SCALING-UP RENEWABLE ENERGY DEVELOPMENT IN JORDAN

Position Paper

March 2019

RES4MED

RENEWABLE ENERGY SOLUTIONS
FOR THE MEDITERRANEAN

About RES4Med&Africa

Renewable Energy Solutions for the Mediterranean & Africa RES4Med&Africa

Who we are: RES4Med&Africa promotes the deployment of large-scale and decentralized renewable energy in Southern-Mediterranean and Sub-Saharan African countries to meet local energy needs. Since its inception in 2012, the association gathers the perspectives and expertise of a member network from across the sustainable energy value chain.

Our work: RES4Med&Africa functions as a platform for members and partners of emerging markets to foster dialogue and partnerships, share knowledge and build capacity to advance sustainable energy investments in Southern-Mediterranean and Sub-Saharan African countries.

Our mission: RES4Med&Africa aims to create an enabling environment for renewable energy and energy efficiency investments in emerging markets through 3 work streams:

- Acting as a connecting platform for dialogue & strategic partnerships between members and partners to exchange perspectives and foster cooperation;
- Providing technical support & market intelligence through dedicated studies and recommendations based on members' know-how to advance sustainable energy markets;
- Leading capacity building & training efforts based on members' expertise to enable skills and knowledge transfer that supports long-term sustainable energy market creation.

At the end of 2015, RES4MED members decided to expand the geographic focus to Sub-Saharan Africa in light of the huge potentials and growth opportunities for Africa's renewable energy sector.

Members: RES4Med&Africa gathers a network of members from across the sustainable energy value chain including industries, agencies, utilities, manufacturers, financing institutions, consultancies, legal and technical services providers, research institutes, and academia.

Partners: RES4Med&Africa works with local, regional and international partners, agencies and organizations to pursue its mission and promote renewable energy deployment in the region of focus.

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Jordan energy landscape

Jordan is a Middle-Eastern country with a population of over 9.9 million of inhabitants and a booming economy that has increased by almost 20% in the last 5 years. In 2017 the Gross Domestic Product (GDP) was around 40 billion USD [1], 3.7% higher than the former year, with an average income per capita of 3,238.3 USD.

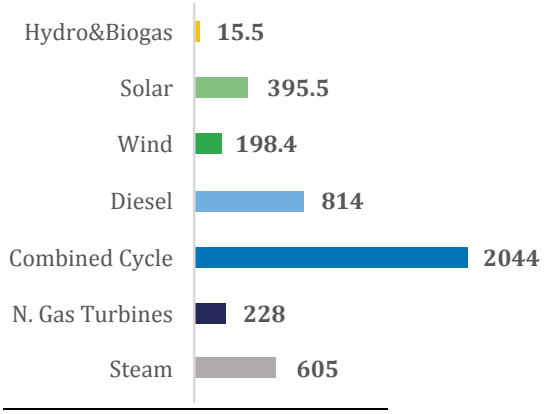
Jordan socio-economic context

Government	Unitary parliamentary constitutional monarchy
Population	9,903,802
Currency	Jordanian Dinar (JOD)
Expected GDP 2018	41.87 billion USD
Expected GDP per capita 2018	4,228 USD
OCSE country risk rating	5/7
Economic freedom	(66.5) 53rd/180

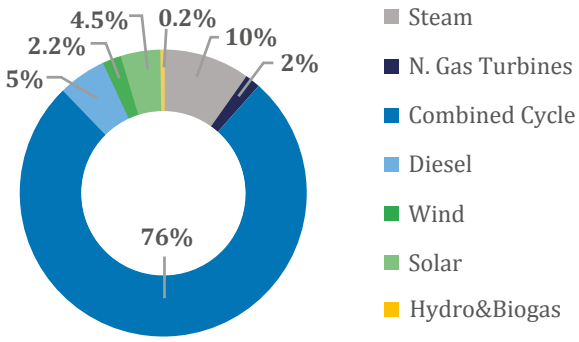
Jordan is considered as a middle-income country with a modern and diversified economy. In 2017, the Services sector contributed to around 66.8% of Jordan's GDP, followed by the Industry (28.9%) and the Agriculture (4.3%). According to the economic freedom index, Jordan appears above the regional and world average scores and is ranked 4th among the 14 countries of Middle East and North Africa areas[2].

Despite a well-known stable economy and a limited risk-perception regarding the local energy market [3], the energy supply still represents a major challenge in the country. Compared to its neighbouring countries, Jordan suffers from a lack of primary energy reserves, resulting in a critical dependency on imports that represented 94% of the total energy consumptions in 2017 [4]. Nowadays, almost all the indigenous primary energy sources are coming from renewables. However, their share on the total power generation capacity, installed in 2017, slightly exceeded 14%, totalising only 600 MW of projects. In the same year, the electricity demand, of around 17.5 TWh (4.8% higher than the former year), was met by an almost fossil-fuel based energy generation mix. Indeed, the 93% of the electricity production came from traditional power plants, out of which 76% from combined cycles systems, limiting the renewable energy (RE)

Installed Power Capacity in 2017 (MW)



Electricity Generation in 2017 (GWh)



[1] *Trading Economics, online Database, https://tradingeconomics.com/jordan/gdp*
[2] *2019 Index of Economic Freedom, https://www.heritage.org/index/country/jordan*
[3] *RES4Med, Survey on the main barriers affecting investments in RE capacity in the Mediterranean, 2017*
[4] *Ministry of Energy and Mineral Resources, Energy 2018 – Facts and Figures, https://data.worldbank.org/indicator/EG.IMP.CONS.ZS?locations=JO*

contribution to only 7% on the total production (4.5% from solar, 2.2% from wind and 0.2% form hydro and biogas together).

Jordan energy statistics of 2017[5]

Electricity Consumption per capita	1748 kWh
Electricity Consumption	17574 GWh
Electricity Generation	20054 GWh
Total Primary Energy Consumption	116405 GWh
Domestic Energy Production (crude oil and natural gas)	965.3 GWh
Domestic Energy Production (renewable energy)	5804.5 GWh
Energy Imports	118710 GWh
Cost of Consumed Energy	2.43 billion JD

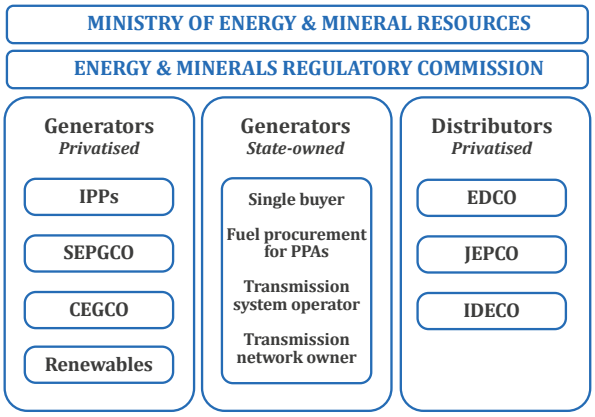
JORDAN 2018 ENERGY SECTOR FIRST ESTIMATES

First estimates, announced by the Government in February 2019, report that the power installations from renewable energy reached **1150 MW in 2018**, corresponding to more than **21% of the total installed capacity** in Jordan. From a preliminary analysis of 2018, NEPCO estimates an overall electricity consumption of 17.54 TWh (0.2% higher than the former year) and a production of 19.82 TWh, out of which 89.2% comes from traditional energy sources, 7.8% form renewables (included hydro) on grid and 3% from solar distributed systems.

Source: Ministry of Energy and Mineral Resources, http://www.memr.gov.jo/DetailsPage/MOE/NewsAR.aspx?PID=483 announcement;
Preliminary numbers from NEPCO Bulletin 2018, http://www.nepco.com.jo/en/nepco_bulletin_en.aspx

On the top of the institutional framework of the Jordan's energy sector there is the **Ministry of Energy and Mineral Resources** (MEMR), responsible for the strategic vision of the country in terms of energy policies and targets for developing the national energy system. The Regulator of the electricity market is represented by the **Energy and Minerals Regulatory Commission** (EMRC), a legal entity with financial and administrative independence, created in accordance with the adaptation of the governmental bodies provided in Law No. 17 of 2014. EMRC is responsible for setting the electricity tariffs and awarding licenses to power providers and distributors. Today, in accordance to the General Electricity Law No. 64 of 2012, the Jordan's electricity market operates as a single buyer model, where the power generation and distribution are privatized sectors while the transmission is held by the **National Electric Power Company** (NEPCO), the single state-owned transmission system operator and the only authorized energy off-taker at the wholesale level. After the reform of the electricity market, NEPCO was deemed to be responsible for the construction, operation and maintenance of the whole transmission system, including purchasing all the electricity produced by the Independent Power Producers (IPPs), as well as managing the interconnections with other neighboring countries.

[5] *The Ministry of Energy & Mineral Resources, Annual Report, 2017*



Jordan renewable sector overview

The Kingdom of Jordan is engaged in a deep transition of its electricity system aiming to diversify its generation mix, reducing the dependency on imported fossil fuels and increasing its energy security, while developing indigenous renewable resources.

Thanks to its geographical position and climate Jordan disposes of a great renewable energy potential, especially of solar and wind energies. The country benefits from more than 300 sunny days, with an average intensity of direct solar radiation of around 6 kWh/m^2, and from a wind speed that can reach up to 9 m/s in specific areas. It has been estimated that the country has the potential to run a 100%-renewable energy system, saving around 12 billion USD per year, and that the exploitation of the whole wind and solar potential "could deliver up to 50 times more power than the country's expected power demand by the year 2050"[6].

Considering the lack of primary energy reserves in the Kingdom and its severe imports dependency, the development of a strong renewable energy market is crucial for the long-term security of Jordan's energy system. In this regard, Jordan within its Updated national Energy Strategy set **targets on the share of renewable energy solutions** (RES) in the total energy mix: **6% by 2017, 8% by 2020 and 9% by 2025**[7].

To supervise to the renewable market development and ensure the achievement of those targets the institutional, legislative and regulatory frameworks were adapted and dedicated authorities and entities have been conceived to support the integration of renewables in the country. According to the National Energy Strategy and National Energy Efficiency Action Plan, it was established the **Renewable Energy and Energy Efficiency Law** (REEEL), Law No. 13 of 2012, providing a legal mandate for the government and a regulatory framework for RE and energy efficiency (EE) development[8]. With REEEL the MEMR becomes responsible for the identification of compliant sites to be allocated for RE projects and the issuing of public tenders on competitive and transparent basis for clean electricity capacities. Thereby, the Law created an attractive market for international and local investors, together with the introduction of the obligation to purchase renewable electricity through standardised Power Purchase Agreements (PPAs) and a priority corridor for RE private companies that enables to directly negotiate with MEMR for new projects not subjected to tendering process. Moreover, further specific incentives for private RE companies were implemented by the REEEL, as the exemption from paying grid connection fee and a policy of tax exemptions and incentives on the equipment whether manufactured locally or

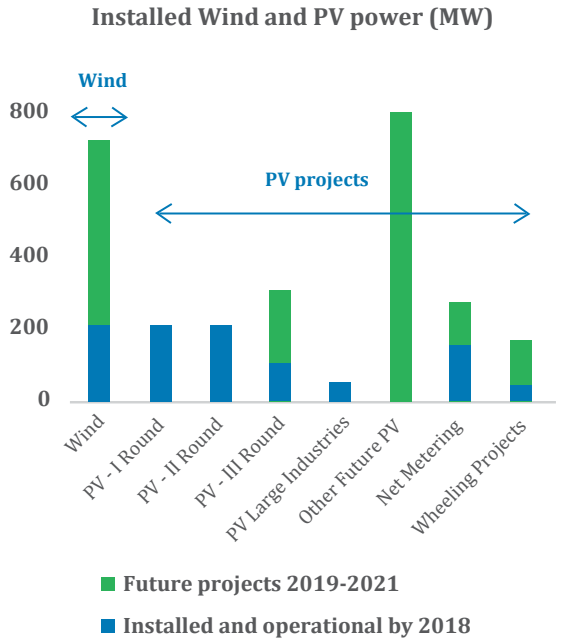
[6] *Greenpeace, Jordan Future Energy, 2013*
[7] *EDAMA, Jordan Clean technology Sector, 2016*
[8] *Renewable Energy & Energy Efficiency in Jordan in Jordan, https://pubs.naruc.org/pub.cfm?id=5380A940-2354-D714-5190-390EF18D3A03*

imported[9]. With article 10 the Law enables the development of distributed electricity generation under the Net Metering and Wheeling mechanisms, allowing small RE installations, for residential, commercial or industrial use, to sell the exceeding electricity to the grid at the same purchasing price established by the Regulator.

The REEEL also provides for the creation of a dedicated **Renewable Energy and Energy Efficiency Fund** (JREEEF), with a main objective of supporting the development of renewables and energy efficiency measures in the country according to the national strategy.

Following the reform of the electricity market, the government announced the **first round of tender in 2012**. The auction awarded twelve PV projects, with a cumulative capacity of 200 MW, and two wind power plants. The 20-years PPAs for the wind projects have been signed at 0.12 USD/kWh while for PV plants they were closed at 0.169 USD/kWh, except for Shams Ma'an PV project (of about 52.5 MW) which was awarded at 0.148 USD/kWh[10]. A **second round of tender** was issued in 2013 and awarded four PV projects of 50 MW each at the beginning of 2015, totalising 200 MW. The awarded tariffs were among the lowest ever recorded in the world (0.0613-0.0767 USD/kWh)[11], mainly due to an increase in efficiencies and the reduction in technology prices which enable a further reduction of solar PV levelized cost of energy (LCOE)[12]. At the end of 2016 a **third round of tender was launched**, planning to develop 200MW of solar PV and 100MW of wind projects in the Ma'an area and in the south of the country, respectively. The winning companies have not been announced yet but it is expected that just two of the PV projects – one 100 MW and one 50 MW – will be selected, given the price gap between the first two and third lowest bids (0.0249 and 0.0250 against 0.0344 USD/kWh)[13].

As of today, RE installed capacity accounted for 600 MW on a total of 4300 MW. Considering the capacities expected to go on-line by 2018 and already planned projects, as listed by the NEPCO Annual Report 2017, total installed renewable capacity should reach 2,726 MW by the end of 2021.



If all those projects will effectively come on-line, Jordan will be able to overcome its 2020 targets, installing **over 1.5 GW of solar PV plants, 723 MW of wind power and 447 MW of distributed electricity generation** under net Metering and Wheeling mechanisms.

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[9] *Law No. (13) Of 2012 Renewable Energy & Energy Efficiency Law*
[10] *Clean Technica, Jordan Awards 200 MW Capacity In Its First Renewable Energy Tender, 2015,*
[11] *NewEnergyUpdate: PV, Jordan PV tariffs drop 50% in second tender round, 2015*
[12] *PV Magazine, Jordan's second PV tender leads to record low tariffs, 2015*
[13] *PV Magazine, Jordan delays announcement of Round 3 PV tender winners, 2018*

A part from wind and solar energy, Jordan has developed projects from other RE sources. From solid waste, which has been estimated to overall account for approximately 2 million tons per year, the Jordan Biogas Company produces biogas energy in Rusaifeh Landfill totalizing 4.1 GWh in 2017. The power plant has been installed in 1999 and has expanded reaching up to 4 MW of capacity, able to **process 60 tons per day of organic wastes** from hotels, restaurants and slaughterhouses in Amman[14]. Despite having one of the lowest existing levels of water availability per capita[15] and being ranked in 2012 "the third most water scarce country in the world"[16], Jordan has also developed **two hydropower plants with a total capacity of 12 MW**. The first one to be built was the King Talal Dam corresponding to a large hydro dam in the hills of Northern Jordan, while the second one was installed at Aqaba Power Station with a technology able to exploit the available head of returning cooling sea water. Currently hydropower counts for 0.2% of the yearly total energy production of Jordan with its 38 GWh generated in 2017. Despite the scarcity of available water on the Jordan ground, various studies show an unexploited potential capacity form hydro that could reach up to 800 MW, using the differences in elevation between Red and Dead Seas[17]. Within the 3rd National Communication on Climate Change of 2014 the Government of Jordan proposed many other RE projects in order to meet the target on total GHG reduction by 2030. Among the renewable alternatives investigated in the 3rd National Communication on Climate Change, it is worth to be mentioned: a first 100 MW of concentrated solar power (CSP) system followed by another plant of 300 MW able to contribute respectively with almost 236 GWh and 710 GWh per year, expected to be operational by 2019 and by 2023 respectively; a 15 MW biogas power plant at Al-Ekader waste dumping site estimated to produce annually 30 GWh of electricity. Moreover, in the 3rd Communication it was proposed a plan for installing 162 MW of solar water heaters, accounting for around 90 thousand facilities, in three stages during 2016-2020 for residential uses and replacing the existing inefficient electric boilers.

Potential barriers and challenges for RES integration in Jordan

The success of renewable tenders and net-metering scheme in Jordan demonstrates the attractiveness of Jordan market for investors, as well as the efficacy of the regulatory framework in providing stable and appealing conditions to them. Generation sector unbundling and cost reflective tariffs played a pivotal role, opening the market to private producers keen to expand and diversify the production to meet the growing demand[18]. Concerning the renewable sector, Independent Power Producers (IPPs) have pointed out that Jordan's regulatory "framework is well established and any investor can easily know the rules governing renewable energy investments"[19].

The key strengths of the market could be resumed as follows:

- **Stability and clearness of the policy and regulatory framework**;

[14] *EcoMENA, Bioenergy Resources in Jordan, 2017*
[15] USAID, Water Resources&Environment, 2018
[16] *State of the Planet, Water Shortages in Jordan, 2012*
[17] *Brussels Invest & Export, The energy Sector in Jordan, 2015*
[18] USAID, Jordan, 2015
[19] *RES4MED Survey on the main barriers affecting investments in RE capacity in the Mediterranean, 2016*

- **Attractiveness of incentives**, mainly regarding taxes and grid connection costs;
- **Availability of competitive financing** from international and local actors.

The presence of small and large foreign IPPs, which count to date for about 89% of all investments in the clean energy sector of the country [20], proves the strong interest of international companies in the Jordanian market. Furthermore, BNEF confirmed it placing the Kingdom's renewable energy market at the 3rd position amongst 103 analysed countries in the 2018 edition of its Climatescope ranking.

Favourable market conditions in terms of procurement rules and incentives, however, are not enough to secure a stable and efficient development of renewable capacities in the long-term and Jordan renewable industry seems to have slowed down its growth, mainly due to:

- **Lack of a comprehensive and timely energy strategies able to go beyond 2025 targets** and embrace a wider perspective on decarbonisation of the Jordan energy sector, although the ministry is working on new strategy for 2030 with an eye on 2050;
- Rising concerns about **grid stability** and its flexibility to efficiently integrate higher renewable capacity;
- **Unexpected changes in the regulatory framework**, in terms of local content requirements, grid connection procedures and costs.

From the investors' perspective it emerges that one of the main concerns that may hinder the scaling-up of the renewable energy sector in the Kingdom is the current lack of a long-term consistent energy strategy, in contrast to many countries in the world. Nowadays, a part from an announced intention to meet 9% of RE share in the energy mix by 2025, **a wider energy vision of the Jordanian energy sector at 2030, or even 2050, is still missing**. Although the Ministry of Energy and Mineral Resources is currently working on it, the lack of preliminary long-term energy targets, especially on renewables, when the national Strategy has been announced have undoubtably affected the investments in the country. This fact is even more relevant for a country that has signed the Paris Agreement and submitted in 2015 its Climate Action Plan with greenhouse gases (GHG) reduction goals at 2030, which will come into effect in 2020[21]. Together with this issue, Jordan seems to suffer from a lack of coordinated planning of the power system evolution with the system infrastructure development in the mid- and long-terms. At the beginning of 2019 The Ministry of Energy and Mineral Resources announced the stop of all the renewable auctions and bids for projects above 1 MW until due to revealed **technical limitations of the electrical grid** until new studies and strategy is finished[22]. The capacity of the grid today stands at 3.6 GW. NEPCO is currently engaged in extending national transmission system capacity up to 4.6 GW by the end of the 2019, through the Green Corridor project (160 million USD), which was conceived after the cancellation of 400 MW of tender in 2014 due to system infrastructures inadequacy to support such stress. The transmission

[20] *BNEF, Climatescope, 2019*

[21] UNFCC, Jordan Submits its Climate Action Plan Ahead of 2015 Paris Agreement, 2015

[22] PV Magazine, Jordan suspends renewables auctions, new licenses for projects over 1 MW, 2019

operator will also benefit from a loan of 256 million USD from the European Bank for Reconstruction and Development (EBRD) to improve the Jordan's electrical network, including substations, automated grid management solutions and transmission infrastructures[23].

The concerns about the technical limitations of the grid have intensified in the last years, also because of the several issues related to the integration of non-programmable renewable technologies in the generation mix. Indeed, it's undeniable that **non-programmable sources of energy could challenge the stability of the electricity supply**, entailing various acknowledged impacts that can be summarised as follows:

- **Variability of the generation**: the instantaneous availability of RE sources leads to increased fluctuations in the electricity generation and, thereby, in the matching between demand and supply, in terms of frequency, length and predictability;
- **Uncertainty of the production**: the unpredictability availability and intensity level of RE sources affects the ability to successfully meet the instantaneous electric demand;
- **Geographical constraint**: many types of RES have specific requirements regarding the features of the site and thereby cannot be arbitrarily deployed prioritising other criteria, such as the proximity to market customers. This often leads to an extension of the grid, additional infrastructures, improvements or adaptations of the transmission and distribution framework and an overall cost increase.

Unmanaged development of **non-programmable renewables could result in grid frequency and voltage disruptions, increase in flexible back-up capacity needs**, due to production forecasts errors, **and grid congestions surge and curtailments**. The severity of those impacts depends firstly on the extent of penetration of non-programmable generated electricity in the energy mix[24], but it is also bounded to the intrinsic characteristics of national electricity market (in terms of market size, capacity mix and regional market integration plans) and to the policy and regulatory framework in force. The absence or weakness of a comprehensive and overarching planning, designed to effectively manage a growing renewable capacity, risks to be a major threaten to the power system cost-effectiveness and to the electricity bills affordability[25]. If Jordan aims at expanding RES deployment – today counting for only 10.8% (including the distributed generation) on total electricity generation according to the most updated estimates of NEPCO – the system operators concerns around what might be the future implications related to the expected growth of wind and solar capacities should be taken into account and timely addressed.

Coming to the Jordan's regulatory framework, the investors, as it has been already pointed out, expressed a high level of appreciation for its stability, to the point of considering it as one of the main strengths of the national energy market. However, some concerns have

[23] *PV Magazine, Jordan gets $265 million loan to improve grid capabilities, integrate more solar, 2018*
[24] *The IEA recognizes four phases of VRE integration, each one characterised by a progressive share of VRE in power generation mix resulting in incremental impacts on the grid stability and on the existing generation fleet.*
[25] IRENA, IEA & REN21, Renewable Energy Policies in a Time of Transition, 2018

recently risen regarding a series of **unexpected changes that have been introduced in the country energy policies.** First of all, the proposal of the Government to **introduce a binding local content requirement** up to 35% for all solar PV projects[26], dated April 2018, has given rise to divergent opinions amongst market experts and players. A legislation of this kind is always designed in the best interests of the country, intended to sustain the domestic industry and job creation. Nevertheless, in case the local manufacturing industry is not ready to foster this increase in demand, there is often a risk of a double negative effect on the country energy market. Indeed, whenever the domestic manufacturing sector is not enough mature in terms of quality and prices of products, setting a challenging binding on local content can lead to an overall slowdown in the solar PV market growth and the cost-effectiveness of the renewable projects might not be guaranteed. In this regard, in 2017 in Algeria a 4 GW PV tender was about to be cancelled due to the IPPs' inability to propose low bids and close bankable PPAs, also because of high local content requirements[27]. On the other hand, a disproportionate support to the domestic resources, if not adequately designed and regulated, threatens to disrupt the competitiveness of the manufacturing industry itself by favouring the few large operating companies in the field. Beyond the recommendations about the modalities through which introducing such legislation, the Jordan's Government proposal to implement a local content requirement in future tenders can potentially be a success for the country's economy and energy sector. However, it is not in the interest of this study focusing on the strengths and weaknesses of this proposal, but rather highlighting how much the investments trend could be affected by a radical changing in the country policy. Indeed, nowadays in Jordan it is currently in force the so-called "Jordanian origin labelling", a regulation that allows to receive additional 15% on the tariff in case of a fully installed Jordanian facility. Such kind of incentive has shown over the years a discrete success in different countries, like it occured in Ethiopia, enabling to boost local manufacturing excellences, attract international IPPs while securing an overall bankability of RE projects. Thereby, moving from such kind of policy that rewards shares of local content through pricing mechanism – as the "Jordanian origin labelling" does – towards a binding 35% of local content for all PV plants represents a radical change of course, for the reasons illustrated above. The risks resulting from a sharp alteration of the national policy and regulation framework, beyond the ones strictly related to the contents of the new legislation itself, could undermine investors' confidence in the country long-term strategy.

Another example of **discontinuity in policies that creates the so-called stop&go effect is the removal of the tax exemption on hybrid cars**, in force since February 2018[28]. The previous regulation has been an unquestioned boost for the hybrid vehicles market, totalising in the country around 31,500 new registered cars only in 2017, representing a first signal of the existence of a decarbonisation strategy at least for the Transports sector. Indeed, through that incentive the taxation on cars, weighting 50% of total price, was fixed at only 25% for hybrid vehicles, accounting for an estimated saving of

[26] *PV Magazine, Jordan mulls 35% domestic content requirement for solar, 2018*
[27] *PV Magazine, Algeria's 4 GW solar tender delayed, again, 2017*
[28] *The Jordan times, No single hybrid vehicle customs-cleared since tax hike, 2018*

around 300-1500 JD. The removing of this tax reduction could damage not only the Jordan's overall economy but more broadly the energy sector. Indeed, the forecast of the number of hybrid and electrical vehicles in use is a key element for estimating the electricity consumption (regarding both growth in volumes and types of uses) and, consequently, for planning an adequate supply system. Moreover, incentivising the e-mobility results in a growth of energy demand and, by extension, in a bigger room for renewables integration within the generation mix. Thus, a clear and predictable market trend together with the large business opportunities led by the creation of a new market (e.g. the hybrid cars trade) are crucial elements to raise the investors' interest in the country. Therefore, following this thesis, any **unexpected and radical change of course in the regulatory framework**, which by nature affects the evolution of a sector, **might generate distortions in the market perception** by investors as well as an increasing distrust in the forecast of the sector evolution, **undermining the appetite for the country**.

Existing strategies and recommendations to secure a successful integration of RES in Jordan

Jordan is expected to timely reach its 2020 renewable energy targets. Nevertheless, there are divergent views regarding the political intention to fulfil the announced commitment to meet **20% of green share in the energy mix at 2025** due to a lack of clear operational plan. To keep up the market attractiveness and the investors' confidence that has recently revealed to be slightly decreased, a strategic improvement of the national long-term energy policy and targets might be crucial. First of all, following the example of many countries in the world, it could be strategic for Jordan **setting more ambitious goals at 2030, 2040 and even 2050**, in terms of generation mix and installed capacity diversified by technology, including also the **investigation of other local renewable resources** apart from wind and solar PV. Such targets have the potential to provide investors with the necessary long-term vision of the country energy sector development and represent the economic signals required in a capital-intensive investment field, as the renewable one is. Moreover, the implementation of the Paris Agreement engagement, planned to be operational in Jordan in 2020, offers the opportunity to rethink the whole energy strategy, going beyond the simple planning of a cleaner and more sustainable power generation mix, but building a **strategy to decarbonise the energy consumptions of all the sectors**. Setting electrification targets on the final uses and expressing clear political ambitions in terms of energy savings and energy efficiency represent the first paths for creating countless business opportunities, reducing the GHG emissions and, above all, **increasing the electrical demand**. Indeed, a growing electricity need is always the key for expanding the market and attracting new players, giving the opportunity for a higher penetration of RES in the generation mix, both off- and on-grid.

On the other hand, the growth of non-predictable installed capacity and electricity consumptions, caused by a higher electrification of final uses, should run in parallel with the long-term planning of system infrastructures development, at all levels. As for the power sector, long-term strategies, encompassing **the planning of national capacity mix together with the evolution of transition and distribution systems**, is fundamental. This kind of overarching

approach enables to minimise the costs related to the growing share of RES in the energy mix and, in the meanwhile, to maximise the flexibility of the whole system. Indeed, as discussed above, a high penetration of unpredictable and variable RES in the country energy landscape inevitably entails a number of impacts on the gird management that should be foreseen and timely addressed. There is not a unique applicable paradigm of solutions to increase the grid flexibility, but a variable set of technologies and strategies that can together, if well designed and planned, be effective in guarantying a reliable and affordable electric service.

First of all, to tackle the variability of the generation from RES and the intense fluctuations in the matching between demand and supply, an optimal solution consists in investing in **dispatchable generators**. Such kind of systems, which can be both traditional carbon-based technologies (like gas turbines) and renewable ones (like biomass plant), are classified among the grid flexibility solutions. They are able to provide electricity and ramp up in an extremely rapid time and equally can be turned off instantly, enabling to accommodate the variable output of RES.

Another crucial element that cannot be neglected in a strategic infrastructures development is the planning of **storage capacity**. The technologies selected to provide and secure an electricity backup range from electric batteries to pumped hydropower plants, all sharing the feature to be fast-response facilities. Today, IPPs acting in Jordan draw attention to a narrow political commitment in securing investments grid flexibility improvement. On the basis of these concerns the Government has recently investigated the opportunity to add storage systems to the grid, issuing a dedicated tender in 2017[29]. The project, for which 23 companies have been prequalified will be installed at 33 kV/132 kV Irbid substation in Irbid governate, and is designed to be used for ramp-rate control of load and renewable power plants and for load peak shaving for a transformer substation [30]. In particular, this initiative will be developed in two phases: the first one will be a pilot project of at least 30 MW of capacity able to generate 60 MWh of energy, while the second phase details have yet to be determined.

Yet, a grid development plan to be fully comprehensive should also consider the extension beyond national borders, connecting to neighbouring countries, as it happens in European Union with the Ten Year Network Development Plan of ENTSO-E. Indeed, adopting **regional power system planning** approaches fosters the solutions to secure the integration and the increase of renewables in the energy landscape, benefiting from the possible regional complementarities and synergies in terms of local resources, peak demands and more over. On this point, Jordan has already taken actions, being connected with Egypt through a 400-kV submarine cable of 13 km crossing the Gulf of Aqaba and with Syria through a 400-kV single circuit transmission line of 147 km[31]. However, in January 2019 the Director General of NEPCO expressed interest to further **extend the national grid** and connect to Saudi Arabia for increasing power exchanges and benefitting from the

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[29] *Salescome, Jordan prequalifies 23 groups for energy storage tender, 2018*

[30] *The Ministry of Energy & Mineral Resources, Instruction and Requirements for Proposal Preparation and Submission (IRPP)*

31 USAID, Phased sector unbundling and cost reflective tariffs create opening for private producers to expand and diversify generation to meet growing demands, 2015

complementarities between the countries[32]. This strategy aims to improve the positive implications from a regional market integration, which can be summarised as follows: larger network for energy exports, better matching between demand and supply at the most competitive price and better exploitation of the production peaks coming from non-programmable RE sources. Indeed, in the case of Saudi-Jordan connection, studies prove that the load curve of Saudi energy demand shows an opposite trend compared to the Jordan's one, especially during summer, with a daily peak during the daytime. As Jordan requires more electricity during the night and benefits from a large installed capacity of solar PV technology, it results able to produce and export a surplus of electricity from renewable energy at a very competitive price (0.239 USD/kWh), importing energy from Saudi after the sunset especially during winter. A potential effect of such a strategy, beyond the already mentioned benefits in terms of higher performances, energy and costs savings, could be a fostering of RES deployment in the interests of meeting a growing electric demand, exporting to neighbouring countries and lowering the huge primary energy imports. Currently, there are other 2 proposed extensions of Jordan's network, both planning to connect with Palestine, amounting to 130 km of line.

Finally, the last solution, to successfully integrate the RES, adopted by several countries in the world, is the **load shaping.** This measure aims at modify the electric demand curve to optimise the matching between demand and supply (often variable and unpredictable). This approach encompasses various activities enabling to adjust the load in terms of volumes (creating new demand through the electrification of consumptions and "sector coupling") and in terms of reshaping the total curve to maximise the daily and seasonally production of the variable RE plants. Moving the load peaks to time windows when RES share in the generation mix is predominant allows to lower drastically the electricity bills and the overall costs of energy. One of the existing policies enabling this operation is the **dynamic pricing** (price tier in terms of consumers and time slot, peak charges, …). This type of approach has been used in many countries all over the world with different market frameworks, from Denmark and U.S. to China and South Africa[33]. To support this strategic reshaping of the costumers' side market, the Government effort to support the integration of advanced **digital metering systems** becomes crucial, in order to automatically tracks the time of energy consumption and gather useful data to manage the quality of energy at the final uses.

In 2017 in Jordan the power plants that have been called to cover peak loads (out of which the highest one was about 3,320 MW reached in July) were mainly combined cycles (68.3%), followed by steam power plants (17.8%) and natural gas turbines (6.2%), showing similarities with the distribution shares of the electricity generation. The RE contribution accounted for only 7.3%, around 240 MW while the renewable installed capacity in 2017 was more than double (approximately 610 MW). These statistics show that in Jordan there is still a large room for **increasing the role played by renewable energies during the peak loads** and displacing the expensive fossil fuel systems. The principal means to

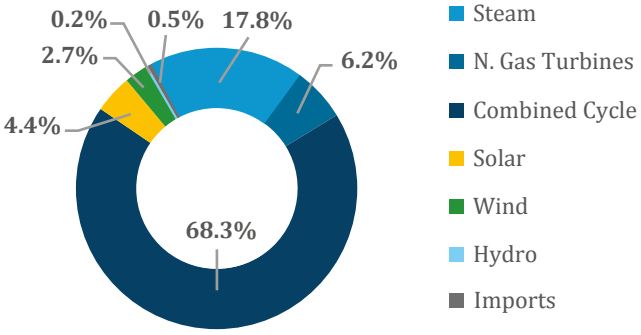
[32] *Arab News, Jordan to accelerate electrical connectivity with Saudi Arabia, 2019*

[33] IRENA, IEA & REN21, Renewable Energy Policies in a Time of Transition, 2018

meet this goal are: adjusting the demand curve, in terms of hourly and seasonally peaks following the RES production trends, investing in storage capacity and providing a flexible and reliable grid system.

Ultimately, the last point that in a process of designing a long-term energy strategy should be taken into account to effectively integrate RES in the energy landscape and attract investors is related to the policy and regulations framework. Nowadays, has it has already been mentioned in the last chapter, the Jordanian legislative scheme appears, for the most, stable and well planned, enabling bankable PPAs and a rapid growth of a RE market in few years. However, few recent episodes, such as the proposal of introducing a local content or the clearance of a successful incentive for hybrid vehicles, generated concerns and divergent opinions among the market experts and players. The reasons behind these quite intense reactions are essentially to be found in the overall **discontinuity in policies** that creates the so-called stop&go effect and not only in the substance of the legislations themselves. What many international best practices show is the importance of having a long-term vision when adopting a radical change, always considering the implications beyond the sector of competence and keeping an overall consistency between all the policies established and the long-term strategy. In this way, it becomes clearer the energy strategy roadmap of a country, especially for international investors, and increases the confidence index and the attractiveness of the market itself.

Peak coverage in 2017 (%)



Coverage of Peak loads

Technology	%	MW
Combined Cycle	68.3	2265.9
Steam	17.8	590.96
N. Gas Turbines	6.2	206.5
Solar	4.4	146.41
Wind	2.7	89.97
Hydro	0.2	4.98
Imports	0.5	15.27

Focus: Jordan's Transport sector – Towards a decarbonisation strategy

This section aims to provide examples of how the given recommendations for a successful integration of RES in the Jordan's energy landscape can be applied, even in a sector that is not strictly the Energy one. The focus will be done on **Transport**, a crucial vector for the national economy, **accounting for around 10% of the Jordan's GDP in 2016**[34], of which the undertaken strategies lead to invaluable effects on the whole country development. There will be given an overview of the policy and regulatory framework in force, followed by an analysis of successful strategies and future proposed plans and conclusive instances of how it could be further fostered the already existing clean development roadmap. For the sake of simplicity, the aviation and maritime transport will be here ignored.

The Jordanian road transport infrastructure counts over 28,781 km of highways and 4,221 km of secondary roads[35], while the national railway counts over 500 km, out of which 210 km are not currently in operation. It has been estimated a yearly average growth of the sector of around 5-6% until 2030, even higher than the forecasts on GDP trend [36]. The Transport sector represents in Jordan the largest energy consumer, contributing in 2017 to about 49% of the total final energy consumption[37], and the second source of GHG emissions of the country (after the Energy sector). For this reason, in the last decade the Kingdom has heavily invested in the transport infrastructures, promoting the urban mobility, enhancing logistic industry, designing a National Railway Project, expanding and improving the overall conditions of roads. Moreover, it was initiated a process of liberalization of the sector with the purpose of enhancing competitiveness and stimulate higher performances. Beyond these actions targeting socio-economic returns, the Jordan's Government interest on the of Transport falls also within a wider commitment to minimise the national GHG emissions. Indeed, the Kingdom has undertaken a long pathway of policies aiming to slowly mitigate and displace polluting sources in the country, starting from ratifying UNFCCC and the Kyoto Protocol in 1994 and 2003 respectively. Subsequently, Jordan has submitted its *Third National Communication* to UNFCCC in 2014, after its first two in 1997 and 2009, and, supported by UNP, has developed in 2013 *The National Climate Change Policy 2013-2020*, the first comprehensive policy issued in the Arab Region and the Middle East. In 2015 Jordan submitted its Intended Nationally Determined Contribution (INDC), targeting to **reduce the overall GHG emissions by a bulk of 14 % by 2030**, identifying a set of key strategies by sectors to achieve this ambitious goal. Obviously, the Transport played a crucial role in this 2030 clean vision, and Jordan committed to announce a number of general measures and specific policies and regulations over the years to give substance to a mid-term roadmap for developing a low-carbon sector. Among all those efforts, **the promotion of a more sustainable mobility and the growth in share of public transport use** are the main pillars. For the sake of this sectorial focus, the discussion will analyse only the political

[34] The Economic Policy Council, JORDAN ECONOMIC GROWTH PLAN 2018 – 2022

[35] *Jordan's Third National Communication on Climate Change, 2014*

[36] Ministry of Transport, Transport in Jordan: Strategies, Challenges and Trends, 2014

[37] The Ministry of Energy & Mineral Resources, Annual Report, 2017

actions affecting (directly or indirectly) the renewable energy integration in the country.

According to the Third National Communication there is a strong correlation between the population trend and the increase of the Transport sector, especially the number of vehicles. It has been estimated that in Jordan there will be over 11 million people in 2030 and more than 14 million in 2050, with an average annual growth rate of 1.13%. To limit the number of cars and the effects on the environment, the Ministry of Transport launched in 2014 a *Long-term National Strategy*, committing to **increase the share of population using public transports** from 13% of 2010 **to 25% by 2025**. To meet this ambitious target Jordan is expected to invest a lot in the infrastructures and facilities, especially in the municipality of Amman, which is ranked as one of the capital cities with the lowest public transportation mode share ratio in the world (11.1%), according to Jordan's Third Competiveness Report [38] . Moreover, another interesting project proposed to mitigate the GHG emissions is the **planning of the National Railway Network**, an extension of the existing rail infrastructure to improve the electric public mobility and the connections between different Kingdom's areas. This investment, beyond the incredible results in terms of environmental and socio-economic impacts, can directly affect the RES integration in the generation mix, since it contributes to increase the electricity demand thus giving a room for additional installed capacity; moreover, the extreme predictability of energy consumptions related to railways (due to train schedules) minimises the issues concerning the matching between unpredictable supply of RES and demand. Nevertheless, both strategies announced by the Government to boost public transport services haven't had the expected positive implications on the energy market attractiveness. One of the reasons might be found in the lack of a clear long-term roadmap and of a subsequent set of specific regulations dedicated to effectively implement the announced efforts. On the other hand, there is another aspect that could have played a crucial role in limiting the feasibility of the proposed projects, consisting in the unreadiness of the electric grid to support such an increase in energy demands. Thereby, a coordinated planning between decarbonisation strategies, deployment of additional power capacity (especially if coming from renewable energy solutions) and grid development is essential to secure a stable growth for all the sectors.

A strategy introduced by the Government in the 3rd National Communication on Climate Change of 2014, which affects both private and public mobility, is the plan to **replace conventional small-size cars with hybrid ones by 2025**. To incentivise the market of hybrid vehicles Jordan established a **tax reduction** on the total price of the cars, lowering it from 50% to 25%, totalising a cost saving up to 1,500 JD per car. This initiative has been well received by the population, producing more than 31,500 new registered hybrid cars only in 2017. However, in February 2018 the Government finally enforced the clearance of this incentive after a long process of negotiation, threatening to penalise the rising market. Together with this policy it was announced the commitment to introduce the **Zero Emission Electric Vehicle** (ZEV), targeting the installation of 3,000

[38] *Jordan's Third National Communication on Climate Change, 2014*

electric charging stations (on- and off-grid), powered by renewable energy, to support the foreseen 10,000 private circulating ZEVs. The project has been signed under a Public Private Partnership (PPP) agreement between the Greater Amman Municipality, the Ministry of Environment and the private sector. Yet, although the project has a great potential and open the gates for new business models, the details about this initiative have never been shown. Those two projects represent evident signals of the existence of a decarbonisation strategy and are vectors for attracting investors in both energy and transport sector. Indeed, beyond the new business opportunities, if in Jordan there were circulating a considerable number of hybrid and electric vehicles, they would contribute to increase the electric demand, stimulating the installation of additional power plants, both on- and off-grid. According to IRENA's study, the clean electric cars in the world are expected to be more than 1 billion by 2050, resulting in over 10% of the total global electricity consumption in that year[39]. Yet, although the efforts done to substantially boost a clean development of Transport sector in Jordan, here illustrated, what have been done may be not enough. Indeed, comparing this scenario to other countries, it could emerge a need for a more concrete and long-term targets and a major consistency between a general 2030/2050 vision and the measures adopted at all levels. Moreover, as it has been discussed above, the stop&go effect produced by the promotion and then the clearance of the hybrid vehicles incentive contributed to limit the confidence of the investors in a potential expansion of the RE market and the creation of new energy-intense business activities. Even in this case, as it has been said for the decarbonisation of public transports, the increase of private electric mobility cannot be addressed without an adequate planning of the system infrastructure alignment with the growing demand and the integration of grid flexibility solutions required by the deployment of renewable energy plants.

Beyond the highlighted barriers and weaknesses of the existing policies and strategies, there is a vast gamut of possible factors related to other domains, which don't fall within the energy sector competence, hindering a successful decarbonisation and development of the renewable energy market. Amongst all, a crucial role is played by the required high energy costs. Massive infrastructures improvements or financial supports to a clean technology entail substantial upfront investments, which could also incur in an increase of electricity bills (an option that is often rejected by the authorities). Therefore, it is undoubtable that planning a clean energy transition roadmap is a complex process, influenced by several factors and limited by various constraints. Moreover, it is undeniable that what appears a successful strategy or policy in a country could not be applicable or appropriate in a different context to address the same type of issue or meet the same type of goal. However, the list of recommendations given within this paper are intended to provide just a set of potential actions that Jordan could undertake to accelerate its decarbonisation process, foster the renewable energy deployment in the country and attract investors.

[39] *IRENA, Innovation landscape for a renewable-powered future: Solutions to integrate variable renewables, 2019*