCGT), however this is not yet fully the case from a capital return perspective. In contrast to this, large PV is clearly competitive with neighbourhood generators, especially when compared to the exorbitant, unregulated neighbourhood generator tariffs which can go beyond 1 USD/kWh (1,000 USD/MWh). It must be noted that the Iraqi Government heavily subsidizes the public grid power: household tariffs range between 0.01 - 0.035 USD/kWh, so that the actual tariffication system fails to reflect the objective Levelized Costs of Electricity (LCOE) of the existing public power plant park in operation, which are in the order of 0.10 - 0.12 USD/kWh, while utility scale solar power is currently generated at an average of 0.05 - 0.07 USD/kWh.

Figure 9: Neighbourhood generation costs compared to the LCOE from utility-scale generation technologies in 2020



Source: IEA, 2019

Cost of decentralized, medium to small scale PV power plant units

In the segments of small and medium power users, the capacity specific costs of PV systems (USD/kWp) are significantly higher than those of utility scale systems, in general by a factor of 1.5 to 3. This is due to smaller purchase lots which are then sold at a higher retail price.

Although the specific investment costs of residential rooftop PV systems are significantly higher than in the utility sector, they have also decreased considerably by between 47% and 80% from 2010 to 2019, depending on national markets observed. In Italy for instance, the LCOE of residential PV dropped from 0.405 to 0.109 USD/kWh between 2010 and 2019. Chapter 3 of this report provides a detailed economic indicators analysis of residential, commercial and agricultural PV applications in the small and medium capacity range. While the LCOE of residential rooftop PV systems cannot compete with the subsidized power from the public grid, they are clearly competitive today with the tariffs of neighbourhood generators, be they unregulated (up to 1 USD/kWh) or even regulated (approx. 0.4 USD/kWh). However, the high costs of batteries required for night-time operation and the generally high upfront investment costs of PV systems compared to diesel gensets are still dissuasive for the general population.

Concerning commercial and industrial (C+I) systems, system investment costs fell by 64% to 86% between 2010 and 2019[19], depending on national markets and plant configurations observed. In Italy the LCOE PV systems operating in the C+I sector dropped from 0.405 to

[19] Renewable Power Generation Costs in 2019, IRENA 2020, page 61

0.109 USD/kWh in the observed period. Even though power generation costs of smaller PV systems are typically twice as high as those of diesel power, it can be expected that cost and learning curve effects, as well as environmental factors, not least autonomy considerations during unstable times, will increasingly play out in favour of an increased demand for PV in the coming years, especially in private economy sectors.

When it comes to agricultural applications such as water pumping and irrigation in remote areas that operate either completely off-grid, or are poorly supplied by the power grid, PV is usually a no-brainer today in most regions worldwide. This is mainly due to the high transport costs of bringing diesel to remote locations, as may often be the case in Iraq. Iraqi private sector experts interviewed for this report stated that PV systems for water pumping and irrigation purposes have payback periods of 5-7 years, as compared to 6-7 years for diesel generators. This means that in pure off-grid situations, smaller and medium sized PV systems are competitive with diesel generators, as long as diesel prices aren not subsidised, which would naturally distort the economics of remote PV.

Beyond pure cost and price dynamics, which are subject to world and local market mechanics, the quality levels of PV equipment sold also plays a major role in PV system prices. Low quality components such as sub-standard PV modules, inverters, chargers, batteries or cabling can be sold at less than half the price of recognized quality brands in the sector. This can lead to unusually low prices for small systems, well below the expected 1000 USD/kWp for an ‘off-grid’ residential rooftop PV system configuration. Sub-standard equipment offers are also frequent in Iraq and they typically result in short-lived PV systems. Another rising phenomenon is substandard PV equipment being fraudulently sold at the price of quality brands. These currently trending irregularities urgently require regulation to avoid provoking market distortions that can seriously hamper the sound development of PV markets. However, quality aspects are especially relevant to the expected lifetime of PV systems and thus their long-term economics, with quality PV modules easily performing for more than 25-30 years. Accounting for the required replacement of some main components, notably quality batteries every 5-10 years and inverters every 10-15 years, a PV system can normally operate for at least 20-25 years to the satisfaction of its owner. If well-maintained, PV systems can operate significantly longer and hence generate power at much more attractive costs.

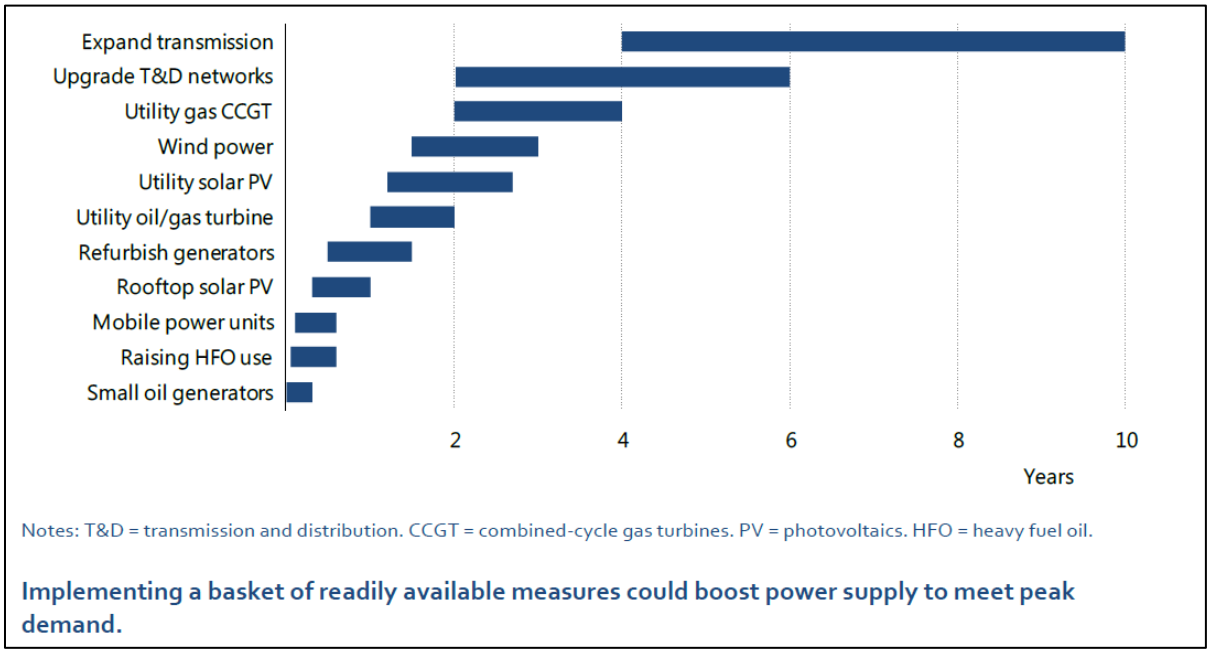
1.2.7 Power supply shortages represent a market potential for solar PV

Alleviating power shortages to meet peak demand in the summer months is a significant priority of the Iraqi government. The status quo of chronic public power grid outages and power capacity throttling has caused diesel-fuelled neighbourhood generators to gain great importance. Once conceived as a makeshift response to the failing power grid, an industry of its own has emerged in past years. It provides an estimated 10 TWh of power to small and mid-sized users at exorbitant tariffs during power outages, corresponding to a huge electricity bill of 4-10 billion USD/year. This overall ineffective, biased and expensive power system impairs all of its users economically, environmentally and in many other ways. As is often the case, the most disadvantaged actors are low-income households, local job-creating business and SMEs as well as the farmers supposed to produce food.

There is however room for cautious optimism, as a number of options are available in the short to medium term to remedy the immediate shortfalls provoked by constant power cuts (see Figure 10). The IEA study from 2019 explored these options and considered how they could be deployed in a manner that compliments long-term planning for a much more reliable and affordable system. While most displayed measures are related to conventional fossil fuel-

based power generation facilities, it is noteworthy that solar PV is considered to play quite a significant role: Rooftop solar PV for small and mid-sized power users are among the immediate and short-term mitigation measures. Utility scale oil/gas, as well as PV power plants, could supply bulk solar power in the short term within just 1, 2 or 3 years, though only theoretically thus far, because such investments are questionable whilst 50% of the power generated is lost on its way to paying customers. In such a context, utility scale PV is clearly not attractive to private investors and only practicable for the state itself, as it is working on rapid improvements, reparation and expansion of various damaged or insufficient power grid facilities.

Figure 10: Technology options to improve electricity supply by time and project type



Source: IEA, 2019

The main lever to reduce electricity cost to consumers and improve their living conditions would seem to be a gradual substitution of those expensive neighbourhood generators which pollute the environment in many ways, raise serious health and safety concerns and furthermore heavily disrupt the public power system from a systemic perspective. It is however unlikely that solar PV will replace significant capacities of neighbourhood generators in the near future for a variety of reasons. Among those cited by our interviewed Iraqi experts are; insufficient roof space in urban environments, high constant loads required for the many operated AC machines, harsh if not hostile competition from neighbourhood generators combined with resistance from local tribal structures and actors benefitting from the status quo. However, residential PV rooftop systems can, in principle, be installed on any house with sufficient roof or ground space, including in urban environments. They can therefore be expected to experience a steady increase in market demand by an increasing number of households who want to act to emancipate themselves from an unreliable public power grid as well as from exorbitant neighbourhood power supply.

Next to the obvious application of PV in the residential sector, which will often be stand-alone systems coupled with batteries, another promising and obvious PV system configuration are PV-diesel hybrid systems: Here, either operating gensets are hybridized by adding PV

capacities or old gensets are fully replaced with a new hybrid solution involving PV. With Iraq being among the countries with the most operating diesel generators, there is a wide range of potential applications for solar hybridisation. Among the first proponents should be industrial & commercial companies as well as farmers operating in remote regions whose business activities are seriously hampered by lack of affordable and reliable electricity. Local suppliers who offer solar PV solutions are beginning to register demand for PV-diesel hybrid solutions from those actors, but lacking adequate information and financing instruments to mitigate high upfront investments are discouraging many potential customers.

1.3 Relevant stakeholders

During Saddam Hussein's reign Iraq was organized as a centralized authoritarian state, with a structured and functional public administration. The public sector dominated the economy, which depended heavily on the revenues of the state-owned oil industry. After the second US invasion in 2003, major state structures collapsed which were later re-built by democratically elected, but mostly unstable governments torn by sectarian interests, malpractice as well as regional and geopolitical conflicts. Today, the public sector is again primarily financed by the revenues from the oil industry and has re-established itself as the biggest employer in the country, dominating its economy. The Prime Minister is the country's active executive authority overseeing all strategic development policies, including the crisis torn power sector.

Government and public sector

The Ministry of Energy (MoE) in Baghdad is the responsible authority for all matters pertaining directly to the national power sector and is considered the public power utility. Several other ministries are however involved, to varying degrees, in policy and decision-making processes related to the power sector and the introduction of renewables energies (RE). In particular, the Ministry of Technology has been coordinating the preparation of the RE Law in 2019/2020 by involving other concerned ministries, such as the Ministry of Construction and Housing, and Municipalities and Public Work, the Ministry of Trade and Industry involved in market regulatory matters, and the Ministry of Planning which coordinates policies with other involved ministries such as the Ministry of Agriculture, the Ministry of Water Resources and others.

These central ministries are located in the national capital Baghdad, but the MoE and most other important ministries also have representations in Basra and other regional capitals. Generally, regional governments and administrations have gained significant influence in the past 15 years. Furthermore, the autonomous Northern region of Iraqi Kurdistan has its own regional government and parliament with the corresponding ministerial structure, acting on behalf of the regional development interests of the autonomous Kurdish region.

Since the era of Saddam Hussein, informal local/regional governance structures controlled by tribal leaders and hierarchies recovered their traditional roles in local decision-making and implementation of policies. They must be actively involved and considered for development activities to be successful on the ground. Here, the Ministry for Decentralisation could help facilitating local arrangements for pilot PV plants.

It should also be noted that in 2016 the Prime Minister ordered all ministries, governorate councils and technical universities to establish their own Renewable and Solar Department with PV demonstration and educational systems.

Industrial and commercial sector

The size of Iraq's oil revenues inhibits efforts to diversify its economy. Besides the dominating oil industry, industrial and commercial sectoral representation is underdeveloped in the country due to a relatively low differentiation of the economy, as well as pronounced regional disparities with a high concentration of significant economic activity in the big cities Baghdad, Basra and Erbil. There are currently just a few solar distribution and small Engineering, Procurement and Construction (EPC) companies active in the country. They register a clear growth in demand for PV systems but have not yet federated into a renewable or solar energy industry association. Therefore, chambers of commerce and chambers of industry and are among the leading actors representing the interests of private sector actors and they hence participate significantly in the shaping of new economic activities. For instance, the Basra Chamber of Industry established the Solar Energy Innovation Club (SEIC) in 2019 in collaboration with GIZ PSD, which is participating in shaping and developing PV markets in South Iraq. Looking at the role these chambers can play in fostering PV market development and job creation, it must be considered that the set-up of Iraqi chambers is not comparable to those in Europe which are private sector organized structures representing company members.

Furthermore, regional business communities are also organised in distinct Businessmen and Businesswomen networks, such as the Basra Businessmen Union (BBU) and the Basra Businesswomen Centre (BBC). These chambers and business networks also have representations in all regional capitals.

Research institutions and academia

Renewable energy has become a focus of most universities and educational institutes in Iraq. Many of them also offer master's or doctoral degrees in renewable energy and energy efficiency. The Nahrain Research Centre for Renewable Nanomaterials was established in 2014 at Al-Nahrain University, Baghdad. Following the Prime Minister's initiative in 2016, around 30 renewable and solar energy centres have been established in technical universities in Iraq, but most of these are still small and do not yet have a significant educational impact on the development of PV markets and technologies. To date, there are no new plans or research projects in the field of renewable energy and energy efficiency that would reflect the enormous potential of PV in the country.

One of the leading research institute working on strategic Iraqi energy topics including renewable and solar energies is the Iraq Energy Institute (IEI) currently headquartered in London with offices in Erbil and Baghdad and which has been acting as official advisor to the Federal Parliament of Iraq on Energy Policy and Economic Reform since 2009.

Development organisations, NGOs, solar market development initiatives

International development organisations from all over the world play an increasingly important role in supporting the economic and social recovery of the war-torn country. In many programmes implemented PV systems play a role contributing to power supply. The United Nations Development Programme (UNDP) in particular is the organisation most actively and systematically promoting PV market introduction in the country since 2014. Many other international organisations contribute to the deployment of PV technology in the country, among them the International Organisation for Migration (IOM), working with a focus on refugee camps or GIZ PSD, with a focus on PV markets and job creation.

There is also a growing variety of public-private, private or religious initiatives acting in various ways to foster the adoption of solar PV technologies and support the development of local and regional projects and markets. Among them are organisations such as the Holy Shrine

Authority in Karbala which is free of corruption, able to finance infrastructure projects, takes decisions through investment commissions, collaborates with provincial authorities and can provide security for the PV systems. Another emerging actor in the Iraqi PV sector is the Baghdad Renewable Energy and Sustainability Centre (BRESC) which together with the Society of Engineers and the Iraqi General Company for Exhibitions and Commercial Services signed a strategic cooperation agreement in July 2020 to support the development of the renewable energy sector in Iraq through a series of measures, such as the promotion of RE, building capabilities that meet the sector needs in cooperation with international training institutions, encouraging youth projects, working on market regulation and standardization schemes.

Furthermore, various structures supporting business creation, such as vocational training offerings and incubators, are currently developing in many cities with the assistance of international development organisations, for example the SEIC established by the Basra Chamber of Industry.

1.4 Power market policies

Reforming the electricity sector in Iraq has been largely ineffective since the fall of Saddam Hussein's regime and the emergence of ISIS. Both historic events set back any progress that had been achieved before in providing reliable electricity. They also stalled efforts to reform the power sector due to divisions within the Iraqi parliament and various government agencies. Now, the power sector is at the forefront of the national agenda because of continued dramatic power supply failures that require a comprehensive modernization of the entire chain of electricity supply: generation, transmission and distribution.

The huge revenues from oil exports are directly channelled to the Government of Iraq. The Government's reliance on tax revenues is therefore low, reducing the pressure for accountability to the Iraqi public.[20] Iraq is a federal parliamentary representative democratic republic which currently functions as a state economy. The country's administration is forced to support large parts of the country's populations with basic subsistence services through the long crisis phase it is traversing. Furthermore, with over 4 million assumed state employees from a working population of 10.5 million,[21] state paid salaries provide a major share of the livelihood of Iraq's population and its purchasing power.

The economic model of the autonomous Kurdistan region in northern Iraq is traditionally more anchored in private business initiatives and market economics. The region has developed a young private sector in past years which is able to actively contribute to economic reconstruction. However, the northern and western regions of Iraq and their power infrastructures were directly impacted by the recent destructive conflict with ISIS. This means that Kurdistan's government is facing special challenges in the power sector today which is a main field of conflict with the central government in Baghdad. The power supply situation is even more drastic in the oil-rich but economically distressed southern Basra region, which faces even tougher environmental and climatic conditions and where stakeholders have been complaining for many years about neglect and malpractice in the power sector.[22]

[20] Oil and Gas Factsheet, IAU/UNDP, 2011

[21] Iraq has approx. 40 million inhabitants, of which 37,5% are in an age of employment (>15 of age), and merely 26% are working populations. Of those, more than 40% receive salaries from public administrations (https://www.destatis.de/DE/Themen/Laender-Regionen/Internationales/Laenderprofile/irak.pdf?__blob=publicationFile)

[22] Iraq's Electricity Sector at a Critical Juncture, Inside Arabia - Voice of the Arab peopleSaltanat Berdikeeva, 2019

This first chapter has shown that Iraq's power generation and distribution system suffers from grave dysfunctionalities, putting all actors under extreme tension. Next to numerous popular uprisings, this situation has also led to the notorious and economically irrational solution of generator-based neighbourhood power generation, provided at extremely high prices for connected power users. Not only does the costly neighbourhood power solution put a strain on household spending, which is mostly limited due to the scarce income situation of most, but it also hampers the economic development of most private businesses. When basic requirements such as available energy and clean water are not sufficiently supplied, many downstream sectors are severely impacted. This strongly delays economic recovery, so urgently needed throughout the country and hampers job creation dynamics as a result of a handicapped private sector caught in a vicious circle.

Without immediate and concerted action, these pressures on the country's power system are likely to inflate, as rapid population growth and economic development bring increased demand for electricity. Achieving stable, affordable and reliable electricity supply is vital not just to serve the basic needs of Iraqi households and to improve general living conditions, but also to stimulate economic growth. Businesses and general industries are reliant on reliable and affordable supplies of electricity and they will be a driving force of the economy in the future, alongside the dominant oil & gas industries. Without reliable grid supply, many firms must meet their own needs, representing an additional cost to doing business in Iraq.[23]

1.4.1 Power sector strategy and plans

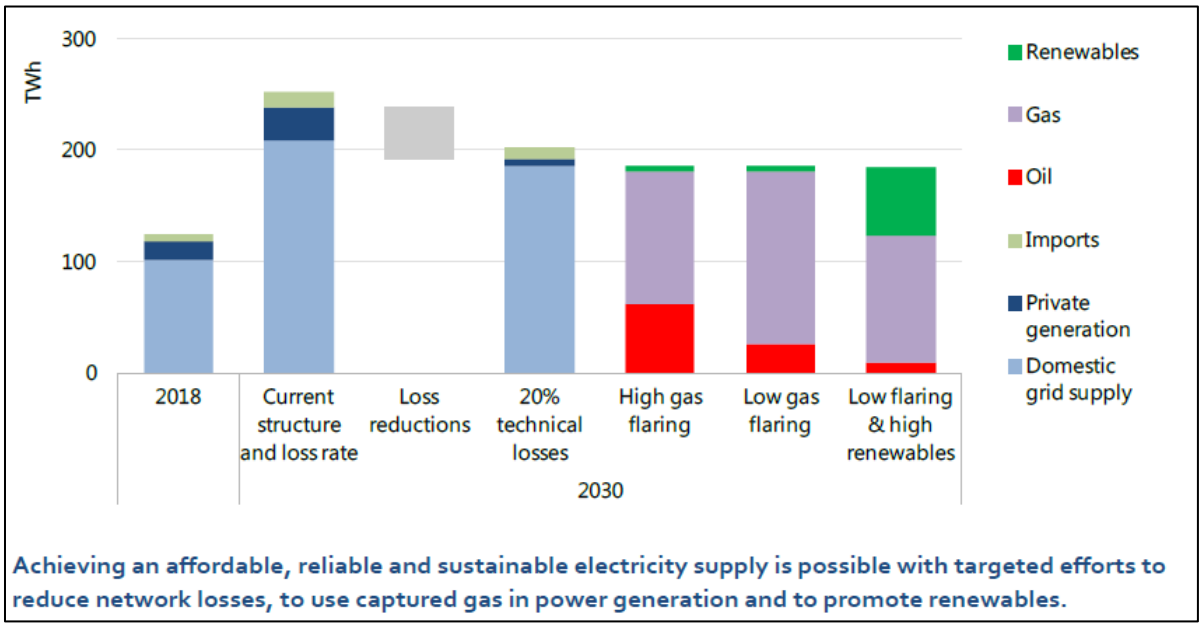
The IEA's suggestions for short-term alleviation of the shortage problems in the power sector have been described in chapter 1.2.7 and PV systems, including residential rooftop PV a well as utility scale PV plants, are considered to be part of the solution. The frequently changing governments of recent years have had difficulties improving the most pressing issues in the power sector and the prevalent crisis atmosphere has impaired the political stability required to address problems in a systematic manner and perform the required work.

In the following, we summarize the analysis and recommendations prepared by the IEA in its Energy Outlook for Iraq 2019, which provides strategic clarity to the various long-term options available for the Iraqi power sector.

By 2030, electricity consumption is projected to increase to about 150 TWh, from 75 TWh in 2018. If the current structure of electricity supply persists, domestic generation, imports and neighbourhood generation would need to double, for a total supply over 250 TWh (Figure 11).

[23] Iraq's Energy Sector - A Roadmap to a Brighter Future, IEA 2019

Figure 11: Steps towards a reliable, affordable and sustainable electricity supply in Iraq by 2030



Source: IEA, 2019

Looking beyond the immediate priority of ensuring the smallest possible gap between supply and the summer peak demand, Iraq has a range of options available to address its power sector challenges in the medium term. They revolve around moderating the growth of energy demand, improving power network infrastructures, increasing the use of interconnections with neighbouring countries, as well as expanding the available grid capacity for existing power plants and new constructions of utility scale solar PV power farms.

Given the high costs of neighbourhood generation, it is vital that the focus shifts to ensuring the growth of grid-based supply, increasing the reliability of services to consumers and improving affordability. This kind of electricity development programme in Iraq would require more than 50bn USD of capital between 2018-2028, presenting significant opportunities for companies that supply to this industry.[24]

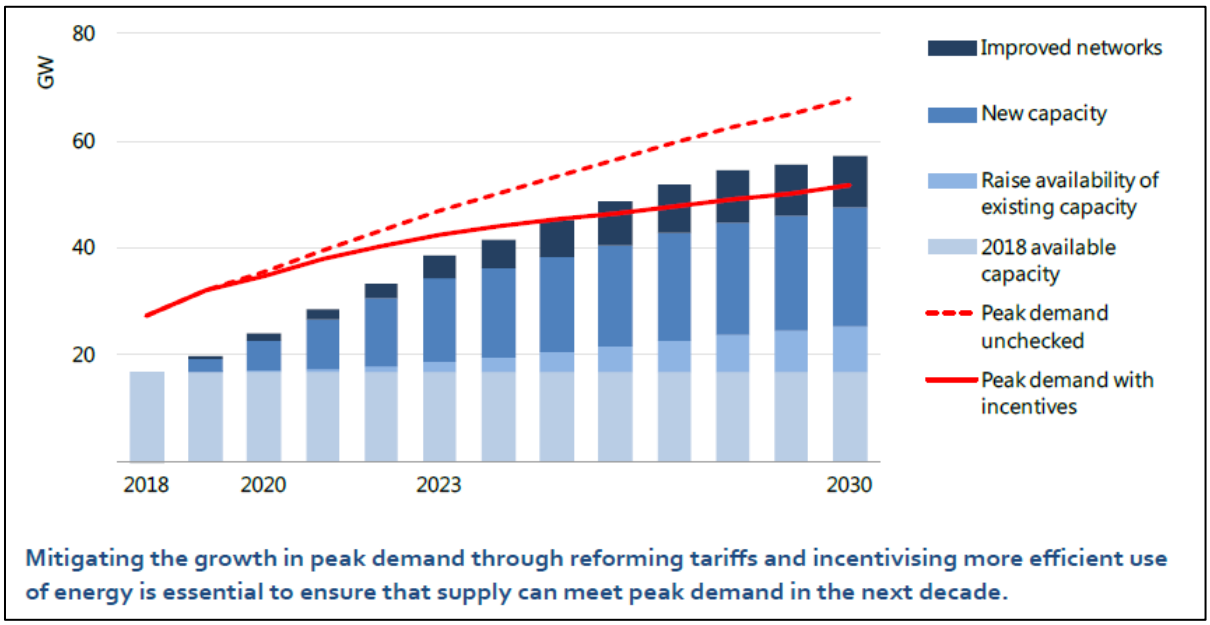
Incentivising efficient power usage

The approximative numbers provided above highlight the strategic imperative of raising the availability of existing power infrastructures: power plants and power grids. In addition, it indicates the necessity of improving the efficiency of end-user power consumption and providing effective incentives to shave the demand peak, especially in summer. Moderating electricity demand growth where soaring cooling demand is one of the key drivers will be critical to tackle power shortages. Supporting the introduction of low consumption air conditioning and cooling systems, ideally subsidising the most efficient equipment, would have a significant impact on mitigating peak load occurrence. More generally, consumers and businesses need to be provided with appropriate price signals motivating them to use electricity more efficiently. This ultimately means that a country-wide reform of power tariffication is needed, inducing more cost-reflective public power prices where neighbourhood power prices are regulated to avoid exorbitant price levels. In addition, bill collection for public grid power must be improved

[24] Development of Sustainable Electricity Resources; Iraq on the Path to Power the Green Economy, Ali Mirmohammad, Frost & Sullivan's Energy Analysis, 2018

or enforced, as people tend to assume that services that come at no costs are not really worth their attention.

Figure 12: Available electricity supply and peak demand to 2030



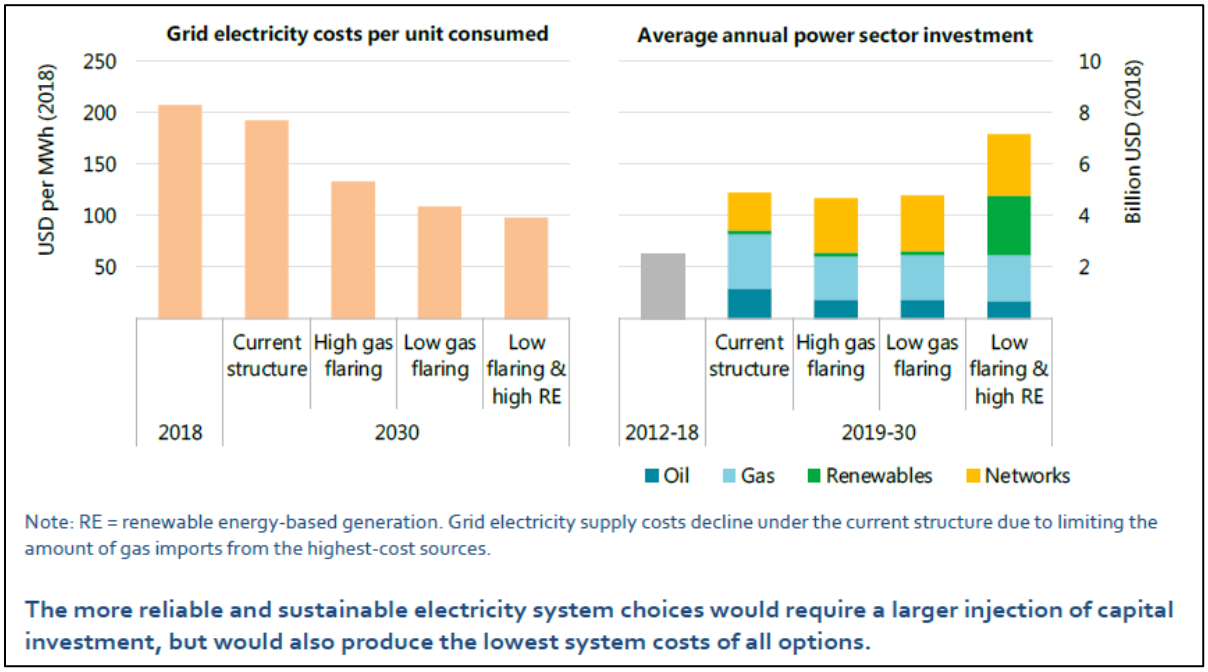
Source: IEA 2019

Expanding available grid supply

As seen above, Figure 11 compares recent power consumption in 2018 with projected consumption level in 2030. It shows how basic energy efficiency measures, combined with a power mix based on adequately operated gas power plants and involving a 30% share of renewable energies, mainly solar, could in principle generate a resilient power system in Iraq, generating below 200 TWh per year.

Figure 13 displays the economic characteristics of the above proposed scenarios: In all presented cases heavy investments are required to prepare the power grid for the coming drastic expansion of demand. Gas-fired power plants and thermal capacity will serve consumers with the bulk of flexibility services, which is essential for fully integrating and accommodating solar and wind generation output. The anticipated strong reliance on gas to run the power plant park in 2030 is based on important associated, as well as non-associated, gas reserves throughout the country. This will require a profound change of energy policy strategy, heavy investments into gas logistical infrastructure to allow for the productive use of gas, as well as intensive coordination by authorities as the use of gas requires a complex process of co-ordination along the value chain. Given the country's historic difficulties in adopting and implementing modern energy policies, some energy experts express doubts as to whether the emergence of gas as the main source of power generation in Iraq until 2030 is a realistic scenario.

Figure 13: Average grid electricity supply costs (2018 and 2030) and power sector investment in Iraq by case, 2019-30



Source: IEA 2019

The high share of renewables in the "Low flaring & high renewables" scenario increases the required investment volumes considerably because of the high upfront costs of renewables. However, this scenario nevertheless provides the lowest electricity costs due to the very low operating costs of solar and wind power plants. Such a diverse power mix would finally offer the required reliability of power supply along with cost-effectiveness and free up oil and gas for other uses or export. Iraq could earn an additional export revenue of over $10 billion in such a scenario.[25]

Whatever role the various energy sources play in the 2030 power mix, the IEA scenarios focus on practical ways to curb demand, improve the fragile power grid and add new capacities that are ideally in line with global climate change mitigation requirements. The scale of contribution by utility scale PV power plants to Iraq's future power mix will depend on political agenda-setting, the priorities of decision-makers in the country and whether it succeeds in attracting international capital that finances utility scale solar power infrastructures worldwide.

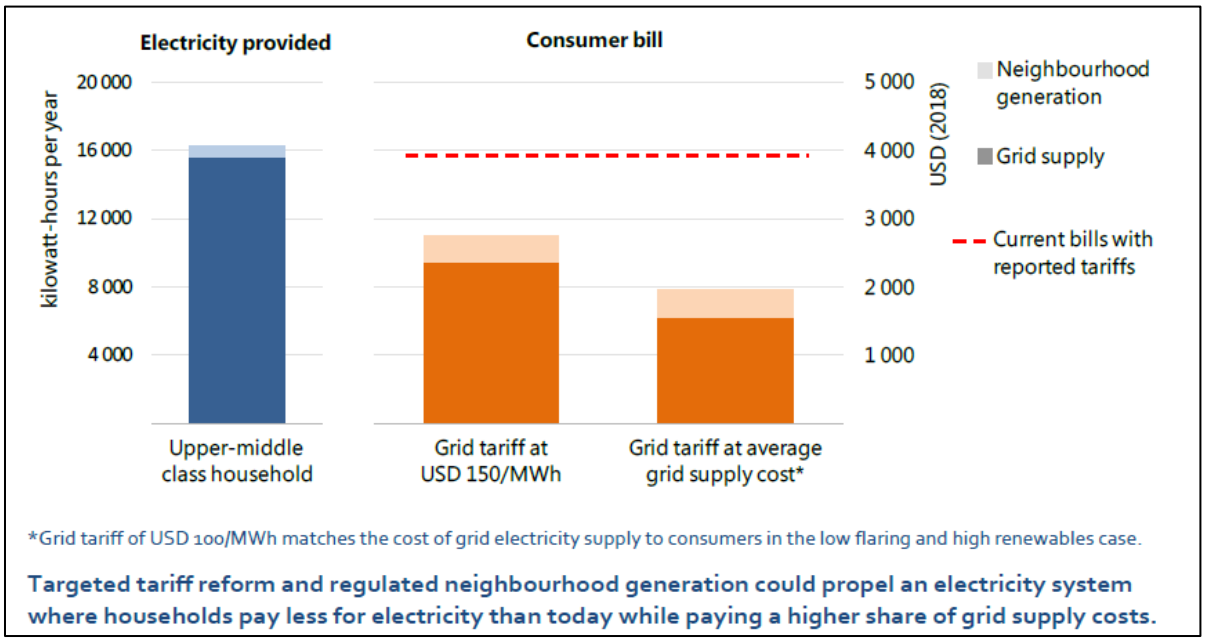
Ending the expensive power supply by neighbourhood generators

The IEA's proposed strategy combines a comprehensive range of measures which address the most pressing issues of the current Iraqi power sector, for example, regulating the neighbourhood generator industry would significantly reduce the power expenses of average Iraqi households (see Figure 14). Compared to the situation of a present-day upper-middle class urban household such as that introduced in Figure 7, the yearly electricity bill in 2030 would be reduced by at least 30% and even cut by half if the power mix comprises a 30% share of renewable power generation. Such development scenarios are realistic and thus feasible if only they can be implemented politically. Another important side-effect of such a

[25] https://www.iamrenew.com/environment/iea-recommends-iraq-to-aim-for-30-renewable-energy-in-power-mix/

stabilised and balanced power sector would be that small and medium sized PV systems would be competitive with public power tariffication which would trigger the kind of market growth dynamics observed in many other countries where PV power systems have reached grid parity.

Figure 14: Electricity provided by the grid and neighbourhood generators, and associated consumer bills for a sample



Source: IEA 2019

1.4.2 Current general and strategic power market policies

1.4.2.1 Status Quo of the power sector strategy implementation

Undoubtedly, the volatile national security environment has significantly affected the development of renewables in Iraq. However, the war against ISIS was not the only reason behind the lack of foreign investments in past years. There is also limited regulatory and legal frameworks to stimulate the use of renewable energy. The current mechanisms for guaranteed purchase of electricity, bureaucratic and administrative bottlenecks, as well as volatility of business environment do not provide sufficient incentives for investors to enter the market. Government's effective recognition of the importance, advantages, and potential of renewable energy is still low and one of the key constraining factors. The Government's top priority in recent years was in adding more fossil fuel units and converting the existing gas turbines units to combined cycles. While this is important, such an approach will not allow widespread adoption of renewables in the current portfolio.[26]

Overview of recent moves by authorities to dynamize power policies

In 2018, the Prime Minister Advisory Committee (PMAC) established the Central High Committee for Sustainable Energy by the Prime Minister Order No. 54, which has the authority to streamline projects/programmes of strategic interest and in which solar energy enjoys "special status." In the context of the Federal Government Programme (2018-2022), the

[26] Solar Energy in Iraq From Outset to Offset, Harry H. Istepanian, Iraq Energy Institute, 2018

Ministry of Electricity announced in May 2019 their long-term target to have a 40% share of renewable power in Iraq's electricity mix by developing solar, wind, waste-to-energy and geothermal projects. The approach was to involve major international energy companies such as Siemens and GE in an effort to rehabilitate Iraq's power sector. Siemens signed an agreement to implement a number of projects under a 14 billion USD roadmap which is still under consideration by the government. An initial short-term national roadmap of power projects was established to develop 1,000 MWp of utility-scale solar PV pilot projects by close of 2020. These plans were not physically realised however, as a result of crisis-level events that shook the country in 2019 and 2020. Furthermore, 8 MWp of roof-top solar projects were set to be developed on government owned buildings within two years. This endeavour is still well underway, but will take longer to conclude than originally announced.

Recently in February 2021, the Ministry of Oil (MOO) announced the government's revised plan to develop seven PV plants with a combined capacity of 700 MWp as well as the goal to reach 10 GWp of installed solar by 2030[27]. Furthermore, in a move to reduce pressure on its hydrocarbon-powered electricity plants, MOO announced its goal to support the MOE to have 20 gigawatts of solar energy capacity installed by 2030.[28]

Persistent lack of decisive motion in public power policies

The country's outdated laws and regulations, unwieldy bureaucracy and deep-rooted corruption do not keep pace with the international, fast-changing market of renewable energy. Nevertheless, a draft law for Renewable Energy was submitted to the Ministerial Energy Council for review in early 2019. The law aims, among many objectives, to remedy to the most urgent regulatory barriers for the market introduction of PV and to encourage the public and private sector to participate in developing renewable energies. It is however, very likely that the draft will not be introduced to parliament for debate until after the new elections in June or October 2021, or even early in 2022.[29] Whenever this RE Law comes into effect and whatever it may contain by then, the involved actors should set the right framework conditions to let the private sector develop and thrive, thereby generating employment.

Prioritisation of centralised versus distributed solar power policies

There seems to be a risk however that the RE law will focus on utility scale solar power, rather than on smaller scale distributed PV systems. It remains to be seen if the collaboration announced in 2019 between RCREEE, UNDP and IRENA to support Iraq's renewable energy efforts and remove barriers to direct private sector engagement in solar will be able to influence the law to foster smaller solar PV systems.

Distributed PV systems, including those operating in off-grid or weak grid environments, have not been expressively considered in the IEA's long-term simulation of the grid-based power mix. Scattered initiatives for small scale PV are developing throughout the country but they lack a systematic integrated approach. Despite their relatively modest contributions to the country's overall power consumption of probably less than 5%, distributed PV can also contribute to significantly reducing electricity expenses of households and medium sized power users because their LCOE are already competitive with those of diesel power. This does

[27] https://www.pv-tech.org/iraq-to-award-700mw-of-solar-tenders-first-step-in-10gw-by-2030-plan/

[28] https://www.iraq-businessnews.com/2021/02/16/iraq-plans-20gw-solar-power-by-2030/

[29] Iraq Solar energy: From Dawn to Dusk, Harry H. Istepanian, Friedrich-Ebert-Stiftung Jordan & Iraq / Al-Bayan Center for Planning and Studies, 2020

however require reasonably attractive financing opportunities to compensate for the typically high upfront investments compared with diesel generators.

In this regard, the Ministry of Electricity and the Ministry of Finance announced a loan scheme in 2020 with several local banks such as Trade Bank of Iraq (TBI) and backed up by the Central Bank of Iraq to facilitate easy loans for households and investors wishing to install rooftop PV systems from accredited manufacturers and suppliers. Developers of smaller PV projects were invited to submit their proposals for review. However, no new developments have been reported since and implementation is uncertain (see also Chapter 2.5.5).

Paying lip service to solar power with no change in reality

Government officials and public administration representatives all support the introduction of solar energy at a larger scale and a number of PV demonstration systems have been realised on ministerial and public buildings throughout the country. However, the declarations of intention about modernizing power politics, by introducing solar PV power alongside other pressing issues, have not yet materialised. All of these declarations are hampered by a variety of market and societal realities on the ground. As we often heard during interviews, the iniatives thus far, remain wishful thinking or “ink on paper” waiting for implementation. However, continued instabilities in international and national, economic, political, social affairs, not to forget the more recent pandemic impact, have clearly occupied the government’s and the state’s attention, distracting from the equally complex problems pertaining to power generation and supply. Given the particularly gridlocked situation in Iraq’s power sector, it is certainly true that national and regional governments need time to implement those complex energy policy measures in the medium to long term.

Some tangible short-term results need to be achieved very soon however, to build trust among the population and energy sector stakeholders towards government action. This is why a comprehensive national energy strategy that considers the marked regional differences in power supply and which integrates modern concepts of decentralised, distributed solar power generation is urgently needed. This strategy needs to include a well thought out short- and mid-term roadmap with a number of visible and realistic activities that can be implemented fast and effectively.

Iraqi expert observers consider, with the high frustration level of the Iraqi populace in mind, that sound and achievable public announcements can only be made on the basis of an integrated, operational national energy strategy. It is obvious, that the many pressing issues cannot be solved overnight. Steadily increasing the number of tangible results in carefully designated fields, with successes well and adequately communicated, can contribute to improving public perception on power issues, which are felt perpetually and quite existentially by the population. Solving Iraq’s power gridlock can only be done by implementing new power policies which will require special efforts from all actors over time, with some buying-in earlier and others later when successes become visible. Solar PV has a special role to play in this particularly difficult context because it allows the gathering of quick and easily reproduceable success stories that can again easily be scaled into the national territory, including the most problematic regions. Furthermore, PV systems are often widely visible symbols in the landscape with a positive connotation, close to people’s realities when they own or work with them.

1.4.2.2 Overview on the perspectives of interviewed authorities

Given the failed experience of the first utility scale PV tender procedure in 2019/20, such projects can only materialise if the Iraqi government manages to engage sound governance and collaboration practices with international industry partners which equally benefit all contractual parties, provided the country is able to offer a secure and stable business environment.

All interviewed ministries agreed that no clear policies exist today for a systematic solar power market introduction in Iraq. There are number of initiatives to adopt PV power, notably rural and peri-urban small size water pumping and water treatment units that have been installed in recent years. However negative experience with several of the involved local solar companies often lead to discouraging outcomes and consequently, to dead-ends.

The lack of laws and regulations for renewables in Iraq makes the market open to unreliable and substandard quality PV components and systems from Asian suppliers as well as producing local supply companies that are not proficient and qualified enough to offer adequate engineering, installation and O&M services. This is why dedicated government policies are required to enhance the overall quality of the PV sector in Iraq. Recent encouraging policy initiatives cited are the tax exemption on PV materials, the prepared RE Law allowing grid-connection and compensation to PV systems as well as new loans schemes for government employees investing in private rooftop-PV systems.

In urbanised residential settings, authorities generally recommend adopting rooftop PV systems that are not connected to the grid and fitted with battery storage. PV systems hybridised with diesel/fuel generators are clearly not recommended in order to mitigate air pollution in the neighbourhoods. It is however often considered that PV-only systems, even with battery capacities, may have limited success among private households that operate AC systems because of intrinsic high loads and lack of efficient power usage patterns. The inefficient use and waste of power by households is a principal problem in the country which would require systematic awareness campaigning to help mitigate daily overloading of the power grid.

Medium-sized hybrid solutions combining PV and diesel are favourably seen in commercial and industrial companies of all sizes as they contribute to reducing the load in public power grids and because they are able provide more reliable power than the grid.

1.4.2.3 Overview on the perspectives of interviewed solar companies

All interviewed companies welcomed the decided upon tax exemption on PV materials, the announced loans scheme for private investors of rooftop PV systems and the expected RE Law that should allow for grid-connection of PV systems and compensation of injected solar power. At the same time, companies clearly state that without a tariff reform of the heavily subsidised public power from the grid, PV is not in a position to compete in the mass market of power consumption by private households. Similar logics apply in the sector of diesel generators where local governments are subsidizing fuel prices during hot summer months because of rising peak demand for cooling by AC systems, this practice also sets economic barriers for solar PV.

The solar company Energy House based in Erbil and Basra was approached in 2019/2020 by public authorities to submit offers for hybrid system in the range of 30-100 kWp to add PV to existing generators in public facilities as well as for grid-tied PV systems without batteries. But those projects plans weren’t realised because of lack of budgets. Concerning financing smaller

PV systems with loans, Energy House approached several local banks in Basra in 2020 to investigate the opportunity for their clients but they were always referred to the banks' headquarters in Baghdad and plan therefore, to travel there for such talks.

Unanimously identified as one of the major issues is the necessity of the introduction of quality standards by law makers to avoid, or at least reduce, imports of substandard solar PV equipment which generally quickly fails and consequently damages public perception of solar power systems.

The recent devaluation of the Iraqi Dinar by more than 20% compared to the US Dollar has further raised import prices and the cost of quality solar equipment in domestic markets. This certainly complicates the establishment of sound PV markets in the country. Consequently, local solar companies struggle to convince their clients with typical solar marketing arguments of advantageous medium to long term economics, being set back by the rising barrier of high upfront costs in distorted local markets with politically biased price signals.

Another frequent complaint from fledgling solar companies is the lack of transparency in the political decision-making processes, whereby suppliers are involved in decision-making and included in information sharing only at a late stage to be provided only with already accomplished facts. Furthermore, there is a widespread feeling that authorities tend to work without comprehensive research and proper pre-analysis, which leads to flawed project implementations and significant financial losses. The typical example cited is of investments in gas power plants that cannot be operated at specification and thus perform at very poor efficiencies. Looking at the Gigawatt scale solar power projects that are expected to be tendered soon, the question in the room is if and how local solar businesses can participate in their implementation in order to learn and grow. Even if nascent solar business in Iraq is oriented at small and medium scale PV systems, growth opportunities for local solar business need be developed systematically and consequently in all market segments, with the objective to harness maximum local employment potential by creating solar jobs for younger engineers who are often unemployed.

Nascent solar business needs significantly more support than in European countries because the unfavourable framework conditions make entrepreneurial tasks quite a challenge in the country. It is much more difficult to start and operate a solar business in Iraq than it is in Germany.

1.4.2.4 Overview on the perspectives of interviewed advisors

The absolute dominance of the oil sector

A high-ranked advisor from the oil sector made clear that with more than 95% of Iraqi power plant parks currently using fossil fuels, RE and solar will need to be experimented "in parallel and introduced step-by-step". The IEA Strategy presented above (see chapter 1.4.1) is not viewed as realistic because most of the power generated will continue to stem from liquid fuels such as fuel oil and conceivably not from gas sources. Alternative scenarios considering more fuel oil would be more realistic. Given the actual financial situation of Iraq, it is likely that no national investments can be made available for gas and solar. There is no masterplan for gas infrastructures being implemented because there is no finance available to do so, although this would now be an urgent task if gas were to play the suggested important role. In reality, gas sources are not currently being developed. PV-diesel hybrid systems are seen as a good and desirable solution for medium and small-scale applications. Energy storage in all sizes (kW to MW equivalent) is important in the future. Using RE sources for power generation, be it in

centralized or distributed systems, will “serve the direction of decreasing the pressure on the national grid by reducing consumer demand”.

These conservative but clear statements accurately portray actual and coming energy policies in Iraq: hydrocarbon-oriented thinking and logics naturally dominate energy policies as well as national policies in general, given that the oil sector finances most of the country’s activity today. However, Iraq’s oil sector seems to be hearing international calls, and understands that “a 10-years energy strategy and policy must be formulated which should contain gas and solar for the electricity sector. Without a long-term policy and plan from the government, initiatives come and go. Also, with changing governments, priorities and people frequently change positions which hampers continuity”, as well as the emergence of new industries which are the main actors of systematic, rational progress and organic growth in national development.

Systemic malpractice hampers the effective implementation of power policies

The seemingly ubiquitous issues with malpractice in the country are a major and serious impediment to the development of new ‘competing’ industries which usually need regulated environments to strive and thrive. The problem of malpractice is best described by the following anonymised statements gathered: The main reason preventing the foreign investors to work in Iraq is the corruption phenomenon. High commissions are required to facilitate regulation and compliance processes with international partners. There are administrative obstacles, with certain routines and procurations to get approvals or asking revisions, which slow down or even prevent needed investments and thereby ultimately serve the “diesel mafia” objectives. A lot of officials are making decent benefits from the current power situation. For example, the power station of Bismayah, located South of Baghdad, has enough capacity to supply the whole of Baghdad and Wassit provinces. But it was never operated to its full capacity, as this would touch a) the vested interests in diesel and b) those of neighbouring countries exporting power to Iraq. It seems that officials have been forcing the Bismayah station to be switched off for neighbourhood generators to operate their infrastructures and improve revenues. Also, the power transmission agreements with neighbouring countries that have come under attack recently by the former US administration also represent a barrier against utilizing solar power in Iraq.

The systemic malpractice in Iraq is rooted in the troubled recent history of the country and to a certain extent also in tribal traditions which have morphed into ‘modernized’ local tribal governance structures and decision-making. The phenomenon can be interpreted as a societal, existential self-protection and subsistence reflex of elites and populations torn by decades of war and administrative chaos. Taking again the example of privately owned diesel generator-based neighbourhood ‘mini-grids’: While tariff regulations for all neighbourhood generators are urgently needed and demanded by all national parties and foreign advisors, their development, implementation and enforcement have remained impossible. Instead, neighbourhood generators are authorized to operate by provincial governments which are dominated by tribal structures and their Sheiks.

In Southern Iraq for example, innovative local projects require the protection of the Council of Ministers as well as tribal agreements that can be reached by means of local workshops to sensitize local leaders or Sheiks for equitable scenarios and solutions where all involved parties benefit. To better understand the complex and often opaque multi-actor processes on the local level, micro-political research on local power politics and local stakeholders is required (Iraq Energy Institute). If local processes are not understood, harsh resistance from

populations can result, such as in the case of an intended roll-out of smart-meters in Basra which was organised by local diesel actors and rejected by the overwhelming majority of households. To better understand the complex and for outsiders often opaque multi-actor processes on the local level, micro-political research about local stakeholders and power politics would be useful as was mentioned by the Iraq Energy Institute.

Iraq's large base of engaged engineers is widely ignored

While the masses of frustrated power users regularly crowd the streets and squares in huge protests, the country's many engineers who belong to the most educated population strata, articulate their positions on the permanent issue with power shortage through the Society of Engineers. After three conferences organized in recent years, of which two were focussed on renewable energies and generated many new ideas and suggestions, the disappointing outcome is that no proposals were implemented. The Society of Engineers espouses the imperative to elaborate and enact a whole range of new laws pertaining to various aspects of energy consumption: For example, construction permits for house builders need to consider engineering instructions issued by engineer institutions on material specifications and qualities, adequate insulation techniques and the use of renewable energy sources such as solar PV and solar water heaters. Countering the many sceptics among established energy decision-makers, the Society of Engineers proposes to establish several well monitored pilot demonstration projects in solar village electrification and to draw from there appropriate conclusions for a national solar strategy.

Addressing the long list of immediate imperatives to relieving the acute power system crisis in the country is vital, but it should not detract from the importance of pursuing long-term power policy targets simultaneously, such as seriously and systematically fostering the diversification into renewable power sources, mainly utilizing the many solar technologies commercially available today. In parallel to considering supply-side options, programmes to encourage energy conservation and efficiency should be given due priority, as they can deliver immediate benefits and are consistent with longer term goals. For example, consumers should be encouraged to shift non-essential demand away from peak hours wherever possible, enabling more households to have cooling during the hottest periods of the day. This may require campaigns in order to increase consumer awareness of a) energy efficient equipment and b) the potential to reduce electricity bills.

The implementation of necessary adjustments to current highly problematic practices in the power sector, which is essential for the systemic development of the country, clearly requires strong support by the omnipresent state and its wide-reaching administrations. The many major institutions working on energy related matters in the country and their significant regional counterparts need to agree on a concerted national energy and power strategy that proceeds in stages until 2050. This national strategy must address how the country's power sector can be raised up to international standards and good practices, thereby lifting populations out of energy poverty, some would even say energy misery, and ultimately bringing the Republic of Iraq on track with global agreements on climate change mitigation.

1.4.3 Strategies with regards to employment creation in the power sector

The current difficulties in Iraq's economic situation are mainly the consequence of close to 30 years of constant crisis due to successive wars, ups-and-downs in the oil sector, not to mention more recent challenges. Rampant unemployment has led public authorities and administrations to currently employing more than 4 million persons, corresponding to about

40% of the working population. These incomes guarantee the livelihoods of millions of households and families, thus representing the most important single income source of Iraq's population. This vital support system will not change that soon, but one of its shadier sides is that a significant share of personnel are not qualified for their assigned roles. The frequent phenomenon of personnel misallocation - which leads to absences, misuse of functions, and other chronical malfunctions - is an obvious nuisance caused by nepotism and favouritism, one that was recurrently cited during interviews. This difficulty could actually be quite easily tackled and improved in a constructive manner by re-allocating strategically selected key positions at various hierarchy levels with competent and motivated younger senior people, men and women, who will attract like-minded people (usually the best of their classes). Such a meritocratic and rational approach would contribute to unleashing the kind of human and societal dynamics innovation required for effective nation and economy building policies.

While the Iraqi oil sector provides more than 65% of GDP, its contribution to national employment is small and assessed to be around 1-2%, equivalent to approximately 150,000 jobs, with the rest of employment coming from non-oil sectors. Several international power actors are active in Iraq, including ExxonMobil, British Petroleum, Lukoil, and China's National Petroleum Corporation in addition to hundreds of international and local subcontractors. These contracts typically commit International Oil Companies (IOC) to hire 80-85% of their workers locally. In the Government controlled power sector, there are plans to hire only graduate engineers, which reduces access for job seekers with lower education profiles but is to the advantage of the large numbers of unemployed young engineers in the country. Most IOC and government projects build their own power system nearby oil fields using gas turbines, resulting in limited job creation in this field as well.

More generally, interviewed institutions clearly stated that there are no official objectives or strategies available to date for significant development of employment in the field of RE and solar energy and that no activities in this direction are underway. However, if authorities and public administrations decided to jointly promote solar energy throughout the country and with real commitment, they would actually have access to a vast reservoir of inactive, unchallenged employees and collaborators. This human potential could be used to promote and advance a state-wide and comprehensive market introduction of solar energy, which would be promoting applications that have been identified as being competitive or particularly close to competitiveness in targeted segments. Furthermore, over the years the dynamic sector of neighbourhood generators has been occupying growing numbers of engineers, technicians and workers to operate the large genset and machines park in Iraq. Once solar PV starts to gain market shares from the various market segments where diesel gensets dominate today in Iraq, that personnel may be easily absorbed by solar markets, provided that it is adequately trained by a general, well prepared nationwide capacity building programme, ideally co-financed by development actors from the international community.

Finally, several interviewed institutions observed that creating job opportunities in the RE and solar energy sector obviously needs an expansion of that sector itself, so it would be able to absorb competent professionals. With more than 4 million employees in the public sector, the limits of what is feasible and affordable has long been reached. It must be considered that the state and changing governments are faced with multiple and considerable economic pressures and are also struggling at times to pay the wages of their millions of formal and informal employees. The above suggestion to re-allocate competent and motivated personnel to key positions along various hierarchy levels in the public sector would be a first positive step but does not provide a panacea to the overwhelming societal unemployment problem in the country.

2. Current situation of the solar PV sector in Iraq

This chapter provides a detailed overview on the history and current situation of solar power in Iraq. The objective is to picture the achievements and disappointments in the field in order to understand the current basis as a starting point of a new growth dynamic beginning from modest levels that can be observed since 2017/2018.

Iraq is located on the sun-belt of the planet and its potential to use solar power is therefore huge in principle: An abundant solar resource, clear skies and relatively low degrees of cloud cover make solar energy a predictable energy source with relatively low fluctuations compared to other geographies. Large arid and sparsely used land areas are available to accommodate solar fields. Sunshine hours match quite well with high day-time power demand where air-conditioning loads play an ever-increasing role as simple split AC machines have inundated markets since the war years. Furthermore, given considerable losses in centralised power transmission and distribution systems, flexibly distributed solar power solutions appear ideally suited to mitigate the severe and persistent weaknesses of public power supply.

The development of solar energy in Iraq has however lagged behind most other solar-belt countries worldwide, mainly due to its war-torn recent history and the absolute, pervasive dominance of the oil sector on a centralised and politically instable state economy. The current governance system appears to have little interest in alternative energy forms that could undermine established business interests vested in oil which provides the large majority of national income. This societal phenomenon generates monochromatic decision-making and dependencies at all levels, as well as industrial monoculture. It is also the cause of a deeply rooted inertia when it comes to introducing improved, transparent governance practices and to fostering international exchange of modern practices and technologies that are needed to further national progress.

Persistent power shortages and resulting energy poverty have become so rampant in recent years, that central and regional authorities are now compelled to effectively modernise energy and power policies, notably given rising pressures not only from the population but also from the international community, which increasingly strives for a decarbonisation of global energy systems. Next to improving the entirely carbon-based power generation and transmission infrastructures in the country, authorities must therefore also strive to diversify the national power mix. For strategic reasons, this should not be done so much by developing natural gas as an energy carrier, but rather by systematically adding renewable generation capacities, mainly solar energy. This would allow Iraq to keep pace with ever-rising global decarbonising targets and standards until 2050, when markets will strongly favour carbon-free energies and fossil energy markets will have shrunk significantly.

The development of RE power generation has been projected to reach up to 21 GW of solar and 5 GW of wind by 2030.[30] Under such premises and considering the IEA's progressive scenario for renewable power, the share of renewables in the energy mix could possibly reach up to 30% by 2030. Such ambitious predictions are however contested by numerous experts (see chapter 1.1.4.2). Furthermore, the country's approach to ambitious solar power objectives has seen muted results in recent years with many initiatives coming to nothing, including the poorly conceived feed-in-tariff regulation from 2017 that was scrapped in 2019.

Today, the reality in Iraq is that fossil-based subsidized public power is so cheap that solar power is widely denied competitiveness on the ground, making the implementation of solar

[30] The MESIA Solar outlook report 2020, Middle East Solar Industry Association

projects very difficult. Since 2018, the build-up of large centralised solar PV parks is being considered by authorities, but concrete implementation of such plans has remained inconclusive thus far. Additionally, the insufficient technical condition of existing power grids is a fundamental limiting factor to the erection of large PV parks. Before adding new generation capacities to the system, power lines must therefore be restored and overhauled, especially in northern parts of Iraq and, more generally, transmission capacities must be effectively expanded throughout the country. Given the obvious limitations posed by weak power grids, distributed solar PV is expected to grow especially amongst agricultural, residential and industrial power users who require reliable power supply at affordable and foreseeable costs.

2.1 A brief history of solar PV market introduction in Iraq

Initial activities related to the development of solar energy in Iraq started in the early 80s, as with many other countries. Several research and development as well as demonstration projects were carried out, covering PV water pumping and other small PV systems, building-integrated solar air-conditioning experiments and pilot manufacturing of solar water heater systems amongst others. This early adoption phase culminated in the establishment of Iraq's first PV module manufacturing line with a yearly production capacity of 300 kWp. Set-up in 1987 in Baghdad in cooperation with Siemens by the company Al-Mansour, it belonged to the Ministry of Industry. Around that time, the first solar housing pilot project was initiated in Baghdad's Abu Nawas area on the bank of the river Tigris where a residential complex of houses relying on solar PV power with PV modules manufactured by Al-Mansour company was built.

Unfortunately, these early solar market development activities largely stalled during the Gulf wars in the 90s and early 2000s, causing solar activities and projects to be widely abandoned. A visible resurgence of solar PV projects happened in the years 2007/2008 when more than 6,500 solar streetlights were installed in Baghdad, Basra, and other cities. This programme failed after less than one year of operation mainly because of the substandard qualities of selected and installed PV lighting components: Batteries often failed due to the extreme operating temperatures under hot ambient temperatures in Iraq and PV modules gathered dust all too quickly, resulting in low system efficiency and performance. Since the programme lacked coordination, maintenance, follow-up and documentation to assess and demonstrate the benefits of solar lighting, it could not be replicated throughout Iraq as initially intended.

The next notable PV project was initiated with the support of UNDP in 2012: At the time, the building complex developer Al Shafei marketed the use of solar power as one of the unique selling points of the Bytti Complex housing construction project, a 50 hectare, 1,300 homes 'New Town' development in the western Iraqi province of Najaf that was initially planned to accommodate a total of 5 MWp of installed PV capacity. The developer Al Shafei started by organising limited in-situ testing of various technical and equipment configurations in order to select the most appropriate components and suppliers and to simulate achievable solar power outputs under real-world conditions.[31]

By 2015 when the oil price hit a new low and the ISIS insurgency began in the North, only half of the housing complex had been built, but houses could not be sold in that crisis-torn environment. This first delayed and then ultimately halted this pilot solar home construction with the result that so far only 6 private households have been equipped with standard PV

[31] UNDP 2013

rooftop systems which are monitored in the frame of a research study. The failure of this important and ground-breaking pilot project, which had the full support of authorities and international development organisations, demonstrated the enormous challenge of introducing solar PV into Iraq. It also revealed many bureaucratic and practical impediments such as a complicated certification procedure wherein PV systems need to get approval first by the MoE and then by the Council of Ministers.

Quality requirements were set to international standards in order to avoid substandard PV equipment, but most local suppliers that proposed 1-5 kWp PV system configurations were unable to get their technical system solutions approved. This was mostly due to sub-standard component purchases from Asian manufacturers and often also a lack of competence and seriousness demonstrated by participating local suppliers. Furthermore, the multi-layered approval process apparently also increased the risk of malpractice influences. Finally, high technical requirements, over-ambitious quality certification procedures as well as administrative inertia inside the MoE congested the approval process. The testing of equipment supposed to be done through ministerial facilities was impossible because national testing laboratories were unable to perform proper quality testing protocols due to lack the operational equipment and procedural practice. Ultimately, the outcome was that a list of approved vendors and PV systems never actually materialised. Nowadays, the initial solar housing complexes are neglected by authorities and fed by power grids and local gensets just like any other residential buildings. However, the UNDP recently announced an initiative to resuscitate the project now that the country is slowly returning to normality.

In addition, during the early 2010s several initiatives centring around the usage of solar PV to pump and/or purify water emerged: The Ministry of Water Resources (MoWR) installed small solar-powered pumping units in remote areas of Iraq that delivered 6-15 litres of water per second. According to MoWR, a significant limitation revealed by the programme was the difficulty of scaling-up solar-powered water pumping to fit the large-scale pumps used in extensive agriculture on large-area irrigated land.[32] The Ministry of Construction and Housing and Municipalities and Public Works (MoCHMPW) implemented a programme numbering about 700 PV-powered water purification stations of capacities between 1-5 m^3/hour that were installed all across the nation. This initiative also proved unsustainable, with the principal challenge encountered being lack of expertise for installation, operation and maintenance of those systems. Those impediments were exacerbated by the remoteness of the locations and the resurgence of war activity so that negligence and abandonment ultimately led to system failures in most cases.

In recent years, national and regional authorities have engaged in erecting dozens of small and medium sized PV pilot systems on public buildings, such as ministries, public administrations and universities, one of the last to date being a 30 kWp PV system on the roof of the MoE's local building in Basra, built by local solar company Energy House Basra. These many smaller and mid-sized systems allow the personnel of these institutions in many cities to gather first-hand experience with PV installation, operation, maintenance and of course with the daily usage of solar power. These demonstration projects not only help to qualify and train Iraqi professionals, they also act as beacons signalling the commitment of authorities towards market introduction of quality solar systems that are designed to deliver for at least 20 years if operated adequately.

[32] UNDP 2013

The country's turbulent history since the early 90s and recurring adverse conditions have clearly interrupted, if not stalled more than once the development of solar energy, although many initiatives and new beginnings were undertaken by various engaged national and international stakeholders. Initial experiences have been made with PV applications that are of particular relevance for the country, be it in residential, agricultural and tertiary sectors. So far, most solar initiatives and activities have remained brief excursions lacking sustainable results upon which to build. The present study seeks to identify and outline how solar PV markets can finally be activated so they can become job creation engines, realising the huge employment potentials inherent to solar PV markets.

2.2 Status quo of solar PV power market development

Recent resurgence of solar politics after parliamentary elections in 2018

Recent oil price collapses in 2015/16 and again in 2020 have spelled out the real economic situation in Iraq, wherein everything revolves around public oil revenues, impacting each sector of society. This revolving situation is making the livelihoods of populations and SMEs largely dependent on this almost sole source of public income. In addition, peak demand for electric power soared from approximately 7 GW in 2004 to at least 24 GW in 2018, causing persistent shortages of public power supply for 12 hours/day on average for more than 15 years.

These cumulating pressure factors and the formation of a new government in October 2018 after parliamentary elections in May 2018 led to a revival of renewable energy politics from early 2019 onwards, when Iraq began making concrete moves towards elaborating more far-sighted solar market development policies. This relaunch and dynamic sampling of solar policy making is supported by international donors such as UNDP, GIZ and others. It has led to a range of new policy initiatives and activities that are described in the following chapters. The most notable agenda-setting political initiative was the formulation of an initial solar strategy in 2019 aiming at deploying 5 GW of utility scale solar plants as well as 5 MW of residential PV in the coming years, with the intermediate goal to cover 10% of the country's power demand with renewable energies by 2028.[33] This agenda was just updated in February 2021 to a projection of 10 GWp of installed solar power capacities covering up to 20% of public power generation by 2030, thereby adding between 500 to 1,000 MW annually. To achieve this ambitious but feasible goal, a whole range of policy instruments need be decided and deployed in the coming years. In fact, many new initiatives and pilot programmes that address some of the identified barriers have already been announced and many more are in development.

Maturity of the power market for PV: Has the time finally come?

Even though PV power has been known and experimented with since the 80s, systematic, self-driven market dynamics were not on display in Iraq until very recently. The main reason was that no adequate, systematic policies and incentives had been put in place, although the government is currently announcing a change. In addition, the war with ISIS contributed to keeping the PV market in Iraq in its infancy, evolving slowly until 2017 but then accelerating since the conflict's end in 2018, notably in the economic regions of Erbil and Baghdad.

In the areas of the KRG the market seems ready to take-off with many companies selling and individuals using PV systems, indicative of obvious signs of existing and increasing demand. People who have used diesel generators for more than 40 years and are increasingly looking

[33] The MESIA Solar Outlook Report, Middle East Solar Industry Association, 2020

for alternatives because they are tired of the noise and environmental pollution which endangers health. Yet this market acceleration is taking place without adequate regulations in place, which favours bad quality equipment, thereby discouraging potential investors and damaging the image of solar PV systems.

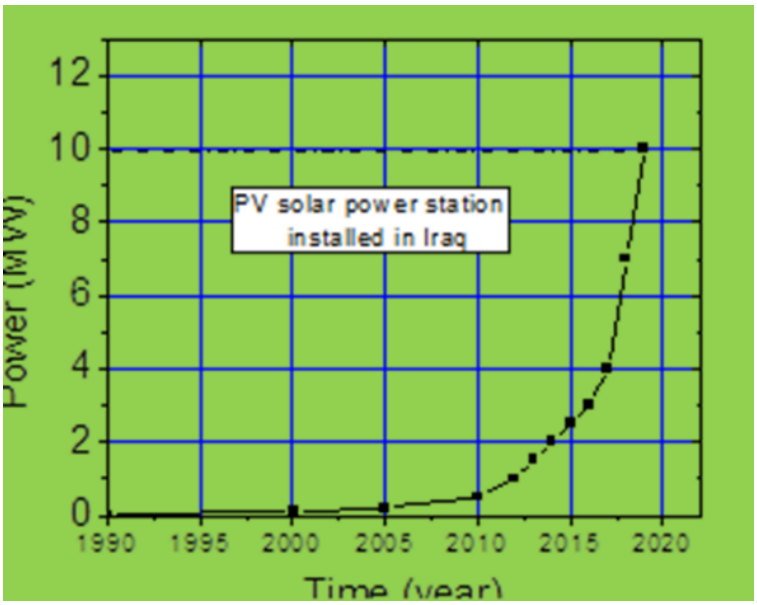
From a country-wide perspective, PV markets are still very modest and lagging far behind their inherent potentials. However, with adequate promotion policies this potential would be easily unleashed, as is being demonstrated in many countries worldwide. In Iraqi media there are more and more reports about solar PV good practice examples, notably from wealthier people. Still, the high upfront investments represent a considerable impediment for a more wide-spread adoption of PV because the majority of citizens are tight on money and are compelled to think in short-term timeframes. In this respect, the ultra-subsidised public power that is available at sensationally low cost of 1-3 USD cents/kWh has a strong discouraging effect when comparing PV power investments with public power for their short-term economics. A similar effect applies when compared to much more expensive neighbourhood power, where solar power storage equipment, able to shift solar power consumption into evening and night hours involves heavy long-term investments that people cannot bear financially. Furthermore, the exorbitant prices of neighbourhood generators also hinder populations to save money for planned investments.

In such deregulated or incorrectly regulated market environments, and given the low purchasing power and investment propension of local populations and actors, worsened by widely missing financial incentives, PV's high upfront investments compare unfavourably to current established power supply options. This situation will mostly prevail until government policies decide to set in motion a long-term oriented, strategic reformation process of the public power sector where prices are more reflective of generation, distribution and market realities; and where dormant solar power potentials can eventually be liberated from the deadlock imposed by public subsidies and neighbourhood generators. Only when this major deadlock is systematically addressed, can sounder legal, regulatory and financial policies be introduced step-by-step.

2.2.1 PV power capacities and actual markets trends influencing the PV sector

The total capacity of PV solar power stations installed in Iraq amounted to approx. 10 MWp in 2019 (Figure 15). This capacity is made of small and medium scale PV systems of which 25-30% are direct government projects, mostly on the roofs of public buildings and several larger ground-mounted plants between 100-1,000 kWp (see the list below). The other 70% or approximately 7 MWp have been built for various sectors, such as the oil industry or refugee camps, which are often owned by the state or built with support from government institutions and international donors. Furthermore, households and private investors have begun to embrace smaller PV systems, especially in the regions of Erbil and Mosul. A list of companies that supplied these PV capacities is provided in Annex 6.4.

Figure 15: Solar PV installed capacities in Iraq, cumulated, 1990 – 2019



Source: Dr. Fallah Al-Attar, Ministry of Science and Technology, Iraq, 2020

PV systems built by the Government

1. Around 600 kWp of total capacity installed (125, 75, 40, 36, 25, 24, 20 kWp and others less than 20 kWp), built by the Ministry of Science and Technology
2. 1 MWp and 250 kWp systems and others of about 100 kWp, built by the Ministry of Electricity, as well as recently, a 30 kWp system in Basra.
3. 1 MWp and 130 kWp and other small-scale systems of less than 20 kWp, built by the Ministry of Industry.
4. 30 kWp installed in Bayti Residential Complex in Najaf city in Iraq by UNDP.

Figure 16: Selection of PV systems installed on state premises from 3.5 to 250 kWp

Source: Ministry of Science and Technology, 2020

Given that government buildings and facilities are estimated to consume up to 35% of total power consumption in the country, there are also plans to drastically increase the use of solar PV on these buildings in Baghdad. But recent instabilities in the country still seem to hamper concrete implementation of such ambitions.

Small scale PV installations in residential and agricultural sectors

According to Frost & Sullivan's energy analysis, the use of rooftop PV in Iraq among home and shop owners has increased significantly within the past two years, especially in the northern area, to smoothen power outages. "Iraq presents a strong potential for deployment of off-grid and distributed solar PV solutions at a micro level. These solutions would present a valid substitute for the extensive deployment of diesel generators that are currently being used all over the country," notes Abhay Bhargava, director for industrial practice for Middle East Africa at Frost & Sullivan.[34]

The market for rooftop PV installations has been gaining pace in Iraq in recent years and all government representatives interviewed for this study agreed that the residential sector should now be tackled as of upmost priority. Announced in early 2020, the UNDP's renewed 5 MW initiative for the residential sector is designed to provide power to 3,000 low-income houses and intended to boost solar energy's appeal for private households in the future. In the Iraqi

[34] Frost & Sullivan's energy analysis

residential context, an important question is whether solar PV can become more competitive at scale and also if solar mini-grids such as those deployed in container refugee camps can complement or compete with the privately owned diesel-based neighbourhood mini-grids, especially in smaller rural or peri-urban communities. Another question is if there are sufficient well-trained professionals in PV system design, installation and O+M.

The agricultural sector also displays an obvious need for solar power and sees an increasing number of project initiatives supported by international donors that are fostering the use of solar PV pumping systems throughout the country. Such solar irrigation projects are implemented by the Food and Agriculture Organization of the United Nations (FAO) in cooperation with the Ministry of Agriculture and the Ministry of Water Resources in the governorates of Nineveh, Salah Al Din and Anbar and with financial support from Japan. Furthermore, to make such approaches accessible to more farmers the government is currently setting up a loan scheme with affordable instalments for farmers in collaboration with the Ministry of Industry and the Central Bank.

Medium scale PV installations

Solar systems of medium sizes between 50 kWp and 1 MWp are increasingly installed in refugee camps in northern governorates, where power is needed for pumping water and to provide basic amenities for up to 2 million displaced people. One of the outstanding examples is in the Mam Rashan camp in the Dohuk district of northern Iraq near the Syrian and Turkish borders, where 300 kWp supply a container camp with a population of 8,500 refugees. The system, built by the German company Autarsys, also integrates a 127 kWh energy storage system (ESS) with a 174-kVA inverter and it has the ability to prioritize the delivery of energy based on needs.[35] This system is currently being extended to a capacity of 1 MWp to supply wider parts of the refugee container camp where life begins to resemble that of a little town.

This YouTube documentary https://www.youtube.com/watch?v=guEOS_Z-Kfk provides an interesting introduction into this outstandingly useful project which is currently among the best planned and implemented PV systems in Iraq.

The Mam Rash camp admirably demonstrates how Solar PV can be put to use throughout Iraq in small communities, thereby substituting or replacing highly polluting diesel generators and also how solar power is able to generate employment. A smart demand management for the available solar power facilitates productive uses, division of labour and job creation within the community. Outside the camp, the supply, operation and maintenance of solar systems contributes firstly to establishing self-sustaining value chains with a developing economic network of small and medium sized companies thriving on PV business and secondly, improving their know-how, access to technology and the quality of PV systems installed.

Another 2 MW PV pilot project funded by the European Union is currently being developed by UNDP in the Governorate of Duhok, KRG. The project will contribute to mitigating chronic electricity shortages in the region and displaying viable alternatives to currently dominate diesel generator power.[36] More and more such projects are being announced and they are always linked to expectations for economic stimulation, private sector investments and green economy job creation. These early PV market dynamics, mainly centred in northern governorates, have led to a fledgling solar PV business network. In accordance with this early trend, it was recently suggested that the rooftop of the Erbil Chamber of Commerce also be

[35] Mam Rashan, Iraq - Renewable Energy for Refugees | Autarsys

[36] PV Magazine, Feb 2020, E. Bellini

equipped with a representative PV demonstration project to motivate private sector companies to invest into their own PV projects.

2.2.2 PV Utility scale government tenders

Already in October 2012, the Iraqi government had announced plans for 400 MWp of solar PV power plants in Iraq at a cost of $1.6 billion, inviting a range of international companies to submit proposals. Aside from the obviously high solar irradiance that Iraq receives, the main justification for such plans was that the power plants would not require fuel, which would gradually offset the initial investment cost from the government. This plan however never gained momentum, notably due to the war with ISIS in the northern territories, but Iraq revisited this unexploited potential in 2018/2019 as a result of the rapid cost reduction in solar power since 2012.[37] In late April 2019, the National Investment Commission (NIC) published details of a new round of utility scale solar power projects where the MoE invited local, regional and international Independent Power Producers (IPP) to submit Expressions of Interest (EOI) in order to embark on a reverse auctioning round for seven green field solar PV IPP projects.

The goal was to develop a total capacity of 755 MWp of utility scale PV power plants by 2020/21, located across the five provinces of Babel, Karbala and Diwaniyah (in Central Iraq), Wasit (in East Iraq) and Al-Muthanna (South Iraq). Annex 6.3 provides details on the modalities of this first solar utility scale tender round issued by the government. This tendering procedure pre-qualified 45 bidders who were not particularly reputable in the sector. The procedure was hampered by many adversities, among which the lack of experience and chronic malpractices on the side of tendering state actors, as well as the strong inhibiting influence of crisis ridden national and international contexts. In early 2020, the tender was eventually suspended due to very narrow purchase price expectations from the off-taker side. A price level of 0.035 USD/kWh for the PV power generated and delivered was assessed as impractical by IPPs. Interestingly this price level is identical to the tariff level of the FIT scheme proposal that was scraped in 2017.

The difficulty of attracting leading international companies and investors for Iraq's utility scale solar PV ambitions revealed a lack of confidence from international market actors in the stability of the country, in the government's good governance practices and the state's ability to meet financial obligations as the client of bulk solar power deliveries. This is why sovereign guarantees to mitigate economic, political, and security risks are the minimum requirement developers ask from the government to make them feel comfortable with a long-term commitment in Iraq. However, the burden of its heavily subsidised, hence deficit laden public power sector, systemically restricts the government's ability to provide financial guarantees and the country is still struggling for stability as a basis to pursue systemic and systematic nation-building. These considerable cumulative risks have so far resulted in the reluctance of international banks to finance utility-scale PV projects in Iraq.

On 22.02.2021, the Ministry of Oil (MOO) announced a relaunch of the 700 MWp solar tender as a first step towards 10 GWp renewable energy capacity by 2030. The statement said the MOO is in consultations with international firms including Total as well as "Norwegian companies" to discuss the construction of these projects. This move shows the present government's determination to materialise its solar implementation plans and is also an indication that new avenues and financing approaches are being investigated. While significant progress has been made in strengthening the IPP model, investors may still be wary of other

[37] Iraq Energy Institute 2019: Powering Up with PV

factors like bankability, weak off-taker credit worthiness, or high risks related to serious safety and security concerns; these all directly influence bidding tariffs through higher risk premiums and spreads. In line with these worries, the government confirmed the waiver of its former power purchase price expectations (3.5 USD cents/KWh) and announced the professional and fair organisation of an open, transparent reverse auction scheme.

2.2.3 General awareness and acceptance of stakeholders: Institutions, populations, companies

Given its beginnings in the 80s, mainly in the region of Baghdad, solar power is in fact not that new of a concept in Iraq. However, after the many attempt to produce solar energy which where seldom perceived as successful, the population of Iraq has a rather muted perception of solar PV power. This has kept awareness about solar PV rather low throughout the country, however the trend has been changing in favour of PV for about five years, especially in northern and central governorates and interest in solar PV is expected to grow further as more PV systems are installed and people work with the technology.

Counter-references such as the failing solar streetlights have inevitably resulted in wide-spread doubts about PV's functionality yet, a growing number of new successful project implementations demonstrate that solar PV systems simply need to be planned, built and operated carefully and that quality equipment from trusted suppliers must be used. This will remove older reservations and contribute to reversing the compromised image of solar PV in the country. This image can only be improved by demonstrating a steadily growing number of successful applications that deliver on their promises in terms of power output, quality and durability. This will ultimately contribute to positioning solar PV as a trustworthy technology of the future.

The persistent power supply crisis and exorbitant power prices from neighbourhood generators are forcing people to look for alternatives where there are few options besides PV. Consequently, people who open up to concepts of power autonomy begin to seriously consider turning to producing solar power by themselves. These necessities, as well as reports from successful PV policies in other Arab countries, not to forget sharply falling PV system prices, have contributed to generally raise the awareness and acceptance of PV. Additionally, average citizens living in densely populated urban environments where diesel generators are par for the course understand quite well the environmental advantages of PV in terms of air-quality, noise reduction, health protection and reducing visual nuisances. It is well understood that PV can improve life-quality in many respects and make dwelling environments more liveable.

PV is generally considered to be an expensive technology in Iraq, so that PV's high upfront investment remains the main obstacle to its dissemination. This is partly caused by extremely low public power tariffs which are often never paid by consuming households and other parasitic users, thereby making a significant part of the power consumption very cheap or even free of charge for low-and middle-income households. In addition, the years long troubled economic situation has impoverished large parts of the population, leaving most families with minimal purchasing power and no creditworthiness to even consider a PV system investment. However, well-informed or educated middle-class populations, among them many engineers, know that the relatively high investment costs of PV are effective in the long run because they lead to low power spending over long system lifetimes, especially if systems are well maintained. This specific knowledge regarding the attractive economics of quality PV systems needs to be rooted in wider parts of the population, including low-income households where the first pioneers are already experimenting with small power storage and incremental PV

equipment purchases. However, tight financial resources force major parts of the population to adopt short term solutions. This obviously remains the main barrier to investing into individual PV systems.

Regional perception differences towards solar PV

The interviews conducted for this study revealed significant differences in the assessment of PV between experts in Baghdad, Erbil and Basra, mirroring discrepancies of market development between northern governorates, the central Baghdad region and southern governorates, thereby revealing a north-south divide of the country not only concerning climates, cultures and socio-economic structuring but also in terms of solar power generation and utilisation.

Solar PV is presently most advanced in northern territories, on the one hand because of internationally supported refugee programmes and widespread reconstruction efforts and on the other hand due to higher occurrence of market-based activities which tend to adopt new market opportunities faster and more effectively. Solar PV has therefore penetrated deeper into the awareness of northern communities, is relatively well known and is now beginning to be taken up by early adopter circles of society, among which are commercial companies such as hotels and family businesses. Furthermore, public power tariffs are higher in KRG than the rest of Iraq so private households have a higher incentive to invest in PV, which they are increasingly doing so.

Awareness regarding the need for proper maintenance of PV panels and systems is under-developed throughout the country, which is particularly visible in the North where many PV modules in the land- and cityscape are covered with dust, while in other parts of Iraq, residential PV owners clean their PV modules everyday if they can have 4 continuous hours of electricity to run the AC machine “to get some sleep in dignity”. This divide of mentalities is caused by many factors which are rooted in significant regional differences concerning local climates and availability of water, economic welfare and living standards, not to forget deeply rooted religious, societal and tribal structures providing subsistence functions.

The difference between societies and current mentalities in the North and South were explained by an interviewed expert in the following manner: For example, in some south regions of Iraq, where power shortages and extremely high ambient temperatures are common, a household would rather invest the relatively large sum of 5,000 USD into a guaranteed solar power supply, while in Kurdish territories people are less bound by basic existential priorities and more inclined to allocate such sums for lifestyle investments like a new car or housing decoration.

In Baghdad and Basra where the influence of the central state apparatus and the oil sector is high, the approach to solar PV has been handled in more a political and administrative, and therefore abstract manner. PV is seen more as a topic of central planning policies and less of market stimulation and dynamics, as can be seen trending in Kurdish territories where PV supply value chains have been emerging for several years. So far, the most visible PV systems in daily life are those installed on government and public buildings, while residential rooftop PV systems are far from breaking through as they cannot compete with the heavily subsidized tariffs of the state’s public power supply, which is barely able to cover the basic needs of households.

Public policies, formal and informal governance structures and decision-making generally appear more conservative in central and southern regions. Additionally, the state and wide

parts of the population are inherently tied to and dependent upon the oil sector which contributes 65% to national GDP and over 90% of central government revenues. Even though all representatives and officials confirm that solar energy is “very important for the future”, a factual widespread loyalty to the current oil-based energy system exists and seems to persist because it factually provides for many people. State representatives and decision-makers generally tend to pursue business as usual, thereby inhibiting the progress of emerging industries such as solar PV, either actively by supporting the old obsolete system or passively by not taking the right measures to introduce and stimulate solar power. Finally, even if the awareness and interest of regular Iraqi people for solar energy was significantly higher, there would be little point to it if political elites and public administrations content themselves with solar patchwork and are not able to seriously plan, enact and systematically implement corresponding policies.

In Basra and more generally in southern territories, the awareness of solar energy is seen by most interviewed experts as particularly weak in the general population in comparison to central and northern regions. There are however some competent professionals in the public and private sector who are actively promoting solar energy in the region and they form the basis of coming awareness building initiatives. So far, interest and knowledge about solar PV remain constricted to the most educated strata of South Iraqi society. Besides the established oil business, economies in the South present serious structural weaknesses leading to more widespread poverty. Also, climate and environmental conditions are harsher than in the rest of the country, with ambient temperatures on the rise.

Most South Iraqi households currently do not pay for their public power consumption and therefore find it difficult to invest their limited incomes for a commodity they get for free which at least covers their basic requirements. Motivating low-income households to use PV would require incentivizing such investments financially. On the other side, cooling the ambient temperatures in homes, shops and restaurants is a luxury for which middle-class households and entrepreneurs are willing to pay high prices to neighbourhood generators today.

Unfortunately, no affordable and efficient PV solutions are available on international markets today to replace and compete with diesel generator power running simple split AC systems. This establishes a market gap and opportunity applying to Iraq as compared to most other hot, sunny countries in the world. Solar cooling and air conditioning could therefore be an interesting field for Iraqi R+D efforts in solar energy.

Summary:

Awareness for solar PV is generally being assessed to be low, but with increasing trends in favour of PV, mostly due to the chronically painful power supply situation. Awareness is a bit higher in KRG, lower in Baghdad and especially low in the Southern region..

Acceptance: Old counter-references are still in people's minds but it is known that the technology is working well if adequately implemented. Growing acceptance is triggered by health and environment issues, and also be the fact that people have suffered enough from energy poverty, being now open to consider alternative solutions. Awareness and interest to use PV technology are growing but the market needs more success stories and advocacy.

High prices still generally hinder investment decisions, because modest people are used to pay so little for the unreliable power from the public grid. At the same time, extremely high electricity bills from neighbourhood generators motivate people to look for cheaper alternatives. Affordable and efficient solar powered AC systems to cool their dwellings would make people very curious and can be considered a market gap.

Triggers for an accelerated market penetration of PV

The Iraqi PV market seems to stand on the cusp of an important growth dynamic. For such a dynamic to materialise, market framework conditions for solar energies must be significantly and systematically improved. During the experts interviews conducted, the following possible decisive market triggers have been cited as most relevant to facilitate a successful take-off and acceleration of PV markets:

1. Conducive market policies: It is high time for the government to issue solar specific legislations and regulations for a more conducive organisation of emerging solar PV markets, among which the possibility to feed power into public grids against compensation.
2. Tax incentives: Purchase costs of PV materials should be lowered by tax incentives and exemption from custom duties. This would also partly compensate for the devaluation of the Iraqi Dinar towards of the USD which makes solar equipment imports more expensive
3. Credit programmes: As most citizens have low incomes and low purchasing power, loans schemes for PV system investments customized to middle- and lower-income households are required
4. Knowhow transfer: Foreign expertise needs to be attracted to Iraq for all types of available solar PV applications. For this to happen, international partnerships and co-operations need to be developed systematically, foreign quality PV suppliers need to get involved in initial market dynamics so that local branches or joint-ventures can be quickly established to support developing national markets with international expertise.

5. Information and education: Iraqi citizens and stakeholders need to be better informed as potential investors and users about the opportunities and challenges of solar PV technology and systems.

6. Development of market niches: Selected high-potential opportunities for agricultural, residential and commercial & industrial applications to be approached systematically with efficient marketing & sales strategies

Like in any other country experiencing a solar boom, the private sector must be allowed, enabled and initially supported to develop new PV markets. This is most effectively achieved if law makers and regulators establish adequate market framework conditions, remaining conscious that public markets tend to be more subject to corruption risks than private ones, which can severely distort overall solar markets. Continuity of policies and government support is required until sound market dynamics allow the sector to prosper on growing demand.

The government's current focus on large, centralised utility scale PV projects is somewhat counter-intuitive given the power grid's obvious difficulties in integrating and transmitting additional (solar) power capacities efficiently to consumers. It would make more sense to support distributed PV generation which contributes to reduce mid and peak power loads right at the place of consumption, that is in the households themselves. Furthermore, from a job and business creation perspective, the focus on large, centralized utility scale plants and thus their preference and prioritisation over the residential sector is not plausible, as decentralised solar markets for distributed systems served by local or regional value chains generate significantly more job opportunities, which are also well distributed over the whole country.

In contrast to the multi-gigawatt deployment plans for utility scale PV, the proposed 5 MW programme for the residential sector would supply only 3,000 moderate income households and represents one tenth of a percent of overall proposed public utility scale solar programmes. At the same time, utility scale PV power is not sure to make it to the points of consumption because the power grid loses >50% of power transmitted while the nation is waiting for urgently needed power grid improvements. It is obvious that an approach to market development focussing on large, centralized PV projects in this context is not balanced: it opens doors to bad planning, mismanagement and malpractice, and could therefore lead to another solar programme failure with misallocation or even loss of financial resources. In the end, such politics do not serve the millions of 'energy poor' Iraqi citizens.

Countering this mismatch, the federal government has been working since 2019 on a solar loan programme for households eager to invest in PV (see chapter 2.5.5). In parallel, the MoE issued several tender procedures for small PV systems to be installed in governorates across the country: One tender was launched in 2019 to install 140 off-grid PV units of approximately 3 kWp in each of the 15 governorates. Totalling 6.3 MWp, this initiative, co-funded by MoE, was open to bids from the private sector and each bidding company would be allowed to work on a maximum of two governorates at the same time. The bids were open from September 2019 until November 2019 and there have been no updates on the status of advancement since this point. Yet another tender was launched in March 2020[38] to supply and install 130 rooftop PV panels on residential houses in each of six chosen provinces, thus a total of 780 systems at a cost of 7,500 USD per unit.[39] Since closing the tender in April 2020, no further updates on the status of this programme have been communicated. Unfortunately, most

[38] https://www.moelc.gov.iq/attachments/03162020121629_1.jpg

[39] Harry Istepanian, Iraq Solar energy: From Dawn to Dusk, Friedrich-Ebert-Stiftung Jordan & Iraq / Al-Bayan Center for Planning and Studies, 2020, page 14

programme announcements and tenders seem to have no concrete or timely outcome in many cases. This can generate considerable frustration with the private sector actors who invested considerable worktime into their proposals. Come and go approaches and announcements that dry up are clearly not the way to trigger the emergence of a diversified private solar sector expected to generate employment.

2.3 The supply for solar PV technologies

The current early market introduction phase which the Iraqi PV market finds itself still consists of demonstrating small and mid-sized PV systems on public buildings, in mostly agricultural solar water pumping, as well as simple residential applications, thereby preparing for wider market introduction. Growing numbers of PV installations have facilitated the emergence of an initial local solar supplier network with primary and rudimentary value chains. The continued rapid decline of PV system costs in recent years has made solar power more affordable for many types of users. This global megatrend of increasing PV competitiveness in more and more sectors will also have an impact on Iraq and could therefore soon boost those solar PV businesses that have been operating early and gathered knowhow and the ability to grow, not only in terms of volumes but also quality.

2.3.1 Available technologies and services and their prices

The supply situation of PV components and systems throughout Iraq

In principle, typical solar energy technologies such as PV-systems, solar water heaters or low consumption lighting systems are available for purchase on Iraqi markets, but most offerings are expensive, while the product quality is often low. The most developed PV offer can be found in Erbil and Baghdad. This offer differentiates into:

a) Small solar retail shops that mainly trade and sell electrical equipment among which an increasing share of PV modules, components and systems, and

b) Specialised solar companies that provide comprehensive, integrated services as a one-stop-shop for solar PV systems.

While small solar retail shops have been sprouting up in recent years in and around shopping districts and market places, most of the products and services they offer are expensive and of poor quality, imported from B- or C-level manufacturers in Asia who bet on aggressive price strategies to sell volumes and have no, or poor, after-sales services in place. This generally results in short product life-cycles, early obsolescence and expensive replacement purchases, not to forget the considerable amounts of excess electronic waste produced, notably used batteries with highly toxic content.

Solar EPC companies providing Engineering, Procurement and Construction services as a one-stop-shop are rarer. They are generally experimental solar project integrators from some demonstration projects who are able to provide quality levels matching distinct specifications. The prices offered in the market are generally high due to lack of competition and some companies take advantage of the ignorance of their customers by selling sub-standard equipment at exaggerated prices. In the Basra region, the offer is least developed with several small retail shops and only 1 or 2 experienced solar EPC companies. Quality brands are an increasingly critical factor for business success.

Given the absence of enabling market framework conditions with established quality standards and regulations in place, customers rarely have enough knowledge about basic quality requirements and have a hard time evaluating the price/quality ratios of PV products offered. There are 3 basic quality levels available on the market today as listed below in order of current market dominance, with Kurdish markets presently presenting the most differentiated offer:

a) Low and lowest quality products often stemming from Asian low-cost suppliers, which can badly harm the customer's financial interest because of short lifetimes, the environment and the solar transition in general by damaging customer confidence in solar equipment. With the establishment of national quality standards and growing customer awareness these offers will have to improve or disappear because of bad reputation.

b) Quality products that generally stem from young industrial countries such as China, Turkey or India, sometimes also offered by lower cost European brands. They will often be used in national project tenders because of their acceptable quality standards combined with attractive prices. These foreign manufacturers are often able to produce to customized specifications and to deliver products branded to the local distributors. This type of product is likely to develop most dynamically in the coming years and China and Turkey seem best positioned to grasp the coming market growth.

c) High quality products of established international brands from industrial countries such as Germany, USA, Japan or South Korea who partly have their components manufactured in the above cited younger industrial countries. These products tend to be used in projects financed by international donors or in utility scale systems where top quality/price ratios are paramount. Such product quality is not affordable nor available to average income people, and thus not very visible on the marketplace.

Installation and operation & maintenance services still present considerable improvement potential in all market segments, notably in the residential and agricultural sectors. The training requirements along product and service value chains and in all solar related businesses are considerable. First professionalisation tendencies can however be observed in the North with larger systems being implemented more frequently.

Costs of PV components and systems throughout Iraq

Small and mid-sized PV systems currently costs between 1,000 and 1,500 USD/kWp without batteries and 1,500 to 2,000 USD/kWp with batteries, depending on the selected battery quality, however huge price and quality differences can be observed on the market place. A professional and well-introduced solar EPC company based in Erbil and Basra provided the following insightful comparison on current turnkey system prices and price/quality ratios for a typical 3 kWp residential rooftop systems: High-quality and low-quality PV system are being offered to customers at quite similar costs of approximately 3,500 USD including installation.

While high quality system suppliers offer quality hardware components at costs of 3,200 USD and charge 300 USD for installation services, lower quality system suppliers offer lower quality hardware components at costs of 2,800 USD and charge 700-1,000 USD for installation services. The latter offer can lead to system prices up to 4,000 USD, although the system's overall quality and useful lifetime will be significantly lower. Well-informed, educated PV customers, who are generally the first-movers in this young market, are currently learning from serious quality and customer-oriented suppliers to make better investment decisions. A major impediment to growing PV system sales remains the high cost of power storage with batteries

that have to be replaced every 3-7 years according to the battery systems chosen. The replacement costs significantly increase the operating costs over a system lifetime of 20-25 years.

It has been remarked that PV prices for government financed projects tend to be higher than those of private projects. This may due to malpractice or other improper tendering processes and such phenomena will likely be difficult to circumvent or alter effectively given current business practices in the country.

Power tariffs and costs of established Iraqi power suppliers

Iraqi households consume significantly more power than European ones because of high cooling load requirements, especially during summer and more generally inefficient uses of power due to wasteful behaviours and inefficient appliances. All power consumers cover their basic power supply from the public grid on which billing is consumption based. Additionally, many consumers are also supplied by neighbourhood generators as a back-up or alternative solution when the public grid is down, and where the billing is load-based (in Amperes).

The comprehensive tariffication scheme for yearly consumption levels of public power in IQD and USD is presented in the following Table 2 and Figure 17. It shows tariffs progressing with incremental consumption tranches where the lowest tariff for the lowest power consumption tranche until 1,500 kWh is applicable for all consumers, which means that bigger power consumers are also subsidized in the low consumption tranches.

Table 2: MoE's public power tariffication schemes in Iraq for yearly consumption levels, in IQD and USD

Category	Monthly Consumption range in kilowatt-hour (kWh)	Tariff (IQD per-kWh)
Residential	1 - 1,500	10
	1,501 - 3,000	35
	3,001 - 4,000	80
	4,001+	120
Commercial	1 - 1,000	60
	1,001 - 2,000	80
	2,001+	120
Industrial	All	60
Governmental	All	120
Agricultural	All	60

Tariff US$ Cent per kWh	Range of consumption level
Domestic	
0.8	1-1500 kWh
2.9	1501-3000
6.7	3001-4000
10	4001 and more
Commercial	
5	1-1000
6.7	1001-2000
10	2001 and more
Industrial	
5	Flat rate
Agriculture	
5	Flat rate

Source: MoE / Al-Bayan Center for Planning and Studies[40]

The Erbil-based green building engineering consultancy KESK has a video on their Facebook page which explains in detail how PV system prices compare to public power tariffication in KRG.[41] It must be noted that the tariffication scheme in KRG is somewhat different from the MoE's scheme for the rest of Iraq, with slightly higher tariffs (see KRG's tariffication system in Annex 6.5. The bottom line of this analysis is that "PV systems cannot compete with subsidised

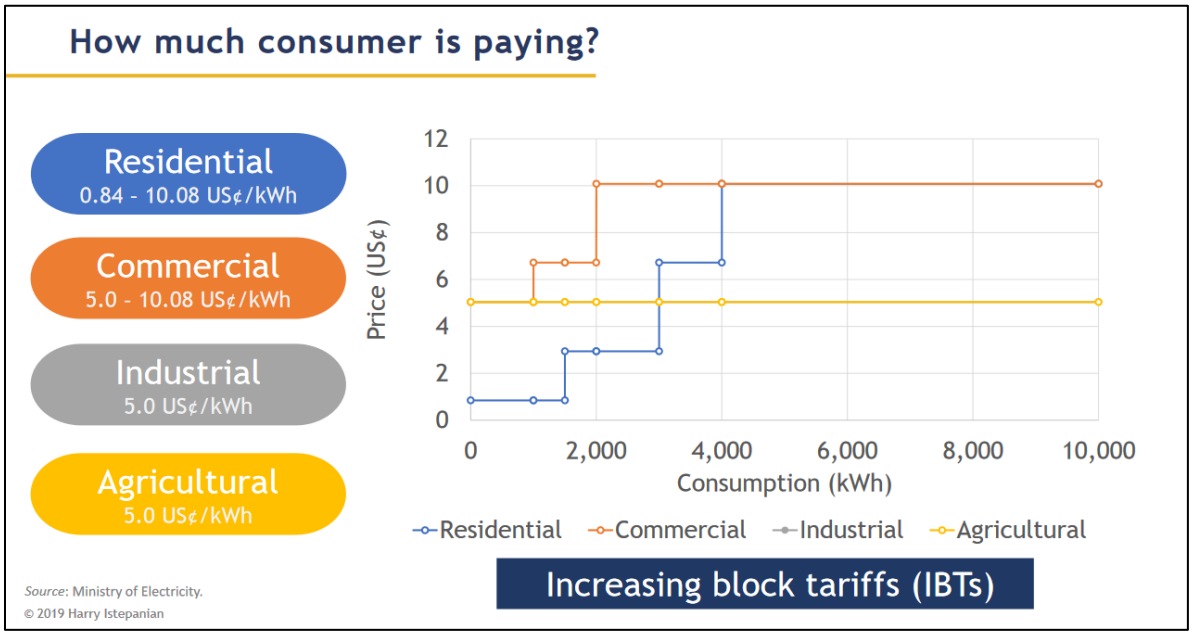
[40] Barik Schuber, "Main Policy Failures and the necessity of effective reforms of the Iraqi Power Sector", Iraqi Economists Network, August 23 (2020)
[41] See KESK's power price comparison on: https://www.facebook.com/Hussien.NiatC/videos/10217429937654239

tariffs in the national grid and are therefore considered to be extremely expensive by potential investors".

According to government representatives, neighbourhood generators sell their power for 3-6 USD per ampere/month during colder winter months and for 10-20 USD per ampere/month during hot summer months. However, Figure 18 below indicates that the average price is closer to 20 USD per ampere/month throughout the country during hotter summer months. To make the unconventional tariffication and billing method understandable to European readers, it must be noted that diesel generation fees are billed in amperes (amps) as a set level of circuit capacity that will cut off if the consumer consumes more amps than they for (the circuit capacity then returns after a few minutes).

This means that consumers pay in fact for "max amperage" subscriptions covering their maximal load requirement within 24 hours, respectively a month, while in reality, consumers might only use a fraction of that subscribed power.

Figure 17: MoE's public power tariffication schemes in Iraq for yearly consumption levels, in IQD and USD



Source: MoE / Harry Istepanian, 2019

Paying for power loads they do not require most of the time, obviously raises their power bills to levels that can be considered exorbitant. Those elevated power bills actually force households to consider methods of reducing their energy costs, which some have done, reporting that amperage can be cut by half by replacing inefficient old household appliances with more modern, energy efficient low-consumption appliances.

The box below shows an example of how PV-suppliers explain to their customers the economics of a solar PV investment compared to renting neighbourhood-lines. The method is quite unorthodox and provides a too rough an estimation, but has the merit of sounding plausible from the households' financial perspective: It suggests that the investor has to pay more in the first 3 years compared to rented neighbourhood lines, then a competitiveness break-even is reached in operation year 4, and thereafter, the PV system power gets comparatively cheaper with every operation year. Hence an interest in proper maintenance

that prolongs the longevity of components is necessary. The advantage of this simplified economic model is that it matches with the pragmatic budget thinking of households.

How solar systems are being sold to customers today by Iraqi suppliers:

1 kWp PV system: The approximate cost is 1,500-2,000 USD. This means an average hourly rate of 0.41 USD/kWh (assume 10 hours supply daily for first year).

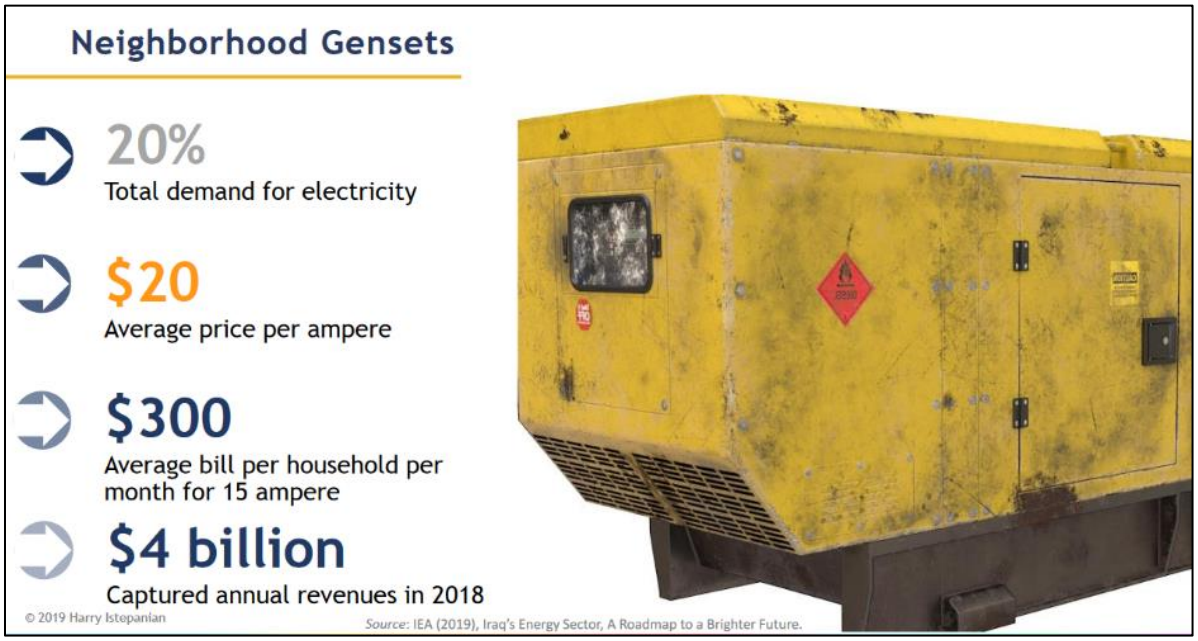
→ 1,500 / (10*365) = 0.41 USD/kWh in years 1-3
→ From year 4, approximately 0.13 USD/kWh

Diesel generator rented line: The approximate monthly costs of 1 kVA are 33$ + one-time 25$ installation costs. Power costs are approximately 0.11 $/kWh (assume10 hours supply daily for all year).

→ 33 / (10*30) = 0.11 USD/kWh
Based on the assumption that the rented capacity accounts for about 300 kWh per month (10 hours x 30 days * 1 kW (= kVA)). The 0.11 USD do only include the monthly costs of 33 USD; the mentioned one-off costs of 25 USD are not included in this calculation as their impact on monthly costs varies with the duration of the supply contract.

Chapter 3 below presents a professional, methodical comparison of the economic performance indicators of various PV systems under Iraqi conditions, notably analysing rooftop PV systems that are combined with public power and neighbourhood generator supply, as well as stand-alone configurations where PV with battery storage is combined with a privately owned fuel generator.

Figure 18: Business model data of neighbourhood generators



Source: IEA / Harry Istepanian, 2019

2.3.2 Supplier landscape: Upstream and downstream value and supply chains

Several companies have been active in solar PV in Iraq since the late 80s. In recent years, some local PV components and systems suppliers have emerged, but the number of supply side actors still remains limited with quite interesting market opportunities for dynamic pioneering companies.

Upstream solar manufacturers active in Iraq

There are no Iraqi companies today manufacturing any items for solar energy production in Iraq, which means that all PV equipment is currently imported from abroad. The only major voyage into manufacturing solar PV in Iraq was undertaken by the Al Mansour State Company, established in 1975 by the Ministry of Industry (MOI). In Baghdad in 1987, Al-Mansour inaugurated Iraq's first PV module manufacturing line with a yearly production capacity of 300 kWp in cooperation with Siemens. In 2010, the company had modernized its module manufacturing line to produce 240 Watts panels at a yearly production capacity of 3 MWp, as well as metal mounting structures for PV modules. However, lack of price competitivity, quality issues and delivery problems of their manufactured PV modules were causing loss-making operations caused by insufficient sales revenues. In 2016, a UNDP programme supplied the Al-Mansour company with state-of-the-art high quality PV modules for comparison and benchmarking purposes in order to help the manufacturing quality adjust to international state-of-the-art standards. However, the PV manufacturing activities had to be stopped eventually and the company was merged with Al Zawra State Company under the umbrella of MOI in 2018. Today, Al Zawra provides technical support to PV demonstration projects implemented on governmental and public buildings in Iraq. Active solar companies in the country state that the Al-Mansour/Al-Zawra company is contributing marginally to PV market development efforts today through donor-based research and demonstration projects but that the company is not able to perform profitably in the PV sector as a supplier.

Downstream solar suppliers active in Iraq

Prior to 2015, there just a hand full of companies active in the supply of PV systems, mainly in Erbil and Baghdad. In the past 3 years however, the private sector has been developing and the number of solar EPC-companies has increased, mostly in Erbil and Baghdad due to the implementation of various demonstration projects. In Basra, at least 3 new companies are active and new company creations are likely. This trend will spur competition on a regional level and it is a reassuring development for the expected market upswing.

Most of these companies are opting for the internationally established EPC-model where turnkey-PV systems are delivered by a 'one-stop-shop' contractor managing all processes for the client. While some companies have already gathered significant experience with project implementations of small and medium sized PV systems and are able to deliver good results, all protagonists along the supply chain refer to important training needs on all levels, that is engineering, installation, marketing and management. These recently established companies purchase their PV equipment on the world market and offer PV at reasonable price levels in the international context, bearing in mind the early stage of market development where higher price levels are considered normal as the market is still far from optimised.

Annex 6.4 provides an overview of 17 companies active in Solar PV from the North, the Central region and the South (Erbil/Dohuk, Baghdad, Basra). This list is not exhaustive because some companies may have been left out and it also does not provide homogenous information about

the companies, whether they are still presently active or where exactly they are located. Also, some company names and their factual activities are difficult to verify. It is therefore suggested to research these supply side actors more systematically in order to identify potential partners for targeted solar job creation programmes and activities, since these actors represent the basis of the expected market upswing. In the following, several of the emergent and most visible solar EPC-companies are presented that have been established in recent years and operate rather successfully.

The solar EPC company Energy House (EH) was established in Erbil in 2015 and also founded a sister company in Basra in 2018. EH has installed more than 1 MWp of PV capacity so far, among which is a 50 kWp System for an agricultural farm and 30 kWp for a government building in Basra. The company currently sells more than 100 PV systems per year in the region of Erbil-KRG and approximately 25-30 residential PV rooftops systems in Basra, where it is the local market leader. The standard offer is a 3 kWp PV system with 6 PV modules and 4 batteries for approximately 3,000 USD. Its clients are generally middle-class households, among whom are also simple worker families which shows that solar PV is currently expanding from educated early-adopter families to lower income households and thus wider parts of the population. Consequently, the focus is on quality equipment sold at moderate margins. Price disadvantages to competitors are compensated by lower charged installation costs under current marketing strategies. 80% of systems sold are complete PV systems, while the remaining 20% of systems are systems without PV modules, comprising just a battery-inverter set that is particularly adapted to low-income households. EH procures its equipment from many different international brands. The company deals with reputable PV module suppliers in China, inverter manufacturers in Taiwan, batteries from India and is able to procure some components customized to its needs and branded in its own name (OEM-partnership). This means that EH knows its local markets and has the competence to adapt offered system solutions to local conditions and requirements, a mark of competence and professionalism.

Infinity Green Energy (IGE), Erbil is another notable EPC-company active in KRG with a track record of 3 MWp of PV systems, and the corresponding experience and knowledge. The company focuses on farmers and the agricultural irrigation market segment, realising those 3 MWp mainly in Western regions and Kurdistan where electricity prices are higher than the rest of Iraq. IGE offers a larger than usual variety of different PV-panels, inverters, chargers, batteries and solar pumps, often available on stock. Having also recently realised a 100 kWp state-of-the-art PV system for a BMW dealer branch in Erbil, the company is well positioned to develop the interesting C+I potential[42] in KRG.

A remarkable start-up company in Erbil is KESK (which means “Green” in Kurdish). KESK offers green building design consulting services and solutions and wants to change the way buildings and communities are planned, constructed, maintained and operated in Iraq, utilizing green technologies. KESK says it is the first initiative established to embrace the concept of green design and construction in the country. The company was founded by female Kurdish engineer Basima Abdulrahman who personally attracted international attention in 2018 and 2019 when she was invited to speak at the World Economic Forum in Davos two years in a row. Realised or on-going projects comprise the reconstruction of the building of the Municipality in Ninawa with green technology and training the staff on green building and renewable energy. With the UNDP, KESK implemented a green building in Baghdad funded by an Iraqi businessman. The company offers PV engineering services and is also working on

[42] PV projects realised for C+I = Commercial and Industrial clients who want to substitute some of the diesel power they require to run their operations with solar PV power, thereby often using PV Diesel hybrid system applications.

a demonstration project for 30 solar air conditioning units for 12 houses. KESK's expertise and the local, national and international network it is establishing should be involved in the development of capacity building projects, training engineers on green building technologies and where solar technologies play a key role.

Most Iraqi companies active in solar PV originate from the central region in and around Baghdad and they have been realising PV projects all over the country. At least 5 companies have a project implementation experience of 1 to 3.5 MWp, which represents about two thirds of PV capacities installed in Iraq, most of which are small and midsized PV systems. We present as a typical example, the company Shomookh Ardh Al-Iraq (SAAI) based in Baghdad and Ninawa and active for over 10 years. The company has installed 3 MW of solar systems so far, consisting mainly of PV pumping systems sold to farmers. In the years 2010/2011, SAAI installed several hybrid demonstration systems combining solar, wind and batteries for the Ministry of Agriculture (MOA) which wanted to test PV systems in remote off grid desert areas. Practical problems and high costs of operating and maintaining battery banks in remote locations, as well as the frequent replacement investments for the battery banks, discouraged the MOA which eventually decided to disable those hybrid systems, especially as public grid extensions reached the test locations in the meantime. SAAI installed several mid-sized PV systems with batteries to public institutions who have so far replaced battery banks at the end of their lifetimes.

2.4 The demand for solar PV power

The demand for PV is still exceptionally low in Iraq compared to the rest of the world. Figure 15 in chapter 2.2.1 shows that the existing PV capacities of 10 MWp (cumulated) until 2019 were installed over a period of 30 years. The recent development of the market volumes is remarkable however with approx. 3 MWp added in 2018 and 2019 respectively, representing an installed capacity growth of 150% in just 3 years. This demand was widely driven by government projects, often supported by international donor projects. With emerging market dynamics, the coming demand cannot be dictated by government, but must rather be investigated with statistical and survey driven market research methods. Today there are virtually no market data available because there is no national solar industry association doing the work, neither empirical data analysing more granularly the demand for solar PV in Iraq because only a handful of professional, forward thinking suppliers are interested to get this information. As a result, this study resorted primarily to using expert interviews to gather qualitative assessments of PV market development processes and to some extent consultation of the recent yet sparse literature on the topic. Quantitative and qualitative consumers studies are the basis of systematic and focussed market development strategies that must be designed to effectively promote and stimulate nascent demand in Iraq.

There are 4 categories of PV users in Iraq today, listed below in order of their relative estimated importance as mentioned by interviewed experts and given that no market segmentation data are available today:

1. Governmental customers, among which are the MoE, the MoA and other state institutions, which provide their own buildings with PV rooftop systems and are also increasingly tendering demonstration programmes throughout the country
2. Farmers are the first private sector actors to implement PV technology, which is expanding fast in agricultural PV water pumping

3. Households are slowly discovering the PV option to increase availability of power and reduce neighbourhood generation bills
4. Commercial and Industrial (C+I) customers, such as warehouses, gas stations, shopping stores and malls, who look for PV solutions in the range of 5 kWp to several hundred kWp

The demand for solar PV is set to increase in Iraq due to its ever-increasing power supply gap (see chapter 1.2.3), increasing competitiveness of international PV prices, and unstable fossil fuel prices which have fluctuated greatly in the past 15 years. Under current power market conditions in Iraq, PV power investments are generally considered by farmers in remote off-grid areas as well as small and medium sized private power consumers for two reasons: 1) to supplement insufficient supplies by the public grid and 2) to substitute power supplies from neighbourhood generators bought at exorbitant prices.

Experts interviewed agreed that, in light of the serious limitations and disadvantages of current power solutions, many people would certainly like to own a PV system in order to improve the power supply situation of their homes, especially if high upfront investments were made more affordable and accessible, and also if supported by the state. It was also stated that customers with more ample purchasing power, such as higher income households and prospering business people who currently rely on their own diesel generators are still largely deterred by the height of initial PV investment costs compared to diesel generator investments. Here, it has to be considered that peoples' current mentality is shaped by short-term thinking, probably induced by decades of instability. Furthermore, people are generally cautious of new 'complex' products and a certain pessimism concerning long term investments in unstable, dynamic environments certainly plays a role as well.

Finally, PV components sold at world market prices, and usually financed with low interest rates loans available in or from developed countries, simply do not match with the current purchasing power of moderate and widespread low-income households in Iraq. Given the difficult overall economic situation on national and individual levels, and the perverted power politics in the country, it is not surprising that Iraqi people have not yet had a chance to participate in the PV boom unfolding in so many other countries. So far it is primarily the technologically adept, early solar adopters, innovative or high-income people with superior financial means who have opted to go for solar.

2.4.1 Power consumers categories and their purchasing power

Table 3: Capacity conversion table for Power (kW) and Amperage (A)

Power (kW)	Voltage (220 V)	Amperage (A)
1 kW to Amps:	220 V	4.55 Amps
2 kW to Amps:	220 V	9.09 Amps
4 kW to Amps:	220 V	18.18 Amps
6 kW to Amps:	220 V	27.27 Amps
9 kW to Amps:	220 V	40.91 Amps
18 kW to Amps:	220 V	81.82 Amps
27 kW to Amps:	220 V	122.73 Amps
36 kW to Amps:	220 V	163.64 Amps
45 kW to Amps:	220 V	227.27 Amps

In order to understand the relationship between PV investments and the prevailing purchasing power in Iraq, let us assume a typical Iraqi single-family house of a higher income family requiring a PV system of a capacity equivalent to 20 Amperes (or approx. 4.5 kWp) which currently cost about 6,000 USD. Table 3 converts kW capacities into Ampere

units[43], as the latter are generally used in Iraq's neighbourhood generation business. PV suppliers who are factually competing directly with expensive diesel power are confronted with this specific metric as their potential customers have been conditioned by neighbourhood generators to think along these lines.

The monthly neighbourhood generator costs corresponding to 20A or 4.5 kWp power requirements are about 250 USD, so that a PV system would amortise within just 2 years when compared to monthly neighbourhood generation bills. Middle-income households with monthly earnings of 2,000 - 3,000 USD can barely afford such elevated monthly power costs, and the high upfront PV investment costs are generally out of their reach, mainly as such households are faced with other priority investment needs besides power consumption. It goes without saying that such power costs are out of reach for low-income households.

Remuneration of Iraqi employees and purchase power of households

The purchasing power of the Iraqi population must be considered as quite low when the average yearly salary of working people in normal local economic contexts is about 6,000,000 IQD or 4,000 USD. In Nassriya, the capital of Thi-Qar governorate for example, the average monthly salary from work for consumers surveyed is 318 USD. No consumers reported having savings or saving a percentage of their income every month. Around 60% mentioned difficulty finding goods and public services, including furniture, car accessories and construction materials, and a further 73% mentioned that they travel outside of their city to purchases these goods.[44]

The salary structure across professions and careers in Iraq differs considerably from those in Europe. Based on the analysis of data available on the website Iraq | Average Salary Survey 2021 (see extracts on Table 4, and Figure 19) and interviews conducted with local experts, we have identified at least 4 major categories of salaries:

a) Highly skilled professionals employed in multinational companies, typically in the oil sector with salaries ranging between 40,000 USD and above 100,000 USD for the highest-ranking managerial positions.

b) Skilled professionals employed in the national private sector with average salaries of 52,000,000 IQD (Gross) or 43,000 USD, corresponding to the salary of an electrical engineer.

c) Skilled and unskilled professionals employed in the public sector with a typical salary is 15,600,000 IQD (Gross) or 12,500 USD. For example, system administrators and mechanical engineers, who generally have an academic education, earn an average of 15,000 and 13,000 USD respectively per year and are typical potential customers of PV systems.

d) Workers employed in local construction, manufacturing, trade, restauration, agriculture, etc. with yearly salaries of 6,000,000 IQD or 4,000 USD.

Average salaries are the highest in the region of Erbil (100% reference level), followed by Basra (92%) and Baghdad (78%). On average, women are generally earning 50% less than men. Often a household of more than 5 persons is dependent on a single income source. Due to the country's overwhelming dependency on national oil production, dropping world market

[43] https://learnmetrics.com/convert-kw-to-amps-2/

[44] Source: Labour Market Opportunities and Challenges - Nassriya District, Thi-Qar Governorate.pdf

oil prices can result in massive drops of national oil revenues. This always comes with the risk of impoverishing Iraqi people.

In general, the income level of people employed in the oil industry or working for international companies is higher as it is pitched closer to international salary levels. These employees and their families must be considered as privileged in the current Iraqi economic and social environment.

In federal Iraq, employment taxes are applied at progressive rates between 3% and up to 15% beyond a monthly salary of 1 million IQD, currently equivalent to 685 USD/month (see Source: Iraq 2020/21 - Average Salary Survey, https://www.averagesalarysurvey.com/iraq

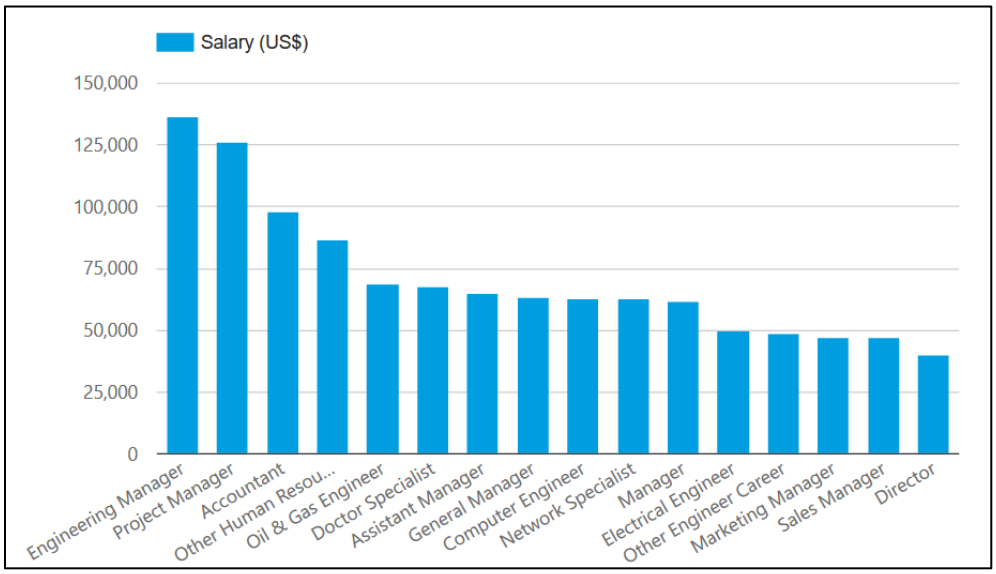
Table 5). Personal income tax is applicable for both Iraqi residents, and non-Iraqi residents who receive an income source from Iraq. Personal income tax is broadly levied on all employees' income, including basic salary and allowances which are paid in addition to basic salary. In the Kurdistan region, a 5% flat tax is imposed on employee salaries plus any allowances in excess of 30% of the basic salary.[45] Iraqi Government employees pay no revenue taxes at all.

Higher income households and farmers

Usually, 'early adopters' of solar products are highly educated middle- or high-income people or farmers who value technology and the environment. Many Iraqi households, families and farmers have enough money to invest in PV systems as the proportion of house and property owners within these groups is significant. These clients generally start with a relatively small PV system and once they are convinced of the quality and performance, they will usually invest in further modular PV capacity increments, thus starting with 1 kWp, then adding capacity increments up to 5-10 kWp. Payments for such investments are generally made in cash. Higher income households are currently drawn to PV because of their access to knowledge/information and because of their superior purchasing power. They suffer particularly from the high costs incurred from the neighbourhood diesel generator-based power supply where actual power consumption is not metered but rather invoiced as capacity payments based on Ampere subscriptions and which need to paid no matter the effective amount of kWh consumed.

[45] Source: Deloitte – International Tax Iraq Highlights 2020, April 2020

Figure 19: Current manager salaries by career path in Iraq



Source: Iraq 2020/21 - Average Salary Survey, https://www.averagesalarysurvey.com/iraq

Table 4: Salary levels and their frequency in the working population

Percentage of people	Earn this salary or more
5 %	IQD 262,405,954
12 %	IQD 122,924,050
24 %	IQD 77,246,192
57 %	IQD 28,800,381
87 %	IQD 9,055,226
94 %	IQD 3,916,150
96 %	IQD 2,166,666

Source: Iraq 2020/21 - Average Salary Survey, https://www.averagesalarysurvey.com/iraq

Table 5: Individual taxation of monthly salaries in Iraq

Individual taxation

Rates		
Individual income tax rate: Federal Iraq	**Employment income**	**Rate**
	Up to IQD 250,000	3%
	IQD 250,001–IQD 500,000	5%
	IQD 500,001–IQD 1,000,000	10%
	Over IQD 1,000,000	15%
Kurdistan Region		5% (employment income)
Capital gains tax rate		Capital gains taxed as income at individual income tax rates

Source: Deloitte, International Tax - Iraq highlights 2021

High income families should therefore be targeted first with rooftop PV systems because they can easily afford a solar power supply and may take the lead as pioneer role models, thereby spurring imitators in the broader population. This applies especially to the Kurdistan region, where awareness of solar PV power in the population is more advanced as a result of higher electricity prices. It would however be naïve to think of wealthy people as an easy to convince target group because they always have alternatives and are in less need of cost-efficient power solutions as the rest of population. This is why positive solar investment decision cannot necessarily be taken for granted among wealthy households as many may be more absorbed with consumerist lifestyles and their own businesses than with environmental and societal consideration. Also, even if exorbitant, high neighbourhood generator costs do not sufficiently hurt the household budget to encourage long term financial savings such as those provided by solar PV. Similar logics as explained above also apply to wealthy independent farmers with an entrepreneurial mindset, freedom of action and room for individual manoeuvre.

Middle income households and farmers

In middle-class neighbourhoods, many households have a family member with academic education who is employed with a basic salary of about 15,000 USD per year. Similar to higher income households, middle-income households are often sensitive to PV investments, but they definitely lack the means to finance high upfront PV investments. Their access to rooftop PV systems would be significantly improved with reasonable loan schemes or grants programmes. Credit will certainly broaden the customer base of the nascent sector of solar power companies, which would then also comprise the segment of middle-income farmer families.

When considering these customer segments, it is important to address wasteful power consumption patterns and mentalities which are primarily encountered in urban lifestyles rather than in rural ones. Energy efficient appliances and behaviour are key to mitigate the high costs of the solar power investments in the medium and long range because conscious usage of solar power has the potential to reduce energy costs significantly, thereby optimizing the solar investment.

Low income households and farmers

The Iraqi working class is the most affected by the lack of power supply. Poor neighbourhoods suffer considerably from shrinking purchasing power and rising diesel prices. Furthermore, besides the obvious advantage of providing them with very low power tariffs to cover their basic need, these low tariffs also foster energy wasting behaviours in wealthier neighbourhoods, stressing the power grid and tends to increase power cuts in poorer, less well-served neighbourhoods. This malfunction phenomenon caused by an indiscriminate, over-subsidized power tariffication model, drives inequalities that ultimately increase the energy poverty of low-income households and neighbourhoods (“Subsidies hurt the poor”).

PV investments are obviously least accessible to low-income urban households and rural farmer families, although it must be noted that the first pioneer investors are also emerging from this customer segment with minimal purchase power. Low-income customers may be oriented towards of small, low-cost off-grid PV systems in capacity ranges of 50 to 500 watts, that can provide basic power supply to household appliances during the times of the day when the public grid is usually down. These more affordable small off-grid PV systems, originating from Asian and African markets, can also be supported with micro-credits or pay-as-you-go

leasing schemes. Such market offers make basic PV solutions affordable, increase acceptance of PV as a concrete working alternative to the lack of affordable power supply, and also open the door to more substantive mid-term PV business.

Small and medium sizes enterprises (SME)

Another high potential target segment for solar PV is the C+I sector. For SME companies, solar power appears more attractive as beyond a monthly power consumption of 2,000 kWh they are charged with the highest public power tariff of 120 IKD or 0.083 USD/kWh. This implies that rising power demands make solar PV more attractive economically with acceptable amortisation periods which may be increasingly relevant for the following list of businesses and operations, out of which early adopters could emerge:

a) Commercial users: shopping centres, supermarkets, retail stores, banks, hotels and restaurants

b) Industrial users: workshops, factories, warehouses in logistics hubs and trans-shipment centres such as ports.

c) Industrial scale agricultural companies with larger water pumping requirements, workshops, warehouses and cold storage facilities

SME power users who have a load requirement of say 150 kW would have to invest up to 200,000 USD for a PV plant while a diesel generator investment would cost just 40,000 USD, no matter how high the subsequent regular fuel and O&M cost. This market segment for midsized PV system solutions is attractive because SME are generally solvent clients. It must therefore be developed with systematic industrial marketing and innovative sales approaches, involving power auditing services, economic analysis of cost/performance indicators, personal advice and B2B management sales techniques.

Large public/private infrastructure companies and public facilities

The eminent role currently played by public authorities in demonstrating PV systems on their own premises has been highlighted above, however this can only be a starting point because the need for environmentally friendly solar power in public facilities is enormous.

a) Infrastructure companies from the oil and refinery sector: cathodic protections for pipelines, staff accommodation and appliances, standalone systems in remote off-grid locations; telecommunication companies with hundreds of remote off-grid transmitter stations.

b) Schools, universities, research centres, private clinics and public hospitals as well as many other public buildings and services.

c) Solar pumping and water treatment, purification or desalination stations mainly using reverse osmosis: Public water wells powered by solar pumps are required for refugee infrastructures in northern governorates. In southern governorates many communities suffer from salinization of water resulting in scarcity of irrigation waters as well as drinking water: Such regions do not only need solar pumps, but also solar powered water treatment units which can serve large parts of local populations.

d) The national army and other military contractors are increasingly looking at powering selected remote facilities with solar PV: An application to look for are mobile solar power

plants that can be deployed at intermittent locations to power military equipment and soldier accommodation.

2.4.2 Typical PV applications with high demand potential in North/South Iraq

Grid-connected PV solutions have not been authorized so far by the government and are therefore not relevant in Iraq today. This reduces the PV market to off-grid applications for the consumer categories presented above. One of the big challenges in Iraq has been improving power transmission and distribution, with priority areas being larger towns and cities that can see high summer peak demand and subsequent social instability when power cannot be supplied. By contrast, more remote communities are more expensive to supply, but the associated governance issue of low power supply, combined with the problem of rural-urban divide, adds to social instability risk. In this regard distributed solar is a very promising idea given Iraq's challenges.[46] Distributed/decentralised PV applications are considered very relevant in Iraq as long as the troubled power supply situation persists and also beyond. The validity of decentralised approaches has been demonstrated in the Jordanian success story, with 10 MWp of PV capacity installed in Amman, facilitated through accessible bank loans and small installing companies on the ground, and it may someday be replicated in Iraqi cities, provided that authorities decide to engage into diversified, smart solar power policies.

2.4.2.1 PV systems for residential applications

Rooftop PV systems

Small rooftop PV Systems of 1-5 kWp with batteries are the most in demand for back-up usage, to stabilise loads in homes and offices and for usage after sunset. The availability of quality battery technologies with lifetimes of 5-7 years has improved recently while prices are generally declining. For average Iraqi households, a 1.5 kWp PV system with batteries costing about 1,500 USD will suffice to operate usual household appliances, but is unsuitable to operate conventional split AC systems with high load requirements of 1.5-3.5 kW; this is why lower income households often use lower consumption appliances such as air-coolers or fans.

Customers often start buying cheap PV systems and are then disappointed by the substandard quality of their equipment purchased. Quality PV suppliers therefore focus on educated middle class clients and those who already had bad experiences with low quality products; they state that it is possible to convince certain customers to buy quality at higher prices if they can be convinced that PV systems will have at least 20 years of lifetime expectancy. Clients with higher knowledge and purchase power can operate advanced power supply systems in their homes, combining a PV system for daytime supply and a diesel genset for night-time supply. Such households are therefore supplied by three power sources, that is 1) Access to national grid 2) Supply line from the genset 3) Supply line from the PV generator and evolved controller systems, managing the supply of those distinct power sources efficiently. However, such hybrid systems are currently not recommended for the residential sector by authorities because the use of diesel gensets is being discouraged due to high operating costs of gensets and high environmental pollution.

Another trend developing in the country are new residential complexes built in recovered areas with solar power supply, similar to those that have been announced by UNDP.

[46] Powering up with PV, Energy Iraq Institute 2019

Battery-only and Hybrid PV system configurations

A new practice disseminating among low-income households is to only purchase batteries, a battery charger and an inverter in order to store power during on-times of the public grid and using that stored power during grid off-times. The principle of such configuration is to fill batteries with cheap public power while available, usually during the daytime, and to shift the stored power consumption into the public grid's unstable or off-times when expensive neighbourhood power usually steps in, usually at night. The approach can help low-income households in reducing their Amps-based power bills from neighbourhood generators. For poor households who cannot afford neighbourhood generators, the configuration can reduce power supply interruptions by providing or maximizing uninterrupted power supplies. This only-battery configuration is significantly cheaper and less technical than a PV system, but it still presents a gateway to add PV equipment at a later stage. Low-income households opting for this approach also generally develop an awareness of efficient power usage and savings.

Once solar panels are added, the resulting hybrid PV system further reduces the electricity bills from neighbourhood generators as the inverter is programmed to fill the battery with solar power for use after sunset and to supply the house load with solar power during the daytime. By reducing the house loads supplied by neighbourhood generators, electricity bills can be reduced in a similar manner as in the battery-only configuration. Customers who opt for such clever options mostly develop more energy awareness and thereby significantly contribute to national welfare at their personal level. Such behaviour could very well be rewarded by public investment incentives. The solar EPC-supplier Energy House in Erbil/Basra, who is among the most innovative and professional companies in the sector, sells the two above configurations with increasing success, of which 80% are hybrid PV systems and 20% battery-only systems.

Solar AC systems

The extreme climate in Iraq, with extreme heat during summer months throughout the country and especially in the South, makes air-conditioning of homes and offices essential. Buildings are generally not insulated, and thus very transmissive for thermal loads. At the same time, commonly used split AC systems require high loads, while running inefficiently in the current uninsulated building stock. The Erbil based consultancy KESK has demonstrated a number of solar PV AC systems in individual houses in Erbil. These solar PV AC systems work only during the daytime using the sun's radiation and avoid batteries due to their high costs. The sizes of demonstrated systems varied according to cooling loads and corresponding power requirement:

- 12K BTU (1 Ton) ➔ 1.25 kW
- 18K BTU (1.5 Ton) ➔ 1.5 kW
- 24K BTU (2 Ton) ➔ 2 kW

The 1.5 Ton/1.5 kW solar PV AC system costs approx. 2,000 USD and is 4 times more expensive than a standard split AC system. A 10 kWp PV systems of 100 m² roof area provides 6 to 7 AC loads. Although this configuration cannot solve the issue with night power cuts and resultant quickly rising in-door temperatures, it can indeed contribute to cooling buildings during the daytime, especially public and private office buildings, thereby reducing pressure on power grids. Without subsidies or attractive financing modalities such systems are not affordable to most people and remain reserved to those higher-incomes that are open to new technologies.

There are however new approaches to solar-based air-conditioning, such as high-efficiency heat pumps powered by solar PV. A relevant brief overview of the state of the field, as well as the pros and cons of solar powered air conditioning has been published in July 2020 on www.greenbuildermedia.com.[47] This sector is set to develop more dynamically in the coming years because the world market potential of solar AC is overwhelming in theory. This market trend is an interesting opportunity for Iraqi actors to get involved through international cooperation. An international R+D programme with research centres, universities and international cooperation partners is imaginable and is discussed later in this study.

Solar PV mini-grids replacing diesel power in remote communities

Even though PV can quite easily be combined with existing diesel gensets, neighbourhood generators operating in towns and larger cities will generally not opt for adding PV capacities because 1) lack of useful area for mid-sized PV fields in densely populated areas and 2) the generator operators rightfully see PV as a possible disruptor of their own locally established, quasi-monopoly business model, based on scarcity and high prices.

In Iraq's urban environments, mini-grid economics are currently not competitive with the heavily subsidized power from the public grid. Solar mini-grids are however imaginable in wealthy gated communities and neighbourhoods that are able to pay for cost-reflexive tariffs. Furthermore, there must be enough space available to accommodate larger solar fields, given that PV must also cover important air conditioning demand during the day.

PV mini-grids that are hybridised with diesel generators are increasingly common in many countries and they should soon propagate in remote, less densely populated areas in Iraq, such as villages, small towns and industrial facilities, especially where grid connection remains weak or non-existent in the foreseeable future.

2.4.2.2 PV systems for commercial and industrial applications

There is an increasing variety of potential PV applications in the commercial and industrial sector (C+I) which started to be demonstrated in Germany from the early 2000s and has since been replicated in many industrialised and developing countries throughout the world. While in industrial countries, PV systems usually compete successfully against expensive, barely subsidized grid power, this competition is generally biased by heavily subsidised public power supplies in developing countries. However, where the availability, quality and continuity of public power supply cannot be guaranteed, the C+I sector is forced to look for back-up alternatives which generally consist of autonomous power production using diesel and natural gas generators. Following this logic, in the period 2009-2014, Iraq's authorities implemented a programme that doubled energy subsidies for SME in the C+I sector with the expectation that this would spur economic activity. This led SMEs to purchase many new generators in that period which are still operating today.

Meanwhile, the constantly improving economics of PV now increasingly allow it to compete with such fossil-fired generators, because the latter's high fuel costs and expensive O+M expenses adding up over the years show them to be a clearly disadvantageous and expensive solution compared to PV, especially in the medium to long range. Still, long term economic comparisons of energy solutions are not the norm as many company decision-makers and entrepreneurs are still guided by short term cost consideration and profits. This is also the case

[47] Pros and Cons of Solar-Powered Air Conditioners (greenbuildermedia.com)

in Iraq where the state's energy policies have always supported the status quo of established fossil-based power generation and continue to do so. In this situation, two financial management approaches distinguish local SMEs from larger national and international companies:

1) Larger companies generally adhere to short term profit maximisation strategies, as propagated by leading economic schools and imposed by international financial markets, which favour fossil fuel generators for their low immediate investment costs (but high operation costs over the system's lifetime).

2) Iraqi SMEs generally evolve in more local, regional or national context and are therefore more sensitive to the medium- and long-term sustainability of their financial operations, especially when they are family managed businesses. These SME are difficult to convince, especially when short to mid-term financial advantages are questionable.

The following examples of C+I-projects recently investigated by local solar EPC-companies in Iraq reflect the circumstances described above:

A few years ago, in Baghdad the company PEPSI, working 24/7, showed interest in using large solar systems, but the project was questioned because of high storage cost of battery systems. A more elaborated hybrid PV diesel system configuration was then proposed but could not convince the client because costs were not competitive with the current public grid and generator-based solution operated, despite high fuel and maintenance costs.

A small plastic pipes factory in Al-Muthana governorate was interested in using solar as an alternative to expensive diesel with monthly costs of 2,000 USD (0.5 USD/Litre). The factory works only during the day, so that operation is matched to solar radiation. A low-priced PV system without batteries was therefore offered as a cost-effective alternative, but lack of attractive financing conditions to make the upfront-investment affordable eventually postponed the investment decision.

Telecommunication is an important sector in Iraq that should theoretically be quite interested in equipping its many transmitter stations throughout the sun-rich country with solar PV, as is observed in most other developing countries on the sun-belt. The operator Asiacell for example, operates more than 700 towers in Ninawa alone which are supplied by 1,300 generators. Each Genset costs 1,000 USD/month for maintenance and security against theft. However, the vast majority of these infrastructures are operated with expensive diesel power, resulting in a tiny fraction of around 1-3% that have been equipped with solar PV. Like in many other sectors involving public/private structures, it is considered difficult to enter PV applications against established vested interests of acting decision-makers.

Banks with ATMs networks are often well suited for solar PV applications, notably PV diesel hybrid solutions because they are cost sensitive, thus interested in longer term savings and have the financial means to invest. There are many more possible client-categories and applications that would qualify for solar PV investments, as listed in the previous chapter under the C+I section. Hybrid systems that integrate the public grid and existing diesel generators with a new solar PV field and battery-based power storage facilities will probably dominate over time, in various country-specific customized configurations.

Cost-efficient hybrid system configurations require lots of know-how as well as smart, high performance system regulation strategies and equipment, that are still mostly unavailable in Iraq, rather only from foreign suppliers. Knowhow transfer is therefore required for developing Iraqi solar EPC-companies so they are able to present clients with convincing technical and

economic hybridized solar PV solutions. Additionally, the client-side technical personnel who are mostly used to operate the current rather primitive power generation solutions will need dedicated training to adjust to the enhanced requirements of such hybridised solar systems.

There have been several attempts made by Iraqi solar companies to gradually move SMEs into utilizing hybrid systems, but without clearly visible success so far. In fact, local solar companies find it hard to integrate the C+I sector because they lack the differentiated knowhow to design and engineer effective PV-diesel hybrid systems that match the clients demanding requirements. Financial arguments are also often not convincing enough to motivate solar purchase decisions on the client side. This is why SMEs operating in remote locations where PV economics are generally more competitive with diesel power should be approached with priority. The most obvious power needs covered will be lighting, ventilation and machine based mechanical production processes. It is therefore advisable to start with small, rather simple PV configurations so clients can get accustomed to PV technology before deciding for more comprehensive integration with more complex PV systems.

Even if many potential C+I customers understand quite well that solar power would help them save energy costs in the medium to long term, short-term cost analysis still dominates their decision-making processes. The typical question/objection that solar companies hear is “Why should we invest in solar if fuel prices remain subsidised?”. To answer such questions efficiently and professionally, as a precondition to making a solar deal, Iraqi solar EPC-companies still have a lot to learn in the discipline of systematic industrial marketing: Here, C+I clients need to be approached with specific selling techniques involving power auditing, initial consultancy services, proper system design and equipment dimensioning, and the proposal of customized service packages that finally combine in an attractive offer that represents obvious palpable gains to the customer.

2.4.2.3 PV systems for agricultural applications

Farmers throughout the country show high demand for solar PV solutions today, especially small and medium sized farm businesses. Indeed, agriculture is currently the sector most interested in using solar PV to overcome the high cost of diesel gensets needed for water pumping and irrigation. There are several reasons for this: according to selected water source (surface or groundwater),irrigation costs can represent 30-60% of agricultural production costs in Iraq; the public power grid often does not reach to the farms and their irrigated lands; logistic costs incurred by transporting diesel to remote locations are high; additional intermediary mark-ups can be charged to the farmer; the maintenance and repair requirements occasioned by diesel generators are generally expensive, especially in remote contexts.

Additionally, the individual situations of farmers vary widely, notably according to the size of their agricultural businesses. Many small and medium sized farmers have been particularly exposed in past decades to cumulating external risks, related to: weather and climate change; price fluctuations of diesel and other goods influenced by global markets; damages caused by military activities, social instabilities, corruption and injustice, etc. Given such challenges, high diesel generator costs present an additional financial risk, particularly in low yield years when they can consume disproportionate parts of farm revenues. Remote farming communities are generally rather poor and the lack of affordable energy can restrict farmers to grow only one crop per year because they cannot afford sufficient diesel for the irrigation requirements of a second or third crop. The negative reaction coupling of energy poverty tends to increasingly impoverish farmers.

Moreover, when generators need major repair or even full replacement, this can expose small farmers to additional severe financial stress which can lead to land loss, poverty and ruin in extreme cases. Solar PV systems on the other hand, can help farmers reduce these risks and increase their revenues because a PV system allows them to irrigate their fields throughout the whole year growing 2 or 3 crops; an insight which has been shared in the Iraqi farmer community in past years.

In the years 2010/2011, the company Shomookh Ardh Al-Iraq (SAAI) installed several hybrid demonstration systems combining solar, wind and batteries for the Ministry of Agriculture (MOA) which wanted to test PV systems in remote off-grid desert areas. Practical problems and high costs of operating and maintaining battery banks in remote locations, as well as the frequent replacement investments for the battery banks, discouraged the MOA which eventually decided to disable those hybrid systems, especially as public grid extensions reached the test locations in the meantime. However, after the end of military conflicts, the government made significant efforts to support the agricultural sector which plays a vital role in national food production and welfare. Varying ministry collaborations conducted PV demonstration projects with farmers to power irrigation systems across the country, significantly helping to establish PV in the agricultural sector. These activities however also revealed that PV systems are not yet suitable to feed the largest water pumping of bigger agricultural exploitations. More recently, loan-based financing schemes are also being established to help small and medium sized farmers finance their PV investments, mainly oriented at irrigation. With financing programmes made available to a growing number of farmers in all regions the use of PV could experience a boom in the agricultural sector, thereby fostering the development of local PV supply chains.

2.4.3 Range of productive use of energy (PUE) applications of solar products and examples of the role of PUE

A productive use of energy is one that involves the application of energy derived mainly from renewable resources to create goods and/or services either directly or indirectly for the production of income or value, generally with significant gains in productivity. In rural and peri-urban contexts in developing countries, typical productive uses can be found in agro-processing (e.g. grain milling), various manufacturing industries such as carpentry, tailoring, welding and looming, and in the service sector, e.g. in bars and restaurants that use electricity for lighting, sound systems and refrigeration, as well as for charging mobile phones.

Agriculture: Water pumping for (drip) irrigation and cattle drinking, aeration for aquacultures, refrigeration of agricultural products, electric fencing, poultry lighting (cf. Lighting Africa study), and pest control.

The main impacts of solar electricity on agricultural activities are described as increased productivity (including higher yields, lower losses and faster production) and improved natural resource management, however PV systems are not an option for energy intensive activities such as in rice mills and other agricultural processing

Cottage industries and small commerce: For cottage industries and small commercial businesses, the most common reported examples of productive use of PV are related to the prolongation of working hours due to lighting. Lighting is reported to improve also the quality of the productive activity and to attract more customers, according to the nature of the business. To a lesser extent, PV systems are also used for providing power for music and TV

in establishments such as in teahouses, as well as for powering electronic devices and tools in repair shops.

The positive impacts on cottage industries and small commerce include longer working and opening hours, higher productivity, higher attractiveness for customers, more employment, and the creation of new productive activities.

Commercial and industrial businesses (C+I): Larger businesses usually operate their own power generation equipment, mostly composed of diesel generators. The interest in PV in this sector is triggered by cost savings potentials and considerations pertaining to energy availability and security.

Social uses of electricity: education and health sectors add productive value to a region and are therefore sometimes included under productive uses as well.

➔ **Restrictions of solar PV for productive use:**

While small solar PV are appropriate for typical household applications and small-scale commercial activity, productive applications on a larger scale (e.g. machines for industrial manufacturing processes) require larger amounts of 3-phase electricity such as can be provided by a larger PV mini-grid system.

Still, there are many small-scale productive use applications requiring small loads that can be provided by small individual solar PV systems. These can seem be seen as potential "carriers of rural socio-economic development in Iraq's underdeveloped rural regions, poor urban/peri-urban dwelling zones, refugee camps that are also disadvantaged in terms of energy security, availability and price. Low power examples of PUE such as small retail and service shops, offices, internet shops and even cell phone charging have an interesting potential today in Iraq as the availability of power can be quite heterogeneous between central and remote regions.

2.5 Legal, regulatory and business framework

Iraq does not have a comprehensive and clear policy plan for renewable energy development today, although the most interesting market segments for market take-off, that is: utility scale, farmers, households and C+I, have been identified and are being more systematically promoted to by government and public action since 2018/2019.

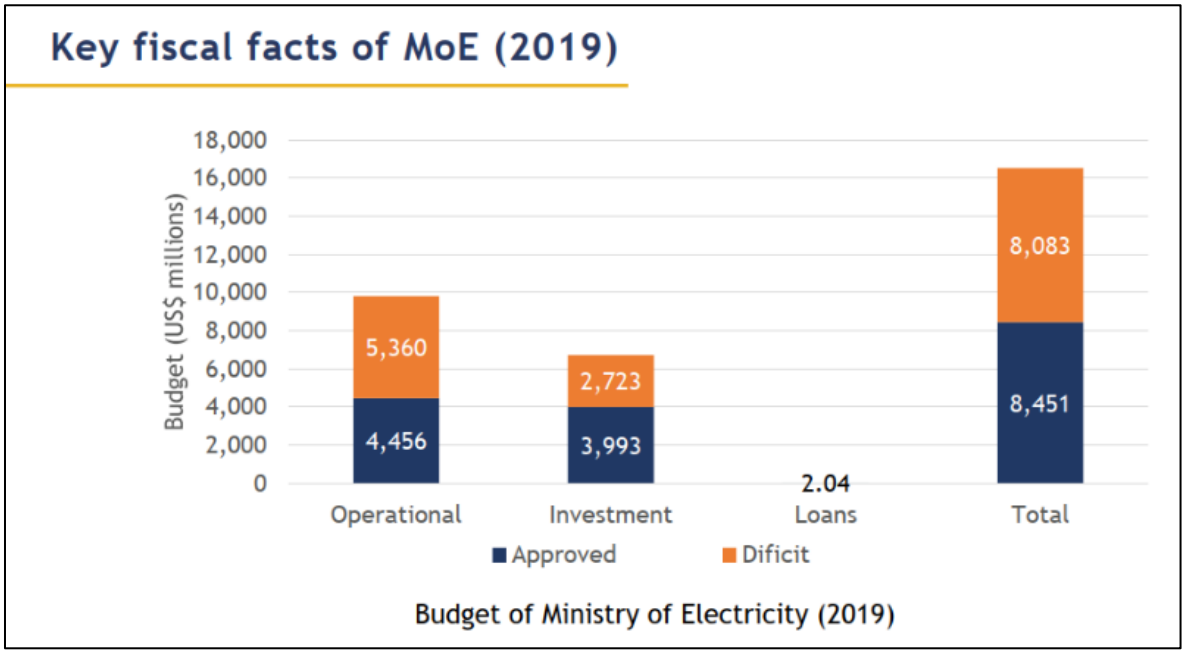
In 2013, the Integrated National Energy Strategy 2013-2030 (INES) presented a vision for Iraq's solar energy future proposing in essence to first focus market development efforts on remote off-grid applications, while utility-scale projects would be developed in the medium-to long-term. This recommendation was widely implemented, but there have been marked delays notably in the field of Solar PV rooftop market development which has been discounted by the government for many years. These are certainly due to many instabilities in the country, but they are also due to a lack of clear will by the government, of consequent allocation of required financial means as well as organisational competence and discipline.

According to Electricity Law No. (53) of 2017, the MOE is in charge of supporting and encouraging the country-wide adoption of renewable energy. The MOE established the Department of Renewable Energies and Energy Efficiency in April 2016 guided by the vision to achieve security of energy supply by increasing the share of renewable energies in the energy mix at the lowest possible cost and with the best specifications. But the progress made

in light of roughly 140,000 employees at the MOE[48] has been somewhat meagre. Many of these people seem to have been employed in past years for subsistence reasons related to the many raging crises. Figure 20 shows that nearly half of the ministry's yearly budget is neither approved not properly financed, which leads to enormous deficits of approximately 8 billion USD (2019). So far, the national power supply system, controlled by the MOE, has not been able to generate adequate revenue to sustain itself and to improve electricity services for consumers. This points to a need for organisation and management reforms.

The current high electricity subsidies, which are among the highest in the region in absolute terms (equivalent to 7.86 percent of total federal budget), dismiss any incentive for consumers to take energy saving measures or invest in alternative energy.[49] While most countries around the world are embracing grid-connected solar PV rooftops, current Iraqi legislations do not allow for net metering schemes. This backwardness is the consequence of a lack of strategy, tools and competences to lead the solar energy transition process using modern proven approaches that have been sufficiently demonstrated in many countries worldwide. It therefore became clear that the MoE needs to do more on legislation and regulation to foster its solar plans. Subsequently, the UNDP issued a tender in January 2019 as part of its 5 years programme to help the MoE catalyse the solar market take-off. The 35.1 million USD project intended to support the development of a regulatory framework, technical guidelines, capacity building and institutional arrangements that are conducive to the development of solar markets identified in high-growth segments.[50] Here some technical progress has been made in the past two years, notably with the elaboration of the first Renewable Energy Law, including a grid code, which passed the national Ministry of Electricity, gaining increasing support and is now being prepared for legislation in parliament.

Figure 20: Budget of MOE in 2019



[48] In neighbouring Kuwait which generates a similar amount of electricity, the corresponding ministry employs just 12,000 people. Cited from Harry Istepanian in his article "Iraq seeks power revamp to head off sanctions, protests" on Iraq Business News

[49] Harry Istepanian, Iraq Solar Energy: From Dawn to Dusk, July 2020

[50] https://www.pv-magazine.com/2019/01/08/iraq-takes-first-concrete-steps-into-solar, PV Magazine (8/12/2019)

Source: Ministry of Finance / Harry Istepanian, 2020

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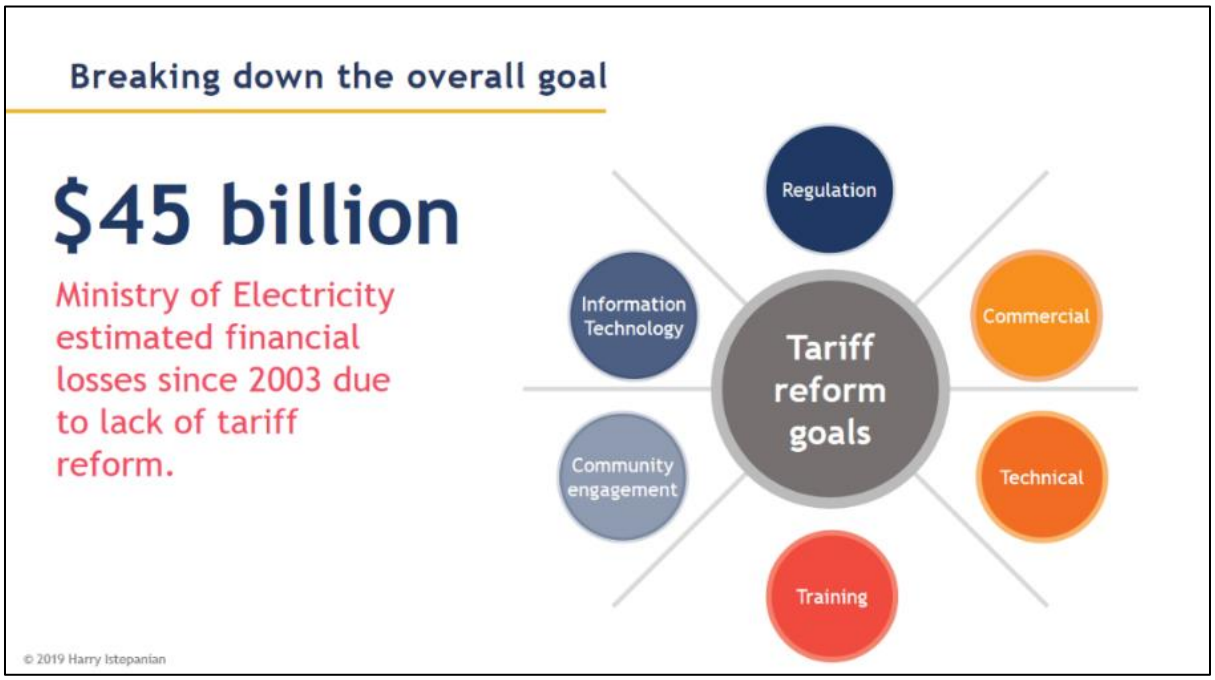
Besides comprehensive measures required to kick-start solar power in the country, the MoE needs enact intelligent, parallel reforms of electricity tariffication and restructuring the power sector as a whole if the power shortage issue is to be solved anytime in the future. As far as modest income Iraqi people are concerned, only a comprehensive public power reform with increasing power tariffs would make PV investment more attractive/competitive. This reform needs to be technically sound, economically feasible and politically supportable.

[51] Harry Istepanian, Iraq Solar Energy: From Dawn to Dusk, July 2020

[52] https://www.pv-magazine.com/2019/01/08/iraq-takes-first-concrete-steps-into-solar, PV Magazine (8/12/2019)

Figure 21: Areas of activity of comprehensive tariffication reform



Source: Harry Istepanian, 2019

A helpful overview of the 6 areas that need to be tackled by authorities and sector stakeholders is provided in Figure 21. This should ideally be done through collaborative approaches and to prepare a comprehensive electricity tariffication reform is available in a presentation by the Iraq Energy Forum,[53] where the critical areas are elaborated in more detail.

Privatisation of distribution has regularly been cited as the first step in a potential reform policy. However, caution precedes privatisation reforms. According to former Minister of Electricity, Luay al-Khatteeb, the government believes privatising the sector is akin to a “radical” reform, which might cause widespread opposition from political hardliners, or put thousands of civil servant employees out of employment in a country where unemployment levels have soared in recent weeks due to coronavirus-led lockdowns.[54] Beside reducing the enormous financial losses incurred by the perverted power supply system, which is a burden to the economic development and modernisation of the country, these reforms need to make sure that solar energy pioneers on the demand and offer sides are adequately incentivised/rewarded for their personal contribution to reducing energy poverty and thereby increasing national welfare.

Next to supporting the agricultural, residential and utility scale sectors that are currently addressed more systematically by authorities, the main cause of chronic power deficit of the demand side, namely air conditioning loads in summertime, needs to be approached more strategically. There are increasing numbers of solar solutions for air conditioning in development or available at the international scale, with opportunities for Iraq to develop a leading position in this important market in the coming years.

[53] Harry Istepanian, Iraq’s electricity tariff reform – easy brought on but hard to bring up, Iraq Energy Forum, 2019
[54] Robin Mills & Maryam Salman, Powering Iraq: Challenges facing the electricity sector in Iraq, 2020

2.5.1 PV regulations

The Renewable Energy Law in preparation

The Renewable Energy Law has been prepared with the help of the UNDP Regional Renewable Energy Centre and in coordination with the High Central Commission for Sustainable Energy in Iraq, as created by the Prime Minister's order no. 54 in 2018. It aims, among many objectives, to encourage the public and private sector to participate in developing renewable energies in Iraq. It is in the process of obtaining final edits by Iraq's Ministerial Energy Council, the highest executive energy body in the country. Given such unstable times, it is highly unlikely that the belated draft will be introduced to parliament for debate until after previously delayed elections have been carried out in 2021. Until the RE law is finalised, the MOE is the regulatory and executive authority controlling Iraq's renewable energy sector, adoption, investment and promotion. Meanwhile, there is an involvement by the Ministry of Science and Technology through its Solar Energy Research Centre as a research and development stakeholder.

Centralised utility scale PV projects

The Grid Code being developed currently is a technical standard regulation that will simplify the technical aspects of grid-connection. Renewable energy projects, if procured through project finance, are considered 'investment grade projects' entitled to facilities like accelerated governmental land allocation, state backed financial instruments (sovereign guarantees), and access to transmission and distribution infrastructure. Public and private institutions should have the right to generate renewable power on their premises for personal use, with access to the national transmission and distribution grid for allocation of power to their other premises (geographically far) or to sell to the Ministry of Electricity under a Power Purchase Agreement (PPA). For private citizens utilizing roof-top solar (above 500 W capacity), a Feed-in-Tariff (FiT) could be implemented as proposed by the law.[55]

From what is known about the draft of the RE Law, it seems to have a strong focus on centralised utility PV projects to make sure the issues resulting from the embarrassing failure of 755 MW utility scale tender in 2019 can be fixed. However, distributed PV markets which are in fact more advanced today in Iraq than the centralised utility scale market could get overrun by those big budgets and big business, as can be seen with large scale solar power strategies in other Arab countries such as Morocco and Egypt, where distributed solar PV is disadvantaged. For example, the high complexities of utility project implementation and the integration of non-dispatchable PV power into the unstable power grid infrastructure could easily cannibalise resources required to systematically deploy distributed PV.

Distributed small and medium scale PV projects

Two strategic objectives underlie the initial Integrated National Energy Strategy (INES) recommendations which are critical issues to the successful realization of a comprehensive renewable energy regulatory framework that should be at the heart of Iraq's long-term energy policy and vision for sustainable energy development:

1) The Government's vision for utilization of renewable energy in Iraq must be clearly defined and economically justified

[55] Overview of Iraq's Renewable Energy Progress in 2019, Yesar Al-Maleki, Iraq Energy Institute

2) The legal and regulatory framework must take into account Iraq's unique socio-economic, infrastructural and environmental features

The new law will hopefully enable consumers to become prosumers in utilizing their houses rooftop to install solar PV panels for their own usage and sell the excess energy to the utility companies. Such a scheme is currently far from implementation due to the lack of required infrastructure including net metering and related regulation.[56] The lack of cooperation with the private sector and citizens to promote alternative energy sources, the absence of regulations that allows the private sector and citizens to install on-grid renewable energy sources and sell excess energy to the public utility are among some of the many reasons for the failure to achieve a coherent market for renewable energy so far. The coming regulatory framework for renewable energy in Iraq should therefore also promote the development of decentralised renewable energies in achieving energy security through balanced plans, policies and funding schemes.

Distributed generation (DG), such as community solar and microgrid, has not yet been exploited but can play a vital role in the integration of renewable energy resources in Iraq. For example, the recognition of microgrids as a platform for integration of renewable energy resources is inevitable once a framework and policy for implementation is put in place with firm steps to get more benefits from distributed renewable generation. In this context, Iraq should consider the Jordanian success story where the validity of decentralised approaches has been demonstrated with 10 MWp of PV capacity installed in Amman, facilitated through accessible bank loans and small installing companies on the ground. DG can offer many economic and technical benefits associated with increased demand for electricity. The key driving factor and benefit that would accelerate the deployment of DG in Iraq at the national level (if proper incentive policies are set), includes cost savings for infrastructure due to aging and overloading of transmission line.[57] However, DG needs to be adequately designed so that the overall efficiency of the power system is increased with less total capital cost, higher installed generation, higher capacity factor on all assets, and higher reliability of the system.

The MoE should aggressively promote renewable energy through DG so that the customer's dependency on power from national grid can be reduced. Nevertheless, development of DG on the consumer side requires extensive regulatory and supportive administrative policies, along with awareness of its benefits to prosumers. A major prerequisite for the main actors of the Iraqi state economy system to enact is to allow the principle of free market economics develop DG markets, which means that the state ultimately will have to release some of its hold on solar power markets. Finally, the role that solar air conditioning could play in the future to limit the never-ending growth of daytime electricity demand peaks in summer is being underestimated or has not yet been fully understood by Iraq's major power sector stakeholders. Technical solutions are beginning to surface in international markets and they present obvious opportunities to a country suffering from extreme ambient temperatures, where huge numbers of engineers are unemployed or not working pursuant to their profession.

2.5.2 Support mechanisms

Mechanisms supporting the market development of solar PV are very rudimentary today. They are mainly based on demonstration projects oriented at public buildings and agricultural

[56] Harry Istepanian, Iraq Solar Energy: From Dawn to Dusk, July 2020

[57] Iraq has spent approximately IQD 400 billion (US$ 335 million) of the federal budget on rehabilitation and new transmission projects in 2019. Cited from Iraq Solar Energy: From Dawn to Dusk, Harry Istepanian, July 2020

irrigation. The Iraqi prime minister ordered the establishment of RE and solar energy departments in all Ministries in 2016 wherein each ministry is required to build its own PV system to build up internal theoretical and practical knowledge and competences. Next to the MoE which is progressively implementing this order on its buildings in major cities, and governorate councils in provinces required to do the same, the Ministry of Higher Education and Scientific Research has provided 30 universities countrywide with PV systems for demonstration, teaching and training purposes.

After a long demonstration phase of PV pumping systems in agricultural water pumping applications piloted by the Ministry of Agriculture and where participating farmers had up to 70% of their solar pumping investments subsidized, the agricultural sector understood that PV can be a competitive solution to diesel generators. However, the state cannot afford to subsidise PV systems for the entire sector, which is why it is currently working and experimenting with new credit schemes helping farmers to finance PV's typically high upfront investment (see chapter 2.5.5). Public subsidies for solar systems are clearly not a sustainable market development model because they are expensive und impracticable in the long run for public budgets, especially those with tight public finances. Most countries that have facilitated solar market booms that were initially based on subsidy schemes, have ultimately turned towards alternatives which involved market principles.

While most PV booms observed around the world happened on the basis of grid-connected PV systems, with support mechanisms either based on feed-in tariffs[58] or net metering,[59] Iraq has not been able to introduce such schemes because electric meters are not common in Iraqi houses and households. More generally, the option of introducing solar PV to the residential sector has been widely disregarded by authorities so far, with the consequence that regulatory work for residential PV still in its infancy. Besides investigating the approaches and methods to PV market introduction that have been implemented successfully in other countries, and developing a customized approach for Iraq, the state needs to develop a pragmatic implementation strategy to introduce power meters in steps. To avoid irrational fears that have led to protests in the population against power meters in the recent past, the use and necessity of such new infrastructures must be explained in transparent manner to power consumers. If a tariffication reform is implemented, such investments can normally be financed and recovered over time via subscription fees. However, the historic lack of metering, whose perpetuation is in the primary interest of the neighbourhood generation industry, making more than 4 billion USD per year, conspicuously shows the current deadlock in which the Iraqi power system finds itself.

International oil companies (IOCs) can play an important role in promoting renewable energy in Iraq, for example by means of an offset programme for greenhouse gasses emitted from oil & gas production and consumption. The programme would aim to offset a defined financial fraction of the oil or gas energy produced, with investments in the development of renewable energy projects that assist Iraq in meeting its high demand for electricity.[60]

[58] A feed in tariff (FiT) scheme provides a guaranteed premium price to the renewable electricity producer and put an obligation on the grid operators to purchase the generated electricity output. The price is typically guaranteed for a long period in order to encourage investment in new renewable energy sources for power generation plants.

[59] Net metering is an electricity policy which allows utility customers to offset some or all of their electricity use with self-produced electricity renewable energy source. Net metering works by utilizing a meter that is able to spin and record energy flow in both directions. The meter spins forward when a customer is drawing power from the utility grid (i.e., using more energy than they are producing) and spins backward when energy is being sent back to the grid (i.e., using less energy than they are producing).

[60] Harry Istepanian, Iraq Solar Energy: From Dawn to Dusk, July 2020

2.5.3 Industry codes & standards

The lack of quality standards and procedural norms in the field of solar PV causes a lot of poor-quality PV system solutions to be sold and installed on the ground as well as costly fraud schemes that generate unhappy customers and damage the image of PV technology and suppliers. This grave issue is so fundamental that it needs to be tackled by authorities with highest priority.

An interviewed expert based in Erbil stated that, “We do not have a law that regulates this field, and therefore there is no systematic compatibility and trust relationship between the producers or service providers and the consumers.” Quality oriented state policies would have a significant trigger effect on the development of PV markets. Another expert from Basra stated, ”The modest photovoltaic market is vaguely defined and not subject to any qualitative control. So far, quality depends on people with practical work experience or those who learned it personally.”

The PV equipment available from manufacturers from all over the world is of extreme diversity, concerning technologies and also qualities. Quite typically for unregulated young PV markets, there is a lot of low-cost, substandard equipment sold to Iraqi purchasers. This phenomenon can also be seen in Yemen, where solar market development faces several similar problems. The safe and reliable installation of PV systems and their integration with the nation’s electric grid requires timely development of the foundational codes and standards governing solar deployment. As explained earlier, legislative and regulatory mandates are currently being prepared by the government in the frame of the RE Law that will hopefully be decided and enacted in 2021. However, there is a risk that the regulation may focus too much on grid-connected large-scale utility applications, thereby neglecting the specific requirements of small and mid-scale distributed and off-grid PV systems.

It is strongly advisable that Iraqi standardization and certification institutions systematically synchronize the regulatory processes pertaining to solar PV power with international standardisation, certification bodies and expert communities. This can happen in the frame of knowhow transfer, coaching, co-operation or partnerships with foreign partners. At the national level, this work must be done in collaboration between Iraqi industries/companies active in the PV sector, relevant public institutions and academia. Provisions should be made that the respective responsibilities and duties of actors involved in the regulatory design, implementation and process are sufficiently clarified in order to avoid operational and supervisory problems resulting from conflicts of competence between multiple regulatory agencies.

Standardisation work is all the more complex as technology advances can quickly outpace the base codes and standards established. New developments, systemic requirements and business opportunities can quickly extend technical needs beyond what is mandated or explicitly addressed in existing codes and standards. The diversity and convergence of distributed generation, storage, and load control technologies require synchronization of the codes and standards that have been developed within other technology silos/lines. However, only clear regulation and well-thought-out, ideally simple support mechanisms which are implemented in effective manner, are able to cut the Gordian knot that stubbornly blocks the modernisation of Iraq’s old fashioned, inefficient power system and hinders its transition to renewables.

The performance of PV systems is seriously challenged by changing climatic and atmospheric environments in Iraq. Pervasive dust and high ambient temperatures generally have significant

impacts on the efficiency and durability of PV modules as well as other solar system components installed. These challenges may well trigger new developments, methods and procedures which ultimately lead to international standardisation requirements. In this field Iraq could develop leading international expertise, since those technological topics are of increasing international relevance with more and more PV farms being implemented in the hot and dusty regions of the sunbelt. All of the above-mentioned strongly points towards international cooperation projects which would help Iraq to quickly catch up with the global state-of-the-field and even participate in international innovation.

2.5.4 Taxation and import duties

All income arising in Iraq is taxable in Iraq. A flat rate of 15% generally applies to corporate income taxes, but a 35% rate applies to companies operating in the oil and gas sector.[61] There are no local, state, or provincial taxes on income in Iraq.[62]

Table 6 gives an overview of corporate taxation. As a semi-autonomous region in Northern Iraq, the Kurdistan region has introduced certain laws and practices that differ from the position in federal Iraq, including certain aspect of the tax regime. Free-zones exist in Iraq but are nascent. A sales tax of 300% is imposed on alcohol and tobacco/cigarettes, 15% on travel tickets, 15% on cars, and 20% on mobile charging cards and internet. Services rendered by deluxe and first-class restaurants and hotels are subject to a 10% sales tax. Furthermore, contract taxes of 3.5% are levied on every contract signed between a private company and governmental customers.

Table 6: Corporate taxation in Federal Iraq and Kurdistan region, 2020

Corporate taxation

Rates	Federal Iraq	Kurdistan Region
Corporate income tax rate	15%	15%
Branch tax rate	15%	15%
Capital gains tax rate	Capital gains taxed as income at ordinary corporate income tax rates	Capital gains taxed as income at ordinary corporate income tax rates

Source: Deloitte, International Tax - Iraq highlights 2021

In accordance with the Iraqi Investment Law, approved industrial projects are given certain tax and custom duty incentives; however, the oil & gas sector is not among those normally granted exemption incentives to promote investment. Tax incentives may include corporation tax, individual tax, and others; however, the tax incentives vary from one project to another. The Board of Investment Promotion has the authority to add any sector or specific project to the list of sectors or projects that benefit from the investment promotion law incentives.[63]

In January 2018, The Iraq General Commission of Customs (IGCC) announced the unification of the classification of goods into four main categories with applicable custom duty rates to be between 0.5% - 30%. Additionally, the IGCC announced that from January 2019, customs duty would be levied on all goods imported into Iraq, including those imported by state departments,

[61] Deloitte – International Tax Iraq Highlights 2021, January 2021
[62] https://taxsummaries.pwc.com/iraq/corporate/taxes-on-corporate-income
[63] https://taxsummaries.pwc.com/iraq/corporate/tax-credits-and-incentives

public and mixed sectors, civil organizations and private parties. In practice, the application of the customs duty has been largely inconsistent and subject to the discretion of the IGCC.[64]

According to all experts interviewed for this report, the government needs to make investments in the solar energy sector more appealing through tax incentives and customs exemptions. Customs regulation could be amended with certain privileges for solar equipment such as import duty exemptions on solar panels and other components that accompany a complete solar-PV system, including inverters, charge controllers and most importantly batteries. “Tax incentives, similar to those in Jordan, should include 100% tax exemption for ten years when investing in renewable energy construction in certain areas where socio-economic developments are needed”.[65] Solar equipment could also be granted simplified customs procedures, leading to an accelerated transit of solar equipment shipments through customs. Furthermore, given that procedures for entry visas can be prohibitively long for certain foreign experts, foreign personnel from the renewable energy sector should be granted significantly simplified and accelerated visa and immigration procedures to improve the implementation of projects and accelerate knowhow transfer towards Iraqi power sector professionals.

2.5.5 Financing conditions for PV systems

Credit schemes for SMEs and households

The banking sector in Iraq must generally be regarded as dysfunctional on traditional banking services such as lending. Banking activity in Iraq is more focused on the business of currency exchange between IQD and USD, which is where most banking revenues are currently generated. The cited Rooftop PV projects implemented on public buildings by the government sector are financed through state budgets or grants from international organisations. Loans to the private sector, that is private persons and small businesses, are very expensive with yearly interest rates of 25%. There are indications that in Baghdad and Erbil some public banks currently offer loans at 7% interest, and selected private banks offer specific loans at interests ranging at 7-9% when guarantees or collateral can be provided. Such indications could not however, be confirmed for Basra where interviewed solar suppliers stated no credit offers were available to small private investors currently looking to invest in PV systems. In this context, the owner of the solar company Energy House Basra mentioned that after having approached several banks in Basra without success, he would soon travel to Baghdad to persuade the headquarters of said banks.

Some bigger retailers offer consumption credits to their clients to promote the sale of household investments such as furniture. Such simple and straightforward loans between private entities are rather easily available to most solvent clients, but these transactions are not secured as banks are not involved. Furthermore, bigger private investments such as cars are generally financed through borrowing from family and friends. When bank loans are granted to the private sector, these are mostly for bigger exceptional or existential investments and they naturally require comprehensive guarantees or collateral. Loans for PV investments are obviously rare and thus not representative for PV systems financing in the current Iraqi economic environment. Consequently, paying for PV investments in cash is by far the most common payment method today. Also, under current economic conditions, the private business sector tends to allocate savings and reserve funds for operative business

[64] Doing business guide - Understanding Iraq’s tax position, Deloitte, 2019
[65] Iraq Solar Energy: From Dawn to Dusk, Harry Istepanian, July 2020

investments where the money is seen to have a higher marginal value, rather than to immobilise precious financial means in energy investments.

It can be concluded from the above that the overall situation of lending schemes from public and private banks is far from transparent for potential private PV investors today. What is known is that upfront costs of approximately 2,000 to 3,000 USD are quite a significant amount for most average Iraqi households and small businesses. The lack of subsidies and limited or non-existent access to debt finance makes many power consumers reluctant to invest in rooftop PV systems because they simply cannot afford them. It is therefore very likely that the availability of affordable bank loans would trigger much more purchasing of residential PV systems, thereby broadening the customer base of solar companies significantly.

This is why the government is currently working through the MoE, the Ministry of Finance and the Energy Council on affordable lending schemes with attractive and comfortable instalments to make solar investments more accessible to private power consumers.[66] On its website, the MoE informs that the definition of legal requirements, technical specifications and a lending mechanism are being elaborated with government banks. Technical surveys on solar PV roof systems and a number of PV systems on government buildings have been conducted to establish initial technical specification references, assisting banks and borrowers to assess the long-term performance and reliability of quality PV systems. The stated goal is to come up with a unified credit scheme that serves all parties.

It has recently transpired, that the Ministry of Finance and Iraq's Central Bank have finalised a mechanism of easy loans in the range of 5 to 50 million IQD (equivalent to 3,500 to 35,000 USD) that are provided by public and private banks at a maximum interest rate of 4% in case a minimum of securities can be provided. These loans will finance the capital investment and installation costs of PV roof-top systems of capacities of 3-5-10 kWp and in some cases even higher capacities, provided they are purchased from and installed by MoE accredited suppliers.[67]

This credit scheme will likely be used primarily by SMEs and middle-income households where many investors may choose to start investing in smaller PV system capacities, in line with their current financial means. Yet in the medium term, some borrowers may use credit lines to increase installed PV capacities over time through modular capacity increments. Such a trend can already be observed in KRG and is also beginning to emerge in central and southern regions. This could help building-up in steps a cost-competitive and viable alternative to diesel gensets. Furthermore, loan schemes could also be designed to foster battery usage through further lowered interest rate gratifications as a means of reducing daytime consumption peaks in the power grid.

Another way for households to finance PV investment are payslip salary retention schemes when family members are employed by larger public or private employers. However, this possibility is available only to a minority of employees and is therefore not applicable to larger parts of the populations.

Specific credit schemes for farmers

[66] The MOE states on its website that it is currently working with several local banks to facilitate easy loans for households to install rooftop solar panels https://rb.gy/jjqysn

[67] Information about this new scheme seems to have been available under the following link until recently https://www.moelc.gov.iq/uploads/attachments/info_1.pdf. However, that link is currently out of service

Although PV pumping projects often already display attractive pay-back times of ±7 years, the investment may still be inaccessible to small farmers who have impoverished due to recent long crisis years. Currently, the most well-known initiative is a cooperation between the Ministry of Agriculture and the Ministry of Industry, aiming at providing farmers with solar pumping systems. The Al-Taraib Group in Baghdad[68] recently closed an agreement with the Islamic Bank where farmers or companies in the agricultural sector can get 4 to 5 year loans for their PV investments in rural off-grid settings. The Al Taraib Group pays the invoiced deliveries directly to solar suppliers and the borrowers reimburse the bank. Instalments for these credits can be adapted to short term solvency variations of borrowers from the agricultural sector. This credit scheme is at its beginnings and thus not widely used yet.

2.5.6 Security situation and business climate

The diversity of security issues throughout Iraq

The country-wide security situation has improved significantly since the end of the conflict with ISIS, however security conditions can vary considerably between regions and locations, especially between the North, the Centre and the South. In fact, the country is divided into three major zones which each have their peculiarities concerning geography and climate, political and socio-economic environment, as well as ethnic and cultural background. Many years of economic and political crises have resulted in an unstable national situation with weakened regional economies all over the country, with the Covid pandemic contributing to further stall economic, social and political activity. The current security situation can be considered as rather stable in KRG and the Centre region around Baghdad, with some ups and downs. The region of Basra where the oil business is of existential importance for Iraq's finances can be considered as politically stable and largely unproblematic.

Still, the security risks for people and businesses across the country are multidimensional and manifold, as categorised below:

1) International war-like conflicts between neighbouring and international actors can flare up again at any time in various parts of the national territory. For example, the ISIS threat does not appear to have been fully overcome and could rise again. ISIS troops stole entire PV systems in the province of Ninewa and relocated them to their own infrastructures.

2) Sectarian and social conflicts due to Iran's influence and meddling and also due to widespread poverty can flare up in the form of public upheavals in different regions and times and for various reasons.

3) Economic and vested interest conflicts can obstruct systematic national development, especially in the electricity sector. Activities in the field of solar PV can be obstructed by established local actors. There also seem to be some cases of deliberate and purposeful vandalism on PV projects, probably by actors from the diesel generator industry who feel threatened by the rising competition from solar power generation.

4) The absence of laws and regulations and lack of enforcement thereof favours malpractice, theft, vandalism, abductions by various interest groups and militias and a variety of other threats to business activities. Development organisations implementing PV systems throughout the country have frequently experienced theft or damaging of

[68] See: https://www.facebook.com/Altaraib/

unguarded PV systems, especially in central and southern regions, which can prevent the implementation of new solar projects, especially in rural areas.

Each of these diverse security challenges requires customised approaches and solutions involving local experience and knowhow. Risk mitigation and security procedures are expensive because they involve many people and impede efficient work progress since they are time-consuming and make project implementations more difficult and complex.

Business climate for local and foreign businesses

As can be seen in Figure 22, doing business in Iraq is more difficult than in average MENA countries, and much more difficult than in average OECD countries. Practically, this means that private sector actors, be they locals or foreigners, are confronted with unusually challenging conditions when carrying out their business activities in Iraq. Projects implemented in the context of influence spheres of local, regional and national authorities can be particularly challenging because of lacking or unclear national regulations and also interferences from informal local governance structures which can have peculiar motives and interests.

In northern regions where the private sector is developing quite well, more economic pragmatism can be expected than in many other territories of Federal Iraq. Relationships between the KRG and central government can be tense at times and threaten the business climate in Kurdistan Region as the KRG budget still depends on Baghdad. Any conflict puts regional economics and business at risk, for example when payments of 800,000 government employees and pensioners are delayed or not paid by central government. The situation in southern regions where the oil industry is extremely developed is a different one, because Baghdad's oil revenues depend in turn from the region around Basra. Solar PV market development is somewhat delayed in the South because of the local dominance of the oil industry and generally rather conservative customs and mindsets compared to the capital and centre regions.

The most unproblematic and straightforward way of doing business in Iraq is in the private sector, through business-to-business approaches, as well as selling to private sector customers. National and regional market framework conditions for solar energy are not attractive or understandable enough at this point to motivate foreign solar companies and investors to get active in Iraq. However, foreign solar companies interested in establishing initial business activities in Iraq as first international movers, are advised to partner with local companies which are well-established and experienced in all necessary legislations, regulations, social acceptance, security, etc. It is in fact not advisable in most cases to establish a subsidiary in Iraq during early market entrance stages, but rather to limit remote activities to engineering, wholesale, training and supervision services provided directly to the Iraqi partner company. Concerning malpractice and compliance issues, foreign companies are best advised to adopt a non-interference stance and to leave negotiations primarily to local partners.

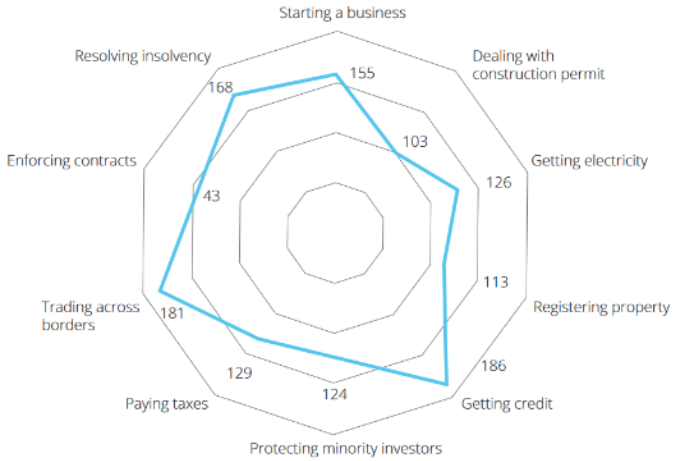
Figure 22: Doing business parameters in Iraq
Note: A total of 190 economies were considered in the comparative study for rankings.

Indicators for starting a business in Iraq

Indicators	Iraq	MENA	OECD
Procedures (number)	**8.0**	7.2	4.9
Time (days)	**26.0**	20.5	9.3
Cost (% of income per capita)	**38.8**	22.6	3.1
Paid-in min. capital (% of income per capita)	**16.6**	8.1	8.6

Source: Doing Business Report Iraq 2019, World Bank Group

Iraq's ranking on doing business parameters in 2019



Source: Deloitte, Doing business guide - Understanding Iraq's tax position, 2019

Another challenge to consider is the bureaucracy of most public bodies and the cumbersome administrative interactions with authorities concerning for instance, permissions and land acquisition. Such procedures tend to be extremely time-consuming bureaucratic routines because comprehensive negotiations and synchronisations are generally required on all administrative levels (national, governorate, local decision-making structures). All of these formal and informal procedures are best managed by local professionals.

The general attitude towards solar PV can be qualified as friendly but sceptical because of PV's long teething troubles specifically in Iraq, where people have been hearing about PV for 30 years but have not yet seen a lot of it. High-upfront costs are also considered a problem, especially in times of never-ending economic crisis. One more aspect to consider for local and foreign solar PV suppliers is that actors from the established diesel generator market may consider solar PV projects as genuine competitors, and sometimes take rather hostile stances towards solar PV. It is therefore wise to avoid head-on competition with established actors to minimise security risks. Regardless, local solar developers and actors generally know where to look for feasible projects and the market potential in the country is big enough, with several interesting market segments available for development, though regional business climates and practice can differ substantially from North to South.

2.6 Conclusions and prospects for PV and related job creation in Iraq

Iraq faces multiple challenges if it wants to harness the ample solar energy resources available on its territory. The country's dependency on international oil prices, recurring economic, political and sectarian shambles, huge public budget deficits, and ultimately the corona pandemic are making the task of tackling the electricity shortage more challenging than ever. But unless the government restructures the power sector and reforms electricity tariffication, it is unlikely that power shortages will be resolved anytime in the future.[69] Such endeavours are

[69] Iraq Solar Energy: From Dawn to Dusk, Harry Istepanian, July 2020

however deadened by intrinsic problems to the country which are its overarching state system and the inertia of its bureaucratic administration structures, caused by conflicting political interests, mismanagement, nepotism and malpractice, and resulting in their immanent resistance to change and new practices.

As if the above was not enough, local (solar) energy projects and policies have to be negotiated in a local context characterised by political power brokerage with tribal structures, vested business interests of energy monopoles in place and malpractice at many levels. Finally, the complex, multifaceted security situation has been a major driver of 'stop or go politics' and could continue to do so for some time. This convoluted situation in the power sector could thus remain a major constriction to national development that hampers industrial modernisation and welfare gains and delays the introduction of solar energy technologies. Under these circumstances and without clear conducive solar PV policies, a country-wide adoption of solar PV by the demand side supply sides will not be easy to achieve, and will be at least significantly more challenging than some traditional energy actors in Iraq seem to think. As one interviewed actor rightfully stated: "It is not useful or practical when authorities make declarations about the simplicity of adopting the PV technologies when at the same time not enough is done to create the required framework for introducing solar PV.

On the other hand, those countries which have opted for extensive diesel fuel electrification, are confronted with considerable problems and limitations inherent to diesel power generation[70]:

- Dependence on foreign fuel markets
- Increased local costs due to high costs of maintenance and repair
- Increased outages due to operations and maintenance problems
- Unreliable and unpredictable transportation of fuel
- Environmental degradation due to fuel emissions
- Cumulating health risks throughout the population that generate high eternal costs
- Retardation of the development of new power generation options (i.e. renewables)
- Retardation of the development of least-cost planning techniques and models

The strain on the population from these impacts grows every day and continuously increases discontent in the masses. As long as the public power sector remains unreformed, Iraqi populations will remain bound to the use of expensive and environmentally detrimental diesel generators. This will ultimately encourage more and more people to protest and ultimately break free from the wearing and harmful effects of diesel power generation.

The answer to strengthening the presence of solar energy in Iraq does not lie in any one solution to these challenges. Rather, a holistic approach must be employed. The government must take bold steps towards restructuring energy policy in order to increase energy security and move towards a sustainable electricity supply in the future. Primarily, policies should focus on bridging the competitive gap between solar energy and fossil fuels through measures such as transferring subsidies from fossil fuels to renewable energies, and accounting for negative and positive externalities. Furthermore, increasing the competitiveness of solar energy alone will not sufficient; issues such as poor power transmission and distribution infrastructures, financing and bankability must also be addressed.

[70] https://www.oas.org/dsd/publications/Unit/oea79e/ch09.htm, CHAPTER 5. UNIVERSAL ELECTRIFICATION POLICY (oas.org)

Financing solar energy will likely remain the major bottleneck for stimulating and encouraging solar PV project development in Iraq. Financing arrangements to support investment in solar energy must be developed at the local, national, and international level in order to encourage technology adoption. Aside from government subsidies, innovative funding programmes should be developed with investment banks and international financing institutions to support small, medium sized and large solar project investors and IPPs in the realisation of distributed and centralised solar power projects. However, government attention appears too focused on utility scale PV projects, even though the power transmission infrastructure is unable to absorb new generation capacities, be they fossil or solar. This is why authorities must make sure that framework conditions for small to medium scale PV systems are conducive, rather than forgotten or sacrificed to the state driven, generally inefficient and biased utility scale PV business. According to Cyril Widdershoven, director at Verocy, a Dutch consultancy advising on investments, energy and infrastructure risks and opportunities in the region, solar power cannot be expected to make a real difference to Iraq's energy scenario in the near term, because Iraq's capacity for change and reforms may be limited due to likely economic and social instability in the coming years.[71] He nevertheless thinks that the importance of substituting renewables for fossil fuels cannot be overstated. A PV market boom is therefore not likely to happen anytime soon because current market frameworks are still too prohibitive.

The number of barriers presented above could seem almost insurmountable. However, if clear foundations are set in the regulatory field and then also implemented with resolution, ideally with the support of established local socio-economic structures (or at worst against them), then encouraging first steps will be made. Initial focus should be placed on those high potential market segments and applications already identified. With dedicated support of these priority market segments and applications from foreign experts, knowhow and finances, there is an obvious potential for initial market dynamics to emerge. Such dynamics are clearly required to trigger the (further-) development of value chains that will be increasingly demanding for skilled labour.

The very important quality aspects related to an efficient use of PV technologies have hardly been considered by most Iraqi actors so far. They may have been omitted due to lack of available knowledge and expertise about quality equipment, installation and maintenance, as a consequence of the turbulent decades the country has experienced. However, people are learning from bad experience, and hence the quality imperative is slowly making its way into the foreground because it is increasingly understood to form the absolute basis of sustainable market growth.

[71] ARAB NEWS, January 2019

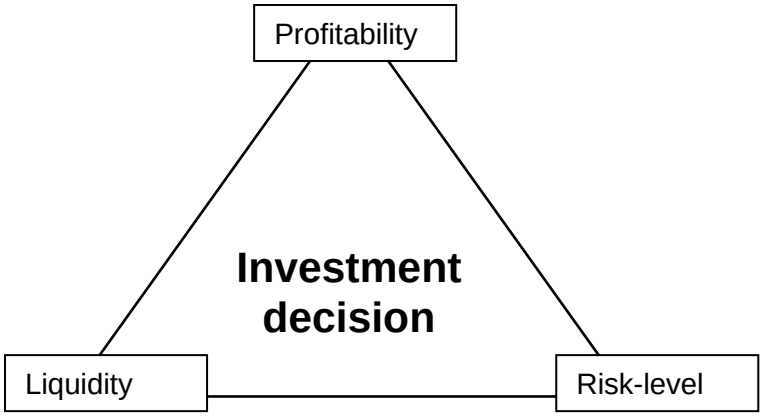
3. Economic analysis of Business Models

This section is dedicated to the profitability analysis of different Iraqi PV business models identified by local consultants. The calculations include cash-flow modelling and sensitivity analyses to assess the impact on profitability related to changes of key input parameters such as the system price, energy yield or electricity savings.

For the business case simulations, we have used solar radiation values representative for Iraq. The values used were benchmarked and compared to information from the Global Solar Atlas,[72] a tool freely provided by the World Bank and International Finance Corporation to provide easy access to data on solar resource and photovoltaic power potential. For more details with regards to the values used, please refer to section 3.2.

The analysis focuses on profitability which is a key criterion for any investment decision. However, profitability is interlinked with at least two more financial criteria that will determine whether a project will be realized or not. The other 2 criteria are (sufficient) liquidity and an acceptable risk-level.

Figure 23: Financial investment criteria triangle



Source: eclareon, 2021

Liquidity for a PV investment describes whether a potential owner has access to the funds necessary to cover the PV investment costs (CapEx). They either own the required money themself or can borrow it. The business cases assume that the funds for a PV investment are available. Whether a potential customer disposes of the funds required or whether they have access to loans may vary from case to case. Based on the interviews conducted, most commercial banks in Iraq have not yet been active in PV financing and / or the costs for the loan are usually considered too high.

The risk-level refers to the possibility to incur losses based on changes to the investment assumptions made at the beginning of the project. The assessment of risks includes the time horizon for which assumptions can be made with a reasonable degree of certainty: for the profitability analysis presented it is assumed that the input parameters known and defined for today will remain reasonably stable over time until the end of the useful life of the PV system:

[72] https://globalsolaratlas.info/map

if however, the electricity supply situation and / or electricity prices, also based on political decisions such as subsidies for specific energy generation technologies, fundamentally change in the future, the outcome of the business cases would be very different as well. If a potential investor cannot reasonably be sure that the PV system will securely produce electricity and generate savings until the end of its useful life or at least until the end of the payback period, they would likely not invest into a PV system today but wait until they can assess the situation with more certainty.

All three investment criteria are interlinked and will vary according to the individual profile, the environment, and the preferences of a potential PV investor. It also needs to be taken into consideration that not only financial criteria are considered for the purchase of a PV system but also criteria such as for example the (current and expected) reliability of electricity supply, independence from public and private power producers, the available electricity generation alternatives, or environmental criteria.

3.1 Methodology of profitability analysis

An MS Excel based discounted cash flow analysis (DCF) was used for the profitability analysis. The DCF methodology evaluates a project using the concept of the time value of money. The analysis is based on monetary values only and does not consider other positive impacts of PV such as environmental or health effects.

All future cash flows are estimated and discounted to their present values. The net present value (NPV) is the sum of all positive and negative cash flows including the initial investment. The NPV allows for the comparison of investments with different durations and cash flow profiles over their lifetime at the present point in time. Besides NPV, the internal rate of return (IRR) for both the equity and the entire project were calculated as well as the amortisation period (payback time) for the invested capital. These parameters give an indication of the attractiveness of a PV investment. Please note that we have used discounted cashflows for the calculation of the amortisation period but that we also show an undiscounted payback period in the project overview charts. These undiscounted payback periods are always shorter than the discounted payback periods because the time value of money concept is ignored, meaning that 1 monetary unit today will still be worth 1 monetary unit at any time in the future.

Another key parameter calculated is the levelised cost of electricity (LCOE) which makes it possible to compare power plants of different generation technologies and cost structures.

Ratios such as the debt service coverage ratio (DSCR) and loan life (-cycle) coverage ratio (LLCR) could provide information to creditors about whether the project cash flows suffice to reimburse the debt invested in a project. However, for Iraq these values were mostly not calculated, as debt financing is not yet common for typical customers.

3.2 Plausibility checks of technical input parameters

The financial analysis calculates operating costs and revenue streams during the useful life of the projects on an annual basis. However, given that the performance of solar energy systems varies during a year based on varying temperatures and radiation levels, some plausibility checks with regards to some PV system parameters were undertaken in order to see whether the annual averages chosen for the solar yield and the performance ratio are realistic when considering periodic variations. For these plausibility checks, primarily data and parameters

from the Global Solar Atlas were used. Moreover, the impact of seasonal variations was checked. In this section, some explanations regarding the plausibility checks are provided.

For a technical analysis, different categories of solar irradiation are normally considered. These categories include direct and diffuse irradiation, irradiation on a tilted surface, accounting for different reflection values etc. All these irradiation categories contribute to the "specific yield" (also referred to as PV output) measured in kWh/kWp), which is the maximum amount of electricity the PV system can produce. The financial calculations in this report use the mean between Global Horizontal Irradiation (GHI) and Global Tilted Irradiation (GTI) at an optimum angle as an orientation for the input values for the irradiation. A performance ratio is then applied to convert this value into the specific solar yield used for the financial analysis. The resulting values are checked for plausibility to the annual values from the Global Solar Atlas. The following table shows different categories of irradiation values and PV output values for 2 different system configurations in three Iraqi cities:

Table 7: Plausibility checks - Technical parameters based on Global Solar Atlas

	Source	Unit	Erbil	Baghdad	Basra	Averages
Global Horizontal Irradiation (GHI)	Global Solar Atlas	kWh/m^2	1,886	1,947	2,031	1,955
Global Tilted Irradiation at Optimum angle (GTI $_{opta}$)	Global Solar Atlas	kWh/m^2	2,139	2,179	2,249	2,189
Calculated average between GHI and GTI$_{opta}$	own calculation	kWh/m^2	2,013	2,063	2,140	2,072
Average annual PV output of a 1 kWp residential system	Global Solar Atlas	kWh/ kWp	1,599	1,603	1,653	1,618
Average annual PV output of a 1 kWp commercial system	Global Solar Atlas	kWh/ kWp	1,602	1,613	1,660	1,625
Calculated PR ratios	**Own calculation**	**x**	**0.83**	**0.81**	**0.80**	**0.81**

Source: Values from the Global Solar Atlas. eclareon. 2021

As can be seen, the calculated average irradiation between GHI and GTI$_{opta}$ varies between 2,013 and 2,140 kWh/m^2 with an average value of 2,072 kWh/m^2. Solar output varies between 1,599 kWh/m2 for a residential system in Erbil to 1,660 kWh/kWp for a commercial system in Basra, where we find the best natural conditions for solar PV among the three cities. However, it needs to be considered that in real life these values differ for every system as different technical equipment, the quality of installation, the location and other criteria have an influence on these values. A well installed quality PV system in an area with less irradiation can produce more electricity than a low-quality system in a region with more irradiation. For matters of comparability and given that differences between different locations are relatively small, an irradiation value 2,000 kWh/m^2/a and a performance ratio (PR) of 0.8 were used for the financial analyses in this report. The resulting solar yield is 1,600 kWh/kWp/a for all business case calculations. The impact of different solar yields is shown in a sensitivity analysis for each business case.

In order to check whether a PR of 0.8 is realistic and can be achieved on a yearly average, additional checks were performed. The difference between 1 and the performance ratio, in the

case of this financial analysis 0.2, summarises the losses that the conversion of solar irradiation to useable electrical energy output entails. There are different loss types that can be incurred and the magnitude of these losses also depends on a variety of factors such as location, service level, components used etc. The loss related plausibility checks for the financial analyses of this report take into account two loss categories: the first category are losses that incur independently from the (cell) temperature, the second are losses incurred based on (high) cell temperatures. The basis of the plausibility checks for both categories were the losses for a residential solar system as disclosed in the Global Solar Atlas which are the following:

Table 8: Plausibility checks - System losses before temperature losses

#	Type of loss	Unit	Small residential
1	Losses due to terrain shading	%	1.00%
2	Losses due to angular reflectivity	%	2.50%
3	Losses due to PV modules outside STC conditions	%	1.00%
4	Losses due to external shading	%	1.00%
5	Losses due to dirt and soiling	%	4.50%
6	DC Cabling losses	%	1.00%
7	Mismatch losses	%	0.80%
8	Losses in inverter	%	4.10%
9	Transformer losses	%	0.00%
10	AC cabling losses	%	0.20%
11	Availability (downtime losses)	%	3.00%
	Overall losses BEFORE temperature losses		**17.63%**

Source: Values 1-4 selected by eclareon, values 5-11 default values from the Global Solar Atlas, Technical report

In total, 17.63% of losses need to be accounted for based on this calculation. Please note: these values are, in accordance with the methodology of the Atlas, not simply added up, but the total loss is calculated as follows:

Total loss = 100 - 100 * (1-1/100)*(1-2.5/100)*(1-1/100).....*(1-3.0/100) = 17.63%

These losses are deemed to be relatively stable over the year. However, a greater concern for a country like Iraq with very high peak temperatures are the temperature induced losses. It is known that the performance ratio of a PV module goes down with higher solar cell temperatures. In order to investigate the temperature induced losses, the base values from the Global Solar Atlas were applied: The module used is a generic high efficiency silicon module. The Nominal Operating Cell Temperature (NOCT) of this module for a residential system was 51.2°C with a temperature coefficient for the maximum power of -0.43%/°C. In addition, the monthly average high temperatures for the city of Bagdad[73] were used in order to estimate solar cell temperatures (Tcell) based on[74]

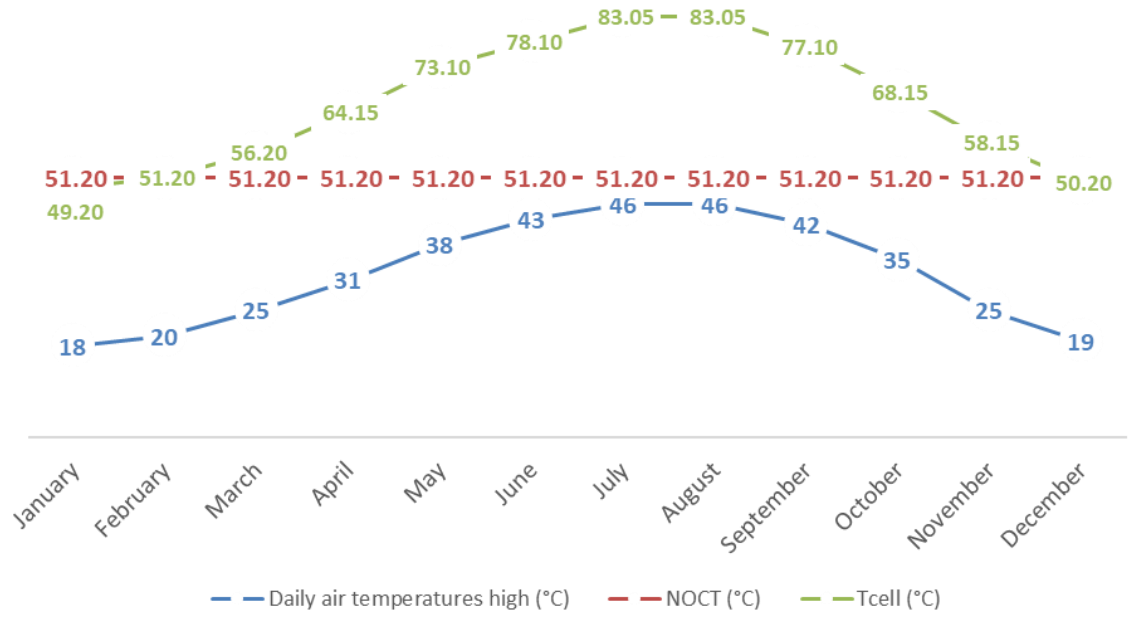
[73] https://www.worldweatheronline.com/lang/de/baghdad-weather-averages/baghdad/iq.aspx
[74] https://www.pveducation.org/pvcdrom/modules-and-arrays/nominal-operating-cell-temperature

$$T_{Cell} = T_{Air} + \frac{NOCT - 20}{80} S$$

with T_{Air} = Air temperature, NOCT Nominal Operating Cell Temperature and S = insolation in mW/cm^2

The following graph gives an overview of the temperatures used for the estimation of temperature induced losses:

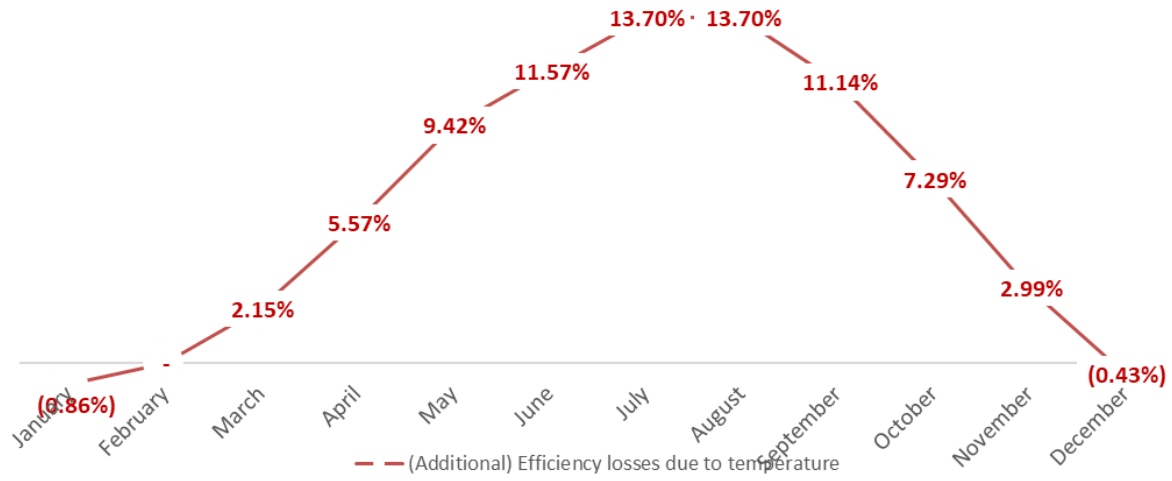
Figure 24: Temperatures used for technical plausibility checks



Source: eclareon, own calculations, based on Global Solar Atlas and worldweatheronline (Bagdad)

Based on these values, the following monthly losses based on temperature variations to NOCT were found:

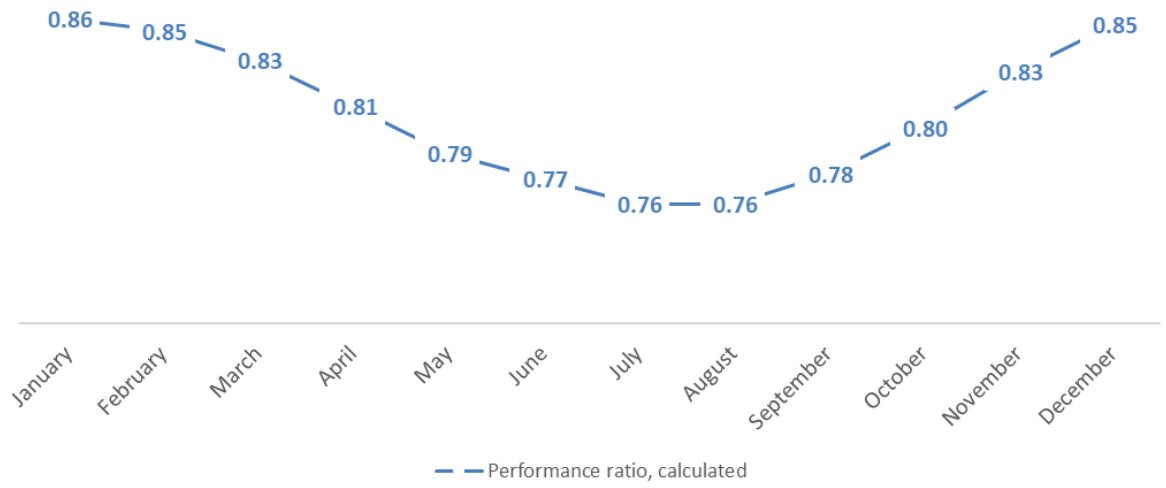
Figure 25: Efficiency losses due to temperature



Source: eclareon, own calculations

When combining the constant system losses and the temperature induced losses, the following monthly deviations of the performance ratio can be observed over the year:

Figure 26: Calculated performance ratio, based on all losses



Source: eclareon, own calculations

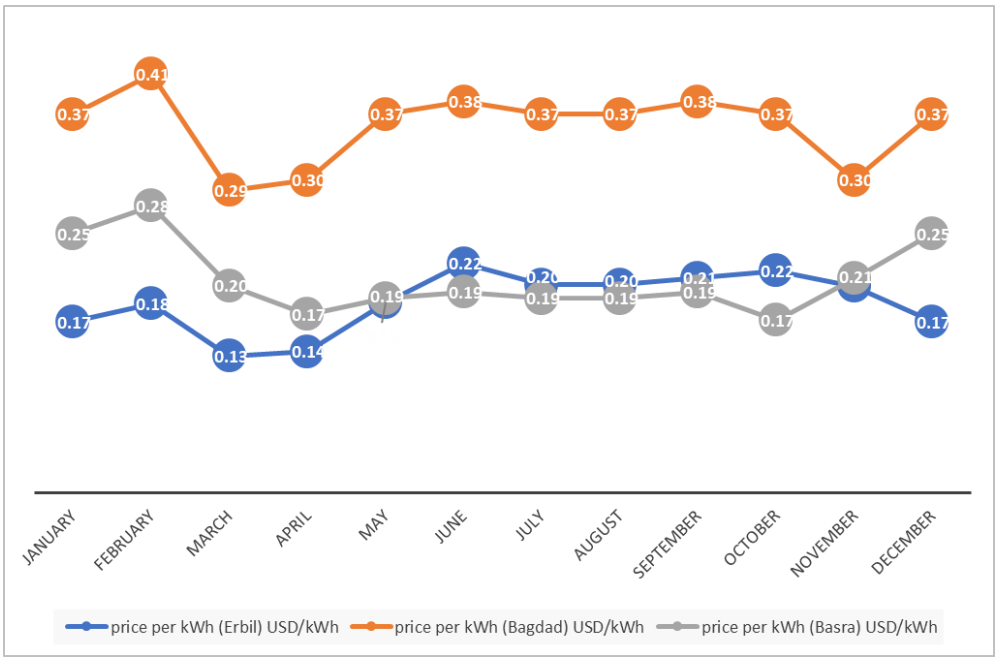
The technical plausibility checks presented in this section do not replace and are not meant to be a substitute for simulations done by dedicated system planning and design software. The calculations done by such software packages are more sophisticated and take into account more parameters than the plausibility checks undertaken for this financial analysis. The checks show however that the magnitude of the technical assumptions used for the assessment of the economic viability of different business cases based on annual cashflows are realistic.

3.3 Residential on-grid: PV without storage vs. neighbourhood generation / public grid

Neighbourhood electricity describes the case when consumers buy electricity from private companies (Independent Power Producers) who centrally generate electricity with diesel generators with a common size between 20 and 100 kVA. The advantage of such generators is that they can generate electricity more efficiently than smaller generators, such as a 2kVA genset that would be owned by single households. Consumers who cover a share of their electricity needs with neighbourhood electricity must often pay high prices in Iraq. Such customers pay a capacity charge per Ampere, per kVA or per kW of generator capacity. According to the IEA, these capacity charges translate into kWh prices of up to 1 USD/kWh, although regulated prices demand an upper threshold of about 40 USDct/kWh for neighbourhood generation.

Research undertaken for this report has shown that neighbourhood tariffs differ by location and time of the year, sometimes substantially. Data from market experts suggest the following annual pricing pattern:

Figure 27: Prices for neighbourhood electricity (USD/kWh)



Source: interviews conducted, 2021

The prices in Basra and Erbil fluctuate between 13 and 28 USDct/kWh while the prices in Bagdad are substantially higher throughout the year. Average annual prices for neighbourhood electricity are 19 USDct/kWh in Erbil and Basra and 36 USDct/kWh in Bagdad.

If only such tariffs were taken into consideration a detailed cashflow analysis would hardly be necessary to determine the viability of a PV investment: Although calculated LCOE values for PV differ by source, country, system type, system price and by other values, the LCOE for residential PV installations do not, under normal circumstances, reach levels > 40 USDct/kWh. For example, according to an LCOE analysis from Lazard,[75] the most expensive residential PV installations (5 kWp. without storage) would reach a maximum LCOE of 24.2 USDct/kWh.

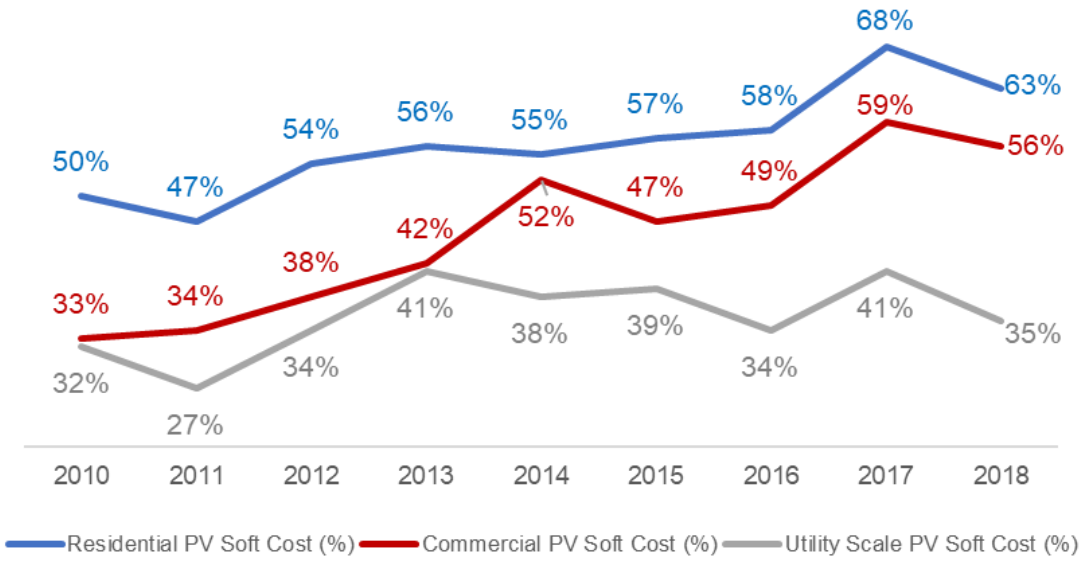
Figure 28: LCOE for different PV system types and sizes (USD/ MWh; USA 2019. unsubsidized and w/o storage)

[75] LAZARD'S LEVELIZED COST OF ENERGY ANALYSIS VERSION 13.0, November 2019

Source: Graph by eclareon,based on Lazard's LCOE Analysis Versiom 13.0. November 2019

Cross country comparisons are often difficult and rightfully criticized because situations in different countries are never the same. However, although every country and national PV market is unique and although assumptions and outcomes of LCOE calculations may vary based on input parameters and underlying assumptions, it should be possible to draw some conclusions for the Iraqi LCOE based on the LCOE from other countries like the US: Investment cost differences between countries arise from taxes and customs, prices of hardware components and so-called soft costs such as costs of labour. While the prices of hardware, before taxes and customs, are largely determined by world market prices, soft costs are more local costs components which depend to a large extent on the wage and salary levels of each country and the total (working) time required to commercialize and build a system, from the import of equipment, over system design, permitting, sales, installation to after sales service etc. Already in 2013, a study comparing the costs differences for residential PV installations between 2 different countries (the US and Germany) found that "the installed price of residential PV is significantly lower [….in one country….] due primarily to differences in "soft" costs".[76] Since then, many solar PV hardware components have seen dramatic price drops and hence the relative importance of soft costs in total system costs should have increased, as shown in the next graph.

Figure 29: Modeled trend of soft cost as a proportion of total cost by sector. 2010–2018. USA



Source: Graph by eclareon. based on NREL. U.S. Solar Photovoltaic System Cost Benchmark: Q1 2018

Taking the special importance of soft costs into account for explaining price and ultimately LCOE differences between countries, it is hard to see how, under normal market conditions, the highest LCOE in the high-price US market of 24.2 USDct/kWh could not serve as an upper threshold for the LCOE of the emerging Iraqi rooftop solar PV market, albeit with the apparent differences between both countries.

[76] "Why Are Residential PV Prices in Germany So Much Lower Than in the United States?", Lawrence Berkeley National Laboratory, 2013

Based on the considerations above, it should always make sense to replace 1 kWh of neighbourhood electricity with a price of 40 USDct/kWh by 1 kWh of solar PV electricity with a an LCOE of 24.2 USDct/kWh.

However, grid connected Iraqi electricity consumers will usually not be supplied exclusively by neighbourhood generation but by a mixture of electricity coming from the public grid and from neighbourhood generation. Residential electricity prices from the grid also vary by city and consumption level but are usually extremely cheap because of heavily subsidized tariffs and because only minor shares of consumption are effectively billed. As a result, it is not uncommon that customers pay effectively as little as 1 to 3 USDct/kWh for electricity from the public grid.

The business case describes a residential electricity consumer who covers their electricity with a mixture of grid and neighbourhood electricity and who would like to substitute parts of this mixture with electricity generated by a PV system. The assumptions for this economic analysis are based on the primary local research of local consultants complemented by secondary research.

3.3.1 Description of customer segment

A typical customer for this business case would be household from the city of Bagdad with 5 persons. Solar irradiation conditions in Bagdad are not identical but similar to those in other Iraqi urban centres such as Basra or Erbil. As explained above an irradiation value of 2,000 kWh/m^2/a was used for all business case calculations.

The average yearly electricity consumption of the household is estimated to be above the latest available annual per capita consumption average for Iraq. This average is approximately 1,300 kWh per year.[77] The household consumes about 11,000 kWh/year which translates into 2,200 kWh per capita and year, or a monthly household electricity consumption of 917 kWh. The average daytime consumption accounts for approximately 70% of this consumption. The household is not interested in covering their night-time electricity with PV given the relatively high costs of electricity storage. However, the typical household would like to cover a share of their daytime electricity consumption of approximately 6,500 kWh with a rooftop PV installation. A 3 kW PV system would be needed to produce the corresponding quantity of electricity. However, as battery storage will not be used, a smaller PV system of 1.5 kWp is installed in order to assure that a relatively high percentage of the generated electricity can also be used.

3.3.2 PV System

The lifetime of the system was rather conservatively set to 20 years. An increase based on the lifetime of the PV modules to 25 years would be reasonable as well provided that the system is installed professionally and with “high enough” quality equipment which, according to local sources, is not always the case. All cash flows including financing for this first case are in USD, interest rates and inflation rate are also based on a mixture of USD and IQD inflation rates which are both relatively low at between roughly 1 and 2%.

Total turnkey PV system costs (capital expenditure. CapEx) for a PV system were usually reported to be around 1,000 -1,500 USD/kWp, sometimes up to 2,000 USD/kWp. Prices are

[77] World Bank data, based on IEA, 2014, https://data.worldbank.org/indicator/EG.USE.ELEC.KH.PC?locations=IQ

different for every project and are based on 3 criteria which are: 1) system-specific criteria, 2) customer type specific criteria and 3) (regional) market-specific criteria:

- System-specific criteria depend for example, on the system size (prices per kWp would be lower for larger systems), system set-up (rooftop or ground mounted), the system configuration (hardware used, most importantly with or without battery storage), the quality of the used components and the qualification/ experience or the installation company.
- Customer type: Regarding the customer type, 3 groups are often distinguished, private (or residential) customers, (private) commercial and industrial (C&I) customers (including the agricultural sector) and public bodies. Commercial and industrial customers would often get the lowest per kWp price for their installation based on the assumption that commercial customers would also order products and services more often than residential customers. The second customer group are households/ residential customers. As they usually would not present continuous future business opportunities for the solar installer, they would pay a price that is 10-15% more expensive than the price for an identical system that would be installed for a commercial customer. Finally, public customers were reported to be priced up to 2-3 times higher that private customers mainly based of the long payment periods that public customers may take to pay their bills (a year and beyond). None of the business cases calculated for this report would be economically viable for prices > 2,000 USD/ kWp.
- Regional market-specific criteria refer to the fact that the competitive situation may be different in every region. “Region” does not necessarily refer to official administrative units but can be measured by the number and the quality of competing solar companies in a specific area. The intensity of competition was reported to have increased generally over the last years, which also explains, in conjunction with the falling world market prices for key hardware components such as the solar panel, the current system price levels. Also, as the regional prices for grid electricity and / or fuel powered generation will largely determine the achievable savings of a PV system, these prices may also be considered for the PV system sales price calculation of a solar company. For example, as stated above, neighbourhood electricity prices are highest in Bagdad which means that installing a PV system there is more attractive.

The final customer price will be a mixture of at least these different criteria and the individual strategy of each PV company: some companies offer the hardware for a cheaper price and charge higher installation costs, while other companies may act differently. In this section, the differences in PV system prices are acknowledged by showing price sensitivity for each business case.

As a base case assumption for the first business case a kWp price of 1,200 USD/kWp was used.

As explained above, the performance factor that determines which share of the solar irradiation can effectively be converted into “useable” electricity was set to 0.8, which means that average annual system losses calculated into the business case represent 20% (please refer to section 3.2). To achieve this rate, a professional quality installation is required, otherwise the value would be lower. Special attention needs to be paid to the cooling of the modules as thermal losses increase with cell temperature, which plays an important role in a city where average high temperatures during summer are 46°C. The resulting applied solar

yield was 1,600 kWh/kW per year. The PV system performance was assumed to decrease by 0.7% per year, accounting for the wear and tear of the system.

The fixed operation costs were reported to account for up to 5% of the system costs which is a very high value for a PV system, not including battery maintenance and costs for insurance. The high rate may reflect quality issues of some components and the installation but may also reflect natural conditions such as dry areas with a lot of dust development that require regular cleaning of the modules. Moreover, given that the PV industry is still in a nascent state, spare parts may be hard to find and can only be purchased for relatively high prices. It should be possible to lower this rate as the PV market matures. A common, non-Iraq specific assumption for Operating costs is rather in the range of 1.5%/year. Taking into account this value but also the higher rates of up to 5%, the value chosen in the calculations was set to 3%.

The PV system related base case assumptions are the following:

Figure 30: Residential on-grid - PV System assumptions

PV System		
Project Duration	Years	20
PV System Size	kWp	1.5
Nominal storage capacity	kWh	-
Total PV system costs /kWp	USD/kWp	1,200
Total PV System Cost	USD	1,800
Performance Factor	%	80%
Degradation	% p.a.	0.70%
Applied Solar Yield	kWh/kWp/a	1,600
Average Yearly Generation	kWh/a	2,233
Fixed Operation Costs PV	% p.a.	3.00%

Source: eclareon. 2021

3.3.3 Financing of the system

It was reported that Iraqi banks rarely finance PV installations and if they do, it is with relatively high interest rates of around 20% or even more. As a result, debt financing of a PV system is not available and / or not attractive for many Iraqis at the moment. Accordingly, the PV system in the business case was financed with 100% equity provided by the owners of the PV system. The main motivation for a typical customer is not a high return on investment but rather access to significantly cheaper electricity. Moreover, typical customers do not wish to lose money either and would therefore expect that their investment would recover the inflation rate. Therefore, the business case was modelled with a modest discount rate for the equity investment of 3%, 1% on top of the expected long-term inflation rate of 2%.

In summary. the financing conditions for the PV system are the following:

Figure 31: Residential on-grid - Financing assumptions

Financing			
Debt (Gearing)	-	USD	-
Loan Tenor		Years	-
Debt Interest Rate		%	-
Initial Equity		USD	1,800
Additional Equity		USD	-
Discount Rate		%	3.0%
Longterm Inflation Rate		%	2.0%

Source: eclareon. 2020

3.3.4 Savings and Revenues

Today, a typical PV system owner in Iraq does not have the possibility to sell their electricity via the grid. Instead, the customer is self-consuming the PV electricity which leads to savings in electricity purchases from the public grid/neighbourhood generation mix. The amount of kWh that can be saved also depends on the direct PV consumption, meaning the percentage of useful electricity generated that can also be used at the time when consumption shall take place. Good system configurations, taking into account times of use, lead to a proper dimensioning of the system and high direct consumption rates. As stated at the beginning of the business case, the PV system installed is rather small compared to the electricity needs of the residential customer. This is because the customer did not want to invest into battery storage but still wanted to use as much PV electricity as possible. For the business case it was assumed that 80% of the electricity generated by the PV system could also be used productively. Such a rate is high for a system that cannot feed into the grid and with no battery storage. Studies from Germany have shown however that self-consumption rates of around 80% are possible if the yearly PV output corresponds to about 1/3 of electricity consumption.[78] In our case, the 1.5 kWp PV system generates as a yearly average 2,233 kWh which corresponds to about 34% of the daytime electricity consumption. In order to achieve a similar self-consumption-rate a larger system with battery storage would need to be installed.

With regards to electricity purchases, it was assumed that the customer purchases 60% of their electricity from the public grid for 1 USDct/kWh. The following price brackets were used for the public grid price:

Figure 32: Residential electricity consumption: consumption brackets, price and volumes

		Tariff (USD/ kWh)	Lower limit (monthly consumption, kWh)	Upper limit (monthly consumption, kWh)
Bracket 1	USD/kWh	0.01	1	1,500
Bracket 2	USD/kWh	0.03	1,501	3,000
Bracket 3	USD/kWh	0.07	3,001	4,000
Bracket 4	USD/kWh	0.10	4,001	

[78] Huld, Heilscher and Ruf, Self-Consumption of Electricity by Households, Effects of PV System Size and Battery Storage, 2014

Source: Based in own research. 2020

In case the customer consumed more electricity from the grid and could substitute parts of their electricity consumption from the brackets with the higher electricity prices, the business case would improve. A (very) high consuming household for instance, with a consumption of 3,500 kWh/month which fall at equal shares in the consumption bracket #2 and #3, would save 5 USDct/kWh instead of 1 USDct/kWh which would positively impact the business case.

The remaining 40% of electricity consumption is purchased for an average of 36 USDct/kWh from a regulated neighbourhood electricity provider. The neighbourhood electricity tariff is expected to decrease by 1% per year. In the beginning. the customer would pay an average price of 15 USDct/kWh for their electricity mix, made of both grid electricity and electricity generated by a neighbourhood diesel.

In summary, the savings for the PV system are the following:

Figure 33: Residential on-grid - Savings and Revenues

Savings and Revenues		
Applied Direct PV Consumption	%	80%
Average grid electricity (public) price	USD/kWh	0.01
Share of grid electricity	%	60%
Price development grid electricity	% p.a.	2%
Neighborhood (NH) electricity price	USD/kWh	0.36
Share of neighborhood electricity	%	40%
Price development NH electricity	% p.a.	(1%)
Average electricity price paid (year 1)	USD/kWh	0.15

Source: eclareon. 2020

3.3.5 Financial results

The results for this business case are a positive net present value (NPV) of 939 USD and an internal rate of return of 9%, which means that the PV system is an economically viable investment under the base case assumptions described above. The equity internal rate also describes the highest equity discount rate for which the NPV would still be positive from the perspective of an equity investor. In this case it means that the owner could only ask for a maximum of 9% of return. If an investor asked for a higher return, the NPV becomes negative and the investment should no longer be undertaken based on the NPV criterium. However, even if the financial criteria suggested not to purchase a PV system, there may still be reasons to invest in PV. These reasons include but are not limited to the reliability of electricity supply, the wish to become more independent from electricity markets and fluctuating energy prices, and the lack of energy supply alternatives.

The equity investment is paid back after approximately 10 years if cashflows are discounted. Using undiscounted cashflows the investment would be paid back after approx. 8.6 years. The LCOE for the installation would be 8 USDct/kWh which is lower than the initial average electricity price mix between public and neighbourhood grid electricity prices. In this case, providers of neighbourhood diesel electricity would sell a kWh on average for 0.6 USD instead

for 0.36 USD, the actual reference price. Accounting for 60% cheap grid electricity and 40% unregulated diesel prices, costs would climb to 25 USDct/kWh which corresponds to approximately 3 times the LCOE of the solar PV installation.

Figure 34: Residential on-grid -Results, public electricity 1 USDct/kWh

Results		
Net-Present Value	USD	939
Project IRR	%	9%
Equity IRR	%	9%
Amortization - discounted payback period	Years	10.33
Undiscounted payback period	Years	8.64
LCOE (no subsidy)	USD/kWh	0.08

Source: eclareon. 2021

In this case, the public electricity replaced by solar would be from brackets with a higher price level, for which the customer would have to pay on average 5 USDct/ kWh, the financial results would improve substantially:

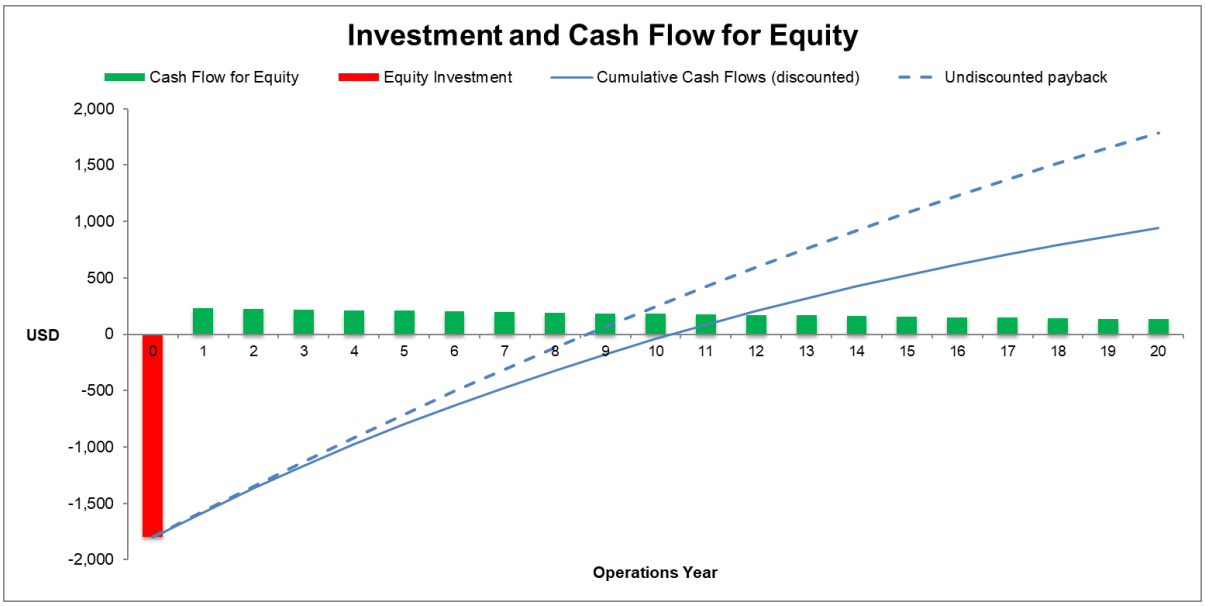
Figure 35: Residential on-grid -Results, public electricity 5 USDct/kWh

Results		
Net-Present Value	USD	1,714
Project IRR	%	12%
Equity IRR	%	12%
Amortization - discounted payback period	Years	7.88
Undiscounted payback period	Years	6.89
LCOE (no subsidy)	USD/kWh	0.08

Source: eclareon. 2021

Looking in more detail at the regulated case, the equity cash flow for the base case looks as follows:

Figure 36: Residential on-grid - Equity Cash Flow



Source: eclareon. 2021

As can be seen, the cash flow for equity decreases each year due to decreasing neighbourhood electricity prices and because operating costs for the PV system were escalated with inflation. The point where the undiscounted cashflows cross the X axis shows the undiscounted payback period of 8.6 years, the discounted payback period is shown after 10.3 years.

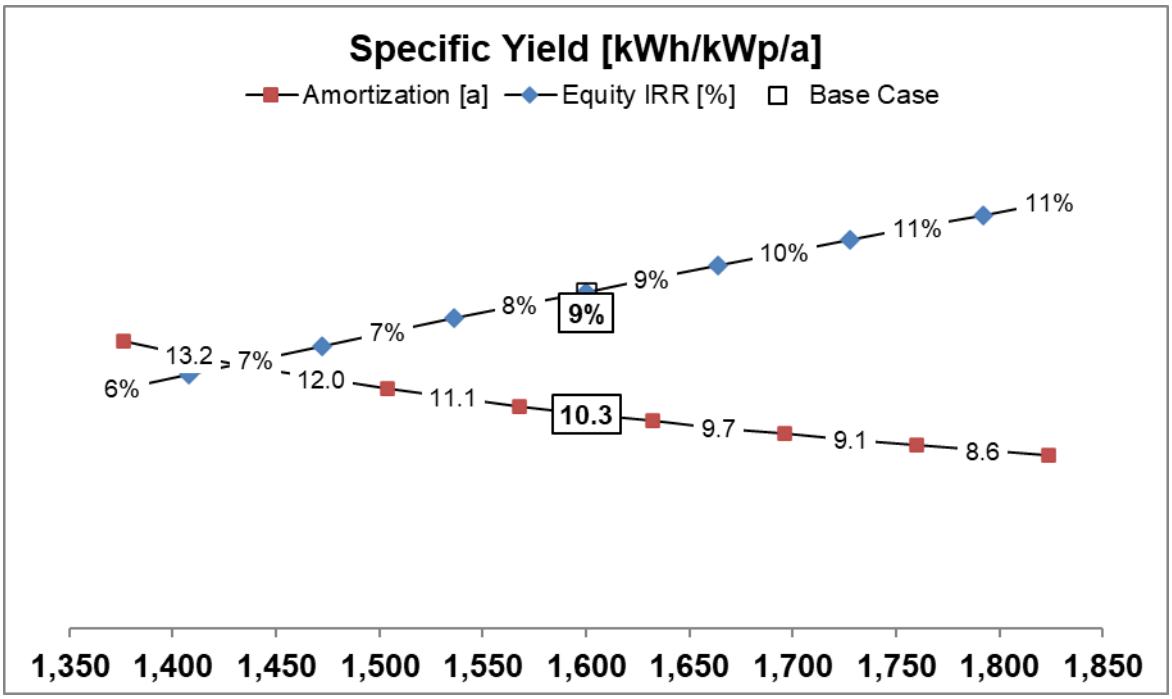
3.3.6 Sensitivity of results

The following figures show how two key economic performance indicators for the investment, that is discounted payback period (Amortisation) and return on equity (Equity IRR), change when some of the assumptions described above are modified. The figures show how variations of assumptions influence the profitability.

The specific yield shows the kilowatt hours produced by a PV system per kWp capacity and per year. It is calculated based on solar radiation multiplied by the performance factor of the PV system. This factor includes the technical conditions for the efficiency of the PV system, the efficiency, orientation and inclination of PV modules, possible shadowing, etc.

The financial results for the PV installation improve when the system is built at a site with higher irradiation and/or with lower losses: the equity IRR increases when more electricity can be harvested and the payback period decreases at the same time.

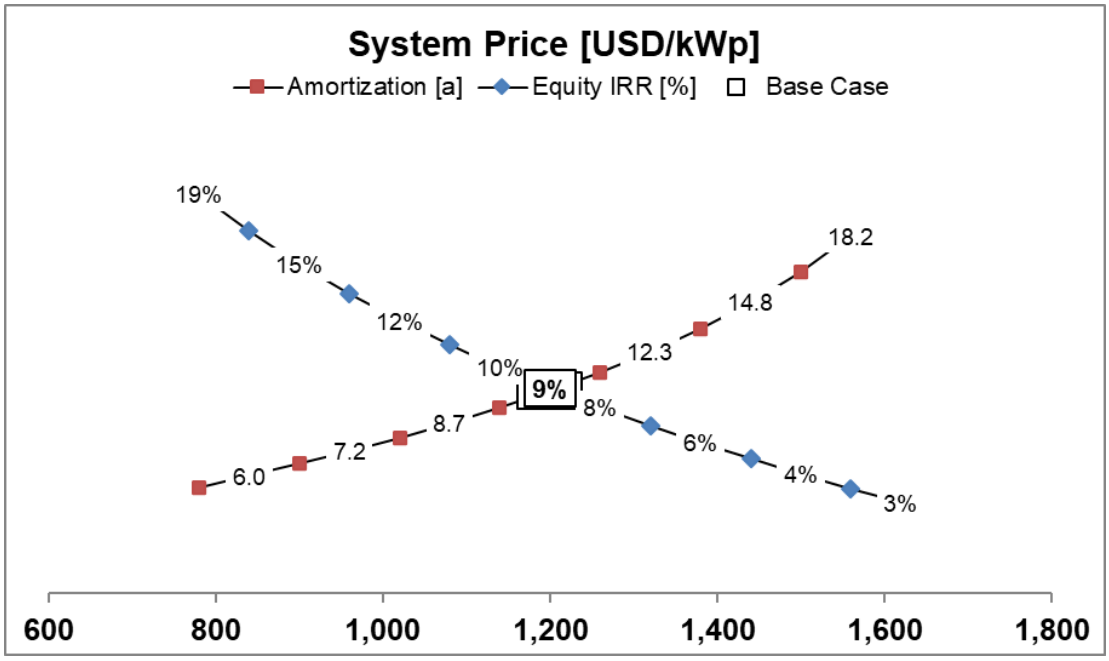
Figure 37: Residential on-grid - Specific Yield Sensitivity



Source: eclareon. 2021

Another important factor to assess the economic viability of a PV system are its system costs: The higher these costs are, the less attractive the investment becomes.

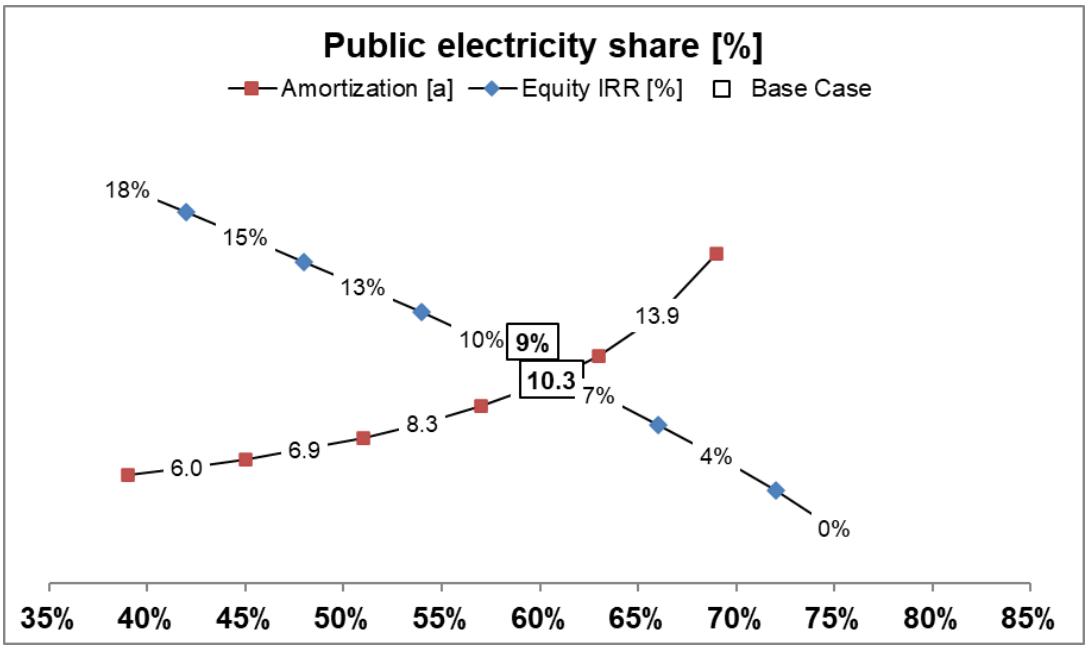
Figure 38: Residential on-grid – System Price Sensitivity



Source: eclareon. 2020

Another parameter that may vary considerably across Iraq is the mix between the low public grid electricity price and the high neighbourhood electricity price. The more of the rather costly neighbourhood electricity the customer needs to buy, the sooner their PV investment will be paid back. Inversely, the higher the share of cheap grid electricity, the longer the payback for the PV system will be. As can be seen in the graph below, a share of grid electricity in the customer's electricity mix > 70% would make the PV investment economically unviable for regulated neighbourhood tariffs of 0.36 USD/kWh.

Figure 39: Residential on-grid – Public electricity share Sensitivity

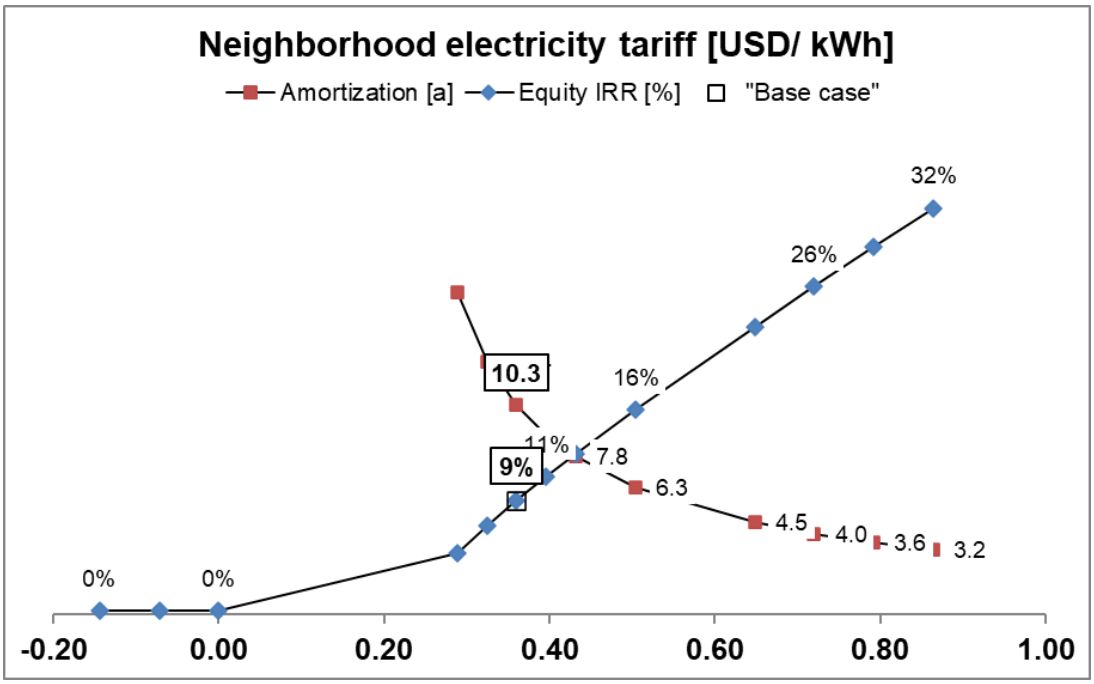


Source: eclareon. 2020

If a higher, neighbourhood tariff of USDct/kWh is applied, the % share of public grid electricity in the electricity mix of the customer could be even higher. Inversely, if only about 40% of the customer's electricity mix is purchased from the grid (and about 60% from the regulated neighbourhood electricity provider), the PV system would already be paid back after less than 6 years.

Regarding the overall tariff value for neighbourhood generation, it is instinctively clear that the higher this tariff, the more economically viable the PV investment becomes as more money can be saved by not having to buy neighbourhood electricity. For instance, a starting tariff of approx. 0.6 USD/kWh would bring down the payback period to less than 5 years.

Figure 40: Residential on-grid – Neighbourhood electricity tariff



Source: eclareon. 2020

A more extreme case when a customer buys 75% of their electricity from a non-regulated neighbourhood diesel supplier for 0.6 USD/kWh can be seen in Figure 41. In such an extreme scenario, the PV system would be paid back in about a year and an investment of 1,800 USD for the PV system would have a net present value of nearly 8,276 USD.

The next sensitivity shows the future development of the tariff for neighbourhood electricity. In the base case the annual decrease was set to 1%, which means that the neighbourhood electricity tariff will become cheaper every year based on the estimates of local market experts. In case this annual decrease was higher or lower the payback period and equity IRR would change accordingly: if the neighbourhood electricity tariff decreased every year the PV investment would become less attractive because potential savings decrease. In the opposite case of increasing neighbourhood tariffs payback periods could become significantly shorter.

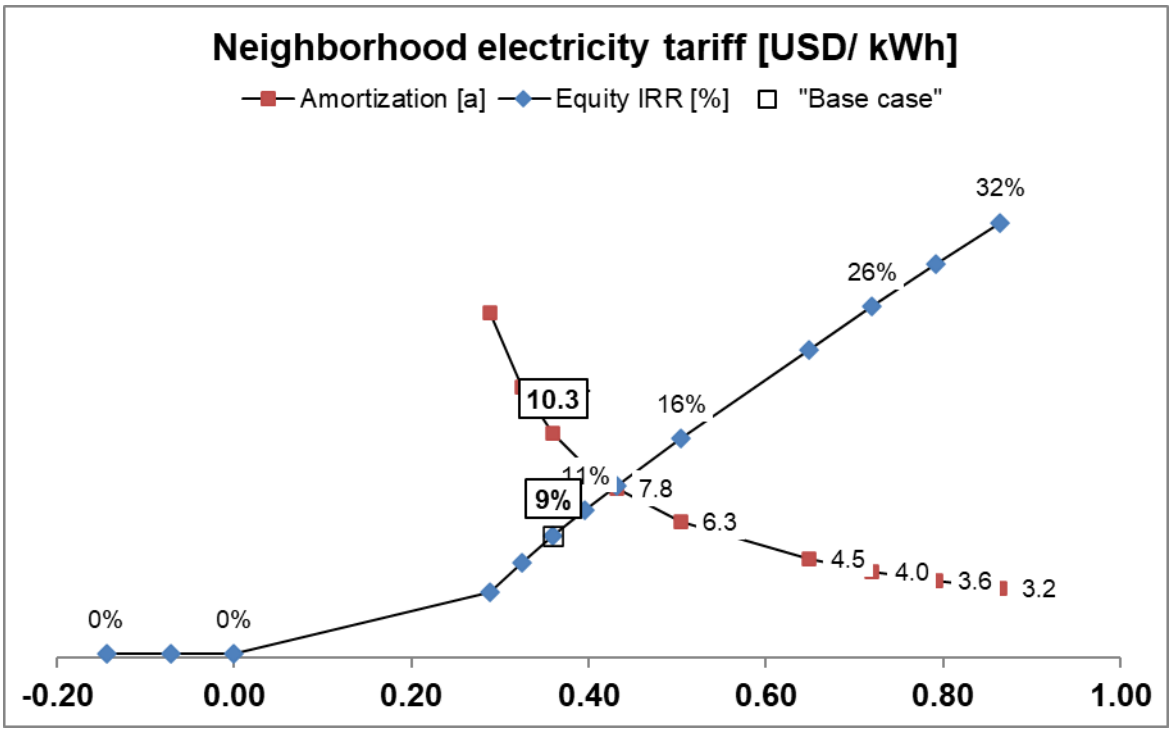
Figure 41: Residential on-grid – Neighbourhood electricity tariff extreme

Savings and Revenues		
Applied Direct PV Consumption	%	80%
Average grid electricity (public) price	USD/kWh	0.01
Share of grid electricity	%	25%
Price development grid electricity	% p.a.	2%
Neighborhood (NH) electricity price	USD/kWh	0.60
Share of neighborhood electricity	%	75%
Price development NH electricity	% p.a.	(1%)
Average electricity price paid (year 1)	USD/kWh	0.45

Results		
Net-Present Value	USD	8,276
Project IRR	%	42%
Equity IRR	%	42%
Amortization - discounted payback period	Years	2.40
Undiscounted payback period	Years	2.28
LCOE (no subsidy)	USD/kWh	0.08

Source: eclareon. 2021

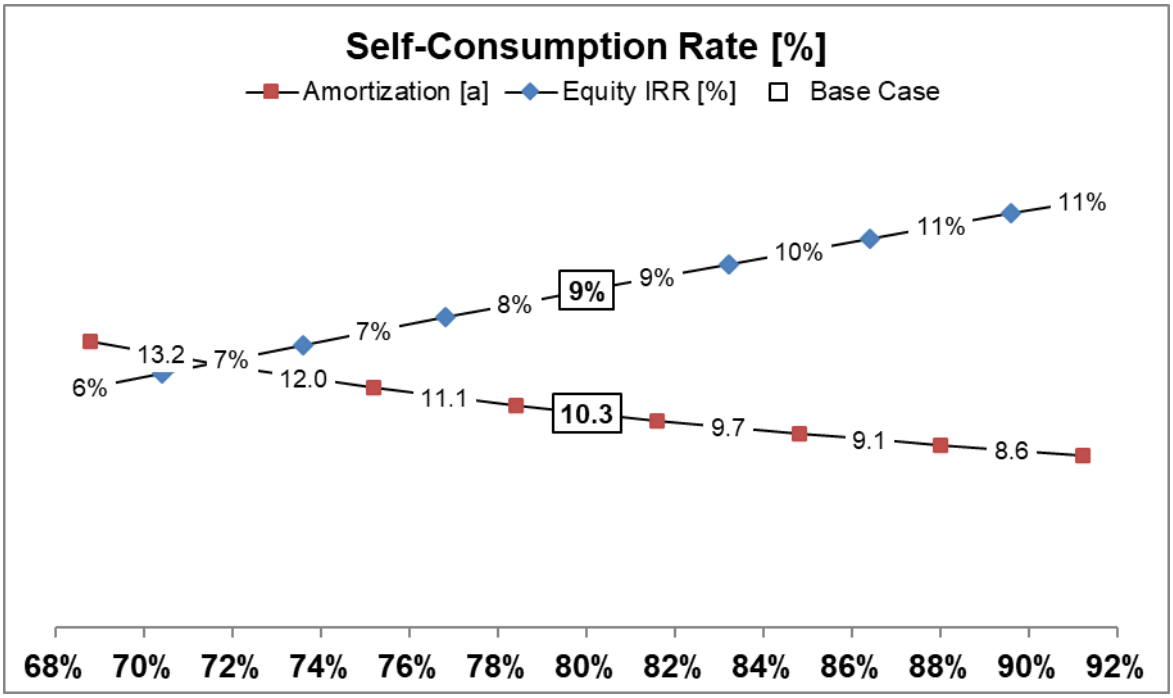
Figure 42: Residential on-grid – Neighbourhood electricity tariff development



Source: eclareon. 2021

Finally, the applied direct PV consumption rate (or self-consumption rate) has an important impact on the viability of the business case. The more generated electricity that can be productively used, the more savings can be generated and the shorter the payback will be. High self-consumption rates can be achieved by proper system design, considering also the daily and monthly electricity consumption patterns of the customer which will also depend on the appliances they use. Appliances whose time of use match the production pattern of a PV system are for example air conditioning systems which are widespread in Iraq given the high temperature overall and especially during the summer months. As can be seen in the next sensitivity analysis, if the self-consumption rate goes up to 90%, the discounted payback period would be reduced to 8.6 years.

Figure 43: Residential on-grid – Self-consumption rate



Source: eclareon. 2021

3.4 Residential off-grid: rooftop PV with storage vs. a privately owned fuel generator

Off-grid electricity describes the case when consumers generate all or parts of their own electricity with a private generator with a common size between 2 and 5 kVA. These generators, which are fuel or diesel powered, generate electricity less efficiently than larger generators, such as a 20 kVA genset that would be operated by IPPs to produce neighbourhood electricity.

The business case describes an electricity consumer who covers about 50% of their electricity with a privately owned genset and who would like to reduce the usage of the generator with electricity generated by a PV system. The assumptions for this economic analysis are based on the primary local research of local consultants complemented by secondary research.

3.4.1 Description of customer segment

A typical customer for this business case would be an upper-class household from the city of Bagdad with 2 persons.

The average yearly electricity consumption of the household is estimated to be far above the latest available annual per capita consumption average for Iraq. This average is approximately 1,300 kWh per year.[79] The household consumes about 8,200 kWh/ year which translates into 4,100 kWh per capita. High electricity consumption is mainly caused by the usage of a 2.5 kW air conditioning system. Since this system is mainly operated during the day, the average daytime consumption corresponds to approx. 2/3 of the overall consumption, while the remainder is consumed during the night. About 50% of the household's electricity supply comes from a privately owned fuel genset and the household would like to reduce the generator runtimes and the money spent on fuel as much as possible by using solar PV. In addition, the household aims at generating a large share of its daytime consumption and a share of its night time consumption with solar PV. The latter will require electricity storage with the help of batteries. The battery chosen is a lead acid gel battery. A 3 kW PV system with 4.8 kWh of storage would suffice to produce the corresponding quantity of electricity.

3.4.2 PV System

The lifetime or useful life of the system was set, rather conservatively, to 20 years. An increase based on the lifetime of the PV modules to 25 years would be reasonable as well provided that the system is installed professionally and with "high enough" quality equipment which, according to local sources. is often not the case. All cash flows including financing for this first case are in USD, interest rates and inflation rate are also based on a mixture between USD and IQD inflation rates which are both relatively low between approximately 1 and 2%.

Total turnkey PV system costs (capital expenditure. CapEx) for the PV system were reported to be around 1,000 USD/kWp -1,500 USD/kWp without storage. As described above, prices for individual PV systems are influenced by various criteria, the type of customer and the competitive situation in a specific region. For this business case the same system price as in the previous business case, 1,200 USD/kWp, was used. However, in this case, storage costs were added: As the price range for the battery was estimated at approximately 250 USD/ kWh, total system costs per kWp including storage amount to 1,600 USD/ kWp. Even lower prices for systems with batteries were reported but the business case is built on the assumption that reasonable quality components are used in order to assure that the PV system generates electricity over its useful life.

The performance factor that determines which share of the solar irradiation can effectively be converted into "useable" electricity was set to 80%. To achieve this rate, a professional quality installation is required, otherwise the value would be lower. The resulting applied solar yield was 1,600 kWh/kW per year. The PV system performance was assumed to decrease by 0.7% per year accounting for wear and tear of the system.

The fixed operational costs were, as in the previous case, set to 3% p.a. which is a compromise between the very high 5% reported and a standard value of 1.5%. The costs for the exchange of the battery were accounted for separately and are not included in the 3%.

[79] World Bank data, based on IEA, 2014, https://data.worldbank.org/indicator/EG.USE.ELEC.KH.PC?locations=IQ

The PV system related base case assumptions are the following:

Figure 44: Residential off-grid -PV System assumptions

PV System		
Project Duration	Years	20
PV System Size	kWp	3.0
Nominal storage capacity	kWh	4.8
Total PV system costs /kWp	USD/kWp	1,600
Total PV System Cost	USD	4,800
Performance Factor	%	80%
Degradation	% p.a.	0.70%
Applied Solar Yield	kWh/kWp/a	1,600
Average Yearly Generation	kWh/a	4,465
Fixed Operation Costs PV	% p.a.	3.00%
Battery Replacement Interval	Years	3

Source: eclareon. 2021

3.4.3 Financing of the system

It was reported that Iraqi banks rarely finance PV installations and if they do, it is with relatively high interest rates of 20% or more. As a result, debt financing of a PV system is not available and/or not attractive for many Iraqis at the moment. Accordingly, the PV system in this business case was financed with 100% equity provided by the owners of the PV system. The main motivation for a typical customer is not a high return on investment but rather access to significantly cheaper electricity. Moreover, typical customers do not wish to lose money either and would therefore expect that their investment would recover the inflation rate. Therefore, the business case was modelled with a modest discount rate for the equity investment of 3%, 1% on top of the expected long-term inflation rate of 2%.

In summary, the financing conditions for the PV system are the following:

Figure 45: Residential off-grid -Financing assumptions

Financing			
Debt (Gearing)	-	USD	-
Loan Tenor		Years	-
Debt Interest Rate		%	-
Initial Equity		USD	4,800
Additional Equity		USD	271
Discount Rate		%	3.0%
Longterm Inflation Rate		%	2.0%

Source: eclareon. 2021

Additional equity is required during the operations phase of the project when the savings realized thanks to fuel saved do not suffice to cover operating costs. In this business case, the replacement of the battery which takes place after 3 years of operation requires the owner to invest additional equity.

3.4.4 Savings and Revenues

The customer is self-consuming the PV electricity which leads primarily to savings in fuel purchases for their generator. The level of savings depends on the price of fuel and on the efficiency of the generator, meaning the kWh that can be produced by 1 litre of fuel. In addition, the amount of kWh that can be saved depends also on the PV consumption, meaning the % of useful electricity generated that can also be used at the time when consumption shall take place. A battery adds more flexibility in this regard because electricity could be stored in the battery at times when PV generation > electricity consumption, provided the battery is not fully charged. Good system configuration leads to a proper dimensioning of the system and high direct consumption rates. For the business case it was assumed that 70% of the electricity generated by the PV system will be directly used during the daytime, while 20% will be used for charging the battery and night-time use, bringing the overall direct PV consumption to 90%.

With regards to generator efficiency, it was assumed that the generator needs 1 litre of fuel to produce 2.4 kWh of electricity. The fuel is purchased for 50 USDct/litre and 13.5% for lube oil that regularly needs to be exchanged was added. Fuel prices were assumed to remain stable and only increase by the long-term inflation rate of 2%. Given that the customer already owns a generator and wants to keep it as a backup system, neither generator purchase, nor replacement costs, nor other operating costs were considered for this business case.

In summary, the savings for the PV system are the following:

Figure 46: Residential off-grid -Savings and Revenues

System Operation - Savings		
Applied Direct PV Consumption	%	70.00%
Applied Battery PV Consumption	%	20.00%
Genset Efficiency	kWh/ltr	2.4
Average Replaced Fuel Consumption p.a.	ltr/year	1,619
Fuel Price (1st Ops Year)	USD/ltr	0.50
Oil costs as % of fuel costs	%	13.50%
Fuel Price Escalation	% p.a.	2.00%
Genset CAPEX fee saved	USD p.a.	-
Genset OPEX fee saved	USD p.a.	-
Generator related savings (average)	USD/kWh	0.26

Source: eclareon. 2021

3.4.5 Financial results

The results for this business case are a positive net present value of 5,579 USD and an internal equity rate of return of 13%, which means that the PV system is an economically viable investment under the base case assumptions described above. The equity investment is paid

back after approximately 7.5 - 9.2 years, longer using discounted cashflows, shorter if cashflows are not discounted. The LCOE for the installation would be 17 USDct/kWh. Therefore, the rooftop PV system's LCOE is 9 USDct lower than the average kWh generated by the fuel genset. The LCOE is relatively high, mainly because of the usage of a battery: storage costs are still relatively high today which means that a kWh that is generated by the PV system and then stored in a battery in order to be consumed at a later point in time is more expensive than a kWh that is directly consumed.

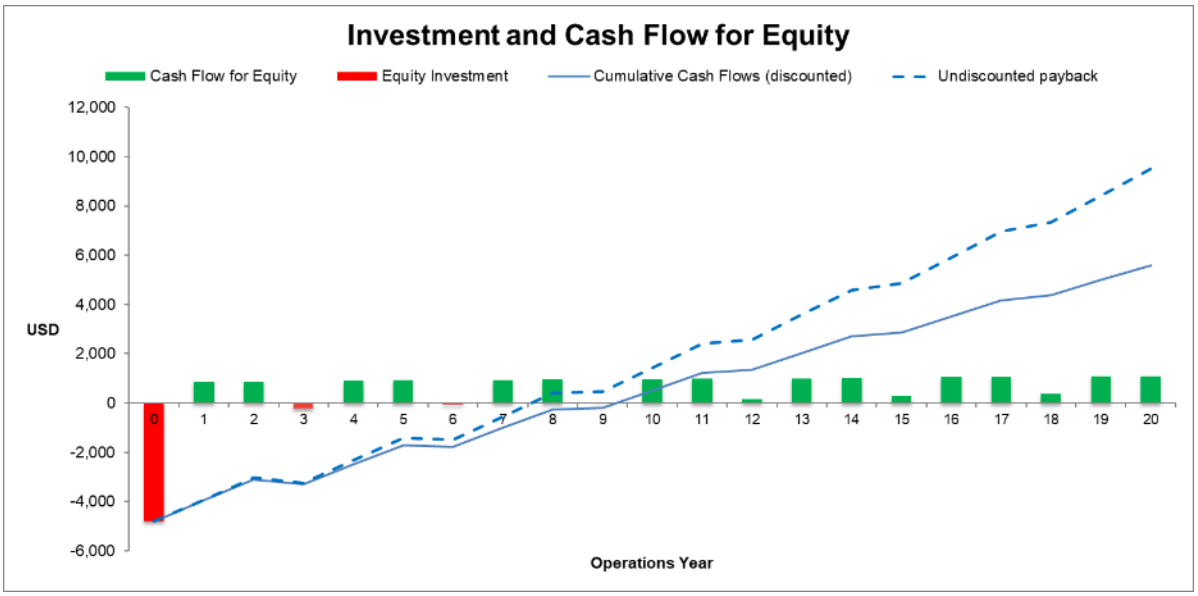
Figure 47: Residential off-grid -Results

Results		
Net-Present Value	USD	5,579
Equity IRR	%	13%
Amortization - discounted payback period	Years	9.29
Undiscounted payback period	Years	7.57
LCOE (no subsidy)	USD/kWh	0.17

Source: eclareon. 2021

Looking in more detail at the regulated case the equity cash flow for the base case looks as follows:

Figure 48: Residential off-grid - Equity Cash Flow



Source: eclareon. 2021

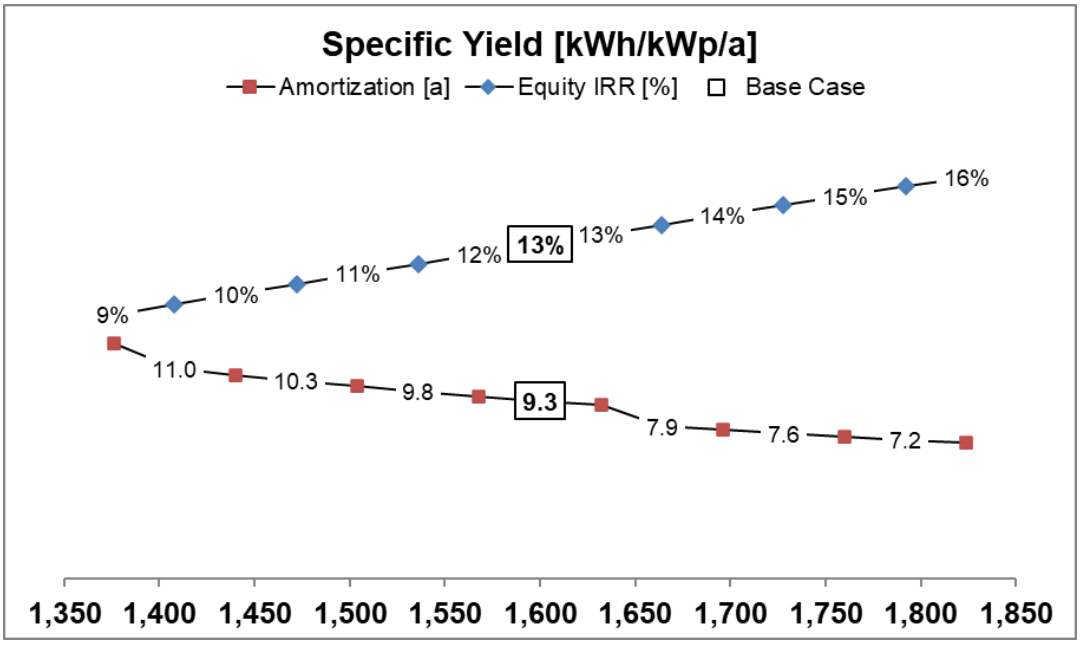
As can be seen. the cash flow for equity is stable each year due to a stable fuel price and hence stable savings. Every 3rd year of operation the battery needs to be exchanged which causes additional costs for the system owner: For the first 2 battery exchanges in years 3 and 6 fuel savings would not suffice to cover these costs, and the PV system owner would have to invest additional equity. For the exchanges from year 9, cashflow from fuel savings would suffice to cover the battery investment costs which were also reduced by 3% p.a. in order to

account for expected future cost reductions of battery systems. The point where the cumulated cashflows cross the X axis shows the discounted payback period of approximately 10 years, the dotted line shows the undiscounted payback period of 7.5 years.

3.4.6 Sensitivity of results

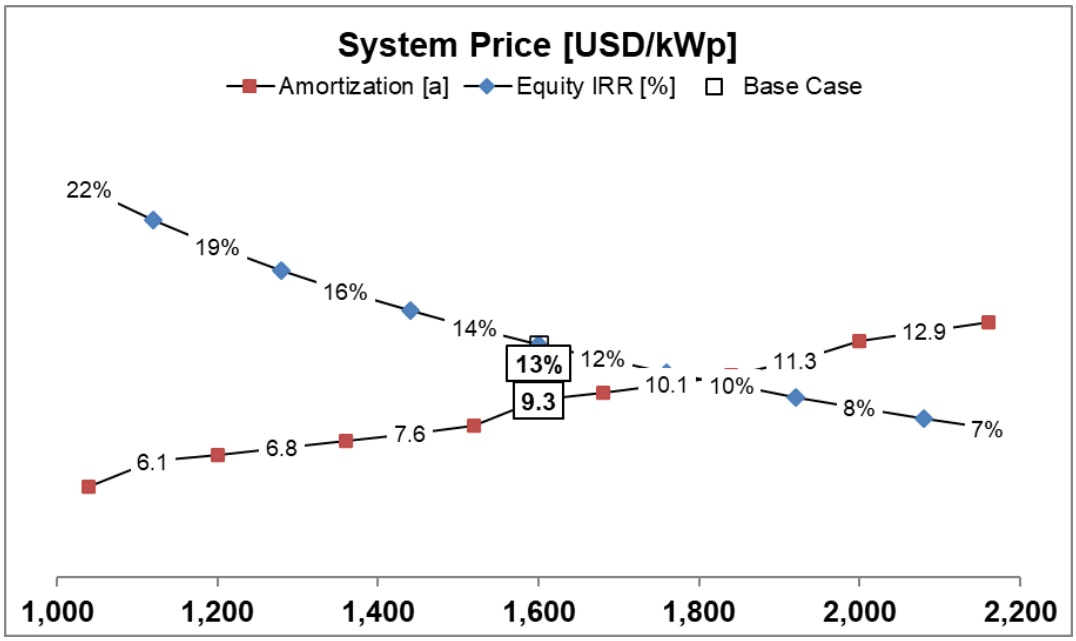
The following figures show how two key economic performance indicators for the investment, that is discounted payback period (Amortisation) and return on equity (Equity IRR), change when some of the assumptions described above are modified. The figures show how variations of assumptions influence profitability. The specific yield shows the kilowatt hours produced by a PV system per kWp capacity and per year. It is calculated based the solar radiation multiplied by the performance factor of the PV system. This factor includes the technical conditions for the efficiency of the PV system, the efficiency, orientation and inclination of PV modules, possible shadowing. etc. The financial results for the PV installation improve when the system is built at a site with higher irradiation: the equity IRR increases and the payback period decreases when more electricity can be harvested.

Figure 49: Residential off-grid - Specific Yield Sensitivity



Source: eclareon. 2020

Figure 50: Residential off-grid – System Price Sensitivity

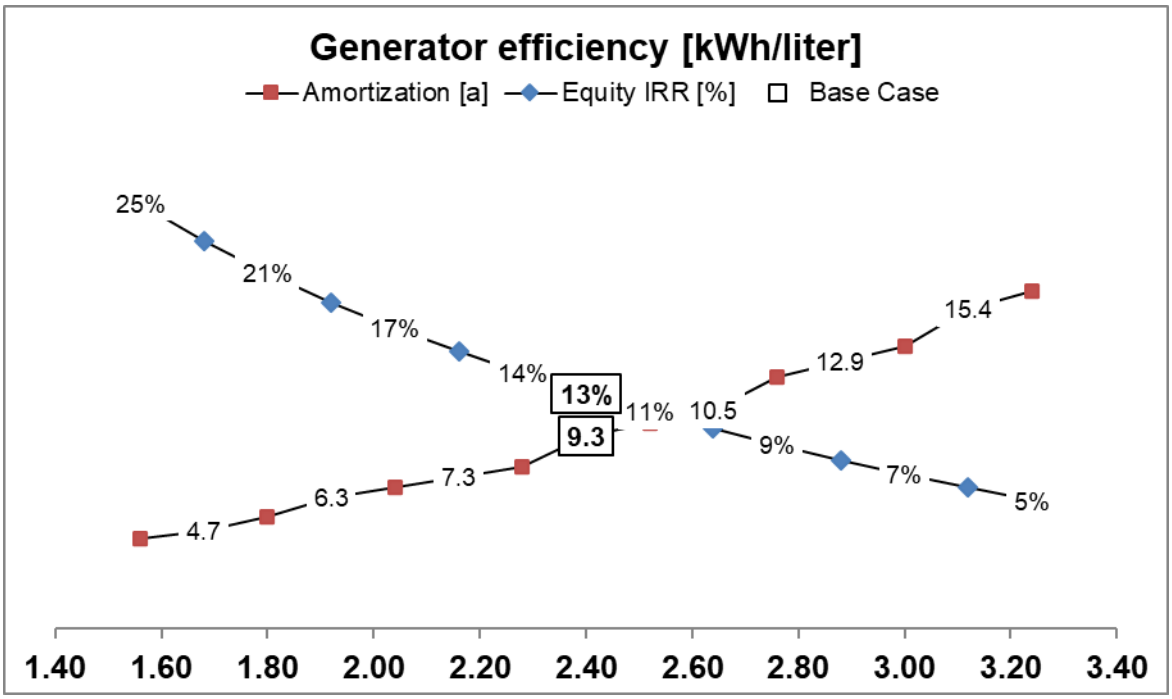


Source: eclareon. 2021

Another important factor to assess the economic viability of a PV system are its system costs: The higher these costs are. the less attractive the investment becomes.

Another parameter that has an impact is the generator efficiency. The more kWh can be generated with one litre of fuel, the more efficient the generator is and the less attractive the PV investment becomes. Inversely, if less kWh can be generated with a litre of fuel, the shorter the payback for the PV system will be. As can be seen in the graph below, a kWh/litre ratio of 3 instead of 2.4, as in the base case, would result in a payback period of more than 13 years. Inversely, if 1 litre of fuel only generates 2 kWh of electricity, the payback period would be reduced to approximately 7 years.

Figure 51: Residential off-grid – Generator efficiency Sensitivity

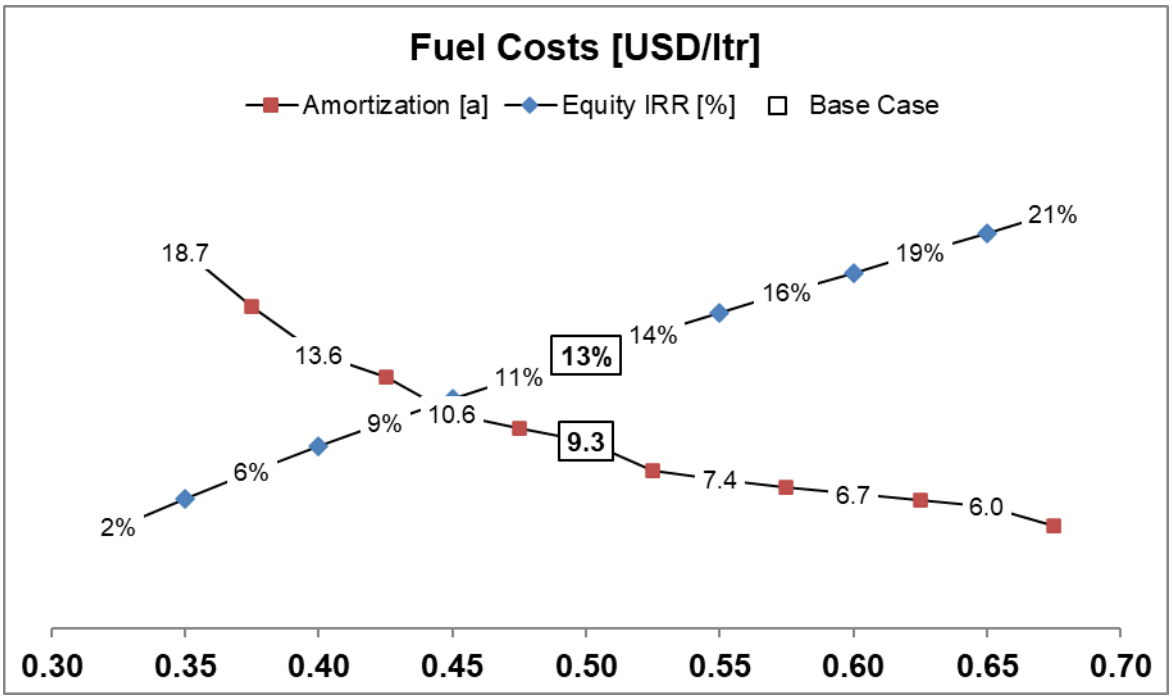


Source: eclareon. 2021

Fuel prices in Iraq were reported to vary between different regions between 500 IQD (~35 USDct) and 750 IQD (~51 USDct). It is clear that the higher the price for fuel, the more economically viable the PV investment becomes. However, if the initial fuel price was lower than 35 USDct/litre, the PV investment could not be paid back in 20 years, all other assumptions remaining equal.

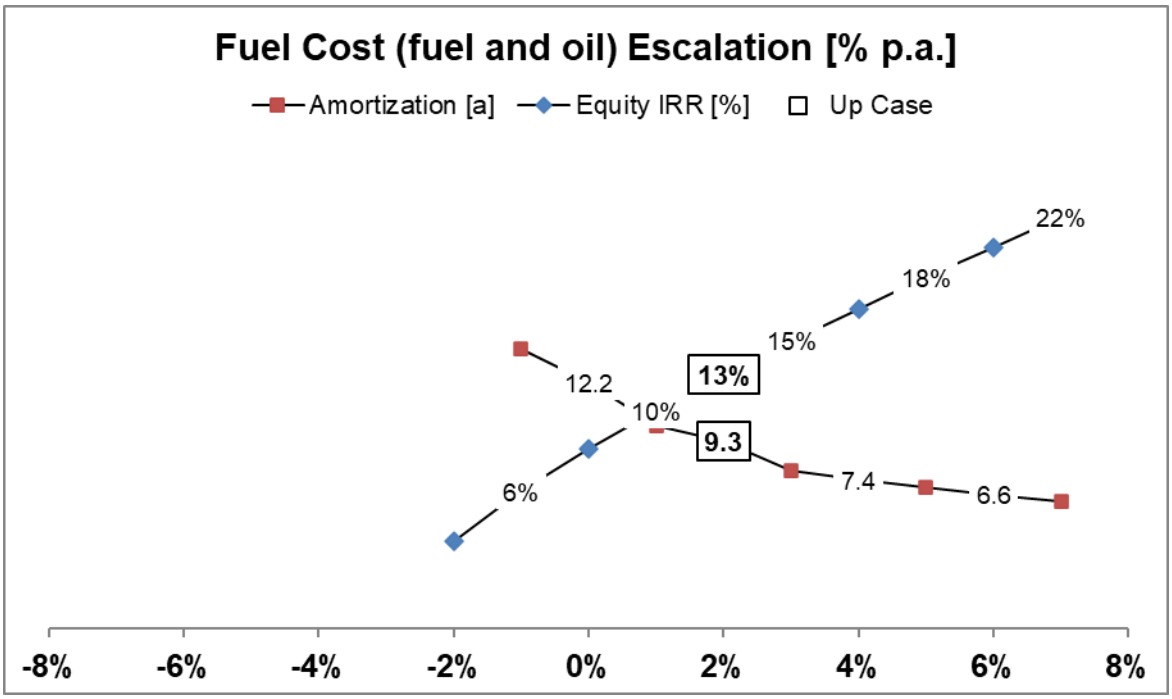
The next sensitivity analysis shows the future development of the price for fuel products. In the base case, the annual increase was set to 2% which means that fuel prices will increase but only along the long-term inflation rate of 2%. If this annual increase was higher or lower, the payback period and equity IRR would change accordingly: if fuel prices decreased every year, the PV investment would become less attractive because potential savings decrease. In the opposite case of increasing fuel prices, payback periods could become significantly shorter.

Figure 52: Residential off-grid – Fuel costs



Source: eclareon. 2020

Figure 53: Residential off-grid – Fuel cost development



Source: eclareon. 2021

3.5 Commercial on-grid: rooftop PV with storage vs. neighbourhood generation / public grid

This business case describes a commercial electricity consumer who covers their electricity with a mixture of grid and neighbourhood electricity and who would like to substitute parts of this mixture with electricity generated by a PV system in order to increase the availability of electricity in case of power outages during the day. The assumptions for this economic analysis are based on the input of local consultants complemented by secondary research.

3.5.1 Description of customer segment

A typical customer for this business case would be a machine-washing garage from the city of Erbil with 10 employees and an overall electricity consumption of 5,400 kWh per month. Solar irradiation conditions in Erbil are around 1,900 kWh/m^2/year (GHI).

Average daytime consumption accounts for about 80% of power usage and night-time consumption for approximately 20%. The garage is not primarily interested in covering their night-time electricity with PV but are still interested in battery storage as a backup system in case of power outages during the day. In addition, the garage would like to cover as much daytime electricity consumption as possible with a rooftop PV installation, however as the rooftop size is limited, only a 15 kW PV system can be installed. Such a system would allow coverage of roughly 50% of electricity needs.

3.5.2 PV System

The lifetime of the system was again set rather conservatively to 20 years. An increase based on the lifetime of the PV modules to 25 years would be reasonable provided that the system is installed professionally and with “high enough” quality equipment which, according to local sources. is often not the case. All cash flows including financing for this first case are in USD, interest rates and inflation rate are also based on a mixture of USD and IQD inflation rates which are both relatively low, between approximately 1 and 2%.

For this business case a system price of 1,100 USD/kWp was used. This price is lower than for the residential neighbourhood electricity case as the installation is larger and the customer is a commercial customer for whom prices were reported to be 10-15% lower than for residential customers if the solar company sees business opportunities beyond the single PV system. In our case, the customer may own a second machine-washing plant that could also be equipped with PV in the future if the first installation proves to be successful. The costs mentioned above did not include the battery, which is estimated to cost approximately 220 USD/kWh. Total system costs per kWp including storage amount to 1,382 USD/kWp.

The performance factor that determines what share of solar irradiation can effectively be converted into “useable” electricity was set to 80%. To achieve the rate a professional quality installation is required, otherwise the value would be lower. The resulting applied solar yield was 1,600 kWh/kW per year. The PV system performance was assumed to decrease by 0.7% per year accounting for the wear and tear of the system.

The fixed operation costs were estimated to account for about 2% of system costs. The battery is exchanged every 4 years and due to technical progress, battery costs are estimated to decrease by 5% per year.

The PV system related base case assumptions are the following:

Figure 54: Commercial on-grid - PV System assumptions

PV System		
Project Duration	Years	20
PV System Size	kWp	15.0
Nominal storage capacity	kWh	19.2
Total PV system costs /kWp	USD/kWp	1,382
Total PV System Cost	USD	20,724
Performance Factor	%	80%
Degradation	% p.a.	0.70%
Applied Solar Yield	kWh/kWp/a	1,600
Average Yearly Generation	kWh/a	22,327
Fixed Operation Costs PV	% p.a.	2.00%
Battery Replacement Interval	Years	4

Source: eclareon. 2021

3.5.3 Financing of the system

Although it was reported that Iraqi banks rarely finance PV installations it was assumed the commercial customer would still like to finance parts of the PV system with a bank loan. A reason may be a temporary lack of liquidity caused for example, by late payments from an important customer. The garage owner contacts their bank in order to discuss a loan for the PV system. The bank offers to finance 25% of the PV investment costs with a tenor of 2 years and an interest rate of 20% p/a. The loan is primarily granted because the garage owner has been a creditworthy client of the local bank for many years. Accordingly, the PV system in the business case was financed with 75% equity provided by the business owner and with 25% debt. The main motivation for a typical customer is not a high return on investment but rather access to cheaper electricity and to increase the reliability of power supply. Still, a commercial customer would also like to see that the PV system recovers more than the inflation rate. Therefore. the business case was modelled with a discount rate for the equity investment of 4%, 2% on top of the expected long-term inflation rate of 2%.

In summary. the financing conditions for the PV system are the following:

Figure 55: Commercial on-grid - Financing assumptions

Financing			
Debt (Gearing)	25%	USD	5,181
Loan Tenor		Years	2
Debt Interest Rate		%	20%
Initial Equity		USD	15,638
Additional Equity		USD	3,423
Discount Rate		%	4.0%
Longterm Inflation Rate		%	2.0%

Source: eclareon. 2021

Additional equity is required during the operations phase of the project, when the savings realised thanks to reduced electricity purchases do not suffice to cover operating costs. In this business case the first replacement of the battery, which takes place after 4 years of operation, requires the owner to invest additional equity in that specific year

3.5.4 Savings and Revenues

Today, a typical PV system owner does not have the possibility to sell their electricity via the grid. Instead, the customer self-consumes the PV electricity, which leads to savings in electricity purchases from the public grid/neighbourhood generation mix. The amount of kWh that can be saved depends also on direct PV consumption, meaning the % of useful electricity generated that can also be used at the time when consumption occurs. Good system configuration, taking into account times of use, leads to a proper dimensioning of the system and high direct consumption rates. For the business case it was assumed that 90% of the electricity generated by the PV system can also be used productively as the washing machine is operated during most days of the year and is only shut off on specific holidays.

With regards to electricity purchases, it was assumed that the customer purchases 60% of their electricity from the public grid. Public tariffs for commercial customer in Erbil were communicated to be one off prices, but it is also possible to find commercial tariffs in other Iraqi regions that are organized by consumption brackets like the tariffs for private households. In the case of commercial customers from Kurdistan, a one-off tariff of 130 IQD/kWh was communicated which corresponds to 9 USDct/kWh. The remaining 40% will be supplied from a regulated neighbourhood electricity provider. Over the years. the neighbourhood electricity tariff is expected to decrease by 1% per year. In the beginning. the customer would pay an average price of 13 USDct/kWh for their electricity mix, made of both grid electricity and electricity generated by a neighbourhood diesel genset.

In summary, the savings for the PV system are the following:

Figure 56: Commercial on-grid - Savings and Revenues

Savings and Revenues			
Applied Direct PV Consumption		%	90%
Grid electricity (public) price		USD/kWh	0.09
Share of grid electricity		%	60%
Price development grid electricity		% p.a.	2%
Neighborhood (NH) electricity price		USD/kWh	0.20
Share of neighborhood electricity	%		40%
Price development NH electricity		% p.a.	(1%)
Average electricity price paid (year 1)		USD/kWh	0.13

Source: eclareon. 2021

3.5.5 Financial results

The results for this business case are a positive net present value of 1,185 USD and an internal rate of return of 4.7%, which means that the PV system is an economically viable investment under the base case assumptions described above. The equity IRR would be higher if the project were 0% debt financed given that the cost of debt (the interest rate of 20%) is higher than the discount rate for the equity.

The equity investment is paid back after approximately 18.1 years using discounted cashflows and after 13.2 years if cashflows are not discounted. The LCOE for the installation would be 14 USDct/kWh. Therefore, the rooftop PV system is more competitive (over its lifecycle) in terms of LCOE, compared to the actual reference price of 0.17 USD/kWh for grid + regulated neighbourhood diesel. The Debt Service Coverage Ratio (DSCR) and the Loan Life Coverage Ratio are <1 which shows that the project cash flow would not suffice to cover the reimbursement of the loan. For “pure play,” project finance projects cover ratios of approximately 1.25 and would usually be required by the financing banks because project cashflows would be the only source of reimbursement of the loan (“non-recourse finance”). In our case, the bank loan would not be primarily granted based on the forecasted cashflows of the project, but rather on the creditworthiness of the owner. The next battery exchanges will be covered by the project cashflows based on the assumption that battery prices decrease by 5% p.a.

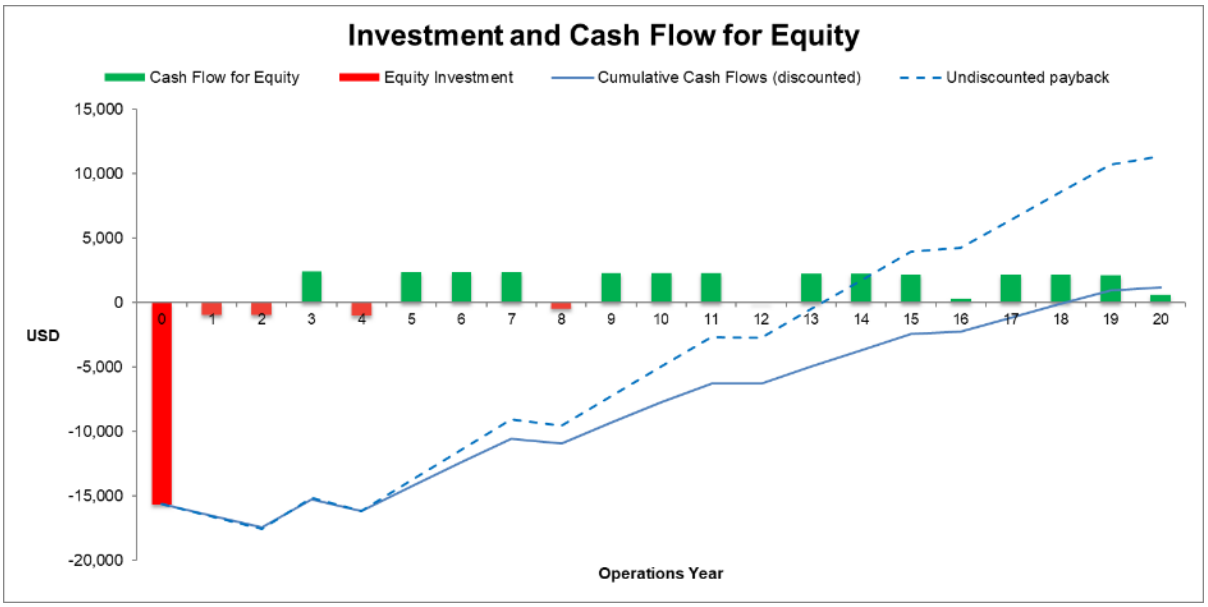
Figure 57: Commercial on-grid - Results

Results		
Net-Present Value	USD	1,185
Equity IRR	%	4.7%
Amortization - discounted payback period	Years	18.10
Undiscounted payback period	Years	13.22
LCOE (no subsidy)	USD/kWh	0.14
Min DSCR**	x	0.72 x
Min LLCR***	x	0.72 x

Source: eclareon. 2021

Looking in more detail at the business case, the equity cash flow for the base case looks as follows:

Figure 58: Commercial on-grid - Equity Cash Flow

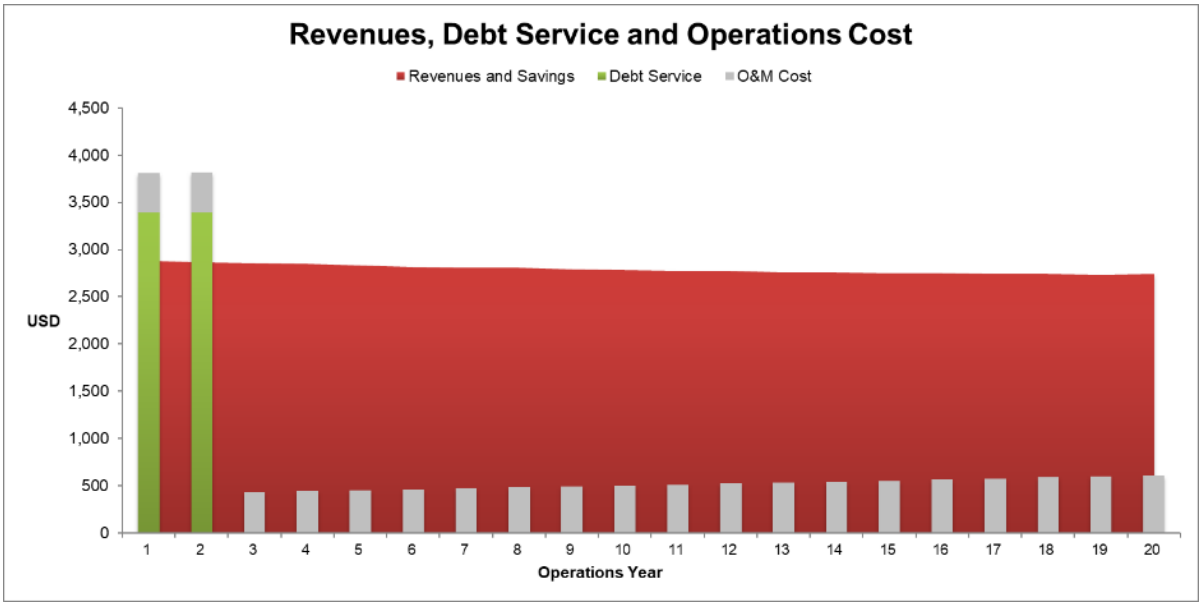


Source: eclareon. 2021

The investment takes place in year 0. In years 1 and 2 the equity cashflows are very low because during these years the project cashflow is used to pay back the bank loan. In year 4. the battery is exchanged for the first time, which again reduces the cashflows available for equity. The same happens in years 8, 12, 16 and 20. Independently from the battery exchanges, the cash flow for equity decreases each year due to a decreasing neighbourhood electricity price and because operating costs for the PV system escalate with inflation. The point where the cumulated cashflows cross the X axis shows the discounted payback period of 18 years, the dotted line shows the payback using undiscounted cashflows.

The following graph shows the revenues, debt service and the operations costs:

Figure 59: Commercial on-grid - Revenues. debt service and the operations costs



Source: eclareon. 2021

The debt service is shown in years 1 and 2. The revenues, savings from electricity purchases in this business case do not cover the debt service in years 1 and 2. During the remainder of the project, the revenues decrease based on a decrease of electricity prices as well as on the decreased performance of the PV system over the years. O&M costs increase in line with inflation.

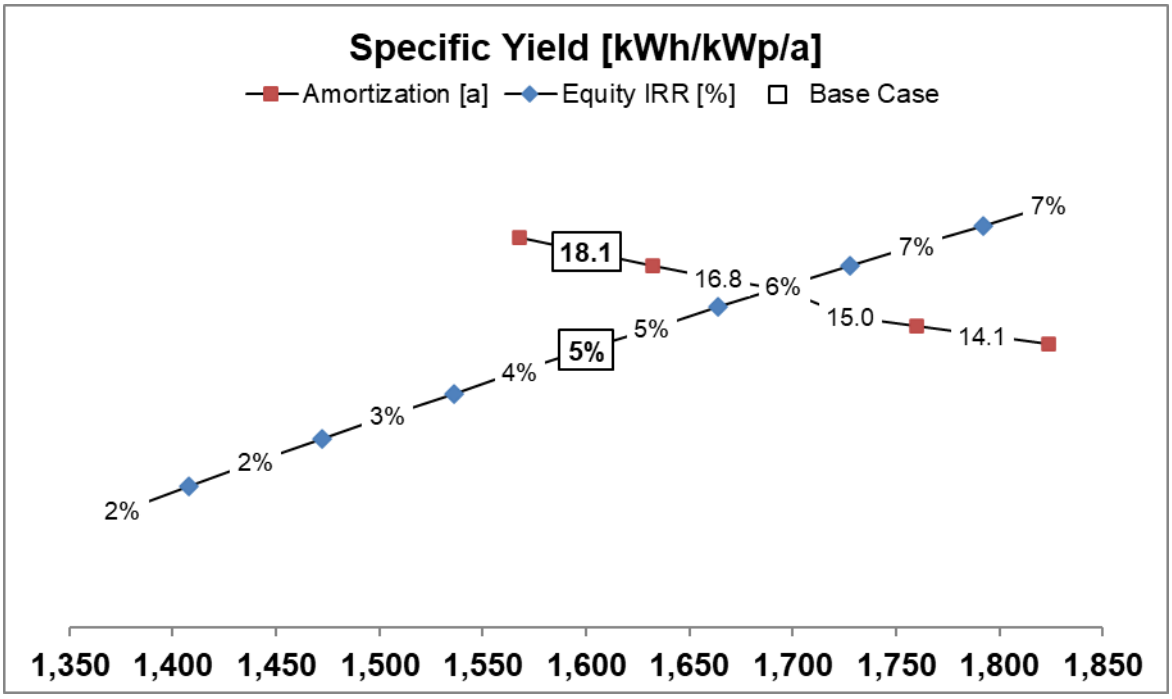
3.5.6 Sensitivity of results

The following figures show how two key economic performance indicators for the investment, that is discounted payback period (Amortisation) and return on equity (Equity IRR), change when some of the assumptions described above are modified. The figures show how variations of assumptions influence profitability.

The specific yield shows the kilowatt hours produced by a PV system per kWp capacity and per year. It is calculated based on solar radiation multiplied by the performance factor of the PV system. This factor includes the technical conditions for the efficiency of the PV system, the efficiency, orientation and inclination of PV modules, possible shadowing. etc.

The financial results for the PV installation improve when the system is built at a site with higher irradiation: the equity IRR increases when more electricity can be harvested and the payback period decreases at the same time.

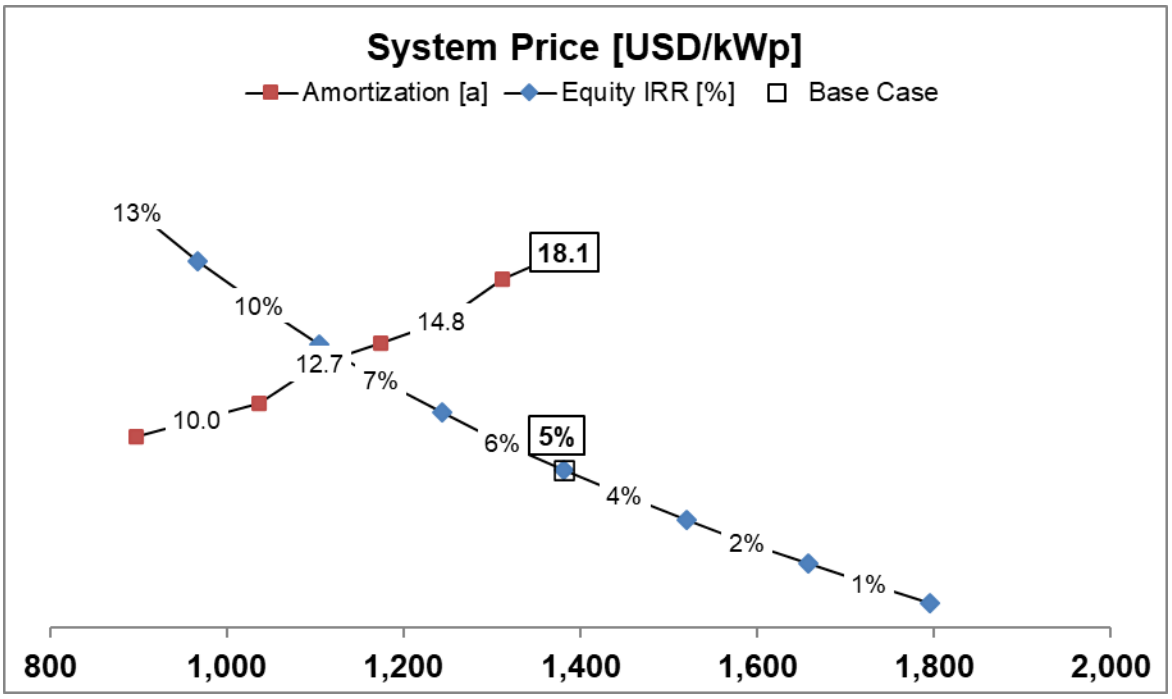
Figure 60: Commercial on-grid - Specific Yield Sensitivity



Source: eclareon. 2021

Another important factor to assess the economic viability of a PV system are its system costs: The higher these costs are, the less attractive the investment becomes.

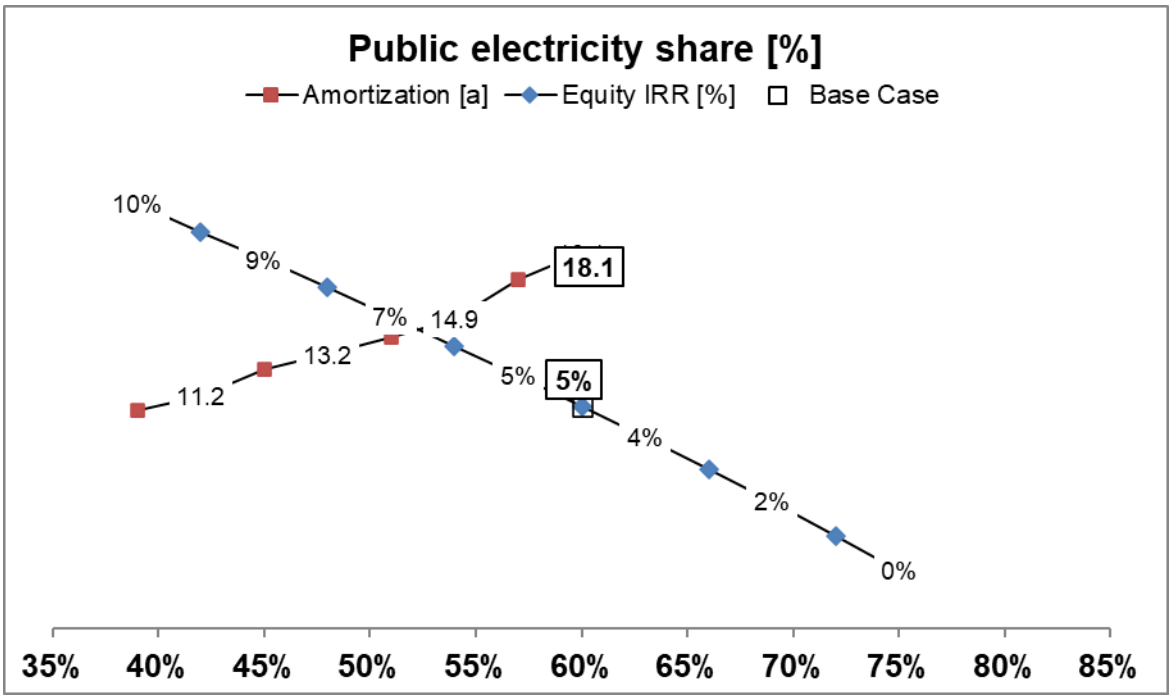
Figure 61: Commercial on-grid – System Price Sensitivity



Source: eclareon. 2020

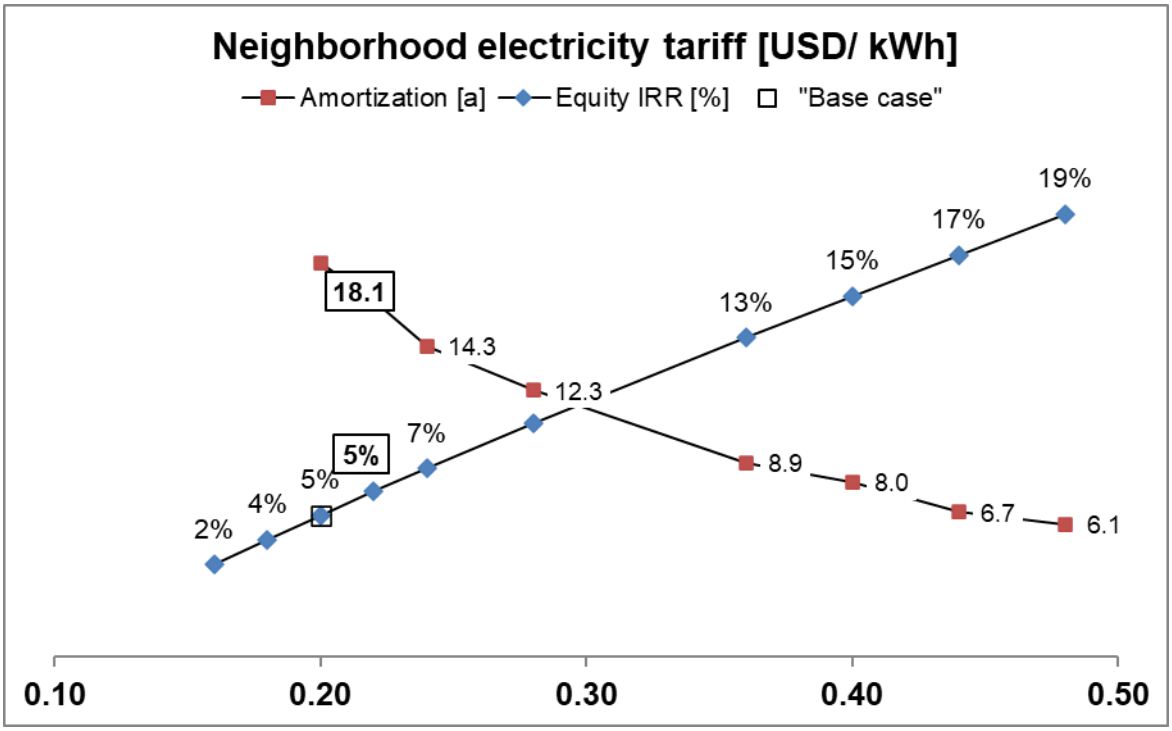
Another parameter that may vary considerably across Iraq is of course the mix between the low public grid electricity price and high neighbourhood electricity price. The more of the rather costly neighbourhood electricity the customer needs to buy, the sooner their PV investment will be paid back. Inversely, the higher the share of the cheap grid electricity, the longer the payback for the PV system will be.

Figure 62: Commercial on-grid – Public electricity share Sensitivity



Source: eclareon. 2020

Figure 63: Commercial on-grid – Neighbourhood electricity tariff



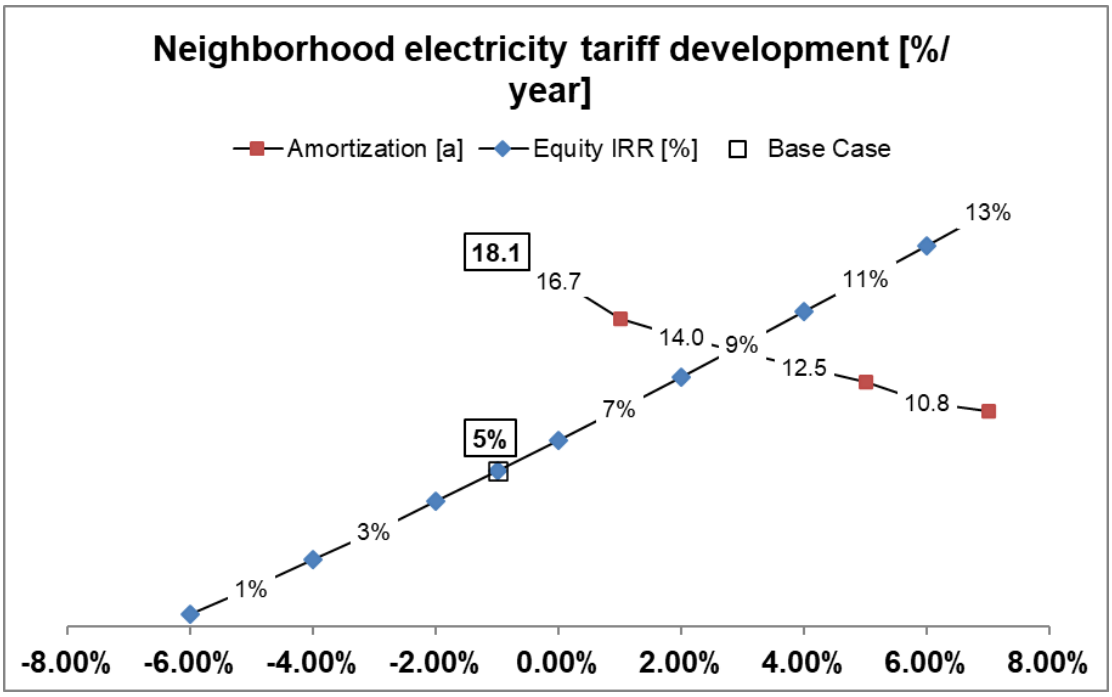
Source: eclareon. 2020

As can be seen in Figure 62, a share of grid electricity in the customer's electricity mix of > 60% would make the PV investment economically unviable for regulated neighbourhood tariffs of 0.2 USD/kWh. Inversely, if only about 40% of the customer's electricity mix is purchased from the grid (and about 60% from the regulated neighbourhood electricity provider), the PV system would already be paid back after less than 11 years.

Regarding the overall tariff value for neighbourhood generation, it is instinctively clear that the higher this tariff, the more economically viable the PV investment becomes. For instance, if a higher, neighbourhood tariff like the ones found for example in Bagdad (around 0.35 USDct/kWh) is applied, the discounted payback would be reduced to less than 10 years.

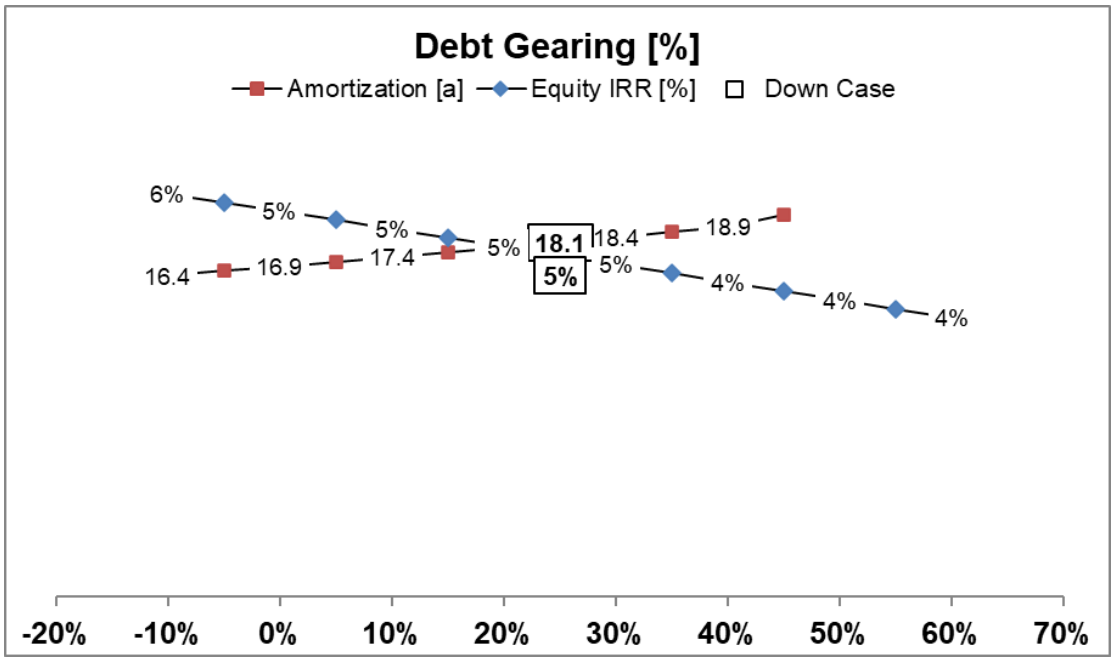
The next sensitivities in Figure 63 and Figure 64 show the future development of the tariff for neighbourhood electricity. In the base case. the annual decrease was set to 1%, which means that the neighbourhood electricity tariff will become cheaper every year based on the estimates of local market experts. In case this annual decrease was higher or lower, the payback period and equity IRR would change accordingly: if the neighbourhood electricity tariff decreased every year, the PV investment would become less attractive because potential savings decrease. In the opposite case of increasing neighbourhood tariffs, payback periods could become significantly shorter.

Figure 64: Commercial on-grid – Neighbourhood electricity tariff development



Source: eclareon. 2021

Figure 65: Commercial on-grid – Debt gearing



Source: eclareon. 2021

Finally, a debt gearing sensitivity is shown: the commercial case is the only case calculated with a bank loan. As the cost of debt with an annual interest of around 20% is higher than the

cost of equity, the equity IRR would decrease if the share of debt were increased. This is a paradox situation as usually costs of equity should be higher than costs of debt, given that the owners of the system have a higher exposure to risks. However, as previously stated, PV systems in Iraq would most often not be debt financed due to the high interests to be paid by the owner of the PV system.

3.6 Agricultural off-grid: solar water pumping system w/o storage vs. a privately owned fuel generator

Agriculture in Iraq contributed about 2% to the country's GDP in 2019[80] and employs about 18% of the Iraqi labour force.[81] Moreover, the agricultural sector is the largest water consumer in the country, accounting for 78% of total water production, however water wastage due to inefficient irrigation techniques is also high.[82] The Food and Agriculture Organization of the United Nations (FAO) states that "the total area which has been used for agricultural production is about 8 million hectares which is almost 67 percent of the cultivable area. However, due to certain limitations such as soil salinity, drought, shortage of irrigation water in summer, fallowing and the unstable political situation it is estimated that the average area cropped each year ranges from 3 to 4 million hectares."[83] Traditionally and still today, irrigation water has been mostly taken from surface water resources, but groundwater suitability for irrigation purposes is especially good in the Northern part of the country.

Addressing the water supply problems in agriculture, the next business case describes a 30 kWp PV system that provides the electricity needed to operate a solar water pump on a farm. With the extracted water the owner of the system can irrigate agriculturally used land. The amount of water that will be pumped depends on the ground water resources in the area and the efficiency of the pump. The business case assumes that the water pump is already in place but is operated by a privately owned diesel genset. The PV system substitutes the genset, therefore, the revenues are based on fuel savings. A chemical battery is not part of the PV system configuration but a physical storage unit like a water tank is already in place. Like this, the fields can be irrigated during the night to decrease evaporation losses and the overall efficiency of the PV system is increased, because it is able to operate in periods when the sun is not shining. It must be pointed out that a water pump should only be installed in areas with sufficient and sustainable water resources, as the system calculated here does not include water resources monitoring. The potential problem of over-extraction of water needs to be closely monitored.

The size of a PV system for an application like this depends mostly on the depth of the water resources, the size and efficiency of the pump and the demand for water. Solar water pump systems can range from single digit kWp to several 100 kWp. In case surface water is used for irrigation, the size of the pump and the dimension of the PV system would be smaller than for ground water pumping for the same volume of pumped water. Compared to the residential business cases, the PV system price per kWp is lower due to larger system size and because the installation is ground mounted and hence less expensive than rooftop mounted systems. Moreover, a farm is also considered a specific kind of business which according to the

[80] World Bank data, http://wdi.worldbank.org/table/4.2
[81] World bank data, https://data.worldbank.org/indicator/SL.AGR.EMPL.ZS?locations=IQ
[82] Quality of Surface Water and Groundwater in Iraq, Nadhir Al-Ansari et al., 2021, https://www.researchgate.net/publication/345896033_Quality_of_Surface_Water_and_Groundwater_in_Iraq
[83] FAO, http://www.fao.org/iraq/fao-in-iraq/iraq-at-a-glance/en/

interviews are the customer group which pays the lowest prices for PV systems in Iraq, given that there are business opportunities going beyond an individual installation. The irradiation values match the values of the previous two business cases.

3.6.1 Description of customer segment

A typical customer for this business case would be a farm from the Central or Southern regions where about 75 % of cultivated areas of the Iraq are located.[84] The customer is using surface pumps to irrigate their fields. Solar irradiation conditions in these regions are similar to those in the previous cases with an annual GHI of approximately 1.900 kWh/m^2 or 5.2 kWh/m^2/day.

The solar company interviewed had delivered a 30 kWp solar system to a farm that wanted to operate a separately purchased pump with solar energy. It was reported that the irrigation specific equipment (mostly importantly the pump but also tubes, a water reservoir, and potentially other components) are often purchased separately by the farmer in order to reduce costs. Therefore, the costs for this business case only include the required solar components.

3.6.2 PV System

The lifetime of the system was again set to a rather conservative 20 years. An increase based on the lifetime of the PV modules to 25 years would be reasonable, provided that the system is installed professionally and with “high enough” quality equipment which, according to local sources, is often not the case. All cash flows including financing for this first case are in USD, interest rates and inflation rate are also based on a mixture between USD and IQD inflation rates which are both relatively low, between approximately 1 and 2%.

Total turnkey PV system costs (capital expenditure. CapEx) for the PV system were as low as 1,000 USD/kWp. As prices for individual PV systems are influenced by different criteria such as the customer type and the complexity of the installation, this rather low price seems appropriate based on the range of system prices presented before. Battery storage is not part of pure irrigation system: instead, a water tank allowing for physical water storage is often part of the system configuration in case the water is not directly administered onto the fields or into irrigation channels. The costs for the water tank are not included in the PV system costs as it was reported that the farmer purchases the irrigation equipment (pump. tank. pipes etc.) separately and not from the PV company.

The applied direct PV consumption which determines what share of solar irradiation can effectively be converted into “useable” electricity was set, as before, to 80%. The PV system performance was assumed to decrease by 0.7% per year, accounting for the wear and tear of the system.

The operation costs were reported to account for about 3% of the system costs which is a rather high value but according to local sources the fixed costs can also reach up to 5%.

The PV system related base case assumptions are the following:

[84] Relief web, https://reliefweb.int/map/iraq/land-cover-iraq-derived-landsat-imagery-2000

Figure 66: Agricultural off-grid - PV System assumptions

PV System		
Project Duration	Years	20
PV System Size	kWp	30.0
Nominal storage capacity	kWh	-
Total PV system costs /kWp	USD/kWp	1,000
Total PV System Cost	USD	30,000
Performance Factor	%	80%
Degradation	% p.a.	0.70%
Applied Solar Yield	kWh/kWp/a	1,600
Average Yearly Generation	kWh/a	44,654
Fixed Operation Costs PV	% p.a.	3.00%

Source: eclareon. 2021

3.6.3 Financing of the system

The PV system in the business case was financed with 100% equity provided by the farmer. The equity is discounted with a rate of 5 % ,which is 3 % higher than the inflation rate. This rate is still rather low but higher than in the previous residential cases given that a farming business also needs to look at the profitability of its investment: it reflects that the farmer's primary objective is irrigate their fields and increase, crop quality which is their most important source of revenue.

In summary, the financing conditions for the PV system are as follows:

Figure 67: Agricultural off-grid - Financing assumptions

Financing			
Debt (Gearing)	-	USD	-
Loan Tenor		Years	-
Debt Interest Rate		%	-
Initial Equity		USD	30,000
Additional Equity		USD	-
Discount Rate		%	5.0%
Longterm Inflation Rate		%	2.0%

Source: eclareon. 2021

3.6.4 Savings and Revenues

The customer is self-consuming the PV electricity which leads to savings in fuel purchases for their fuel-powered generator that would otherwise power a water pump. The savings depend on the price of fuel and on the efficiency of the generator, meaning the kWh that can be produced by 1 litre of fuel. In addition, the amount of kWh that can be saved depends also on

the PV consumption, meaning the % of useful electricity generated that can also be used at the time when consumption occurs.

The applied direct PV consumption was set to 70% because the system supplies electricity only to a single appliance, the water pump. If this pump is not working the electricity generated by PV cannot be used productively. Moreover, depending on the farm and its agricultural products, more or less water may be needed depending on the seasonal irrigation requirements of the different crops. If water is pumped at times when no irrigation is required by the cultivated plant, water is wasted and water resources are unnecessarily strained. Pumping of water therefore needs to be closely monitored. If the farm is also active in livestock breeding the seasonal water requirements may not vary that much and the applied direct PV consumption may be increased. It also needs to be taken into account that revenues and ultimately the profitability of a solar irrigation system, do not depend only on diesel savings but also on the number of planting cycles per year. The more planting cycles exist (e.g. in a greenhouse), the more water can be used efficiently and the higher the applied PV consumption can be.

With regards to generator efficiency, it was assumed that the generator needs 1 litre of fuel to produce 3 kWh of electricity. The fuel is purchased for 40 USDct/litre and 13.5% was added for lube oil, which regularly needs to be exchanged. Fuel prices were assumed to remain stable and only increase by the long-term inflation rate of 2%. Given that the customer already owns a generator and wants to keep it as a backup system, neither generator purchase, nor replacement costs, nor other operating costs were considered for this business case.

In summary, the savings for the PV system are the following:

Figure 68: Agricultural off-grid - Savings

System Operation - Savings		
Applied Direct PV Consumption	%	70.00%
Applied Battery PV Consumption	%	-
Genset Efficiency	kWh/ltr	3.0
Average Replaced Fuel Consumption p.a.	ltr/year	10,419
Fuel Price (1st Ops Year)	USD/ltr	0.40
Oil costs as % of fuel costs	%	13.50%
Fuel Price Escalation	% p.a.	2.00%
Genset CAPEX fee saved	USD p.a.	-
Genset OPEX fee saved	USD p.a.	-
Generator related savings (average)	USD/kWh	0.13

Source: eclareon. 2021

3.6.5 Financial results

The results for this business case are a positive net present value of 29,248 USD and an internal rate of return of 14%, which means that the PV system is an economically viable investment under the base case assumptions described above. The equity investment is paid back after approximately 6.-8.3 years: longer using discounted cashflows, shorter if cashflows are not discounted. The LCOE for the installation would be 8 USDct/kWh. Hence, the PV system's LCOE is 5 USDct lower than the average kWh generated by the fuel genset.

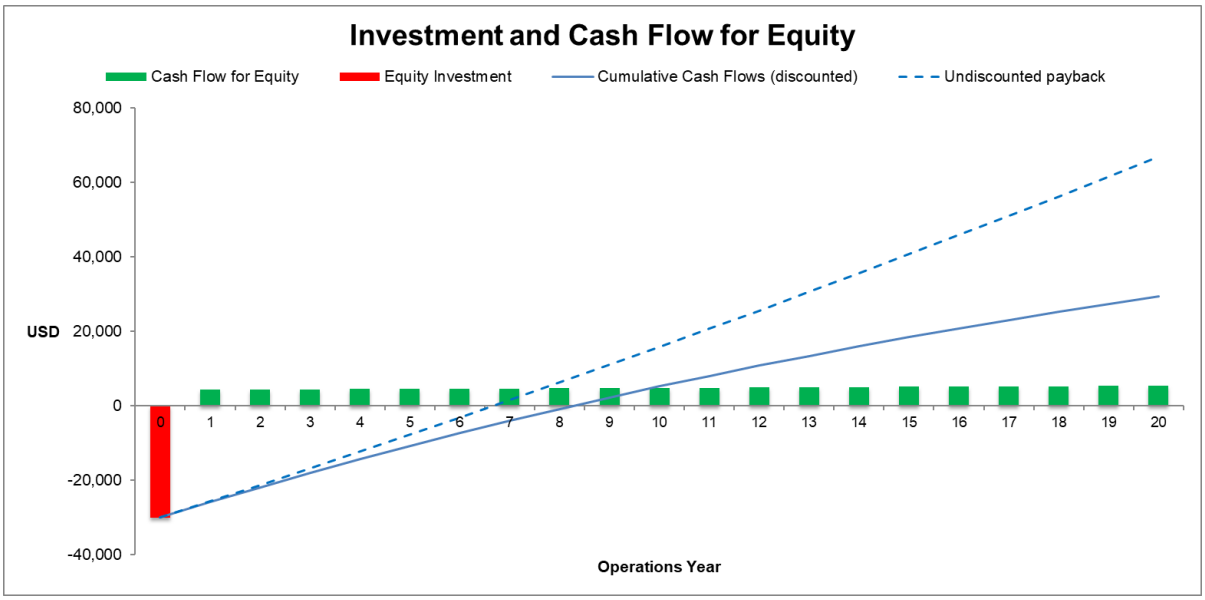
Figure 69: Agricultural off-grid - Results

Results		
Net-Present Value	USD	29,248
Equity IRR	%	14%
Amortization - discounted payback period	Years	8.27
Undiscounted payback period	Years	6.68
LCOE (no subsidy)	USD/kWh	0.08

Source: eclareon. 2021

Looking in more detail at the case, the equity cash flow for the base case looks as follows:

Figure 70: Agricultural off-grid - Equity Cash Flow



Source: eclareon. 2021

As can be seen the cash flow for equity is stable each year due to a stable fuel price and hence stable savings. The point where the cumulated cashflows cross the X axis shows the discounted payback period of approximately 8.2 years.

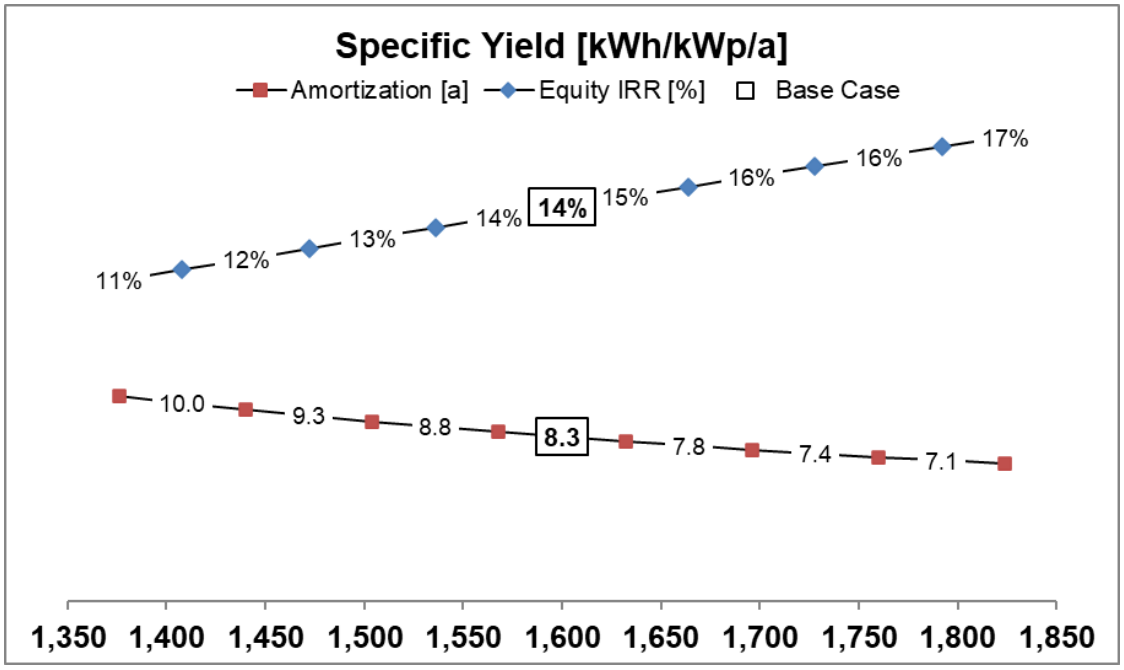
3.6.6 Sensitivity of results for this Agricultural Off-grid Business Case

The following figures show how two key economic performance indicators for the investment, that is discounted payback period (Amortisation) and return on equity (Equity IRR), change when some of the assumptions described above are modified. The figures show how variations of assumptions influence profitability.

The specific yield shows the kilowatt hours produced by a PV system per kWp capacity and per year. It is calculated based on solar radiation multiplied by the performance factor of the PV system. This factor includes the technical conditions for the efficiency of the PV system, the efficiency, orientation and inclination of PV modules, possible shadowing. etc.

The financial results for the PV installation improve when the system is built at a site with higher irradiation: the equity IRR increases when more electricity can be harvested and the payback period decreases at the same time.

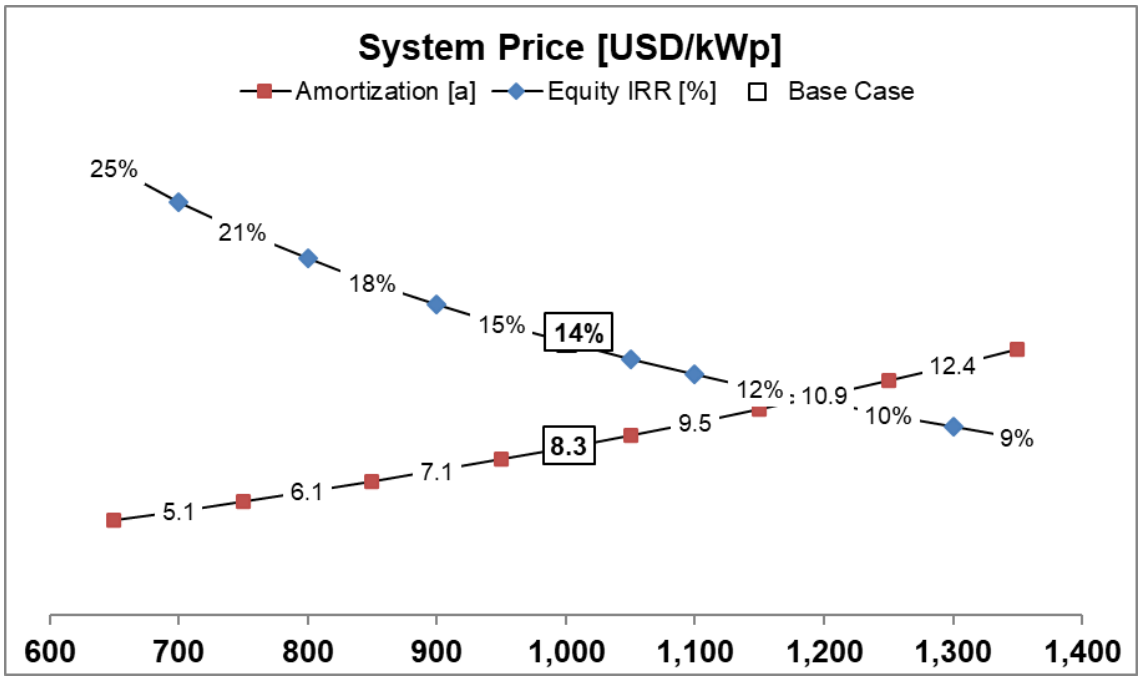
Figure 71: Agricultural off-grid - Specific Yield Sensitivity



Source: eclareon. 2021

Another important factor to assess the economic viability of a PV system are its system costs: The higher these costs are, the less attractive the investment becomes.

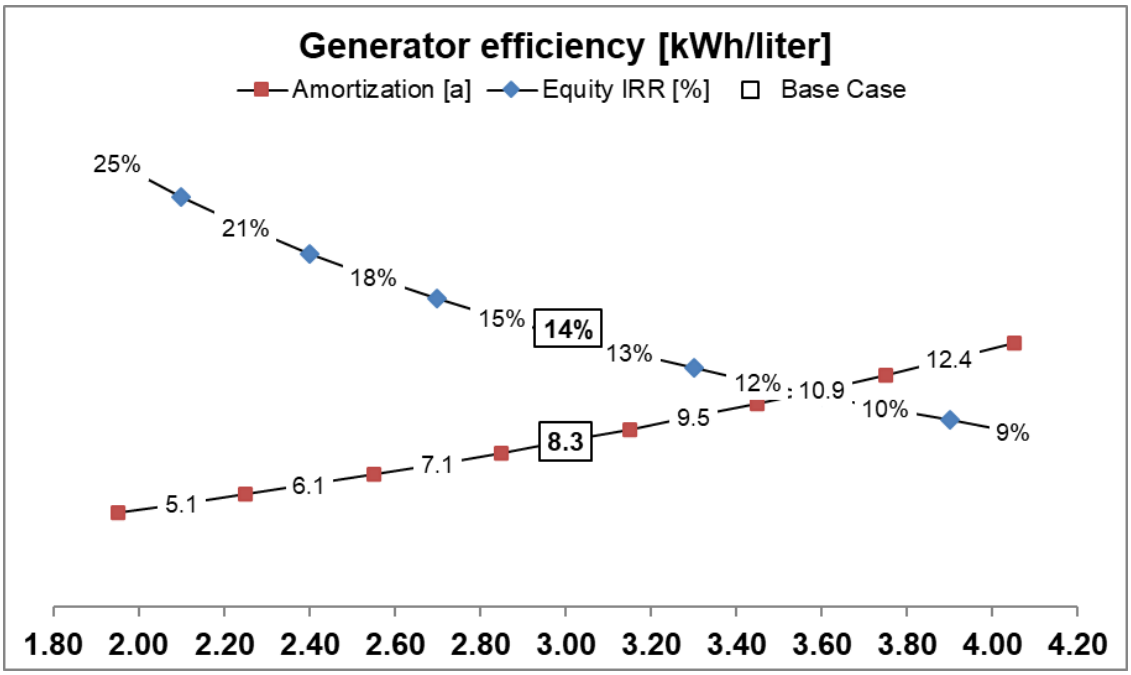
Figure 72: Agricultural off-grid – System Price Sensitivity



Source: eclareon. 2021

Another parameter that has an impact is the generator efficiency. The more kWh can be generated with one litre of fuel, the more efficient the generator is and the less attractive the PV investment becomes. Inversely, if less kWh can be generated with a litre of fuel, the shorter the payback for the PV system will be. As can be seen in the graph below, a kWh/litre ratio of 3.6 instead of 3, as in the base case, would result in a payback period of more than 11 years. Inversely, if 1 litre of fuel generates only 2 kWh of electricity the payback period would be reduced to less than 5 years.

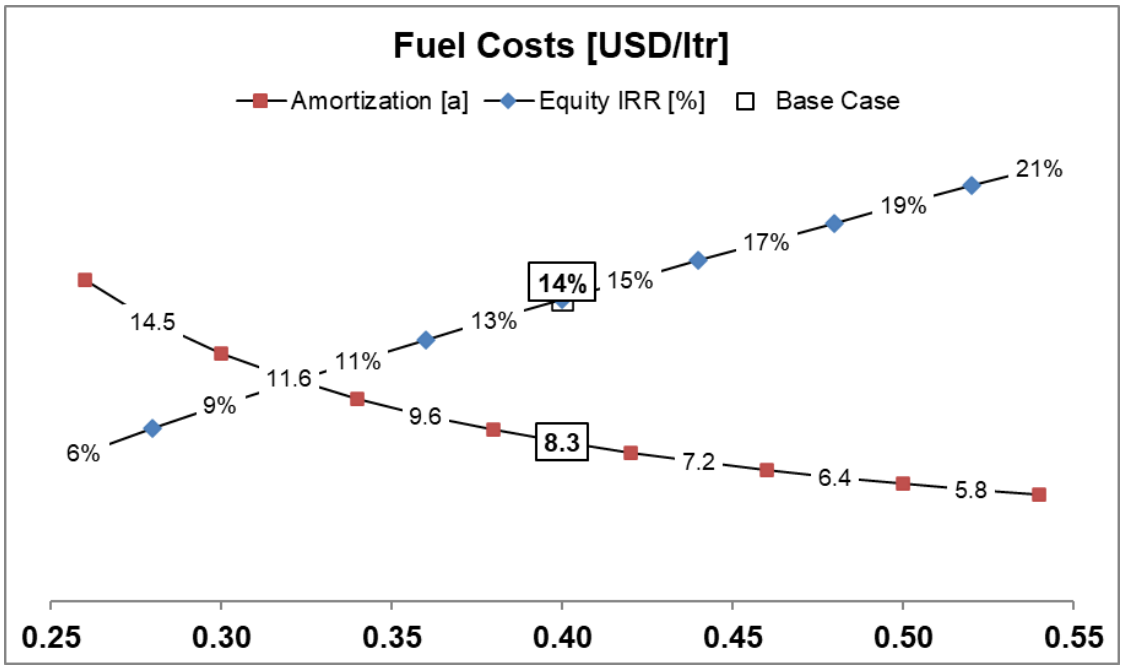
Figure 73: Agricultural off-grid – Generator efficiency Sensitivity



Source: eclareon. 2021

Regarding the fuel price for the generator it is clear that the higher the price for fuel, the more economically viable the PV investment becomes. However, if the initial fuel price were much lower than 30 USDct/litre, the PV investment could not be paid back, all other assumptions remaining equal.

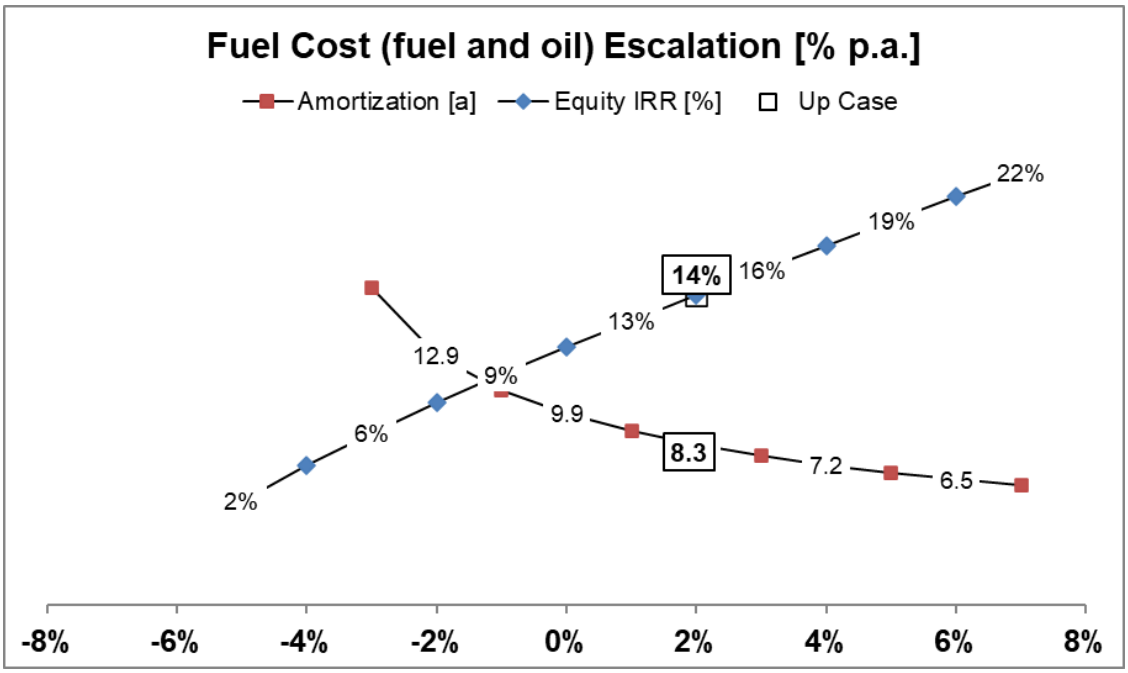
Figure 74: Agricultural off-grid – Fuel costs



Source: eclareon. 2021

The next sensitivity alaysis shows the future development of the price for fuel products. In the base case, the annual increase was set to 2% which means that fuel prices will increase but only along the long-term inflation rate of 2%. In case this annual increase was higher or lower, the payback period and equity IRR would change accordingly: if fuel prices decreased every year, the PV investment would become less attractive because potential savings decrease. In the opposite case of increasing fuel prices, payback periods could become significantly shorter.

Figure 75: Agricultural off-grid – Fuel cost development



Source: eclareon. 2021

3.7 Conclusion of Economic analysis

Both on-grid and off-grid business models for both residential and commercial/agricultural customer groups were analysed. Two business cases included battery storage and two did not. Key assumptions and results (of the base cases) are summarized in the table below:

Table 9: Summary of business cases

	Residential on-grid (section 3.3)	Residential off-grid (section 3.4)	Commercial on-grid (section 3.5)	Agricultural off-grid (section 3.6)
System size	1.5 kW	3 kW	15 kW	30 kW
System price	1,200 USD/kWp	1,600 USD/kWp	1,382 USD/kWp	1,000 USD/kWp
Battery included	No	Yes	Yes	No
Debt/ equity share	0% / 100%	0% / 100%	25% / 75%	0% / 100%

Cost of equity (discount rate)	3%	3%	4%	5%
Cost of debt (interest rate)	N/A	N/A	20%	N/A
Equity IRR	9%	13%	4.7%	14%
Discounted payback period	10.3 years	9.2 years	18.1 years	8.2 years
Undiscounted payback period	8.6 years	7.5 years	13.2 years	6.7 years
LCOE	0.08 USD/kWh	0.17 USD/kWh	0.14 USD/kWh	0.08 USD/kWh

Source: eclareon. 2021

It can be concluded that there are viable PV business models throughout different private customer segments. Regarding the investment criteria triangle presented at the beginning of this section (please refer to section “3 Economic analysis of Business Models”), the following can be said:

Profitability for an equity investor over a 10-year time horizon is between 5-14%. Payback periods vary between 6 and 18 years, which may be a long-time horizon for some customers especially if they judge it impossible to predict with “good enough” certainty what will happen in the next years (at least until payback is reached). Profitability is determined by the savings realized by purchasing less grid electricity or less fuel for a generator. Public electricity is very inexpensive which has a negative impact on the profitability of solar PV installations. Neighbourhood diesel prices are in contrast expensive, which improves the profitability of PV. The seasonal and regional/local differences with regards to (neighbourhood) diesel prices are considerable (see Figure 9), which also means that the profitability of a PV system strongly depends on the local electricity market conditions.

Regarding liquidity it was found that there is only limited access to loans from commercial banks. Given the high interest rates that banks may charge, bank financing would currently have a negative impact on project profitability because there is no debt leverage effect, meaning that debt financing does not bring down the overall costs of financing for the PV system wherein instead debt financing increases the average costs of capital.

Today, the risk level potentially linked to the stability of the local and regional energy markets and the predictability of future developments is the most important obstacle to invest in PV in Iraq: the perception of risk encompasses many criteria and will mostly be different for every individual investor based on, for example, their experience with PV technology and PV companies and the satisfaction with their current electricity supply, including the available electricity supply alternatives, the quantity of electricity available and the price of the electricity.

Moreover, the inclination of a potential PV customer to invest in PV does not only depend on today’s situation but also on their expectations regarding the stability and predictability of their future energy supply situation: the financial models presented in this report presume future parameters to be both relatively stable and comparable to today’s situation. However, if an

investor believes that there is a high enough probability that the situation will change in the future, they may be either more or less inclined to invest in PV which is, by the nature of its investment structure (high upfront costs (CapEx) and low O&M costs (OpEx)), a long-term investment that requires to be able to predict the future development reliably enough.

For instance, if a grid-connected customer believes that the share of their inexpensive public electricity supply will be substantially higher in the future than today and that the expensive neighbourhood electricity is bound to disappear in the short run, this customer may not invest in PV right now. However, if the government, pressured by international institutions, was to announce a reform of the public power tariffication system, this would drive the customer to consider a PV investment, especially if tariffs are expected to rise significantly. If, by contrast, customers expect neighbourhood electricity to become even more important and/or more expensive in the future, a PV investment will become more attractive to them. If they do not know what the future will bring, they may simply delay their investment decision until a moment in the future when more reliable information will be available.

The perception of risk and the risk level that is still acceptable is different for every investor. In finance, risk levels would be reflected in the costs of capital of both the owner (cost of equity which is the equity discount rate used in the models) and of the lender (costs of debt). Equity would usually be more expensive than debt in order to reflect the higher risk exposure of the owner: the risk of the bank is limited to the credit amount and secured by collateral from the owner. The owner is exposed to default risks and other market risks such as a decrease in electricity prices etc.

As was stated by many stakeholders, Iraqi commercial banks only rarely finance PV. If they do, the interest rate would be around 20%. If the equity owner asked for the same compensation for their investment the business cases would not be profitable.

4. Supporting viable PV business models for strong business growth and impact on job creation

From the various PV related business models that have been implemented successfully throughout the world for different PV applications and market segments, only the most basic ones have so far been implemented by Iraqi solar entrepreneurs. Among them is the EPC[85] model which involves a one-stop-shop approach where interested clients can order a turnkey PV system and are provided by one single contractor with PV-system engineering, components' selection, logistic delivery of all components to the construction site, construction/installation and commissioning of the system. Often, an operation and maintenance service contract will complement such a construction contract. We have identified 17 Iraqi companies (see Annex 6.4) that have been active in recent years, among which 6 are located in the region of Erbil (KRG), 8 in the region of Baghdad, and only 3 in the region of Basra, where the solar market is the least developed. Although PV market dynamics seem to be gaining pace recently through a developing demand from first-mover clients, these solar companies are developing moderately but with consistency. Given the still relatively small PV sales volumes, companies struggle to provide more competitive prices that would be comparable to those in more developed international markets.

Most interviewed Iraqi experts agreed that the PV market offer must be developed by private sector companies because state-owned companies generally neither have the motivation, competence or the operative efficiency and customer-oriented business culture to serve private clients. However, even though the private sector is the key to bringing PV technology to the market, all experts underlined that it remains crucial that the country's main electricity actor, the Ministry of Electricity (MoE), leads and strongly supports the market introduction of PV technology by setting and effectively implementing ambitious policies. The landscape of industrial and commercial companies in Iraq that could someday engage into the PV business can be distinguished into 3 categories:

Tier-1 companies: A few large, established companies able to compete on international markets. An example is Mass Group Holding active in power plants, cement and steel who have access to international capital markets. These large professional companies, often stemming from the sectors of refinery, power generation or construction are potential candidates to integrate PV business activities, provided the framework conditions for PV in Iraq are significantly improved and that business practices in the PV sector are transparent and ruled by good governance approaches. Good governance problems frequently occur during the implementation of larger contracts; they can result in complete contract failures and significant financial losses. Hence, larger Iraqi companies are generally hesitant to enter new business fields where they lack operational knowhow or have even gathered negative experiences.

Tier-2 companies: Middle sized companies in various sectors that have the potential to ascend to Tier-1 with dedicated support by the government. These companies generally have enough access to capital but tend to lack the necessary modern management skills to participate in international markets.

[85] EPC = Engineering, Procurement, Construction

Tier-3 companies: Generally local SMEs with business practices that do not qualify them for international markets or that practice "bottom fishing," meaning they are look for easy business opportunities. They typically participate in public tenders and sub-contract the awarded works with arbitrage type of revenues. These are often poorly managed and can lack serious practices or even venture into illegal activities.

While currently active small Iraqi solar companies belong primarily to the Tier-3 segment, the more potent private sector actors among Tier-1 and Tier-2 companies are not yet showing signs of interest in engaging in the PV solar business. In addition, no foreign solar company has so far engaged into systematic market activities in Iraq because the market demand currently does not justify any investment in commercial activities. Furthermore, the currently unfavourable market framework conditions for PV in Iraq and the still problematic and complex security situation in the country discourage foreign solar companies from engaging; they can find many countries today throughout the world where the conditions for solar business are more attractive and thus business opportunities more enticing.

The most promising PV applications from an economic point of view and under current local market conditions have been identified in Chapter 2 and financially analysed in Chapter 3. Currently, the most obvious market opportunities to be tackled by Iraqi companies are in the segments of small and midsized PV systems for private households, farmers and SMEs in the commercial and industrial sector. Should long awaited utility scale PV projects finally materialise, then local solar companies should be systematically involved in their implementation wherever possible, ideally by requiring local content shares in the international tendering procedures.

4.1 Typical PV oriented business activities along value and supply chains

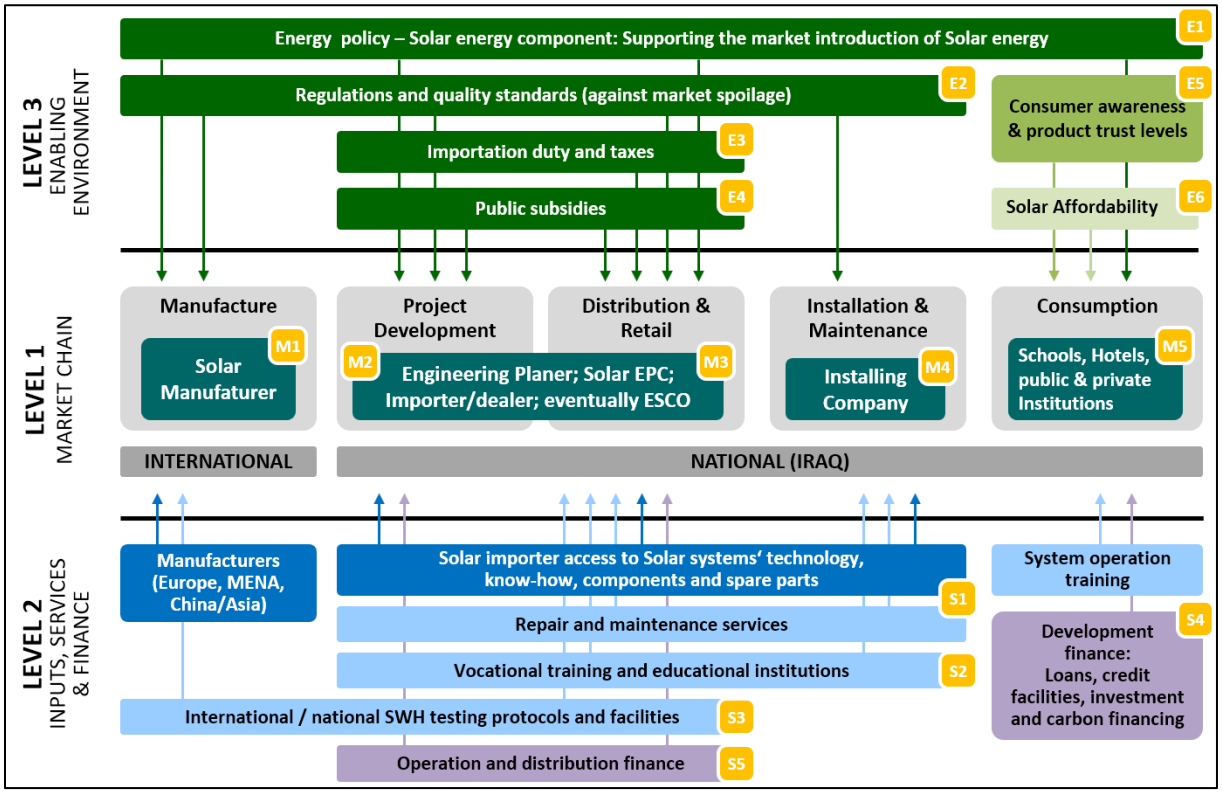
Solar companies evolve in economic, social and political environments that are more or less favourable to their solar business activities. The solar PV market in Iraq, as described in Chapter 2, and the many processes that describe and characterise its actual functioning are modelled in Figure 76.

All possible local solar PV business activities are represented in "LEVEL 1 – Domestic Market Chain". They are provided by various "LEVEL 2" suppliers, often from foreign countries, notably for PV power equipment as well as specialised knowhow and financial services. All market actors, but especially local Iraqi companies active in solar PV, are subjected to national and regional market framework conditions - displayed in "LEVEL 3 – Enabling Environment". These environments can vary considerably on regional and local levels, especially in Iraq due to geographic, climatic, cultural, political and other differences. The yellow squares with 2-digit codes marks specific identified issues in the Iraqi market environment which are summarized at the beginning of Chapter 5.

LEVEL 1 displays from left to right and in functional order the main companies and their business models along the solar PV value chain: It logically starts with solar manufacturers, followed by a variety of different types of specialist and generalist companies that are active along the sales-oriented value chain links (or market functions) of 'Project development', 'Distribution and retail' and 'Installation'. Here, there are two main categories of companies and business models:

1) Specialist companies are mainly engineering companies (such as individual system planers and planning offices), distribution companies (such as importers, wholesalers and retailers) and installation companies. This category of companies generally works in line with long established market functions and traditional business models that rely on a division of labour and clear interfaces. These types of specialised SMEs are most common in Iraq today.

Figure 76: Solar market and value chain model in Iraq



Source: BSW/Olivier Drücke, 2021

2) Generalist companies tend to integrate all distribution- and sales-oriented market functions under one single brand that offers turnkey PV systems to their clients. They are often called integrators or EPC-companies and some solar companies with this one-stop-shop approach are already active in Iraq (ex. Renewable Energy House with branches in Erbil and Basra). These companies either provide all offered services themselves with their own personnel or by subcontracting certain functions to specialist companies, thereby also affecting established margin policies along the value chain. Another category of generalist companies are those which buy equipment in wholesale and then retail various household appliances ("white goods") or other electric equipment. Energy Service Companies (ESCO[86]) do not focus on selling energy systems, but rather on installing their own proprietary renewable energy systems which then provide end-users with energy services, generally in the form electrical and thermal kWh delivered in the frame of Power

[86] ESCO stands for Energy Service Company. The term Energy Savings Company is also used. It is a company or an entity that delivers energy services or other energy efficiency improvements in an energy user's premises, and accepts some degree of financial risk in doing so. The range of energy solutions includes designs and implementation of energy savings projects, retrofitting, energy conservation, energy infrastructure outsourcing, power generation and energy supply, including risk management.

Purchase Contracts (PPA). The B2B business model of ESCOs is not yet established in Iraq, although neighbourhood generators could theoretically be assimilated into the ESCO model, however this is unlikely in practice because these power suppliers do not care at all about the environment nor about the consumptive and financial efficiency on the side of their customers.

4.1.1 Upstream manufacturing activity business models

The PV manufacturer Al-Mansour which started in the early 80s as a spin-off venture from the Ministry of Industry ceased manufacturing activities many years ago because of a lack of competitiveness and adverse market conditions. There are presently no plans to establish any PV oriented manufacturing in Iraq, given that the local industrial knowhow deficit and market framework conditions do not allow Iraq based manufacturing to compete with the international state-of-the-art of PV-module manufacturing technologies and world market prices. Iraqi solar companies will therefore continue to purchase all PV-related equipment abroad in the foreseeable future. This does not mean however that new opportunities could not arise in the coming years as Iraq theoretically has enough resources to venture into establishing new industries that can supply the solar sector.

4.1.1.1 Linkages between the solar sector and other sectors in the economy

Most of existing industrial value chains in Iraq are aligned to the procurement requirements of the oil industry. These are generally basic commodity industries active in steel processing or plastic products. Several significant steel manufacturers are active in the region of Erbil (Erbil Steel Company, Steel Field Company, Darin Steel Company) who may be able to produce mounting structures for PV systems. However, such steel structures need to be treated to withstand long-term corrosion and most PV solar field support structures today are made from aluminium because of its lower weight and non-corrosive properties. Since there are no active aluminium producers in Iraq, these products are bought from more competitive neighbouring markets in Iran, Jordan or Kuwait by several Iraqi companies that process aluminium sheets for applications in the oil industry. There are also several plastic products manufacturers, notably in the field of plastic tubing, but no obvious PV related manufacturing such as electric cabling is visible so far.

Some of these companies may have the potential to integrate the manufacturing of selected basic PV related components or supplies such as those mentioned above, but they would require strong regulatory support by the government in the form of concrete and reliable national solar market development policies that are combined with Local Content Regulations (LCRs), thus motivating local manufacturers to invest in corresponding capabilities. Iraqi politics has tried in past years to make advances on these two key preconditions for a systematic solar market development, but nothing concrete has been achieved so far. Furthermore, local manufacturers presently have no access to domestic or foreign investment capital and state-controlled companies suffer from tight public budgets in times of fluctuating international oil prices and pandemic induced economic recession. Potential foreign PV-technology partners are currently reluctant to allocate their resources under extreme risks into Iraq's unstable economic and policy environment, especially as the global PV boom offers them countless opportunities to invest in much more stable countries and promising market environments.

A way out of this current deadlock may consist in Iraq's collaboration with big multinational oil and gas companies that are increasingly engaging into solar power under the pressure of

international climate protection politics. The French energy company Total has just recently signed a multi-billion dollar deal with the Iraqi government to implement four energy projects, among which is the construction of a 1 GW solar PV power plant.[87] Total Energie has evolved into a major player in solar energy and provides all types of PV systems ranging from small and midsized systems to utility scale power plants. Similarly, traditional power utility companies from all over the world are beginning to venture into solar power markets in emerging markets. Therefore, although international solar PV specialists are reluctant to enter the Iraqi market, the pivotal gamechanger could come from large energy multinationals who have oil business interests in Iraq but also the financial means and technological knowhow to help establish solar PV in Iraq.

4.1.1.2 Local production and technological leap-frogging

If such strategic energy collaborations are also systematically oriented towards solar power, they could allow the country to leapfrog the considerable technology gap that has developed since the first Iraqi PV venture Al-Mansour Factory abandoned its PV manufacturing activities. However, given the state economy driven business culture in the country, malpractice and tribal decision-making realities on the ground, all of which strongly discourage foreign companies from investing in Iraq, such technology and manufacturing leap-frogging opportunities would require dedicated strategic and innovative solar industrialisation policies from the government that prioritise major domestic private sector players and the creation of special economic frameworks and zones that are aligned with international business practices.

During the interviews conducted with Iraqi experts three potential fields of activity connected to solar PV value chains emerged repeatedly:

1) One the world's biggest silica resource is located in Anbar province, Western Iraq, with a mining potential of about 330,000,000m³. Initial price benchmarking studies comparing the potential mining costs in Anbar with world market prices have been discouraging, but it is likely that well-designed strategic co-operations with international silicon manufacturers for the PV and semiconductor industries would open up avenues for Iraq to exploit this abundant natural resource.

2) Iraq's harsh and dusty environment poses particular problems for the efficient operation of solar fields because PV modules are quickly covered with thick and persistent dust layers. These adverse conditions could also be seen as an opportunity for the development of new technologies that improve the performance of PV modules, thereby opening international market potentials in similarly demanding environments throughout the globe.

3) The extremely hot climate and the ever-rising cooling loads from AC systems are the main contributor to Iraq's unstable grids. What is considered a curse by discontented populations each summer and has remained an unsolved problem throughout hot countries on the sunbelt could actually also be seen as an opportunity to tackle a dormant market potential that is not only enormous in Iraq but internationally. Engineers at KESK in Erbil are working on solar AC systems that could reduce some of the extreme loads stemming from conventional AC split systems.

These three fields provide concrete co-operation opportunities with specialised international solar components manufacturers that could be backed by international technology development funds. Even though solar technologies have come a long way in the past 30-40

[87] Total signs multi-billion dollar deal for four energy projects in Iraq (nsenergybusiness.com)

years, there are always market gaps to fill, especially for applications that are non-typical for the origin countries of those established manufacturers and for which no ideal solutions yet exist on the world market.

4.1.2 Downstream commercial activity business models

Several companies are already active in distributive functions along the Level 1 solar PV value chain, as displayed in Figure 76 and briefly explained in the paragraphs around it. While wholesale, trade and retail companies are not yet active in the sector, because the demand for solar is still in its infancy, several EPC-companies have become active in recent years. As 'one-stop-shops' they generally also take care of installation and O+M functions. More than half of these new entrants are said to have serious knowhow deficits and therefore tend to offer substandard quality systems because of:

a) the choice of low-cost equipment generally stemming from unprofessional Asian suppliers, in an effort to lower the PV price threshold considered as high by their customers, and
b) poor system engineering and installation, which will often generate rapid disappointment among their pioneer customers because PV systems that should work for at least 20 years fail within the first 1-2 years of operation.

This quality issue is quite typical for new PV markets in developing or transition countries where quality standards have not yet been established and where customers are therefore unable to differentiate between quality levels. However, people are learning from bad experiences and are therefore increasingly requesting quality products, thereby forcing existing suppliers to professionalize their offering.

Besides technical knowhow deficits, another major weakness is the professional marketing required to identify, address, convince and retain new customers. As in many Arab countries, engineering disciplines traditionally dominate the professions chosen by Iraqi university graduates, with an increasing share of females. Micro-economics and marketing disciplines are drastically underrepresented, although the income perspectives they offer are often more attractive because of the current oversupply of engineers. Generally speaking, engineers are good at solving technical problems, but often weak at selling solutions and effectively convincing clients. The need for and remuneration of business management disciplines will therefore further increase as Iraq opens its economy to world markets and adopts more market-driven economics.

Today, the widespread technical orientation and reasoning of engineer elites serving Iraq's oil-based state economy results in widespread business management deficits on all levels, which are mirrored in weak entrepreneurial and business cultures and consequently in companies which are fragile in their national context and lack competitiveness on international markets. In order to be more successful, solar companies must urgently learn to approach their clients from a customer benefit-oriented marketing perspective, rather than using technology driven sales approaches which fail to persuade the majority of potential clients. Furthermore, system solutions must be tailored to regional and individual customer requirements and habits, which means that suppliers need to adapt to their customers and not the other way around.

The rise of internet communications has made modern marketing techniques much more accessible and affordable to small and medium companies. Effective sales strategies are not necessarily expensive nowadays, but these new techniques require competent business managers and marketers, which the country largely lacks. These gaps need to be

systematically addressed to allow decentralised solar energies to gain ground in the context of a dramatically inefficient centralised energy system.

While local humanitarian initiatives such as solarised refugee camps and communities in the Kurdish provinces of Northern Iraq, as well as sporadic market development projects financed by international donors, are already facilitating the emergence of the first local solar suppliers, this will not suffice to create a sustainable Iraqi PV supplier base. The intended development of a sustainable solar market will clearly require the Iraqi state to establish a conducive market framework and business environment for distributed solar energies. The intended penetration of solar power can furthermore be significantly accelerated by involving the growing numbers of foreign specialised solar SMEs to partner with Iraqi companies. Examples of such PV market activating strategies can for example be observed in western and eastern African countries such as Senegal, Benin, Kenya or Tanzania, which are opening their centralised power sectors to foreign solar companies in the context of rural electrification, mid-sized C+I as well as utility scale projects. Here the key is to compel highly professionalised foreign PV system suppliers to collaborate with local companies, thereby involving and systematically training local entrepreneurs and workforces. Such approaches are all the more realistic, as foreign PV suppliers will be attracted by the business opportunities of the significant Iraqi market potential, but reluctant to establish themselves permanently in Iraq as long as the region and the country remain torn by chronic instabilities.

4.2 Market barriers, challenges and risks for the private sectors

This chapter provides a summarized overview of barriers and risks encountered by companies and their job creation in the so far slowing evolving PV sector in Iraq, some of which have been mentioned in previous chapters. It can be said that the number of barriers and risks is particularly high in Iraq, so that local and foreign solar suppliers face an unusually high number of challenges impeding the success of their business activities. Not all barriers can be removed at the same time, especially as many of them are deeply entrenched into the national culture and others are caused by external factors that cannot be influenced by Iraqi actors alone. An individual prioritisation of more or less influenceable barriers and a set of risk mitigation measures needs to be defined by each actor engaging into the solar PV business on Iraqi soil, which will strongly depend on the market entrance strategy chosen. The obstacles and risks addressed in the following apply in more or less equivalent manners to the distinct PV market segments of small, mid-sized and utility scale PV systems.

4.2.1 Brief barrier analysis

Political barriers

Given its organisation as a state economy system, there is no real concept of market economy processes in the country. Public companies, often inefficiently managed, dominate most transactions in the economy. This makes it challenging for the private sector to establish and run commercial, industrial and service provider companies successfully.

Although solar policies were previously launched in the early 80s, they have been repeatedly interrupted or flawed up until recent years, and thus have not currently been successful in establishing local solar markets. A new Renewable Energy Law is presently underway which could be enacted in 2021, thereby providing an initial legislative framework for the development and promotion of solar power. It can be expected that the new law will focus more on regulating

utility-scale PV than covering the whole range including small to midscale systems. There are a number of Iraqi companies that are prepared and motivated to enter the solar PV business, but which are waiting for laws that will ultimately promote the emergence of PV markets. However, many legislative obstacles remain, among them key obstacles related to outdated investment laws and regulations.

Given intense sectarian competition between national and also international factions, constant bias from parliament and local authorities, it is particularly challenging to establish and implement national policies on the ground. When PV projects are about to be implemented on selected land properties, political or tribal parties, driven by local interests, and not initially involved can suddenly appropriate the process by altering conditions to their advantage and interest. Such practices shy away foreign investors who are experiencing increasing compliance pressure from international good governance rules.

Administrative barriers

Iraq's business community state that their greatest challenge today is not security but the bureaucracy and its attendant malpractice. Iraq ranks 172 out of 190 economies in the World Bank's Ease of Doing Business Index for 2020. Transparency International ranks Iraq at 160 from 179 with an overall tendency for improvement in past 10 years.[88]

There are systemic supervisory obstacles resulting from competence overlaps between multiple regulatory agencies. Furthermore, agreements and permissions regarding land acquiring, project implementation, security and many others need to be reached not only with central government institutions in Baghdad, but also with local governments as well as tribal decision-making structures.

The mills of Iraqi administration grind slowly: Locals complain about great losses of time to get official approvals because processing and answering requests take a lot of time, especially in the government sector, sometimes to the point of unpredictability, if no work arounds are found. There are many implementation obstacles related to the relationship with tax institutions and customs, as well as cumbersome and confusing procedures for business entry visas for foreign workers or new business registration; long payment delays on some Iraqi government contracts; and sometimes unreliable, non-transparent dispute resolution mechanisms.

But things are beginning to change: "Improving the business environment in Iraq is our top priority," said Mohammed Honoun, Iraqi deputy minister of trade. "Automation of government sectors is a critical part of that process.".[89] In late 2020, a large alliance of national and international actors together launched a new straightforward online business registration platform in an effort to supporting entrepreneurship during the pandemic. The system greatly simplifies official registration procedure, thereby encouraging citizens to start new companies. The system is currently only available to Baghdad-based entrepreneurs, but the government plans to roll it out across the nation over time.

Economic barriers

The legacy of central planning and inefficient state-owned enterprises continues to inhibit economic development. It is accompanied by important infrastructural deficiencies and an unbalanced subsidy regime for fossil fuels and electric power systems that undermines their function and operability. Such paradoxical situations are difficult to handle for all private sector actors, but they are especially challenging and difficult to overcome for start-ups and foreign market entrants.

Overall, the economic situation in the country was far from rosy before 2020, and the sudden pandemic induced slump of international oil prices fuelled fears of a deep recession of the Iraqi economy. Ultimately, international oil prices recovered quite quickly which left only a short-term dent in the public budget. It is nevertheless a common reality that average households struggle to secure basic and vital needs such as food, medicine and clothes, so that these spending priorities necessarily overlap the propensity of people to make PV investments. Consequently, the high upfront cost of PV systems is obviously perceived as a main barrier by the wider population. People generally lack the financial means to afford a PV investment and are therefore waiting for new and adequate financial support mechanisms such as loan and leasing schemes to help them with access to ownership of PV systems on their property, ideally at competitive monthly costs as compared to current electricity costs. The large majority of

[88] Corruption Perceptions Index 2020 for Iraq - Transparency.org

[89] New system boosts ease of doing business in Iraq | UNCTAD, 28.10.2020

higher income households who can afford modern amenities, have not been motivated adequately thus far to consider investing into solar PV.

Constant external environment pressures have conditioned people to short-term financial planning habits and methods which mainly aim at securing existential needs and being able to counter sudden challenges and demands. This phenomenon also applies to the power sector, where people are caught in the vicious circle of betting on improving low cost (or cost-free) public power deliveries in order to avoid expenses for private neighbourhood power, while the latter profit disproportionally from increasingly deficient public grids. Household deciders and entrepreneurs need to be presented with individualised financial solutions for solar PV as an alternative to the bilateral closed-loop dependency on current providers of sub-standard power deliveries that are also susceptible to various kinds of manipulation.

If reforms are planned, they should first address the financial sector and the framework conditions for financial investment from all kinds of sources, be they national or international, private or public. Basic infrastructures such as digitalised public service and business processes including financial transactions need to be modernized with the support of the government and international financial markets. Such a dynamic is currently emerging from Iraqi digital start-ups which are successfully implementing shopping apps and other digital solutions. Solar start-ups should try to surf the wave of Iraqi digital start-ups so that the tremendous entrepreneurial potential might actually be unleashed, starting with digital service providers and solar start-ups.

Knowledge and cultural barriers

The consequences of the destruction and hardships that the country encountered in past decades and lasting up to present day, have had a strong impact on everyone and society as a whole. Iraq went through several difficult recovery processes within deteriorating ecological and geo-political environments. The population became dependent on government spending in the process, while having to dedicate more time and effort to provide for essentials. Besides multiple wars, Iraq's 20th century state economic background and the revival of tribal societal organisation structures in the aftermath of years of war and chaos may have cost Iraq 20-30 years in national development. This period also contributed to unpluging Iraqi populations and professionals from the development of high-speed and dense information and innovation flows of today's digitalised scientific and economic global acceleration. Consequently, Iraqi companies are rarely involved with these new markets and their business practices.

Generally, local business practices are rather traditional, except when meeting professionals who have worked for longer periods in foreign companies, generally in the oil sector, or studied and worked abroad. Many public and private market actors still prefer payments in cash, despite systematic efforts by foreign actors and donors to introduce computerized accounting and payment systems. More generally, knowledge of economics and entrepreneurial knowhow need to be made available to all potential actors in the private and public sector, as well as for other levels of society. Developing a basic understanding of market economic processes will be useful in the post-oil world that seems to lay ahead, and when the Iraqi economy will need to complement shrinking oil revenues with other economic activities, preferably in the green energy sector. All actors need to grasp that the era of oil industries is reaching its end because of climate change, and that beyond a deficient and expensive power supply, efficient and cost-effective solar energy generation is possible and available at all levels already today, provided energy prices are set through basic market mechanisms.

That is why long-term popular and pragmatic education initiatives for the masses, as well as 'global technology and business update trainings' for professionals about the most commonly available renewable energy systems are needed. The same applies to other sustainable, efficient technologies in the sectors of agriculture, infrastructure, manufacturing and others.

4.2.2 Challenge and Risk analysis

External Risks

Political risks

The dynamics of international and national politics are a constant cause of instability in the country. They have led to frequent changes of governments and political personnel in recent years, often accompanied by administrative changes. Such turbulences can stall the implementation of large business contracts, at worst leading to project failures and generating financial damage.

The rules governing the renewable energy sector and public-private partnerships remain unclear to foreign investors who approach the market with caution. Many local and foreign companies have invested significant work time into activities in Iraq with meagre or no result. One of the current examples are the many companies that were shortlisted for the latest utility scale PV tenders but then saw implementation postponed and later aborted by the MoE on grounds of unavailable funds.

Political support for PV projects is generally available officially, but when it comes to making concrete contractual arrangements and agreements towards project implementation the decision-making process is easily swayed by various vested interest networks. The still pervasive malpractice problem is a big hindrance to attracting reputable international players who are subject to severe international regulations and compliance requirements.

Economic risks

Economic downturn risks are greatly increased by a set of possibly force majeure events and situations, such as the pandemic, contracting world economy and oil demand and geopolitical tensions which cannot be directly influenced by the government.

The national welfare and state budget's direct dependency on world oil markets is staggering. Falling oil prices have a direct impact on public budgets from which millions of household incomes depend through the payment of civil servant salaries and pensions. In times of contracting state budgets, the economy is seriously impacted and shrinks and people tend to increase saving, investments are delayed and poverty spreads.

"An economic risk is also when the current subsided national power tariff is not challenged by societal actors!" as stated by one interview participant. However, drops of power subsidies and hence tariff increases of electricity and petroleum by-products can have dramatic impacts on daily life and can ignite public turmoil.

Natural Environment risks

Major growing environmental issues are related to increasing atmospheric temperatures of 50°C and beyond, rising dust concentrations in the air, as well as increasing dust storms throughout the country. Overly heated solar panels with dust depositions on their surface are

frequent in Iraq, which can significantly reduce solar cell output and system efficiency while increasing cleaning cost for the solar panels.

Security risks

Security dangers caused by war-like activity which although common until recent years are now widely under control, although terrorism remains a threat in central and northern regions. Costly protection and security measures remain necessary, especially for foreigners. Next to persons, current security risks also pertain to solar power plants which can be subject to theft, vandalism and sabotage. Altogether, potential investors need to plan for significant security costs.

Implementing larger PV projects connected to the grid without full consent of all public, societal and private parties can generate obstructions and security issues from various antagonistic actors. During the conducted interviews the example of an Iraqi company was cited which successfully developed a 10MW PV project, but saw its owner's life threatened. Other personal security threats can involve blackmailing, kidnapping or melting opponents into malpractice systems. Vandalism or sabotage from competitors can be a risk and potentially evolve into serious local interest conflicts.

More generally, stealing of PV components is on the rise, maybe as a consequence of high unemployment and increasing poverty rates. Larger PV installations, remotely located, are more at risk than small private installations that are generally installed on less accessible house roofs or fenced areas. Implementing security measures, posting guard personnel and arranging local political stakeholder acceptance can remedy the theft problem quite well.

Internal Risks

Process oriented and contractual risks

State bureaucracy hampers the private sector from taking active roles in many industries, among which are larger infrastructure related business. There is no reliable mapping of private sector capacities in the country. An established lack of trust and commitment between both the government and the private sector is observed, due also to lack of active communications and efficient collaboration.

Conducting a private business in Iraq is therefore no easy thing and involves many management challenges to avoid making losses: Private actors working in innovative sectors are particularly vulnerable to regulatory risks: Projects can suddenly be put on hold or halted for a variety of reasons which quickly generates liquidity risks. Current questions are related to how modern contractual laws can be enacted, implemented and enforced with consistency, for example in the field of counterparty risks in credit, investment, and trading transactions. Foreign market entrants are strongly advised to partner with an established trustable local company that knows how to navigate Iraqi business environments.

The resource/sourcing risk is set to increase dramatically in coming years, especially given inefficient logistics and low qualifications of available personnel, not to mention currency risks which became visible in December 2020 with a sudden 20% depreciation of the Iraqi Dinar, thereby increasing the cost of imported solar PV equipment correspondingly.

Infrastructure risks

After years marked by wars, occupations, and difficult recovery processes, Iraq's infrastructures have suffered, to greater or lesser extent according to the regions impacted. Among weakened infrastructures are water distribution and sewage systems and the power

grid which still requires complete overhaul in many regions, especially in Northern regions impacted by the war against ISIS, many systemic improvements causing heavy hardware and personnel investments.

This means that private companies generally need to be prepared to furnish themselves with their most strategic resources, such as for example diesel generators providing electricity. If companies are unable to be provided for by or rely on local work sharing economies, this generates significant extra costs which may be too high to offer products at competitive prices, likely one of the causes of the rather weak private economic activity in the country.

Finally, the logistics sector itself, including all transport vectors is highly inefficient due to a wide range of factors, among them fixable and thus annoying issues such as insufficient exchange and information flow between logistics actors causing many bottlenecks and delays. Customs services in the country tend to contribute disproportionally to the long transit delays of imported and exported goods, in the case of medical goods even to the points of exceeding sell-by-dates.[90]

Technology risks

In the case of solar PV, technology risks are relatively manageable in principle because equipment is amply proven in worldwide markets, provided quality suppliers have been chosen. Risks are related instead to a lack of expertise and knowhow by the local workforce, which needs to be systematically supported by international experts and companies providing training and hands-on management support. For these strategically required actors, visa restrictions need to be eased and other facilities provided to motivate them to invest in what is perceived as one of the most challenging environments worldwide to do business, beyond the well-established, privileged and protected oil sector.

Reduced module outputs due to ambient heat and exceptionally high atmospheric dust occurrences are a special challenge of the Iraqi operation environments which can however be solved with adapted maintenance protocols. These extreme conditions furthermore provide special opportunities for local researchers, engineers and entrepreneurs to cooperate and innovate with foreign actors interested to adapt solar PV to some of the world's harshest operating conditions.

4.3 Innovative paths for private sector development with solar PV

This chapter provides an overview of the various instruments available to stimulate company creation and company reorientation in the fields of solar PV applications in changing market environments, knowing that the specific challenge in Iraq's state economy environment consists in a lack of understanding of genuine innovation market dynamics of the role, practice and requirements of private sector actors contributing to develop those new markets.

It is clearly understood by all interviewed Iraqi experts that solar market dynamics can only be born and sustainably developed by the national private sector collaborating with international companies and other actors such as development agencies and other donors, as well as financial institutions and financing companies. Government institutions representing several concerned ministries (such as energy, construction, agriculture, water) are expected to enact and implement solar policies that provide adequate concrete measures to help facilitate the development of strong initial market dynamics. Once accepted basic market framework

[90] Logistics Preparedness Gap Analysis Workshop, WFP / Ministry of Interior / Logistics Cluster, Erbil, 2020

conditions are in place, government institutions should let PV market dynamics unfold with minimum interference to let private actors self-organise and entrepreneurial dedication find the best solutions to attract and convince new clients.

Table 10: The main determinants of FDI induced spillover effects

Broad Variable Categories for Determinants of Spillover Effects

Category	Specific Variables
Absorptive capacity	◆ R&D performance ◆ Innovativeness ◆ Education/skill level
Openness of economy	◆ Trade/GDP ◆ Migration/immigration
Nature of FDI and FDO linkages	◆ Wholly owned affiliates ◆ Vertical linkages ◆ Joint ventures
Regulations and related policies	◆ "Buy local" ◆ Requirements to export ◆ Location requirements
Infrastructure	◆ Transportation ◆ Telecommunications
Industrial structure	◆ Industrial concentrations ◆ Geographical concentrations

Source: Steven Globerman and Victor Zitian Chen.

In order to attract urgently required foreign market actors, a number of important market conditions and framework policies must be developed or improved (see Summary of required improvements in Chapter 5.1), including policies to attract foreign direct investment (FDI). FDIs normally generate productivity spill-over effects that benefit the wider economy, which is an important incentive for governments to deploy and strengthen FDI policies.[91] Table 10 provides an overview of the main determinants of successful FDI policies and desired spill-over effects, which constitute the main fields where policies and activities should be aimed.

The absorptive capacity stands for the qualification level and innovation dynamics of the domestic workforce. The openness of economy is relative in Iraq because its oil sector is dominated by co-operations with large foreign energy companies, while local companies mostly work on their national contexts with no export activity. The nature of FDI and FDO[92] linkages expresses the form of cooperation between foreign and local companies. On the regulatory side, FDI can be accompanied by policies that introduce and enforce local content regulations (LCR) to strengthen local economic, industrial and services structures and allow local companies to strive in a protected environment.

4.3.1 Supply side activation: Existing SME support structures and networks

Given the many challenges described in Chapter 4.2 and the above listed success determinants of attracting FDI and establishing a new economic sector such as solar PV, there are many possibilities to help develop the private sector, which ultimately is the main driver on the supply side. It should therefore be supported systematically with adequate supply side policies by government to increase productivity and efficiency in the economy. If successful, these policies increase the supply in the economy and enable higher economic growth in the long run. This is especially true for solar PV, which not only covers basic energy needs, but also generates more economic activity through productive uses of solar power, and thus wider

[91] Best Policy Practices for Promoting Inward and Outward Foreign Direct Investment, Steven Globerman; Victor Zitian Chen, The Conference Board of Canada, 2010

[92] Every FDI (foreign direct investment) into a target country comes embedded with a significant FDO (foreign direct outflow) from the source country. Promoting FDI without assessing the FDO is an incomplete picture and can potentially lead to misjudgements. Source: The 'FDO' in FDI — I - The Hindu BusinessLine

growth and demand. In this sense, solar PV is one of the industries able to trigger virtuous cycles on local, regional and national levels as solar energy is truly abundant throughout the country and PV inherently is a decentralised technology.

There are two main types of supply-side policies.

1. **Free-market supply-side policies** involve policies to increase competitiveness and free-market efficiency. For example, deregulation, lower income tax rates, privatisation, or reduced power of trade unions.

Deregulation involves reducing market entry barriers to allow new companies to make the market more competitive, as has been the case in the telecom and energy industries of most Western countries. Competition tends to lead to lower prices and better quality of goods and services. Reducing or even exempting income tax rates will increase the incentives for people to work harder, leading to an increase in labour supply and more output. Similarly, a cut in corporation tax gives firms more retained profit which they can use for investment. Increasing free trade by lowering tariff barriers will increase trade and provide incentives for export firms to invest, although non-tariff barriers tend to be important. Negotiating frictionless trade-deals can lead to lower costs for business and improve productivity.

2. **Interventionist supply-side policies** involve government intervention to overcome market failure. For example, higher government spending on transport, education and communication.

Education and training programmes are the most important tool to improve labour productivity and their under-provision can greatly contribute to market failure. Government intervention therefore needs to invest in suitable education and training schemes to fill PV-related knowhow deficiencies, as well as human resource vacancies in the labour market. However, since government intervention costs money, the state will either have to raise taxes or arrange for international support from foreign donors and industries. In the case of solar market development in Iraq, the latter approach looks more plausible. Such policies take several years to have an effect, and the government is well advised to involve independent and competent advisory parties to avoid subsidising the wrong types of education and training activities.

A range of demonstration projects have been established throughout Iraq over the past years on various public buildings, universities and several residential buildings as well as for solar pumping projects with farmers, although experts say that the deployment of demonstration systems has been too slow due to budget problems. More demonstration and pilot projects covering more PV applications such as schools and hospitals are required in the coming years, such as those financed by the IOM in the region of Erbil and implemented through a collaboration between local installers and a Spanish EPC company.

In the case of Iraq, which is naturally inclined towards interventionist supply-side policies, a balanced combination of both policy approaches is required. The most important policy measure to indirectly support solar PV would actually be a tariff reform in the public power sector were ultra-subsidized and unnaturally cheap public power tariffication compromises the competitiveness of unsubsidized solar power. However, since a public power tariff reform is not likely to occur soon, the government should look into other forms of supporting solar PV autonomy in the private sector of households and companies, such as the construction of new social housing projects equipped with solar PV and increased knowhow and technology transfer co-operations with the international community.

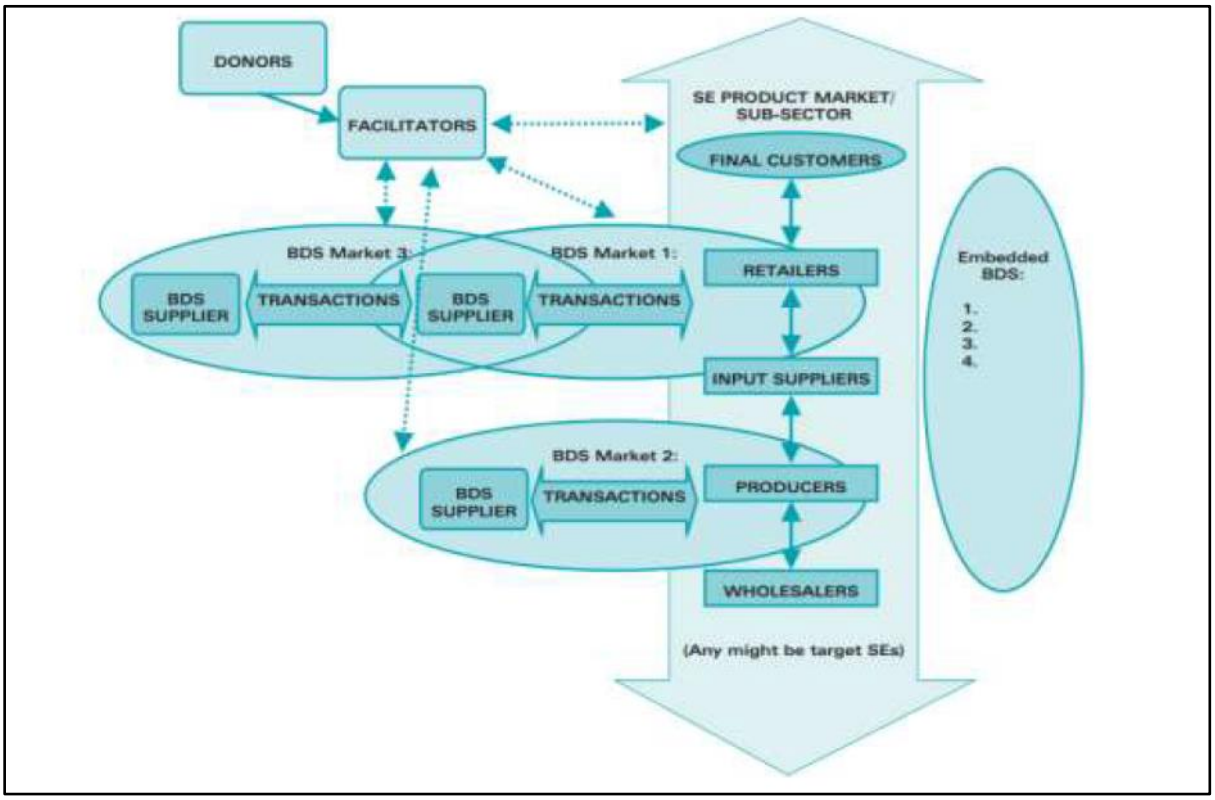
Given the recent pacification of the country since 2018, the government has started to systematically act on economic and energy policies, but things have continued to evolve slowly, due also to the pandemic crisis. Foreign donors and development agencies are currently involved in initial efforts to activate Iraqi supply-side actors. GIZ PSD for example is supporting concrete market development programmes for waste management and solar PV by collaborating with chambers of industry and chambers of commerce/trade in the north, centre and south of the country. The effects of well planned and executed supply side policies should be in line with many of the government's core objectives for Iraq in the medium term, that is: lower inflation due to improved energy price competition, improved economic growth due to more power available at affordable costs, and lowered unemployment due to job creation in dynamized economic activity.

4.3.2 Private sector development and employment promotion by GIZ PSD

The importance of Business Development Services (BDS)

Dynamic business activities in established economy sectors (e.g. reconstruction) or emerging new industries are the main motor for sustainable job creation. Hence, the international community is increasingly supporting the economic recovery of Iraq by investing in supply-side oriented programmes focused on the creation, growth, diversification and success of established and start-up companies covering the whole range on Micro, Small and Medium Enterprises (MSME). Business Development Services (BDS) are used to improve the performance of an enterprise, its access to markets, and its ability to compete.

Figure 77: Business Development Services



Source: ILO, 2003

The needs of MSMEs vary according to the environmental and social context and range from financial constraints, market access challenges, regulatory issues, operational issues, legal constraints, input supply problems, access to new technologies and training needs. BDS are tools designed and tailored to the specific requirements of individual enterprises as exemplified in the above Figure 77, as opposed to measures targeted to the larger business community. The definition of BDS includes an array of business services such as training, consultancy, technology development and transfer, information, marketing, business linkage promotion, etc. They address both, short to medium range operability and long-term strategic issues that will improve the enterprise's performance, as well as operational day-to-day issues.

The mechanism for the delivery of BDS is critical to any MSME support effort. BDS can be provided in a number of different ways, such as through business support centres, mentoring, clusters and networks, business incubators, specialized or general training programmes or institutions, and others (UNDP, 2004). What ultimately determines the selection and use of one delivery mechanism in preference to another is a function of policy, budget and targeted market sectors and SMEs.

The BDS suppliers or delivery agents for these services can be public agencies, academic institutions, the private sector or non-governmental organizations (NGOs). In recent years, however, the use of public agencies to promote MSMEs has declined, while international NGOs and private sector organizations and firms have assumed a leading role. Various BDS suppliers can collaborate by addressing different positions or levels on the value chains of targeted markets, be it vertically along a specific product value chain, or horizontally targeting various component suppliers of a specific product (See markets 1 and 3 in Figure 77).

GIZ PSD's approach to support solar job creation in Iraq currently is an institutional support and BDS model that intends to foster market development, company creation or diversification and corresponding job creation in nascent PV markets. The below outputs A, B and C of GIZ's Private Sector Development & Employment Promotion programme describe precisely the market development activities currently implemented in different economy sectors and regions of Iraq. These outputs also apply to solar market and jobs development and are among the main guidelines considered for the preparation of this study. PSD intends to broaden the below listed scope of activities, notably also in the field of solar PV.

Output A: Support associations to offer business development services to MSMEs

Support the sustainable introduction of business development services (BDS) for MSME (Micro, Small and Medium Enterprises) through a systemic approach by strengthening the capacities of partners such as the Kurdistan Federation of Chambers of Commerce and Industry (KFCCI) to provide Business Development Services (BDS). This is done by:

- Supporting chambers and industry associations to develop a portfolio of business development services to MSMEs based on market needs,
- Supporting the establishment of a pool of trainers in order to be able to roll-out trainings for growth-oriented MSME member companies,
- Training of trainers (TOT) and co-development of curricula, with following topics covered:
    - Business administration and finance for MSME
    - Standard Bid Document (SBD) and Letters of Credit
    - Successful tender bids
- Financial literacy and access to finance, notably bank credit: Banking institutions that provide MSMEs with loans are identified and understand the needs of loan seekers,

- Roll-out to growth-oriented MSME.

Output B: Promoting innovation in the local market to generate new job offers for young people.

Enlarge the market base by supporting the introduction of new services and goods into the market (solar energy, waste management).
Combines technical and business development trainings; study trips, business linkages with German companies, as well as tailored support to promising new businesses

- Identification of projects (MSME and young graduates).
- Technical trainings on promising business models, business development trainings and targeted coaching.
- Business linkages, including with German companies.

Output C: Cooperate with international companies to increase employment opportunities.

Cooperate with international companies on:

- Training measures of young people matching their labour needs (examples: Health Safety and Environment, Photovoltaic, Fast Moving Consumer Goods).
- Job placement with international and German companies.
- Business linkages between Iraqi and German companies to foster job creation (ex: local MSME and international large companies).
- Investment by German and international companies in Iraq to create new job offers for local job seekers and returnees.
- Transfer of expertise from German chambers through to Kurdish business chambers, business associations or unions.

For example, in April 2019, 30 people were trained on central heating techniques in cooperation with Vaillant. 20 have since gained employment or set up their own business following the training. One was permanently hired by Vaillant. Plans to upscale this partnership through the inclusion of Liquified petroleum gas (LPG) training as this is the source of energy for the central heating units thus training in its installation and maintenance will be a vital inclusion to upcoming training held.[93]

4.3.3 Supporting established companies to diversify into solar PV business models

Locally owned businesses play a central role in healthy communities and are among the best engines towns and cities possess for advancing economic opportunity. Small business ownership has been a pathway to the middle class and continues to be a crucial tool for building wealth and community self-determination. Also, medium sized growing companies, that are more personnel intensive, generally develop from small businesses. This is something many people understand intuitively, and it is also borne out by research that finds that the presence of locally owned businesses is linked to higher rates of job creation, less income inequality, and stronger social networks. [94]

[93] Source: Private Sector Development & Employment Promotion - Progress Report / 1st & 2nd Quarter 2020, GIZ
[94] "Key Studies: Why Local Matters," *Institute for Local Self Reliance*, Jan. 8, 2016

Despite these benefits, small and medium sized businesses are disappearing. This trend is currently threatening SMEs in manufacturing, retail and trade globally, thereby also reshaping developed economies. Given that the Iraqi SME base is weakly developed because of the persistent state economy system unfavourable to private entrepreneurial initiative, this threat on existing and emerging middle classes looms in Iraq as well as when reconstruction and investment dynamics accelerate and large foreign multinational companies heavily invest into dormant Iraqi markets, thereby risking the supplanting of local business initiatives that are waiting for improving national context conditions to unleash their potential. Furthermore, the pandemic so far has had a tendency damaging the interest SMEs, requiring they invest in internet-based business models to participate in local digital markets and actively address the local demand-side.

Adding to the overall decline in small and medium businesses is the fact that it appears harder to launch a new business: Contrary to popular perception, this decline is not necessarily because local businesses are not competitive. In many cases, it is because public policy and concentrated market power are working against them. Furthermore, destroyed or outdated infrastructures, misguided zoning policies and soaring real estate costs are making it harder for local businesses to find suitable space. Long administrative processes with public administrations bodies delay investments and entrepreneurial initiative. Also, local financial institutions mostly do not work with entrepreneurs struggling for capital, a barrier that is especially acute for women entrepreneurs.

Therefore, although not particularly likely given Iraq's oil dependent and unstable state budget, should efficient economic development subsidies, tax incentives or other support policies be introduced, it must be assured that the benefits reach all private sector actors equitably, be they micro, small, medium, or large local or joint venture companies. Private sector companies should be granted with privileged access to such programs, while the involvement of state companies and public-private firms requires differentiated consideration given their governance practices. In public or government projects, many project participants are assigned through nepotism and therefore often underqualified or simply incompetent because they come from other educational backgrounds. Such practices favour malpractice and generally lead to considerable implementation inefficiencies, so that the implementation and supervision of strategic projects should always be assigned to qualified staff. This differentiated approach really matters because politicians publicly like to praise MSMEs for their contributions to economic growth and job creation, but in reality, states tend to skew the playing field by granting big businesses with the dominant share of their economic development incentive awards.[95]

Beyond urgently required national regulations on PV related markets, current support policies and practices need also to consider that a) SMEs lack dedicated support programmes specifically customized to their requirements and b) are often working under the most difficult local conditions that justify compensating measures and targeted support activities. Namely, the focus of government policies should be on ensuring the efficient provision of public goods such as education and physical infrastructure, and on promoting the technological capabilities of private firms and non-profit institutions, such as universities, that contribute indirectly to bolstering the absorptive capacity of domestic organizations.

[95] Shortchanging Small Business: How Big Businesses Dominate State Economic Development Incentives by Greg LeRoy, Carolyn Fryberger, Kasia Tarczynska, Thomas Cafcas, Elizabeth Bird and Philip Mattera, October 2015

4.3.3.1 Requirements for co-operation with international suppliers

A number of local companies are prepared to enter the PV business but they require support from reliable foreign manufacturers and suppliers for all matters pertaining to technology and equipment, for adequate practice-oriented training, as well as commercial support including conducive financial conditions. Iraqi entrepreneurs generally favour working with German or Turkish companies for which experience and trust is available, while Chinese suppliers are considered to supply low quality products and services. In private projects offers, quality often plays a bigger role than price, whilst in public projects, price is the ruling criterion far above quality. Combined with attractive payment conditions, this also means that Chinese products are often favoured in public projects because the inherent motivation is malpractice margins that are more easily applicable with cheap sub-standard products.

The requirements to attract competent foreign suppliers and co-operation partners are manifold in present day Iraq, however, the most substantial ones are directly discussed below, while a more general macroeconomic perspective is provided thereafter:

Economic Incentives

Although it would represent an enormous incentive for foreign investors because of the public commitment they signal, direct state subsidies for PV systems are rather unlikely today. The investment law provides tax holidays and exemptions from import/export taxes for specifically approved projects. PV equipment is not yet exempted from custom duties, although this alleviation is expected to be introduced soon in the context of the new renewable energy law. Tax free or special economic zones exist but are merely nascent, However, the development vector of special economic zones needs to be pursued more vigorously if one wishes to improve the chances of attracting international companies.

Foreign exchange control

In practice, it is challenging to repatriate capital outside of Iraq. Practical challenges are mainly due to a general lack of foreign currency and the levels of documentation required to be presented to the relevant banks. This issue can also be solved through provisions governing special economic zones and privileging strategically important foreign companies such as from the RE sector.

Geographic concentration

Geographic concentration does matter for the quality of FDI. When foreign and domestically owned companies and their activities are located close to each other or better share the same operation location, there are more direct and indirect technology transfers between organizations which tends to generate more investment productivity spill-overs from FDI.[96] The state should therefore incentivise joint venture collaborations with foreign companies in order to optimise technology and knowhow transfer aspects and tie the knowledge domestically.

Local judiciary, good governance and Corporate Social Responsibility (CSR)

An active, ideally reliable law and court system is important for international co-operation. If this cannot be guaranteed, then foreign courts could step in for equitable conflict resolutions where the local justice system fails. Compliance with good governance principles and rules as

[96] Best Policy Practices for Promoting Inward and Outward Foreign Direct Investment, Steven Globerman; Victor Zitian Chen, The Conference Board of Canada, 2010

well as corporate social responsibility impose high standards on foreign companies' implementation of contracts and projects. All their finances have to be handled and managed in accordance with international economic and financial standards and practices, leaving little or no room for 'special arrangements'.

Impact of macroeconomic variables on FDI and FDO and spill-over benefits

Finally we must briefly interpret the major findings from the afore cited synthesis study on best policy practices for promoting FDI[97] as presented in Table 11 below.

Looking at its macroeconomic circumstances, Iraq's untapped solar PV market potential is principally quite attractive for foreign companies if the political and economic situation stabilizes, thereby enabling sustainable co-operations with Iraqi local companies. The spill-over effects of such foreign involvement will have many positive effects on the national knowledge base with positive effects in R&D, education and the skill level of the Iraqi workforce, as well as intensifying the exchange of Iraq's business and scientific community with the rest of the world.

Table 11: Determinants of FDI macroeconomic variables and factors of spill-over productivity

Summary of Empirical Findings on the Determinants of FDI and FDO: Macroeconomic Variables

Macroeconomic Variables	Relationship to FDI	Relationship to FDO
Market size	Positive	Positive
Exchange rate (home per host)	Mixed	Mixed
Market size growth	Positive	Mixed
Per capita income	Mixed	Mixed
Inflation rate	Negative	n.a.
Exchange rate stability	Positive	Negative

Note: "Mixed" means that the positive and negative results for the variable in question were about equal in number, and/or the majority of the results for the variable in question were not statistically significant; "n.a." indicates only a small number of studies reported results for the variable in question, such that no reliable inferences about the variable could be drawn.
Source: Steven Globerman and Victor Zitian Chen.

Factors That Determine the Degree to Which FDI or FDO Has Spillover Productivity Benefits

Variable	Impact
R&D	Strongly positive
Education and skill level	Weakly positive
Linkages to foreign affiliates	Mixed
Domestic competition	Mixed
Geographic density	Strongly positive
Export orientation	Mixed
Openness of economy	n.a.
Regulation of foreign affiliates	n.a.

Source: The Conference Board of Canada, S. Globerman & V. Zitian Chen, 2010

International PV actors interested in establishing business activities in Iraq are strongly advised to partner with domestic businesses for easier access to infrastructure, administration and local decision-making processes. A transition period of 1, 2, or maybe 3 years will be required to bring Iraqi colleagues up to speed on the technical, commercial and management matters brought in by their foreign partners.

4.3.3.2 Technical Vocational training

The offer of vocational training on solar technologies and targeted capacity building for businesses and organisations is still very limited throughout Iraq. Although primary training centres in the major cities convey the theoretical basics and installation/manipulation of small training systems, the practice-oriented relevancy of these courses is generally minor given the lack of local market activity and contacts with international companies; this gap must be

[97] Best Policy Practices for Promoting Inward and Outward Foreign Direct Investment, Steven Globerman; Victor Zitian Chen, The Conference Board of Canada, 2010

systematically addressed as a priority by involving foreign and increasingly local market solar professionals.

In fact, all kinds of targeted capacity building programmes are required to modernise the Iraqi economy and business world as a whole, including solar energy as an important (symbolic) spearhead of new market opportunities and job creation. Several dynamic branches require competent local workforces who must be trained domestically. This demand has already translated into an initial dynamic of training institute creation in the major cities such as Baghdad, Erbil and Basra. Local training professionals confirm that the demand for solar courses is much higher than the offer and that there is a clear lack of solar experts and trainers with the required state-of-the-art expertise. Those Iraqis who can afford it, attend trainings in Turkey, Jordan or other countries.

Trainings offered by international agencies

In 2010-11 a comprehensive 2-year capacity building initiative, supported by Japanese JIICA, was carried out in the MoE on all energy topics (except renewables) was implemented and which was co-managed by Mr. Rawa. 1,400 MoE employees were trained locally, 300 internationally, including 200 in Germany. The evaluation of training in the local settings showed that this is generally more effective for participants because their attention is much more focussed on the training and not diverted by touristic distractions. Additionally, if trainees are not directly put into business or practice their newly acquired knowledge, the utility of the training will quickly fade. Due to non-existent or very early PV market activity at the time, lots of capacity building done in KRG and Iraq in general missed its mark and could not be substantiated by practical business-based activity and learning.

However, PV maturity and competitiveness have further increased in the past 10 years and the effectiveness issue can be mitigated by developing and offering mainly domestic capacity building to established Iraqi companies who want to seriously explore diversification into solar energy, alongside the solar start-ups for which such capacity building was initially designed. Given the imminent business opportunity that solar PV represents today, the personnel delegated to such training seminars will probably be focussed and able to put their newly acquired knowledge directly to work in their companies.

Trainings offered by government institutions

The government is currently not able to finance comprehensive capacity building activities. However, donor-based activities are very welcome and seen as important contributions. The MoE has well equipped training facilities and is ready to provide them for new international training initiatives.

Trainings offered by universities

Many universities have been equipped with PV systems for demonstration purposes and are training their students on them. Like most other trainings offered by local trainers, these trainings tend to convey the theoretical basics but mostly cannot offer differentiated, practice-relevant knowhow such as on assembly, installation and O&M which is most effectively conveyed by professionals working with PV in the field.

Trainings offered by companies

The most relevant trainings are generally conveyed by PV companies with ample practical field experience. The few active PV companies in Iraq do not have a lot of training capacity and they primarily train their own employees and partners because these efforts actually represent a significant time and resource investment for young companies. Foreign companies will generally be able to deploy larger training courses, inviting more trainees including motivated students for talent scouting. These trainings focus much more on concrete products and systems offered by the foreign company, as well as on operational issues and troubleshooting related to their specific product solutions.

Furthermore, a big plus is highly relevant, specific marketing, sales and aftersales knowhow that experienced PV companies are able to deliver. In Iraq the specific marketing and sales challenge consists in attracting clients who suffer from low quality power provision at partly exacerbated prices but generally have sparse financial means to shoulder the upfront investment. The specific marketing and sales knowhow of experienced foreign PV suppliers of quality systems sold at higher prices, and the way they apply their PV business models to local markets and customers can be considered critical for a successful market introduction into private sector PV customer segments. Customers specifically need to understand the attractiveness of PV's mid to long term economic investment indicators as compared to their current spending on electricity, before they can make an educated purchase decision.

In summer 2020, GIZ PSD commissioned a scoping and concept study to the Berlin-based German RE training provider RENAC on skill development for SME development, innovation and job creation in the PV sector. The results of this study are not known to the study team of the report presented here, however they are assumed to be complementary to its findings and recommendations. Given current digitalisation and civilisation trends, it is further assumed that significant parts of the training programmes will be held online or in hybrid mode, that is as online and presence seminars as well as other digital/online formats. Online training reduces training costs and allows for tremendous increase in reach and accessibility.

4.3.3.3 Financing instruments for diversifying business activities

Every entrepreneurial activity requires some financing, the type(s) and level of which depend on the nature and scale of the activity. In developing economies, capital markets tend to be weak and rarely offer long term finance. The most common types of financing are corporate finance and project finance, although many important financial instruments within these categories such as local and foreign equity, debt, guarantees, bonds, insurance, hedge or export finance are difficult if not impossible to access.

So far, many solar companies have often been working "for free" investing their time rather than urgently needed finances. Furthermore, the lack of financing instruments responding to the borrowing requirements of their clients makes it difficult to develop and retain new customers. Thus, many local companies and entrepreneurs with good business ideas are deterred from attempting to implement their visions. To trigger the nascent PV market, businesses need a basically functional investment environment with available long-term finance to purchase fixed assets or to finance projects with a payback over many years. Local banks however, may only provide short-term overdraft or loan facilities at relatively high rates of interest that are unsuitable and unattractive, both for businesses and their customers.

In many developing economies the private sector operates with the following financial constraints:

- Limited budgets and internal funding capacity

- Limited management capacity, with a business often dominated by one person
- Companies rarely have solid and consistent financial performance to provide comfort to potential financiers or have sponsors who can provide acceptable guarantees
- Borrowing limitations, which are usually dictated by a company's charter documents
- There is limited or no long-term capital available in the domestic banking system
- Interest rates are often prohibitively high, which adds considerably to the cost of doing business
- High interest rates reflect both the economic situation and risks
- Political elements may concentrate ownership of commercial activity and deter other entrants.
- There is the frequent presence of corruption, which in some countries is endemic. This too, adds to the cost of doing business.

Hence the need for innovative financing mechanisms that assist the private sector and complement domestic capital market development. This is where development finance institution (DFIs) play an important role. DFIs do not compete with domestic finance institutions, their involvement rather, is in response to a market failure or to distinct gaps in the market. Due to different country risk dimensions and different legal structures, the financial instruments that may be employed will also differ.[98]

Underdeveloped national banking system.

Due to obsolete technologies in use, outdated management methods, redundant administrative staff who fail to keep up with modern technologies, the absence of an enabling environment to deal with customers, and poor marketing of non-traditional banking products, banks have been unable to keep abreast of modern banking and management systems. This is evidenced for example in the high value of doubtful debts (IQD 3079.7 billion in 2015), which has placed a burden on financial stability, with the ratio of credit failures of government banks reaching 67.1%.[99] Local banks are therefore failing to supply basic banking services and generally lack customer-orientation and reliability, while international banks are either not present or too expensive.

National accounting principles, financial statements and losses

Registered entities must prepare annual financial statements, with IQD as the accounting currency, in accordance with the Iraqi Uniform Accounting System, and in Arabic. The Iraqi Unified Accounting System does not match International Accounting Standards. Losses are tax deductible and may be carried forward for up to five consecutive years, but no more than 50% of any year's taxable income may be offset, and any losses carried forward may be offset only against the same source of income from which the original loss arose. The carry back of losses is not permitted. Such rules can actually be modified or adapted to international standards, especially in the context of special economic zones.

National financing instruments for the private sector

[98] Financial Instruments for Private Sector Development, EPS Peaks Project, UKAID/DFID, 2014
[99] National Development Plan 2018- 2022, General Framework.

In December 2019, the Ninewa Investment Forum brought together international and diaspora investors with local businesses to showcase the investment potential of northern Iraq.[100] The event, sponsored by the DAI-led and USAID-funded Iraq Governance and Performance Accountability project (IGPA)/Takamul), was part of an initiative to revitalise the region's economy. The Ninewa Investment Forum showcased more than 20 established companies and entrepreneurs seeking funds to expand their operations or launch new businesses. Featured enterprises came from rural and urban areas and include agricultural, food processing, manufacturing, pharmaceutical, tech, and hospitality businesses, representing 130 million USD in investment opportunities. Business owners ranged from family-owned tahini factories needing new equipment to expand distribution, to a real estate developer seeking funding for a residential project in Mosul. IGPA/Takamul is helping business owners to develop investment plans and prepare to pitch their new ventures. There is no clear outcome from this Forum so far and the pandemic evolution may have slowed related processes, but it still appears that international equity investors from the Emirates, Europe or Asia tend to avoid the elevated country risk associated with Iraq.

Funding scheme for SMEs and business innovation: In 2015, the Iraqi government announced a twofold financing programme for private sector companies as part of a wider strategy to boost economic growth and create new job opportunities through the production of local goods and services. The scheme is led by the Central Bank of Iraq (CBI) and should be implemented with the participation of approximately 35 private and state-owned banks. One '1 Trillion Dinars (870 million USD in 2015, worth today 680 million USD) Initiative' is dedicated to support small and medium private-sector projects who can apply for grants between 1 and 5 trillion dinars. The other '5 Trillion Dinar initiative' addresses Tiers1-companies. Regrettably, those finance programmes have not yet been operationalised and no loans were released to MSMEs.

Loans for projects in transition and emerging economies such as Iraq typically require guarantees: By far the largest demand stems from government projects where the government provides sovereign guarantees and the financing comes from IFC and other standard development banks. Large solar PV plants in preparation are said to be provided with state guarantees to assure the participation of large international players in the latest tender after the first two tenders failed. Larger infrastructure companies such as Iraqi power plant contractors or telecom companies use government licences to access foreign capital.[101]

A guarantee is a non-cancellable indemnity bond or "security" that is usually backed by a state, bank, insurer or corporation in order to guarantee creditors and investors that principal and interest payments will be made. It can lower the cost of financing for issuers because the guarantee typically earns the security a higher credit rating and therefore lower interest rates. From a government's perspective, guarantees help catalyse private financing, improve financial terms, provide access to capital markets, and support sector reform and growth. The private sector benefits from guarantors' safeguards, which help mitigate some lending risks, improve a project's viability and help reinforce government undertakings.

In Iraq, various types of guarantees engaging the state directly or indirectly have been issued in an uncoordinated manner by various government entities and individual decision-makers in the past 15 years. This has resulted in a lack of transparency in the government's exposure to fiscal risks. Controls on the issuance of new guarantees need to be strengthened by an improved policy framework. A more regulated use of state guarantees will see the legal status of all given guarantees clarified and those with no legal basis voided. This would also allow the

[100] DAI Project Supports Key Investment Forum in Northern Iraq · DAI: International Development

[101] Iraq Energy Institute, Yesar Al-Maleki, 2020

establishment of a new guarantee mechanism emphasizing the RE and EE sectors and that would provide private actors in the local RE and EE business with access to international financing and solar markets. A guarantee mechanism supported by several international financers as listed below could facilitate private investment into RE and EE sectors by covering national banks' credit to local private sector companies and entrepreneurs.

International financing facilities

Due to the repayment duration, interest rates and risks, substantial corporate debt finance or finance for projects are generally not available in many transition economies. Consequently, the main sources of debt finance in emerging markets are:

1) Multilateral development banks (f.i. WB, IMF, IFC)
2) Regional multilateral development banks (f.i. ADB, EBRD, IDB)
3) Bilateral and other development institutions (f.i. FMO, DEG, AFD/Proparco)
4) National development banks (f.i. KfW, BPI, BBB)
5) Global and national private commercial banks (China IDCBY, JPM, BAC)
6) Global and national investment banks (Goldman Sachs, UBS, Citygroup)

The difficulty that arises for local companies from the above range of different financial actors are manifold. One is the variety of decision-making procedures leading to loan commitments by this wide range of banks and the high level of financial professionalism required to interact with them. Also, often 'ticket sizes' (overall project cost) of local business projects will be too small for consideration by most of the international banks. Local Iraqi SMEs do not generally contain the financial competence and personnel required to engage with international financers, so that many SMEs would require systematic support from financial consultants.

Furthermore, given that bridging over this financing gap is of eminent strategic importance, a study and derived project activities should be considered on how to specifically improve the access of local RE companies to international finance, noting that there are already several programmes underway, such as the EU's Electrify programme which are working to improve the access of small tickets to international (development) finance. Another option may be a specific international refinancing programme for selected local financial institutions enabling them to provide debt finance for private investments of local MSMEs engaging into RE and EE. For instance, in January 2020, the German development bank KfW announced a $33 million credit facility in Nigeria called "Green Credit Line" in order to empower 10,000 Nigerian MSME with a focus on RE/EE. The German bank designed the initiative to support the African Guarantee Fund (AGF) to realise its goal of providing financial guarantees to African entrepreneurs, while the continent's MSME sector has been singled out as a key driver of economic growth and welfare improvement.

4.3.4 Supporting solar PV start-up creation

The following statement from Mohamed Ridha of the Baghdad entrepreneurial tech collective 'Fikra Space' (Space for ideas) describes quite well the reality and insight of young Iraqi entrepreneurs : "I think we need to split the political situation away from actual development that happens within society. When I think about the political situation, there's a lot of challenges and it is difficult to see the light. When I think about society, we can be optimists, because I feel that there are a lot more opportunities now than three years ago, but I think we have come to the point where people think, "you can't rely on the government to provide everything for

you. I need to create my own opportunities"… Iraq is a great country for technology because we have 35 million people and 50% of them are below 35 years of age so you have a huge population of early adopters, people that learn quickly, and people that want new things, if only for entertainment."[102]

The conditions for establishing a start-up company successfully in Iraq are very difficult, especially compared to their peers in industrial countries. This is why young Iraqi entrepreneurs who dare to take the challenge are best supported when they can work in functional environments with many likeminded people and companies. Furthermore, good access to modern digital technologies is crucial and being coached by professionals in achieving set technical and commercial start-up objectives. The following recommendations are summarised from a paper published by 'Allied for Startups,'[103] a worldwide network of over 45 advocacy organisations in 4 continents focused on improving the policy environment for start-ups. They reflect the experience of thousands of start-up entrepreneurs throughout the world and are of particular interest to Iraq, where entrepreneurship and entrepreneurial culture are seen as an important coming vector for economic development and recovery.

Start-ups' enormous potential is worth tapping into for any economy.

Regardless of whether small or large, developed or developing, digital or not yet, start-ups promise more than just some apps or a few jobs. They offer a forward-looking, positive, entrepreneurial mindset. Mobile and on the lookout for the best ecosystem for their product, they have new ideas and a problem-solving approach that is close to users. That's why start-ups deserve a meaningful place in any country or region.

Accept start-ups as they are and without categorizing them.

Often, they go on new innovative paths that are not immediately understandable by established market actors. Let them grow their way without trying to press them into established moulds. That means, voiding to stick them into the same confines of other industry players. Or trying to shove them into categorisations that might work for SMEs. There are good reasons why start-ups and SMEs are different. Start-ups begin to exist when a teenager is building software in his garage. They don't necessarily stop being one even when they have thousands of employees and billions of revenues. So, don't limit your understanding of them by defining them as either a small-business or a medium-sized one.

Consider start-ups as part of their ecosystem. Don't cherry-pick.

Start-ups stand for an orientation towards innovation, disruptive ideas, and an enabling ecosystem behind them. They need to be embedded in an interdependent ecosystem, consisting of markets, talent, accelerators, access to finance and more. Start-ups aren't just a few new business models that will enter the energy sector. They will reorganise the way most businesses work and then connect dots between sectors. For instance, by working on the Solar-Water-Food nexus, solar start-ups may come up with entirely new and customer targeting and delivery systems that have the potential to disrupt local or regional distribution and supply systems. Today, we see data science permeating almost every sector, to improve efficiency, increase sales or simply monitor a brand. This happens through start-ups more

[102] Interview with Mohamed Ridha, of the Baghdad entrepreneurial tech collective Fikra Space, by Robert Tollast, Iraq Business News, 2015
[103] https://alliedforstartups.org/2020/03/17/the-dos-and-donts-of-policies-for-startups/, 2020

often than not. If legislators want to intervene, sectoral legislation will, by definition, make an incision between all these new links that are being established. It can never do justice to the cross-sectoral links start-ups make every day.

Design laws that work for start-ups from day one and also in the long run

The best thing policy makers can do is to create an innovation-friendly regulatory framework. Start-up founders need policy makers that deliver the laws that let them deal with bureaucracy easily, hire talent and scale-up. They don't need policy makers that only invite them to give a keynote at their panel or visit them in their accelerator. To be clear, founders love to showcase their latest innovative pride, and are not against interaction with policy makers. Only, when they are reduced to photo-ops and a start-up prize, they feel more like zoo animals and less as accepted stakeholders. It is also important to understand that government is not there to deliver funds for start-ups; If public money can leverage private capital, that is a welcome side-effect, but this should not be the primary concern of policy makers. Finally, governments shouldn't have to pick winners and losers among start-ups.

The role of the government

In Iraq, the state needs to create significantly more favourable framework conditions for SMEs and start-ups in general, and for solar start-ups in particular. This is because the success chances of solar start-ups are currently higher than in most other sectors and branches because certain solar PV market segments such as solar water pumping, utility scale or residential PV could soon experience accelerating dynamics. Central and local government institutions can support start-ups by reducing administrative requirements, creating shortcuts and foremost by reducing their administrative processing time. The online business registration platform launched in late 2020 is an example of the kind of administrative facilitation measures that are needed to take down the many barriers that hinder the striving of start-ups and MSMEs.

Furthermore, a meaningful, regular and institutionalised dialogue needs to established between entrepreneurs and the government to overcome what can typically be labelled the start-up/government gap. Such discourse can lead to the creation of foreseeable market frameworks and conditions that work for start-ups today and tomorrow, because that is the direction founders are looking.

4.3.4.1 Setting up a national coalition supporting the 'solar start-up initiative'

A start-up dynamic has been underway for several years and has already produced some initial success stories, notably in the digital sector. In early 2020, a group of organizations supporting start-ups in Iraq joined forces to create the Iraqi Innovation Alliance (IIA). The initiative, which includes start-up support providers like Fikra Space, Kapita, The Station, 51Labs, Basra Science Camp aims to empower and support technology and entrepreneurship communities around the country.

Capitalising on the experience with these pioneer activities, a solar, renewable energy or simply green start-up initiative should be established by a national coalition for green economic growth (working title). This core group devises a convincing and attractive strategy and searches for the broadest possible support from all relevant stakeholders. While many local experts interviewed for this study tended to see the government as placed in a crucial position to support solar start-ups, others had a more realistic approach, anticipating that traditional state actors might in fact be promoting the emerging distributed/decentralised PV market

segments in half-hearted manner. A ‘solar start-up initiative’ in Iraq should involve all other renewable energy and energy efficiency technologies, as well as those other sustainable technologies that are tied to solar energies through the solar-water-food nexus, which would make it appear more like a green start-up initiative with a strong solar component.

In the end, a much broader coalition needs to be envisaged involving all stakeholders impacted by start-up policies on national, regional and local level in what is not only to be considered a national effort towards energy transition but also towards green entrepreneurship and market-based economies. To get an overview of whom to consider and how to adequately integrate their contributions into a national solar start-up coalition, a wider comprehensive stakeholder map is required showing all actors and their respective influence as well as analysing relations and interdependencies on national, regional and local levels. On this basis, common goals and an implementation strategy can be devised.

The national coalition for a solar or green start-up initiative

Although major political and public actors cannot really be of direct help in implementing solar start-up initiatives, notably because they likely have no budget to allocate, they can surely improve/support the market framework conditions and take the legitimate initiative to establish a national coalition with below listed partner categories. The initial kick-start should therefore come in the form of a concerted governmental initiative which would involve quite a range of ministries that are tangled up in the market introduction of solar energy and/or by the establishment of start-up friendly frameworks, among which the following where cited by the interviewees of this study:

- Ministry of Electricity: for regulating the various emerging solar PV market segments
- Ministry of Water Resources: for irrigation systems
- Ministry of Municipality: for domestic water treatment and distribution systems and where saving water is the top priority
- Ministry of Commerce: for regulating the quality requirements applying to RE and EE as well as the framework conditions applicable to (solar) start-ups
- Ministry of Industry and Minerals: for similar purposes to the Ministry of Commerce
- Ministry of Finance: for budgetary and financial questions related to the funding of such initiatives
- Ministry of Higher Education: to develop and diversify university curricula for solar energy as well as business management disciplines, research into solar technologies and to support spin-off activities combined with start-up creations
- Ministry of Technology: for the support of new R+D projects and programs, as in the field of module cooling from extreme operating temperatures and module cleaning from extreme dust coverage.

Next to the national ministries and their regional branches, governorates and municipal governments need to be actively involved in the implementation of PV and start-up policies providing them also with a certain scope of action when adapting those policies to their local and cultural context. Among the many other actors to involve are the local chambers of trade and industry, agricultural administrations, the universities already actively engaged in solar energy and other public and private sector stakeholders such as national and international foundations, community organisations, schools and NGOs. Last but not least, the variety of

the private sector institutions spanning from small solar companies to large oil companies with CSR activities and corresponding budgets.

Preparation of the solar or green start-up initiative

The announcements of a national coalition should be well prepared beforehand with a minimum of concrete measures in place for immediate implementation. For this, an initial core committee should make required preparations assisted by competent consultants and communication/moderation experts. Comprehensible political decisions and implementation instruments (see next chapter) that positively impact the framework conditions for start-up companies must obviously flank the solar start-up initiative. Then, successful start-up support projects in one, or better two separate locations/cities need to be achieved before being able to extend the initiative geographically. Such extension should happen based on proof-of-concept achievements which bolster credibility and stimulate imitation activities in new locations.

There are many international development organisations and consultancy specialists who can support and facilitate the programmatic steps and processes needed for the effective establishment of such an initiative. But there are also many specialised national organisations who can bring in their network experience in entrepreneurial and start-up activation, in craftmanship for solar installation, operation and maintenance as well as in the establishment of business and R+D ties to foreign partners.

Iraq's strategic partner Germany alone has ample and long-standing experience with most of the required market activation instruments:

1) **The German founder/start-up network EXIST** is a platform that cooperates with all other major German organisations committed to the promotion of start-ups and entrepreneurship. EXIST has systemised all processes and functions around fostering and supporting entrepreneurship, company creation and development. The network presents its comprehensive offer through its German/English website https://www.exist.de/. Entrepreneurs of all ages and sectors get easy access to an efficient, perfectly coached company creation process that deploys regionally or even locally into urban centres. Applying and customizing the EXIST knowhow to the requirements in Iraq would certainly dynamize the start-up activity in the country.

2) **The German export matchmaking activities under the German Energy Solutions Initiative** started in the early 2000s. They are mainly intended for SMEs in Germany offering renewable energy, energy efficiency, smart grids and storage technologies and for their counterparts in target regions and countries. The AHK network of German Chambers of Commerce Abroad has a German Liaison Office for Industry and Commerce in Erbil. Selected instruments of the comprehensive export activation toolbox of the AHK network and the German Energy Solutions Initiative could be put at targeted use to connect Iraqi companies, entrepreneurs and start-ups with German and European companies serving the solar sector.

3) **The two leading organisations of German Craftsmen**, that are the German Craftsmen Chambers (Handwerkskammern) and the Associations of German Craftsmen (Zentralverbände des deutschen Handwerks) both offer a wide range of specialised BDS for established and starting craftsmen companies in Germany. The chambers are also involved in numerous educational collaborations with MENA countries and throughout

the world, transferring their methods, knowhow, and adapted curricula to partners in target countries.

4) **The organisation of Fraunhofer Institutes in Germany** operates nationwide and international networks of R+D. The Fraunhofer ISE - Institute for Solar Energy in particular is generally interested in working on the environmental operational limits and boundaries of solar equipment, such as frequently occur in Iraqi PV operation environments. Collaborations with Iraqi research institutes, engaged scientists, and engineers are conceivable if they can be organised in efficient manner.

The various above suggested partners can be aggregated to support the Iraqi (solar) start-up and entrepreneurial initiative with powerful means and measures if on the other side the Iraqi government put its most competent human resources in charge of local implementation. Also, such efforts can only be justified if the overall security situation in the country is stable and if the government demonstrates strong determination in implementing solar power policies that might also go against interests of established energy and power structures.

Improvement of solar policies and market framework conditions

It is obvious that Iraq urgently needs to reform and diversify its energy and economic policies to prepare the country for the coming challenges resulting from increasingly fast changing worldwide economics and energy systems. Ideally, the government would finally tackle the seemingly Herculean task of reforming the power sector by introducing a new tariffication system that gradually evolves into a new balance between the established fossil based power system and coming solar power capacity increments (off-grid and grid-connected) that should soon begin to contribute to the power supply of Iraqi power consumers. Ideally tariff reform would also ultimately reduce the electricity sector's yearly deficits and relieve the Iraqi treasury, thereby releasing funds to re-invest into deficient power infrastructures and energy transition.

A similar paradigm change that can engage wider parts of Iraqi societies also needs to occur in economic policies. Market framework conditions eventually need to be improved significantly for businesses in Iraq, of which many are struggling, and also to allow entrepreneurial initiative, company creations and innovative start-ups to thrive in more conducive environments with modern technologies at hand. The private sector must ultimately be allowed to move more freely to partner and collaborate with foreign experts and companies, and to pull international experience, knowhow and successful examples into the country. Increasing national security conditions and a relaxing pandemic situation should be used to revitalise travel and personal exchange with foreign companies.

Collaboration with foreign companies should be facilitated in any possible and responsible way to accelerate the learning curve; returnees who have received relevant educations abroad should be involved with preference because they have often lived and navigated in foreign industry countries. Government can also provide certain protections and preferences to established and start-up companies: Firstly, when dealing with conservative local actors and lengthy administrations, and secondly when dealing with foreign companies and partners. Concerning the latter, protective measures such as local content requirements (LCR) in infrastructure construction and other large projects are frequently used in other emerging countries, and if required, protective competition regulation that can apply for a certain period and in specific sectors to facilitate the initial growth phase of local industries and companies. Companies in Iraq, be they established or start-ups foremost need stable and conducive

framework conditions to develop and grow their domestic markets which by the way are large enough in principle to provide for long-term development potential.

Other possible and required improvements to PV market framework conditions are presented in the following chapter below as well as in Chapter 5.1.2.

4.3.4.2 Instruments for Promoting solar entrepreneurship in Iraq

The market barriers, challenges and risks for established and newcomer companies in Iraq have been described in Chapter 4.2, and the most obvious policy approaches to promote solar entrepreneurship in Iraq are briefly discussed in a snapshot below. However, a more thorough country-based analysis with local consultants is required to review existing market barriers on the ground and planned economic and business policy reforms in Iraq. The more barriers to entry or expansion there are, the harder it becomes for entrepreneurs. It therefore needs to be assessed in detail what makes it easier or harder for would-be or existing entrepreneurs to start and scale a company in Iraq. Besides the observed decline in small businesses that has even accelerated during the pandemic, it appears to have become also much harder to even launch a business. Such a study should propose solutions or work-arounds that can work in the diverse national, regional and local contexts of the country. The general idea would be to create pilot framework conditions for (solar) start-ups, that can later be applied to other sectors of the economy.

Develop talents

Students, graduates and young employees from SMEs should be engaged and encouraged several times a year with interesting seminar course offerings in their environment; in a next step, projects can be created and implemented to select the most talented individuals for further engagement. These offers should be free of cost, attract and promote the most motivated and talented individuals who can later spread the knowledge and dynamic to other campuses. The incentive ladder should ultimately include a job perspective in an established or newcomer company. A simpler visa system should be introduced for foreign professionals travelling in and Iraqi professionals travelling out. Specific incentive schemes are needed to attract returnees with special acquired skills or educations to participate in new businesses in Iraq. New academic pathways need to be developed to facilitate confrontation of students with RE and EE technologies as well as with economic and business administration study disciplines. Bursary schemes should support international academic exchange and collaboration in selected academic sectors.

Support services

Provide direct incentives and encouragement to universities to engage, incubate and support R&D collaborations between their academic departments and personnel and small businesses. Too often universities focus exclusively on generating income for the university or in supporting their own IP rather than the generation of local clusters of innovative companies that lead to dynamic knowledge-based economies that over time can pay back to the university. Open a Small Business Office – Cities should create a position within city government to guide business owners through local permitting requirements, and to serve as a liaison between small businesses and policymakers. Provide significant international development funds and financing blended with domestic public funds to establish a distributed network of efficient entrepreneur and start-up incubators and accelerators that span over the economic centres of the country.

Access to markets

Authorities could 'Set Aside' particularly attractive, exposed space for local solar businesses in city centres. Because of financing incentives and national political relationships, new development is often oriented to the needs of larger corporations; here set asides can help close the gap for SMEs. For example, new development projects that are often financed internationally, can be required to reserve attractive adequate portions of their floor space for small storefronts and for locally owned businesses, either as a condition of permitting or through agreements in particular projects. Municipalities can establish adaptive reuse programmes to help local entrepreneurs turn vacant buildings into new businesses. Open work spaces or co-working spaces should be created that provide lowered rates to start-ups and MSMEs which contribute remarkable impact services for the community.

Economic development incentive programmes generally favour big companies disproportionately, and what is more, they often do not work. Instead of giving public funds mostly to big businesses and state companies, authorities could reserve and orient some of these resources to strategically foster locally important businesses, such as solar or water companies for example. Many German RE companies grew out of local community projects as alternative projects that had often been supported by municipalities. Furthermore, too few of the established Tier-1 and Tier-2 Iraqi firms are engaged with the nascent Iraqi start-up environment and therefore miss out on innovations that are being generated. These established Iraqi private sector actors should be provided with incentives and opportunities encouraging them to fund 'Proof of Concept' pilot projects with innovative start-ups (see proposed Pilot projects in June 2021) which might well lead to follower projects. For start-ups, more important than investment and support, is an early adopting customer that allows them to gather references, experience and speed. Finally, public authorities should establish clear preferences for locally owned businesses in purchasing and contracting, especially since they are the biggest purchaser in the country. They further need include clear definitions, goal-setting, and reporting to ensure that their local purchase habits increase steadily and markedly over time.

Selection of specific start-up promotion instruments

There are a wide range of instruments providing specific benefits to support the initial operation of start-ups. The single largest online platform for start-ups and entrepreneurs in India https://www.startupindia.gov.in/ provides an excellent overview of the quite impressive range of services available to Indians keen to create a new business.[104] This includes all kinds of digitalized business services to operate start-up companies fully online and in the cloud and thus as cost effectively as possible. A selection of the most typical types of benefits is provided below for quick reference. Those instruments must be carefully selected to match the individual requirement of start-ups and adapted to the national, eventually even to regional or local contexts which can vary considerably from North to South:

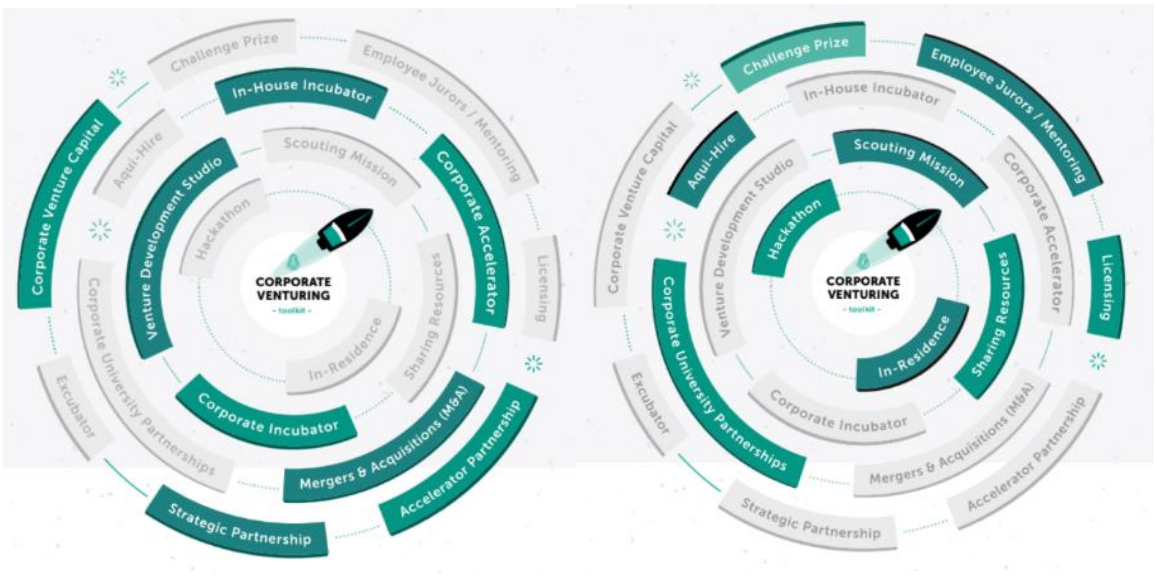
- Start-up monthly allowances for a limited time period
- Start-up growth grants
- Marketing and Sales Assistance
- Subsidised incubation/co-working spaces at no or low rent for a limited time period
- Patent cost reimbursements
- Reimbursement of taxes, if applicable

[104] See Homepage (startupindia.gov.in) and Partnered Services (startupindia.gov.in)

- Digital technology subsidy: Reimbursement of parts of the capital expenditure for purchase of computers, related hardware, relevant software. Provide start-up kits with cloud credits and software-apps.
- Power subsidy subject to consumption thresholds and for a limited time period.

A wider and more systematic overview of the differentiated scope of instruments available to promote new business creation is shown in Figure 78.

Figure 78: Corporate Venturing Toolkit



1) Most common types of instruments

2) More unconventional types of instruments

Source: www.bundl.com, 2021

The little boat pictured symbolizes the perspective of Corporate Venturing (CV) which is a strategy used by established corporations to invest into promising new start-up companies (often referred to as 'Unicorns') that are active in fields with high strategic relevance to the investor. We recommend in this context having a look into the quite interesting presentation "16 Strategies for Disruptive Innovation" by the company Bundl[105] which explains vividly by using astonishing examples how new corporate giants can emerge within just 5-10 years today.

Finally, emergency economic programmes that support MSME have proliferated during the Covid-19 pandemic all over the world and the policies they employ related to environments of scarcity are particularly relevant to the Iraqi context.[106] Given the widespread decline of small and medium businesses throughout the world, many cities in industrialised regions facing deep structural change and resulting challenges are looking for new ways to support their local business network.[107] Learning from their policy approaches and strategies can be a source of inspiration and leapfrogging opportunities when shaping new business environments for municipalities in Iraq.

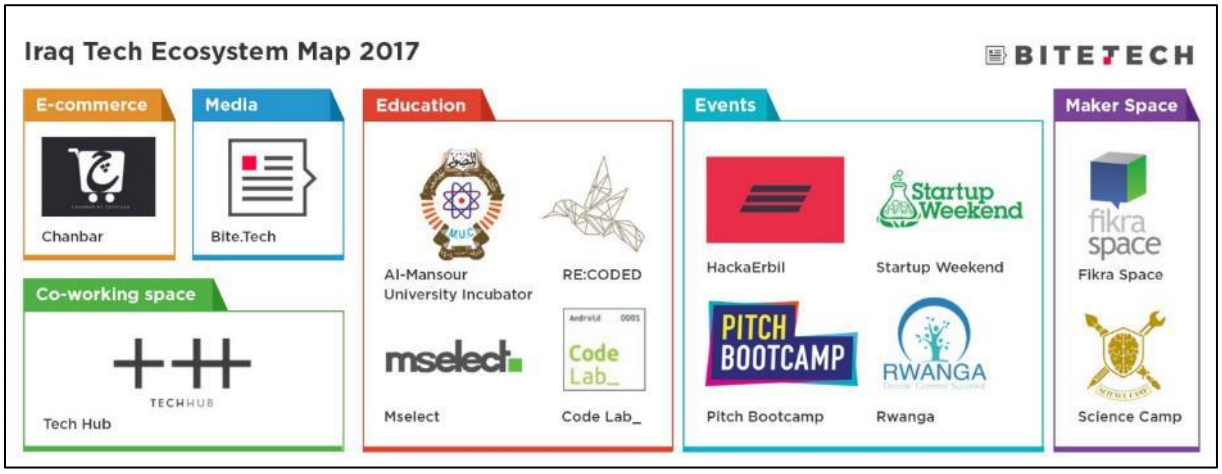
[105] Report • 16 strategies for disruptive innovation | Bundl, 2021
[106] Blog: A variety of policies to support micro and small businesses hit by COVID-19 (intracen.org)
[107] 8 Policy Strategies Cities Can Use to Support Local Businesses – Institute for Local Self-Reliance (ilsr.org)

4.3.4.3 Modern Start-up supporting facilities: incubators, accelerators and hackathons

There are very few real start-up incubator type facilities in the country today since the trend of establishing modern supporting structures for start-ups is quite new and only lately has began to be picked-up systematically by development organisations. The first professional start-up supporting facilities and networks are active in Baghdad, Erbil and Mosul, however none of them has a focus on solar, RE or energy efficiency. In the region of Basra, no professional start-up facilities are available so far. In collaboration with GIZ's PSD program, the Solar Energy Innovation Club (SEIC) has begun to offer initial coaching for young engineers and solar entrepreneurs as well as technical and entrepreneurial capacity building.

The Iraq Tech Ecosystem in 2017, shown in Figure 79, displays the start-up supporting landscape at the time.

Figure 79: Iraq Tech Ecosystem Map 2017



Source: BITE.TECH

The entrepreneur scene has further dynamized in the meantime with more private initiative start-up supporting facilities and structures being added. Some representative facilities are:

1) FIKRA SPACE - https://www.facebook.com/FikraSpace started as a hackerspace in Iraq and is today a social enterprise that supports tech and science enthusiasts to work together and realise their ideas. FikraSpace mentors young people who want to create start-ups and offers them a place to come and work on them. Free workshops on technical topics, such as coding and programming are offered, and on business management topics, such as how to start your business and how to market it to customers.

2) THE STATION - TheStation - Home (the-station.iq) located in Baghdad and Mosul, co-financed by GIZ and other international organisations, is one of Iraq's leading co-working spaces, and Baghdad's first co-working space. More than 50 start-ups have been supported, mostly service oriented companies ranging from education, training, publishing, consulting, advertising and branding, IT services, lawyers, consulting engineers, as well as rather retail oriented creative and skilled trade businesses such as fashion & apparel, diverse products such as antiquities, food, restauration. All these activities are non-technologic and standard services offered to average urban populations.

3) KAPITA - KAPITA Business Hub | Home located in Baghdad, is a private sector development company that aims to empower small and medium-sized enterprises (SMEs) through investment, research, incubation/acceleration, and market development programs. The ScaleUp Academy provides several entrepreneurial development programmes and is operated with support from GIZ.

These pioneering platforms, which can also collaborate with each other, have in common that they are working to create a new generation of entrepreneurial problem solvers by changing the mentality[108] which is still impressed with the legacy of a socialist, centrally planned economy. Most Iraqi start-ups are service oriented, which is a trend in itself, and thus influences the offer of start-up supporting structures. This makes them also a good biotope for company start-ups offering solar energy services, and the latter would contribute well to diversifying and complementing existing start-up facilities by adding the dimension of future oriented technologies.

Strategic planning of start-up supporting policies

It is however obvious that many more start-up support structures, facilities and efforts are required in Iraq to be able to contribute significantly to national economic development. Linking newcomer start-up companies with foreign manufacturers, supply partners and investors is essential to develop technology-oriented and diverse companies that work and specialize in the variety of solar applications, different market segments and business models, including along the solar-water-food nexus. The variety of BDS services to be offered should also be of interest to established companies to help them diversify their activities by founding spin-offs that can develop outside the mother company or by supporting pioneering start-ups that go new ways. In particular, this may be the case for established technical companies wanting to venture into solar PV business. Modern digitalised start-up support is also a key for low start-up costs which grants access to young Iraqi entrepreneurs from all origins.

The table in Figure 80 shows different ways to trigger new company and start-up creation, of which incubators are today the most commonly known structures to accompany entrepreneurial and start-up ideas until they mature to young companies, ready to conquer markets. The table is made from the perspective of a large multinational corporation but can be read from the perspective of a higher public entity or an international donor consortium looking at a toolbox to establish an ecosystem of start-up companies that can quickly evolve into a value chain system gaining in complexity and resilience based on the contributions of each participant.

[108] Creating problem solvers for Iraq | so/creatie (socreatie.nl), Hanneke Kastelijns, 2020

Figure 80: Strategic use and value assessment of corporate venturing tools

Source: www.bundl.com, 2021

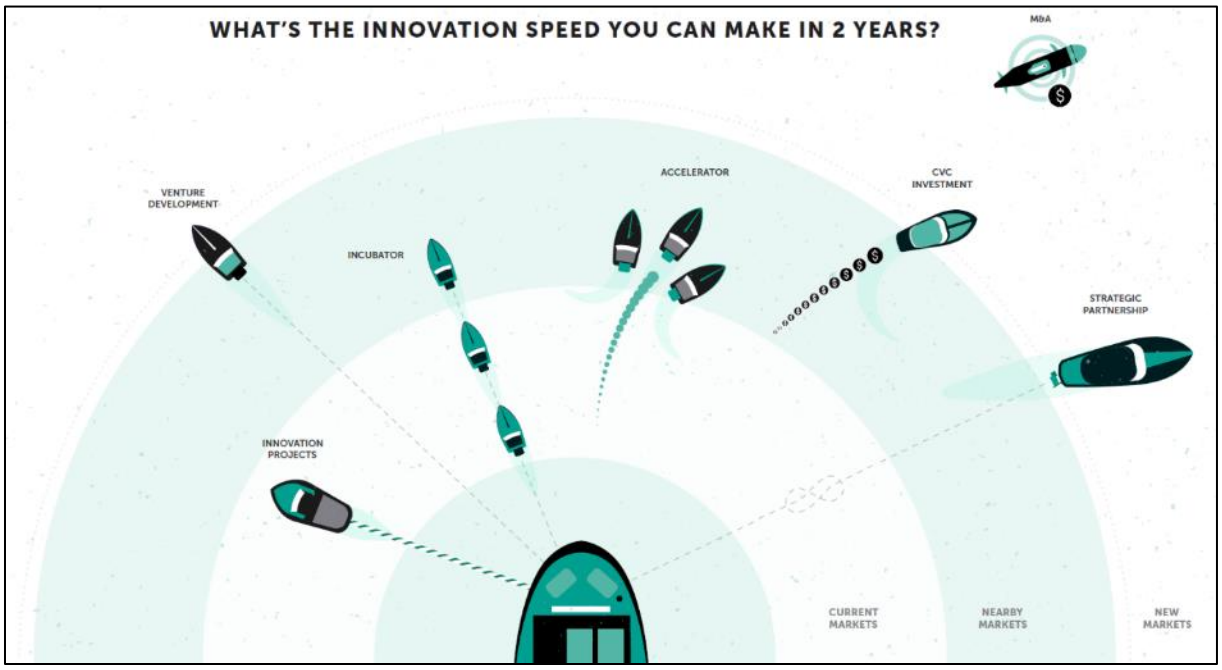
The right mix of tools or approaches depends on the decision-makers' strategic objectives which are titled as Ecosystem, Culture, Innovation and New Markets in the table. Such a strategic cockpit approach would have to be adapted to the context of the Iraqi national start-up initiative. Looking however at the here presented cockpit, something between the objectives 'Innovation' and 'new Markets' would fit the requirements of an Iraqi solar start-up initiative. The main approaches available to systematically foster start-up environments and company creation are classified and shortly explained below:

1) **Corporate Venture Capital (CVC):** Corporations use direct equity investments to target and purchase shares in start-ups of strategic interest to their diversification objectives.
2) **Merger and Acquisitions:** Established firms purchase start-ups or young companies and their commercially-ready products in order to access new technologies or markets.
3) **Strategic Partnership:** Alliances between established corporations and start-ups can take many forms, including the co-development of products and services.
4) **Incubators/Inhouse-incubators:** This includes mentoring and value-added services to support entrepreneurs building viable, market-ready ideas. In-house incubators function as start-ups within a corporate setting. Teams of intrapreneurs convene for short projects, during which they prototype new products or services and pre-test a minimum viable result on the market by the end of the project.
5) **Accelerators:** Accelerators offer highly structured programmes that typically last no more than three months. These programmes provide start-ups that do not yet have proven products or services with the facilities, resources, and expertise needed to speed their product development and time to market.

6) **Venture Development Studio:** A start-up studio, company builder or venture builder, is a structure that creates repeat start-ups based on shared resources and a multidisciplinary team. It provides Start-up as a Service (SaaS).

Figure 81 illustrates from the perspective of the higher public entity or a donor consortium introduced above (or figuratively an oil company symbolised by a central crude carrier working on diversification of its business) how the 6 just described venture stimulation tools are activated (sent out) to generate a) entirely new ventures and start-ups and/or b) new business units in the case of established companies looking for diversification of their activities. Referring to the solar PV value chain in Figure 76 (Chapter 4.1) and to the Business Development Services and value chain interactions shown in Figure 77 (Chapter 4.3.2), these 6 distinct approaches should be combined in such a manner as to create a web of solar and other green companies. These new actors can ideally collaborate and even be partially interdependent, thereby weaving local and regional economic networks with commercial and industrial patterns. The above presented toolbox allows to plan quite systematically the development and erection of basic value chain systems over a period of 2 to 5 years if implementation can be done in efficient manner; in the current context of Iraq, it is however assumed that 5 to 10 years would be required to achieve corresponding results.

Figure 81: Deployment of corporate venturing tools



Source: www.bundl.com, 2021

4.3.4.4 Financing instruments for start-up MSME entrepreneurs

Unlike large corporations which have access to equity and bond markets for financing, smaller businesses depend primarily on credit. Banks generally provide the lion's share of small business credit, but there is a significant variation in small business lending based on bank size, which has exacerbated worldwide since the last financial crisis in 2008. As bank size increases, their support of small businesses declines, with the biggest banks devoting very little of their assets to small business loans. At the same time, the number of smaller banks is

shrinking due to heavy consolidation processes in the banking sector. That is why small businesses, start-ups, and enterprises worldwide are having a particularly difficult time accessing credit. One consequence of this credit shortage is that many small businesses are not adequately capitalized and thus are more vulnerable to failing.

The difficulty small businesses are having in obtaining financing is a major concern for the economy. In industrialised countries like the USA, about two-thirds of net new job creation has come from small business growth. Studies show locally owned businesses contribute significantly to the economic well-being and social capital of communities. Yet, the number of new start-up businesses has fallen by one-fifth over the last 30 years (adjusted for population change), as has the overall number and market share of small local firms. Inadequate access to loans and financing is one of the factors driving this trend.[109]

There are no institutionalised offers available in Iraq today to financially support MSME and start-ups. In the best of cases, isolated start-ups sporadically manage to convince private local investors to invest equity. And bank loans and grants may sometimes be facilitated in exceptional entrepreneurial cases. However, public and private banks in Iraq have not yet developed the business segment of financing MSMEs and start-up companies, previously proposing elevated credit rates too high for MSMEs to cope with. Given that global and local perspectives for banks are not generally favourable and have continued to tighten under the impact of the pandemic, banks' financing conditions for small and medium companies are not likely to improve soon.

Crowdfunding has garnered a international lot of attention in recent years as a potential solution to the small business credit crunch. However, it is worth noting that crowdfunding remains a very modest sliver of small business financing. While crowdfunding will undoubtedly grow in the years to come, at present, it equals only about one-fifth of 1 percent of the small business loans made by traditional financial institutions in the USA and Europe. Crowd-funding and other alternative financing vehicles may be valuable innovations, but they do not obviate the need to address the structural problems in banking system that are impeding local business development.

Expand Access to risk capital

In principle, financing for MSME could come from a variety of different sources:

1) International donors
2) International finance actors (DFI)
3) The Iraqi state and the national banking system
4) The Iraqi state through its public companies:
5) Larger private or public/private Tier-1 Iraqi companies

Concerning 1 and 2: Acquiring funds directly from national and international donors may be possible in particular cases, but in practice they are difficult to find, apply to and get approved. These financing sources should rather be coordinated at higher levels between Iraqi government institutions and the various international development organisations and donors

[109] Access to capital for local businesses, Stacy Mitchell, Access to Capital for Local Businesses – Institute for Local Self-Reliance (ilsr.org)

that would ideally co-ordinate their approaches and measures increasing their impact by joining their forces.

Concerning 3: As explained in chapter 4.3.3.3, state financial guarantees have been an overused instrument in the past in Iraq. A reshaping of guarantee policies is underway that should eventually spur the emergence of new guarantee mechanisms and loan funds targeted at key national needs such as the development of the RE and EE sectors. Guaranteed loans provide significantly longer terms, which improve cash flow and thus can make the difference between success and failure. Loans to MSME should have maturities of at least 5 years and longer, depending on the borrower and the purpose. This compares to conventional small business loans available in Iraq today with maturities of less than a year.

Although a loan guarantee scheme for RE/green start-ups and companies accounts for a very small share of overall public lending and spending, it would play a disproportionate role in credit access for these innovative businesses that take the challenge of an improved energy supply in the future of Iraq. It must however be ensured that the guaranteed loans effectively go to eligible start-ups, very small businesses, women-owned and minority-owned businesses, hence those actors who are targeted by the scheme.

With the systemic malfunction of Iraq's banking systems in financing MSME not likely to change soon, and in light of the challenges faced by international and national banking sectors, the government announced a '1 Trillion Dinars (1 billion USD) Initiative' in 2015. This public loan fund is dedicated to SME and young entrepreneur private-sector projects but has not yet been implemented systematically. It also remains to be seen when and how precisely it is going to be structured, but conducted interviews hinted that the interest rate could be 4.5 to 5.0%, which comparatively represents a very low interest rate for Iraq. The programme is showing first encouraging results in Mosul, Ramadi (Anbar), Nasiriyah, and Basra, according to experts interviewed. This facility should also be used as a spring-board by the first and upcoming second generation of RE and solar pioneers. Eventually, a loan fund for RE/green start-ups and company diversifications should be considered as an additional priority. Furthermore, new forms of financing MSMEs such as through community banks and credit unions should be considered and investigated.

Concerning 4 and 5: As international equity investors from the Emirates, the USA, Europe or Asia still avoid the perduring high country risks in Iraq, local capital should be taken into focus as well, in the end it can also be considered a matter of national interest and patriotic endeavour. The financing sources from private local Tier-1 companies, innovative public companies and foreign companies could be activated through the "Corporate Venturing" approach described earlier in chapter 4.3.4.3. Corporate venturing - also known as corporate venture capital - is the practice of directly investing corporate funds into external start-up companies. This is usually done by large companies who wish to invest in small, but innovative, start-up firms. They do so through joint venture agreements and the acquisition of equity stakes. The investing company may also provide the start-up with management and marketing expertise, strategic direction, and/or a line of credit.

The established Iraqi oil industry and other large private sector actors have an inherent strategic interest to by early participants in the upcoming solar business in Iraq. Considering that the average lifespan of a company in the American S&P 500 index has decreased from 61 years in 1958 to just 18 years today, it is never a bad idea to start exploring alternate options of future growth, especially in the energy sector. In this manner, "corporate dinosaurs avoid extinction by using corporate venturing to hunt for start-up unicorns" because "In this fast-

changing world, it is not necessarily the big fish which eats the small fish, it's the fast fish that eats the slow fish."[110]

To increase the chances of success of the solar start-up initiative, the corporate venture approach and the launch of a new loan fund for RE/green start-ups and company diversifications should be combined with an international donor consortium providing seed financing and capacity building to all involved national stakeholders.

4.3.4.5 Technical and managerial vocational training

Contrary to engineering and technical disciplines that are quite well developed in the Iraqi education system, economics and business management have been much underexposed disciplines so far, notably in universities and vocational education centres. Consequently, there is an obvious lack of economist trainers and experts, making it difficult for young entrepreneurs to efficiently acquire knowhow in economics and business management. This forces most entrepreneurs to develop their skills with autodidactic online studies from foreign providers (which is easier today than ever) or to risk learning the hard way by making avoidable beginners mistakes.

The main target groups for RE and green start-ups and the corresponding required capacity building are a) young adults in general and university graduates specifically, with a technical background or interest in technology, innovation, economic and social progress and b) more experienced professionals and entrepreneurs with longer career tracks. The various regional trade and industry chambers, the Society of Engineers and other relevant institutions should be systematically involved in identifying, orienting and supporting young entrepreneurial talent and technical start-ups with advice and if applicable, hands-on collaboration from experienced and qualified seniors.

While the average competence level of young engineering graduates and professionals in general technical topics can be qualified as fair to good but insufficient in RE, economics and business management disciplines are widely new topics. Most participants of a 2-week technical-economical training conducted for young engineers and entrepreneurs from Basra displayed poor knowledge, understanding and interest in economics, business management, marketing and sales topics. This may also be a consequence of Iraq's central planning socialist system.

All start-ups require very hands-on practical capacity building for younger or older but unexperienced company managers in concrete business management fields with various specialisation levels. The skills learned need to be the skills required in everyday business, notably as related to financing, costs and revenues or marketing and sales. Most business operation and management trainers required will need to come from other Arab or Western countries because the required competence and knowhow is not sufficiently developed locally.

The state-of-the-art technical skills required by start-ups for the new technologies they are dealing with can be transferred in collaboration with foreign suppliers in person, online, or through hybrid seminars, as long as well sufficiently equipped and internet connected working facilities are available for the start-ups to participate in such course efficiently. German solar suppliers are also establishing professional online training facilities to accommodate their global training needs with local staffs. Although these active diversified trainings of a length of weeks or months rather than days will engage mostly foreign companies, trainers and experts, each training should have a train-local-trainers component included to systematically build up

[110] Report • 16 strategies for disruptive innovation | Bundl

competent local Iraqi trainer capacities within 3-5 years. The most engaged and promising training participants can be rewarded with training visits to the headquarters of some other countries where the participating foreign suppliers have their branch offices. Talent identification and their targeted promotion play an important role throughout the above discussed capacity buildings requirements.

4.3.5 Supporting local (EPC and IPP) companies to participate in utility scale PV PPA projects

For a local industry to develop inside Iraq that can grow in parallel with the intended market introduction of utility scale PV power plants, local PV companies need to develop step-by-step, collaborating with experienced international EPC and IPP companies that are actively implementing initial projects in Iraq. The precondition for this is that the market introduction can happen soon and that the selected international project implementing companies find a conducive project environment, though this last aspect has been the weak point so far in getting the planned 700 MW in projects of the ground.

According to a presentation provided by the Ministry of Science and Technology, international investors and contracted EPC companies need the following criteria to be fulfilled in order to engage into large projects in Iraq[111]:

1. Political commitment and investors' confidence in the national market.
2. Effective engagement (partnership) of utilities and state-backed private RE companies
3. Project support (grid connection, zoning/allocation of land, fiscal incentives, concessional finance)
4. Clear set of bankable project contractual documents with all required licenses
5. PPA contract in foreign and/or local currency with a duration of 20-25 years
6. Credit support through the government for off-takers
7. Most investors who submitted their offers for utility scale projects Iraq asked for the sovereign guarantees. Usually issued by the Ministry of Finance or the Central Bank of the State concerned Confirming the rights of the investor to keep his money against all risks (sabotage, terrorism)

The other major prerequisite to get local companies involved in the coming deployment of utility scale projects is the definition and implementation of balanced and realistic, thus effective local content regulation (LCR) policies. When formulating such LCR policies, Iraq could learn from analysing the LCR policies that oil producing country, Malaysia, began in the 1970s and which led the country to develop a strong industrial and export base, that has earned international recognition. Additionally, it must be noted that the Malaysian government did not allow the oil sector to drive up costs and wages in the Malaysian economy. As a result, rapid non-oil related industrialization has taken place in parallel with the expansion of the oil sector, which is seen as an outstanding achievement in the international context. Since 2007, when Malaysia saw its first solar module factory implemented (by US-based PV manufacturer First Solar), it has succeeded in establishing fully integrated value chains for the production of PV panels in its territory, both for crystalline and thin film cell technologies.

[111] Solar Energy in Iraq and Future Plans, Dr. Falah Al-Attar, Ministry of Science and Technology, 2020

Malaysia started its LCR approach by fixing local content quotas and requiring foreign contractors and suppliers of various industries to use local products, service and human resources to the extent that they are available locally. International tenders are only allowed for goods and services that are not available in Malaysia or in members countries from the Asian Pacific Economic Cooperation (APEC). Often, foreign contractors are also required to submit their offers in partnership with a local company. Furthermore, local contractors are favoured with bonus remunerations, for example in the form of a slightly improved PV feed-in tariffs to the public grid. Since establishing manufacturing capacities for PV equipment in Iraq is not currently realistic and thus out of reach, LCR concerning the implementation of utility scale PV plants should target system installation and O+M services in a first step, followed at the next stage by more demanding activities such as increasing system engineering responsibilities, construction supervision, etc. Those Malaysian policies were accompanied by heavy investments in personal professional training and organisational capacity building programmes over decades to ensure that local companies are put up to speed with international work methods, quality standards and foreign contractor expectations.

Some of these international PV supplying companies from regional neighbouring countries such as Turkey and Jordan, or from Europe will also be increasingly active in the field of medium-sized PV systems from the kWp to the MWp scale. Local content regulation would also be required in these apparently less political and voluminous market segments to ensure that local Iraqi PV companies are actively involved as subcontractors in those mid-sized projects which qualify for contracts in the utility scale sector and can climb the learning curve with increasing market activity. The formulation of local content regulations would actually justify a pragmatic technical study to analyse possible LCR policy approaches for Iraq in general and more specifically in the fields renewable/solar energies and green technologies.

4.4 Other key requirements for successful implementation and operation of PV business models on the supply and demand side

One major advantage of solar PV is that these investments, if made into quality equipment and services, generate significant welfare gains at a personal and societal level because the core hardware investment, that is the PV field, can operate for up to 25-30 years under local conditions, or even longer if well maintained. The welfare improvement comes from the fact that once the PV investment is amortised after say 5-10 years, it will generate solar power at very low costs for the rest of its lifetime, considering however that periodical replacement investments are required for some electronic equipment and batteries will remain the highest cost factor over system lifetime. Solar power produced this way disconnects users from volatile national and international energy prices and will allow them to significantly reduce energy costs over the long term, freeing funds over time for other important investments.

Deeply entrenched attitudes, mentalities, decision-making and behaviours concerning the generation and use of energy and electric power in Iraq have to be overcome. They manifest today in the form of a deeply impaired public power supply with daily frequent outages and private generators charging exorbitant prices. Iraqi society urgently needs to be made aware that solar PV and more generally RE/EE can help to significantly reduce the long-term costs of living and economic activities and thereby raise national welfare. If this understanding sinks in for significant parts of the population, supported by awareness campaigning and further

financing instruments are made available to investors in the various PV segments, then the market is sure to develop at an accelerating pace.

4.4.1 Awareness raising of public and private stakeholders

Awareness raising of institutional and professional target groups is most efficiently and systematically done through structured, customized training and capacity building programs, as opposed to a one-time inland or foreign seminar. Such programmes provide a process into which the stakeholder representatives can be engaged more comprehensively and durably using modern means of digital collaborative working. Capacity building on Solar PV/RE technologies, policies, entrepreneurship, targeted economic development and others is obviously required by all actors in the public and private sectors as well as on all hierarchic levels. However, the required specialized institutes and competent trainer capacities are very scarce and need to be systematically developed by integrating and adapting foreign knowhow to local requirements. Special focus must be placed on educating a new generation of Iraqi trainers, who are able to convey all aspects of first solar, then other RE technologies, policies and businesses.

All interviewed Iraqi experts agreed that the most urgent needs for awareness raising through capacity building are with officials, politicians, decision-makers and civil servants in the national, regional and local public sector. Most frequently cited were capacity building needs in the MoE and MoP. The overall objective of such institutional capacity building and personnel training efforts must be to mobilise the support of critical parts of the public sector and to reduce inactivity, deliberate ignorance or intentional obstruction of solar PV/RE by or through public agents.

The UNDP section in Iraq, which has been active in solar market development for many years, has a good understanding of the requirements to promote solar PV in Iraq. The UNDP recommends a set of measures which are mostly focussed on maintaining and expanding efforts to build awareness among major stakeholders:

Capacity building programs: Mentalities of local populations related to unrestrained power usage or wasting due to lack of awareness, or the short-term orientation of energy spending and investment decision making could be addressed by focused awareness campaigning. This concerns both private and public PV decision makers and investors alike who mostly are not equipped with the required knowledge to be able to choose the adequate technical PV solution that will meet their needs.

So far, approximately 500 Iraqi decision makers have been reached through UNDP supported capacity building initiatives, even bringing some of the high-level participants to foreign Arab countries to visit flagship solar projects. This has not however been enough to make a significant impact so that the number of trained persons should actually be further increased. Such capacity building programmes should therefore be intensified, diversified and detailed in their content scope:

- Professionals from the banking sector would require specialised training on solar project financing. The Green Climate Fund (GCF) could provide such trainings.
- Professionals from the agricultural sector would require more dedicated capacity building efforts given that they are often not connected to the power grid and do not receive any energy related subsidies.

- There is also a high interest for lifecycle analysis of PV systems to be applied in Training-of-Trainers (ToT) seminars oriented towards academics, politicians, private sector companies and NGOs.

Demonstration and Market introduction: In the Iraq marshlands, the SDG facility is currently offering a 1 million USD seed money co-financing grant which is expected to lead to investments for water pumping and water treatment investments worth 5 million USD. In this context, DFID and SEDA (Malaysia) have been approached to investigate co-operation opportunities.

Some interview partners also stated that conferences and seminars like those organised by GIZ in collaboration with the Ministries and the Iraqi chambers of commerce and industry are important as they contribute to the transfer of state-of-the-art knowledge and knowhow, confront actors with strategic long-term thinking and also present networking and interaction opportunities. Other local interview partners have stated on the contrary that when organising conferences and workshops among Iraqi stakeholders and without foreign institutions involved, most government representatives attending do not signalize sharp and serious interest, but rather divulge common places that do not really help the cause of solar and RE.

The scoping and concept study recently prepared by RENAC for GIZ PSD and which is not known to the study team of the work presented here, likely details the various training and capacity building requirements of stakeholders and decision-makers on all levels discussed in this study.

As part of the suggested Solar/RE/Green start-up Initiative in chapter 4.3.4.1 where a comprehensive training and capacity building programme is suggested for start-ups, entrepreneurs and established companies who want to diversify into solar business. This start-up context can actually also be used to institute a series of other capacity building, training and other activity offers directed at public companies, administration and key political institutions involved in decision-making processes relative to solar PV/RE technologies. This concept approach could, for example, materialise in the form of relatively cost effective private/public training centres that are operated and managed by local private sector actors, as well as co-financed and advised by an international consortium of interested donors and their expert contractors. The public sector would participate in the strategic steering bodies of these centres.

An obvious advantage of unique private/public training and event locations which are ideally adjacent to the local start-up incubator, is that the frequently cited so-called gap between politics/administration and the private sector can be more easily bridged in such centres where start-ups, entrepreneurs and companies on the one side and civil servants, politicians and academia on the other can meet in joint seminars, workshops, regular networking events, in the cafeterias/restaurants inhouse or outdoors. Such formal and informal interactions and meeting possibilities/platforms, located first in Basra, Baghdad and Erbil or other major cities, can ideally lead to the creation of public/private work groups, joint task forces and other forms of exchange and collaboration that can improve all sorts of processes around the proposed national solar/RE/green start-up initiative. It needs to be discussed though among Iraqi actors if such an approach can make sense and with international donors how to finance and implement such centres.

4.4.2 Awareness raising of the demand side

With the Iraqi PV market being still in its infancy, the awareness of demand side actors needs to be developed from scratch in order to establish the societal foundations for a national solar culture to be seeded, steadily cultivated and brought to fruition after a number of years. The major challenge resides in the fact that solar PV systems are not competitive with the heavily subsidized and exceedingly cheap tariffs from public power systems, and that the attitude of Iraqi power consumers clearly favours short-term thinking, still preferring low cost offers over quality offers, even if this will often lead to disappointments.

This is why Iraqi people need to be sensitised to the important role solar can play in Iraq's future nationwide power supply and be educated about the economic and ecological advantages of solar PV in the long run, as opposed to always looking into temporary solutions that look relatively cheaper in the short-term but are significantly more expensive in the long-term view. Most of the interviewed local experts stated that more public communication and education on the economic and ecological advantages of solar PV compared to the current power supply are needed to contribute to spreading solar culture in the country. More concretely, these PV-induced economic and financial trade-offs in the medium- to long-term need to be clarified and demonstrated in simple and understandable manner to the various investor target groups, from private households to farmers and commercial/industrial MSME. Additionally, people's awareness of energy efficient power consumption behaviours need to be anchored and sharpened in general, but also to make sure people use their available yet limited individual solar power supply wisely.

However, public awareness building using standard marketing and advertising techniques, as often cited by interviewed experts, can be costly if traditional mass media such as TV, radio stations and print/online media means are used. Costs can still be kept low if publicly owned media are systematically involved on the editorial and content levels, especially as the Iraqi population is closely following political developments and statements by authorities. Some private media may participate as well by providing cost-free support, using the opportunity to strategically engage into a future-oriented, modern market position. Public communication demonstrating full endorsement by public authorities is very important because it has a strong encouraging, motivational effect on populations, relativizes lingering misconceptions and is also effective in containing fraud by establishing transparency and confidence among parties interested in PV. Involving popular Iraqi personalities such as TV actors would have a fortifying impact, especially if they act as testimonials prescribing the solar solutions they have implemented themselves.

The few PV companies that operate today in bigger cities are doing so without direct public support, many of the PV systems they are contracted to build are however, subsidised. Communication about solar is weakly developed and passive rather than active and dynamic. These companies are therefore confronted with the immediate market realities, demands and attitudes of clients. All work by compiling solar PV system equipment from different sources, mostly Asian and Indian, and experimenting with various system packages to serve their designated clients, mostly the authorities, households and farmers.

While in a first step to more private autonomy, low-income households increasingly opt for a basic inverter-battery solution that allows them to store power from the grid, their suppliers are well advised to make additional offers for well packaged and priced modular PV capacity increments to ease their adoption of PV. The standardisation of PV offers and attractive offers for modular capacity increments will generate better user experience and more confidence on

the demand side, driving prices down and thus improving acceptance and willingness to pay. Furthermore, households opting for this approach generally increase their awareness of efficient power usages and savings, which is another reason to attract households towards ***'Inverter-battery solutions for storing power from the grid that can be easily upgraded with solar PV'***. If such messages are well conceived and effectively conveyed to the population and the supply actors and structures behind are adequately involved and prepared to serve the generated interest and demand, then solar jobs are being effectively created.

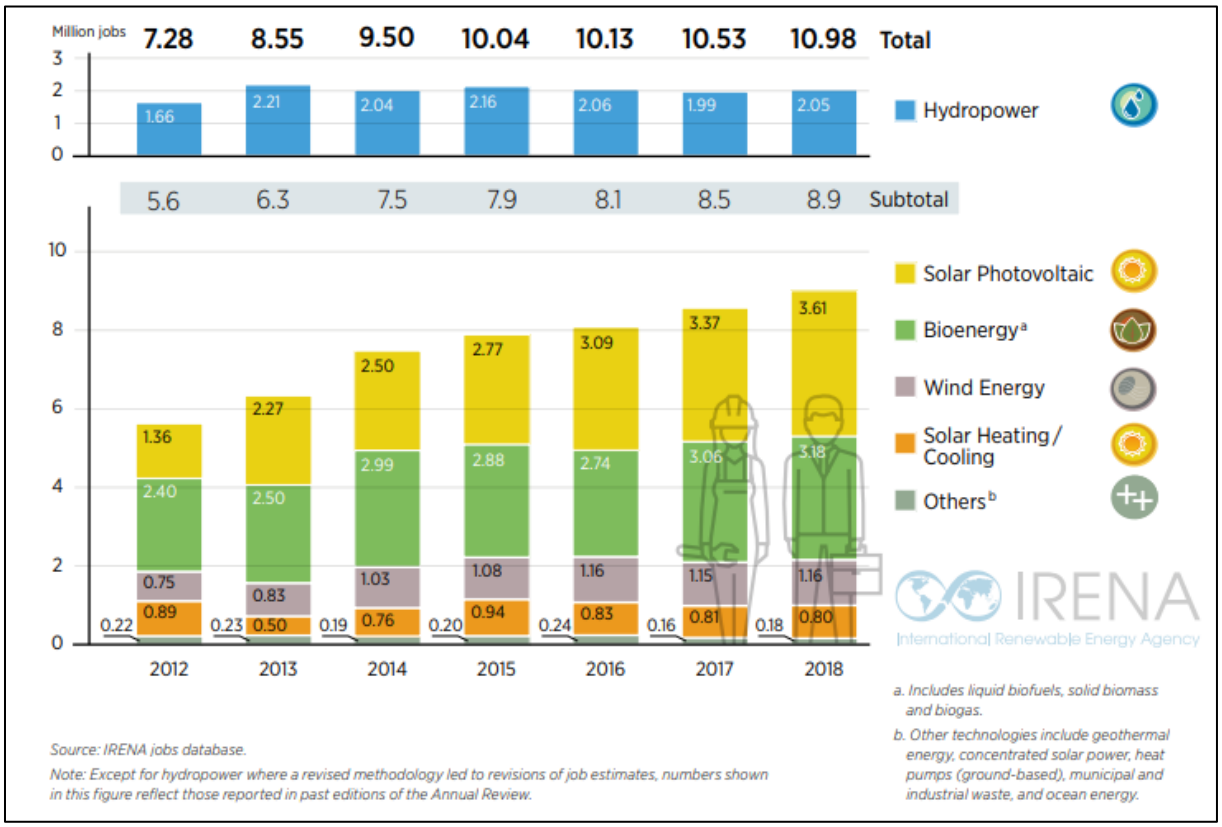
The approach exemplified above can be translated into a lean awareness and market activation campaign carried out in partnership between the private and the public sector, where the latter contributes its national, regional and/or local communication means to convey targeted messages that have been developed with the local PV suppliers. The supply side knows best the current triggers that can be used to catch the attention of potential customers and transform interest into purchase decisions. Pragmatic minimum quality standards and requirements have to be agreed for a start that can be evolved in later steps. A simple trigger-response campaigning model can be developed that uses call for action mechanisms to motivate people to get more information on an online campaign platform where they get access to neutral information, simple calculation tools and can ask for quotations from participating storage and PV system suppliers.

Such a lean campaigning model can first be implemented in a rudimentary manner, starting with local/regional test markets to first gather experience and improve the call for action mechanisms. Subsequently the campaigning model can be added to with more complex communication instruments to increase outreach, such as including televised and digital testimonials from satisfied first movers and popular Iraqi personalities who ideally talk about their own operational PV systems and success stories. Although the campaigning model can be deployed at national scale over time and should be conceived with this idea in mind, initial campaigning activities should follow a regional approach and reference system to make sure the campaigns are well grounded in their regional context and thus can be easily adopted by Iraq's diverse populations. Since smartphones have seen a vast adoption by populations in recent years, involving the diversity of social media in the campaigning model will be key for cost efficient outreach and to spread the success stories that Iraqi people should be made aware of. In the observed regions of Baghdad, Basra and Erbil there are already numbers of passioned solar professionals and activities that are promoting solar market development and who can be easily involved and tied into campaign activities.

4.5 Employment and job creation in the solar PV sector

Figure 82 shows that renewable energy transition and solar energy in particular, generates many jobs in all markets where it has been introduced in a systematic and regulated manner. Between 2012 and 2018, the number of PV jobs worldwide has nearly tripled, surpassing the labour-intensive bioenergy sector in 2016 to become the leader of the field, with millions more jobs to be created in coming years. Iraqi experts with practical knowledge in Iraq's small solar sector all agree that an uptake of solar markets will also create a variety of direct and indirect jobs in Iraq, such as system engineers, logisticians, electricians, blacksmiths, casual labours, etc.

Figure 82: Global renewable energy employment by technology, 2012-2018



Source: IRENA, 2019

The dynamic growth of PV markets generally leads companies to adopt different business models and product offerings. While many companies remain focused on the established business model of selling, engineering and installing PV systems, others are moving toward more complex solar-powered appliances and agricultural equipment, proprietary software, non-energy loans, digital financial and internet services. This expansion of the sector will see increasingly diverse products and services being offered, and subsequently, an increasingly diverse range of employment opportunities.

In addition to the jobs created within solar companies, the solar market supports employment in other sectors through partnerships and links to complementary service providers. Indirect jobs are being created in other sectors through linkages with local suppliers for services such as logistics, construction, recruitment, marketing and communications, insurance and telecommunications. One typical example from African off-grid markets are the partnerships with mobile phone companies, where products are sold via mobile phone retail outlets, helping to boost sales and sales positions, and PV user payments are made through mobile phones.

4.5.1 Employment situation in the power and solar PV sectors

The current general job market situation in Iraq has been briefly portrayed in chapter 1.4.3; it must be qualified as poor with no real improvement in sight. There is sporadic solar job creation through local companies implementing the first small and medium scale PV units, as well as contracting small installation teams, mainly in the northern and central region cities, as well as nascent activity in the region of Basra, borne by engaged entrepreneurs and individuals. Fully

qualified PV professionals that have studied or successfully completed professional qualifications abroad are rare in the country, and most professionals currently active in PV have acquired their knowhow from on-the-job or autodidactic experience.

The research and interviews carried out for this study clearly indicate that there are no official objectives or strategies available to date to develop employment in the field of RE and solar energy (nor green technologies, such as in the water sector). Besides relaying initiatives by international organisations which for the past several years have been offering more or less sporadic training seminars and several Iraqi initiators that are in the process of setting-up first local training centres, often with scarce means, no systemized long-term training programme offers exist in the country. Hence, the rising demand for qualification programmes in RE, solar and other green technologies reveals a growing market gap that is obstructing the development of PV markets throughout the country.

4.5.2 Profession categories along the PV value chain

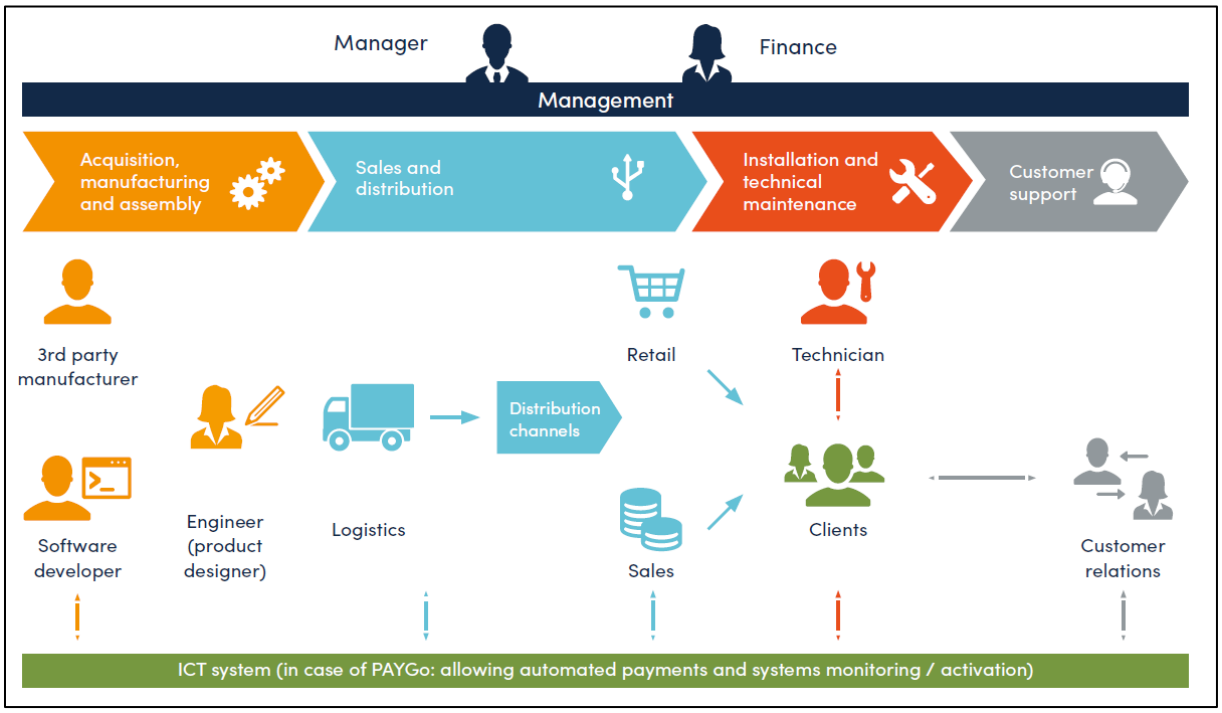
Given that Iraq has little manufacturing capabilities in general and that solar manufacturing capacities in the proper sense are not likely to be established in the coming years, it is the downstream value chain functions, typically represented by EPC companies, that are especially relevant for job creation in Iraq:

1) Engineering & Purchase
2) Sales & Distribution
3) Installation & Commissioning
4) Operation & Maintenance
5) Management & Finance

The variety of professions across the whole value chain is displayed in Figure 83, stemming from a GOGLA study on South Asian and African off-grid markets[112] which can be considered as fully applicable to the Iraqi context as 1) although PV was introduced to Iraq in the 80s, the market is still in its infancy, 2) besides utility scale systems, the market will mostly consist of off-grid applications with households, farmers and smaller companies (such as those found in the GOGLA study) that can be considered as operating off-grid given their generator based self-production, 3) the professions involved are quite the same.

[112] Off-Grid Solar. A Growth Engine for Jobs, GOGLA, 2019

Figure 83: Types of employment or professions across the downstream value chain

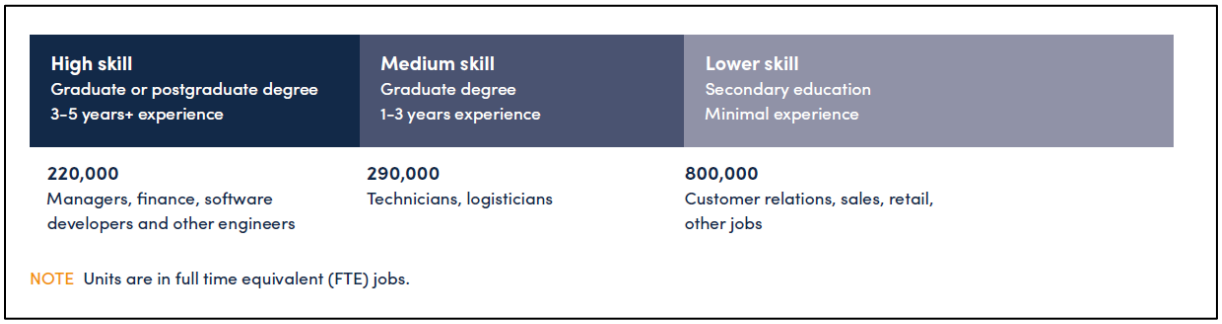


Source: GOGLA, 2019

The 'Sales and Distribution' function displayed quite prominently in the above figure mirrors the relative importance it plays in the African and Asian off-grid sectors where rather small compact and modular Solar Home Systems (SHS) below 1 kWp are generally distributed to remote rural communities, thus requiring more time and effort to reach clients. This emphasis also makes sense in the context of this study as Iraqi actors generally tend to underestimate the sales, distribution & logistics function or the share of human resources required within said function, as an equally important value chain component for company success.

The typical skill levels required in the off-grid PV downstream value chain and their relative shares are shown in Figure 84, which highlights the example of African and South Asian markets by 2022. Lower skilled jobs make up approximately 61% of the total labour requirement, while medium skilled and high skilled jobs make up for 22% and 17%.

Figure 84: Required professional skill levels in the off-grid PV downstream value chain



Source: GOGLA, 2019

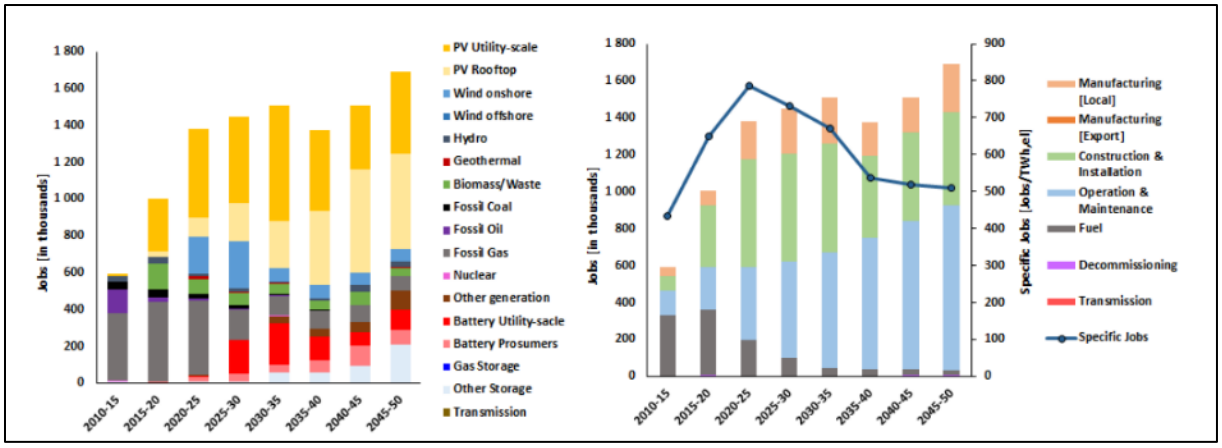
Many of the positions created by the solar PV sector will also deliver substantially higher wages than the average wage of the country in which they are created. Even amongst the lower skilled positions in the sector, incomes are typically above countries' respective minimum wages, and often above the average national wage.[113] Additionally, in lower skilled positions, there is often opportunity for quick progression and wage increases due to training opportunities and the rapid growth of companies. Well-paid and highly skilled jobs created by the off-grid solar sector may also have wider positive economic impacts. Not only do these competitive wages directly benefit employees and their families, but they may provide an indirect boost to local economies.

4.5.3 PV related job creation potential

Although it is not within the scope of this study to precisely quantify the job creation potential of solar PV market dynamics in Iraq, this chapter provides a general overview of the major job creation potentials that can be unlocked in coming years and a rough estimation of the number of jobs that can be created in the various professions involved in solar market development. Figure 85 displays the job creation potential in various power generation and storage technologies in the MENA region from 2010 to 2050. It shows the impressive job creation dynamics triggered by PV alone (utility scale and rooftop PV systems) starting from 2015 and from there on developing a dominant position over the complete field by the year 2030.

An interviewed Iraqi government expert stated that the private solar sector implemented more PV solar stations in past 10 years than the government. No reliable market statistics are available and it is not sure whether those capacities are really from private investors or if they have been provided by international donors. Should the first option apply, this would mean a certain market dynamic with job creation potentials is on the horizon.

Figure 85: Jobs created by the various power generation and storage technologies (left) and jobs created based on different categories with the development of electricity demand specific jobs (right) during the energy transition from 2015 to 2050 in the MENA region.



Source: Technological Forecasting and Social Change Journal, July 2019

At the outset solar sector jobs in Iraq will be largely focused on sales, distribution, installation and maintenance. Only later may manufacturing jobs be added, either through particularly innovative Iraqi start-ups which develop new products, or through partnerships with foreign

[113] Interviews conducted with GOGLA company members in 2019

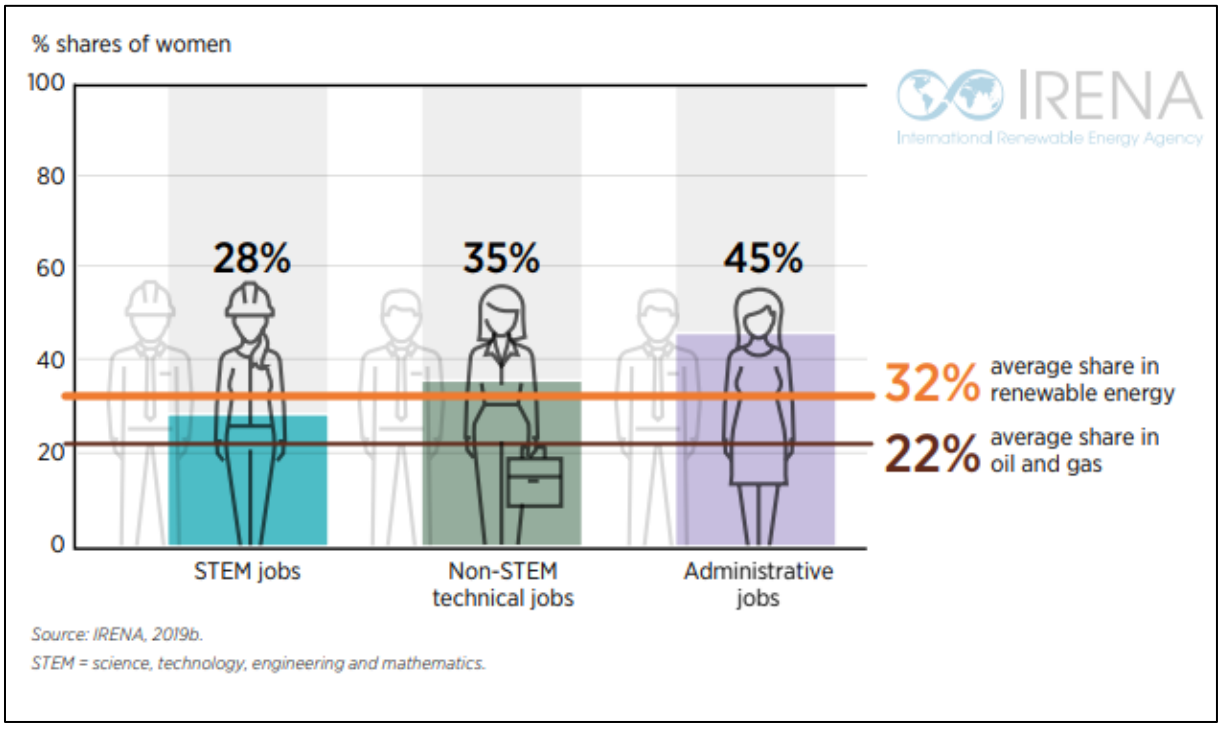
manufacturers where solutions adapted to the extreme conditions of Iraq and other arid zones are developed and eventually manufactured locally.

For a majority of these positions, companies employ payroll staff on long-term contracts, with opportunities for progression in line with business growth. Where sales or other part-time roles are commission-based, they can provide flexible ways for women to augment their household income working in the neighbourhood. The benefits of employing staff in local communities is not only felt by the employees but also the companies they work for. Companies are increasingly gaining from the direct personal knowledge that their team have of a community's needs. This can create a virtuous circle where strong sales can lead to new employment opportunities for local staff.

PV related jobs for women

The solar industry presents good employment opportunities for women, as IRENA studies have reported for many years. Figure 86 shows that women currently represent 32% of the global renewable energy workforce, substantially higher than the 22% average reported for the global oil and gas industry. Still, within renewables, women's participation in science, technology, engineering and mathematics (STEM) jobs is far lower than in administrative jobs.

Figure 86: Share of women working in different job categories of RE and O&G sector



Source: IRENA, 2019

These opportunities for women's employment are increasing in many emerging economies as solar technologies for households and digital business models based on leasing schemes with constant customer interactions such as PAYGo become more widespread. Furthermore, in emerging economies, women are traditionally more closely involved in fulfilling the household's energy needs and are often responsible for the procurement and use of energy. They therefore have greater understanding of how to engage a key customer demographic. A recent pilot study by Value for Women found that when women were provided the right training on product

demonstration and sales techniques, their performance rose to surpass that of their male counterparts - generating 45% more sales and 52% more revenue than male agents.[114]

Although the involvement of women in all functions of the value chain is principally possible in Iraq, especially relating to administrative and customer service/relations roles, its progress and frequency will likely be reduced compared to many other countries. The main reasons are more or less severe religious and cultural traditions in different regions and communities, as well as the high unemployment rate generating highly competitive pressure from the side of male workforces. Whether a significant proportion of those jobs can be accessed by women in Iraq's daily reality remains to be seen and should actually be studied using a set of countrywide conducted social surveys among local populations. Digitally based administration, sales and customer support jobs with reduced physical contact strengthens the trend towards more women's inclusion and may improve access to solar jobs for younger unmarried and married women alike.

Estimation of the solar employment market in Iraq by 2030

We have roughly estimated Iraq's solar PV direct employment market by multiplying the estimated future installed PV capacities (MWp) with the specific person years worktime spent over the full lifetime of each MWp of capacity installed, thereby obtaining for each observed year the cumulated numbers of person years of worktime provided by the solar sector:

1) The estimation of the market evolution is based on six market segments whose respective market evolutions have been estimated based on the information contained and synthesized in the study presented here. See the corresponding Excel table and assumptions under ANNEX 6 – Estimation of PV market and job creation evolution until 2030.

2) The specific job creation multipliers also called "employment factors" and quantified as 'Person years worktime per MWp' are extracted from the study "Potential for renewable energy jobs in the Middle East,"[115] dating from 2013. This is the most actual and accurate analysis we could find, and although it is not particularly recent considering the cost degression observed in PV during the past 5-10 years, it is considered a valid reference as the Iraqi PV market is still at its very beginning and is currently out of phase with the latest technological developments and international market trends.

The job creation multipliers or "Direct employment factors" - that will be multiplied with installed PV capacities to result in solar job occupation years - have been elaborated by the study cited above; they are presented in Table 12.

Table 12: Minimum, median and maximum direct employment factors (job creation multipliers) for the main phases of deployment of PV capacities

	Manufacturing	Installation	O&M	TOTAL
	(person years/MWp)			
Minimum	3.2	3.9	0.1	**7.2**
Median	12.6	15.4	0.3	**28.3**
Maximum	19.4	23.6	0.7	**43.7**

[114] Value for Women (2018), A Business-First Approach to Gender Inclusion: How to Think about Gender Inclusion in Small and Medium Enterprise Operations.

[115] Potential for renewable energy jobs in the Middle-East, Bob van der Zwaan, Lachlan Cameron, Tom Kober, 2013

Source: B. van der Zwaan, L. Cameron, T. Kober, Potential for renewable energy jobs in the Middle East, 2013

The minimum factors are applicable to the utility scale market segment due to the economies of scales of large series; median factors which are 3 times higher are applicable to most other small to medium scale PV systems, while maximum factors are more rare and refer, for example, to highly customized, high-end PV systems for applications under extreme environmental conditions.

These various employment factors presented in Table 12, which represent "Direct Jobs linked to PV," are distinguished into three rough categories of Manufacturing, Installation and Operation & Maintenance, whereby the business function of 'Distribution' is considered as "Indirect Jobs" at "secondary level" by the study.[116] Making 'Distribution' a fourth job category in the above introduced methodology makes sense, which is why we added it to the existing numbers by scaling up the 'Person years worktime per MWp' by an additional 20%.

The following Table 13 presents the results of rough potential calculations made for solar PV jobs in Iraq over the time range 2020-2030, based on a range of simple assumptions among which:

a) Iraqi energy politics are finally reformed, and
b) The government takes the minimum measures required to establish favourable market framework conditions for solar PV markets.

Starting at a cumulated work time level of about 500 person years that have accrued to date in Iraq, the total potential work time including all PV market segments increases to 5,000 person years in 2025 and 70,000 person years in 2030. To translate these numbers into 'permanent job equivalents' the most straightforward estimation method is to divide the increase of work time by the number of years in the period observed. This results in approximately 800 new solar jobs created by 2025 and multiplies today's existing solar jobs in Iraq by a factor of more than 15. By 2030, 7,000 new jobs can be created.

Table 13: Work time generated and jobs created in the solar PV sector by 2025 and 2030

Work time in cumulated person years	**2019**	**2020**	**2025**	**2030**
Gvt./Public projects	99	127	849	8,490
Solar PV rooftops	28	28	283	7,075
Solar water pumping	113	142	991	11,320
Commercial & Industrial	-	14	283	7,075
Refugee camps/towns	42	57	198	283
Total incl. Distribution mark-up 10-20%	**340**	**441**	**3,124**	**41,092**
Utility Scale	-	-	2,880	72,000
Local content share 40%	**-**	**-**	**1,152**	**28,800**
TOTAL (Person years)	**340**	**441**	**4,276**	**69,862**
Total permanent job equivalents (#jobs)	**38**	**44**	**767**	**6,945**

[116] See page 2ff. in: Potential for renewable energy jobs in the Middle-East, Bob van der Zwaan, Lachlan Cameron, Tom Kober, 2013

Source: Own calculations – BSW/Olivier Drücke, eclareon/Ulf Lohse

The simple 'permanent job equivalent' method generates very conservative, likely underestimated results, because the estimated numbers are mathematically based on simple averages, so that the exact amounts of occupied jobs at the end of the observed period are not revealed; more elaborated calculations may therefore be performed in the future in the frame of more dedicated analyses.

For the moment, it can be roughly assumed that around 1,000 PV full-time jobs can be made available and occupied by 2025 and 10,000 full-time jobs by 2030. Another important take-away is that decentralised small and medium scale solar PV applications generate significantly more local jobs than utility scale power parks, by a factor of approximately 3 (See Table 12).

4.5.4 National, regional and local support policies for solar job creation

This chapter briefly describes the views of major Iraqi stakeholders interviewed on how the authorities at the national, regional and local level can support solar job creation processes.

Iraqi researchers and consultants often stated that national authorities should focus on setting the right framework conditions, notably in the fields of norms, standardisation and quality assurance, to let the private sector develop, thrive and generate growing demand for personnel. However, the one specific job creation support policy expected from central authorities is an intensified effort by the Ministry of Higher Education and Scientific Research (MOHESR) to include RE and solar technologies curricula into the education and courses offered in universities and vocational education centres throughout the country. Furthermore, all universities (technical and non-technical) should be equipped with adequate PV demonstration systems that allow engineering students to gather initial hands-on experience. The objective must be to provide students with basic and relevant state-of-the-art knowledge on solar energies before they enter highly competitive RE and solar job markets and to enable them to specialise in those fields which are of particular relevance for the RE and solar markets in Iraq and the Middle Eastern region.

Given the pervasive lack of trained Iraqi personnel in RE and solar technologies, the few local solar companies that are already established have taken the initiative to build up their own workforces through in-house and on-the-job training, thereby adapting existing skill sets to the specific requirements of the sector. Particularly for managerial, sales and logistics roles, many companies establish their own formal local training programmes for logistics and sales staff and invest in external training for their management and technical staff. In the field of vocational education and further education, larger institutional and TOT-based capacity building cooperation programmes with international development agencies and donors should be devised which is also part of our recommendations in chapter 5.2

Regional and local authorities are seen as important actors with enough command to contribute concrete and pragmatic policies that are effectively able to support and dynamize the local employment markets. Authorities in Basra for example, are well aware that the private sector must be allowed to act with a minimum of state interference and that bureaucratic procedures or hurdles obstructing private business investments and job creation initiatives should be submitted to thorough revisions. Consequently, serious investors should be systematically supported with adequate land allocation and eased/fast-tracked approval procedures in the next step.

Another obvious measure to support local business is to generalise the use of solar power in public facilities such as streetlights, public garden irrigation, public buildings, social housing and to tender and subcontract those small and medium sized projects to the local/regional economy. When the products and services of foreign companies are required, local authorities may also impose hiring quotas for local work forces and adequate training courses.

Furthermore, municipal authorities have command over significant infrastructures and means which can be allocated to purposes of public interest, such as economic growth initiatives and business incubating facilities. They can cooperate at the governorate level with other key actors, such as chambers of industry, chambers of commerce and other private sector organisations to jointly establish regional support networks that provide collaborative environments, infrastructures and cultural frameworks for start-up and job creation as well as for interdisciplinary exchange.

The result could be regional start-up fairs and contests where students, young entrepreneurs and Iraqi companies that are diversifying into solar meet with other local and regional actors to investigate cooperation opportunities. Regional and local authorities can also help establish ties with established regional companies, including O&G companies, who are interested in solar energy and may be ready to support local and regional economic growth support initiatives through their CSR programmes. The establishment and consistent operation of such networking platforms, organising regular interesting networking events attracting all actors could be arranged by the private sector (e.g. chambers, associations, institutes or other interest groupings) with logistics support from regional and local authorities, principle support and endorsement by central authorities and funds from international institutions.

5. Supporting national structures to dynamize solar PV based entrepreneurship and job creation

Based on the findings in previous chapters and the PV market and value chain model in particular (introduced under Chapter 4.1), this final chapter provides a summary of the PV market framework conditions in Iraq and gives general recommendations categorised into 16 Intervention fields on how to take the next steps in improving these framework conditions.

This chapter differs from the previous 4 main chapters as to the written style being often more enumerative and its appearance more visually/graphically structured. This is to done to better synthesize the abundant information for hasty readers.

Working hypotheses guiding the recommendations elaborated below

During the data collection and analysis process, several strategic working hypotheses emerged that guided the study team in the preparation of this recommendation chapter. These working hypotheses are listed below:

- ➔ The state-driven power utility sector cannot really be influenced. It is however important to make sure that a minimum set of local content regulations are developed and considered in the MW- and GW-scale tenders to be issued by the MOO and MOE. The opportunity for local labour and companies to grow with the 10 GWp PV utility scale programme should not be missed.
- ➔ Diesel and fuel generators of various sizes are the main antagonists and competitors to PV. The huge generator market has different segments, such as private residential and neighbourhood generator systems and farmers that operate their irrigation systems in off-grid environments or connected to a weak grid. After due analysis by the study team, the PV-system options retained for priority market introduction are those where power users have an obvious interest to reduce the power consumption stemming from Diesel or fuel generators:
  1) Medium sized Solar Pumping Systems, mainly for agricultural applications
  2) PV Rooftops for residential buildings and small businesses
  3) Commercial and industrial applications in remote regions and where economically viable
- ➔ The triggers that efficiently accelerate the market penetration of PV in Iraq can vary considerably between regions. A regional differentiation of market development approaches and strategies may thus be required to a certain extent. For example, the residential PV sector in KRG is more advanced than in the South in PV and thus market readiness is more advanced.
- ➔ Various interviewed experts have insisted on the urgency to use Solar PV for improving agricultural irrigation as this are directly impacting livelihoods in low income communities. Using PV systems in these remote environments will generally release a lot of load from the regional grids and improve the general power supply of the population. It is furthermore assumed that the developing the Solar-Water-Agriculture Nexus would support job creation dynamics in the agricultural sector because PV systems allow for a

second or even third crop per year. These PV applications should therefore be prioritised in the coming years because they are critical to food supply and national subsistence.

- ➔ The government is already recommending today to widely replace small private Diesel and fuel generators with cleaner and cheaper solar PV systems, especially in residential neighbourhoods because of environmental pollution concerns. Solar promotion efforts should therefore also systematically address home owners with first mover mentalities.
- ➔ Local experts advise against venturing into direct competition with established neighbourhood generators in cities and towns for the time being, because serious conflicts and vandalism could be consequences which may even endanger the integrity of solar power developers and their equipment. However, combinations of neighbourhood diesel generators with PV mini-grids should indeed be tested in smaller remote communities where arrangements to implement PV-diesel hybrid mini-grids demonstration projects can be facilitated and reached more easily with local authorities, tribal leaders and other local stakeholders.
- ➔ With usually sufficient rooftop space available on Iraqi town and city houses to accommodate smaller individual PV systems, distributed and digitally managed neighbourhood PV grid models may appear. The German company Pionierkraft based in Munich for example, enables PV power generating neighbours to share and exchange their self-generated power inside the community.
- ➔ International development actors working on developing PV markets in Iraq should clearly strive to balance top-down approaches involving on the one hand the centralistic large-scale projects and measures of state authorities, and on the other hand bottom-up grassroot approaches carried by private initiatives on the ground. It's the right mix of these market development approaches that will create sustainable market dynamics.
- ➔ Finally, when trying to introduce new, ground-breaking solutions to pressing societal problems in Iraq, it is necessary to have the endorsement and support of the central government, and to do anything possible to support national actors improving the framework conditions for PV market introduction. However, gaining the full support and collaboration of regional and especially of local stakeholders and actors is always key to effective project implementations on the ground.

5.1 Summary of PV market framework conditions in Iraq and general recommendations

Many of the challenges associated with the wide-scale market introduction of solar PV into Iraq are related to the difficult situation in which the country finds itself today, after 30 troubled years. The "National Development Plan 2018-2022" has analysed the various generalised challenges for economic development which likewise have consequences for solar market development; the scope of these challenges is summarized in Annex 6.7.

Based on a good understanding of the value chain market model chart already introduced in Chapter 4.1 with Figure 76 (shown again below for readers' convenience) and the findings elaborated in this study, this subchapter summarizes the broad situation of PV markets in Iraq and highlights essential general actions needed to concretely improve the market framework for PV.

5.1.1 Snapshots characterising the PV market

CURRENT AND FUTURE MARKET SIZE: 10 MWp of PV capacities have been installed so far in Iraq, but none are connected to the grid. To date Iraq is a pure off-grid PV market.

MOST AFFECTED USERS BY POWER OUTAGES: The quite complex and often catastrophic power supply situation, especially during hot summer times, affects all power users, notably households, farmers, the commercial and industrial sector (C+I) as well as government facilities. These customer segments or target groups have consequently been analysed with priority in this study

DEMAND SIDE: The government sector has traditionally been the most active in demonstrating PV systems at its own facilities but this has changed in past years as private investors, be they middle-income households, farmers or business owners are beginning to invest in PV systems, notably in the North and Central regions. In fact, a growing number of economic actors such as hotels, private hospitals and factories are beginning to seriously consider solar PV investments and are looking for competent suppliers.

SUPPLY SIDE: The number of companies offering PV solutions is still very limited. Country-wide the most elaborate offer of PV equipment is localised in Erbil and in Bagdad. In the South supply activities are weak but are slowly developing with raising customer demand. The quality standards of PV equipment offered varies. High and low qualities are available, but lower quality equipment dominates sales.

BUSINESS CLIMATE: The country-wide security situation is currently a bit better, but remains compromised and varies between regions. The pandemic has stalled the already weakened economic activity in the country.

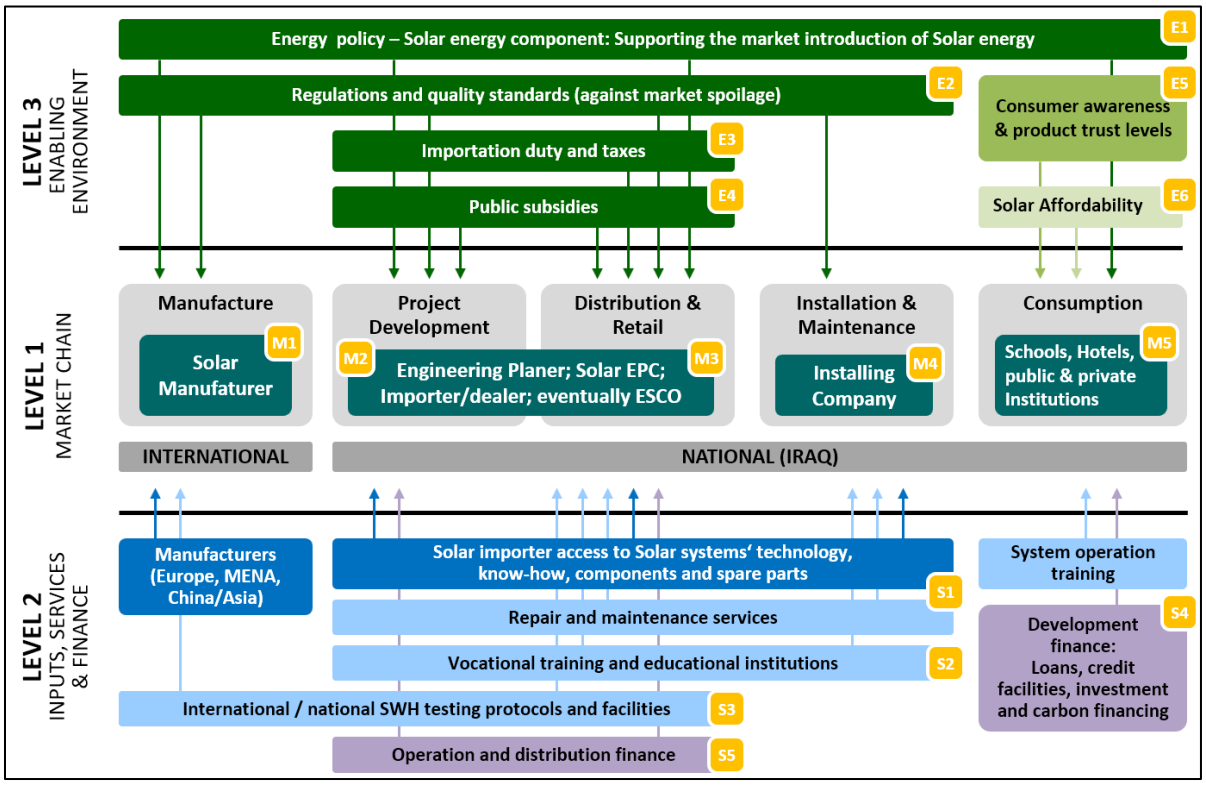
- National and regional market framework conditions are not attractive or trustworthy enough for foreign solar companies and investors who are afraid of malpractice problems.
- Safe business is possible within the private sector. Business activities with public actors can be tarnished by malpractice issues.
- Quality aspects were undervalued first, but they are making their way into the foreground because people learn from experience with substandard equipment.
- Customers targets have to be properly identified and addressed. Much more professional marketing and selling techniques are needed.
- Adapted, relevant and reliable product solutions need to be customized to Iraqi specificities, notably also differentiating between requirements and habits in North and South Iraq. Prices and quality features need to be reasonable.
- Established diesel actors may take a rather hostile stance towards of solar PV.

5.1.2 Intervention Fields with ‘Problem – Solution’ characterisations

The proposed intervention fields to improve PV market framework conditions are marked as small yellow boxes in Figure 87. These boxes contain a short alphanumeric code (e.g. “M1 to M5”) which refers to intervention fields with corresponding ‘Problem – Solution’ descriptions. These codes are listed in the below tables corresponding to each of the yellow tagged coloured functions in the value chain market model.

The described fields of intervention are addressed in logical order starting with “LEVEL 1 – Market chain”, followed by “LEVEL 2 – Inputs, Services & Finance” and “LEVEL 3 – Enabling environment”.

Figure 87: Solar market and value chain model in Iraq



→ LEVEL 1: The Market Chain

M1	The only local PV module manufacturer stopped operation years ago; There is no PV manufacturing operating in Iraq, and no actual plans to establish any. → **TRIGGER INTERNATIONAL R&D TO PARTNER WITH IRAQ TO ADAPT PV EQUIPMENT TO LOCAL CONDITIONS**
M2	Market and project development is hampered by distorted power sector structures and prices, also by vested interests on many levels (malpractice by local & national elites). → **REFORM OF POWER POLICIES AND POWER SYSTEM OPERATION**
M3	First suppliers have established PV businesses, generally positioned as EPC companies. Suppliers have huge training needs in technology, marketing and business management. → **OFFER TRAINING & CAPACITY BUILDING**
M4	Local electrical installation companies require intensive technical training on construction, operation and maintenance of small to medium sized PV systems. → **OFFER TRAINING & CAPACITY BUILDING**
M5	User categories need to be sensitised to several paradigm changes: Maturity of PV systems; Sales logic switches from Ampere to kWp; efficient use of power; power autonomy as a response to problematic power supplies, …

	➔ **DEVELOP AWARENESS CAMPAIGNING PROGRAM**
→ LEVEL 2: The Inputs, Services and Finance	
S1	Commercial access to international PV technologies is given in principle, but quality suffers from Low-cost temptations triggered by sub-standard Asian manufacturers. However, partnerships with European suppliers are likely more reliable and more sustainable. ➔ **CONSIDER SPECIAL MATCHMAKING PROGRAMMES WITH EUROPEAN SUPPLIERS (e.g. individualised coaching approaches)**
S2	Huge need for professional training offers on the supply-side with competent trainers; educational programmes supported by donors need to be implemented country-wide. ➔ **DEVELOP A DIVERSIFIED SET OF SPECIAL TRAINING PROGRAMMES FOR THE SUPPLY SIDE**
S3	Access to international institutions and professionals working on R&D, norms and standards is widely absent. Iraqi engineer associations and academics should be involved much more into international activities. ➔ **SUPPORT TECHNICAL EXCHANGE WITH INTERNATIONAL TECHNOLOGY AND STANDARDISATION COMMUNITIES**
S4	No or scarce access to affordable loans for project financing, nor to equity investors for business creation or growth and project development. ➔ **SUPPORT ACCESS TO INTERNATIONAL INSTITUTIONAL FINANCING**
S5	No or scarce access to operational financing/insurance instruments for trading activities of companies which seriously hampers the RE/Solar/Greentech sector. ➔ **DEVELOP STRATEGY FOR IMPROVED FINANCIAL SERVICES TO SUPPLIERS**
→ LEVEL 3: The Enabling Environment	
E1	The government's energy and power policies have remained highly inconsistent; the priority is too much focussed on large utility scale PV; other PV segments are not systematically addressed (initial pilot projects had mitigated successes). ➔ **SUPPORT THE GOVERNMENT TO BRING ABOUT SEVERAL KEY REFORMS IN THE NATIONAL POWER SECTOR**
E2	Regulation by standards and norms has been absent until recently and caused market spoilage through counter-references and disappointed users due to poor planning, sub-standard equipment, avoidable errors in construction and O+M. ➔ **(See also S3) ESTABLISH ADEQUATE STRUCTURES INTERFACING WITH INTERNATIONAL TECHNOLOGY AND STANDARDISATION COMMUNITIES**

E3	So far, no exemptions of import taxes and custom duties are in place, but there are plans to exempt solar equipment for 10 years under certain conditions (e.g. registration of project at MOI) ➔ **SUCH EXEMPTIONS ARE A STANDARD SUPPORT MEASURE AND OVERDUE**
E4	There are no funds available for subsidy programmes or low-interest loan schemes. Almost all support measures are provided by international donors. The government is working on loan schemes with the Central Bank of Iraq. ➔ **CONSIDER LAUNCHING A FUND WITH INTERNATIONAL SUPPORT TO FOSTER THE EMERGENCE OF 1) SOLAR PUMPING AND 2) PV ROOFTOPS**
E5	Populations are largely un- or misinformed, if not disinformed about many aspects of solar PV. Affordable and effective awareness campaigns are required on all actor levels. ➔ **CONSIDER DEVELOPING AN AWARENESS CAMPAIGN CONCEPT THAT IS INEXPENSIVE AND ADAPTS WELL TO LOCAL CONTEXTS & REQUIREMENTS**
E6	Competitiveness of PV power needs to be systematically demonstrated to potential clients and investors, in an objective, plain and correct manner. ➔ **CARRY OUT A DETAILED LOCAL SURVEY AND ECONOMIC STUDY ON NEIGHBOURHOOD GENERATION, COMPARE TO PV AND COMMUNICATE**

Snapshots characterising the enabling environment

ENERGY POLICIES: The visions and strategies for the countries energy future are not clarified yet. All stakeholders agree there is no clear, consistent and accepted state energy policy visible presently. Official RE targets vary between 10% and 30%, but experts reckon that 3-5% are achievable at most. Political decision-makers seem stuck in the inefficient fossil energy-based power system and too much focused on the oil business, but are officially all in favour of solar energy. However, a RE law is in preparation or due, and the central government is currently preparing its third tendering attempt for utility scale projects of 700 MW of capacity. There is also an increasing number of encouraging PV initiatives on the ground in the various regions.

However, strongly diverging/opposing interests & trends characterise the playing field of electric power:

1) Centralistic power policies versus regional and local power requirements and policies
2) O&G interests versus RE and Solar interests
3) Public commons interests versus private vested interests

In February 2021, Iraq's MOO announced its goal to more actively support the MOE to install 20 gigawatts of solar energy capacity by 2030. Consequently, the government is currently engaging into negotiations and partnerships on PV market introduction programmes with established actors from the O&G sector, such as with French energy company Total or BP, to use their sites to produce solar power. This signals the willingness of Iraq's government to get the countries financially strongest actors and partners from the O&G sector involved into solar PV market introduction and deployment. At the same time however, old foreign partners in the oil sector such as BP, Lukoil and ExxonMobil seem to be preparing their retirement from the

country. According the MOO, Iraq's current investment climate is not suitable for keeping major international oil companies in the country.[117]

In parallel in June 2021, Masdar, a subsidiary of the Abu Dhabi-based Mubadala Investment Company, signed a strategic agreement to develop 2,000 MWp of solar photovoltaic (PV) projects in Iraq to supply the national power network.[118] This cooperation will also contribute to supporting Iraqi efforts aimed at implementing 10 GWp of solar energy quality projects by 2025. Given that Masdar brings in its own wide expertise and networks, GIZ and the international development community active in the country will likely recalibrate their support policies and programmes oriented towards 2030 and explore co-operation opportunities with Masdar.

MARKET FRAMEWORK: Some initial framework conditions are being established, especially for the utility scale power generation and also for the agricultural sector. But the residential sector is being disregarded still and neglected with programmes of too small dimensions.

- Regulatory work is at its absolute beginnings.
- No generalised and binding quality regulations are in place for PV.
- Financial instruments are challenging due to the dysfunctional Iraqi banking sector.
- Only 50% utility scale solar power added to the power grid would reach the final users, which is a strong argument for distributed PV systems.

INSIGHT: Besides supporting ongoing energy policy processes, GIZ PSD could address the currently excessive focus on utility scale projects by advocating for more ambitious PV policies in favour of residential, the agricultural and the commercial/ industrial sectors.

AWARENESS: Is generally low, but improving due to people's saturation with the catastrophic power supply situation since many years. Awareness is significantly higher in the KRG, and especially low in the Southern region.

ACCEPTANCE: Old counter-references are still in people's minds but they know that the technology is now proven if adequately implemented. Growing acceptance is triggered by health and environment issues, and also be the fact that people have suffered enough from energy poverty and are now finally open to consider alternative solutions.

The high prices are still hindering most investment decisions, because modest people are used to pay extremely low and subsidised price for unreliable power from the public grid. On the other side, extremely high electricity bills from neighbourhood generators motivate people to look for cheaper alternatives, so that the tide is definitely turning in favour of PV with its continually decreasing prices.

The difficulties of operating AC systems with PV systems is a stumbling block for many middle-class households to invest into PV systems.

INSIGHT: 1) Iraqi power users have suffered enough from energy poverty to consider solar power more seriously. Therefore, now seems to be the right time to support PV.

2) Low acceptance of high upfront investment must be tackled systematically through different measures, such as standardized offers, explaining economic and ecologic advantages of PV, low interest loans, awareness campaigning.

[117] https://oilprice.com/Latest-Energy-News/World-News/Iraq-Confirms-BPs-Plans-To-Leave-The-Country.html, 05.07.2021
[118] https://www.iraq-businessnews.com/2021/06/25/masdar-to-develop-solar-in-iraq/, 25.06.2021

5.2 Strategic recommendations to dynamize the PV sector and activate its job creation potential

This chapter puts into context the **bottom-up market stimulation** approaches and recommendations elaborated within the previous chapters of this report.

5.2.1 Recommended strategic activities to support solar business and job creation

The recommendations provided in this chapter refer to the market development activities targeted under GIZ's Private Sector Development & Employment Promotion, and more precisely to Output B: Promoting innovation in the local market to generate new job offers for young people (see Chapter 4.3.2). The below recommendations are structured into Intervention Fields; they are conceived to effectively stimulate PV market and job development and therefore extend to a wider, more comprehensive set of measures and activities than merely training and capacity building projects.

Improving PV market framework conditions

Number of Iraqi companies are prepared and motivated to enter solar PV business, but are actually waiting for better framework conditions to facilitate and promote the emergence of PV markets. Furthermore, market barriers, challenges and risks for established and newcomer companies in the PV sector are considerable.

1) **Policies promoting small and medium PV systems:** Given the government's strong centralistic focus on utility scale PV, it is of great importance to convince Iraqi decision makers that the main solar job creation potential lies in the market segments of distributed small and medium systems. The government should be supported by international experts in devising a policy that fosters the development of a new category of SME that promote RE and Solar technologies and well as green technologies.

2) **Development of PV standards and norms:** PV standards and norms have been completely absent until very recently, when 38 standards solar PV components were introduced in May 2021. This finally marks the beginning of quality assurance politics in the PV sector. In accordance with the recommendations provided above for the Intervention fields S3 and E2 (see previous Chapter 5.1.2) it is recommended to strengthen the technical exchange with international standardisation committees on solar technologies by involving especially younger and highly motivated engineering talents.

   In recent years the BSW has developed a pragmatic **certification scheme for PV systems** 'Solar Quality Passport' or simply **'PV passport'**. In 2016, this innovative quality scheme was first introduced in South Africa under the label "PV Greencard". The PV GreenCard programme is designed to ensure quality and safety standards are introduced and maintained by all solar PV installers and this scheme is now the leading quality assurance standard and training programme for solar PV installers in South Africa[119]. The approach is currently also implemented in Pakistan in collaboration with

[119] SAPVIA collaborates with German BSW-Solar on rooftop PV | ESI-Africa.com

GIZ[120] and an introduction of the scheme is currently being prepared in Afghanistan, also in collaboration with GIZ.

3) **Import procedures for solar equipment:** Solar shipments are generally strongly delayed by entry port procedures and logistics. Although malpractice is a widespread problem that can accelerate transit times through customs, there are also knowledge based and administrative deficiencies in port and customs administrations that can be improved with adequate capacity building, both on the side of authorities and of importing companies.

4) **Manual for PV entrepreneurs:** A more thorough country-based analysis involving local consultants is required to review more specifically existing market barriers on the ground in selected target regions and to synchronize concrete company needs on the ground with planned economic and business policy reforms in Iraq. Tenders published by authorities are often not accessible for local companies which cannot comply with the formal requirements. These shortcomings need to be identified and analysed in a comprehensive manner and solutions provided that will likely involve capacity building and other technical measures.

5) **Local content regulations:** LCR are needed to make sure that local companies can actually participate in the planned deployment programme of 10-20 GWp of utility scale PV by 2030. This very important aspect of local economic stimulation would actually justify a pragmatic technical study to analyse possible LCR policy approaches for Iraq in general and more specifically in the fields renewable/solar energies and green technologies.

Establishing market intelligence & PV sector representation

1) **PV market data:** Beside some basic data on installed PV capacities available from authorities upon request, there are virtually no public market data available today to market actors because there is no national solar industry association doing the work. However, empirical market data needs to collected and analysed systematically. Furthermore, the demand-side needs to be much better understood by conducting granular surveys among customer target groups in the various regions of the country. Such intelligence is necessary for forward thinking, professional entrepreneurs to decide whether or not to engage into PV business. Without intelligence, no strategies can be developed, no lobbying can be organised to gather political support, and no PV markets can be developed.

2) **Assessment of job creation potentials along the PV value chain:** There are currently no operating manufacturing facilities for PV components in Iraq, nor are there any PV related manufacturing activities currently planned in the country. This report hence concludes that the main potential for solar PV job creation lies in the downstream PV value chain. The PV related job creation potentials have been described and roughly estimated in Chapter 4.5.3. Whether a significant proportion of those jobs can be accessed by women in Iraq's daily reality remains to be seen and should be studied using a set of countrywide conducted social surveys among local populations.

[120] https://solarqualitypassports.com/

Most countries preparing to develop their PV market potentials generally consider the establishment of an initial PV module assembly line because the scale of investment is manageable and also due to its iconic character for a nascent national PV sector. However, the number of jobs created will seldom exceed 30-50 workplaces in the short to medium term. Such a manufacturing facility should be dimensioned to fit the developing domestic demand and specialise on PV modules adapted to the extreme local atmospheric and environmental conditions in Iraq. This would open the possibility to establish module specifications for the domestic PV markets that privilege locally manufactured PV modules.

3) **Uncharted market potential of SHS:** Furthermore, although the electrification rate of Iraq was reported at 100 % in 2019, according to the World Bank, this number says nothing about the low quality of power supply services provided. It is therefore suspected that a market potential exists in the country for small Solar Home Systems (SHS) for the poorest households, similar to those marketed with great success in Africa and South-East Asia. The potential for SHS that come with affordable Pay-As-You-Go schemes should be systematically investigated, because such business models can be easily deployed in partnership with international SHS market leaders if matched with the expectations and habits of Iraqi low-income households.

4) **Required comprehensive stakeholder mapping and management:** This report has identified 17 companies active in Solar PV from the North, the Central region and the South. Given that it impossible to verify those companies and their activities from afar, it is therefore suggested to establish a small research project to identify and categorise these supply side actors more systematically in order to identify potential partners for targeted solar job creation programmes and activities that are to come.

   More generally, to get an overview of all stakeholders and actors to consider and how to adequately integrate their contributions into a national solar start-up coalition (see Chapter 4.3.4.1 and further below), a wider comprehensive stakeholder map should be elaborated with local experts showing all actors and their respective influence as well as analysing relations and interdependencies on national, regional and local levels as well as interconnections with international institutions. On this basis, common goals and an implementation strategy can be devised.

5) **Sectoral representation for the emerging PV/RE value chains:** Interviewed Iraqi PV companies agreed that private RE/solar sector actors should unite to conduct concerted actions in favour of regulatory improvements, anti-dumping practices and fair business practices. There are currently several emerging initiatives trying to build sectoral representation for the RE/solar sector actors and communities in Basra (SEIC), Erbil (KESK) and Bagdad (BRESC). The most promising of those relatively young organisations and/or other relevant candidates for RE/Solar sectoral representation - as identified in the frame of the above proposed comprehensive stakeholder mapping and management - could be supported in the professionalisation of their institutionalised activities. The German development aid proposes such capacity building measures under the “Kammer- und Verbandspartnerschaftsprogramm -KVP” where German associations such as the BSW support the establishment, build-up and process optimisation of partner associations in developing, emerging and transition economies/countries.

Improving access to finance

Affordable finance is key to viable PV investments with good economic performance indicators, especially in the commercial sector where profitability is the main criterium of all activities.

1) **Access to finance for Iraqi solar companies:** A study on how to specifically improve the access of local RE companies to national and international finance is required minding that there are already several programmes underway such as the EU's Electrify programme that are working to improve the access of small tickets to international (development) finance. Setting-up a pilot programme to test the ability of Iraqi companies to serve their financial engagements with credit grantors would involve manageable quantity of financial means.
2) **Getting larger Iraqi companies involved:** Too few of the established Tier-1 and Tier-2 Iraqi firms are engaged with the nascent Iraqi start-up environment and may therefore risk missing-out on innovations being generated. These established private sector actors should be provided with incentives and opportunities, encouraging them to fund 'Proof of Concept' pilot projects with local solar companies and start-ups.
3) **State guarantees for small and medium scale PV deployment programs:** A more regulated use of state guarantees will see the legal status of all guarantees given so far clarified and those with no legal basis voided. Besides utility scale projects where the state has already announced it would provide financial guarantees, it should also consider setting up a guarantee programme for both the demand- and the supply-side, covering urgently needed loan-based financing mechanisms for the development of small and medium PV market segments. Such a guarantee mechanism could be supported by international development banks and would ideally result in a one-stop solar investment platform available to suppliers and customers.

Societal capacity building

1) **General awareness building:** Popular pragmatic education initiatives should be developed to educate the masses on solar energy and the nexus with energy efficient consumption practices. Furthermore, interested professional target groups should be offered general 'global technology and business updates' in seminars or webinars organised by chambers of commerce and industry about the most commonly available renewable energy systems, their economics and market potentials. The same applies to other efficient green technologies in the sectors of agriculture, infrastructure, manufacturing and others.
2) **Understanding complex local decision making and transaction structures:** During an interview conducted for this report, the Iraq Energy Institute suggested to carry out micro-political research about local stakeholders and power politics to better understand the complex and for outsiders often opaque multi-actor processes on the local level.

Focused Segment Marketing

1) **Customer-oriented marketing techniques:** In order to be more successful, solar companies in Iraq need to learn how to approach their clients from a customer benefit-

oriented marketing perspective rather than using technology driven sales approaches which do not persuade the majority of potential clients. Effective sales strategies are not necessarily expensive nowadays if digital techniques are used, but these new techniques require competent business managers and marketers, which the country largely lacks.

2) **Convincing C+I customers:** The attractive client segment for midsized PV system solutions must be developed with systematic industrial marketing and innovative sales approaches, involving power auditing services, economic analysis of cost/performance indicators, personal advice and B2B management sales techniques.

3) **Establishing an internet-based virtual market place:** Today, the few established PV suppliers in the country have a hard time identifying and acquiring clients. A virtual marketplace needs to be established informing potential customers about the advantages of PV, presenting domestic best-practice projects with testimonial videos and putting them in contact with competent local PV suppliers and installers.

These marketing gaps need to be addressed systematically with modern marketing techniques that address the peculiarities of Iraqi consumers and their decision-making practices.

Supporting research and development

Pervasive dust and high ambient temperatures generally have significant impacts on the efficiency and durability of PV modules as well as other solar system components installed. These extreme conditions provide special opportunities for local researchers, engineers and entrepreneurs to cooperate and innovate with foreign actors interested to adapt solar PV to some of the world's harshest operating conditions. This points towards an international R&D cooperation project which would help Iraq to quickly catch up with the global state-of-the-field and even participate in international innovation. An international R&D programme on "PV for harshest desertic environments" may be conceivable with research centres, universities and international cooperation partners.

Another interesting avenue would consist in systematically advancing applied research in the field of **solar thermal and/or PV-assisted air conditioning systems**. If efficient solar assisted AC systems can be made commercially available, their international market potential would be tremendous. Such applications have the potential to produce successful solar start-ups that could even evolve into the high-growth unicorns mentioned earlier in the Chapters 4.3.4.2 and 0.

Institutional and Human Capacity building

1) **Comprehensive HCD/ICD requirements in technical, commercial and business management requirements:** All professional functions involved in the downstream PV value chain, as described in Chapter 4.5.2 and which are mostly dedicated to distributive activities, require comprehensive and intensive HCD/ICD efforts in both, technical handling of PV technologies as well as standard commercial and technical-economic company functions. The latter functions are generally underrated in companies that are dominated by engineering personnel. This is typically the case in Iraq where companies generally have significant weaknesses concerning modern business management techniques.

2) **Digitalisation of business models on the rise:** The pandemic so far has had a tendency of hampering the business activities and interests of SME worldwide. Companies mostly react by pushing their online based business and investing in internet-based business models, so they can participate in local digitalised markets and actively address local customers who themselves increasingly migrate towards online shopping models. This transition of purchase practices by the demand-side ultimately also requires Iraqi companies to digitalise their business activities. This generates significant HCD/ICD requirements because Iraqi companies have been relatively slow in adopting modern digitalised work techniques for a variety of reasons.

3) **Preparing local companies to participate in utility scale project implementation:** In light of the current concretisation by the Iraqi government of the 10-20 GWp utility scale PV deployment programme by 2030, Iraqi construction, electric installation and other auxiliary service companies urgently need institutional capacity building in order to comply with the international quality standards required in large-scale PV projects. Among the most obvious requirements are e.g. the ISO 9000 and 14000 certifications which are generally prerequisite to participate in large utility scale projects such as those currently planned for nationwide deployment.

4) **Joint donor approaches:** Given the huge efforts and financial means required for building the capacities of supply-side PV actors in Iraq, it is recommended that development organisations and donors collaborate to tackle the challenge jointly. Training-the-trainer approaches should be preferred because they will strongly contribute to building up a competent trainer base in the country over time, and also because they are generally more cost efficient over the long run. Online training concepts also allow institutions to reduce significantly training costs. However, recent experiences with technical-economic PV training seminars have shown the limitations of pure online training formats, especially when trainees are beginners in the subjects conveyed. This is why hybrid training formats that blend in-person trainings with online trainings should be favoured in the Iraq context.

5) **Mapping the HCD/ICD sector in Iraq and supporting local pioneers:** The HCD/ICD strategy that will be devised for the PV sector in Iraq should map all actors involved in higher education and vocational training and carefully select those to involve in HCD/ICD efforts. It is highly advisable in this context to identify and collaborate intensively with local champions in solar training.

5.2.2 Rating and prioritisation of presented recommendations with local experts

These here proposed measures can be combined strategically to achieve optimum results in selected priority Intervention Fields (as listed in the tables above where problems in the value chain model are described and solutions proposed). The more Intervention Fields can be tackled with a set of lean but intertwined measures, the more integrated and effective the implemented set of measures will be in achieving PV market activation objectives. Most market activation measures should be implemented as pilot projects in 1, 2 or 3 test regions, constantly monitored for possible conceptual improvements and if proven successful, extended to more cities and regions.

6. Annexes

6.1 ANNEX 1 - Average Power Supply to the Iraqi Governorates

Governorate	Actual Power Supply (MWh)	Power Load (MW)
Baghdad, Al-Rusafa	6,824,322	779
Baghdad, Al-Karkh	12,060,575	1377
Baghdad, Al-Sadir	7,898,944	902
Anbar	3,159,418	361
Diyala	4,609,646	526
Ninawa	4,882,886	557
Salah Al-Din	4,909,232	560
Kirkuk	3,579,224	409
Babylon	4,776,170	545
Karbala	4,338,817	495
Najaf	4,766,824	544
Al-Diwanyah	3,211,610	367
Wassit	4,371,722	499
Basra	14,501,033	1655
Dhi Qar	5,679,842	648
Missan	3,791,372	433
Al-Muthana	2,040,476	233
TOTAL	95,402,113	10,890

Source: MoE Baghdad

6.2 ANNEX 2 - Demand vs Actual Supply – Regional Differences

Directorate	Governorate	Population	Demand MW	Exceptional load MW	Actual Supply MW	shortage %
Baghdad	Al-Rusafa	8,126,755	1467	134	1263	40%
	Al-Karkh		2136	280	1367	63%
	Al-Sadir		1320	34	885	33%
	West Anbar	1,771,656	300	15	165	45%
	Ramadi		630	19	190	69%
	Al-Furat		350	12	90	25%
	Diyala		939	54	528	44%
North	Ninawa	3,729,998	1600	134.2	595.2	63%
	Kirkuk	1,597,867	1150	106.9	590.7	48%
	Salah Al-Din	1,595,235	1180	102	417.9	64%
Middle	Babylon		1620	85	650	60%
	Karbala		1350	192	536	60%
	Najaf		1400	49	582	58%
	Diwania		1000	22	391	61%
	Wassit		1200	59	540	55%
South	Basra		2331	246	1887	81%
	Thi Qar		1286	47	725	56%
	Missan		788	21	457	58%
	Al-Muthana		483	17	249	52%

Source: MoE Baghdad

6.3 ANNEX 3 – PV utility scale tender issued by MoE in April 2019

Solar energy IPP projects in Iraq – tender announcement by the Republic of Iraq – Ministry of Electricity:

The following Projects were tendered for a planned completion by 2020/2021:

1. Sawa-1 Solar PV IPP with a capacity of **30 MWp** to be located in Muthana Province,
2. Sawa-2 Solar PV IPP with a capacity of **50 MWp** to be located in Muthana Province,
3. Khidhir Solar PV IPP with a capacity of **50 MWp** to be located in Muthana Province,
4. Iskandariya Solar PV IPP with a capacity of **225 MWp** to be located in Babil Province,
5. Jissan Solar PV IPP with a capacity of **50 MWp** to be located in Wassit Province,
6. Karbala Solar PV IPP with a capacity of **300 MWp** to be located in Karbala Province,
7. Al-Diwania solar PV IPP with a capacity **50MWp** to be located in Diwania province

The tendering of these projects involved the design, finance, construction, operation and maintenance of utility scale solar power projects by Independent Power Producers (IPP) on a Build, Own and Operate (BOO) basis. These IPPs would establish dedicated Special Purpose Vehicles (SPV) to undertake the construction and operation of each project. The Ministry, in its commercial capacity as a grid operator, would connect the PV plants to the Iraqi transmission grid under a Transmission Connection Contract (TCC) and, in its capacity as owner of the land, would lease the land to the SPV under a Land Lease Contract (LLC). Also, the Ministry would purchase produced solar power from the SPV under the terms of the power purchase Contract (PPC).

The MoE expected these projects to employ around 1300 people in the Republic of Iraq and supply more than 250,000 households with critically needed electricity supply.

6.4 ANNEX 4 – Local companies active in Solar PV in the North, Center, South of Iraq

Companies in the North - Erbil and Dohuk:

1) Energy House Erbil: Solar EPC company was established in Erbil in 2015 and also founded a sister company in Basra in 2018. EH has installed more than 1 MWp of PV capacity so far with a focus on residential systems, but also supplied a 50 kWp System for an agricultural farm and 30 kWp for a government building in Basra.
2) Infinity Green Energy, Erbil: apparent specialization and deep knowledge of renewable energy systems. They have many different Panels, inverters, chargers, batteries and even solar pumps on stock.
3) Hivion Ltd., Dohuk: Solar Panels of Turkish Manufacturer “Ödül”. Accumulators are procured in Turkey. Inverters from different brands
4) RS Company, Dohuk: experience with installation of Solar Pumping Systems, small stock of solar panels (Turkish made) and accumulator (also Turkish made)
5) Dusava Company, Erbil: specialized in pumping. Official sales representative of a number of Italian brands (including SAER – which also produces DC solar pumps). Started to diversify into solar systems. Basic knowhow in solar systems and certainly have the backing up of Turkish colleagues with higher level of know how.
6) Gimini Company, Erbil: general trading company in the technological field. They are a sales partner of Lorentz Pump (Germany), one of the lead solar pumping brands. They have the experience of 8 installed solar pumping systems – all of them located in Syria. For installation, they rely on local engineers with experience in solar technologies

   ➔ Source: Dominik Zwicky, PV Expert and Consultant for WHH, Small market investigation for North Iraq in 2019:

Companies in the Center region - Baghdad:

1) Alhadbaa Modern company: 3.5 MWp of total capacity of PV systems installed in Erbil city.
2) Al Taraib smart solutions company: more than 3 MWp of total capacity of PV systems installed in Iraq.
3) MTS Company: about 2 MWp of total capacity PV systems installed in Iraq.
4) Johart Albark: about 1 MWp of total capacity PV systems installed in Iraq
5) Brighter Domain company: 1 MWp of total capacity of PV systems installed in Erbil city
6) Bilad Utu for Energy solutions company: 250 kWp of total capacity of PV systems installed in Iraq.
7) Bereket Alnoor company: 100 kWp of total capacity of PV systems installed in Iraq

8) Al-Ezz General Company: One of the companies belonging to Ministry of Industry and Minerals, has equipped many areas in Baghdad with solar lighting poles [Miqdam & Hussein 2018]

Companies in the South - Basra:

1) Energy House Basra: See Energy House Erbil above
2) Power Maxma:
3) Renewable Energy Ray:

6.5 ANNEX 5 – Power tariffication system in KRG

Power tariffication system in KRG – May 2021

1) Residential tariffs

Residential		
Tariff Range (kWh)	**Price IQ Dinar**	**Price USD**
1~450	15	0,01
451~900	20	0,014
901~1500	35	0,024
1501~2100	60	0,041
2101~3000	75	0,051
3001~5000	150	0,10
5001~above	200	0,14

2) Governmental – one single tariff

150 IQ Dinar/kWh, or 0,10 USD/kWh

3) Industrial - two tariffs

120 IQ Dinar/kWh for the 33kV Grid, or 0,082 USD/kWh
100 IQ Dinar/kWh for the 132kV Grid, or 0,068 USD/kWh

4) Agriculture - one single tariff

30 IQ Dinar/kWh, or 0,021 USD/kWh

5) Commercial - one single tariff

130 IQ Dinar/kWh, or 0,089 USD/kWh

6.6 ANNEX 6 – Estimation of PV market and job creation evolution until 2030

Estimation of PV capacity evolution in Iraq until 2030

Cumulated capacities	2019	2020	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030
Gvt./Public projects	3,5	4,5	5,5	7	10	20	30	50	70	100	200	300
Solar PV rooftops	1	1	3	4	6	9	10	20	50	80	120	250
Solar water pumping	4	5	6	8	12	25	35	60	80	120	250	400
Commercial & Industrial	0	0,5	1	2	4	6	10	20	50	80	120	250
Refugee camps/towns	1,5	2	3	4	5	6	7	8	9	10	10	10
Utility Scale	0	0	0	0	100	300	400	1000	3000	5000	8000	10000
TOTAL	**10**	**13**	**18,5**	**25**	**137**	**366**	**492**	**1158**	**3259**	**5390**	**8700**	**11210**

Assumptions

1) The official 10 GWp objective by 2030 is taken as basis in this market volume projection (whether conxidered realisitic or not), and all other PV applications together make about 10% of this volume.
2) Iraqi energy politics are finally reformed and subsidy levels in the field of conventional grid power and fuels will ultimately have to be lowered for a variety of reasons. The 2019 market data stems from Government sources.
3) The government takes the minimum measures required to establish favorable market framework conditions for solar PV markets to develop in a more realistic price environment which will automatically accelrate PV market dynamics.
4) Gvt. /Public projects accelerate moderately until 2023, when in parallell to the roll-out of first utility scale projects, more midscale systems are installed in public and social projects because the power grid situation remains problematic for quite some years.
5) Together with Gvt./Public projects, agricultural solar water pumping (SWP) are the leading applications today. Once the pandemic is overcome, SWP will likely get more support and develop more and more dynamically over coming years.
6) The Distribution mark-up is 20% in the first years until 2025 and is then reduced in steps to 15% and 10% by 2019/2020. In the case of utility scale capacities the distribution/sales mark-up is only a few percent and thus omitted for simplification.

Work time generated and jobs created in the Iraqi solar PV sector by 2025 and 2030

Work time in cumulated person years	2019	2020	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030
Gvt./Public projects	99	127	156	198	283	566	849	1.415	1.981	2.830	5.660	8.490
Solar PV rooftops	28	28	85	113	170	255	283	566	1.415	2.264	3.396	7.075
Solar water pumping	113	142	170	226	340	708	991	1.698	2.264	3.396	7.075	11.320
Commercial & Industrial	-	14	28	57	113	170	283	566	1.415	2.264	3.396	7.075
Refugee camps/towns	42	57	85	113	142	170	198	226	255	283	283	283
Total incl. Distribution mark-up 10-20%	**340**	**441**	**628**	**849**	**1.257**	**2.241**	**3.124**	**5.366**	**8.796**	**13.244**	**23.772**	**41.092**
Utility Scale	-	-	-	-	720	2.160	2.880	7.200	21.600	36.000	57.600	72.000
Local content share 40%	**-**	**-**	**-**	**-**	**288**	**864**	**1.152**	**2.880**	**8.640**	**14.400**	**23.040**	**28.800**
TOTAL (Person years)	**340**	**441**	**628**	**849**	**1.545**	**3.105**	**4.276**	**8.246**	**17.436**	**27.644**	**46.812**	**69.892**
Total permanent job equivalents (#jobs)	**38**	**44**					**767**					**6.945**

6.7 ANNEX 7 – Summary of challenges for the economic development of Iraq from the "National Development Plan 2018-2022"

I. Institutional challenges

1. Low efficiency of institutional performance. The State administration continues to fail to adopt sound economic calculations and principles of efficient management of public resources in a holistic framework. This failure is deepened by: continuing disconnect between Government investment programmes and State budget allocations; failure to place public finances and their monetary contents in a broader context and across long-term horizons; and poor economic management interest in the diversification of the productive structure of the Iraqi economy.

2. Overstaffing and low productivity of labour force. A number of factors have contributed to a reluctance to rebuild and restructure Government agencies under a management reform programme aimed to reduce costs while ensuring efficiency and proper resource management – including: overstaffing in Government management, low performance, unjustified waste of resources, service of personal and factional interests, and behaving as if a government position allows to deal with State property as a personal right of its employees and thus the state should not jeopardize their privileges and incentives.

3. Financial and administrative malpractice. Malpractice has deepened; it has transformed from a behavioural issue of certain groups into an integral and core aspect of institutional structures linked to serving interests that impede development. Corruption leads to depletion and waste of public money and it diverts a major part of income and output out of the economic system. According to the TI Governance Index, in 2015 Iraq was one of the top 10 corrupt countries in the world.

II. Economic challenges

1. Poor investment climate. The investment climate continues to deteriorate ,influenced by a combination of political, economic, institutional, legislative, legal and regulatory factors which in turn affect the level of and ability to attract foreign investment. This is evidenced in international indicators: e.g. in 2020, Iraq ranked 172th from 190 countries on the Ease of Doing Business Index and it scored only 27.3 of 100 on the Investment Attraction Index.

2. Disrupted production structure. Between 2010 and 2015, the oil sector remained the main contributor to GDP(actually, it increased from 51.26% to 55.1%), due to the lack of an economic diversification policy .The GDP contribution of both agriculture and manufacturing dropped – respectively from 4.17% and 2.1% in 2010 to 2.02% and 0.84% in 2015.

3. Trade imbalance. The lack of a trade policy that considers the economic conditions required to maintain international competitiveness, the growing imbalance in the GDP structure, and the low exchange rate of the Iraqi dinar have led to (1) a clear trade imbalance ,evidenced in the increase in the oil export to 99% of total Iraqi exports and the high diversification of import structure, and (2) significant economic openness, with the ratio of foreign trade to GDP reaching 50.25% in 2015.

4. Imbalanced budget structure. Oil revenues continue to be the top contributor to public budget revenues – comprising 85.9% of the estimated total income for 2017 (IQD 79.011

trillion). This renders the budget susceptible to external shocks from fluctuating oil prices, internal imbalances of non-oil revenue diversification, and high estimated operational expenditure (IQD 75.217 trillion, or 74.7% of the total estimated budget). In result, the planned deficit of the 2017 Budget amounted to IQD 21.6 trillion.

5. High public debt. The huge reliance on public debt (internal and external) to cover the budget deficit is a constraint on development rather than an alternative to financing the budget from non-oil sources. Additionally, in the absence of coherent and harmonised macroeconomic policies to manage debt efficiently, this debt is a burden for present and future generations. The planned deficit constitutes 21.6% of the estimated budget and it will be financed through internal and external loans. Thus, as of 13/12/2017, the public debt has reached IQD 135851 billion.

6. Underdeveloped banking system. Due to obsolete technologies in use, outdated management methods, redundant administrative staff who fail to keep up with modern technologies, the absence of an enabling environment to deal with customers, and a weak marketing of non-traditional banking products, banks have been unable to keep abreast of modern banking and management systems. This is evidenced in e.g. the high value of doubtful debts (IQD 3079.7 billion in 2015), which has placed a burden on financial stability, with the ratio of credit failures of government banks reaching 67.1%.[121]

7. Large informal sector. Poor private investment resulting from a worsening investment climate has expanded small-scale economic activities that are not controlled by the government and operate outside the public tax and insurance framework. They are not included in GDP calculations and operate at the expense of the activities of the formal economy. Outputs, practices and dealings in the informal sector are uncontrolled at the economic and societal levels.

8. Limited role of the private sector. The deteriorated working and investment environment, slow adoption of (i.e. disregard for) the commodity dumping policy, and lack of participation in the design and implementation of economic policy goals have perpetuated the limited role of the private sector in the development process. In 2015, the private sector contributed barely 44.6% of GDP (at current prices) and 35% of fixed capital formation (at constant prices).

[121] There was a significant expansion of credit activity in 2013–2016, with monetary credit increasing from IQD 29.9 trillion in 2013 to IQD 37.16 trillion in 2016 with growth rate of 7.5%. The services sector accounted for the largest share of the total credit granted by banks – even though this share fell from 49.8% in 2010 to 39% in 2016 – followed by construction, trade, restaurants and hotels. Other sectors, such as industry, agriculture and others, accounted for smaller shares. The latter suggests that Iraqi banks rely heavily on granting loans for commerce and construction given the guarantees these sectors can provide compared to other sectors.