Ministry of Energy
and Mineral Resources

IRENA
International Renewable Energy Agency

THE HASHEMITE KINGDOM OF JORDAN

Renewables Readiness Assessment

February 2021

Citation:

IRENA (2021), Renewable Readiness Assessment: The Hashemite Kingdom of Jordan, International Renewable Energy Agency, Abu Dhabi.

ISBN: 978-92-9260-277-2

About IRENA

The International Renewable Energy Agency (IRENA) is an intergovernmental organisation that supports countries in their transition to a sustainable energy future and serves as the principal platform for international co-operation, a centre of excellence and a repository of policy, technology, resource and financial knowledge on renewable energy. IRENA promotes the widespread adoption and sustainable use of all forms of renewable energy – including bioenergy, geothermal, hydropower, ocean, solar and wind energy – in the pursuit of sustainable development, energy access, energy security and low-carbon economic growth and prosperity.

Acknowledgements

This report was prepared by IRENA in close collaboration with the Government of Jordan, as represented by the Ministry of Energy and Mineral Resources (MEMR).

The report benefited from the input of various experts, notably from Denis Korchunov (UNDP), Stephen Gitonga (UNDP), Reem Al Masri (EDAMA), Ahmed Bassam (JREEEF), Rasmi Hamzeh (JREEEF), Yacoub Marar (MEMR), Ziad Hammoudeh (MEMR) and Ziad Jebril (ex MEMR).

IRENA colleagues who provided valuable review and support include: Abdulmalik Oricha Ali (ex-IRENA), Imen Gherboudj, Dolf Gielen, Nadeem Goussous, Ricardo Gorini.

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THE HASHEMITE KINGDOM OF JORDAN

Renewables
Readiness
Assessment

Foreword

from the Minister of Energy and Mineral Resources

The contribution of renewables to Jordan's electricity mix has grown impressively in recent years, rising from just 1% in 2014 to 13% in 2019. Renewable energy systems feeding into the national power grid reached 1 558 megawatts (MW) by 2019 and have since swelled to some 2 200 MW, or 20% of our overall electricity mix.

The integration of renewables reflects extensive preparation via the legislative and procedural framework, coupled with the progressive strengthening of human capacity and formation of partnerships with the private sector. Jordan's recently launched National Energy Strategy for 2020-2030 aims to ensure energy security, affordability and sustainability, along with increased use of domestic energy resources.

After close consideration of various possible scenarios for 2030, the strategy promotes a high independence scenario as the most compatible with achieving broader strategic objectives. These include diversifying our energy sources, boosting the use of domestic energy resources, increasing energy efficiency and reducing energy costs throughout the national economy, and continuing to develop the Jordanian energy system. The strategy calls for increasing renewables to 21% of power generation within the year and 31% by the end of the decade.

The National Energy Efficiency Action Plan, adopted in 2014, created the Jordan Renewable Energy & Energy Efficiency Fund (JREEEF), which helps farmers, households, industries, hotels, mosques, churches, schools and communities optimise their energy consumption and use more renewable power.

The International Renewable Energy Agency (IRENA) has helped us evaluate our current position, including successes and achievements, as well as our challenges. The resulting Renewables Readiness Assessment outlines key measures and solutions to enable us to move forward and meet our renewable energy targets. The recommendations are consistent with our 2020-2030 energy strategy. Moreover, the groundwork behind this report is reflected in our latest implementation plans.

Our ambitious targets for the energy sector require a strong partnership between the public and private sectors. We are eager, also, to work with international friends and partners to make renewables a prominent pillar of Jordan's energy system.

Hala Zawati
Minister of Energy and Mineral Resources, Jordan

Foreword

from the IRENA Director-General

As governments plan for the post-COVID future, the transition to renewable energy offers the prospect of rapid job creation, intensified economic development and enhanced social equity and welfare. For Jordan, diversifying the energy mix and reducing energy costs with renewables promises to strengthen long-term socio-economic and industrial development, without putting added strains on public finance.

For a country with abundant renewable energy resources, the envisaged transition would improve energy security and reduce costs to consumers, as well as improving environmental preservation. Jordan's energy strategy for the decade reinforces the diversification policy with an updated target of 31% renewable power capacity by 2030. Renewables Readiness Assessment: Jordan, prepared in collaboration with the Ministry of Energy and Mineral Resources (MEMR), identifies key challenges as the country pursues environmentally and economically sustainable power and heat. It offers recommendations in seven key action areas, aiming to scale up renewables for power generation, transport, industrial uses and the heating and cooling of buildings. The net result would be greatly increased renewable energy use, improved energy security and lower costs.

While Jordan made major strides over the past decade, the linkages and synergies could be strengthened between renewables and efficiency measures, as well as with grid upgrades, domestic industrial development, and the diversification of energy sources for transport and mobility. National financing institutions and project developers need their capacity built up to unlock faster investment in renewables.

Since 2011, nearly 40 countries, spanning the Middle East, Africa, Asia and the Pacific, Latin America and the Caribbean, have undertaken similar assessments, exchanging knowledge and fostering international co-operation to accelerate the deployment of renewables. Each process has been country-led, with IRENA providing technical expertise, highlighting regional and global insights, and facilitating consultations among a range of national stakeholders.

IRENA appreciates the vital input and engagement of the MEMR team on this study. Numerous national stakeholders and international partners also made valuable contributions. I sincerely hope the present report helps to accelerate Jordan's shift to a sustainable energy future.

Francesco La Camera
Director-General, IRENA

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Abbreviations

°C	Degree Celsius
CBJ	Central Bank of Jordan
CBO	Community based organisation
CEGCO	Central Electricity Generating Company
CO_2	Carbon dioxide
CSH	Concentrated solar heat
CSP	Concentrated solar power
DEG	German Development Bank
DLS	Department of Land and Survey
EBRD	European Bank of Reconstruction and Development
EDCO	Electricity Distribution Company
EESCO	Energy efficiency service company
EMRC	Energy and Minerals Regulatory Commission
EPC	Engineering, procurement and construction
ESCO	Energy service company
EU	European Union
FMO	Netherlands Development Finance Company
GAM	Greater Amman Municipality
GDP	Gross domestic product
GEF	Global Environmental Finance
GIS	Grid impact study
GWh	Gigawatt-hour
IDECO	Irbid District Distribution Company
IFC	International Finance Corporation
IPP	Independent power producer
IRENA	International Renewable Energy Agency
JCI	Jordan Chamber of Industry
JEDCO	Jordan Enterprise Development Corporation
JEPCO	Jordan Electric Power Company
JGBG	Jordan Green Building Guide
JICA	Japan International Cooperation Agency
JISM	Jordanian Institution for Standards and Metrology
JNBC	Jordan National Building Council

JOD	Jordanian dinar
JREEEF	Jordan Renewable Energy and Energy Efficiency Fund
K-Exim	Export-Import Bank of Korea
km	Kilometre
ktoe	Kilotonne of oil equivalent
kW	kilowatt
kWh	Kilowatt-hour
kWp	Kilowatt- peak
LED	Light-emitting diode
LNG	Liquefied natural gas
m^2	Square metre
MEMR	Ministry of Energy and Mineral Resources
MENA	Middle East and North Africa
m/s	metre per second
MSW	Municipal solid waste
mtoe	Million tonnes of oil equivalent
NDC	Nationally determined contribution
NEEAP	National Energy Efficiency Action Plan
NEPCO	National Electric Power Company
NREAP	National Renewable Energy Action Plan
O&M	Operation and maintenance
PPA	Power purchase agreement
Proparco	Promotion and Participation for Economic Cooperation
PV	Photovoltaic
REES	Renewable Energy Establishments Society
RRA	Renewables Readiness Assessment
RSS	Royal Scientific Society
SCADA	Supervisory control and data acquisition
SEED	Sustainable Energy and Economic Development
SEPCO	Samra Electricity Power Company
SHAMCI	Solar Heating Arab Mark and Certification Initiative
SME	Small and medium-sized enterprise
TPES	Total primary energy supply
TWh	Terawatt-hour
UNDP	United Nations Development Programme
USD	US dollar

Executive summary

Rapid population growth is bringing the economy under immense pressure in the Hashemite Kingdom of Jordan. New engines of economic development must be found, along with long-term spill-over benefits for the current population of 10.6 million as well as future generations. While Jordan's economic challenges are further compounded by the COVID-19 health crisis, the country is resolved to advance the use of domestic energy resources.

Indeed, energy is central to the growth of the Jordanian economy, which relies on imports to meet energy needs. This reliance strains the economy and poses energy supply security risks. These vulnerabilities drove the development of the Master Energy Strategy 2007 2020, which called for greater utilisation of domestic resources, including renewable energy.

The share of electricity from renewables in Jordan grew from 0.7% in 2014 to over 13% in 2019, making Jordan a regional front-runner in renewable energy. The country has established the necessary policies and regulations to support renewables, including solar photovoltaic (PV) and onshore wind development.

The updated Master Strategy for the Energy Sector 2020-2030, developed by the Ministry of Energy and Mineral Resources (MEMR), calls for a sustainable future energy supply, diversification of the national energy mix, increased dependency on the share of domestic energy resources, enhanced energy security, and reduced energy dependence and cost of electricity supply. The strategy targets a 31% share for renewables in total power generation capacity and 14% of the total energy mix by 2030.

The Renewables Readiness Assessment report prepared by, prepared by the International Renewable Energy Agency (IRENA) in close co-operation with MEMR highlights existing challenges and key opportunities as the country aims for greater energy security, supply diversity and sustainability. Recovery plans amid the COVID-19 crisis could also align closely with clean energy and other sustainability goals.

Renewable energy in Jordan: Drivers and status

Jordan's most abundantly available renewable energy resources are solar and wind, with smaller potentials for bioenergy, hydropower and geothermal.

The Renewable Energy and Energy Efficiency Law No. 13 of 2012 and its amendments form the backbone of Jordan's policy landscape for renewable energy and energy efficiency. Bylaw (79) year 2019 for Climate Change set requirements for stakeholders to report greenhouse gas emissions.

Jordan's nationally determined contribution (NDC) commits to a 14% reduction in greenhouse gas emissions by 2030. The NDC's actions include developing and utilising renewable energy sources while encouraging investments in renewable energy.

Purely from a cost perspective, substantial reductions in the cost of renewable energy technologies over the past decade offer a compelling case for the government to pursue a greater role for renewables in the future energy mix. In Jordan, the results of the latest (third) round of direct proposal submissions in 2018 yielded bids as low as USD 0.03 (US dollars)/kWh (kilowatt-hour). In comparison, the average cost of electricity purchased by National Electric Power Company (NEPCO) in 2018 was (USD 0.114/kWh).

Jordan's record shows that decarbonisation of the energy mix can be achieved while securing a reliable energy supply. In 2018, electricity generated from solar PV and wind avoided nearly 1.5 million tonnes of carbon emissions. Renewable energy use for heating/cooling applications has been limited – and based mostly on solar water heaters – the launch of the Jordan Renewable Energy and Energy Efficiency Fund (JREEEF) has catalysed the market for these heaters.

In addition, the government supports the adoption of electric vehicles, even while expansion of the charging infrastructure is needed.

Advancing renewable energy in Jordan

Renewable energy solutions will be instrumental in improving energy security, reducing the cost of energy supply, advancing environmental preservation and strengthening Jordan's recovery from the COVID-19 crisis. To support the next phase of renewables growth, a broader policy mix focusing on deployment, integration and enabling conditions at the sector level is needed. Demand creation and electrification of end-uses will also be crucial.

The report gives key recommendations for Jordan to realise the full economic, social and environmental potential of renewables in seven key areas, with applications spanning power, transport, and heating/cooling for buildings and industry. Renewable energy investments and local industry development and job creation are also addressed, as illustrated in Figure ES1. The outcome is for renewables to comprise a much higher share of Jordan's energy mix while improving energy security and reducing the cost of supply.

1: Provide the conditions for renewables to grow in the power sector

Clarify the trajectory for renewables in Jordan's energy mix. The Master Strategy for the Energy Sector provides a long-term vision for the evolution of the country's energy sector. However, the indefinite suspension of new projects over 1 megawatt (MW) since January 2019 has introduced uncertainty to the sector.

To achieve high shares of renewables in the energy mix and low energy costs, integrated plans and policies for electricity demand stimulation through the electrification of end-uses should be pursued between ministries, cross-sector applications improved, and energy poverty alleviated. Partnerships among ministries, distribution companies and municipalities can help to achieve this.

2: Foster continued growth of renewable power generation

Shorten approval processes and project timelines that add to risks and transaction costs. While utility- and small-projects are affected differently, the time needed between expressing interest and project commissioning can be several years. Steps are needed to establish a fixed milestone-based timeframe. Standardising land acquisition processes by pre-developing sites – including the development of grid interconnection infrastructure, conduct of sector-specific environmental and social impact assessments (e.g., bird migration studies in the case of wind) and completion of land acquisition – can level the playing field for private participation in future tender processes.

Government programmes have also been launched to deploy rooftop solar PV systems for small residential consumers currently under national welfare schemes. Such programmes should be scaled up to increase social impact, reduce consumer energy expenditure and limit government subsidy costs. The electricity

Figure ES1. **Overview key recommended action areas**

tariff design and charges (e.g., wheeling rates) for renewable energy projects should accurately reflect the true cost of the services delivered by the network.

Strengthen linkages to energy efficiency. Despite numerous bylaws enacted to advance energy efficiency measures – as well as the JREEEF and the Jordan Chamber of Industry's targeted financing programmes for energy audits – renewable energy penetration has been limited. Therefore, the industrial sector's capacity could be developed to implement energy efficiency (and renewable energy) measures and institute industry-specific benchmarks and best practices.

In power generation, for instance, combined heat and power applications can dramatically improve efficiencies and can offer cost-effective energy alternatives, especially in industries where both electric and thermal energy are consumed. Pilot projects already exist, such as in Wadi Shalala in Irbid; therefore, dedicated regulations are needed to scale up the adoption of such solutions.

3: Plan for the integration of higher shares of renewable power

Strengthen national transmission and distribution infrastructure. The lack of capacity to handle higher shares of renewables in the transmission and distribution infrastructure is a key hurdle for further growth. Tools – such as the IRENA FlexTool – are available to analyse a power system's flexibility needs, determine least-cost solutions and integrate them into the strategy. Liaising with other ministries related to industry, agriculture, transport and water is crucial for identifying regions with existing and upcoming power demand potential.

In the short-term, Jordan should identify priorities for the distribution network, mobilise investments to strengthen infrastructure and unlock network capacity to integrate renewables and other loads, such as those from electric vehicle charging stations.

Introduce a storage code for grid management at the transmission and distribution level. Storage brings substantial value for grid management, whether as a stand-alone asset or when integrated with a renewable power supply. Therefore, the formulation of a dedicated storage code provides regulatory guidance for the development of battery storage infrastructure at the generation, transmission, distribution and end user levels, as well as instructions to connect to the grid. These actions must be taken at the ministerial level in consultation with the system operator, distribution companies and other stakeholders.

Improve load management through demand-side solutions. The increasing share of variable renewable power in Jordan's electricity mix will require active measures to match demand and supply in a manner that reduces overall system costs and incremental integration infrastructure investment. A renewable energy peak-load strategy must be developed and implemented to address peak demand in buildings and industry through solar PV and storage, when this is competitive with expensive peaking plants. In parallel, the feasibility of time-of-use tariffs must be assessed to facilitate demand shifting towards low-load periods.

4: Incentivise the use of renewables for heating and cooling

Support greater adoption of renewable solutions in buildings and industry. Solar water heating applications remain the most mature forms of renewable usage in heating/cooling, but deficiencies in targets for deployment, enforcement of mandates and codes, and a long-term financial incentive programme addressing end users' present challenges. The development of a clear, long-term solar water heater penetration strategy for the residential, commercial and industry sectors is recommended, as is annual reporting of the data collected from the sales of such systems.

5: Support renewable options for transport and mobility

Start to diversify energy use in the transport sector.The transport sector – Jordan's largest energy consumer – relies mainly on diesel and gasoline. Government efforts to decrease energy use in the sector rely on incentivising high-efficiency vehicles. However, the development of charging infrastructure has lagged. An improved business case for the private sector's participation in charging infrastructure development is needed urgently. Time-of-use pricing should also be enacted to avoid additional burden on the grid.

6: Catalyse renewable energy investment

Build the capacity of local financing institutions and project developers. Local financial institutions have low involvement with utility-scale renewable energy financing. On lending and risk mitigation facilities by international financing institutions can increase local banks' experience and mobilise larger shares of domestic capital for renewable energy development. Moreover, developing the capacity of green lending units in local commercial banks will improve the implementation of programmes from JREEEF and the Central Bank of Jordan, as well as widen access to

additional international financing. These actions can be undertaken in collaboration with the Association of Banks.

7: Strengthen local industries and create jobs in renewables

Leverage capacity from other sectors and maximise renewable energy job creation. Achieving the benefits of a renewable energy-based energy transition requires a broad mix of policies beyond those that focus on deployment alone. These include industrial policies, skills development, and research and development.

Beyond the manufacturing of renewable energy technologies, new opportunities for value creation range from operation and maintenance, design, engineering and financial services to innovative solutions such as industrial automation, smart metering and hydrogen infrastructure.

The sector must build adequate skills to meet the needs of a rapidly growing renewable energy sector by partnering with training institutes, universities and industry in a manner that ensures a gender-equal workforce.

Finally, abrupt policy changes – such as the suspension of new projects over 1 MW – negatively impact the market growth potential of local enterprises. While a local content regulation is in place, its definition, effectiveness, and influence on cost and quality need to be closely assessed.

Introduction

The Hashemite Kingdom of Jordan is located in the heart of the Arab world with a population of over 10.6 million people (Jordan Department of Statistics, 2020a). The country is divided into 12 governorates. Over the past decade, the Jordanian economy has weathered several challenges, such as the financial crisis of 2009, instability due to regional conflicts, an energy crisis following the natural gas supply disruption in 2011, closure of trade routes and an influx of over 1.4 million refugees (Economic Policy Council, 2017; Chan and Kantner, 2019).

Economic growth in the kingdom slowed from an average of 6.5% between 2000 and 2009 to 2.5% from 2010 to 2016, reaching under 2% in the third quarter of 2019 (Jordan Department of Statistics, 2020b). Unemployment has been rising. In the first quarter of 2020, the unemployment rate stood at 19.3% compared to 12.5% in 2010 (Jordan Department of Statistics, 2020c). The country's social services system and its economy are under heavy stress from sudden population growth, and the Covid-19 health crisis has further compounded the Kingdom's economic challenges. To meet these challenges, the country needs to identify new engines of growth, generate employment and create prosperity for all.

The services sector has consistently accounted for a majority of the gross domestic product (GDP), exceeding a 60% share for most of the last six decades. The manufacturing sector contributes about 20% of GDP (Jordan Department of Statistics, 2020b). Jordan's Economic Growth Plan 2018-22 strongly emphasises developing key infrastructure and economic sectors, such as water, energy, transport, industry, tourism, agriculture, and micro, small and medium-sized enterprises, as well as social development aspects related to education, labour rate participation and health care (Economic Policy Council, 2017). Sectors such as agriculture, pharmaceuticals and tourism are also seen as central for rapid recovery from the Covid-19 economic crisis (Royal Hashemite Court, 2020).

As Jordan reinvigorates economic growth and long-term development, energy will play a crucial enabling role. A secure, stable, affordable, environmentally sustainable and inclusive energy system underpins the social and economic development objectives. The lack of domestic fossil fuel resources has resulted in Jordan relying exclusively on imports for meeting its energy needs, which places substantial strains on the economy and poses risks for the security of supply in terms of affordability, reliability and accessibility. In 2018, Jordan imported 92% of its primary energy needs, with the cost accounting for about 10% of its GDP (2019a).

The disruption in the supply of natural gas in 2011 – a mainstay of Jordan's energy mix – resulted in the use of expensive alternatives, such as heavy fuel oil and diesel, for several years and led to substantial financial losses for the state-owned off-taker NEPCO, severely burdening the economy. This illustrates the vulnerability of the Jordanian economy to disruptions in fossil fuel supplies and has strengthened the resolve to advance domestic energy resources at a brisk pace.

The Master Strategy for the Energy Sector 2020-2030 positions renewable energy as a central pillar of the energy diversification agenda. Backed by strong policy and regulatory action, the share of electricity generated from renewables reached over 13% in 2019 over a short span of time. Rapid reductions in technology costs have made renewables, in particular solar photovoltaic (PV) and wind, substantially more competitive with conventional energy options. Even under the current trajectory of renewables growth, Jordan will have successfully integrated 20% of electricity from renewable energy by 2021 (Marar, 2019). This growth has been impressive, making Jordan a frontrunner in attracting renewable energy investment in the region. Jordan now has a unique opportunity to further accelerate the scale-up of renewables use in the energy sector to reduce energy costs for consumers, enhance energy security, increase the competitiveness of local industries and advance environmental preservation objectives.

To support future renewables growth, actions will be needed by different stakeholders to support grid integration, increase use for heating/cooling and transport, pursue deep electrification of end-use sectors, and leverage energy management technologies at both the supply-side and demand-side, such as storage and smart grids. This Renewables Readiness Assessment (RRA) for Jordan provides a comprehensive evaluation of the conditions for renewable energy and identifies the actions needed to further raise renewables' share in Jordan's energy mix. This assessment, conducted by the International Renewable Energy Agency (IRENA) on request from and in co-operation with the Ministry of Energy and Mineral Resources (MEMR), benefitted from a country-led, consultative process. It provides a platform for multi-stakeholder dialogue to identify challenges to renewable energy deployment and to devise solutions to existing barriers. It comes in tandem with the background of the government's National Energy Strategy 2020-2030, released in June 2020.

This report presents the outcomes from the RRA Jordan process. It highlights the key trends and challenges in the energy sector and the drivers for energy diversification (Chapter 2). Chapter 3 discusses trends in renewable energy adoption, focusing on applications in the power, heating/cooling and transport sectors. Chapter 4 delves deeper into the emerging issues and challenges in renewable energy policy and regulations, as well as investments. The report concludes with a set of short- and medium-term recommendations and priority action areas for the government to support accelerated renewables development and maximise socio-economic benefits (Chapter 5). The recommendations have been validated through several rounds of multi-stakeholder consultations.

The RRA benefitted from the valuable guidance of the MEMR and other relevant public and private sector entities. Extensive stakeholder consultations were organised. These included an in-depth survey and face-to-face interviews with around 40 experts, followed by an expert consultation workshop co-organised by IRENA and the MEMR in October 2019. The findings from the RRA were validated in a workshop organised in January 2020.

Renewables and COVID-19 crisis management

Amid the coronavirus (COVID-19) health and economic crisis, recovery plans can be most effective if linked closely to the advancement of clean energy and other sustainability goals. Investments in renewables, energy storage and grid modernisation, along with building efficiency retrofits, can strengthen socio-economic resilience, provide immediate economic relief, reduce carbon dioxide (CO_2) emissions and lay the foundations for a decarbonised, climate-safe society.

Energy sector landscape

Energy represents a central pillar of Jordan's economy, both as a key input for growth and development as well as a major cost. Between 2014 and 2018, final energy consumption grew by 22% and electricity use by 14% (MEMR, 2019b). Devoid of domestic fossil fuel reserves, energy demand has largely been met through reliance on imports. About 92% of Jordan's energy supply in 2018 was imported (MEMR, 2019b). This comes at a substantial cost to the economy – 10% of GDP in 2018 – as well as concerns over long-term energy security to support sustainable economic growth and development. This chapter analyses Jordan's energy sector, providing insights on the institutional landscape and trends in primary energy supply, the power sector and final energy consumption. It aims to provide insights on fuel supply and consumption across different sectors of the economy, and highlights key risks and opportunities for the long-term security of energy supply. It concludes with an analysis of the key drivers of the government's energy diversification objective and renewable energy's role in this drive.

2.1 Energy sector institutions and responsibilities

The institutional landscape of Jordan's energy sector involves multiple stakeholders across the power, petroleum, gas and minerals sectors. Table 1 provides an overview of the key institutions in the energy sector and their responsibilities. At the top of the institutional hierarchy lies the **Ministry of Energy and Mineral Resources (MEMR)**, which provides the strategic vision for the development of the energy sector in terms of planning, policy formulation and implementation. It takes on the responsibility for developing the Jordan National Energy Strategy and the subsequent laws, bylaws and instructions for implementation. It is entrusted with ensuring the development of various energy resources and providing the conditions for attracting investments in electricity generation, oil production and refining, and utilisation of domestic resources, including renewable energy and oil shale. The MEMR is also responsible for energy efficiency in Jordan and the management of the Jordan Renewable Energy and Energy Efficiency Fund (JREEEF).

Several other ministries play crucial roles in the effective implementation of strategies and policies introduced by the MEMR. The Ministry of Environment, Ministry of Public Works and Housing, Ministry of Transport, and Ministry of Industry and Trade and Supply, as well as local municipalities, are all significant partners in the institutional framework of Jordan's energy sector.

The regulatory function is fulfilled by the **Energy and Minerals Regulatory Commission (EMRC)**, which is a legal entity with financial and administrative independence established under Law No. (8) for the year 2017, Law of Energy and Minerals Regulatory Commission. As a result of the government institution restructure plan in 2014, the EMRC is a legal successor of the erstwhile Electricity Regulatory Commission, the Jordan Nuclear Regulatory Commission and the Natural Resources Authority. It serves as the regulatory and monitoring body for the electricity, nuclear safety and security, and mining sectors, and therefore ensures

the application and enforcement of laws, by-laws, instructions and directives specific to the regulation within these sectors.

In the power sector, the generation segment is unbundled with a mix of public and private sector participation. The generation segment comprises companies with public and private sector holding, such as **Central Electricity Generating Company (CEGCO)**, state-owned **Samra Electricity Power Company (SEPCO)**, and renewable and other independent power producers (IPPs). Other sources of electricity generation include large industries, imports and small-scale solar PV connected to the distribution network.

The **National Electric Power Company (NEPCO)**, a state-owned company, is a single-buyer, single-seller of electricity. It also manages the transmission system. Under power purchase agreements (PPAs) with "take-or-pay" clauses, NEPCO procures power from the generation companies and sells to bulk consumers in industry and three distribution companies that service different parts of Jordan. NEPCO is the single importer of liquefied natural gas (LNG), pipeline gas and oil products for electricity generation, as well as manager of the cross-border electricity grid with neighbouring countries. NEPCO is also responsible for the construction, operation and maintenance (O&M) of the transmission network in Jordan.

The three distribution companies – **Jordan Electric Power Company (JEPCO)**, **Irbid District Distribution Company (IDECO)** and **Electricity Distribution Company (EDCO)** – are all public shareholding companies licensed to service the central, northern and southern parts of the country, respectively. Together they accounted for 90% of all electricity procured from NEPCO in 2018, with JEPCO accounting for the largest share.

Beyond the power sector, publicly owned companies are responsible for oil and natural gas exploration and the operation of refineries in Jordan. The Jordanian Egyptian Fajr for Natural Gas Transmission & Supply Co. Ltd. builds, operates and owns the pipeline to collect natural gas from Aqaba to the north of Jordan. Several non-governmental entities are also key stakeholders in the energy sector, including industry associations, non-profits and international financing institutions.

Table 1. **Overview of selected institutions in Jordan's energy sector**

Segment	Institution	Mandate
Planning, policy making and regulation		
Planning and policy making	Ministry of Energy and Mineral Resources (MEMR)	Responsible for strategic vision of country in terms of planning and policy formulation for the development of energy and mineral resources.
	Ministry of Environment	Responsible for the Environment Impact Assessment for renewable energy and other energy projects, as well as for climate change mitigation and adaptation efforts, including nationally determined contributions (NDCs).
	Ministry of Public Works and Housing	Responsible for the Jordan National Building Council (JNBC), which issues the Building Codes. In addition to the Jordan Green Building Guide, 23 codes related to energy have been issued.
	Ministry of Planning and International Co-operation	Responsible for formulation of policies to enhance relationships with donors and international financial institutions, and liaising between relevant ministries and government institutions. Facilitator for the implementation of the Jordan Response Plan 2020-2022, which includes the promotion of renewable energy and energy efficiency to the Zaatari and Azraq camps and other vulnerable areas.
	Municipalities	Control building zoning and solar PV projects installed on buildings, including installation of solar water heaters in new construction according to the instructions issued on 1 April 2013.

Segment	Institution	Mandate
Planning, policy making and regulation		
Regulation	Energy and Minerals Regulatory Commission (EMRC)	National entity mandated to develop laws, legislation and executive decisions governing energy, electricity tariffs for consumers, sale price of electricity between NEPCO and distribution companies and minerals sectors, including those of relevance to renewable energy.
Electricity sector		
Upstream fuel supply	National Electric Power Company (NEPCO)	Single importer of LNG, pipeline gas, and oil products for electricity generation, for its own gas-fired generation and IPPs.
Generation	Central Electricity Generating Company (CEGCO)	Majority private holding generator. Contributed 9% of total electricity generated in 2018.
	Samra Electricity Power Company (SEPCO)	State-owned generator. Contributed 37% of total electricity in 2018.
	IPPs (Amman East, Qatrana Power Company, Amman Asia, AES Levant, Attarat Power Company – under construction)	Private generators. Contributed 39% of total electricity in 2018.
	Renewable energy power producers	Solar PV, wind, hydro and biogas generators accounting for 13% of total generation in 2019.
	Industrial sector	Large industries generating power accounting for 4% of total generation in 2018.
	Electricity imports	Imported electricity through interconnections, accounted for about 1% of generation in 2018.
	On-site renewable energy generation by consumers	Accounted for 590 gigawatt-hours (GWh) in 2018, representing about 3% of electricity consumption.
Transmission network **System operator**	NEPCO	System operator, transmission provider and market operator. Single state-owned transmission system operator and the only authorised energy off-taker at the wholesale level. Responsible for management of interconnections.
Distribution and retail	Jordan Electric Power Company (JEPCO)	A 20-year licensed public shareholding company that distributes electricity in central Jordan. Accounted for 55% of total electricity consumption in 2018.
	Irbid District Distribution Company (IDECO)	A 25-year licensed public shareholding company that distributes electricity in northern Jordan. Accounted for 17% of electricity consumption in 2018.
	Electricity Distribution Company (EDCO)	A 25-year licensed public shareholding company that distributes electricity in southern Jordan. Accounted for 18% of electricity consumption in 2018.

Segment	Institution	Mandate
Electricity sector		
Financing[1]	Jordan Renewable Energy and Energy Efficiency Fund (JREEEF)	Provides a set of financial products, such as revolving credit, grants, loan guarantees and equity financing, to advance renewable energy and energy efficiency solutions. Provides soft loans with subsidised interest rates with the support of the central bank. Provides capacity building for professionals in renewable energy financing.
	Central Bank of Jordan	Provides concessional financing for renewable energy up to JOD 4 million (Jordanian dinars).
Oil, petroleum, gas, and mineral ore institutions		
Oil and gas extraction	National Petroleum Company	A public company owned by the government in the concession area responsible for prospecting oil and gas in Northeast Jordan.
Refining	Jordan Petroleum Refinery Company	Operates the only operational refinery in Jordan to produce various products, including asphalt, fuels, lube oil and special products.
Natural gas transmission and supply	Jordanian Egyptian Fajr for Natural Gas Transmission & Supply Co. Ltd.	A limited liability company which builds, operates and owns the gas pipeline from Aqaba to northern Jordan. Collects natural gas in Aqaba through the Arab gas pipeline and transfers and sells the gas to power plants and industries.
	Noble Energy	Provides supply of pipeline natural gas from the Leviathan Gas Field to NEPCO under a 15 year agreement.
Non-governmental entities		
Industry association	EDAMA	EDAMA is a business association comprising private sector entities in the green energy and water sector.
	Renewable Energy Establishments Society (REES)	REES was established in 2014 under the purview of the Ministry of Environment. It provides a platform for companies, advocacy and market improvements.
	Jordan Chamber of Industry (JCI)	JCI was established in 2005 to support the growth and development of industries and small and medium-sized enterprises (SMEs) in Jordan. It is leading a 100 MW solar PV project specifically for industry.
Non-profit	Royal Scientific Society (RSS)	RSS provides expert testing services for technology quality as well as standards, consultations, training, and information and communications technology services.
	Jordan Renewable Energy society	A global platform of researchers, entrepreneurs, and decision makers tasked to create awareness and facilitate technology transfer and expertise. Also promotes nationally recognised education and training in renewable energy technologies.
International organisation or non-governmental organization (NGO)	United Nations High Commissioner for Refugees	Management of refugee camps and development of associated energy supply infrastructure. For instance, a 12.9 MW plant at Za'atari Camp provides 80 000 refugees with electricity.

1 A number of international finance institutions, commercial banks and micro-finance institutions are also present in the sector to deliver financing for energy projects at different scales.

Note: This is not an exhaustive list of institutions in the energy sector. Several others are involved in various capacities, including the Jordan Engineers Association, Jordan Construction Contractors Association, Department of Antiquities, Civil Aviation Authority, Council of Ministers, Higher Council for Science and Technology, Customs Department, Jordan Institute for Standards and Metrology, Royal Jordanian Geographic Center, Industrial Zones Authority, Ministry of Municipalities, Ministry of Transport, Aqaba Special Economic Zone, Department of Land and Survey, Chamber of Commerce, and Royal Society for the Conservation of Nature

2.2 Trends in primary energy supply

Total primary energy supply (TPES) grew at an average annual pace of 3% between 2010 and 2017, reaching 10 million tonnes of oil equivalent (mtoe) in 2017 (Figure 1). In 2018, it fell by 3%, reaching 9.7 mtoe due to stagnating consumption across certain end-use sectors. This is discussed further in Chapter 2, Section 4. Oil accounted for more than half of all energy supply in 2018, followed by natural gas and electricity. Crude oil and its derivates are predominantly used in the transportation sector, where fuel demand has grown rapidly amid population growth, increasing urbanisation and greater economic activity.

The share of natural gas in TPES has varied greatly over the past decade, falling from 40% in 2009 to 4% in 2014 and rising to 35% in 2018 (MEMR, 2019). The fluctuation is a result of supply disruptions in imported natural gas in 2011. The reduction in natural gas share in TPES was compensated with oil products, such as heavy fuel oil and diesel, for use primarily in the power sector. Resorting to imports of high-priced oil products to bridge the energy gap has had far-reaching consequences for the financial health of NEPCO, highlighting the case for pursuing diversification through domestic energy resources (discussed further in Chapter 2, Section 5).

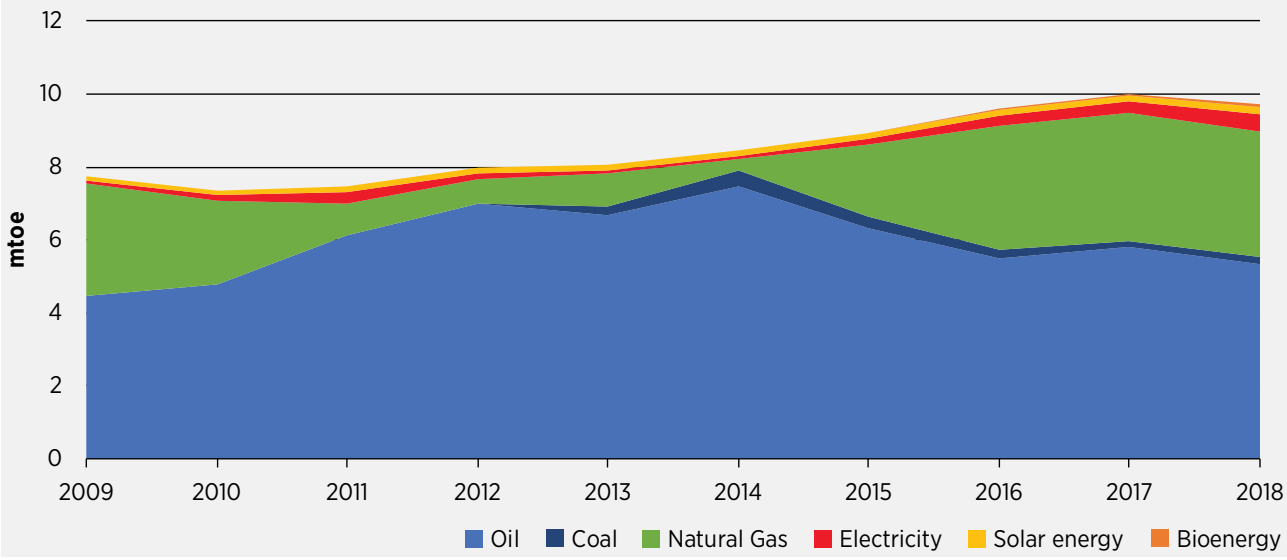
Driven by strong policy action towards the diversification of energy supply, the share of renewables in TPES has gradually grown from around 1.8% in 2009 to about 8% in 2018. Since 2013, the coal supply has also grown – due to rising use in industry – with its share ranging between 2% and 5% of TPES.

Despite a reduction in 2017, the MEMR estimates that primary energy supply will grow from 9.7 mtoe in 2018 to 10.3 mtoe in 2020 and 12.4 mtoe in 2030 (MEMR, 2019b). The import dependence of TPES has remained high over the past decade, peaking in 2014 to reach 99.9% and 92% in 2018. The Master Strategy of the Energy Sector 2020-2030 aims to increase the share of domestic energy resources in primary energy to 48.5%, primarily through the use of renewable energy and oil shale.

Table 2. **TPES shares by fuel**

Energy source	% share in 2009	% share in 2018	
Natural gas	40%	35%	**Average annual growth of TPES at 3%**
Oil share	58%	55%	
Coal share	-	2%	
Renewable energy share	1.6%	2.9	

Figure 1. **TPES, by fuel (2009-2018)**



Source: MEMR (2019b)

2.3 Trends in the power sector

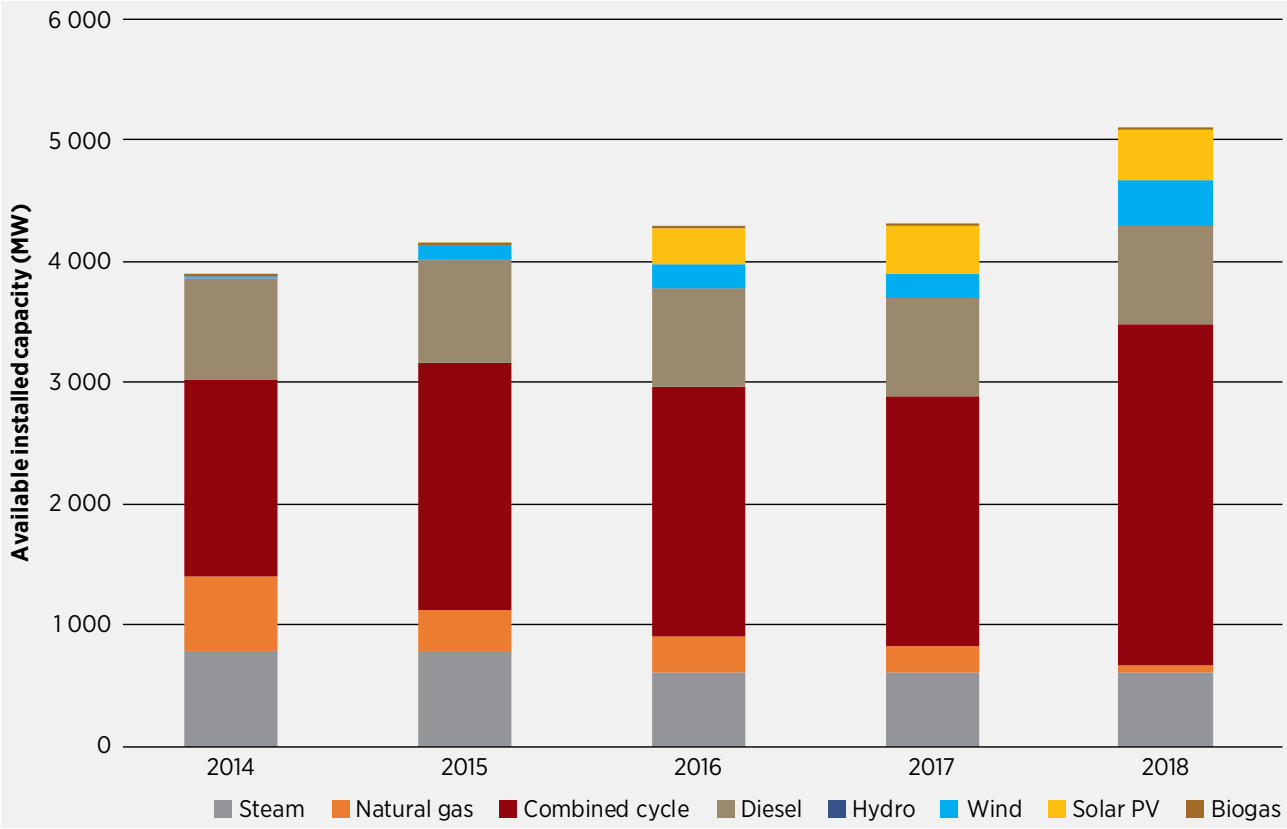
By the end of 2018, the total installed power capacity in Jordan was 5.2 GW, growing from 3.9 GW in 2014 (Figure 2). Combined cycle power plants accounted for the largest share of installed capacity at over 50%. Diesel accounted for a marked share of total installed capacity at 16% in 2018. The share of renewable power capacity has grown, rising from under 1% in 2014 to over 20% in 2018. It is expected to reach 31% by 2030 (MEMR,2019a). The rise in renewables' share of total installed capacity is driven primarily by capacity additions of wind and solar PV (utility-scale and distributed). The summer peak load in Jordan in 2018 was 3 GW compared to a winter peak load of 3.2 GW. In January 2020, due to extreme cold weather, the peak load hit a historical high of 3.6 GW (NEPCO, 2020a).

Total generation in Jordan's power sector has also grown steadily over the past decade from about 15 terawatt-hours (TWh) in 2010 to nearly 21 TWh in 2018 (Figure 3). The fuel mix has changed dramatically during this period owing to changes in the regional geopolitical conditions and their impact on fuel supply for domestic electricity generation. Until 2009, natural gas accounted for nearly 80% of total electricity generation in Jordan. Following disruptions in 2011, Jordan turned to greater use of heavy fuel oil and diesel fuel for electricity generation.

As a result, by the end of 2014, diesel and heavy fuel oil accounted for over 90% of the electricity mix, while the share of natural gas had fallen to a little over 7%. With imports of LNG through the port of Al-Sheikh in Aqaba beginning in mid-2014, the share of natural gas in electricity generation was restored to over 80% by 2018. In January 2020, pipeline natural gas supply from the Leviathan Gas Field began trials as part of a 15-year agreement with Noble Energy (Jordan Times, 2020a).

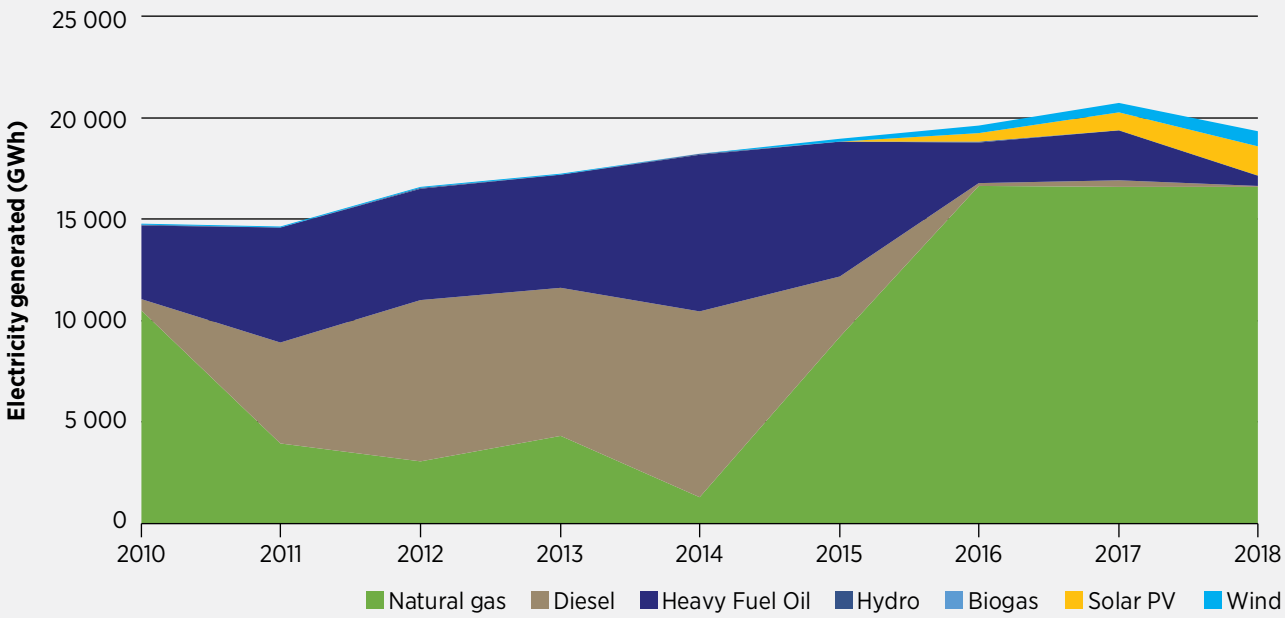
Making investments in new power generation infrastructure has been a key priority for the government. New natural gas-based power projects are under development through partnerships with the private sector as IPPs. Recently, the 485 MW new Zarqa combined-cycle power station was commissioned and developed by ACWA Power using natural gas as the primary fuel and diesel oil as the secondary fuel.

Figure 2. **Installed capacity in the power sector, by source (2014-2018)**



Source: NEPCO (2019a)

Figure 3. **Total electricity generated, by fuel**



Based on: NEPCO (2019a, 2018)

The growing reliance of the power sector on a single, largely imported fuel has resulted in concerns for long-term energy security and the affordability of supply. In recognition of these concerns, the government has taken important steps towards the diversification of the energy mix, as exemplified in the updated National Energy Strategy 2020-2030. It sets a target for increasing the share of renewable energy in the electricity mix to 31% by 2030 (3 200 MW), up from 20% by 2020 (2 400 MW) (MEMR, 2019a).

Backed by strong policy support, renewable energy, especially solar PV and wind, has grown tremendously over the past few years in the power sector. Total electricity generated from renewable sources has grown multifold, from 125 GWh in 2015 to 2 188 GWh in 2018, driven in large part by the development of solar and wind projects (discussed in greater detail in Chapter 3).

The government is also pursuing diversification through other fuels. The National Energy Strategy 2020-2030 includes a share of 2% of total electricity generation coming from coal by 2030, in line with the 2% share presently available. Accordingly, work is underway for the development of a 30 MW capacity coal power plant – the first of its kind in Jordan (Ghazal, 2016). Additionally, the Kingdom is looking to exploit its oil shale reserves for power generation. The Attarat Power Company project comprises two generating units – each with a capacity of about 235 MW – which are being constructed for direct burning of oil shale for power generation. It is estimated that oil shale will meet up to 15% of Jordan's electricity needs by 2021 (Jordan Times, 2019).

Grid interconnection with neighbouring countries and the region broadly is also an important pillar of diversification for Jordan. The interconnection of 500 MW capacity is the strongest in terms of volume of electricity traded in recent years. In 2018, electricity imports amounted to over 188 GWh, up from 51 GWh a year earlier but down substantially from 604 GWh in 2015 (NEPCO, 2019b; NEPCO, 2018). In promoting Arab and regional electrical interconnection, NEPCO has recently signed memorandums of understanding with the Gulf Electrical Interconnection Commission and the Saudi National Electricity Transmission Company.

In light of the low growth in electricity consumption domestically and a strong pipeline of power projects due to come online over the next two to three years, cross-border electricity exports are a key part of the strategy for stimulating demand. In October 2019 the National Electricity Company of Jordan signed an agreement with the Jerusalem local electricity company to increase its export capacity of electricity from 30 MW to 100 MW (NEPCO, 2020b). In 2019, the volume of exported electricity increased by 4.7% to about 98 GWh (NEPCO, 2020c).

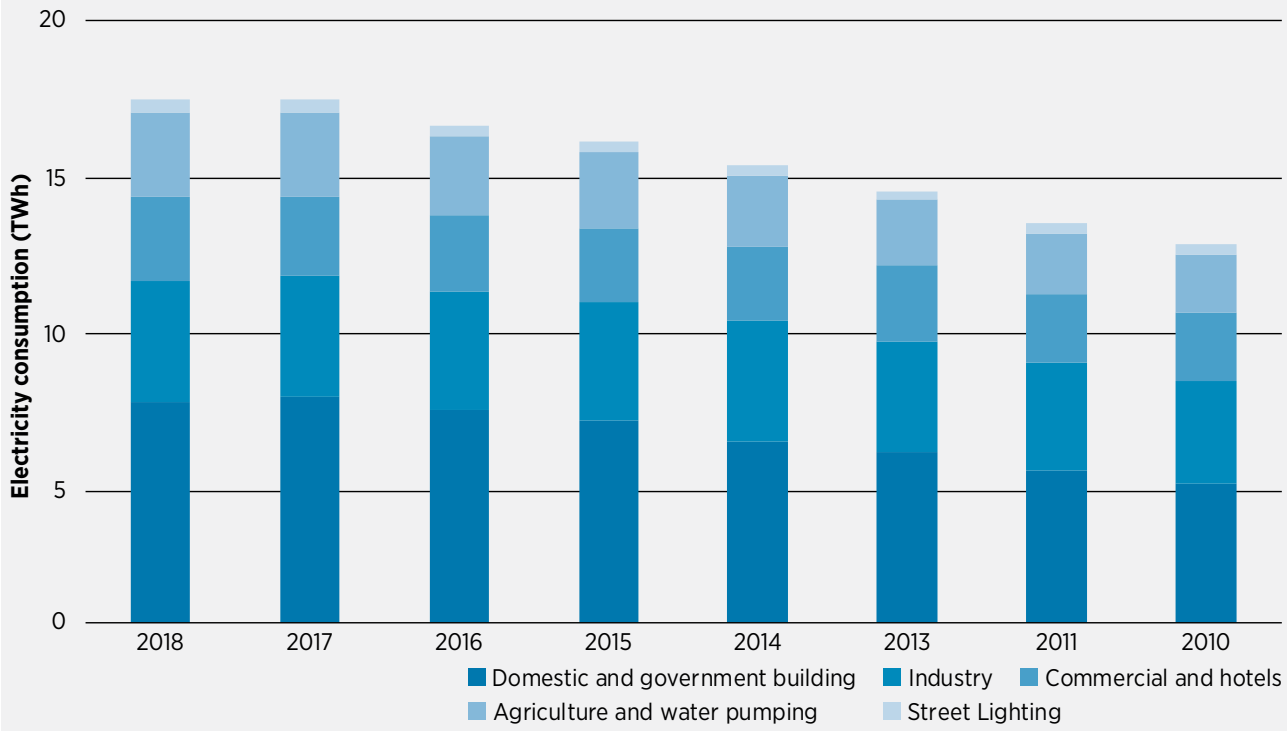
From an electricity consumption perspective, the per capita annual consumption of electricity has fallen from 2.3 MWh in 2014 to 1.7 MWh in 2018 primarily as a result of rapid population growth. This compares to a world average of 3.2 MWh per capita (IEA, 2017). Per capita household electricity consumption was around 0.77 MWh in 2018, suggesting that a large proportion of the population lives in energy poverty. Energy poverty is also seen in refugee camps, which often lack access to sufficient, reliable and affordable energy services for electricity and heating (UNHCR, 2019a). Distributed renewable energy solutions are increasingly deployed to provide immediate energy access (discussed further in the next chapter). The low per capita consumption leaves substantial scope for electricity consumption growth.

Electricity consumption has grown at an average annual pace of about 4% since 2010. However, in 2018 the growth stagnated, reaching 17.5 TWh (Figure 4). Several factors are potentially behind the slowdown, including energy efficiency and the rise of distributed generation for captive use. Under the second National Energy Efficiency Action Plan, the target is to reduce electricity consumption to 2 000 GWh per year over a four-year period (2017-2020).

According to data from MEMR, households accounted for nearly half (46%) of total electricity consumption in 2018 (MEMR, 2019a) (Figure 5). Industry is the second largest consumer, accounting for about a quarter of total consumption. Among the major industries that account for a considerable share of electricity use are cement, phosphate and fertiliser. The commercial sector consumes about 14% of all electricity.

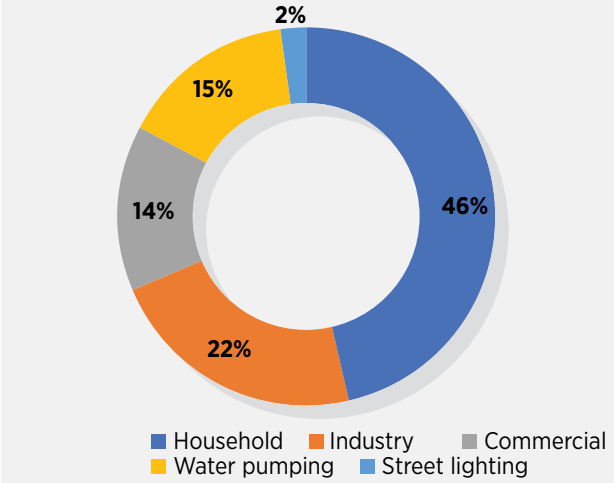
Water pumping is also a significant electricity consumer, accounting for 15% of total consumption. Jordan is one of the most water-scarce countries in the world, so the sector is highly energy-intensive to meet needs for extraction, transport and treatment of water. To reduce the energy costs of water pumping, the Ministry of Water and Irrigation aims to improve energy efficiency by reducing the specific power consumption for water supply by 15% by 2025 and raising the share of renewable energy in power consumption to 10% by 2025. Several other programmes have also been implemented to deploy solar-powered solutions for water pumping in the agriculture sector (discussed further in Chapter 3). As water demand grows and energy-intensive solutions are needed (e.g., Red Sea-Dead Sea water conveyance project, desalination), coupling affordable renewable energy supply with water infrastructure will become crucial, as seen increasingly across the Middle East.

Figure 4. **Electricity consumption, by sector (2010-2018)**



Source: MEMR (2019a)

Figure 5. **Total electricity consumption, by sector (2018)**



Source: MEMR (2019a)

The retail tariffs in the power sector are presently structured differently for 18 consumer groups, including domestic, commercial, agriculture, small and medium industries, the telecommunication sector, and hotels. A stepped-up tariff design is in place with varying tariff levels depending on monthly consumption. For medium-size industries and agriculture, day and night tariffs are in place, as are peak load charges (JOD per peak kW per month). In general, cross-subsidies from industry and large consumers are used to keep tariffs for low-income households at affordable levels. Currently, the average tariff is almost at cost-recovery but still insufficient for debt service of the state-owned NEPCO. In its 2018 Annual Report, NEPCO reported annual losses of JOD 106 million (~USD 150 million) (NEPCO, 2019a).

NEPCO has accumulated substantial debt (~18% of national debt) due to high crude oil prices between 2011 and 2014 and imports of expensive fuel alternatives as a result of disruptions in the supply of natural gas. High consumer subsidies and the "take or pay" structure of contracts with power generators have resulted in NEPCO absorbing a large part of the increases in energy supply costs. Even as crude oil prices have plummeted in recent years, natural gas supply has resumed and new LNG supply options have become available, there is a continued focus on ensuring cost-recovery for NEPCO through tariff adjustments and other measures (Fairbanks, 2019). In December 2017, the EMRC started applying a new tax called Fuel Price Increase. This is an additional expense for all electricity consumers consuming above 300 kilowatt-hours (kWh)/month. The amount of this tax is based on the fluctuation of international fuel prices. It is announced by the EMRC at the end of each month.

During the first few months of 2018, the tariff increase was on average USD 0.034/KWh, but in 2019 it was reduced to USD 0.014/KWh (IMF, 2019). The response of the public to growing energy prices and electricity tariffs led the government to suspend some increases and even lower tariffs in the second half of 2018 and early 2019. Furthermore, high tariffs for large consumers negatively impacted the competitiveness of local industries, and have incentivised some to invest in renewable power for self-consumption, leading to a loss of high-paying consumers.

Addressing NEPCO's legacy debt and long-term financial sustainability will be critical for the growth of Jordan's power sector and its macro-economic stability. The World Bank Group and the International Monetary Fund are supporting a Roadmap for Financial Sustainability of the Electricity Sector that includes a host of measures, including rationalising the cross-subsidised tariff structure, adopting cost-reflective charges, restructuring debt and addressing the accumulation of money owed by NEPCO.

Looking ahead, MEMR has estimated that electricity demand will grow at an average annual pace of 4% until 2030 (MEMR, 2019b). The recent stagnation in electricity demand, likely to be further compounded by Covid-19 impacts, points to the importance of several factors that drive demand growth, including cost of supply that catalyses industrialisation and economic growth. Therefore, reaching electricity demand projections and ensuring utilisation of power capacity will require several measures, including reducing energy costs to stimulate demand and promoting the electrification of different end-uses, including in industry and transport. To shore up electricity demand, in October 2019, the government introduced preferential tariffs for those industries that increase consumption over the previous year as part of the financial incentive package.

2.4 Trends in final energy consumption

The final energy consumption in Jordan grew from 5 mtoe in 2009 to nearly 7 mtoe in 2018 (Figure 5). The transport sector is the largest energy consumer, primarily of crude oil derivatives, including gasoline and diesel. The share of households and the services sector in final energy consumption has largely remained constant. Meanwhile, energy consumption in industry has fluctuated with limited growth over the past decade.

A closer look at the final energy consumption by sector provides insights on the slowdown observed in energy use in 2018. Compared to 2017, industry registered a 2% growth in energy consumption in 2018. Meanwhile, the household, service and transport sectors all saw declines. Energy consumption in the household sector reduced by 5% year-on-year (MEMR, 2019b).

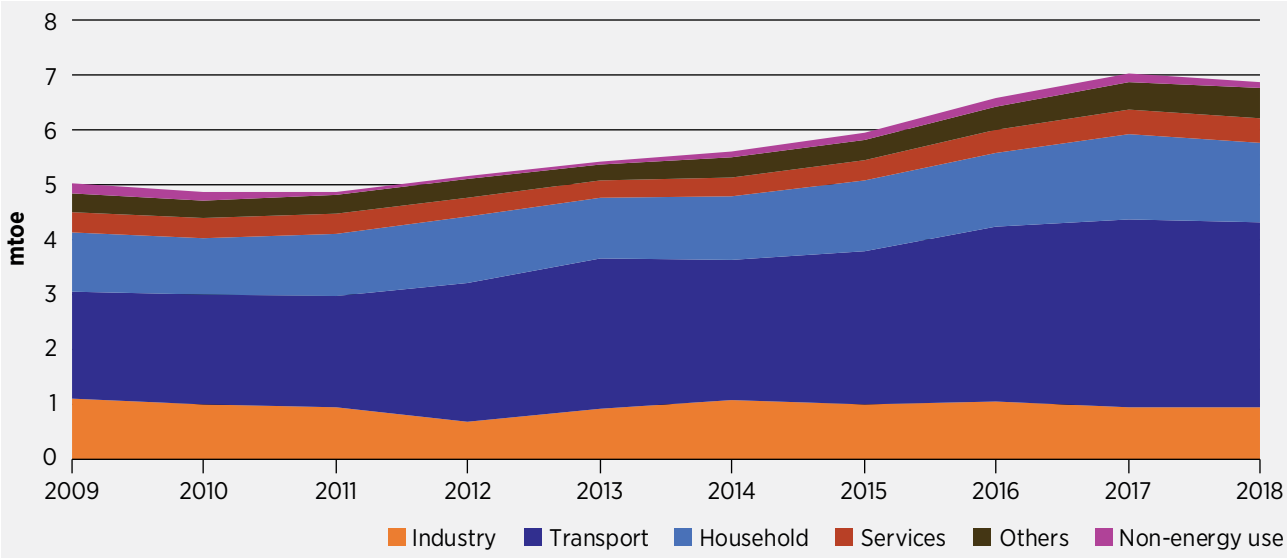
Industry

Industry is the third-largest energy user in Jordan and the second-largest consumer of electricity. Low-cost, reliable energy is a critical input for industry and it strongly influences the competitiveness of Jordanian products and services at the local, regional and global levels. Most of the industries in Jordan have high thermal energy demands which are predominantly supplied through fuel oil, diesel and coal (Figure 6). In the cement sector, the high cost of energy has prompted some producers to shift away from fuel oil towards coal to reduce operating costs (USGS, 2019).

In an effort to reduce the burden of the energy bill on industries and improve their competitiveness, the government has been encouraging industry to switch to natural gas. Recently, NEPCO signed an agreement with the Jordanian-Egyptian Fajr Company to provide natural gas to the Southern Industrial Complex of Jordan Phosphate in Aqaba and the Al Sanawbar Sanitary Paper Manufacturing Company/Nuqul Group. The use of natural gas is estimated to reduce energy costs in factories by 25-55%, depending on the type of fuel substituted. The special tax on natural gas for industries has been reduced from 16% to 7%, and the companies that switch to natural gas are exempted from the special tax imposed on natural gas for three years, according to criteria set by the Ministry of Industry (NEPCO, 2019c). Solar thermal technologies are also being deployed to meet heating/cooling needs in industry and, while its use is still in nascent stages, it offers tremendous potential to displace non-domestic fuel use in a growing sector (discussed further in Chapter 3, Section 3).

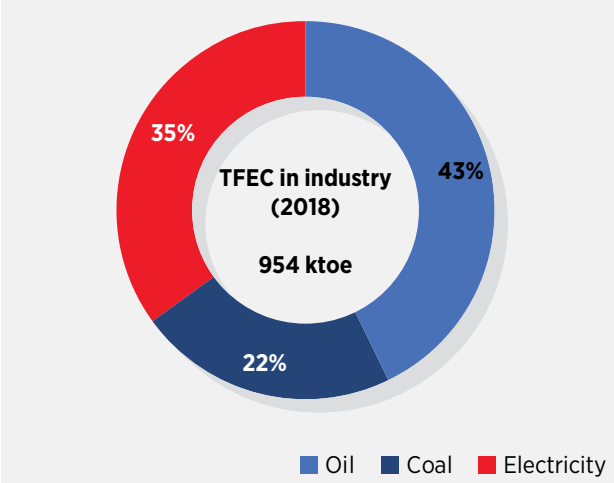
Electricity remains a key fuel for industry – electricity costs as a share of all operating costs can be nearly half for the plastic and rubber sector, and over a quarter for the construction, food, packaging, furniture, mining, and leather and garments sectors (Ali Ayasrah, 2018). The largest bulk industrial consumers of electricity include cement, and phosphate and potash mining and processing. These industries consumed over 970 GWh of electricity in 2017, accounting for almost 6% of the country's total consumption (NEPCO, 2019a). In an effort to reduce electricity costs and environmental impact, several large industries are turning to solar PV to meet part of their electricity needs. Lafarge Cement, for instance, has completed construction of a 15.6 MW solar PV project to cover part of the electricity needs at the Rashadiya cement plant (LafargeHolcim, 2017).

Figure 6. **Final energy consumption, by sector**



Source: MEMR (2019b)

Figure 7. **Final energy consumption in industry, by fuel (2018)**



Note: ktoe = kilotonne of oil equivalent.
Source: MEMR (2019b)

Transport

The transport sector is the largest consumer of energy in Jordan. Gasoline and diesel use account for nearly 90% of all final energy consumption. Rising population numbers and greater movements of passengers, goods and services all result in the significant use of these fuels in the sector. Between 2007 and 2018, the number of operating vehicles doubled from 842 000 to 1.6 million (Jordan Department of Statistics, 2019). Over 70% of the vehicles are saloons, followed by vans and trucks, which account for 18%. Private ownership vastly dominates public ownership, accounting for 93% of all vehicles. Vehicle ownership is expected to continue, largely relying on fossil fuels. Reducing Jordan's reliance on imported fuels will depend on a substantial shift in energy use patterns in the transport sector. Some efforts are being made to tap into alternative energy sources in the transport sector, including the promotion of hybrid and electric vehicles.

Electric vehicles were piloted in Jordan in 2014 with the establishment of the first electric charging station. Since then the number of electric vehicles has grown from 9 that year to 18 000 in 2018 and up to 30 000 by the end of 2019 (Khalaileh, 2017). The government introduced several incentives, including waiving of import duties on the vehicles and components for charging infrastructure, as well as instructions for installing dedicated electricity meters for electric vehicles providing electricity at USD 0.19/kWh.

Electric mobility is also being piloted for public transportation in tourism sites (e.g., Petra archaeological park). Some challenges faced in accelerating electric vehicle adoption include, but are not limited to, raising awareness about the cost effectiveness and benefits of such vehicles and the large-scale development of charging infrastructure (El Issa, 2017). Opportunities for the development of liquid and gaseous biofuels, as well as hydrogen, have not been explored at scale yet.

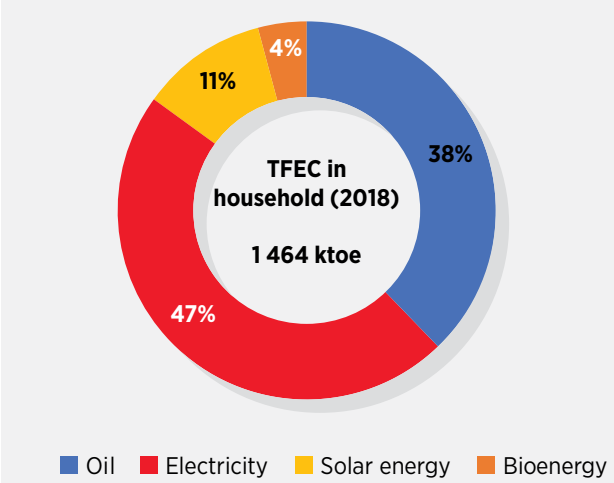
Households

The residential sector in Jordan accounts for 21% of total final energy consumption and 46% of electricity consumption (MEMR, 2019b). Urbanisation, growing population and improvements in living standards are driving up demand for energy in households. Electricity accounts for the largest share of energy consumed in the sector for lighting and powering appliances such as refrigerators, air conditioners and water heaters (Figure 8). Jordanian households own an estimated 1.4 million refrigerators, 1.6 million TV sets, 1.4 million washing machines and 205 100 freezers. As much as 61% of households surveyed as part of a demand load survey in 2015 owned electric water heaters (USAID, 2015).

Solar water heating solutions are used in a growing number of households for the provision of hot water, providing around 4% of final energy consumption in households. The growth of solar water heaters is a result of large-scale programmes by JREEEF in partnership with other donors that has led to the deployment of over 26 000 installations so far (discussed further in Chapter 3, Section 3). More than 60% of energy consumed in households is used for space heating and cooling. In high-income areas, central heating using diesel oil and air conditioners using electricity are common, while in lower-income areas, small stoves using kerosene or LPG are used (Al-Sallami and Al-Hinti, 2017).

Energy poverty among households is a key area of concern. Several programmes are in the process of addressing low-income households living in energy poverty. For instance, programmes for the adoption of solar PV systems have been launched, including for 85 000 households under national welfare programmes. Public infrastructure, including schools and clinics, also suffers from poor energy access, which impacts the delivery of services such as education and healthcare. The Royal Initiative for Heating in Schools seeks to address this challenge (see Box 4). Furthermore, a large population of refugees live in non-permanent settlements with limited access to energy for heating and cooling. Various programmes have been launched to support solar-based solutions for lighting and water heating in these settlements.

Figure 8. **Total final energy consumption in households, by fuel (2018)**



Source: MEMR (2019b)

2.5 Drivers for energy diversification

The **Master Strategy for the Energy Sector 2020-2030** has set out clear objectives to be pursued:

i. secure a sustainable future energy supply
ii. diversify the national energy mix and increase dependency on domestic energy resources
iii. achieve sustainability
iv. reduce the cost of electricity supply.

These mutually reinforcing objectives are critically important to "recapture the growth momentum and realise Jordan's development potential" as targeted in the Jordan Economic Growth Plan 2018-2022 (Economic Policy Council, 2017) and ensure a rapid recovery from the impacts of the Covid 19 crisis. The new engines of economic growth in Jordan, including manufacturing, transport, construction and agriculture, will require access to low-cost, reliable, secure and environmentally sustainable energy to ensure competitiveness.

A key pillar of the energy diversification strategy will be the development of renewable energy technologies. It contributes to all four objectives of the Master Strategy outlined above. The Strategy targets a 31% share of total installed capacity by 2030 (MEMR, 2019a).

There is a strong case for leveraging this momentum and further accelerating renewables adoption in the power sector, as well as penetrating other end-use sectors e.g., heating/cooling and transport:

1. **Energy security:** The majority of Jordan's energy comes from imports. This comes with substantial economic costs, supply disruption risks and price fluctuation vulnerabilities. Disruptions and their implications for the fiscal health of both NEPCO and the government demonstrate the importance of diversifying energy sources (e.g., import of natural gas from other sources) and energy fuels (e.g., developing domestic resources such as renewables and oil shale). Renewable energy solutions benefit different elements of energy security: availability, accessibility, affordability and long-term permanence. Dependence on imports for meeting energy needs has decreased in the past few years from 99% to 94%, in part due to the implementation of energy efficiency and renewable energy measures.[2]

2. **Economics:** Substantial reductions in the cost of renewable energy technologies over the past decade offer a compelling case for governments to pursue a greater role for renewables in the future energy mix. In most parts of the world today, renewables are the lowest-cost source of new power generation.[3]

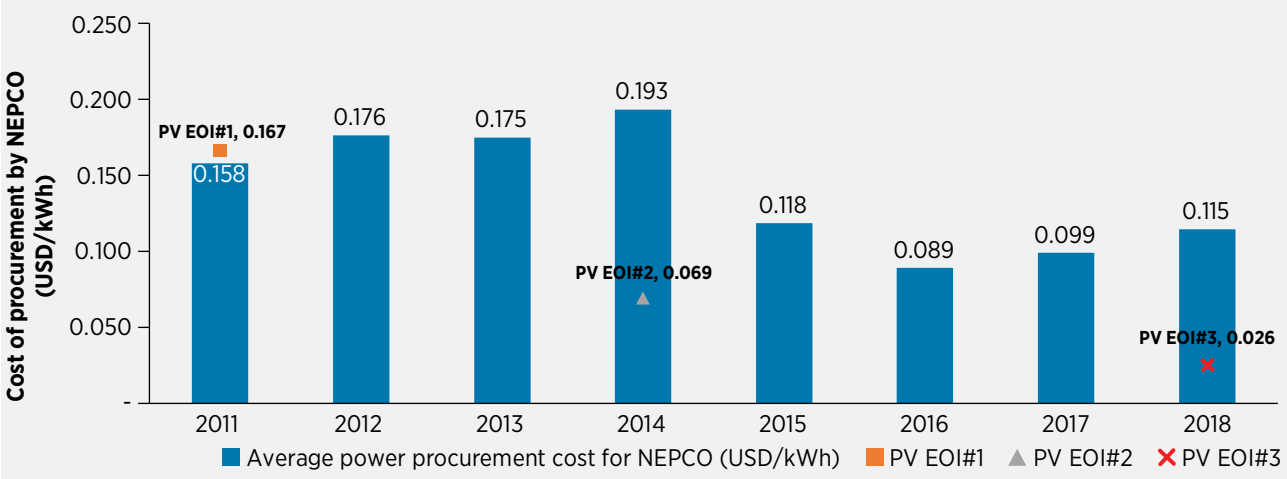
   In Jordan, the results of the latest (third) round of direct proposal submissions in 2018 yielded bids as low as USD/kWh 0.026. In comparison, the average cost of electricity purchased by NEPCO in 2018 was 0.081 JOD/kWh USD 0.114 /kWh). The cost of electricity purchased from renewable energy averaged 0.076 JOD/kWh USD 0.11/kWh) compared to 0.082 JOD/kWh USD 0.12 /kWh) from conventional sources (NEPCO, 2019a). It is important to note that the renewable energy projects from the third round have not yet been commissioned and, therefore, are not reflected in NEPCO's cost of procurement. Purely from a cost perspective, the economics of renewable energy, especially solar PV, are favourable in the power sector (Figure 8) and, combined with decreasing costs of storage,[4] offer a viable alternative to both imported and domestic fuel-based solutions. The economic case for renewables in the heating/cooling and transport sectors is also strong, especially for solar water heaters and solar heat solutions for industry.

2 Jordan implemented the first National Energy Efficiency Action Plan (NEEAP) in 2013 and reduced to 400 GWh. The second NEEAP (2017-2020) is expected to reduce electricity consumption to 2 000 GWh, in addition to decentralised solar PV and 20 000 solar water heater (SWH) in 2018-2019. This has reduced electricity demand by 0.6% in 2018, according to NEPCO.

3 In 2019, global electricity costs from utility-scale solar PV fell 13% year-on-year, reaching USD 0.068 per kWh. Onshore wind fell about 9% year-on-year, reaching USD 0.053/kWh for renewable energy projects, especially solar PV (IRENA, 2019a).

4 Lithium-ion battery costs have reduced 85% in the 2010-18 period, according to Bloomberg New Energy Finance (2019a).

Figure 9. **Comparison of solar PV bids under three rounds with average cost of power procurement (USD/kWh) by NEPCO**



Note: EOI = Expression of interest

Based on: NEPCO (2019a); NEPCO (2018) for cost of procurement

3. **Socioeconomic benefits:** Diversification of the energy mix brings opportunities for job creation and the development of new industries. The socio-economic dimension of renewable energy is critically important for emerging economies looking to maximise the benefits from the transition in terms of job creation and local value creation.[5] Since 2013, close to 300 licensed companies have been established in solar PV design, procurement, installation and O&M, providing full-time employment to several thousands of people. For a 50 MW solar PV plant, for instance, a total of 229 055 person-days are needed. O&M workers are needed throughout the project lifetime, and therefore represent the bulk of the labour requirements (56% of the total). Equipment manufacturing (22%) and installation and grid connection (17%) also require significant labour inputs (IRENA, 2017). The jobs exist across the value chain in Jordan, including in manufacturing. Philadelphia Solar, a company involved in solar PV module assembly and mounting structure manufacturing, employs 250 people full-time. Across the segments of the value chain for different renewable energy technologies, such as solar PV, onshore wind and solar water heaters, varying skills and material inputs are required.

   Existing industries can be leveraged and integrated into renewable energy supply chains to create local value. In the development of CSP, for instance, at least 30% (by value) of a project could be manufactured locally, including steel support structures, piping systems, storage vessels, coating, connection boxes and cables (IRENA and ESCWA, 2018). To maximise the socio-economic benefits of renewable energy, different measures are needed, such as visibility on long-term deployment, targeted incentives for domestic manufacturers, enterprise- and human-capacity development, and partnerships in technology transfer and research and development. Across the Middle East and North Africa (MENA) region, jobs in the renewable energy sector have the potential to expand from an estimated 542 000 in 2017 to 1.2 million in 2030 and 2 million in 2050, accounting for nearly 30% of all energy sector jobs (IRENA, 2020d).

4. **Climate and NDCs:** Jordan, in its NDC, committed to a reduction of its greenhouse gas emissions by 14% up to 2030 (1.5% through its own resources and 12.5% conditional on the receipt of international financial aid and support) (UNFCCC, 2015). Bylaw (79) year 2019 for Climate Change set requirements for the different stakeholders to report their greenhouse gas emissions. The development of renewable energy is a central pillar of decarbonising the energy mix while also securing a reliable energy supply. In 2018 alone, electricity generated from solar PV and wind avoided nearly 1.5 million tonnes of carbon emissions.[6] Substantial additional benefits of diversification are also recognised in terms of reduced air pollution in urban areas from increased adoption of hybrid and electric vehicles and the use of electricity and cleaner fuels for heating and cooling.

5 IRENA's Leveraging Local Capacity series quantifies the labour and skills needs, as well as material inputs required, for the development of illustrative renewable energy projects, including solar PV, onshore wind, offshore wind and concentrated solar power (CSP).

6 Based on a grid emissions factor of 690 grams of carbon dioxide (CO_2) per kWh and accounting only for emissions during electricity production stage.

RENEWABLE ENERGY RESOURCES AND USE

Jordan is a front-runner in the region in terms of the speed and scale with which it has deployed renewable energy, especially in the power sector. Renewables accounted for over 13% of total electricity generated in 2019, up from a near-zero share in 2012. The growth has been made possible largely due to strong government commitment and action to diversify the primary energy mix.

The potential for renewable energy to contribute to Jordan's energy mix is much greater. The next phase of renewables growth in Jordan could focus on building the right enabling conditions for integrating higher shares of electricity from renewables in the power sector. Electricity also represents only 22% of final energy consumption as noted in the previous chapter. To diversify Jordan's energy mix, reduce reliance on imports and bring down energy costs, renewables in non-power end-use sectors – heating/cooling and transport – will absolutely need to be scaled up substantially from current levels.

This chapter discusses the renewable energy sector in Jordan, analysing the trends in deployment in the power, heating/cooling and transport sectors. It sets the stage for an in-depth discussion in the next chapter on policies and regulations – a key enabler for adoption and integration – and the investment landscape to identify gaps and challenges that need to be addressed to scale up renewable energy adoption.

3.1 Renewable energy resources

The presence of abundant resources is a crucial starting point for the development of renewable energy. It greatly influences the operational performance and financial viability of projects. Owing to its geographical position, Jordan's most abundantly available renewable energy resources are solar and wind, with potential also for bioenergy, hydropower and geothermal.

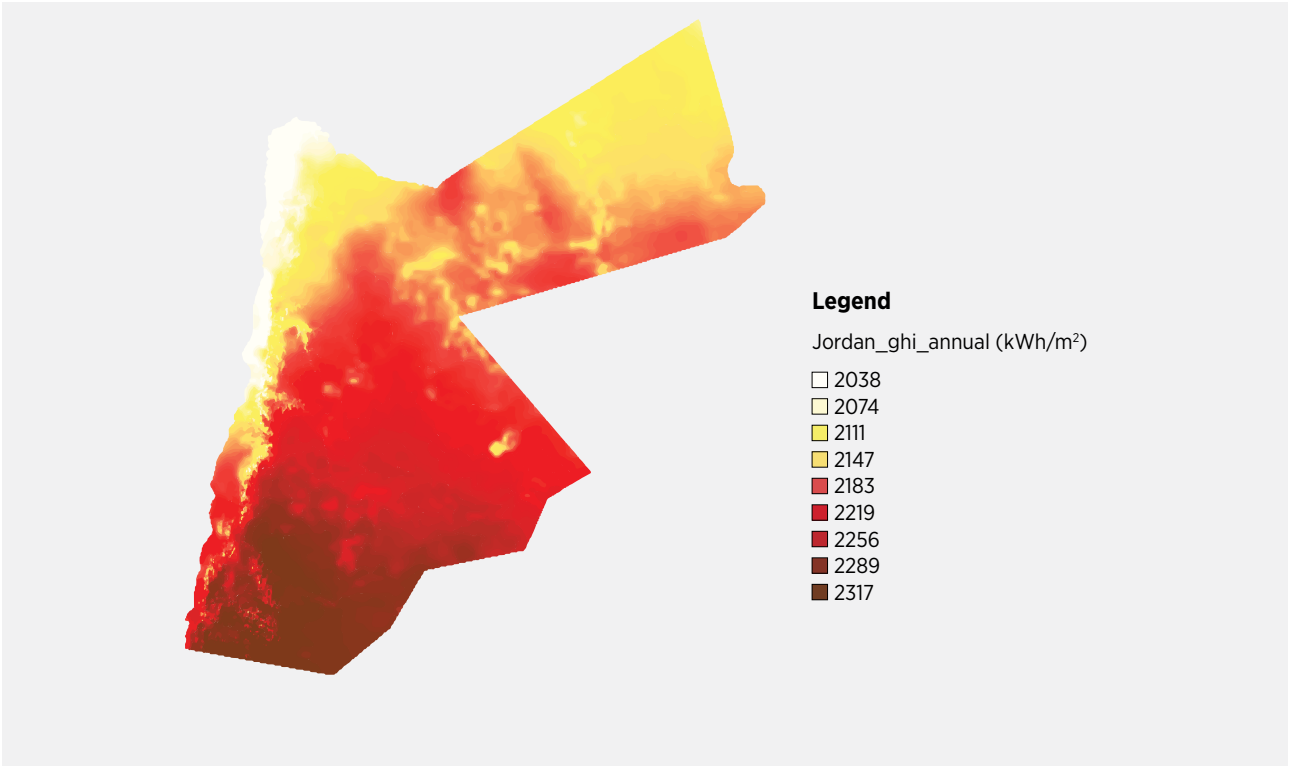
Solar

Average daily solar irradiation ranges between 4 and 7 kWh/square metre (m^2), with about 300 sunny days per year, which corresponds to an annual average solar irradiation of 1 400-2 300 kWh/m^2 (Figure 10). The favourable climate conditions have allowed Jordan to benefit from some of the most conducive solar sites at the regional and international levels. This is also reflected in the low cost of electricity generated from new projects.

Wind

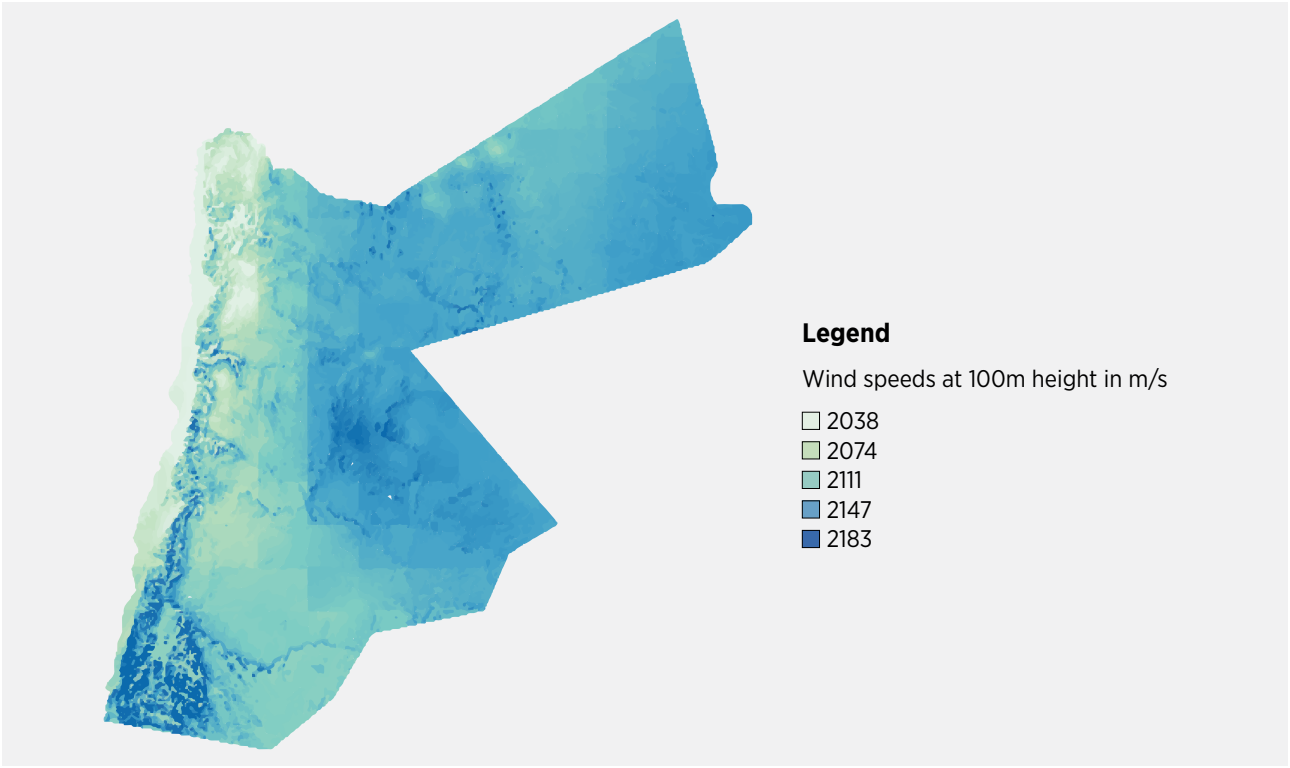
Jordan has significant wind energy resources to exploit for electricity generation. Average wind speeds are site-specific and generally range from 6 metre per second (m/s)to 8 m/s in good locations in the Kingdom (Marar, 2019) (Figure 11). According to a study carried out by the MEMR and the Royal Scientific Society, approximately 16% of the total country's land are suitable for wind power production, with a total technical potential of 3.6 GW (AlRahahleh, 2018).

Figure 10. **Spatial distribution of global solar irradiation in kWh/m² resource maps for Jordan**



Based on: IRENA Global Atlas, Solar PV Map Data: World Bank Group, 2018, Global Horizontal Irradiation kWh/m² World 1 km

Figure 11. **Spatial distribution of wind irradiation in Jordan**



Based on: IRENA Global Atlas, Wind Map Data: Technical University of Denmark Global Wind Atlas, Average Wind Speed 1 km at 100 m height

Bioenergy

Bioenergy resources in Jordan exist primarily in the form of municipal solid waste (MSW). The amount of municipal waste is rapidly growing as a result of the increasing population and represents an important resource. A pilot plant using MSW with a capacity of 3.5 MW has been operational since 2000. The Greater Amman Municipality plans to implement a biogas project by using the methane gas captured in the Ghabawi landfill, the main solid waste landfill in Amman. With the expansion of the landfill, the capacity is expected to reach 6 MW in 2020 and 7 MW in 2022. The opportunity to utilise biogas from waste for the transport sector also exists.

Animal waste also has potential for utilisation – albeit with a lower resource potential compared to municipal waste – on a smaller scale for heating/cooking purposes. More than 80% of total manure production, mainly from cattle, poultry and sheep, is concentrated in four northern governorates: Al Zarqa, Amman, Al-Mafraq and Irbid (Barilaro, 2019). Jift – a waste product from olive oil harvesting – is also available in Irbid and Al-Mafraq. It can be used either as fuel or feed. Estimates suggest that the total jift supply in these regions is around 19 000 MT annually (Mercy Corps, 2017).

Geothermal[7]

Jordan has several thermal water resources (springs and wells) spread along the Rift Valley, in addition to thermal wells in the central and eastern plateau. The geothermal gradient map of Jordan shows two distinct regions with high gradients up to 50°C/km (degrees Celsius per kilometre) – one in the immediate vicinity of the east Dead Sea escarpment and another in the Northeast of the country. The former represents a locally available energy resource for heating along the eastern margin of the Dead Sea Rift, where temperatures range from 53-63°C, with many hotels and resorts in the vicinity.

Hydropower

Jordan's hydropower resources are currently limited to the King Talal Dam – the country's only hydropower plant – with 7 MW of installed power capacity. Aqaba Power Station has been equipped with hydropower turbines with 6 MW of total capacity using the available head of returning cooling sea water. The elevation difference between the Red Sea and the Dead Sea also provides a potential hydro resource of an estimated of 400-800 MW, which could be exploited via the proposed Red Sea Dead Sea Canal project. Meanwhile, to improve power system flexibility, MEMR has recently conducted feasibility tests on Jordan's existing dams and reservoirs with a view to establishing pumped storage hydro power projects (see Box 5).

3.2 Renewables in the power sector

Renewable energy in the power sector has existed since 1998, with the first wind energy farm of 1.125 MW operational at Hofa in northern Jordan. A strong impetus for the adoption of renewables for electricity generation came in 2012 with the introduction of the Renewable Energy and Energy Efficiency Law (13). Until 2014, the total installed capacity of renewables in the country's power sector stood at about 14 MW, comprising predominantly hydropower. Total renewables capacity had grown to about 500 MW in 2016 and to over 1.5 GW by early 2020 (Figure 10). Renewables now account for over a quarter of total installed power capacity in Jordan. This rapid growth has primarily been driven by capacity additions of onshore wind and solar PV technologies.

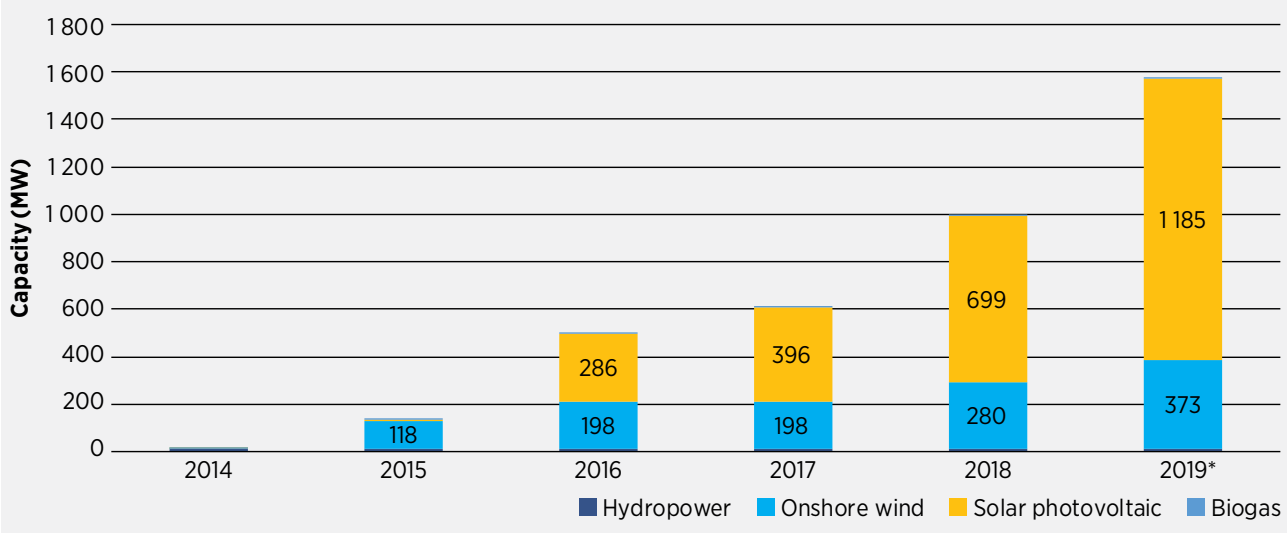
In 2015, the 117 MW Tafila wind project came online, followed by the 80 MW Ma'an wind project in 2016. In the same year, solar PV projects from the first round of direct offers comprising 200 MW of capacity were commissioned. In 2018, the second-round projects – along with the 103 MW Quweira plant – were commissioned, taking the total solar PV capacity up to nearly 700 MW. By the end of 2019, solar PV installed capacity had risen to about 1.2 GW and wind capacity hit 373 MW. Of the total solar and wind capacity installed, about 985 MW are connected to the transmission system, while about 573 MW are connected under the net metering and wheeling schemes (MEMR, 2020).[8]

As the capacity of renewables in the power sector has grown, so has generation. Total electricity generated from renewables reached 2 187 GWh in 2018, accounting for about 11% of all generation. Solar PV represented well over half (65%) of all electricity generated from renewables, followed by onshore wind (32%), hydropower (3%) and biogas (0.3%) (Figure 11).

7 Based on Saudi and Swarieh (2015).

8 Based on MEMR presentation (January 2020).

Figure 12. **Renewable energy capacity, by source (2014-2019)**

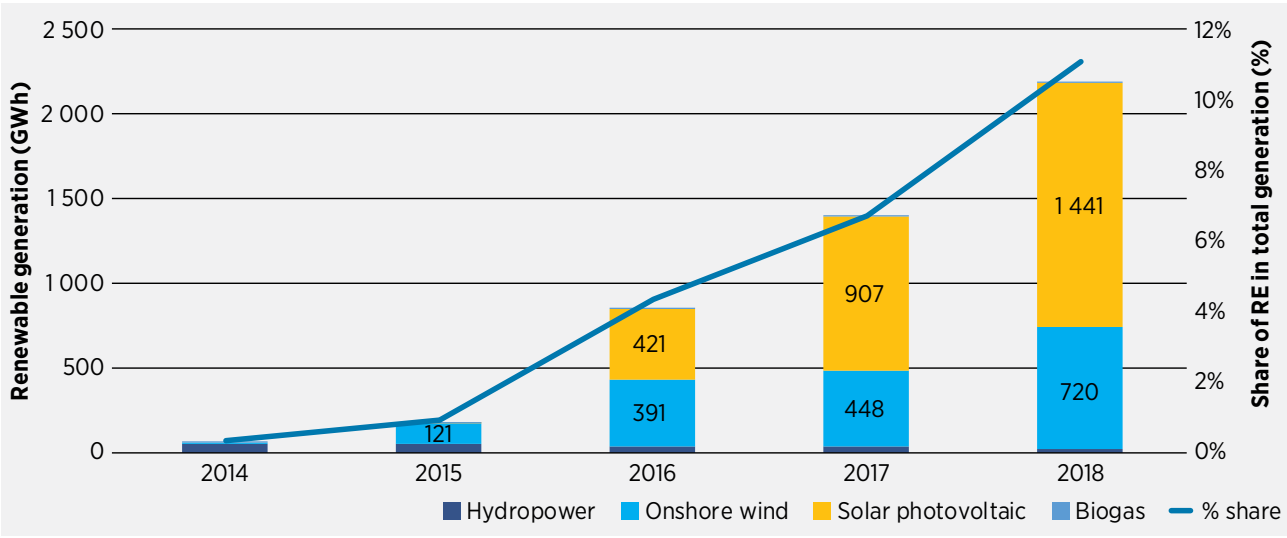


* Reported as of January 2020.

Note: Hydropower and biogas generation capacity remained the same throughout the reporting period at 12 MW and 3.5 MW, respectively.

Source: NEPCO (2019a); MEMR(2019b)

Figure 13. **Renewable energy generation, by source (2014-2018)**



Based on: Data from NEPCO and MEMR

Note: In 2018, hydropower generation amounted to 23 GWh, while biogas supplied 3 GWh.

Table 3. **Solar PV and wind project status (as of January 2020)**

Energy source	Under construction	Operational
Utility- scale wind	247 MW	373 MW
Utility-scale solar (direct proposal)	250 MW	612 MW
Wheeling solar projects	-	222 MW
Distributed solar PV net metering projects	-	351 MW

The pipeline for **utility-scale renewable energy projects** is composed primarily of solar PV and wind. About 250 MW of solar PV and 247 MW of wind projects are currently under construction (not including net metering and wheeling projects).[9] Besides stand-alone utility-scale renewable energy projects, multi-fuel IPPs are also integrating solar PV projects into the fuel mix to reduce conventional fuel use during peak-load hours. AES Jordan's 250 MW IPP project was commissioned in 2014 and was originally designed to be tri-fuel using heavy fuel oil, light fuel oil and natural gas. However, 46 MW of solar PV is anticipated to be connected to the existing plant to reduce engine use and associated fuels during peak solar generation and to cut emissions (Wartsila, n.d.).

Targeted policy support through **net metering and wheeling** projects (discussed in depth in Chapter 4) has provided further impetus for investments in renewable energy solutions for self-consumption projects. More than 15 300 applications have been approved so far by distribution companies (Jordan Times, 2020b). Under the Fils Al Reef initiative, over 2 000 solar PV systems of 2 kW size are also being installed in households that are under national support and that have electricity consumption of under 200 units.

Figure 13 shows that electricity generation from renewables has grown rapidly over the past four years, reaching around 11% of total supply mix from a negligible starting point. With nearly 500 MW of utility-scale solar PV and wind projects under construction and due to come online by 2021, as well as already approved net metering and wheeling projects, the share of renewable electricity is estimated to continue to rise.

Jordan has so far managed to integrate the rapidly growing share of electricity generated from renewables through various measures including the development of a dedicated transmission grid infrastructure to evacuate power from resource-rich regions to load centres and the reinforcement of existing grid networks (Bellini, 2018). The Green Corridor Project, presently under development, is one such example (Box 1). The Kingdom has also been a pioneer in the MENA region in the development of grid-scale energy storage projects. In February 2019, commercial operations of the expanded 23 MW/12.6 MWh solar PV plus storage project began in the Al-Mafraq region. This is the first utility-scale solar and storage combined project in the MENA region. It demonstrates the value of storage to support integration by smoothing out variability and allowing load-shifting. MEMR had also announced a 30 MW/60 MWh project in Ma'an for which proposals have been received (MESIA, 2019). Qualified bidders were announced in January 2020; however, in April 2020 it was confirmed to have been cancelled (Colthorpe, 2020).

Raising the share of renewables beyond the current pipeline of projects has raised grid integration concerns. A Cabinet Resolution dated 9 January 2019 was issued to suspend granting approvals for renewable energy projects exceeding 1 MW until the MEMR has studied the ability of the grid to absorb additional power and included appropriate integration measures into its long-term strategy (EDAMA, 2019a). Raising the share of renewables in the electricity generation mix will require efforts to stimulate demand, as well as integration measures such as storage, electrification of end-uses and demand-side management. These will be discussed in greater detail in Chapter 4.

Box 1. Transmission grid development to facilitate renewable energy integration

To facilitate the integration of utility-scale solar PV and wind, measures are being taken to support the development of adequate transmission infrastructure. A Green Corridor project is underway that includes the construction of a new substation in Ma'an (400/132) kilovolt (kV), and the expansion of the Qatrana and the airport substations (132/33) kV in addition to constructing the necessary transmission lines for connecting these substations.

Source: NEPCO (2018)

9 Based on MEMR presentation (January 2020).

Off-grid renewable energy solutions are also being deployed for the provision of electricity services in villages, border points, telecommunication stations, desert camps and rural communities in Jordan. Although the national electrification rate is close to 100%, a number of households located in remote areas are unconnected to or under-served by the grid. For those areas, off-grid solutions are deemed suitable and economical to deliver basic electricity services.

Distributed renewable energy solutions are also increasingly being adopted across sectors such as agriculture and water. Under the European Union (EU)-funded Renewable Energy and Energy Efficiency II Programme, 214 solar pumps were installed in the Jordan Valley and 106 in the Highlands. The project was developed by the National Energy Research Centre and the Ministry of Environment. The energy costs of large water conveyance projects, such as the Red Sea Dead Sea project, can be prohibitively high. The Ministry of Water and Irrigation has taken steps to tap into low-cost renewable energy, reducing its electricity costs.

3.3 Renewables in heating/cooling and transport

Renewable energy use for heating/cooling applications has been limited compared to that of the power sector. The market for renewable energy heating in Jordan is based mostly on solar water heaters dating back to the 1970s. The solar water heater industry is well developed, catering to domestic, industrial and commercial applications. The domestic sector dominates, with solar meeting hot water requirements for residential use. Other applications include those for swimming pools, hospitals, hotels, universities, schools and sports facilities, as well as for space heating. In industry, solar heating solutions deliver process heat and pre-heating systems (e.g., in dairy) (CRES, 2008).

In 2016, the total number of solar water heaters reached 3 500 systems with the installed capacity of water collectors reaching nearly 880 Megawatt-thermal (MWth)) (IEA-SHC, 2019). This number almost tripled, reaching 16 000 installed solar water heaters by the end of 2018 with at least 24 000 systems now in place (JREEEF, 2020). The market for solar water heaters grew organically for several decades and was catalysed with the launch of dedicated financing programmes. The JREEEF financing programme for the installation of over 22 000 solar water heaters was completed in 2019 with the next phase being rolled out in partnership with commercial banks (discussed further in Chapter 4) (Jordan Times, 2019b).

The solar thermal program in the 2007-2020 energy strategy set a target to increase household penetration from 15% to 25% by 2015, but the target has not been met (Abu-Dayyeh, 2015). This has primarily been a result of a lack of enforcement of regulations that came into effect in 2013 which made it solar water heaters installation mandatory for households, apartments and offices above a specific area.

Besides solar water heaters, concentrated solar heat (CSH) applications for the provision of process heat in industries has been piloted. In 2015, a CSH Fresnel collector pilot was installed in Sahab. It had a thermal capacity of 223 kWh and provided process steam at 160 degrees with suitable applications for drying and sterilisation processes in the pharmaceuticals industry (Solar Concentra, 2017). JTI (Jordan), the largest cigarette manufacturer in Jordan, has installed a solar steam generation unit which covers 85% of the annual steam consumption and 30% of cooling and heating needs. It saves over 2.8 GWh of LPG energy consumption and 1.6 GWh of electricity per year (JTI, 2018).

In February 2020, the Solar Heating Arab Mark and Certification Initiative (SHAMCI) mark and certification for solar thermal systems was endorsed. SHAMCI is the first Arab certification scheme providing a regional industrial and regulatory compliance for policy makers, industry and end-consumers (RCREEE, 2020).

Geothermal-based heating and cooling solutions have also been piloted. The American University of Madaba, about 50 km south of Amman, has deployed two geothermal systems to meet the cooling load of 1 680 kW and heating load of 1 350 kW of two buildings. It is estimated to reduce CO_2 emissions by 223 tonnes annually, a 47% reduction compared to conventional chiller/LPG boiler (Laylin, 2012).

The transport sector accounts for nearly half of all energy consumed in Jordan. Direct renewables use in transport is very limited. Jordan inaugurated its first solar-powered charging station for electric cars as early as 2012 at El Hassan Science City. Incentives have been offered for the adoption of hybrid and electric vehicles although these are not coupled with renewable power for charging. Jordan has experienced a surge in the adoption of electric vehicles, from around 9 000 in 2016 to 18 000 in 2018 with a compounded annual growth rate of up to 34% by 2025 (Friedrich-Ebert-Stiftung, 2019).

The Greater Amman Municipality (GAM) has set up 120 charging stations (five utilising solar to cover part of the consumption) and is working on installing fast charging stations. GAM has also worked with taxi operators and provided incentives (e.g., fee exemptions, use of public charging infrastructure) to reach 30% of fleet size with electric vehicles.

Besides electrification, renewable energy potential for fuelling transport through biogas generated with municipal waste and liquid biofuels also exists. Given the excess power generation scenario in Jordan, energy carriers, such as hydrogen, may also be relevant as they can create new electricity demand while also facilitating storage and integration in industry and transport sectors.

3.4. Conclusion

Jordan has abundant domestic renewable energy resources, in particular for solar and wind. Developing these resources supports all four pillars of the Master Strategy for the Energy Sector 2020-2030: to secure a sustainable future energy supply, diversify the national energy mix and increase the share of local resources, reduce dependence on external energy resources, and enhance environmental protection.

Backed by strong government action, the renewable energy sector has seen rapid growth since 2012, especially in the power sector. Renewables' share in total installed power capacity grew from under 1% in 2012 to 20% by the end of 2019. Concurrently, of total electricity generated in Jordan, renewables' share has risen rapidly to over 13% during the same timeframe (MEMR, 2020).

Sustaining continued growth of renewables in the power sector will call for a stronger look at a portfolio of short-, medium- and long-term integration solutions as the share of renewables in the electricity mix grows. Under the present conditions in the power sector, the future growth of renewables is contingent upon the growth of electricity demand, which has been slow in recent years and is further compounded by the Covid-19 crisis. Demand stimulation requires cross-sector policy making and strategies aimed at demand stimulation and electrification of end-uses.

Non-electricity end-use sectors comprise over 60% of final energy consumption and, therefore, reducing reliance on imported fuels will inevitably require much greater adoption of renewables-based heating and transport. Mature renewable energy applications, such as solar water heating systems, as well as new solutions, such as CSH for industrial applications and electric vehicles, are already present in the market.

The next chapter tackles emerging issues facing the further expansion of the renewable energy sector in Jordan and the measures available to address the current barriers and accelerate progress towards much higher shares of renewables in the primary energy mix.

Al-Rajif wind plant 86 MW 1
Photograph: MEMR

RENEWABLE ENERGY POLICIES AND INVESTMENT: CURRENT LANDSCAPE AND EMERGING ISSUES

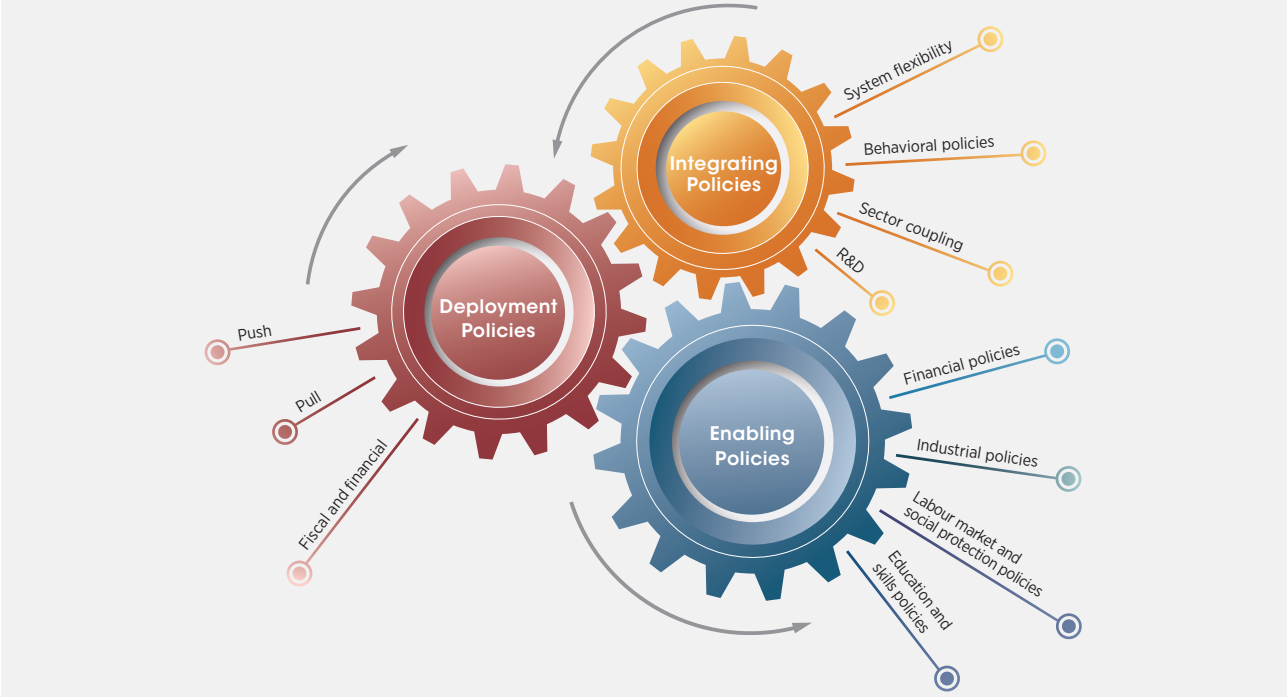
As seen in the previous chapters, Jordan has made remarkable progress over a short span of time in deploying renewable energy, especially in the power sector. A robust deployment policy has played a crucial role in driving the development of utility-scale and distributed renewables capacity, as well as selected applications across end-use sectors (e.g., solar water heaters). This chapter will discuss the policies and investment frameworks that will be instrumental for achieving a much deeper penetration of renewables in Jordan's energy mix. It will analyse the present landscape, identify the emerging issues and challenges, and highlight the pressing issues that require action.

4.1 Adapting the policy and regulatory environment for future renewables growth

The policy and regulatory landscape strongly influence the appeal of the renewable energy sector to attract investments and scale up deployment. Country experience has shown that to harness the full potential of renewables and reach majority shares of renewables in the electricity and energy mix, deployment policies alone are not sufficient. A wider policy mix is needed, as illustrated in Figure 14, that also includes policies for integration of renewables in the energy system and for supporting long-term sector development and maximising local benefits.

This holistic view of the policy and regulatory environment is particularly crucial in the context of Jordan, which is on track to reach a relatively high share of renewables in the electricity mix and whose future growth will rely strongly on demand growth and implementation of a wide range of integration measures across the energy sector. This chapter will first discuss planning and target setting, followed by a detailed assessment of the policy mix in Jordan needed to achieve a much deeper penetration of renewables in the coming decades.

Figure 14. **Policy mix to reach substantially higher shares of renewable energy**



Source: IRENA, IEA and REN21 (2018)

Plans and target

The Jordan National Energy Strategy 2007-2020 set an objective of reaching 7% of renewable energy contribution in the primary energy mix by 2015 and 10% by 2020. As part of the updated 2015-2025 Master Strategy for Energy Sector, the target was updated to 20% of renewables share in the electricity generation mix by 2025. To advance the implementation of the 2015-2025 strategy, the government of Jordan, with the technical assistance of the EU, undertook the task of developing the National Renewable Energy Action Plan (NREAP) for the period 2018-2023. However, the NREAP was not adopted in light of the recent update to the National Energy Strategy for 2020-2030.

The National Energy Strategy for 2020-2030 was developed and released in June 2020. The strategy provides long-term clarity on the evolution of the energy sector and includes an updated target that renewables will make up 31% the total installed power generation capacity by 2030. This involves setting a vision for improving flexibility of the electricity system (e.g., through storage), demand stimulation and harnessing synergies with energy efficiency (MEMR, 2019a).

The updated National Energy Strategy would pave the way for a NREAP, which would provide greater insights on the vision for the renewable energy sector to 2030 and the mechanisms for reaching the set targets. Through follow-on regulations, end-user sector targets can be further disaggregated (e.g., specific to industry, households, public buildings) for effective policy making, monitoring and enforcement. The data and information base guiding planning and target-setting also needs to be strengthened, especially for industry. By law, the Department of Statistics is authorised to gather data, and sector-specific efforts are needed to standardise and gather energy end-use data. In the specific case of industry, for instance, the Chamber of Industry and MEMR would be the key stakeholders to conduct a nationwide effort such as this.

The successful design and implementation of the policy mix illustrated in Figure 14 rests on a cross-sector and multi-institutional approach. For instance, the effective integration of variable renewables in the power sector, as will be elaborated upon in Chapter 4, Section 1, "Policies and regulations to maximise benefits", requires cross-sector policies for the electrification of end-use sectors such as transport. The National Energy Strategy must incorporate the cross-sector interlinkages (e.g., electrification of transport, water, agriculture), consider emerging technologies (e.g., storage, electric vehicles and other decentralised applications) and provide the optimum roadmap to reach higher shares of renewable energy in the primary energy mix.

Box 2. Bylaws and instructions for the implementation of the Renewable Energy and Energy Efficiency Law No. 13 of 2012

Several bylaws, instructions and directives have been issued to support the implementation of the Renewable Energy and Energy Efficiency Law No. 13 of 2012. These address different aspects of renewable energy development, including conditions and procedures for developing, connecting and remunerating projects of different scales and applications. Some important bylaws and instructions issued are:[10]

1. Bylaw No. 50 of 2015 and its amendment in 2016 sets the conditions and procedures of the renewable energy direct proposal submission and connection to the grid.

2. Instructions for costs of connecting renewable energy sources to the distribution system in the cases of competitive bidding and direct proposals related to the Article 9/B of the Renewable Energy and Energy Efficiency Law.

3. Instructions governing the sale of electrical energy generated from renewable energy systems related to the Article 10/B of the Renewable Energy and Energy Efficiency Law (net metering system).

4. Instructions governing electricity wheeling for energy generated from renewable energy sources, for consumption purposes and not for sale to others (electricity wheeling) and for wheeling charges (costs of the electricity wheeling).

5. The instructions issued based on Article 2 of Renewable Energy and Energy Efficiency Law 13/2012 for the reference pricelist record for the calculation of electrical energy purchase prices from renewable energy sources.

6. Bylaw No. 49/2015 concerns the establishment of the Jordan Renewable Energy and Energy Efficiency Fund, which aims to provide funding for the preparation of projects and programmes for the purpose of exploiting, implementing and developing renewable energy sources.

7. Bylaw No. 10 of 2013, amended in 2015, 2017 and 2018, concerns tax exemptions for renewable energy and energy efficiency systems and equipment. A list of imported and locally manufactured equipment is attached to the bylaw.

8. Intermittent Renewable Resources Distribution Connection Code at Medium Voltage: MEMR has set the rules and designed a contract for projects interconnecting renewable energy with the transmission network.

9. Guidelines for interconnection of renewable energy sources on distribution and transmission grids as well as on electric meters for net metering apply to both distribution and transmission grids.

10 In addition to those listed, several other important bylaws and instructions were issued, including the mandatory Environmental Impact Assessment by the Ministry of Environment; Mandatory Licensing of companies working in RE by EMRC; Mandatory Licensing of Solar companies working in construction by the Jordan Construction Contractors Association; Optional Certification of Design and Supervision Engineers working in Solar PV by the Jordan Engineers Association; and the Mandatory Zoning check by Greater Amman Municipality and the municipalities.

Policies and regulations for deployment

The policy and regulatory landscape for renewable energy in Jordan is composed mainly of laws whose implementation is undertaken through a series of supporting bylaws, instructions and directives. The Electricity Law No. 64 of 2002 lays down general rules for generation, transmission and distribution activities. There is no specific Heat Law that guides the utilisation and retailing of heat. The Renewable Energy and Energy Efficiency Law No. 13 of 2012 and its amendments form the backbone of the policy landscape for renewable energy and energy efficiency in Jordan (Box 2).

The policy and regulatory framework for renewables deployment in the power sector is among the most advanced and elaborate in the MENA region. Renewable energy projects are mainly developed through three routes: direct proposal submission (build-own-operate projects offered through competitive bidding), government-owned (offered as engineering, procurement and construction [EPC] contracts for the private sector) and self-consumption (wheeling and net metering projects). Off-grid projects, including those for solar water pumping, are also being pursued. Each of these will be discussed in depth in this section, followed by the policy and regulatory landscape for renewables deployment in heating/cooling and transport end-use sectors.

Power sector: Direct proposal submissions

Under the direct proposal submission route, investors can identify and develop grid-connected renewable energy projects and propose these to MEMR. The direct proposal submission by the private sector takes place in rounds defined by the MEMR considering the capacity to be contracted. The Direct Proposal Committee was established by the provisions of the Direct Proposal Bylaw 50/2015 to identify the appropriate opportunity to conduct a new round. Each round comprises a two-stage tender process: the pre-qualification stage to confirm developer experience and ability, and the tender stage for short-listed developers to prepare proposals and submit tariff bids. For the first round, the submitted tariffs must be lower than the ceiling reference price, which is calculated based on a methodology issued by the EMRC.

The first expression of interest in 2012 offered a feed-in tariff. Twelve solar PV projects with a cumulative capacity of about 200 MW were approved (Infrastructure Journal, 2013). Further, the PPA for the first wind direct proposal submission for 117 MW at Tafila was signed in 2013. The 20-year PPAs were signed for USD 0.12/kWh for wind and USD 0.169/kWh for solar PV (barring the 52.5 MW Ma'an project, which was awarded at USD 0.148/kWh). In the first round, MEMR focused on the southern region of Ma'an, which was attractive from a resource standpoint as well as the applicable regulatory and administrative regime in the Ma'an Development Area.

The second round was launched in August 2013 and switched from a feed-in tariff to competitive bidding. It awarded four projects of 50 MW each at record-low prices of USD 0.0613-0.0767/kWh (New Energy Update, 2015). The projects focused on the northern and eastern parts of the Kingdom to ease pressure on the grid. MEMR required interested parties to identify the project location and ascertain from the relevant transmission or distribution company whether the site was deemed suitable for grid interconnection (Infrastructure Journal, 2013). At the end of 2016, the third round of tender was launched, planning to develop 200 MW of solar PV in the Ma'an area and 100 MW of wind projects in the south of the country. In September 2018, the results of the Round 3 auction were announced and a record-low bid of USD 248.9/kWh was submitted (RES4Med, 2019).

The rounds of direct proposal submissions have been a strong driver of renewables growth in the power sector. Regular updates of the bylaw (e.g., the Direct Proposal Bylaw (50) year 2015 and Bylaw (66) year 2016) were undertaken based on the lessons learned since 2012. To attract the private sector to participate in the tenders, the government took additional steps to address key investment risks. First, a government guarantee backed the PPAs to address off-taker risks. Second, template contractual documents were made part of the tender package, including the PPA, Land Lease Agreement, Grid Connection Agreement and the Government Guarantee Agreement.

Third, a slew of preferential taxation schemes have been introduced. These include, for instance, 75% relief from income tax normally levied on the project company (from resource assessment to construction) for ten years; exemption from all customs and other duties, taxes, fees, returns and levies; exemption from stamp duties; exemption from general sales tax and withholding tax on income relating to local or imported goods, material and services; exemption for non-Jordanian investors and financiers from income tax and general sales tax that may arise on interest payments, fees and any instalments resulting from financing activities.

The Direct Proposals Bylaw prioritises the use of private land for renewable energy, and developers often have to negotiate directly with local communities rather than through formal institutions, which poses risks of project delay and disruption. Further, developers are required to pay a fee for change in the "type of use" for the land which ranges from JOD 5-8 per square metre. Public lands are managed by the Department of Land and Survey (DLS) in Jordan and where such land is required under the Direct Proposal Scheme, developers should approach MEMR which will in turn liaise with DLS. The exact leasing price is determined by a special committee in the DLS and has to be approved by the minister of finance.

The current pipeline of utility-scale projects provides an outlook to 2021, beyond which subsequent rounds of direct proposal submissions need to be issued to benefit from electricity from renewable energy that is substantially cheaper than the NEPCO's current average cost of electricity procurement. Indeed, several factors are contributing to a slowdown in the issuance of subsequent rounds, including uncertainty related to the overall electricity demand growth, available grid infrastructure capacity and existing take or pay contracts with IPPs. Without demand growth measures, such as incentivising electricity consumption, reducing energy poverty and electrification of end-uses, future rounds of direct proposal submissions are unlikely to take place.

However, important steps have already been taken to ensure the benefits of low-cost electricity from renewable energy can be passed on to sectors presently most vulnerable to high energy costs. Industries, for instance, can already benefit through earmarked renewable energy projects. The 100 MW solar project in East Amman is an example in this regard where land has been allocated for lease to generate low-cost solar power to improve the competitiveness of industries (Jordan Times, 2020c). It is, however, important to ensure equitable access to low-cost renewable power for small and medium enterprises, including those most at risk due to high energy costs.

Existing and future industrial zones should pursue dedicated renewable power supply coupled with energy efficiency and storage. The expedited development of renewable and storage projects as well as strategically positioned development of new projects such as these can facilitate deployment with limited stress on the grids for integration.

Power sector: Government-owned projects

Renewable energy projects developed under this route include those that are government-owned and publicly financed through grants and loans provided by governments and development agencies. For such projects, MEMR issues a tender to select an EPC contractor. The EPC contractor is responsible for all activities from design to engineering, procurement, construction, commissioning and transferring the renewable energy plant over to MEMR. However, renewable energy developers licensed by EMRC must apply for government tenders in partnership with an accredited contractor listed by the MEMR.

The total installed (or under construction) capacity of government-owned commercial power plants has reached 149 MW from PV and 169 MW from wind. Besides solar PV and wind, either government-owned or through public-private partnerships, projects focused on biogas and hydro have also been developed in the past. The Jordan Biogas Company has a landfill project in Rusaifa, with further plans by the Greater Amman Municipality to implement a biogas project using the methane gas captured in the Ghabawi landfill.

Power sector: Wheeling and net metering projects

The development of renewable energy projects for self-consumption is guided by the wheeling and net metering programmes depending on the location of the generation facility with respect to the consumption site. The capacity of projects under the programmes grew from around 250 MW at the end of 2018 to 573 MW in January 2020.[11] At over 35%, Jordan has among the highest percentages of wheeling and net metering projects relative to total renewable installed capacity.

The Electric Power **Wheeling Scheme** has been devised to encourage large consumers to develop renewable energy for self-consumption with a view to reducing energy costs and increasing competitiveness. The scheme allows the user to install the renewable energy system in a different location of the consumption facility and connect it to the transmission or distribution grid. The directive for the scheme was issued in 2013 and later amended in 2015 (EMRC, 2015). As of January 2020, wheeling projects totalled a capacity of over 222 MW,[12] with strong interest from large consumers. The Jordanian telecom operator Orange Jordan, for instance, has announced a 37 MW solar project to help meet part of its electricity needs. The capacity is spread across three sites in the King Hussein Bin Talal Development Area, the Mafraq and the Amman governorate (Willuhn, 2019).

Beyond commercial entities and industry, refugee camps have also been able to benefit from the wheeling scheme, with the Azraq and Zaatari camps meeting a large share of total electricity needs through solar projects (UNHCR, 2020). The solar plant in Azraq refugee camp was inaugurated in May 2017 while the one in Zaatari camp opened in November 2017. The Azraq refugee camp is now powered by a 5 MW solar PV project which covers 70% of the total electricity required. In the case of the Zaatari refugee camp, the solar project connects all shelters in the camp and provides 12 hours electricity per day. The projects help UNHCR save an average of USD 6 million annually in electricity costs while bringing an improved electricity supply to those living in these camps (UNHCR, 2019b).

11 Based on MEMR presentation (January 2020).

12 Based on MEMR presentation (4 January 2020).

The **Net Metering** scheme is focused on the development of renewable energy, mainly solar PV, for all metered consumers to cover up to 100% of their own consumption and connect the system mostly to the distribution grid. The scheme is based on the Directive Governing the Sale of Electrical Energy Generated from Renewable Energy Systems, which provides guidance on the conditions for existing and new users, as well as specifies the mechanism for billing and remuneration for users under this scheme. Net metering is most attractive for high-consuming residential consumers and public buildings (Box 3) that are paying high electricity tariffs (reaching JOD 0.30 [USD 0.42] per KWh).

For net metered users, the distribution company undertakes monthly billing and annual settlement between the electricity consumed from the grid and exported to the grid. For the total installed capacity to be connected to the grid, the expected generation must not exceed the average monthly consumption (IEA, 2020). For the monthly billing, if the electricity consumed from the grid is higher than renewable electricity exported, then the consumer pays for the extra consumed electricity to the distribution company according to the prevailing tariff structure. In case export is higher than consumption, then the excess electricity is rotated to the next month, also known as "banking of power". The annual settlement can be either on a financial basis (capped to 10% of the electricity imported from the grid) or on an energy basis, where the surplus is rotated to the next year. The tariff for purchasing surplus renewable electricity by the distribution company is set at 0.12 JOD per kWh (USD 0.17 per kWh) for solar PV systems. It is important to note that the exodus of high-paying commercial and industrial electricity consumers from the electricity grid risks undermining the cross-subsidisation mechanism (Vinter and Norman, 2019).

Substantial interest in self-consumption (wheeling and net metering) programmes has resulted in rapid capacity deployment, as well as several implementation-related challenges. Applications are generally submitted to distribution companies, which then undertake a review and conduct the requisite technical and grid impact studies (GISs). Distribution companies are faced with high loads of applications and are unable to increase capacity to address this. The potential for a one-stop shop for project proponents is being explored to complete all necessary processes, as is the use of online platforms where possible (EDAMA, 2019b). Simplified processes may also be designed for small and zero feed-in systems.

Box 3. Facilitating development of distributed solar on public buildings

The implementation of renewable energy and energy efficiency measures for public buildings holds immense potential for reducing electricity costs. While several mandates and programmes have been launched, enforcement has remained a key challenge. The lack of transparency in available budget in existing areas on electricity bills inhibits public buildings from conducting energy audits and implementing renewable energy and energy efficiency measures. The Ministry of Public Works and Housing, which is responsible for all government buildings, has a methodology for energy efficiency. It has implemented the same with the Ministry of Education and Health covering over 500 buildings.

Incentives can be introduced for managers of public buildings to adopt renewable energy and energy efficiency measures through dedicated financing schemes. Energy service companies (ESCOs), which carry out energy performance contracting, allow savings from annual electricity bills to be utilised for other budget lines, as well as ensure that buildings are able to connect to the grid without paying dues.

Under both the wheeling and net metering schemes, projects mostly connect to the distribution network. However, owing to uncertainties in grid capacity to absorb further generation, new projects over 1 MW on the distribution network have been suspended until the completion of technical studies to assess the capacity of the electrical grid to integrate further capacities. Even those under 1 MW are reportedly often not approved, or approval is granted for only part of the capacity applied for, by the distribution companies owing to limitations on the grid. The private sector has strongly noted the importance of communicating information regarding where capacity is available on the grid and for distribution companies to consider providing conditional approvals for projects. This includes, for example, conditions regarding integration of storage or limits on electricity exports to reduce stress on the grid.

Wheeling and net metering projects will play a fundamental role in the growth of Jordan's renewable energy sector. Such projects allow end-consumers to benefit directly from the low cost of electricity from renewable energy and, in the case of large private sector entities, improve the competitiveness of products and services. The freeze on projects over 1 MW due to grid limitations highlights the need to identify pathways through which wheeling and net metering projects can continue to expand, while integration challenges are addressed (discussed in greater detail in Chapter 4, Section 1, "Policies and regulations for integration"). The transition also brings challenges for incumbent distribution companies and bulk power suppliers as high-paying commercial and industrial end-users essentially utilise only the carriage (network) and reduce power consumption from traditional suppliers. In this context, it is important to ensure that the allocation of costs is fairly distributed across the end-consumers.

Since 2012, even as electricity generated from renewable energy has grown substantially, the electricity tariff structure has remained unchanged. Tariffs need to appropriately reflect the grid usage of self-consumption renewable energy projects (net metering and wheeling) to ensure proper allocation of network costs with other consumers and the distribution companies. As renewables continue to grow, the distribution companies will face greater challenges. EMRC will need to adapt regulated tariff design structures to ensure viability for the distribution companies in the long-term, even as distribution companies also evolve business models with the changing structure of the energy system.

Power sector: Off-grid and cross-sector projects

With rapidly decreasing technology costs and scalability of solutions, diverse renewable energy applications are also emerging in off-grid and cross-sectoral contexts. The first zero feed-in project of 9 MW was recently given approval. From a regulatory perspective, zero feed-in systems are permissible with the approval of the distribution company, with EMRC developing a relevant bylaw. As battery storage costs continue to fall, it will become increasingly competitive for certain categories of consumers (e.g., commercial establishments with majority day-time loads) to transition towards zero feed-in distributed solar. To facilitate this, instructions will need to be issued by distribution companies and design codes.

In addition, several cross-sector projects have also been developed. In June 2017, the Jordanian Ministry of Agriculture signed an agreement with the National Energy Centre of the Royal Scientific Society to develop over 320 solar water pumping systems on farms in the Jordan Valley and valleys of the south and 100 on the high plateaux (Azraq, Mafraq, Madaba). While the majority operate in an off-grid configuration, some are connected to the grid under the net metering programme (MEDENER, 2019).

As discussed in Chapter 2, water pumping accounts for 15% of all electricity consumed in Jordan. Electricity is a major cost for water utilities, and the Ministry of Water and Irrigation has pursued the development of solar projects to cover its electricity costs. However, a 50 MW proposed solar project was cancelled in light of the technical challenges related to the grid and the prevalent oversupply situation in the power sector. A joint committee between the Ministry of Water and Irrigation and MEMR has been constituted to discuss several issues related to the management of water and energy, (pumped) storage and desalination.

Heating/cooling

Chapter 3, Section 3 discussed the diversity of renewable energy applications in the heating/cooling sector. These included solar water heating for domestic, commercial and industrial applications, as well as geothermal and solar for space heating. Several projects already exist, with a strong presence of local system manufacturers and installers, and demonstrated benefits in terms of reduced energy consumption, decreased expenditures, improved reliability of supply and emissions reduction.

Despite the potential, the policy and regulatory landscape for renewable energy in heating/cooling is not as developed as that of the power sector. The adoption of solar water heaters has grown gradually over the past decades with a number of local enterprises deploying systems for residential, commercial and industrial applications. Partnerships with financing institutions were developed to deliver end-user financing for such systems. With the NEEAP and JREEEF programme, the sector received a strong impetus with end-user financing available through a network of community based organisations (CBOs). The JREEEF programme deploying 22 000 systems concluded in 2019, with the next phase in partnership with the commercial banks in the early stages of implementation.

In follow-up to the Renewable Energy and Energy Efficiency Law No. 13 of 2012, mandates were also issued to deploy solar water heaters on all new buildings exceeding a pre-defined area. Solar water heaters became compulsory for apartments with an area greater than 150 m^2. Commercial offices with less than 100 m^2 and private dwellings with less than 250 m^2 were exempted.

In addition, in 2013, the Ministry of Public Works and Housing Council issued the first Jordan Green Building Guide (JGBG), providing the basis for a local green building rating system. The incentive programme gives extra floor area ratio for buildings that achieve high levels of energy and water savings (Zawaydeh, 2018). Renewable energy integration in buildings is mentioned in the guide, and users can acquire eight points for integrating more than 20% renewable energy.

At the municipality level, the Greater Amman Municipality issued a special regulation in 2015 regarding solar system installation requirements on building rooftops, vacant lands and parking lots. This regulation ensures that installed systems to satisfy zoning requirements. An updated version of the requirements will be issued and released by the end of 2020.

A key challenge for solar water heater penetration in Jordan has been the enforcement of existing mandates, the lack of stringent penalties and the lack of capacity to ensure compliance. Furthermore, the focus of the next phase of the JREEEF programme on partnerships with commercial banks to provide end-user financing, as opposed to CBOs in the first phase, has led to a substantial slowdown in the adoption of solar water heaters, especially in the domestic segment. Each market segment requires a tailored financing approach to support solar water heaters. While the delivery of end-user financing through CBOs for domestic consumers was effective, commercial and industrial consumers may benefit from dedicated financing lines through commercial banks.

In industry, several projects using heat from renewable energy sources already exist. CSH applications have been deployed in pharmaceutical and cigarette production as process heat. In addition to the financing needs discussed earlier, capacity building initiatives focusing on local suppliers and manufacturers is needed to improve awareness of renewable energy-based heating/cooling technology applications.

Renewable heat use, including solar water heaters, currently lacks a clear long-term target that provides local suppliers visibility into the future market, especially given the dependence on public programmes (and accompanying subsidies) for deployment. To improve reporting on the progress, the data collected from the sales of such systems should be collected and reported regularly as part of the Annual Report of the MEMR.

Box 4. Addressing energy poverty through renewable energy: The case of the Schools Heating Program and refugee camps

In February 2015, the Schools Heating Program (King Abdullah II Initiative) was launched to provide heating in public schools. The project was envisaged to roll out in two phases. In the first phase, central heating would be installed in 50 schools located in extreme cold conditions. The second phase would expand the scope of the project to over 3 700 of Jordan's public schools. The programme has been implemented through the JREEEF, and has now covered over 134 public schools.

The schools have been equipped with solar-PV based space heating and cooling units along with solar water heating solutions. In addition, energy efficiency improvements have been made to school buildings by improving insulation, changing windows, installing energy efficient lights and upgrading electrical wiring. Awareness campaigns for students, teachers and the community on energy conservation and renewable energy applications is also being conducted.

Renewable energy solutions have also been applied to address energy poverty in refugee camps and associated public service infrastructure (e.g., education, healthcare). The Norwegian Refugee Council, for instance, initiated a Renewable Energy and Energy Efficiency Program in 2015. It installed grid-connected solar PV systems in 34 public schools, thus reducing the cost of additional shifts for refugee students, as well as improved energy efficiency. Additionally, 710 solar water heaters were installed in refugee households, reducing the cost of living and improving tenure security.

Source: MEMR (2019c), MESIA (2018), Royal Hashemite Court (2015), NRC (2020)

Transport

The transport sector accounts for the largest share of energy consumption in Jordan. Efforts to diversify the energy mix in the sector have focused mostly on incentivising the purchase of hybrid and electric vehicles through sales tax and customs exemptions. Fiscal incentives have been used extensively as a tool to facilitate adoption. Electric vehicles were exempted from clearance taxes on import for five years until the end of 2018, which improved their attractiveness substantially and has driven adoption. However, the clearance tax of 25% was reinstated in April 2019, which reduced sales sharply. In November 2019, the government reintroduced the incentives based on the battery capacity of the electric vehicles. Those with a capacity of 250 kilowatts (kW) and lower (which represent 95% of the electric vehicles in Jordan) saw clearance taxes reduce from 25% to 10%. Meanwhile, taxes on vehicles with a capacity above 251 kW were reduced to 15% (Xinhua, 2019; Zeidan, 2019). The impact of this tax reduction on electric vehicle sales remains to be seen; however, stability in policy support is seen to be crucial for the sustained growth of the sector.

To support the adoption of electric vehicles, simultaneous efforts are needed to expand the charging infrastructure. The EMRC currently provides licenses to public and private electric vehicle charging stations. So far, the commission has issued licenses to 16 charging stations and announced intentions for all new gas stations to have electric charging facilities. To achieve large-scale and rapid electrification of the vehicle fleet in the Kingdom, the rollout of charging infrastructure has to be substantially accelerated.

The economics of electric mobility are fast evolving with rapidly decreasing costs of storage technologies and improving maturity of applications across the different transport segments. In the specific case of electric buses, for instance, these have been found to be a technically and financially feasible option with substantial co-benefits in terms of reduced air pollution and GHG emissions, as well as dependence on imported diesel fuel (GGGI, 2018). Pilot projects across specific routes will improve the understanding of operational viability of electric buses for intra- and inter-city transport.

Coupling the electrification of transport with renewable power will be important to diversifying energy use in the sector. This will require strong co ordination between the Ministry of Transport and MEMR, as well as a holistic strategy or long-term roadmap which sets targets for the electrification of private vehicles, fleets and public transportation. It should further guide the development of complementary infrastructure and skill sets. Municipalities, such as GAM, have taken steps to set targets for taxi fleets.

Policies and regulations for integration

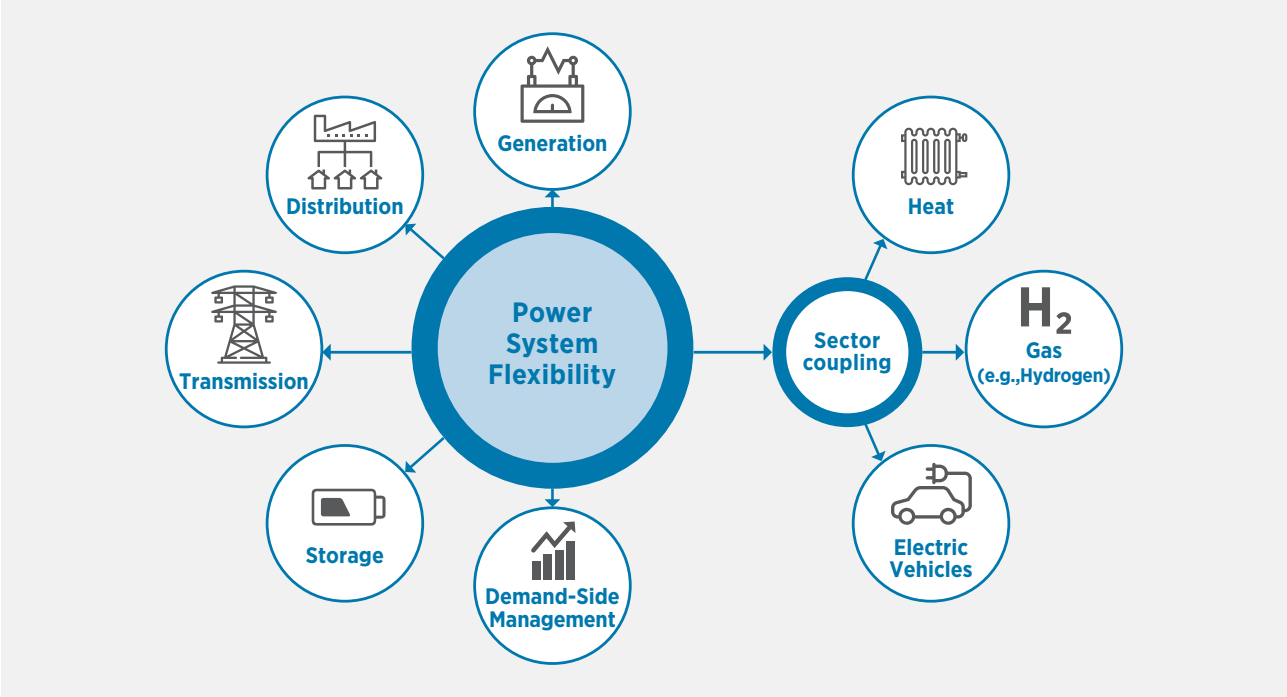
The integration of higher shares of variable renewables has emerged as a primary concern holding back continued growth of the sector. By 2021, it is anticipated that renewable energy will account for 30% of total installed power capacity and 20% of electricity generated in Jordan (Marar, 2019). Concerns over the ability of the grid to integrate renewables beyond the existing pipeline have led to the suspension of new projects above 1 MW since January 2019. This has contributed to uncertainty in the sector and, importantly, not allowing large consumers to benefit from a low-cost energy supply from renewable energy.

Some steps have been taken towards integration in Jordan, which has enabled the integration of a rapidly growing share of electricity generated from renewables over the past few years. These have largely focused on developing and strengthening the transmission and distribution infrastructure, as well as introducing dedicated regulations for injecting renewable power into the grid.

However, further growth in the share of renewables in the electricity generation mix requires a wider range of actions to improve overall system flexibility in the short-, medium- and long-term. As illustrated in Figure 15, the measures range from reinforcing transmission and distribution infrastructure to increasing storage, managing the demand side, and incentivising flexible generation, as well as introducing sector coupling (IRENA, 2018; IRENA, OECD/IEA and REN21, 2018). The optimum mix of measures varies from context to context and should form part of a holistic strategy to improve system flexibility in a least-cost manner and be backed by dedicated regulations to guide deployment and operation.[13]

13 The IRENA FlexTool is a detailed tool that analyses the flexibility needs of a power system covering traditional options (e.g., flexible thermal and hydro generation with high ramping capability and very low start-up time), as well as other innovative technologies (e.g., flexible demand, energy storage and sector coupling). The FlexTool is capable of analysing current system operations and performing future analysis with high penetration of variable renewables, thereby proposing the optimum possible flexibility solutions. Country-level analysis has so far been conducted for Colombia, Panama, Thailand and Uruguay (IRENA, 2018).

Figure 15. **Measures to integrate high shares of variable renewables in the power mix**



Source: IRENA (2018a)

Transmission and distribution infrastructure

The expansion and strengthening of grid infrastructure have to keep pace with renewable energy development. The scope of infrastructure work needed for effective integration varies from constructing dedicated transmission corridors between renewable resource-rich regions to load centres (e.g., the Green Corridor) to strengthening the distribution infrastructure through upgradation of equipment (e.g., transformers) and improved system management.

While the National Energy Strategy provides an outlook to 2030, grid infrastructure needs to plan for the longer term. A much higher share of renewables also needs to be assessed and planned for. NEPCO's network expansion and development strategy should offer a blueprint for stakeholders, including the private sector and other ministries, to develop the necessary infrastructure, raise capital and devise a time-bound plan. A similar exercise will need to be conducted by the distribution companies to identify network bottlenecks that require investments for upgradation and modernisation. This is particularly crucial given the growth of electric vehicle sales and the associated charging infrastructure. Investments in smart grid systems, including metering, across the distribution network can help implement a tailored approach to managing renewables integration at the transformer level.

Effective co-ordination between MEMR, NEPCO and the distribution companies can ensure optimum network management during the transition towards higher shares of variable renewables in the electricity mix. Integration measures can also be mainstreamed into deployment policy design by setting up renewable energy projects in areas of close proximity to loads (e.g., industrial zones) or regions with available grid capacity. Hybrid projects (e.g., solar-wind, solar-on site storage) can further support integration by smoothening generation, increasing network utilisation and enabling load shifting.

The scope of infrastructure work needed for effective integration varies from constructing dedicated transmission corridors between renewable resource-rich regions to load centres to strengthening the distribution infrastructure through upgradation of equipment and improved system management.

Storage

Managing the increasing share of renewable energy in Jordan's electricity mix will require active measures to match (existing and new) demand and supply in an optimum manner that reduces overall system costs (e.g., need for peaking plants) and incremental integration of infrastructure investment. Energy storage costs are expected to decrease by 2030. With rapid construction times and lower social and environmental impacts, energy storage could be a solution to some of the challenges of integrating renewable energy (IRENA, 2020b). In Italy, for instance, Terna installed 38.4 MW/240 MWh sodium sulphur batteries for transmission investment deferral. Over 330 MW of such projects had been deployed by 2017 and are expected to reach around 14.3 GW by 2026 (IRENA, 2020b).

The level of flexibility storage can offer for Jordan's power system needs to be studied closely. Broadly, two storage options are available – battery storage and pumped hydro – each offering its unique set of characteristics and flexibility services.

Developing battery storage at the transmission and distribution levels and on the demand side can increase self-consumption and reduce variability for the grid. When combined with renewable power and energy efficiency, storage can reduce peak-load demand and help achieve "zero-to-grid" configuration for buildings, commercial sites and industries. In the specific case of the residential sector, which accounted for 46% of total electricity consumption in 2018, the daytime peak-demand load can be reduced through energy efficiency measures, coupled with growing solar PV generation and storage, thus reducing the need for expensive peaking plants. Having a renewable energy peak strategy with targets is critical to cover part of the peak requirements.

Grid-scale energy storage infrastructure can provide a wide range of grid services, including renewables smoothing, arbitrage and ancillary services. The benefits are already demonstrated by the solar PV Li-ion battery storage project in the Al-Mafraq region. While bids for a larger solar-storage project are in the evaluation stage by MEMR, there is presently no long-term strategy or target for storage deployment in the Kingdom. There is also no regulatory framework to facilitate and guide storage deployment at the transmission, distribution and end-user-level. With storage costs falling, the business case for storage adoption will become strong, both at the utility scale and behind the meter, and enabling regulations will be needed for rapid adoption. The distribution company, JEPCO, began receiving applications for storage in January 2020.

Pumped hydropower storage is being closely considered, with several sites being studied for development (Box 5). Key issues remain to be resolved between MEMR and the Ministry of Water and Irrigation in terms of ownership of water resources and regulations to govern the operation and remuneration of services provided by the pumped hydro facility.

Grid-scale energy storage infrastructure can provide a wide range of grid services. The benefits are already demonstrated by the solar PV Li-ion battery storage project in the Al-Mafraq region.

Box 5. Assessment of pumped water storage

Under the EU-funded Renewable Energy and Energy Efficiency II programme, an assessment of pumped-hydro storage was conducted for five reservoir/dam sites in Jordan. Among the sites assessed, Wadi Mujib, Wadi Arab and King Talal reservoirs were found to have the highest potential for pumped-hydro development. The turbine capacity at each site is 215 MW, 95 MW and 225 MW, respectively, and the assessment was conducted based on the energy storage capacity, fulfilment of grid service re equipments (NEPCO) and potential transmission line losses. Wadi Mujib was found to have the highest potential among all dams in Jordan.

Given that Jordan is a water-stressed country, the development of pumped-hydro infrastructure has to equally consider other uses of the dam such as supply of water for irrigation, industry and domestic purposes. Mujib Dam, for instance, is a multipurpose water source and serves as an important water supply source in central western Jordan. Co ordination between MEMR and the Ministry of Water and Irrigation will be needed to address issues related to water resources and minimise conflict between different end-uses. Further, EMRC will need to issue adequate codes for the operation and remuneration of services provided by pumped-hydro storage.

Sector coupling and load-shaping

In an environment of slow demand growth, deploying new renewables capacity to lower energy costs will still pose challenges for NEPCO and the distribution companies given existing tariff structures and nature of "take or pay" contracts in the sector. The government took measures in 2019 to stimulate demand through reduced tariffs for the industry. As noted, steps towards incentivising the adoption of electric vehicles have been taken; however, the scale of adoption has been limited in the absence of stricter mandates and complementary infrastructure. Other opportunities such as utilising excess low-cost electricity for the production of energy carriers, such as hydrogen, for use in transport and industry are yet to mature and be fully explored (IRENA, 2018b).

The electrification of end-use sectors can potentially drive demand growth. However, its management needs to be accompanied by strategies for demand-side management and load shaping. The growth in new electricity demand, for example from growing electric vehicles in the transport fleet, may not necessarily coincide with peak renewable generation. Load shaping includes measures to match electricity demand to variable supply with demand-side management (IRENA, IEA and REN21, 2018). Time-of-use tariffs are important market signals to shift certain loads during times of low loads, thus also reducing peak-load demand. Jordan's tariff structure is currently fixed-consumption based for various consumer groups. Increased digitisation of systems will be also be crucial to enable load shaping.

Policies and regulations to maximise benefits

The share of domestic energy sources in primary energy is targeted to grow from 8% in 2017 to 15% by 2020 and 40% by 2025. Import substitution of energy fuels with domestic energy resources offers the opportunity to localise segments of the energy value chain, develop new industries and create employment opportunities – key political priorities in the Kingdom and the region (EIB and IRENA, 2015). Beyond manufacturing of renewable energy technologies, new opportunities for value creation also exist in operation and maintenance, design, engineering and financial services, and development of new solutions such as smart grids and metering.

Presently, hundreds of companies are working in the renewable energy and associated sectors in Jordan. More than 5 000 people are estimated to be working in the supply chain, ranging from design, procurement, electrical, mechanical and civil Installation to quality control, safety, commissioning and operation and maintenance (EDAMA, 2019c). Many existing companies have established new business lines to respond to the growing domestic market for renewable energy, in particular for distributed solar PV systems and solar water heaters.

Jordan's existing domestic manufacturing base for renewables is strong in many areas – modules, cables, mounting structures and solar water heaters – although the limited size of the local market is a significant constraint. Instability in the policy environment – such as the suspension of new projects over 1 MW connected to the distribution network that has been in place since January 2019 and the changes in the design of financing support programme for the solar water heaters – strongly impact the sustainability of businesses and investments in capacity augmentation and product/service diversification in Jordan's renewable energy sector.

There is substantial potential for leveraging the strength of the existing domestic manufacturing base to meet the sector's requirements domestically as well as internationally. Domestic module manufacturers – such as Philadelphia Solar, which has a combined module manufacturing capacity of 800 MW – are already exporting products and delivering EPC in markets such as the United States. To support the local industry, a comprehensive industrial policy is needed that provides an actionable vision for the development of a robust, local industry around a changing energy sector through dedicated incentives, creation of industrial clusters and facilitation of joint ventures and technology transfer. Such a policy should build on the rounds of incentive packages introduced by the government in 2019 to stimulate the economy. Recent packages encompass programmes to support industry and introduce incentives for exports which benefit all industries, including renewable energy.

The competitiveness of existing industries (e.g., cables) can be strengthened through incentives, such as exemptions and concessional loans, that level the playing field for competition in domestic and international markets. By leveraging regional agreements, such as the Joint Arab Market, Jordan could become an important exporter of the various products and services demanded to drive the energy transition.

Domestically, the scale and structure of utility-scale projects can often crowd out local suppliers, developers and financiers. While a local content requirement is in place – and the share has gradually been increased to 35% with each subsequent round – its definition

and effectiveness needs to be closely assessed. It was reported that the 35% requirement can be fulfilled by procuring the necessary value of the project through local contractors even if the products and services are being imported. The design of tenders, both public and private, are also known to introduce challenges for local enterprises to actively participate in due to barriers such as the inclusion of material origin requirements. When possible, these should be reviewed to ensure a level playing field for local technology and service providers to participate in the sector's development.

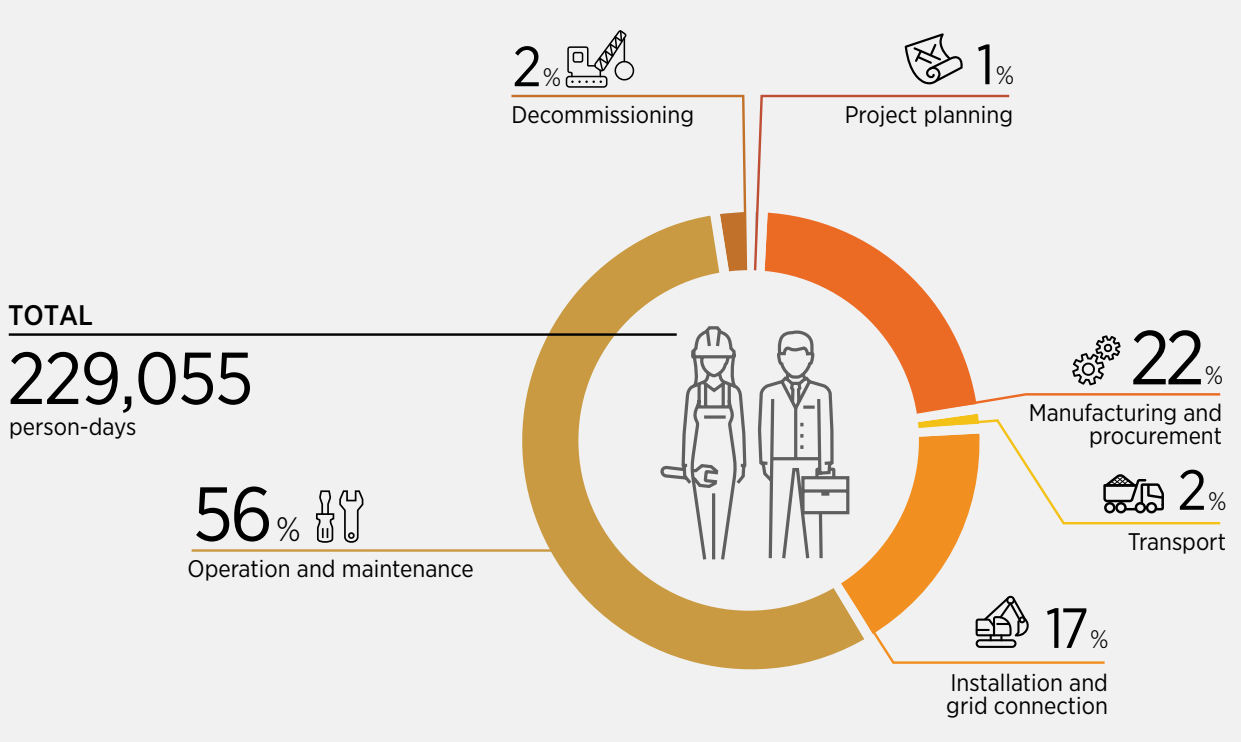
Standards and quality assurance frameworks are crucial for a sustainable and renewable energy market. New regulations issued in July 2019 mandate the testing of all modules at the Jordan Institute for Standards and Metrology and the Royal Scientific Society. Affordable, third-party testing and certification centres need to be accessible for renewables equipment, as well as for raising awareness among consumers on product standards available in the market (e.g., through labelling of solar water heaters).

Building adequate skills for the growing renewable energy sector is crucial to ensuring quality installations and long-term permanence. Identifying the current and future skills needs and partnering with training institutes, universities and industry are important for the development of curricula and delivering quality training for the workforce (Box 6). With the expansion of the renewables sector in the recent past, skills availability in the sector is projected to be satisfactory with several universities having integrated energy-related programmes.

Box 6. Assessing skills needs across value chain: The case of solar PV

IRENA's Leveraging Local Capacities studies assess skills and occupational requirements along the renewables value chain. For solar PV, IRENA analysis shows that 56% of the total jobs are in O&M, 22% are created in manufacturing and 17% are in installation and grid connection. Notably, while jobs in manufacturing and installation are temporary, those created in O&M last throughout the lifetime of the project.

Distribution of human resources required along the value chain for the development of a 50 MW solar PV plant by activity



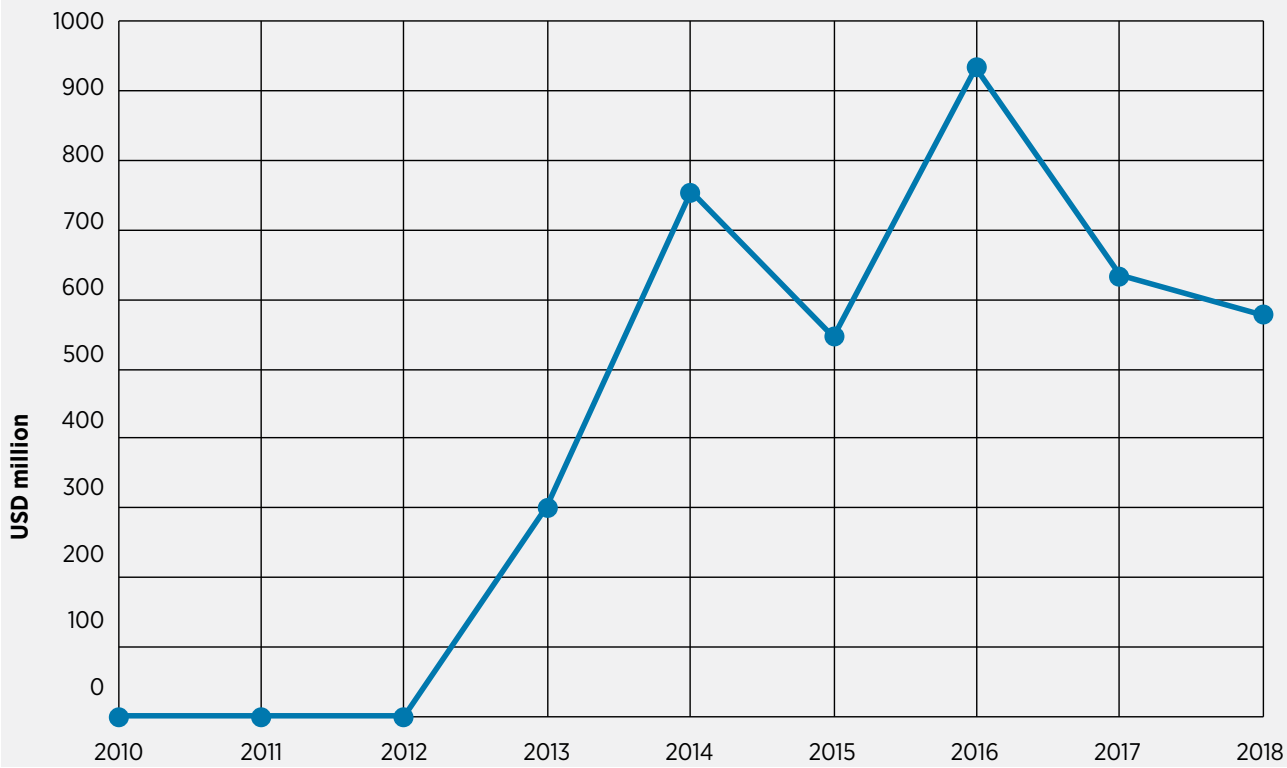
Source: IRENA (2017)

4.2 Catalysing investments to meet renewables ambition

Investment flows into the renewable energy sector have grown substantially since the Renewable Energy and Energy Efficiency Law (13) of 2012 was passed. Beginning from a negligible base in 2012, investments rose in 2013 to USD 300 million, rising to USD 935 million in 2016 and reaching USD 580 million in 2018 (Figure 11). A large share of the investments were targeted at solar PV and wind projects being developed under the various schemes discussed in the previous section.

The share of foreign investment in the sector is high at 75%, with limited participation of the local financial institutions especially in the utility-scale segment (Climatescope/BNEF, 2019). The key actors involved in the renewable energy financing ecosystem in Jordan vary greatly depending on the scale and nature of the project. These usually involve local and international commercial banks, development finance institutions, the Central Bank of Jordan, NEPCO, the Jordan Renewable Energy and Energy Efficiency Fund and enterprise development entities, as well as a number of donor agencies such as Foundations and National Development Banks. Table 4 provides an overview of the main stakeholders and the main areas of financing activities.

Figure 16. **Investment in renewable energy in Jordan (2010-2018)**



Source: Climatescope/BNEF (2019)

Table 4. **Overview of stakeholders and main areas of financing activities**

	Utility-scale	Distributed	Transmission and distribution infrastructure	SME financing	Technical assistance and capacity building
Local commercial banks (e.g., Cario Amman Bank, Bank al Etihad, Arab Bank, Bank of Jordan)	X	X		X	
International commercial banks (e.g., Standard Chartered, Shinhan Bank)	X				
Development finance institutions (e.g., EIB, EBRD, Netherlands Development Finance Company FMO, German Investment Corporation – KfW DEG, ADFD, IFC, JICA)	X	X	X		X
Government grants (e.g., EU, Spain)	X		X		X
Foundations/Donor agencies (e.g., IKEA Foundation, NRC)	X	X			X
Central Bank of Jordan		X (on-lending)			
NEPCO			X		
JREEEF		X		X	X
Jordan Enterprise Development Corporation				X	X
Jordan Chamber of Industry Factories Support Programme		X			

Note: denotes relevant area of financing activity

Financing utility-scale renewable energy projects and infrastructure

International development finance institutions have actively participated in the financing of utility-scale renewable energy projects. Unless developed under government-to-government agreements, the majority of the utility-scale plants have been developed under a project financing structure. Table 5 provides an overview of the financing structure of selected utility-scale solar and wind projects in Jordan, as well as the Green Corridor transmission project.

The European Bank of Reconstruction and Development (EBRD) has played a key role as a financier of renewable energy projects and infrastructure in Jordan. EBRD has committed over USD 350 million so far for a total of 392 MW of utility-scale wind and solar projects in Jordan.[15] The majority of the investments are in the form of senior secured loans, in partnership with other financiers involving commercial banks (e.g., Europe Arab Bank) and development finance institutions (e.g., Development Energy Bank, Netherlands Development Finance Company [FMO], Proparco [subsidiary of the French Development Agency]). The International Finance Corporation (IFC) has also played a key role in the financing of renewable energy projects in Jordan as a direct financier as well as a lead arranger for project financing.

While some local banks are co-financing large projects with multilateral development banks, the local financial institutions are still not very actively involved with utility-scale renewable energy financing, especially related to non-recourse financing that requires larger volumes of investment, longer tenor and unique documentation. Over time, capacity is being developed as the understanding of the sector improves. Increasingly, local banks are involved in refinancing projects that initially received international financing.

15 www.ebrd.com/work-with-us/project-finance/project-summary-documents.html?1=1&filterCountry=Jordan

Table 5. **Insights on financing structure of selected utility-scale projects**

Type of project	Project	Financing structure
Solar PV	60.3 MW King Hussein Bin Talal development area, Mafraq region	Two USD 27 million loans: A loan from EBRD and B loan from FMO.
	133.4 MW FRV Al Mafraq	Mafraq I received financing from the IFC, FMO and the Europe Arab Bank. Mafraq II received financial support the EBRD and the Society for Proparco.
	50 MW Risha	EBRD provided a senior secured limited recourse loan of up to USD 27.6 million. The German Development Bank (DEG) and Arab Bank met the rest of the financing requirements.
	200 MW Baynouna	An IFC-arranged financing package included a USD 54 million loan from the IFC and USD 134 million from other senior lenders, including Japan International Cooperation Agency (JICA). Other lenders included FMO, Europe Arab Bank, the OPEC Fund for International Development and DEG.
	103 MW Al Quweira	The project is funded by MEMR through a grant from the Abu Dhabi Fund for Development.
	51 MW Al Safawi	Up to USD 70 million senior secured loan split between EBRD and FMO.
Onshore wind	50 MW New Tafileh Wind – "Korea Southern Power Company Ltd." & "Daelim Energy Company Ltd."	The IFC is 1) providing a USD 10 million loan for its own account; 2) structuring an equity bridge loan of USD 26 million – its first in project financing; and 3) mobilising loans of USD 26 million from its Managed Co-Lending Portfolio Programme, as well as USD 27.7 million from Standard Chartered Bank and USD 8 million from Korea's Shinhan Bank.
	89.1 MW Fujeij	USD 6 million direct loan by the Export-Import Bank of Korea (K-Exim) and a USD 52 million K-Exim covered facility provided by Mizuho Bank Ltd. and Sumitomo Mitsui Banking Corp. Europe Ltd. Equity bridge facilities of a combined USD 81 million are being funded by commercial banks.
	82 MW Al-Rajef	EBRD approved a USD 68 million loan, while Proparco provided USD 50m project financing. A USD 19 million loan will later be provided by DEG.
	45 MW Shobak	Provision of a senior secured loan by EBRD of up to USD 52 million.
Transmission infrastructure	Green Corridor	EBRD extended a USD 72 million loan, Proparco provided a USD 55 million soft loan, NEPCO contributed USD 12.6 million, and the EU provided a grant of USD 20.2 million.

Source: Rahim and Eid (2017); Carvalho (2018); EBRD (2016); Maisch (2017), EBRD (n.d.)

Financing self-consumption and small-scale renewables

The scale of self-consumption renewable energy projects can vary from tens of megawatts of wheeling projects to a few kilowatts of net metered installations for use by households or public buildings/institutions. With the exception of a few large wheeling projects – such as the 37 MW Orange Jordan project, which follow a similar financing structure to large utility-scale projects – self-consumption projects generally see a stronger participation of local financing institutions. Such projects also benefit from several government finance promotion programmes by the Central Bank of Jordan (CBJ) and the JREEEF.

Since 2011, the CBJ has offered a credit facility with reduced interest rates to support economic activities in nine key sectors, including renewable energy and energy efficiency. It offers a low interest rate to local banks of around 1.75% for projects in Amman and 1% for projects outside Amman, allowing these banks to on-lend at final interest rates up to 4.5% for projects up to a limit of JOD 4 million (USD 5.6 million). As part of the post-Covid-19 recovery plan for Jordan, interest rates of around 0.75% are offered inside Amman and 0.5% outside Amman. The facility offers the loan for a period that can reach ten years with a one-year grace period. As of December 2018, more than 270 renewable energy and energy efficiency projects have been financed, amounting to JOD 182 million (USD 257 million). The CBJ's concessional financing scheme can only be accessed by the beneficiary and not the project implementor. With certain beneficiaries unwilling to take debt against their balance sheets, several developers have asked the CBJ to consider expanding the programme for them to take loans on behalf of end-users.

While the CBJ programme for renewable energy and energy efficiency is part of a broader package to support economic activities, it serves as an important blueprint for tailored financing programmes for sectors covering specific end-use sectors and applications (e.g., dedicated funding line for industries, portfolio financing of developers). Such programmes will support the objective of local banks being more aggressively involved in financing non-utility-scale renewable energy projects. A key lesson from the CBJ programme has also been the need to focus on capacity building of project proponents on project documentation preparation, including costings and feasibility analysis.

JREEEF implements dedicated public financing programmes for renewable energy and energy efficiency. JREEEF offers financial support to consumers through loan guarantees, interest rate subsidies and grants for solar water heaters and PV systems, as well as for implementing energy efficiency measures (e.g., solar streetlights, energy audits in industries). JREEEF had a programme that offered loan guarantees and covered interest on loans, while also offering grants of up to 50% for solar water heaters and 30% for solar PV (up to 2 kilowatt -peak (kWp) through 220 local CBOs building on the experience of the Global Environmental Finance (GEF) Small Grants Programme (Box 7). Over 24 000 solar water heaters have been installed under the now-concluded programmes (JREEEF, 2020).

A new programme for 30% support on solar water heater and solar PV systems up to 3.6 kW was issued in November 2019 (Bellini, 2019). For this phase of the programme, JREEEF is partnering with local commercial banks, such as the Jordan Islamic Bank, for the provision of soft loans for renewable energy systems including household PV systems and solar water heaters (Bank of Jordan, 2017). The banks offer attractive loans to cover 70% of the system costs, while JREEEF takes 30-50% of the cost of the system or the full grant for end-users with limited creditworthiness so that the beneficiaries receive almost interest-free loans.

A key difference between the subsequent JREEEF programmes has been that end-users are now able to select among different accredited technology suppliers and access financing by approaching various commercial banks. This compares to the earlier case wherein a single supplier had been selected through a competitive process to supply all systems deployed through CBOs. A key challenge with the new phase has been that the customers looking to secure financing from commercial banks are not able to meet the bankability requirements, which are more stringent compared to lending through CBOs. Further, limited experience among participating banks and the challenge faced by installers to unlock financing available for end-users through the new JREEEF programme have been identified. Targeted capacity building programmes are needed to strengthen Green Lending Units within financing institutions by improving awareness of technologies and financing programmes (at the branch-level) and understanding of accurately estimating the risks and costs of renewable energy projects.

JREEEF also provides financial support to industry for conducting energy audits. It covers 50% of the cost of the audit. There are lessons that can be extracted from the energy audits with the opportunity to develop industry-specific recommended energy-saving measures and energy-use indexes.

Another public financing instrument that has been established is the Rural Electrification Fund (Fils Il Reef). The MEMR has issued the first round out of several to install 2 113 solar PV systems of 2 kW size that will be installed at no cost for applicants with sufficient roof space, those who are on national support (approximately 85 000 families) and have monthly electricity consumption under 300 kWh.

Financing renewable energy enterprises

Renewable energy enterprises have varying funding needs depending on the part of the renewable energy value chain they are part of. Jordan has established entities that offer equity products to new and established companies. The Jordan Enterprise Development Corporation (JEDCO), for instance, supports start-up companies by allowing up to 80% of equity in renewable energy projects, as well as SMEs. The cost of equity is significantly reduced because JEDCO requires only a 10% return on any profits. However, the fund has not seen great take-up (RCREEE, 2018). The World Bank also launched the Innovative Startups Fund Project in Jordan with a USD 50 million investment complemented by USD 49 million in co-financing from the CBJ. It has been designed to provide early stage financing for start-ups across several sectors, including green energy (World Bank, 2017).

A non-refundable capital subsidy for small industrial enterprises looking to install either solar PV or solar water heaters is offered by the Jordan Chamber of Industry Factories Support Program. The programme's objective is to familiarise industry with the technology by installing small projects. The subsidy covers up to 50% of the product costs if the product is made in Jordan and up to 35% if the product is imported (IRENA, 2018; RCREEE, 2018).

The development of dedicated enterprise funds can play a catalytic role in supporting local industry and facilitating innovation in the renewable energy sector as well as complementary technologies such as storage, smart grids, demand side management and digitisation.

Box 7. Revolving fund for solar water heaters: The case of United Nations Development Programme (UNDP)-GEF and Sustainable Energy and Economic Development (SEED) project

The GEF Small Grants Programme provides grants of up to USD 50 000 directly to local communities including CBOs and other NGOs to set up revolving funds to finance renewable energy projects. In addition, the grants focus on building awareness and capacity among local communities on the benefits of renewable energy solutions. Through the programme, over 435 solar water heaters and 100 kW solar PV systems have been developed since 2009. The use of the revolving fund financing instrument – small grants of USD 50 000 – has mobilised over USD 579 000 (JOD 406 000) worth of investments in renewable energy systems. The impacts of the programme have been multifold: lower expenditure on traditional fuels, reduced deforestation and emissions, improved health outcomes and biodiversity conservation.

SEED is a programme funded by the Global Affairs Canada and JREEEF from 2016 to 2020. It aims to improve the livelihoods, well-being and resilience of poor and disadvantaged groups in the Jordan Valley and Ajloun regions through uptake of renewable energy and energy efficiency measures. SEED worked in partnership with local CBOs to design a financing programme for solar water heaters and solar PV: the beneficiary pays 25% as down-payment, 50% is capital subsidy and the remainder is paid in instalments to the local CBO. The proceeds from the instalments create a revolving fund for CBOs to continue supporting the community after the project concludes. So far, over 1 300 solar water hearing systems and 987 on-grid solar PV systems have been installed. In addition, six public schools and five health clinics were equipped with 150 kWp on-grid PV systems and 12 solar water heaters.

4.3 Conclusion

The renewable energy sector in Jordan has grown rapidly over the past decade on the back of a robust policy and regulatory framework. The sector is at an important juncture. There is a strong track record of deploying renewables in the power sector, with a growing number of applications being demonstrated in heating/cooling and transport. Jordan can leverage the momentum and deepen the energy transition towards renewables. A continuing pursuit of renewable energy promises that a more secure, resilient and environmentally sustainable energy system can also be affordable, support industrialisation and bring a wide range of socio-economic benefits.

As argued in this chapter, to support the next phase of growth for renewables in Jordan, a broader policy mix will be needed that focuses on deployment, integration and the enabling conditions at the sector level to maximise benefits (e.g., local industry development, skills). Further, to unlock future growth of renewables, efforts for demand creation and electrification of end-uses will be crucial. Based on the analysis and extensive stakeholder engagement, the next chapter summarises the key recommendations for policy makers to scale up renewables deployment. Renewable energy should be seen in tandem with energy efficiency as mutually reinforcing components for Jordan to reach higher shares of local energy resources in the energy mix and reduce dependence on imported fuels. Box 7 outlines the current framework for energy efficiency in Jordan, highlighting the key aspects and emerging issues.

Risha PV plant 50 MW
Photograph :MEMR

Box 8. Framework for energy efficiency in Jordan: Key aspects and emerging issues

The Renewable Energy and Energy Efficiency Law (13) of 2012 underlines the importance of pursuing renewable energy and energy efficiency in tandem. In addition to improving the reliability, security and cost-effectiveness of energy supply, a key objective of the National Energy Strategy 2007-2020 was also to improve energy efficiency to reduce imports and postpone the need for new investment.

In 2013, Jordan adopted its first NEEAP, which covered the period 2012-2014. It set a target of reducing energy consumption by 7.1% by 2014 (relative to the average consumption between 2006 and 2010). The target was divided across sectors: residential, industrial, commercial, water pumping and street lighting. The programme met with some success, reaching about 40% of the reduction originally targeted (Hamzeh, 2018). Jordan decided to update the NEEAP for the period 2018-2020, setting a target of reducing electricity consumption by 17.5% by 2020 (1 975 GWh) compared to the annual average electricity consumption of the five-year period 2010-2014. Half of the reductions will be delivered from the residential sector, followed by industry and commercial and services.

Bylaw 73 (2012) mandates energy audits for all large consumers. However, enforcement has been a key challenge. The JREEEF and Jordan Chamber of Industry have targeted financing programmes for energy audits; however, the penetration has been very low due to lack of enforcement and awareness. Industry-specific expertise is also lacking to conduct energy audits and draw meaningful lessons to develop tools such as a sector-specific energy-use index.

With lack of awareness and end-users' hesitance to spend on energy audits, improving the regulatory environment for energy efficiency service companies (EESCOs) and developing the capacity of industry-specific audit specialists should be pursued. With regard to the energy efficiency of industry equipment, incentives can play an important role in ensuring that certain standards are followed (e.g., import exemptions for equipment meeting set energy efficiency standards) without compromising the competitiveness of the industry.

In buildings, the Jordan National Building Council is responsible for the development of the building codes. The JGBG was issued in 2013, and an incentive programme for the adoption of green buildings was approved in 2015. The building guide has four levels (A to D), each offering a specific incentive in terms of increase in floor area ratio. Meeting Level D under the JGBG also ensures compliance with all other mandatory codes, such as the Jordan Thermal Insulation Code and Jordan Energy Efficiency Building Codes. In 2019, MEMR and JREEEF launched a programme to replace 150 000 units of lighting in homes (Khaberni, 2019). Energy labels have also been introduced for large household appliances since 2017. Despite a comprehensive set of codes and incentives, enforcement has been a key challenge that requires putting in place enforcement mechanisms and capacity for ensuring compliance, awareness and stronger incentives.

Energy efficiency programmes have already been rolled out by several ministries covering public buildings. The Ministry of Industry and Trade and Supply conducted audits for 17 institutions to identify energy efficiency interventions. The Ministry of Public Works and Housing, which manages all government buildings, has rolled out energy audits and efficiency measures across more than 500 buildings. Recommendations have been for energy audits and efficiency measures to be succeeded by renewable energy installations to reduce system sizing and costs. Light-emitting diode (LED) labs have been established at the Jordanian Institution for Standards and Metrology (JISM) and RSS to regulate the quality of LED lights imported into Jordan.

KEY CHALLENGES AND RECOMMENDATIONS

Diversification of Jordan's energy mix and reductions in the cost of energy are fundamental to ensure long-term industrial and socio-economic development. The Master Strategy for the Energy Sector 2020-2030 targets a share of 48.5% of primary energy from domestic sources, up from about 15% in 2019 (MEMR, 2020). Further, it sets a target of reaching a 31% share of renewables in the electricity generation mix by 2030 (MEMR,2019a). With increasing cost-competitiveness and abundantly available resources, renewable energy solutions will be instrumental in achieving the objectives of improving energy security, reducing the cost of energy supply for consumers and advancing environmental preservation. The transition to low-cost renewable energy will also strengthen Jordan's recovery from the Covid-19 crisis (Box 9).

Box 9. Contextualising Jordan's energy transition within Covid-19 recovery

The Covid-19 pandemic is compelling governments to simultaneously manage a health crisis of unprecedented proportions and the subsequent economic and social fallout. As governments deliberate on recovery plans amid significant public financing constraints, especially in emerging economies, strategic investment choices need to be made that yield long-term socio-economic dividends. In particular, the plans must foster economic development and job creation, promote social equity and welfare, as well as advance resilience to future shocks.

Due to a significant decrease in energy consumption as a result of the Covid-19 pandemic, the renewable energy sector has been negatively impacted. Following the lockdown, the network has been exposed to technical challenges which were the result of a decrease in electricity consumption at a time when there was an increase in electricity supply from renewables. This greatly affected the network and led to increased volatility and threatened the stability of the network. In addition, NEPCO reduced electricity consumption from government-owned renewable energy projects during the first period of Covid-19 to alleviate impact on the grid. Faced with this situation, renewable energy systems have been disconnected from all the sectors, including the health, tourism and communication sectors, which has resulted in great economic and financial losses for renewable energy companies.

To mitigate these effects, MEMR is working with all relevant stakeholders to reconnect renewable energy projects. The wheeling-based renewable energy systems were progressively reconnected and became fully operational over the period of March to May 2020, as the country eased Covid-19 restrictions and energy demand increased.

As the economy gradually reopens, Jordan is continuing to pursue its efforts to achieve a needed energy transition and reap its socio-economic benefits (EDAMA, 2020).

The acceleration of a renewables-based energy transition in Jordan is in alignment with its economic recovery plan, which centres on building up the manufacturing, transport, construction and agriculture sectors. A low-cost, secure and less-volatile renewable energy supply will also catalyse domestic industries, improve their competitiveness and support job creation throughout the economy. Savings from displaced imported fuels and a lower risk of supply disruption over the long-term can also be significant. With the impressive gains made over the past decade, the building blocks of such a transition are already in place in Jordan. The country is well positioned to leverage the transition and serve as a lighthouse for emerging economies globally.

With the necessary policies and regulations to support renewable energy development now in place, Jordan has experienced an impressive increase in the share of electricity from renewables, jumping from 0.7% in 2014 to over 13% in 2019. The Kingdom has in fact become one of the most attractive markets for renewable energy globally (Bloomberg NEF, 2019b). However, increasing the share of domestic resources in the energy mix in line with the targets and reducing the cost of supply will require continuing efforts to deploy and integrate renewables in the power sector, as well as in other end-use sectors (heating/cooling and transport), which account for over 75% of Jordan's energy consumption.

Building on an assessment of the country's renewable energy landscape and extensive stakeholder engagements, the RRA presents the key recommendations for Jordan to realise the full economic, social and environmental opportunity that renewable energy presents. It offers recommendations under seven thematic areas that address renewables applications in the power sector, for heating/cooling in buildings and industry, and transport. Renewable energy investments, local industry development and job creation are also addressed, as illustrated in Figure 17. The actions and recommendations presented under each thematic area are seen to be mutually reinforcing – the collective outcome of which is for renewables to reach a much higher share of Jordan's energy mix while improving energy security and reducing the cost of supply.

Figure 17. **Overview of key thematic areas of recommendations**

5.1 Provide the conditions for renewables to grow in the power sector

The Master Strategy for the Energy Sector provides a long-term vision for the evolution of the energy sector in Jordan. It identifies the key objectives for the energy sector; sets targets; and defines priorities for different domains of the energy sector, including oil and gas, renewable energy, energy efficiency, and transmission and distribution infrastructure. The update of the Master Strategy provides an outlook for the sector to 2030 and 2050 while also setting intermediate targets.

Action 1: Clarify the trajectory for renewables in Jordan's energy mix

The release of the updated Master Strategy provides stakeholders in the sector with clarity on the trajectory of renewable energy in the short-, medium- and long-term. The indefinite suspension of new projects over 1 MW since January 2019 has added to the uncertainty in the sector.

On the one hand, renewables are key to meeting the government's objective of increasing the share of domestic energy sources in the energy mix and reducing the cost of the energy supply. However, the renewable energy sector also faces several challenges to further expansion due to a confluence of factors at the level of the energy sector: sluggish electricity demand growth, high capacity margin and limited capacity on the grid.

The likelihood that renewable energy will reach much higher shares of Jordan's primary energy mix is closely intertwined with the trajectory of the broader energy sector. The Master Strategy addresses critical holistic issues, including the trajectory towards long-term viability of the power sector enabled by regulations that ensure cost-of-service recovery at all stages; electricity demand stimulation (e.g., through electrification of end-use sectors, elimination of energy poverty, cross-sector integration in water, agriculture, transport); rapid roll-out of storage and demand side management for smooth grid integration; as well as the incorporation of future fuels such as green hydrogen.

Recommended actions:

- Provide a vision for renewable energy sector development with medium- and long-term targets for renewables in the overall energy mix and end-use sectors (power, heating/cooling and transport). The long-term vision for renewables must include a just transition. Therefore, employment, economic welfare and land-use models should be integrated within the Master Strategy for the Energy Sector.

- Formulate disaggregated renewable energy targets for the industry, building, residential and transport sectors and integrate these within the NREAP for the implementation of the Master Strategy.

- Devise a plan for electricity demand stimulation through the electrification of end-uses, especially in industry, residential and transport, improving cross-sector applications (e.g., in water, agriculture) and addressing energy poverty.

- Strengthen multi-stakeholder consultation, especially with the private sector, civil society and cross-sector entities, during the formulation of the action plans, implementation bylaws and instructions. For example, Chile's Ministry of Energy incorporates citizen participation in every step of the long-term energy scenario (LTES) development. Meanwhile, in the United Kingdom, a co ordinated process is in place for both energy and climate (IRENA, 2019b).

- Pursue integrated plans and policies between ministries to reach the objectives of having high shares of renewables in the energy mix and a low cost of energy. Examples include partnerships between MEMR and the Ministry of Public Works and Housing to address enforcement challenges; MEMR and the Ministry of Water and Irrigation to develop pumped-hydro storage and replace diesel pumps with renewable energy; MEMR, distribution companies and the Ministry of Transport to develop a roadmap to strengthen distribution grid infrastructure to support electric vehicle charging stations; and with municipalities to advance urban planning that promotes the electrification of mobility and mass transport.

- Study the long-term potential of energy carriers, such as green hydrogen, and its use in industry and transport, where direct electrification and other renewable applications may not be feasible.

5.2 Foster the continued growth of renewable power generation

The power sector in Jordan has seen rapid uptake of renewable energy facilitated by enabling policies and regulations. Utility-scale projects have advanced through subsequent rounds of direct proposals, and substantial capacity is being deployed under the wheeling and net metering scheme, which is focused on the self-consumption of various end-consumers such as industries, commercial enterprises, public buildings and households. The impressive growth since the enactment of Renewable Energy and Energy Efficiency Law No. 13 of 2012 has highlighted the scale of opportunity in Jordan, with access to low-cost electricity from renewable energy as well as challenges related to integration.

Advancing further renewables growth in the power sector will require wide-ranging actions that focus on expanding the pipeline of projects under the various schemes with a focus on effective integration, as well as on addressing project development challenges and linkages to energy efficiency.

Action 2: expand the project pipeline through direct proposal, net metering and wheeling schemes

The current pipeline of utility-scale projects under the direct proposal scheme provides an outlook to 2021. The latest (third) round of the direct proposal auction took place in 2018, achieving record-low prices for solar PV (USD 0.0255/kWh); however, these are not reflected in the electricity mix yet. The realised prices for new solar are substantially lower than the average cost of electricity procured by NEPCO. Since the third round, there have been no further rounds. This is a result of several factors, including reduced power demand growth and excess capacity in Jordan's power sector. Under the right conditions, subsequent rounds of direct proposals could establish a pipeline of low-cost electricity from renewable resources, which could contribute to decreasing bulk supply costs in the long-term and positively impact electricity tariffs while also shoring up power demand.

Given the apparent limitations on the grid for integrating renewables and the oversupply in the power sector, a holistic approach may be needed to accommodate further renewables covering integration measures (e.g., storage, network upgradation), demand generation (e.g., electrification of end-uses) and energy efficiency. For instance, combining storage with on-site generation can help address variability and grid management issues for projects developed to cater to specific demands (e.g., industrial parks). Existing (e.g., in Qastal, Madaba and Sahab) and future industrial zones could pursue dedicated wheeling projects coupled with storage, building on the model followed for the Ma'an Development Area. For industry-specific wheeling projects, a key challenge is to ensure that the available grid capacity is equally accessible for all, including SMEs, non-energy entities (e.g., water utilities) and those most vulnerable due to the high cost of energy supply.

With significant annual electricity subsidies for agriculture, low-income households and SMEs, cost-effective distributed renewable energy solutions could represent a win-win solution for consumers and governments. Rooftop solar has substantial untapped potential in public buildings, including government offices, mosques, hospitals, commercial entities and residences. Government programmes have also been launched to deploy rooftop solar PV systems for small residential consumers currently under national welfare schemes. Such programmes should be scaled up to increase social impact, reduce consumer energy expenditure and limit government subsidy costs. The electricity tariff design and charges (e.g., wheeling rates) for renewable energy projects should accurately reflect the true cost of the services delivered by the network.

Recommended actions:

- Implement subsequent rounds of direct proposals to develop a long-term renewable energy project pipeline, and reduce bulk power costs and tariffs for end-consumers. Subsequent rounds will be conditional upon an increase in electricity demand and the availability of grid capacity for large-scale projects.
- Support the development of dedicated areas for new wheeling projects for large consumers, building on the model of the 100 MW community solar PV for the industrial sector. Ensure available capacity on the grid is equally accessible, including for SMEs and those most vulnerable to the high cost of energy.

16 Annual electricity tariff subsidies for the agriculture sector amount to JOD 40 million, while those for small-scale industries are JOD 29 million and medium-sized industries are around JOD 50 million (Jordan Times, 2020b).

- Support the development of small-scale renewable energy projects to maximise social impact and reduce energy expenditure.

- Design renewable energy projects with a focus on effective grid integration through hybrid solutions (e.g., solar-storage, solar-wind) building on lessons from existing storage projects in Jordan. IRENA finds that renewable energy hybrid projects have higher capacity utilisation factors and make more use of the grid, thereby reducing grid integration costs. In 2018, India's Ministry of New and Renewable Energy issued a National Wind-Solar Hybrid Policy that sought to optimise the utilisation of infrastructure and better match the generation of renewable energy with the demand profile. Not only was the project able to meet a capacity factor of 30%, the bids received for the nationwide auction were as low as USD 38.7/MWh (IRENA, 2019a).[17]

- Activate existing bylaws and instructions for the adoption of rooftop solar PV and energy efficiency solutions in government buildings through a combination of incentives and enforcement. In this regard, address the challenge of outstanding bills to distribution companies that inhibits government buildings from connecting rooftop solar PV to the grid through tailored repayment schemes or public financing outlay.

- Assess and support renewable energy other than solar PV and wind, including geothermal and waste-to-energy for municipalities, as well as applications across sectors (e.g., replacement of diesel pumps for irrigation, water supply pumping systems).

Action 3: Address project development challenges

Lengthy approval processes and project development timelines increase developers' transaction costs and risks. These affect utility-scale and small-scale projects differently. The time between an expression of interest and project commissioning can be several years, and efforts are needed to establish a fixed milestone-based timeframe. For renewable energy projects where interaction with distribution companies is required, it is important that EMRC ensures the processes are streamlined across the companies and simplified for small and zero feed-in systems.

For utility-scale projects, land acquisition can be a challenge for developers. Standardising land acquisition processes by pre-developing sites – such as the Ma'an Development Area and Mafraq Development Area for utility-scale solar PV projects – including the development of grid interconnection infrastructure, conduct of sector-specific environmental and social impact assessment (e.g., bird migration studies in the case of wind) and completion of land acquisition, can level the playing field for the private sector participating in future tender processes. At present, the private sector integrates perceived land acquisition costs into their bids, which may affect fair competition.

A key challenge for the development of net metering projects is the waiting period for applications and subsequent smart-meter installations. Applications for the development of projects are submitted to the distribution companies, which then undertake a review and conduct the requisite technical and grid impact studies. Waiting periods for applications, GIS and smart metering installations can be time-intensive (up to three months) even for smaller projects (e.g., 10 kW). Distribution companies are faced with high loads of applications, having approved over 15 300 applications by the end of 2019. Developers could potentially bring in third-party studies; however, there are several challenges to this such as lack of data and software availability with third parties and a trust issue wherein studies conducted by the distribution companies are preferred.

Recommended actions:

- Consider the use of online platforms for project developers of net metering and wheeling projects to complete all necessary processes. Simplified processes and a separate grid code may be designed for small and zero feed-in systems.

- Introduce a clear plan to reduce the waiting period for applications and smart metering installation. Consider augmenting in-house capacity within distribution companies to undertake GIS and reduce time for processing.

- Improve access to outcomes from grid impact studies and consider conditional approvals for projects based on certain pre-requisites (e.g., integration of storage, control systems).

17 In May 2020, a record-low bid of INR (Indian rupee) 2.9 per kWh (USD 0.038 per kWh) for the first year (with 3% escalation each year) was received for 400 MW of "round-the-clock" supply through wind, solar or hybrid solutions with storage: www.rechargenews.com/transition/india-hails-renewable-milestone-after-first-deal-for-24-7-green-power/2-1-806047.

- Separate city planning requirements from the process of securing a connection to the distribution grid for small-scale renewable energy projects.

- Engage local communities around project sites to maximise social impact. In this context, IRENA's Renewable energy auctions: Status and trends beyond price (IRENA, 2019a) finds that community involvement can increase social acceptance and minimise land acquisition processes. In South Africa, project developers are required to submit evidence to support community engagement and benefit sharing guideline that includes a social risk analysis, a community engagement strategy, a benefit sharing program, and letters of support as well as reporting, monitoring and evaluation plans (IRENA, 2019a).

- Develop and issue instructions for land use for renewable energy projects. For utility-scale and wheeling projects, pre-developing sites and allowing entities like the Ma'an Development Authority to provide infrastructure management can level the playing field for the private sector participating in the auction process.

Action 4: Strengthen linkages to energy efficiency

Renewable energy and energy efficiency should be pursued in tandem. The Energy Efficiency Bylaw No. (73) for the year 2012 and the NEEAPs have provided the foundations for advancing energy efficiency measures in the Kingdom. Some linkages between renewable energy and energy efficiency were made by design, with the Energy Efficiency Bylaw No. (73) making compulsory the instalment of solar water heaters from April 2013 on pre-specified buildings. Enforcement, however, has been a key challenge, as discussed further in Chapter 5, Section 3.

Bylaw No. (73) also mandates energy audits for all large consumers. The JREEEF and JCI have targeted financing programmes for energy audits; however, the penetration has been limited. A key challenge has been that the bylaw outlines that MEMR bear responsibility for reviewing the audits, but MEMR has limited capacity to review thousands of energy audits annually. Shifting this responsibility to entities with sufficient capacity, such as JISM, may be considered.

For buildings, the building codes issued by the National Building Council need to be enforced. The JGBG was issued in 2013, with an incentive programme for the adoption of green buildings being approved in 2015. Meeting Level D of the JGBG is equivalent to abiding by all the codes. Despite Jordan's comprehensive energy efficiency framework, challenges of enforcement remain to be addressed.

Large-scale improvements in efficiency across the energy sector and the wider economy directly impact primary energy needs, thereby directly reducing the need for fuel imports. In power generation, for instance, combined heat and power applications can drastically improve efficiencies and offer cost-effective energy alternatives, especially in industries where both electric and thermal energy is consumed. Pilot projects already exist, such as in Wadi Shalala in Irbid. However, dedicated regulations are missing to scale up the adoption of such solutions.

On the consumption side, progress has been made on energy efficiency through dedicated programmes to deploy LED street lighting in municipalities and replacement of inefficient lighting in households. The Ministry of Public Works and Housing, which is responsible for all government buildings, has also rolled out an energy audit and energy efficiency programme. Benefiting from the experience, energy efficiency programmes can be substantially scaled up with substantial cost-saving opportunities for end-users, especially government buildings.

Recommended actions:

- Improve compliance of industry, commercial and public buildings, as well as households, with existing codes and the Energy Efficiency Bylaw. This can be achieved through a combination of well-designed strict penalties and incentives devised by MEMR.

- Ensure effective implementation of the NEEAP 2018-2020 and reporting on periodic basis while also working towards issuing the update to the NEEAP beyond 2020.

- Incentivise compliance with JGBG in Jordan's building sector. Support thermal insulation inspection for new construction in co ordination with the UNDP's ongoing programme in Jordan.

- Improve compliance with energy audit requirements for large industry consumers. MEMR should ensure that multiple licensed and specialised entities are available to specific industries to undertake the audits.

- Develop capacity within the industrial sector to implement energy efficiency (and renewable energy) measures. Based on findings from energy audits, consider development of industry-specific benchmarks and best practices.

- Encourage the adoption of energy-efficient equipment in industries with due consideration for their market competitiveness.
- Scale up the adoption of energy-efficient streetlights and replacement of inefficient residential lighting, building on the programmes being undertaken by municipalities and MEMR.
- Introduce dedicated regulations and codes for combined heat and power applications that can substantially increase energy efficiency by building on existing pilot projects. A dedicated heat law would enable NEPCO to sell heat as a commodity as with electricity, thus equipping itself with the ability to supply industrial areas with electricity and heat through combined heat and power.

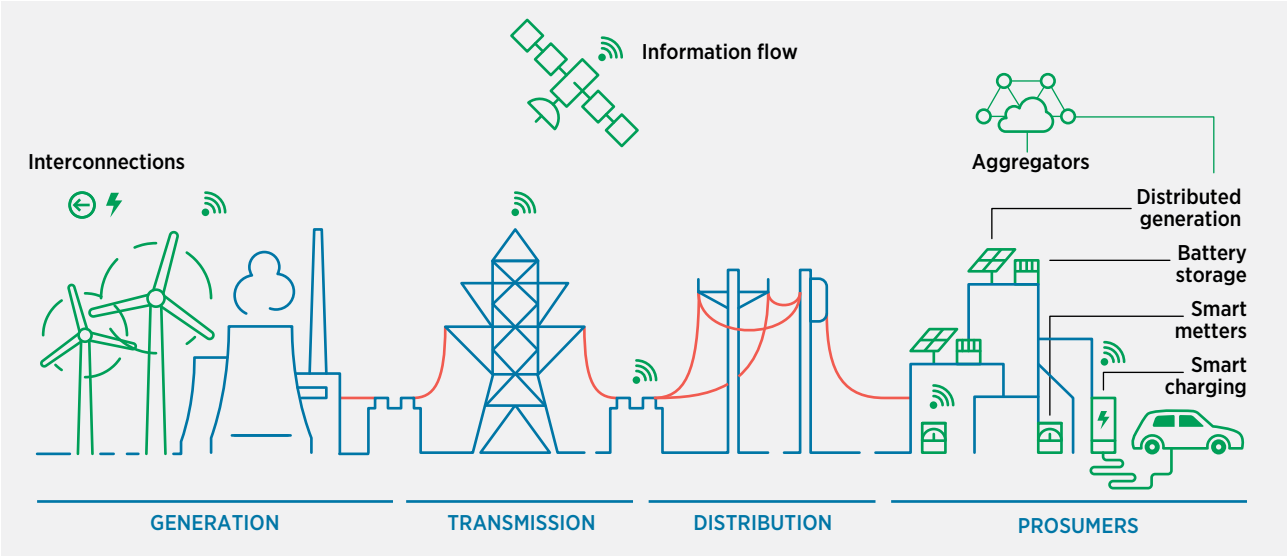
5.3 Plan for the integration of higher shares of renewable power

The share of electricity from renewables in Jordan's power mix has grown rapidly over the past decade. Concerns have emerged over the ability of the power system to integrate renewable shares well beyond 25%, resulting in the suspension of new projects over 1 MW and no additional direct proposal rounds since 2018. The integration challenge is further exacerbated by slow electricity demand growth and the nature of "take or pay" PPAs with conventional IPPs, resulting in capacity charges and adding to integration costs.

Addressing the integration challenge will require a wide range of actions to improve overall system flexibility in the short-, medium- and long-term. In Jordan's context, these include building and upgrading transmission and distribution infrastructure, deploying battery and pumped-hydro storage, promoting demand-side management, and incentivising electrification of end-uses. These measures cannot be pursed in silos and must form part of a holistic strategy to improve the flexibility of the power system to integrate higher shares of renewables. Several tools are now available to analyse the flexibility needs of a power system (e.g., IRENA's FlexTool) and identify the least-cost flexibility solutions and integrate within the strategy.

The integration challenge requires a wide range of actions to improve system flexibility. These include building and upgrading transmission and distribution infrastructure, battery and pumped-hydro storage, promoting demand-side management, and incentivising electrification of end-uses.

Figure 18. **Innovative solutions in power system**



Source: IRENA (2019c)

Action 5: Strengthen national transmission and distribution infrastructure

The lack of transmission and distribution infrastructure capacity to handle higher shares of renewables is a key hurdle to further growth. Strengthening networks involves the development of dedicated transmission corridors between areas with high concentrations of renewable energy projects and load centres, upgrades to existing distribution infrastructure to accommodate higher shares, as well as improvements in grid management to reduce losses and enable active load management.

As seen in the case of the yet-to-be-commissioned Green Corridor project for transmission of renewable power from the south of the Kingdom, the development timeframe for such infrastructure is long (usually five to six years). Therefore, long-term planning is needed to align the timelines of infrastructure development with those of new utility-scale projects and load centres (e.g., industrial zones) to ensure power is evacuated in a timely way. With the Kingdom faced with sluggish demand growth and high capacity factors, measures for demand creation and enhancement of regional electricity trade building on existing agreements. The majority of the net metering and wheeling projects connect to the distribution grid, large parts of which are congested. Strengthening distribution networks, coupling generation with storage and adopting digital technologies (e.g., smart meters, supervisory control and data acquisition [SCADA] systems) can support integration of higher shares of renewables. These measures can also allow effective load management, which is necessary with large-scale electrification of end-use sectors such as transport.

Recommended actions:

- Upgrade the transmission network and system management to manage future increases in the share of renewable energy and electrification of end-uses. Other ministries related to industry, agriculture, transport and water are crucial for identifying regions with existing and upcoming power demand potential.

- Expedite the commissioning of the Green Corridor for transmission of renewable power generation from the south of the Kingdom. Greater focus is needed on transmission infrastructure requirements in the east for future renewable energy projects.

- Continue to focus on regional infrastructure development to facilitate electricity trade, building on recently signed agreements with different countries.

- Identify priority areas within the distribution network – especially in industrial zones – with high congestion, in the short-term. Mobilise investments to strengthen infrastructure and unlock further network capacity to integrate renewables and other loads such as from electric vehicle charging stations.

- Increase the rate of penetration of smart meters to improve grid management, building on the successes of distribution companies such as IDECO.

- Upgrade NEPCO control centre and, building on rollout of smart meters, issue regulations and bylaws for smart grid implementation. These measure should be led by EMRC, in consultation with NEPCO and the distribution companies, to improve grid monitoring and maintenance and thereby to reduce losses and downtime.

- Develop a strategy for data and knowledge management to leverage data emerging from smart meter rollout and better understand consumption. Such data form the bedrock for the implementation of smart grids and facilitates reaping the full benefits of grid digitisation.

Action 6: Introduce storage code for grid management at the transmission and distribution level

Storage brings substantial value for grid management as a stand-alone asset as well as when integrated with a renewable power supply. Battery and pumped-hydro storage can reduce the variability of renewables, increase self-consumption (even enabling "zero-to-grid" installations in some cases), reduce peak-load demand and allow load-shifting. When deployed as part of a holistic strategy, storage also has the potential for reducing the investment needs in transmission and distribution infrastructure to integrate higher shares of electricity from renewable energy.

While Jordan has had a 23 MW/12.6 MWh Li-ion solar-battery project operating since February 2019, the main shortcoming for the future growth of storage in the Kingdom is the lack of a regulatory framework to support large-scale deployment at the generation, transmission, distribution and end-user levels. The current scope of energy storage projects is largely utility-scale, with high untapped potential for combining storage with distributed renewables in buildings (public, private and commercial), and small and medium-sized industry. The regulation is important to guide investments in storage with private sector participation, as well as to create

market mechanisms for storage solutions to provide additional grid services related to demand response, ramp controls, ancillary services and power quality.

Recommended actions:

- Conduct a comprehensive flexibility needs assessment to identify least-cost storage solutions, including battery storage, pumped-hydro needed at the transmission, distribution and end-user levels, and supply-side flexibility (e.g., CSP with molten salt storage).

- Formulate a dedicated storage code to provide the regulatory guidance for the development of battery storage infrastructure at the generation, transmission, distribution and end-user-levels and instructions to connect to the grid. The actions have to be taken by MEMR and EMRC in consultation with the system operator (NEPCO), distribution companies and other stakeholders with relevant experience.

- Integrate utility-scale and distributed energy storage into the overall Energy Sector Master Strategy, including targets, which clarifies the services storage can provide within the power sector (e.g., spinning reserve, arbitrage, load-shifting, peak shaving) and the remuneration models.

- Prioritise the development and financing of combined renewable energy and storage projects in regions where grid congestion is high and low-cost energy supply is a priority (e.g., industrial zones, SMEs, public buildings).

- Take steps towards the implementation of a project in collaboration with the Ministry of Water and Irrigation Building on outcomes of the assessment of reservoirs for developing pumped-hydro storage conducted under the EU-funded Renewable Energy and Energy Efficiency II Programme.

Action 7: Improve load management through demand side solutions

The increasing share of variable renewable power in Jordan's electricity mix will require active measures to match (existing and new) demand and supply in an optimum manner that reduces overall system costs (e.g., need for peaking plants) and incremental integration infrastructure investment. At present, there is no peak-load strategy, which leads to expensive, flexible generation (e.g., diesel, oil-fired generators) being procured during high-load times to balance demand and supply. This increases the overall cost of electricity supply and, if passed on to consumers, would be reflected in rising consumer tariffs.

Further demand-side management measures could shift parts of the load to non-peak times of the day with use of incentives such as time-of-use tariffs. With the growth in demand for electric vehicles, for instance, offering lower charging tariffs during high solar generation/low-load times (11 a.m. to 2 p.m.) can facilitate load shifting and reduce peak load demand. At the same time, the cost of charging can be substantially higher during off-peak solar periods, leading to increased revenues for the electricity companies.

Recommended actions:

- Develop and implement a renewable energy peak-load strategy to address peak demand in buildings and industry through solar PV and storage, when competitive with expensive peaking plants.

- Set targets for renewable energy and storage to meet a certain share of peak-load demand.

- Assess the feasibility of time-of-use tariffs to facilitate demand shifting towards low-load periods. Incentivising electric vehicle charging and high industrial loads during low-load/high-renewable generation periods with low tariffs, and correspondingly higher tariffs during high-load periods, can support integration efforts.

- Create new demand streams from electric water heaters. In Oregon, a smart grid enables water heaters to be fitted with a two-way communication response system such that a "fleet" of water heaters can be used as a virtual battery (Routefifty, 2020).

5.4 Incentivise the use of renewables for heating and cooling

As discussed in earlier chapters, the power sector accounts for less than a quarter of Jordan's final energy consumption. Increasing the share of domestic resources in the Kingdom's energy mix and reducing the cost of energy requires a stronger focus on the

use of renewables for meeting energy needs for heat across different end-use sectors. The use of renewables to meet heating energy needs has largely involved solar water heating systems for domestic applications and, to a lesser extent, concentrated solar heating solutions to provide process heat in industry. Despite successful programmes, there is still large untapped potential for renewables use for heating/cooling.

Action 8: Support greater adoption of renewable solutions in industry and buildings

Solar water heating applications remain the most mature form of renewable use for heating/cooling, mainly in the domestic sector. The solar water heater programmes in Jordan have successfully installed over 26 000 systems (as of 2018), and these should be supported to continue deployment in the domestic sector. Some of the challenges faced include the lack of targets for deployment, lack of enforcement of mandates and codes, and absence of long-term financial incentive programmes for end-users.

There is also substantial untapped potential across other end-use segments such as commercial and public infrastructure (e.g., hotels, swimming pools). This is also the case in industry, with CSP and CSH solutions meeting process heat needs. Several installations are already in place in pharmaceutical and tobacco plants, among others. In industry, such solutions have the potential to substantially reduce the need for traditional fuels such as LPG, electricity and coal. On the one hand, awareness of the economics and applications of renewable heat in industry and commercial sectors is limited on the part of both end-users and local vendors.

On the other hand, there is a lack of a dedicated heat bylaw to provide long-term targets for various renewable heat applications across domestic, industry and commercial sectors and to lay out the mechanisms for deployment. The enforcement of the Bylaw for Energy Efficiency and the Jordanian Code for Thermal Insulation, among others, plays a complementary role by reducing loads and sizing of systems, as well as by facilitating energy audits and raising awareness.

Given Jordan's climatic conditions, meeting heating and cooling requirements in areas faced with energy poverty is a key challenge.

The Royal Initiative for Heating in Schools represented an important step to tackle this challenge, utilising distributed renewable energy solutions for delivering heating and cooling services, while also improving insulation of school buildings, among other infrastructure upgrades. The programme has the potential to be scaled up to include other public buildings and households faced with energy poverty.

Recommended actions:

- Develop a clear, long-term solar water heater penetration strategy for the domestic, commercial and industry sectors backed by targets building on lessons learned from the programmes implemented in 2018 and 2019. The data collected from the sales of such systems should be collected and reported regularly as part of the Annual Report of the MEMR.

- Develop a programme for incentivising and enforcing existing and new facilities that are using conventional boilers for heat (e.g., in swimming pools and industrial processes) to shift towards renewable energy.

- Address enforcement challenges by developing a mechanism to improve compliance with existing mandates through a combination of penalties, incentives and creating sufficient capacity within institutions (e.g., training of staff/inspectors on the use of Monitoring, Reporting and Verification (MRV) protocols).

- Implement the JGBG (Level D), which includes compliance with all mandatory building codes.

- Support capacity building of architects for the development of solar roofs.

- Gather data from industries using renewable energy solutions, including CSH and water heaters, to conduct industry-specific techno-economic feasibility studies to increase awareness and inform target setting.

- Improve awareness among local suppliers and manufacturers on renewable energy-based heating/cooling technology applications, specifically in industry.

- Make accessible and affordable infrastructure for testing and certification of technology through specialised entities such as the RSS. Quality marks and logos, such as the SHAMCI developed for solar water heaters jointly by MEMR, NERC, JSMO and RCREEE, need to be devised for various technological applications.

- Build on the success of the Royal Initiative for Heating in Schools by expanding the coverage of renewable energy solutions among buildings and households where energy poverty is prevalent.

5.5 Support renewable options for transport and mobility

The transport sector is the largest energy consumer in Jordan and is reliant mainly on crude oil derivatives such as diesel and gasoline. Government efforts to decrease energy use in the sector have primarily relied on incentivising high efficiency vehicles, including non-plug-in hybrids and fully electric vehicles. While the adoption of hybrid and electric vehicles has grown rapidly over the past few years, they still represent a small share of the overall transport fleet. Rapidly scaling up the use of hybrid and electric vehicles will require a holistic approach that focuses on different vehicle segments, concurrent charging infrastructure development and smooth integration with the grid. Additionally, other domestic energy sources also need to be tapped, including gaseous and liquid biofuels, as well as green hydrogen in the long-term.

Action 9: Start to diversify energy use in the transport sector

To reduce reliance on imported fuels and tackle environmental pollution, the government has since 2008 offered varying levels of incentives to support the adoption of hybrid and electric vehicles. This resulted in the purchase of over 30 000 such private vehicles by the end of 2019. However, this represents a small fraction of the overall fleet of road transport in the Kingdom. The adoption of electric vehicles remains highly sensitive to fiscal incentive schemes introduced by the government, and sales have fluctuated with changes in policy.

The economic and environmental case for electrifying fleet vehicles, in particular public buses and fleets, is stronger than the case for private vehicles. It offers the opportunity to benefit from economies of scale, higher utilisation of vehicles and displacement of polluting vehicle stock (e.g., public buses). Aside from initiatives taken by various municipalities, there is presently no incentive or regulation that encourages the shift. Furthermore, awareness of the techno-economic and environmental opportunity presented by the electrification of fleets is limited. This lack of awareness potentially impacts key decisions related to upcoming public transport procurements, including the Amman Bus Rapid Transit.

The development of charging infrastructure – a critical feature of the electric vehicle ecosystem – has lagged. EMRC was the first in the region to introduce instructions for licensing electric vehicle charging stations in 2014, but their rollout has not kept pace with the requirements necessary to meet a rapidly growing market segment. There is an urgent need to improve the business case for private sector participation in charging infrastructure development in partnership with distribution companies and municipalities.

The rapid growth of electric vehicle adoption offers both challenges and opportunities. Incentivising electrification of the transport sector provides the benefit of coupling with cost-effective renewable power and addressing slow electricity demand growth. However, increasing charging load during non-solar peak hours will place additional burdens on the grid. Through measures such as time-of-use pricing, charging can be incentivised to take place during low-load hours and peak solar PV generation. With smart metering and digitisation, electric vehicles also have the potential to participate actively in providing grid services, including storage.

To harness these opportunities, however, a long-term energy diversification strategy for the transport sector is necessary that also considers other alternatives such as biogas for large municipality vehicles and green hydrogen. The Ministry of Transport will be the nodal agency at the national level responsible for integrating alternate mobility solutions within the national transportation strategy. Experience from emerging economies is now available on designing holistic electric vehicle policies that include long-term targets (by segment), incentives for vehicles, models for private and public charging infrastructure development, vocational training, and research and development. Furthermore, end-of-life management of batteries also needs to be considered for sustainable recycling and disposal. The absence of such a strategy and the lack of a clear roadmap with targets and siloed policies are substantially slowing down the energy transition in the transport sector.

Recommended actions:

- Devise a long-term energy diversification action plan for the transport sector in line with Jordan's Master Strategy for the Energy Sector and the Long-Term National Transport Strategy.[18] The plan should include targets for an appropriate mix of alternative fuels such as renewable electricity, liquid and gaseous biofuels, as well as green

hydrogen. Such a strategy should be backed by stable policies and incentives.

- Develop a holistic electric vehicle policy to facilitate adoption and reduce air pollution. The policy should include targets and stable incentives for the electrification of public transport, fleets and private vehicles and address charging infrastructure development and capacity building for O&M.

- Introduce mandates for large fleet owners to transition to electric vehicles and put in place adequate measures to facilitate the transition, building on the experience of GAM.

- Conduct a comprehensive techno-economic and environmental assessment of electric public buses and undertake pilot projects to inform decision-making regarding upcoming public transport procurements.

- Identify the most appropriate business models for rapidly scaling up public and private charging infrastructure development led by the private sector, distribution companies (as non-core business) and municipalities.

- Integrate electric mobility within the Jordan National Building Code, incentivising existing and new buildings to develop necessary infrastructure for distributed charging.

- Adapt the licensing instructions issued by EMRC in 2014, as well as the electricity tariff structures for charging stations to improve the business case for private sector investments.

- Adopt a holistic strategy to effectively integrate electric vehicles into the power system by offering low-cost tariffs for charging during peak solar PV between 11 a.m. and 2 p.m. Furthermore, devise an electric vehicle-to-grid strategy that integrates electric vehicles into providing grid services, including storage and demand-shifting, enabled by smart metering and digitisation.

- Plan for end-of-life management of lithium-ion batteries with increasing electric vehicles and associated capacity building, including re-use for stationary electricity storage applications (stand-alone or grid-connected applications).

- Support the development of alternative fuels such as liquid and gaseous biofuels (e.g., for large municipality vehicles) and green hydrogen for segments of the transport sector, such as large freight, for which electrification is not feasible.

5.6 Catalyse Renewable Energy investment

With the expansion of the renewable energy sector since 2012, investment flows have grown rapidly, reaching a cumulative USD 5 billion by the end of 2019 (MEO, 2020). The bulk of investments have been from international sources, involving both commercial and development finance. Several factors have limited the mobilisation of domestic financing for the sector. These factors include a lack of capacity and skills within local banks to project-finance utility-scale renewable energy projects, the scale of investments required, and the ability of international project developers to secure more attractive capital from external sources. However, with strong support from donors and development finance institutions, local commercial banks and co-operatives have played a catalytic role in the implementation of public financing schemes for small-scale renewable energy applications, such as rooftop solar PV and solar water heaters, through the CBJ and the JREEEF programme. Financing has also been made available to conduct energy audits in large energy consumers.

To scale up renewable energy adoption, much greater levels of domestic capital will need to be mobilised in both the utility-scale and distributed power sectors, as well as in transport and heating/cooling sectors. Substantial investments will also be needed in energy efficiency and complementary infrastructure development, such as electric vehicle charging infrastructure, transmission and distribution grids, and storage. With a strong track record of international financing institutions participating in Jordan's renewable energy sector, focused attention is needed to increase the capacity of local financing institutions to mobilise greater capital for the sector.

Action 10: Build the capacity of local financing insitutions and project developers

While some local banks are co-financing large projects with multilateral development banks, local financial institutions are still not very actively involved with utility-scale renewable energy financing. This is especially true of financing related to projects that

18 http://www.trt.it/en/PROGETTI/development-of-long-term-national-transport-strategy-for-jordan/

require larger volumes of investment, longer tenor and unique documentation. Over time, capacity is being developed as understanding of the sector improves. On-lending and risk mitigation facilities by international financing institutions, including multilateral development banks and national development banks, can play a key role in increasing the experience of local banks and mobilising larger shares of domestic capital for renewable energy development.

Beyond financing renewable energy projects, large investment needs exist for energy efficiency (e.g., LED lighting, industrial equipment replacements) and complementary infrastructure development (e.g., distributed storage, electric vehicles, charging infrastructure). The distributed nature of these investments means that local financing institutions will have to play a fundamental role in designing financing products to meet these investment needs. For instance, vehicle financing departments within banks must consider dedicated lending lines for electric vehicles, home loan financing to be linked with rooftop solar and enterprise financing with energy efficiency investments. The lack of capacity within local banks to understand emerging financing opportunities strongly inhibits their ability to design tailored products and services for various consumers.

Capacity gaps also exist among developers and proponents of renewable energy projects. The limited skills to prepare project documents, develop business plans, undertake accurate project costing and seek financing are leading to low-quality proposals reaching financing institutions.

Recommended actions:

- Develop the capacity of green lending units in local commercial banks with regard to renewable energy and energy efficiency as well as new technologies (e.g., storage, electric charging infrastructure, energy efficiency in industries). The increased capacity should improve the implementation of programmes from JREEEF and CBJ, as well as access to additional international financing (e.g., climate finance). This can be undertaken in collaboration with the Association of Banks.

- Increase awareness among financing institutions (including branches of banks) on the scope of technologies covered under various financing programmes.

- Encourage international financing institutions, including multilateral development banks and national development banks, to establish co-lending and risk mitigation facilities to increase the experience and exposure of local banks to the renewable energy sector.

- Design capacity-building initiatives for developers on the preparation of bankable project proposals and business plans covering renewables, energy efficiency and emerging technologies (e.g., storage).

- Consider lending requirements for local banks to meet in certain priority sectors, including renewable energy.

Action 11: Improve access to public financing programmes

To support the implementation of Law No. 13 of 2012 concerning the Renewable Energy and Energy Efficiency Law and subsequent revisions, several public financing schemes have been established with the involvement of the CBJ, JREEEF, co-operatives, commercial banks and donors.

The CBJ's concessional financing facility is delivered through commercial banks for an amount up to JOD 4 million. A challenge faced in accessing the financing is that the loans can be accessed only by end-consumers and not by the project developers themselves. Some end-consumers are unwilling to take on debt leading to less uptake, while the programme also does not benefit from portfolio lending to project developers. Other challenges faced by project proponents are the varying levels of awareness among local bank branches on the terms of the programme and their capacity to evaluate proposals in a timely manner. Finally, the due diligence standard applied while assessing project applications is the same, irrespective of the magnitude of financing sought, leading to long lead times and higher transaction costs for smaller projects.

Regardless, the CBJ concessional lending facility has received a strong response and has played a catalytic role in developing projects not large enough for project financing and yet not small enough for alternative financing programmes by JREEEF and donors. Tailored lending facilities with higher investment limits and provisions for allowing portfolio lending could play a crucial role in accelerating the deployment of renewables and energy efficiency across sectors (e.g., in industry, commercial, transport).

JREEEF's scope of coverage applies to small-scale

systems and is largely capitalised by domestic funds and contributions from international financing institutions and donors. JREEEF has successfully implemented a number of financing programmes covering solar water heaters; rooftop solar for households, public buildings and commercial entities; heating for schools; and energy audits for industry. In implementing the financing programmes, JREEEF has partnered with several entities including CBOs for installing over 20 000 solar water heaters. In the next phase of the programme for solar water heaters, JREEEF is partnering with commercial banks, which is presenting challenges given the lack of awareness and capacity within banks to implement small-scale lending programmes.

Recommended actions:

- Design tailored lending facilities with higher investment limits and provisions for allowing portfolio lending to support deployment across specific sectors (e.g., in industry, commercial, transport) in partnership with development finance institutions and building on the experience of the CBJ programme.

- Develop differentiated due diligence standards for proposals seeking financing from commercial banks depending on the size of the project to reduce time and transaction costs for smaller projects.

- Introduce sector-specific funding facilities for renewable energy applications, such as solar water heaters, building on the JREEEF experience and under various models such as ESCO.

- Design incentives for renewable energy solutions based on instruments, such as revolving funds, that reduce uncertainty for the private sector and consumers and contribute to long-term market development. Lessons can be drawn from the implementation of the revolving fund for solar water heaters, such as in the projects of Co-Water in Ajloun and Deir Alaa.

- Increase awareness among consumers on the new programme launched by JREEEF for solar water heaters in October 2019.

- Ensure capitalisation of existing funds, such as JREEEF, utilising domestic and international financing to support long-term market development.

5.7. Strengthen local renewable energy industries and job creation

Renewable energy technologies offer the opportunity to reduce the cost of energy in Jordan, while also contributing to energy security and environmental preservation objectives. The benefits of the energy transition can be maximised by ensuring the active participation of the local renewable energy industry, thus contributing to job creation and wider socio-economic benefits. Jordan's renewable energy industry has strong foundations, with hundreds of registered companies employing several thousand people across different segments of the value chain. Targeted actions can ensure that local industry has the right ecosystem to provide the diverse products and services needed for the energy transition in Jordan, as well as on the regional and global scale.

Action 12: Leverage capacity from other sectors and maximise renewable energy job creation

A renewable energy-based energy transition offers the opportunity to develop new manufacturing and non-manufacturing industries and generate employment opportunities. Achieving these benefits requires a broad mix of policies beyond those that focus on deployment alone. These include, for instance, industrial policies, skills development, and research and development.

The Kingdom has implemented several initiatives to support local industry development, including the introduction of local content requirements. The existing domestic manufacturing base for renewables is strong in some areas – modules, cables, mounting structures and solar water heaters – with several new opportunities (e.g., solar water heating with PV, single axis tracking and bifacial modules).

However, local enterprises continue to face several challenges. A key determinant of domestic manufacturing's attractiveness is the size of the local and export market. At the local level, abrupt policy changes, in particular the suspension of new projects over 1 MW, have negatively impacted the market growth potential of local enterprises. The updated Master Strategy for the Energy Sector is expected to offer clarity for domestic and international investors to plan for capacity augmentation locally, as well as product/service diversification to cater to local and regional markets. While a local content regulation is in place,[19] its definition, effectiveness, and influence on cost and quality need to be closely assessed.

Aside from the manufacturing of renewable energy technologies, several new opportunities for value creation exist. These range from various O&M, design, engineering and financial services to the development of new solutions such as industrial automation, smart metering and hydrogen infrastructure. A key challenge for the sector is also building adequate skills to meet the needs of a rapidly growing renewable energy sector. Identifying future skills needs and partnering with training institutes, universities and industry are important steps for developing curricula and delivering quality training for the workforce. Skills development and training opportunities should be equally accessible to both men and women, with a view towards greater participation of both genders in the renewable energy workforce.

Recommended actions:

- Devise a comprehensive industrial policy providing a vision for the development of a robust local industry (manufacturing and non-manufacturing, including O&M) around renewable energy, energy efficiency and complementary solutions (e.g., storage, smart grids, green hydrogen).
- Provide a longer-term outlook for renewables demand to enable the private sector to plan for capacity augmentation and product/service diversification.
- Review existing public procurement processes to identify design features, such as origin of equipment requirements, that present challenges for local suppliers to participate in the sector.
- Strengthen the export incentives available for local renewable energy products and services, building on regional agreements such as the Joint Arab Market.
- Assess how local content regulations and their definition, effectiveness, and influence on cost and quality can be optimised.
- Develop innovation hubs and pilot projects to address solutions needed for renewable energy integration across sectors to build knowledge and experience.
- Create a national master plan for the development of local job creation in the renewable energy industry in collaboration with the MEMR, the Ministry of Higher Education and Scientific Research, the Ministry of Labour, the EMRC and the Ministry of Industry, Trade and Supply. The master plan should identify future skills needs across the renewable energy value chain, including manufacturing and O&M, as well as complementary technologies such as battery storage and electric vehicles.
- Focus on education and training programmes and partnerships between universities and industry to ensure skills availability in the sector.

Action 13: Raise awareness and strengthen the information base on renewable energy

The lack of awareness among different stakeholders on the costs, benefits and opportunities of renewable energy solutions is a key impediment for the expansion of the sector. The sector is rapidly evolving, with costs falling and new technologies and applications emerging for residential, commercial, industry and transport end-uses, leading to information asymmetry among policy makers, industry and consumers. This directly impacts effective decision-making and the uptake of renewable energy solutions despite a strong economic case for adoption. Lack of awareness is also seen among consumers regarding existing policies and financial incentives offered by the government. Integrating much higher shares of variable renewables, creating end-user awareness, changing behaviours and fostering the ability to adopt new technologies (e.g., electric vehicles) will be crucial for successfully diversifying Jordan's energy mix.

Access to up-to-date data is important for planning, effective decision-making and developing awareness programmes. Yet disaggregated data related to energy use and consumption at the subsector level is not easily accessible. In industry, for instance, access to plant-level energy use data can be instrumental for national and regional benchmarking, for informing planning processes at the national level as well as for assessing the viability of renewable energy and energy efficiency measures. The enforcement of requirements for energy audits under the Energy Efficiency Bylaw No. (73) for the year 2012 already provides a sound basis to gather standardised data disaggregated at the industry level.

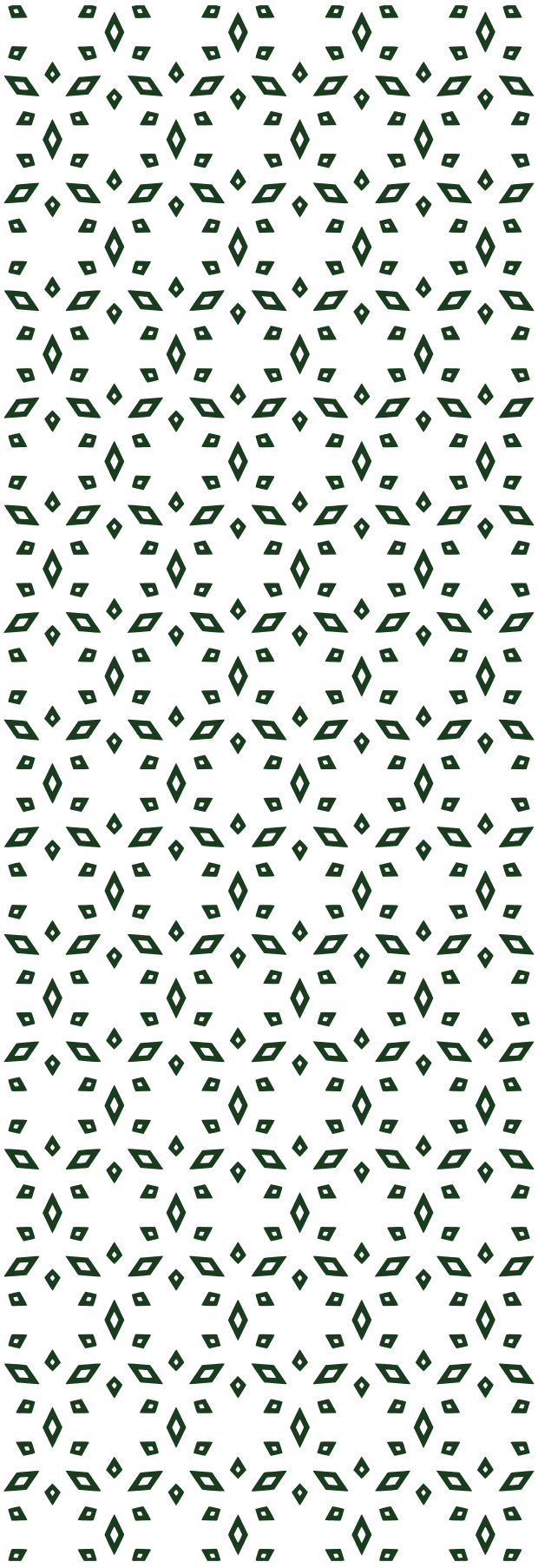
Recommended actions:

- Convey the convincing business case for renewable energy in Jordan and its long-term socio-economic and environmental benefits. This key message should be effectively communicated by both

19 Currently set at 35% for utility-scale solar PV and 20% for wind projects.

governmental and local-level decision makers such as those at MEMR, the Ministry of Environment and other relevant institutions.

- Design tailored public awareness raising campaigns around the available renewable energy options, their costs and benefits, as well as accessible financing schemes.
- Design focused outreach programmes and campaigns aimed at high potential end-user groups, such as in industries, commercial businesses (e.g., hotels), residential and water sector, to share opportunities for renewables adoption supported with case studies of benefits realised.
- Increase outreach through media and public information agencies on the socio-economic and environmental benefits of renewable energy.
- Strengthen the data and information base on energy use at the subsector level, especially in industry. By law, the Department of Statistics is authorised to gather data; for industry, a collaborative effort with MEMR and the Chamber of Industry and Commerce is needed to conduct a nationwide effort to standardise and gather industry-specific energy data.



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