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LEBANON:
Derisking Renewable Energy Investment

Selecting Public Instruments to Promote Renewable Energy Investment for the Lebanese National Renewable Energy Action Plan

SUMMARY REPORT

Federal Ministry for the
Environment, Nature Conservation,
Building and Nuclear Safety

gef

Australian Government

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The Low Emission Capacity Building Project is part of the LECB programme, launched in January 2011 as a joint collaboration between the European Union (European Commission and Member States) and the UNDP and encompasses 25 participating countries, one of which is Lebanon. The project is implemented by the Ministry of Environment and managed by UNDP. The project is designed to improve Lebanon's relevant infrastructure, capacity building, information sharing and processes through the development of a greenhouse gas emission inventory system, identification and development of NAMAs, and the design of an MRV system to support the different NAMA types, and the development of the national low emission development strategy. For more information on the LECB project please check www.lowemissiondevelopment.org and www.climatechange.moe.gov.lb.

DREG

UNDP is implementing the Small Decentralized Renewable Energy Power Generation (DREG) Project which is funded by the Global Environment Facility (GEF) and nationally executed by the Ministry of Energy and Water (MoEW) with the Lebanese Center for Energy Conservation (LCEC). The project's objective is to reduce greenhouse gas emissions by the removal of barriers to widespread application of decentralized renewable energy power generation. The project will catalyze the development of the small, decentralized, grid-connected renewable energy power generation market in Lebanon. The target is to facilitate the installation of at least 1.75 MW of new decentralized RE power generation capacity during the lifetime of the project, which would reduce approximately 35,500 tonnes of CO_2e in greenhouse gas emissions (GHG).

CEDRO
Empowering Lebanon with Renewable Energy

Project funded by the EUROPEAN UNION

UNDP, in partnership with the Ministry of Energy and Water and the European Union, has initiated the fourth phase of the CEDRO Programme (CEDRO 4) funded by the European Union. The CEDRO 4 project includes several sustainable energy projects that are designed to further mature the local market. The project will work on three levels, including: the implementation of model end-use energy efficiency and renewable energy demonstration projects for private sector buildings and facilities; the set-up of an enabling environment for the conversion of other private sector buildings and facilities into energy efficient modalities, and the assistance in the development of a national sustainable energy strategy and action plan.

REPUBLIC OF LEBANON
MINISTRY OF FINANCE

UNDP is implementing the Technical Assistance for Fiscal Management and Reform Project at the Ministry of Finance. The project supports the Ministry of Finance in developing public finance policy and enhancing fiscal management, furthering the efficient achievement of the Ministry of Finance's policy objectives and reform initiatives

LCEC
LEBANESE CENTER FOR ENERGY CONSERVATION
المركز اللبناني لحفظ الطاقة
efficient resources, sustainable achievements

The Lebanese Center for Energy Conservation (LCEC) is the technical arm of the Ministry of Energy and Water in all subjects related to energy efficiency, renewable energy, and green buildings. LCEC offers proven expertise and support to the Government of Lebanon to develop and implement national strategies towards saving energy, saving money, reducing greenhouse gas emissions with the final target being to improve durability, safety and comfort of the Lebanese pollution.

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Acknowledgments: UNDP would like to express its gratitude to the Lebanese Center for Energy Conversation (LCEC) for providing invaluable support and inputs for this report. The authors would also like to thank the wind energy and solar photovoltaic energy investors, development specialists and stakeholders in Lebanon who participated in structured interviews for the modelling. This report has been produced in close coordination and with the involvement of the UNDP Lebanon – Ministry of Finance team (Technical Assistance for Fiscal Management and Reform Project – 0077489) providing the Lebanese Ministry of Finance oversight of the report. Finally, the authors are grateful to all reviewers and contributors for their valuable comments and inputs. Any errors and oversights in this report are the sole responsibility of the authors.

This publication builds on a series of prior research papers. This includes the original *Derisking Renewable Energy Markets* (Waissbein *et al.,* 2013) report, which sets out the methodology used in this publication.

This report should be referenced as: UNDP (2017). *Lebanon: Derisking Renewable Energy Investment*. New York, NY: United Nations Development Programme.

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September 2017, New York and Beirut.

This Summary Report is accompanied by a **Full Report version**.

Acronyms

Acronyms

BAU	Business as usual
BDL	Banque du Liban
BOO	Build-Own-Operate
CCGT	Combined Cycle Gas Turbine
CDM	Clean Development Mechanism
CO_2e	Carbon Dioxide Equivalent
CoD	Cost of Debt
CoE	Cost of Equity
CSP	Concentrated Solar Power
DREI	Derisking Renewable Energy Investment
ECN	Energy Research Centre of the Netherlands
EDL	Electricité du Liban
EIA	Energy Information Administration (US)
EPC	Engineering, Procurement and Construction
EU	European Union
EUR	Euro
FiT	Feed-in Tariff
FTE	Full-time Equivalent
GDP	Gross Domestic Product
GEF	Global Environment Facility
GoL	Government of Lebanon
IEA	International Energy Agency
INDC	Intended Nationally Determined Contribution
IPP	Independent Power Producer
IRENA	International Renewable Energy Agency
kW	Kilowatt
kWh	Kilowatt-hour
LCEC	Lebanese Centre for Energy Conservation
LCOE	Levelised Cost of Electricity
LEEREFF	Lebanon Energy Efficiency & Renewable Energy Finance Facility
MoF	Ministry of Finance
MoE	Ministry of Environment
MoEW	Ministry of Energy and Water
MRV	Measuring, Reporting and Verification
MW	Megawatt
MWh	Megawatt-hour
NA	Not Applicable/Available
NAMA	Nationally Appropriate Mitigation Action
NEEREA	National Energy Efficiency and Renewable Energy Action
NERA	National Electricity Regulatory Authority
NREAP	National Renewable Energy Action Plan 2016-2020
NREL	National Renewable Energy Laboratory (US)
O&M	Operations and Maintenance
PDD	CDM Project Design Document
PPA	Power Purchase Agreement
PRI	Political Risk Insurance
PV	Photovoltaic
UNDP	United Nations Development Programme
UNFCCC	United Nations Framework Convention on Climate Change
USD	United States Dollar

Executive Summary

Executive Summary

Introduction

The analysis set out in this report forms part of the United Nation Development Programme's (UNDP) support to the Government of Lebanon in increasing the country's security of supply of energy by means of low-carbon technologies. UNDP is providing this support under the umbrella of three projects: 1) the *Low Emission Capacity Building* (LECB) project with the Ministry of Environment (MoE) serving as the national implementing partner and funded by the European Union (EU), and the Governments of Australia and Germany; 2) the *Small Decentralized Renewable Energy Power Generation* (DREG) project implemented with the Ministry of Energy and Water (MoEW) and the *Lebanese Center for Energy Conservation* (LCEC) and funded by Global Environment Facility (GEF); as well as 3) the EU funded fourth phase of the *Country Energy Efficiency and Renewable Energy Demonstration Project for the Recovery of Lebanon* (CEDRO 4) programme.

Recently, the MoEW/LCEC has released Lebanon's National Renewable Energy Action Plan 2016-2020 (NREAP; MoEW/LCEC, 2017). Its primary purpose is to further break down the legally-binding target of 12% renewable energy (RE) by the year 2020 (MoEW, 2010). Moreover, the NREAP outlines a vision for a tangible RE target by the year 2030, considering that Lebanon's total energy demand for heat and power is expected to more than double between 2015 and 2030[5]. The NREAP envisages utility-scale RE projects to be financed exclusively through private investments. Lebanon's Intended Nationally Determined Contribution (INDC), submitted by the Government of Lebanon (GoL) as part of its commitment under the Paris Agreement, stipulates a 15% RE target (power and heat demand) by 2030, which can reach 20% with proper support.

"The NREAP envisages utility scale solar and wind projects to be financed exclusively through private investments."

By systematically assessing the impact of investment risks alongside a menu of public derisking measures, this study aims at contributing to an enabled environment for large-scale renewable energy investments. The focus is set on onshore wind and solar photovoltaic (PV) energy, the two key technologies for achieving the NREAP's 2020 renewable energy target and its 2030 vision, as well as its INDC RE targets.

Context and Opportunity for Renewable Energy in Lebanon

Lebanon's power sector is currently characterised by a significant supply-demand imbalance, high generation costs and a lack of financial sustainability. Electricté du Liban's (EDL) available installed capacity is 1,616 MW, contrasting with peak demand of up to 3,000 MW. This current installed capacity is almost entirely powered by fuel oil, a relatively expensive source of power. EDL's end-user tariffs are in turn not cost-reflective, with EDL requiring a large annual subsidy, estimated at close to USD 2 billion in 2013, or 4.5% of GDP. Annual electricity demand is projected to grow at around 5% per year[6].

"Renewable energy has the opportunity to decrease Lebanon's dependence on fuel imports."

Renewable energy holds strong potential in Lebanon. Lebanon is well positioned for investment, with good renewable energy resources and a dynamic domestic business and financial sector. Renewable energy has the opportunity to contribute positively to Lebanon's power sector, increasing the reliability of the power supply, decreasing the country's dependence on fuel imports, improving the affordability of the energy mix, and reducing the need for subsidies to EDL. Renewable energy can also support Lebanon's contributions to climate change mitigation under the UNFCCC.

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1 Regarding renewable electricity, the 2030 NREAP vision in terms of total installed capacity is 450 MW onshore wind energy, 300 MW solar PV, ca. 473 MW hydro power (today 190 MW), and ca. 320 MW other new REs (distributed PV, CSP, Bioenergy) (MoEW, 2017).

2 This projection accounts for the recent demographic development related to the immigration of Syrian displaced.

To date there has been limited investment in large-scale renewable energy in Lebanon; in wind energy, there has been no investment; in solar PV, there are two government-owned 1.1 MW plants. In 2013, a procurement process for a 50-100 MW wind farm was initiated; this process has faced delays and is still ongoing. There are longstanding efforts to put in place an appropriate legal framework for large-scale renewable energy, including power sector reform. A new electricity sector regulation, Law 462 (to be viewed in conjunction with amended Laws 288 and Law 54), has existed on paper since 2002, but has never entered into force. This law is aimed at unbundling EDL, allowing private power generation and grid connection through independent power producers (IPPs). On the other hand there have been successful efforts and schemes put in place in small-scale renewable energy. Overall, as informed by interviews for this study, private sector investor interest in large-scale renewable energy is strong.

The Derisking Renewable Energy Investment Methodology

In 2013, UNDP issued the Derisking Renewable Energy Investment report (the "DREI report") (Waissbein *et al.,* 2013). The DREI report introduced an innovative methodology (the "DREI methodology"), with an accompanying financial tool in Microsoft Excel, to quantitatively compare the cost-effectiveness of different public instruments in promoting renewable energy investment. The analysis of Lebanon set out in this report is based on the DREI methodology.

"The DREI methodology explores how public derisking measures can attract private sector renewable energy investment."

A key focus of the DREI methodology is on financing costs for renewable energy. While technology costs for renewable energy have fallen dramatically in recent years[7], private sector investors in renewable energy in developing countries still face high financing costs (both for equity and debt). These high financing costs reflect a range of technical, regulatory, financial and informational barriers and their associated investment risks. Investors in early-stage renewable energy markets, such as those of many developing countries, require a high rate of return to compensate for these risks[8].

In seeking to create an enabled environment for private sector renewable energy investment, policy-makers typically implement a package of public instruments[9]. From a financial perspective, the public instrument package aims to achieve a risk-return profile for renewable energy that can cost-effectively attract private sector capital. Figure 1 on page 17, from the DREI report, identifies the four key components of a public instrument package that can address this risk-return profile.

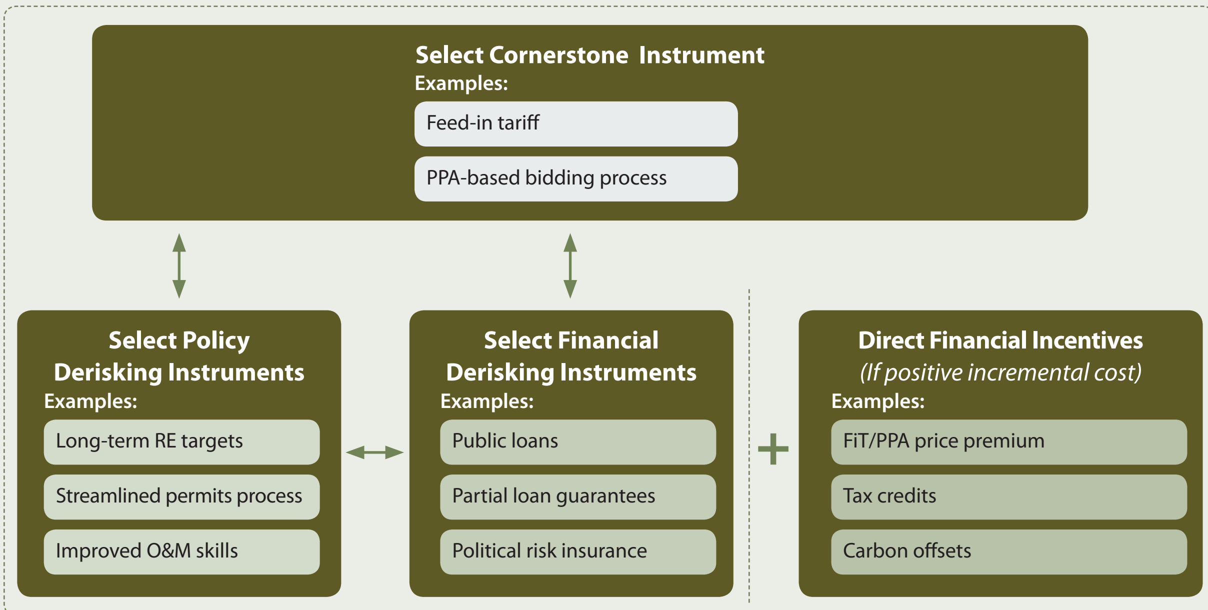
The **cornerstone instrument** is the centrepiece of any public instrument package. For large-scale renewable energy, the cornerstone instrument is typically a Feed-in Tariff (FiT) or a tendering process, either of which allows independent power producers (IPPs) to enter into long-term (e.g. 15-20 year) power purchase agreements (PPAs) for the sale of their electricity. The cornerstone instrument can then be complemented by three core types of public instruments:

[7] For example, in the case of solar photovoltaic, module prices declined by around 80% between the end of 2009 and the end of 2015, while in the case of onshore wind energy, the installed cost went down by 7% each time that the cumulative installed capacity has doubled between of the of onshore wind between 1983 and 2014 (IRENA, 2016).

[8] Indeed, as is shown later in this report, interviews with project developers identified higher financing costs for wind energy and solar PV investment in Lebanon in comparison to Germany, a well-established market. For example, the cost of equity (USD-denominated) is estimated at 16% in Lebanon today, in comparison to 7% in Germany.

[9] Public instruments can be understood to be domestic government interventions in the form of policies and programs. These instruments can be non-financial or financial in nature.

Figure 1: Typical components of a public instrument package for large-scale renewable energy



Source: Derisking Renewable Energy Investment (Waissbein *et al.,* 2013)

- **Instruments that reduce risk,** by addressing the underlying barriers that are the root causes of investment risks. These instruments utilize policy and programmatic interventions. An example might involve a lack of transparency or uncertainty regarding the technical requirements for renewable energy project developers to connect to the grid. The implementation of a transparent and well-formulated grid code can address this barrier, reducing risk. The DREI methodology terms this type of instrument "**policy derisking**".

- **Instruments that transfer risk,** shifting risk from the private sector to the public sector. These instruments do not seek to directly address the underlying barrier but, instead, function by transferring investment risks to public actors, such as development banks. These instruments can include public loans and guarantees, political risk insurance and public equity co-investments. For example, the credit-worthiness of a PPA may often be a concern to lenders. In order to address this, a development bank can guarantee the PPA, taking on this risk. The DREI methodology terms this type of instrument "**financial derisking**".

- **Instruments that compensate for risk,** providing a financial incentive to investors in the renewable energy project. When risks cannot be reduced or transferred, residual risks and costs can be compensated for. These instruments can take many forms, including price premiums as part of the electricity tariff (either as part of a PPA or FiT), tax breaks and proceeds from the sale of carbon credits. The DREI methodology calls these types of instruments " **direct financial incentives**".

"Public instruments for renewable energy act in one of three ways, *reducing, transferring* or *compensating* for risk."

Modelling Results

This report, using the DREI methodology, sets out the results of modelling to select public instruments to attract private sector investment in Lebanon to meet the 2030 targets envisioned in the NREAP for large-scale wind energy and solar PV.

"Financing cost waterfalls quantify how different investment risks contribute to higher financing costs in Lebanon."

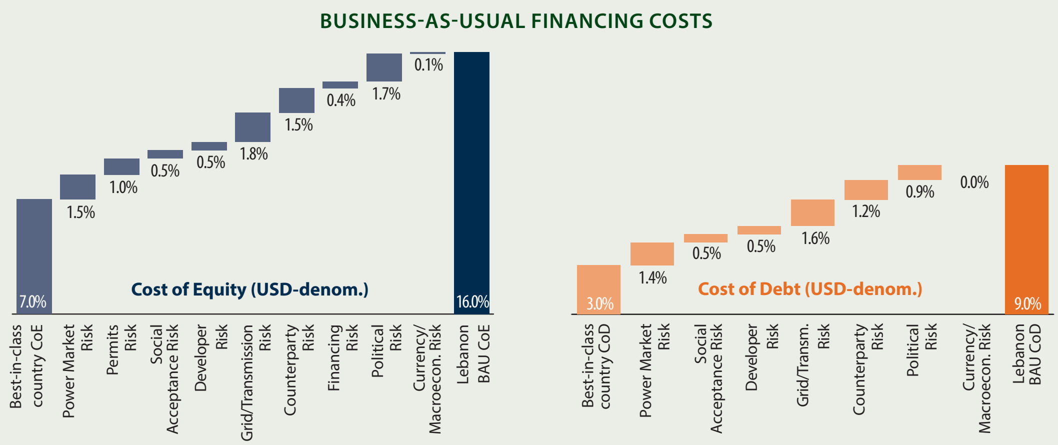
Risk Environment

Data on the risk environment were obtained from a total of 17 structured interviews held with 12 domestic and international project developers and with 5 domestic debt investors who are considering, or actively involved in, wind energy and solar PV opportunities in Lebanon.

The results estimate that financing costs for wind energy and solar PV in Lebanon today are 16.0% for the cost of equity (CoE), and 9.0% for the cost of debt (CoD)[10]. These are substantially higher than in the best-in-class country, Germany, which are estimated at 7.0% CoE, and 3.0% CoD. Given the longevity of energy assets in general as well as the capital intensity of renewable energy investments in particular, the impact of Lebanon's higher financing costs on the competitiveness of wind energy and solar PV is significant.

Figure 2 shows how a range of investment risks currently contribute to these higher financing costs. The risk categories with the largest impact on elevated financing costs are 1) *power market risk,* which relates to accessing power markets and the price paid for renewable energy, 2) *grid and transmission risk* that concerns the failure-free feed-in of the electricity produced; 3) *counterparty risk* that concerns the credit-worthiness of the electricity off-taker; and 4) *political risk* that concerns a country's general intra- and international stability.

Figure 2: Impact of risk categories on financing costs for wind energy and solar PV investments in Lebanon, business-as-usual scenario[11]



Source: interviews with wind energy and solar PV investors and developers; modelling; best-in-class country is assumed to be Germany; see Annex A for details of assumptions and methodology.

[10] USD-denominated cost of equity and debt

[11] The financing cost waterfalls shown here are calculated by differentiating between the answers from equity and from debt investors, but not distinguishing further between investors with focus on wind energy and investors with focus on solar PV. It is recognized that the risk profiles of large-scale wind energy and solar PV can differ. However, the results of the interviews with wind energy and solar PV investors made clear that these differences are minimal in the Lebanese context. As such, the interview answers from equity and from debt investors were not further split into 'wind energy focus' and 'solar PV focus' sub-groups, in order to bring simplicity to the analysis and to avoid multiple result sets. For comparison, cost waterfalls with a distinction between answers from wind energy and solar PV investors are shown in Annex A.

Public Instrument Selection

The modelling uses 2030 targets for both large-scale wind energy (450 MW) and solar PV (300 MW), based on the NREAP's 2030 vision[12]. It then models the implementation of a package of public instruments, containing both policy and financial derisking instruments, to promote investment to achieve these targets. The instruments are selected in order to specifically address the risk categories identified in the financing cost waterfalls. A list of these public derisking instruments is shown in Table 1. For wind energy, the costs until 2030 for policy derisking instruments are estimated as being USD 6.7 million, and for financial derisking instruments USD 91.4 million[13]. For solar PV, the policy derisking instruments are estimated as being USD 4.8 million, and the financial derisking instruments USD 40.9 million[14].

"The modelling identifies a comprehensive package of public instruments to target investment risks."

Table 1: The selection of public instruments to achieve the envisioned NREAP investment targets for wind energy and solar PV.

RISK CATEGORY	POLICY DERISKING INSTRUMENTS	FINANCIAL DERISKING INSTRUMENTS
Power Market Risk	• Long-term, legally-binding RE targets • Establishment of an enabling regulatory framework • FIT/PPA tender (standardized PPA) • Independent regulator for power sector	NA
Permits Risk	• Streamlined process for RE permits (dedicated one-stop shop) • Contract enforcement and recourse mechanisms	NA
Social Acceptance Risk	• Awareness-raising campaigns • Stakeholder outreach, including operators of private generators	NA
Developer Risk	• Capacity building for resource assessment (wind only) • Technology and Operations & Maintenance (O&M) assistance	NA
Grid/Transmission Risk	• Strengthen EDL's grid management capacity • Transparent, up-to-date grid code • Policy support for grid infrastructure development	• Take-or-pay clause in PPA[15]
Counterparty Risk	• Strengthen EDL's management and operational performance	• Government guarantee for PPA payments • Concessional public loans to IPPs
Financing Risk	• Fostering financial sector reform towards green infrastructure investment • Strengthening financial sector's familiarity with renewable energy and project finance	• Concessional public loans to IPPs
Political Risk	NA	• Political risk insurance for equity investments
Currency/Macroeconomic Risk	NA	NA

Source: modelling. See Annex A for a full description of these instruments. "NA" indicates "Not Applicable".

[12] NREAP assumes these targets to be achieved exclusively through private-sector engagement.

[13] Different methodological approaches (e.g., face value, reserve, cost, no-cost) may be taken to costing financial derisking instruments. Here, a cost approach has been taken for the 'take or pay clause in PPA' and 'government guarantee for PPA', totalling USD 55.1m; a reserve approach has been taken for 'public loans' and 'political risk insurance', totalling USD 36.3m. See Section 4.2.4 for sensitivity analyses on costing. See Annex A for details.

[14] Like in the case of wind energy (see previous footnote), for solar PV, too, a cost approach has been taken for the 'take or pay clause in PPA' and 'government guarantee for PPA', totalling USD 25.0m; a reserve approach has been taken for 'public loans' and 'political risk insurance', totalling USD 16.0m. See Section 4.2.4 for sensitivity analyses on costing. See Annex A for details.

[15] A "take-or-pay" clause is a clause found in a Power Purchase Agreement (PPA) that essentially allocates risk between parties in the scenario where transmission line failures or curtailment (required by the grid operator) result in the IPP being unable to deliver electricity generated by its renewable energy plant.

Levelised Costs

The modelling is performed for two risk environment scenarios; first, a *business-as-usual* scenario, representing the current risk environment (with today's financing costs); and second, a *post-derisking* scenario, after implementing the public instrument packages (resulting in lower financing costs).

"With derisking measures, wind falls from 11.4 to 9.4 USD cents per kWh; solar PV falls from 10.0 to 8.2 USD cents per kWh."

The results for generation costs, expressed as the Levelised Cost of Electricity (LCOE), are shown in Figures 3 below:

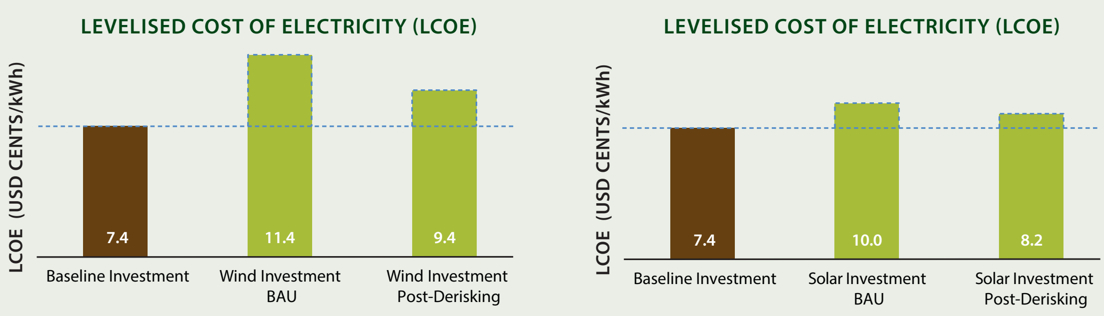
- In the business-as-usual (BAU) scenario, wind energy and solar PV are more expensive than the baseline. The baseline technology mix considers primarily combined cycle gas turbine (CCGT) plants, which Lebanon will likely use to increase its electricity generation capacity, and to a smaller extent also the existing power generation fleet that could be partly replaced by wind energy or solar PV[16]. This approach results in baseline generation costs of USD 7.4 cents per kWh, assuming unsubsidized fuel cost that are based on projections by leading international energy organizations (see Appendix A). In comparison, wind energy in the BAU scenario is estimated at USD 11.4 cents per kWh, and solar PV at USD 10.0 cents per kWh. This means that both wind energy and solar PV require a price premium (USD 4.0 cents per kWh and USD 2.5 cents per kWh, respectively) over the baseline energy technology mix.

- In the post-derisking scenario, the cost of wind energy falls to USD 9.4 cents per kWh, and the cost of solar PV falls to USD 8.2 cents per kWh. As such, following government interventions to derisk the investment environment, and with resulting lower financing costs, the price premium for wind energy and solar PV is reduced by roughly 50% and 70%, respectively.

Evaluation of Public Instruments' Effectiveness

The DREI methodology uses four performance metrics to analyse the impacts of the selected public instrument package to promote investment, each metric taking a different perspective: the ability to catalyse investment (leverage ratio); the economic savings generated for society (savings ratio); the resulting electricity price for end-users (affordability); and the efficiency in mitigating greenhouse gas emissions (carbon abatement).

Figure 3: LCOEs for the baseline, wind energy (left) and solar PV (right) investment in Lebanon



Source: modelling; see Table 13 (wind) and Table 14 (solar PV), as well as Annex A for details of assumptions and methodology.

[16] In other words, renewable energy is compared to a generation mix that is partly composed of yet-to-be-built new technology (build margin) and of existing technology that were to be replaced (operating margin). See Annex A for details.

Figure 4 shows exemplarily the results for two out of the four performance metrics, namely the leverage ratio and carbon abatement for wind energy:

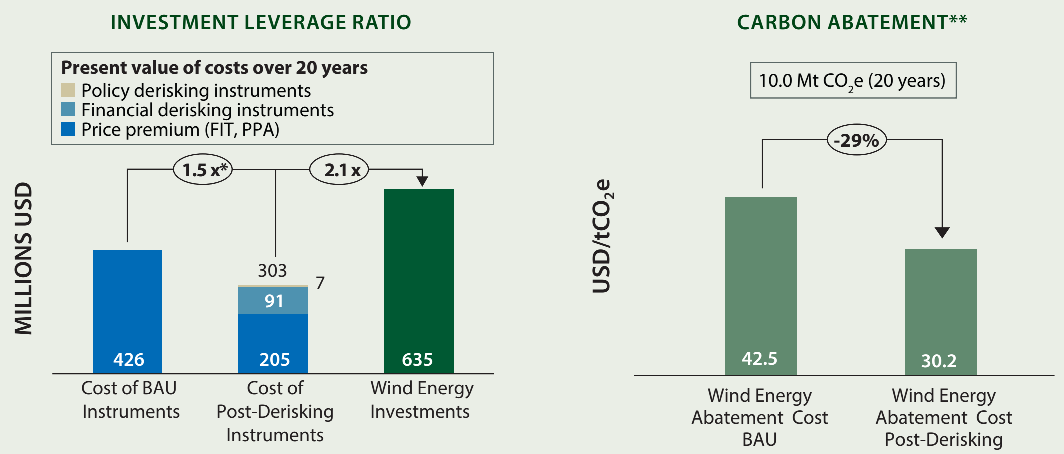
- For the leverage ratio, achieving the envisioned 2030 target of 450 MW in installed wind capacity equates to USD 635 million in private sector investment. In the *business-as-usual* scenario, the model estimates that achieving this target will require a direct financial incentive in the form of a price premium over 20 years of USD 426 million. This results in a leverage ratio of 1.5x, i.e. the investments catalysed are 1.5 times the amount spent on the public instruments. In the *post-derisking* scenario, the model estimates that this same investment target can be achieved with a package of derisking instruments valued at USD 303 million, including the price premium. This raises the leverage ratio to 2.1x, indicating a higher efficiency in terms of the use of public instruments.

- For carbon abatement, achieving the 2030 target of 450 MW in wind energy is estimated to result in a total reduction of 10.0 million tonnes of CO_2e over the lifetime of the wind plants. In the business-as-usual scenario, the abatement cost of the investment in wind energy is USD 42.5 per tonne of CO_2e. Or, in other words, the cost of public instruments equates to USD 42.5 for every tonne of CO_2e reduced by the investment in wind energy. In the post-derisking scenario, this cost falls to USD 30.2 per tonne of CO_2e. This performance metric is helpful in terms of understanding a carbon price that is necessary to promote investment, and in comparing the relative costs of different low-carbon options.

"Investing in derisking measures totaling USD 303m, catalyzes USD 635m in private sector investment in wind energy."

As such, both the leverage ratio and carbon abatement metrics from the modelling on wind energy show improved cost-effectiveness from government measures to derisk the investment environment.

Figure 4: Performance metrics for the selected package of derisking instruments in promoting 450 MW of wind energy investment in Lebanon

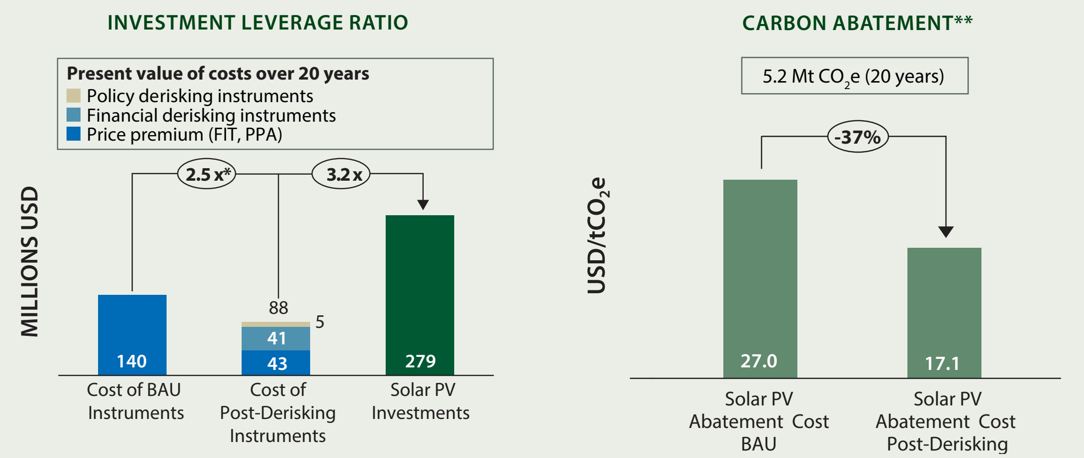


Source: modelling; see Table 13 and Annex A for details of assumptions and methodology.

* In the BAU scenario, the full 2030 investment target may not be met.

** The Carbon Abatement metric can be broken down into the costs of policy derisking instruments, financial derisking instruments and the price premium. While in the BAU scenario, the total of USD 42.5 per tCO_2e is due to the price premium, in the *post-derisking* scenario, this breakdown for the total of USD 30.2 per tCO_2e is USD 0.7, USD 9.1 and USD 20.4, respectively.

Figure 5: Performance metrics for the selected package of derisking instruments in promoting 300 MW of solar PV investment in Lebanon



Source: modelling; see Table 14 and Annex A for details of assumptions and methodology.

* In the BAU scenario, the full 2030 investment target may not be met.

** The Carbon Abatement metric can be broken down into the costs of policy derisking instruments, financial derisking instruments and the price premium. While in the BAU scenario, the total of USD 27.0 per tCO_2e is due to the price premium, in the *post-derisking* scenario, this breakdown for the total of USD 17.1 per tCO_2e is USD 0.9, USD 7.9 and USD 8.2, respectively.

Figure 5 shows selected results for solar PV in Lebanon, this time with the envisioned 2030 target of 300 MW of large-scale solar PV private sector investment. The results demonstrate the beneficial impact of derisking even more strikingly than the case with wind energy. In the post-derisking scenario, the package of derisking measures increases the leverage ratio from 2.0x to 3.2x, while the carbon abetment cost fall by 37% from USD 27.0 to USD 17.1 per tonne of CO_2e.

Sensitivities

"Sensitivities show that overall implementing public derisking measures is always more cost effective than paying higher generation costs."

Sensitivity analyses can assist in gaining a better understanding of the robustness of the outputs and in testing different scenarios. Three broad types of sensitivity analysis have been performed on (i) key input assumptions, such as investment cost, capacity factors and fuel costs, (ii) on public instrument selection and cost-efficiency and (iii) on the approach to costing financial derisking instruments. The sensitivities on public instrument selection show a range of cost-effectiveness, but that overall implementing public derisking instruments is always more cost-effective than paying higher generation costs, across all scenarios.

Detailed results for the sensitivities can be found in Section 4.2.4

Conclusions

The results in this report should not be interpreted as a definitive quantitative analysis of wind energy and solar PV in Lebanon but, rather, as one contribution to the larger policy decision-making process.

"The results identify a comprehensive package of public derisking measures to achieve the 2030 investment objectives envisioned for wind and solar PV in Lebanon."

Implications for promoting renewable energy in Lebanon

The results confirm that financing costs for wind energy and solar PV in Lebanon are currently high, particularly in comparison to countries with more favourable investment environments. The cost of equity for wind energy and solar PV in Lebanon today is estimated at 16%, and the cost of debt at 9%[17]. The modelling evaluates nine different risk categories regarding their contribution to these higher financing costs in Lebanon. Four of these – power market risk, grid/transmission risk, counterparty risk, political risk – are large contributors to high financing costs, increasing the cost of equity by more than 1% point (100 basis points) each.

The results identify a comprehensive package of public derisking measures to achieve the 2030 investment objectives for wind and solar PV envisioned in Lebanon's National Renewable Energy Action Plan. These measures, consisting of a collection of policy and financial instruments, systematically target the identified investment risk categories. Table 1 itemises each of the measures. The modelling also estimates the public cost of these measures until 2030.

A key conclusion from the modelling is that investing in derisking instruments is a cost-effective approach for achieving Lebanon's wind and solar PV investment objectives. The derisking measures that are modelled bring down the generation cost of wind energy from USD 11.4 cents per kWh to USD 9.4 cents per kWh, and solar PV energy from USD 10.0 cents per kWh to USD 8.2 cents per kWh.

- For wind energy, in the business as usual scenario, the modelling estimates that a premium price totalling USD 426 million will be required over the next 20 years to achieve the envisioned NREAP target. However, if over the same period a total investment of USD 98 million is made in derisking measures, wind energy will become 18% cheaper and the premium price reduces to USD 205 million, thereby saving USD 221 million in generation costs over the next 20 years[18].
- For solar PV, in the *business as usual* scenario, the modelling estimates that a premium price totalling USD 140 million will be required over the next 20 years to achieve the envisioned NREAP target. However, if over the same period a total investment of USD 46 million is made in derisking measures, solar PV will also become 18% cheaper and the price premium price reduces to USD 43 million, thereby saving USD 97 million in generation costs over the next 20 years[19].

The modelling thus clearly demonstrates that investing in derisking measures is good value for money when compared to paying a premium price for wind and solar PV energy. The results show that the identified derisking measures are cost-effective both collectively, taken as a package of derisking measures, and individually, as single derisking measures. Overall, the results indicate that all derisking instruments that can be immediately implemented should, if possible, be prioritized.

"All derisking measures that can be immediately implemented should, if possible, be prioritized."

[17] USD-denominated cost of equity and cost of debt.

[18] Net savings of USD 123 million (USD 221 million minus USD 98 million)

[19] Net savings of USD 51 million (USD 97 million minus USD 46 million)

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September 2017, New York and Beirut