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LEBANESE REPUBLIC
MINISTRY OF ENERGY
AND WATER

RENEWABLE ENERGY SECTOR IN LEBANON

VALUE CHAIN ASSESSMENT AND ANALYSIS

Executive Summary and Recommendations

LIST OF ABBREVIATIONS

ALI	Association of Lebanese Industrialists
CAS	Central Administration for Statistics
CEDRO	UNDP program being implemented in Lebanon and focused in RE
CSP	Concentrated Solar Power
DREG	Small Decentralized Renewable Energy Power Generation project
EDL	Electricité Du Liban
EE	Energy Efficiency
FDI	Foreign Direct Investment
FiT	Feed-in Tariff
FTE	Full-Time Equivalent
IEA	International Energy Agency
ILO	International Labor Organization
IPP	Independent Power Producer
IRENA	International Renewable Energy Agency
LCEC	Lebanese Center for Energy Conservation
LCR	Local Content Requirements
MENA	Middle East and North Africa
MOEW	Ministry of Energy and Water of Lebanon
MW	Megawatt
NEEREA	National Energy Efficiency & Renewable Energy Action
NREAP	National Renewable Energy Action Plan
O&M	Operations and Maintenance
PPA	Power Purchase Agreement
PV	Photovoltaic
RE	Renewable Energy
SWH	Solar Water Heaters
UNDP	United Nations Development Programme
WTO	World Trade Organization

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EXECUTIVE SUMMARY

Renewable energy (RE) can contribute to solving some of the challenges of the Lebanese electricity system. The government of Lebanon (GoL) has been active in setting targets for the improvement of the country's energy efficiency (EE) and RE capacity through the National Energy Efficiency Action Plan (NEEAP) and the National Renewable Energy Action Plan (NREAP), respectively.

NREAP pledges to increase renewable energy technology adoption in Lebanon to reach 12% of all energy demand by 2020, it focuses on three main pathways to achieve the target. First by increasing wind energy production to reach 2.06% of energy demand by 2020, second by increasing solar energy production to meet 4.2% of energy demand and increasing biomass use reaching 2.5% of energy demand by 2020. The remaining renewable energy capacity will be met by new and existing hydropower plants. The NREAP on the other hand, focuses on decreasing future energy demand by discussing multi-sectoral energy efficiency measures, these cover energy efficient lighting and appliances, heating and cooling, the industrial and agricultural sectors, power losses from the supply side and the sustainability of the transport sector.

This study assesses how sustainable energy can support in improving Lebanon's strained economic and labor market situation. RE is expected to provide employment opportunities for people at all qualification levels but a clear regulatory framework and support in building capacities are necessary to achieve the ambitious plans set out by the government and allow youth and vulnerable people to capture the employment opportunities in RE sector.

The selection of the renewable energy sectors analyzed in this study has been done taking into account the potential of each technology in terms of job creation, the potential to contribute effective solutions for the current challenges of the Lebanese energy system, and the feasibility in terms of realization potential. The three value chains selected for in-depth assessment are:

• **Solar Photovoltaic (PV).** Solar PV is already an established sector in Lebanon with a decent number of competitive private companies. However, the sector still has a large growth potential. This assumption is underpinned by the government's plans to upscale the installed capacity of this technology. Government's intentions are confirmed by the recent processes to sign Power Purchase Agreements (PPA) for the installation of large solar farms. This agreement is a contract that defines all the terms for the sale of electricity between the government utility (the buyer) and the solar PV developer (the seller). Additionally, it is considered that solar PV can contribute towards the decentralization of power supply. The market trends show an increasing interest in the installation of this kind of facilities. Though, value creation in the manufacturing of modules and cells seems to be better placed in Asia, all other aspects along the value chain look promising. For all these reasons, solar PV has been prioritized and selected for a more in-depth assessment as a value chain with good opportunities for job creation in the future.

• **Wind Energy.** The wind energy sector is new in Lebanon with no prior experiences in the installation and operation of wind farms. However, the GoL has signed a PPA with 2 private developers for the installation of the first 200+ Megawatts (MW) wind farm in the northern and mountainous district of Akkar. This process has been followed by an additional bidding process currently under way to install additional capacity between 200 and 400 MW. In this context, wind energy has been selected for a more in-depth analysis as it is deemed necessary to prepare the local workforce for these near future developments.

• **Bioenergy.** Bioenergy has neither been developed extensively in the past in Lebanon nor has a privileged treatment in the government's long-term plans. Nevertheless, bioenergy offers very good potential synergies with other sectors such as forestry, agriculture, water treatment and waste management. For this reason, it was decided to select bioenergy for further assessment and specifically to narrow the focus to biomass (briquettes) and biogas.

MAIN FINDINGS

The Lebanese economy has a well-established service sector, it therefore assumed that the service components of all renewable energy technologies exhibit opportunities for domestic provision. These are jobs created in design and planning, installation, transportation and logistics, and operation and maintenance. Moreover, the research and science sectors are also strong and is considered capable of contributing to essential services for the development of renewable energies.

In terms of manufacturing, the metal industry and machinery can contribute to all renewable energy systems because they currently exist in Lebanon, despite their relatively small size. However, manufacturing the main components of renewable energy systems in Lebanon is hard to achieve in the short-medium term, the Lebanese industrial sector lacks the necessary infrastructure and experience required to produce these components at competitive prices.

In this regard, up to 100% of the solar PV modules will be considered to be imported. The reason behind this assumption is twofold. Firstly, PV module prices are sensitive to economics of scale, meaning that the larger a factory for the modules is the smaller the costs of the modules. Secondly, Lebanon currently has no semiconductor industry and no experience in this field. In consequence, Lebanon is not identified as a potential manufacturing country for PV modules.

In the case of wind, it is assumed that wind turbines will be imported. This is due to the fact that the size of the projected wind farms is still small and would not justify the investments needed to set a local manufacturing industry. From the economic potential, blades could spin-off the existing chemicals and plastic fiber industry if the regional market is large enough. In any case, transportation and logistics will present be an issue that could be solved relying on local expertise. Blades have a length of 50-100 m and the transport is challenging, in particular through mountainous regions.

For Bioenergy, the largest share of permanent jobs can be found in technologies which need fuel. Therefore, the biogas deployment can lead to high shares of permanent jobs. However, since the waste management strategies in Lebanon are not fine-tuned between incineration, waste to biogas and other uses, we have not modeled explicitly employment from waste collection.

In technologies which are currently mature in Lebanon, such as solar water heaters, the growth potential for further domestic value creation is exhausted. Growth is expected to come from the increase in the number of new production and installation projects.

The above assumptions and analysis translate to the results (figure 1) in terms of job creation for the different sectors. In the analysis, employment is considered through the direct effects in installation and operation and maintenance and indirect effects along the value chain in the service sector such as the construction sector, the metal industry, education on vocational and higher education level, whole sale and import as well as transport. A more detailed description of the scenario can be found in the annex.

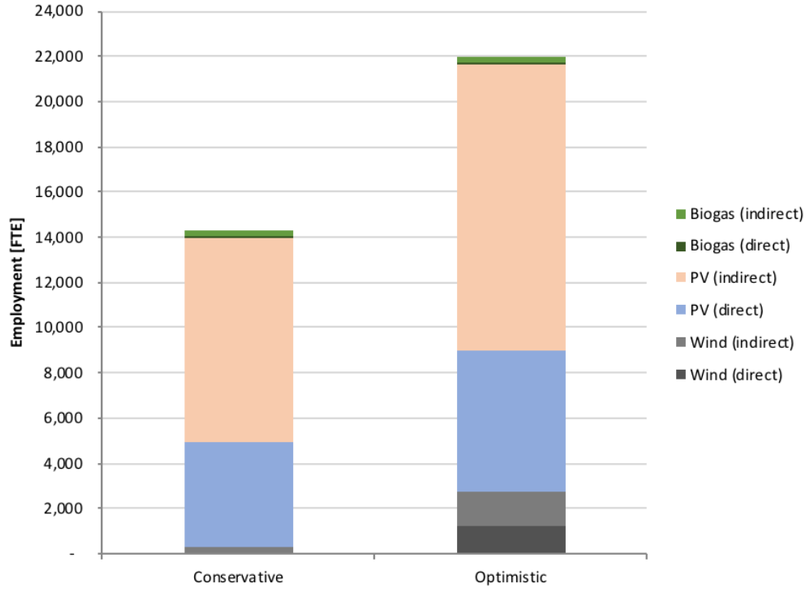


Figure 1. Employment from PV, wind and biogas, by value chain phase for 2021 under the conservative and the optimistic scenario

(Source: Own graph)

RECOMMENDATIONS

Based on the findings of the interviews and the sector analysis, and due to the peculiarities of the three technologies and their value chains, it is suggested that each technology requires a specific approach regarding their implementation strategy to maximize local job creation in each value chain. Strategic renewable energy actions are therefore necessary to maximize local value creation from renewable energies, in this context it is recommended to:

• **Establish a central RE knowledge hub that provides general RE but also technology-specific support and services:** This hub would become the central focal point for both companies and customers, driving the development of the RE sector and support the uptake of jobs by carrying out several of the actions proposed in this action plan.

The implementation strategy of the RE knowledge hubs are depicted in Figure 2 as follows:

• Solar – decentralized approach with central support due to the expected uptake of distributed generation.

• Wind – centralized approach as projects are large and only expected in the northern part of Lebanon where wind resource is high, as least in the current rounds of tenders.

• Bioenergy – centralized approach with local project support because of the complexity of the technology, which requires special knowledge but also potential support in-situ where plants are to be built.

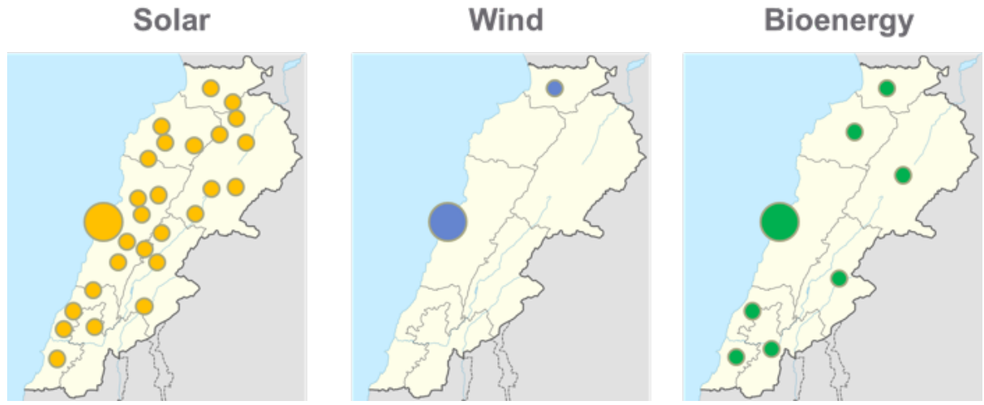


Figure 2 Proposed RE Knowledge Hub distribution in Lebanon

• **Promote R&D and companies working on hybrid systems:** The specific situation of Lebanon with Electricity du Liban (EDL) and private generators as energy providers that rely on diesel generation provides an opportunity for PV hybrid systems. Research and innovation in technological implementation terms will require extensive collaboration between energy companies and research institutes. In that unique area, Lebanon may even be well positioned to play a role on an international level.

Prosumers (producers and consumers of energy) invest in local RE projects. They can do this individually or together with others for larger projects like wind or solar farms, e.g. through cooperatives or other forms of cooperation. As they are local citizens or commercial entities (like SMEs with available roof-space), the revenues of the projects are more likely to stay within the local community as when foreign investors finance RE projects. Prosumers also play a key role to increase acceptance of RE installations and to secure distributed generation.

Prosumer projects should therefore be promoted to lift the local potential of funding. The RE knowledge hub (or other organizations) could for instance:

• Define and propose prosumer projects;

• Invite interested individual or collective prosumers to submit project ideas;

• Support in finding financing and/or funding;

• Support in creating information (leaflets, newsletters, etc.) on best-practice examples;

• Show business case calculations or accompany the creation process of prosumer initiatives with technical, economic and legal advice.

Eventually prosumerism should be an integral part of the future energy system of Lebanon, therefore any activities that help increasing the number of locally supported projects will increase the number of local jobs.

• **Implement a quality assurance framework for PV:** It is crucial that customers of distributed PV systems can rely on high-quality products and installations. A system that includes the

application of international standards and certification of project developers and installers will ensure that PV projects deliver as planned.

Others measures to improve quality should be taken such as:

• Establish lists of products that adhere to international quality standards (especially for PV modules and inverters), available online and regularly updated.

• Develop an education and training framework, including:
- Develop technical standards / Codes of Practice.
- Develop training programmes based on Job Task Analyses (JTAs).
- Develop curricula, teaching materials, equipment lists, practical and theory exams.
- Define examination regulations.
- Define certification schemes.
- Develop assessment procedures for training providers.
- Etc.

• Potentially establish an organization that serves as **certification body** for RE companies. For instance, the Industrial Research Institute may be empowered as its current portfolio already includes certification activities[1].

• Provide education and training, especially for PV installers and wind service engineers: In these parts of the value chain a large number of jobs is expected to be created. Therefore, a timely training and capacity building is needed to both ensure quality and reliability of RE installations and allow people to seize the employment opportunities in the RE sector.

- Provide technical and vocational training to installers: Especially AC/DC training is required according to interview partners. Those trainings need to be organized locally, i.e. there should be offerings in every larger city. Although those training offerings may become available through specialized service providers once demand for distributed PV systems goes up, it would help to pro-actively organize trainings within a network of certified training institutions.

- Educate and train craftsmen working in the informal and specifically in the construction sector, who very often have no or very little formal qualifications, but who play an important role for the RE sector as well. As part of this, RE employers should be encouraged and supported to provide on-the-job-training and apprenticeships.

- Educate architects and real estate developers / promoters: As the design of buildings establishes for decades to come the energy needs of their users, it is crucial to educate architects and real estate promotion companies early on.

Since they usually do not have an incentive to build energy efficient buildings or to integrate renewables, building codes are indispensable. However, the more these professionals understand and know about RE/EE, the more they may get interested to apply them in order to increase customer satisfaction.

[1] *http://www.iri.org.lb/certification.html*

The full list of recommendations have been categorized according to their timeline, priority, costs and responsible parties and are summarized in the table below.

ACTIONS	TIMELINE	PRIORITY	COSTS/ EFFORTS	RESPONSIBLE
Proposed actions applicable to all RE value chains				
Renewable Energy Strategy				
Update the NREAP taking into account the recent developments	2018-19	high	low	government
Regularly enhance RE support policies to counter RE investment risks	annually, starting 2018	medium-high	low-medium	government, input from RE sector
Tackle energy sector reform, establish regulatory authority	2019-20	medium-high	medium	government
Industrial strategy				
Introduction				
Define a strategy for the Lebanese RE industry	2018-19	high	low-medium	RE sector, supported by government
Establish a RE knowledge hub / RE help desk	2018-19	high	medium	RE sector, supported by government
Attract foreign direct investment	2018-20	medium	medium	RE sector, supported by government
Promote local investment through prosumer projects	2018-20	medium	low	RE sector, supported by government
Linking investment to employment creation and capacity building				
Introduction - supplier development programs and Local Content Requirements (LCRs)				
Organize trade RE shows and events	2018-20	medium	low-medium	RE sector, supported by government
Provide economic incentives to encourage local subcontracting	2018-20	medium	medium	government

ACTIONS	TIMELINE	PRIORITY	COSTS/ EFFORTS	RESPONSIBLE
Improving cooperation between public research organizations and private sector				
Introduction				
Think about RE clusters – but rather at a later stage	beyond 2020	low	tbd	government, RE sector
Enhancing know-how through education & training				
Introduction				
Implement quality standards for RE education and training	2018-19	medium-high	low-medium	government, RE sector, training providers
Plan RE Education and training	2018-20	medium	low	RE sector, supported by government
Specific Actions for PV				
General strategy – decentralized approach with central support				
Establish a central PV knowledge hub	2018-19	high	medium	PV sector, supported by government, donors
Establish local energy centers on PV (and EE)	Starting 2018	medium-high	medium-high	PV sector, supported by government, donors
Strategic investment promotion				
Introduction – PV value chain				
(Continue to) provide and promote an attractive and stable PV support scheme	on-going	high	low	government
Streamline the NEEREA process	2018-19	high	low	government
Accelerate the introduction of grid connection standards and guidelines	2018-20	medium-high	medium	government, EDL
Provide maps indicating useful roof-tops and available land	2019-20	medium-high	medium	PV sector, supported by government

ACTIONS	TIMELINE	PRIORITY	COSTS/ EFFORTS	RESPONSIBLE
Improving cooperation between public research organizations and private sector				
Promote R&D, pilots and companies working on hybrid systems	2019-21	medium	medium	PV sector, government, research institutes
Improve Building Code	2018-20	high	medium	PV sector, government, research institutes, building developers
Enhancing know-how through education and training				
Implement a quality assurance framework for PV	2019-20	high	medium	PV sector, supported by government
Provide technical and vocational training to installers (and others)	2018-20	medium-high	medium	PV sector, education sector
Organize awareness raising campaigns to promote RE prosumers	2018-20	medium-high	low-medium	PV sector, supported by government
Specific Actions for Wind				
General strategy – centralized approach				
Establish a central wind knowledge hub	2018-19	high	low-medium	wind sector, supported by government
Strategic investment promotion				
Introduction – wind value chain				
Define and show the pipeline of wind projects	2018-19	high	low	government
Promote small wind farms with citizen participation	2019-20	low	low	wind sector, supported by (local) government
Enhancing know-how through education and training				
Develop trainings for service for wind companies	2018-20	medium-high	low-medium	wind sector

ACTIONS	TIMELINE	PRIORITY	COSTS/ EFFORTS	RESPONSIBLE
Develop trainings for suppliers	2018-20	medium	low-medium	wind sector, supported by government
Improving cooperation between public research organizations and private sector				
Improve information on resources and site availability	2019-20	medium-high	low-medium	wind sector, supported by government
Specific Actions for Bioenergy				
General strategy – centralized approach with local project support				
Establish a central bioenergy knowledge hub and give local project support	2018-19	high	low-medium	bioenergy sector, supported by government
Strategic investment promotion				
Introduction – bioenergy value chain				
Define a bioenergy strategy and an incentive scheme for biogas plants	2018-19	medium-high	low-medium	bioenergy sector, supported by government
Define a holistic waste management strategy	2019-20	high	high	government, supported by bioenergy sector
Improving cooperation between public research organizations and private sector				
Combine biogas plants for of MSW with agricultural waste and/ or sewage plants	2019 onwards	medium	medium	local governments, bioenergy sector
Enhancing know-how through education and training				
Provide education and training for engineers and project developers	2019-20	medium	medium	bioenergy sector, supported by government

CONCLUSION

The actions proposed in the strategic renewable energy action plan aim to support the deployment of RE as well as the creation of jobs in Lebanon. It concludes, that more than 20,000 jobs could result from the deployment of renewable energy systems by 2021 under the optimistic scenario (see annex 1). The bulk of this number (14,000 – 18,000) is found in the PV sector, from distributed as well as from large PV installation, with or without batteries. Most jobs are in the installation phase, which means they are temporary however a succession of installations can turn these temporary jobs into permanent careers.

Wind energy can potentially employ up to 2,753 people under the optimistic scenario in 2021, roughly half of them in direct jobs. The largest number of jobs will be however in the service sector and during the construction phase. The transport of wind energy equipment will also create employment wherever infrastructure is needed, be it at the port or along the roads. Roads have to be widened and the area around the roads has to be cleared.

Under the deployment assumptions taken the expected number of direct jobs in the biomass sector is expected to be rather low (a few dozen) and also the indirect jobs will be only a few hundred. However, the biogas sector if seen in context of proper waste management, the sector as a whole can become of a strategic value due the expected synergies.

ANNEX 1: SCENARIO DESCRIPTION AND ASSUMPTIONS

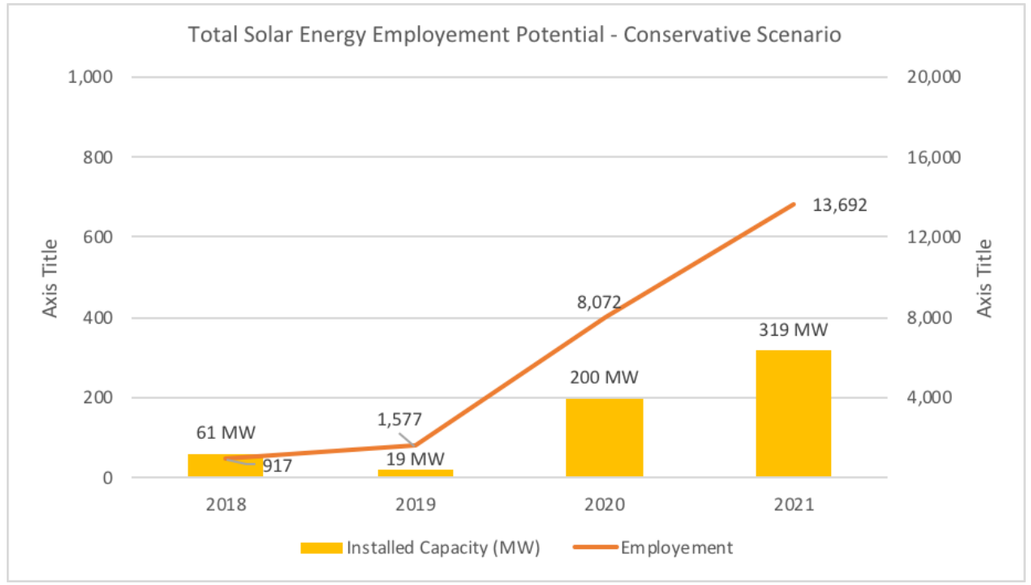
	Cumulative Capacity (MW):			
	2018	2019	2020	2021
SCENARIO A: Optimistic				
SOLAR	**73**	**283**	**738**	**1198**
Large Solar	*0*	180	*450*	*720*
Large Solar with Storage	*0*	*0*	*150*	*300*
Distributed Solar	*73*	*103*	*138*	*178*
WIND	**0**	**0**	**200**	**500**
BIO	**0**	**3**	**6**	**9**
Total	73	286	944	1707

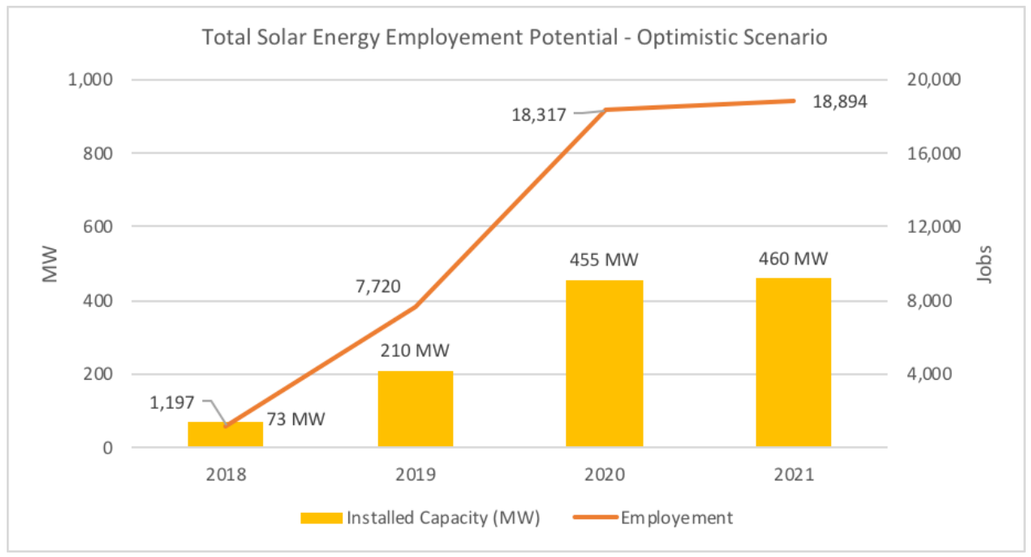
	2018	2019	2020	2021
SCENARIO B: Conservative				
SOLAR	**61**	**80**	**280**	**599**
Large Solar	*0*	*0*	*180*	*180*
Large Solar with Storage	*0*	*0*	*0*	*300*
Distributed Solar	*61*	*80*	*100*	*119*
WIND	**0**	**0**	**200**	**200**
BIO	**0**	**3**	**6**	**9**
Total	61	83	486	808

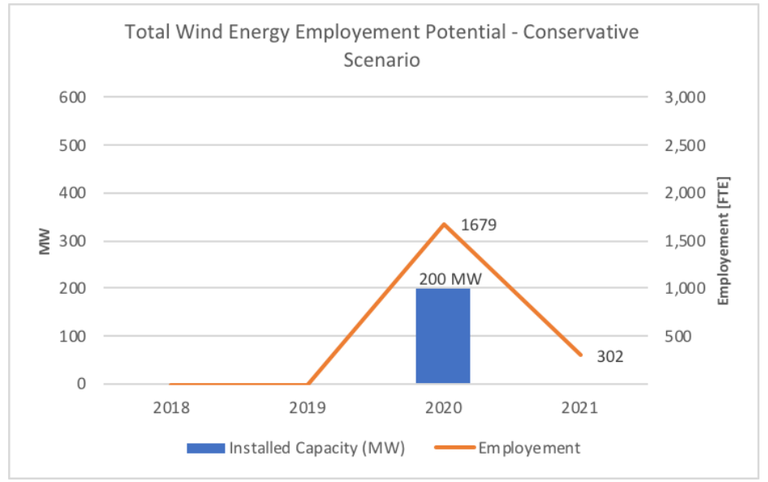
SOLAR PV	2018	2019	2020	2021
SCENARIO A: Optimistic				
DIRECT EMPLOYMENT	**556**	**2.606**	**6.115**	**6.267**
Installation	*550*	2.574	*6.025*	*6.118*
Operation & Maintenance	*6*	*32*	*90*	*149*
INDIRECT EMPLOYMENT	**641**	**5,114**	**12,202**	**12,627**
Installation	*609*	*4,987*	*11,707*	*11,763*
Operation & Maintenance	*32*	*127*	*496*	*864*
TOTAL EMPLOYMENT	**1,197**	**7,720**	**18,317**	**18,894**
SCENARIO B: Conservative				
DIRECT EMPLOYMENT	**423**	**606**	**2759**	**4,619**
Installation	*418*	*596*	*2725*	*4,545*
Operation & Maintenance	*5*	*10*	*34*	*73*
INDIRECT EMPLOYMENT	**493**	**971**	**5,313**	**9,073**
Installation	*463*	*926*	*5,077*	*8,485*
Operation & Maintenance	*30*	*45*	*236*	*588*
TOTAL EMPLOYMENT	**917**	**1,577**	**8,072**	**13,692**
DIFFERENCE				
TOTAL EMPLOYMENT DIFFERENCE	**280**	**6,143**	**10,246**	**5,202**

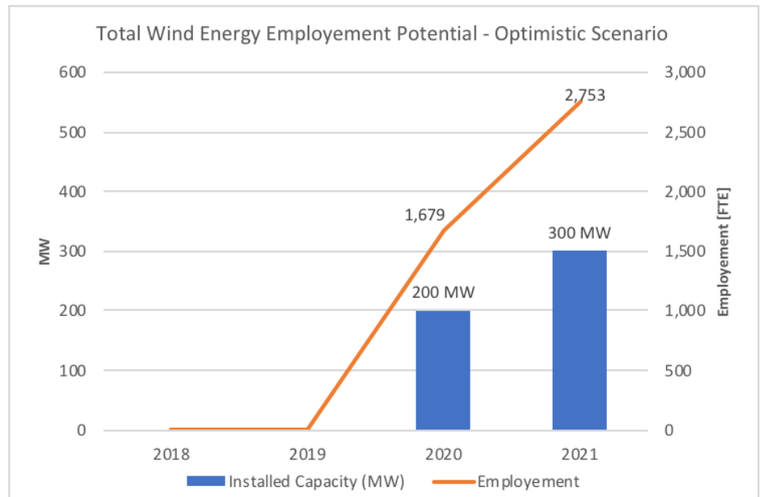
WIND	2018	2019	2020	2021
SCENARIO A: Optimistic				
DIRECT EMPLOYMENT	**0**	**0**	**777**	**1.222**
Installation	*0*	0	*720*	*1.080*
Operation & Maintenance	*0*	*0*	*57*	*142*
INDIRECT EMPLOYMENT	**0**	**0**	**902**	**1.531**
Installation	*0*	*0*	*657*	*936*
Operation & Maintenance	*0*	*0*	*245*	*595*
TOTAL EMPLOYMENT	**0**	**0**	**1.679**	**2.753**
SCENARIO B: Conservative				
DIRECT EMPLOYMENT	**0**	**0**	**777**	**57**
Installation	*0*	*0*	*657*	*0*
Operation & Maintenance	*0*	*0*	*57*	*57*
INDIRECT EMPLOYMENT	**0**	**0**	**902**	**245**
Installation	*0*	*0*	*657*	*0*
Operation & Maintenance	*0*	*0*	*245*	*245*
TOTAL EMPLOYMENT	**0**	**0**	**1679**	**302**
DIFFERENCE				
TOTAL EMPLOYMENT DIFFERENCE	**0**	**0**	**0**	**2.451**

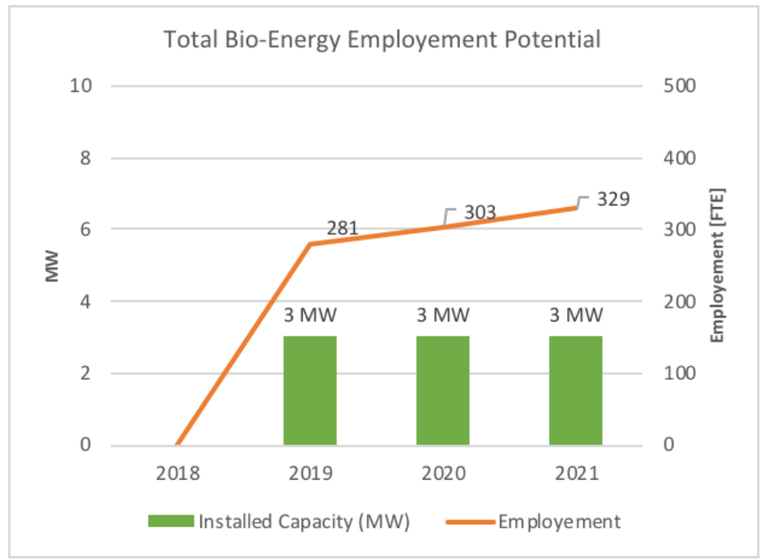
BIOGAS	2018	2019	2020	2021
DIRECT EMPLOYMENT	0	47	51	56
INDIRECT EMPLOYMENT	0	234	252	273
TOTAL EMPLOYMENT DIFFERENCE	**0**	**281**	**303**	**329**











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