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RE-ENERGIZE LEBANON

5 ACTION STEPS TO REBUILDING LEBANON'S COLLAPSED ELECTRICITY SECTOR

RESEARCH PAPER

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Disclaimer

LIST OF ABBREVIATIONS

bn: Billion
BDL: Banque du Liban
CCGT: Combined cycle gas turbines
DISCO: Distribution service companies
EDF: Électricité de France
EDL: Électricité du Liban
EDZ: Électricité de Zahle
GW: Gigawatt
Gwh: Gigawatt hour
HFO: Heavy Fuel Oil
IMF: International Monetary Fund
IPP: Independent Power Producer
IRENA: International Renewable Energy Agency
Kwh: Kilowatt hour
LBP: Lebanese Pounds
m: Million
mt: Metric ton
mmbtu: Million British thermal units
MOEW: Ministry of Energy and Water
MOF: Ministry of Finance
MW: Megawatt
NG: Natural Gas
OCGT: Open cycle gas turbines
PG: Private Generators
PPA: Power Purchase Agreement
PPP: Public-Private Partnership
RE: Renewable Energy
SLA: Staff Level Agreement
USD or $: US Dollars
WB: World Bank
$ cent/kwh: US Dollars cents per kilowatt-hour

KEY TAKEAWAYS

- The Lebanese crisis has led to the near full collapse of EDL, with an average production of 1-2 hours of electricity per day in 2022.
- Electricity consumption has been suppressed by more than 52% due to the unaffordability of electricity from private generators, whose costs have risen above 50 $ cent/kwh, as poverty levels continue to rise.
- Despite the sharp decrease in consumption, whereas imported quantities of fossil fuels for electricity production have fallen by 67% in 2022 compared to 2019; the country's fossil fuel bill has only fallen by 17% due to the increase in oil prices and large reliance on inefficient private generators.
- Real electricity demand is estimated to have fallen by 25% to an average of 2,067MW in 2022, in line with a drop in real GDP, compared to 2,740 MW pre-crisis.
- The collapse of EDL has prompted the surge in decentralized solar applications despite the lack of a favorable regulatory and financial environment. The total capacity of solar applications is estimated to have reached 690 MW in 2022, representing a 7-fold increase since the start of the crisis.
  With this new reality, the sector's vision and planning need to be adjusted to take into consideration decreased demand and the rapid scale-up of decentralized solar energy applications. This includes the Least Cost Generation Plan prepared by EDF for the Ministry of Energy and Water, EDL and the World Bank[1] published in September 2021. While welcomed reform measures have been taken, such as the increase in tariffs to27 $ cent/kwh, urgent action is required on the governance and distribution fronts.
- Regarding distribution, this paper recommends establishing a new decentralized distribution model; whereby EDL sells all its production to private companies who onsell the electricity to consumers. In Lebanon's experience, the public sector was never successful in bill collection from individuals, while suffering from a high level of technical and non-technical losses (exceeding 40% of production). However, private companies (including EDZ, Électricité de Jbeil and even illegal private generators) have been successful in collection and distribution, despite other issues surrounding their operations.

[1] https://energyandwater.gov.lb/mediafiles/articles/doc-100797-2022_05_21_02_31_54.pdf

RE-ENERGIZING LEBANON REQUIRES 5 ACTION STEPS:

SHORT TERM	**STEP 1** **Governance and Transparency**	• Implementation of an IMF program to restore trust and capital flows to the Lebanese economy. • Appointment of a new Electricity Regulatory Authority (ERA) as per Law No. 462 dated 2002 following a transparent process, based on meritocracy. • Adopt a Least Cost Generation Plan updated for the current status of the sector. • Follow the Public Procurement Law when tendering new contracts to ensure transparency. • Publicize a sector vision and conduct public consultations. • Complete the audit of EDL.
	STEP 2 **Restore the Financial Balance of EDL**	• Adopt a monthly adjustable cost-reflective tariff linked to the LBP real exchange rate and oil prices, while maintaining a social safety net[2] for the lowest consumption bracket in order to protect the most vulnerable population. • Digitize the billing process (e-bills). • Make the billing cycle current, with monthly issuance and 30-day payment terms. Rescheduling of arrears, especially for public institutions and water establishments. • Improve collection efforts and remove illegal connections with the support of the judicial and security apparatus • Adopt a new decentralized distribution model with the participation of the private sector as stated in Law No. 462. • Accelerate the roll-out of smart meters and deployment of pre-paid cards.
	STEP 3 **Restore EDL Electricity Production**	• Secure fuel contracts supported by guarantees from international donors (preferably) or the BDL. • Engage in regional trade of gas and electricity with Egypt and Jordan. • Secure funding to maintain existing power plants.
	STEP 4 **Support the Scale up of Distributed Solar**	• Enact the Distributed Renewable Energy (DRE) Law to enable the scale up of distributed renewable energy. • Create a department within EDL to manage the renewable energy sector, including decentralized installations (for net metering, power wheeling and grid connectivity). • Create a transparent process to protect consumers against fraudulent practices. • Work with development banks to secure intermediate loans through BDL or banks (post-restructuring) for private sector-renewable energy projects. • Develop a market for carbon credits.

[2] A social safety net (SSN) program consists of assistance existing to improve lives of vulnerable families and individuals experiencing poverty and destitution. Examples of SSNs could be conditional cash transfers for electricity consumption capped to the lowest bracket or in kind like the distribution of electricity prepaid cards.

MEDIUM / LONG TERM	**STEP 5** **Investment in Generation, Gasification and the Grid**	• Launch tenders to build and operate up to 1.5GW of new gas fired power plants on a BOT basis, including gas procurement for the old and new power plants (gas-to-grid) using a PPP model. • Decommission the old plants in Zouk, Jieh, Tyre, Hrayche and Baalbeck due to high pollution levels and inefficiency. • Reinforce and enhance the grid by implementing the national transmission plan and securing financing envelopes to transform the grid to a smart grid. • Launch tenders for utility scale renewable energy projects in wind, solar and hydro; prioritizing public land to reduce time of execution and tariffs; with the aim of installing 4,100 MW of installed capacity in solar, hydro and wind by 2030, as per the IRENA REmap and Outlook for Lebanon.

POLICY GOALS

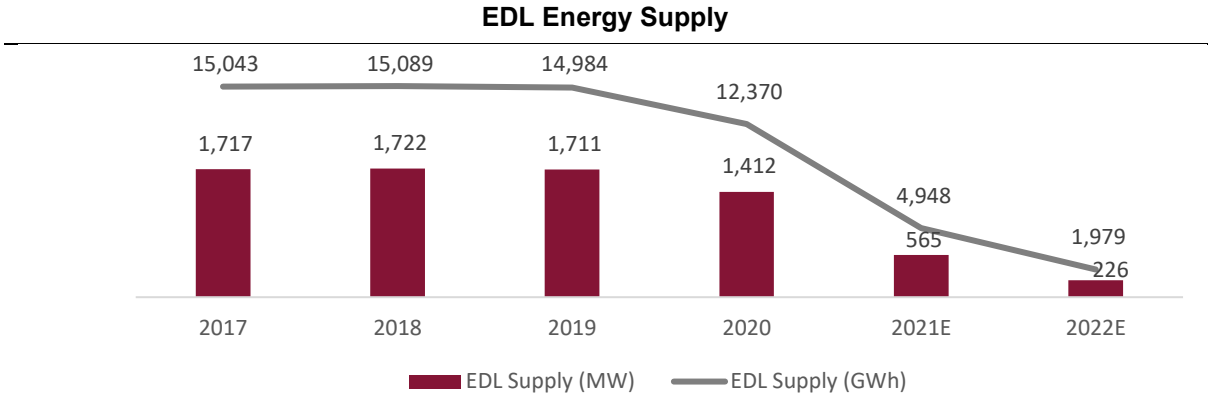
- **Provide the most affordable, sustainable and stable electricity to all Lebanese**
- **Maximize Lebanon's renewable energy potential to provide price stability, electricity security and insulate Lebanon against oil price shocks**
- **Turn EDL into a profitable public institution and enhance its governance and accountability**
- **Reduce pollution levels and meet Lebanon's Paris Agreement climate goals**
- **Ensure a safety net is provided for the vulnerable segments of the population**

IMPACT OF THE CRISIS ON THE ENERGY SECTOR

Access to electricity is a basic human right. Electricity reduces poverty, improves health, increases productivity and improves standards of living. In Lebanon, not only did the electricity crisis deprive citizens from a basic human right, but it has also contributed to one of the most severe financial and economic crisis in contemporary history. Power cuts have hurt the economy and subsidies have racked up one of the world's largest public debt burdens. The accumulated cost of subsidizing EDL since 1992 amounts to around USD 43 billion, which has had a dual impact on the budget and balance of payment deficits.

Collapse of EDL

Since 2019, Lebanon's economy has plunged into a severe economic and financial crisis caused by years of bad monetary and fiscal policies, mismanagement and corruption. The crisis has hindered EDL's access to foreign currency, stalling its ability to import fossil fuels and cover its maintenance costs. This has led to a near collapse of EDL's operations, with electricity shortages reaching 23 hours per day in 2022. Over the last two years, EDL production was exclusively reliant on a fuel swap deal with the Iraqi government, in addition to limited and variable hydropower.



Source: EDL data, World Bank estimate for 2021 and the author's estimate for 2022.

The supply gap has been compensated by expensive and polluting private generators whose tariffs range from 50-100 $ cent/kwh. On top of the financial costs, the heavy use of private generators has contributed to alarming pollution levels impacting public health. According to researchers at the American University of Beirut's Nature Conservation Center, pollution levels have increased by 300% in 2021 due to the heavy use of private generators.[3] Moreover, electricity blackouts have affected the water sector and the ability to treat, pump and distribute water. This has resulted in water sanitation issues and the rise of water-born illnesses such as the recent cholera outbreak,[4] cholera being a "classic disease of a state in collapse, poverty and moral bankruptcy."[5]

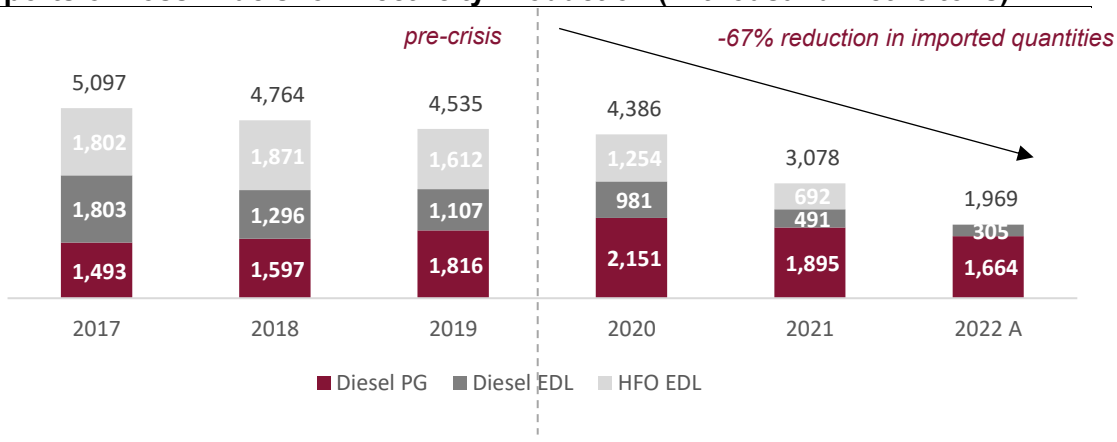
[3] https://today.lorientlejour.com/article/1280014/researchers-estimate-a-300-percent-increase-in-toxic-emissions-due-to-generator-use-in-electricity-crisis.html
[4] As of October 2022.
[5] Quote by Dr. Joelle Abi Rached on Twitter.

EDL's collapse has prompted massive energy poverty in the country, as more than 82% of the population has fallen under poverty levels in 2021 according to UNESCWA,[6] with the minimum wage dropping from USD 450 prior to the crisis to less than USD 50 (assuming an LBP/USD exchange rate of 40,000). The same study estimated that 40% of the population is under extreme poverty levels, with no access to electricity. Therefore, **electricity consumption has been suppressed by the excessive cost of electricity** charged by inefficient diesel-powered private generators. In other words, electricity in Lebanon has been turned into a luxury.

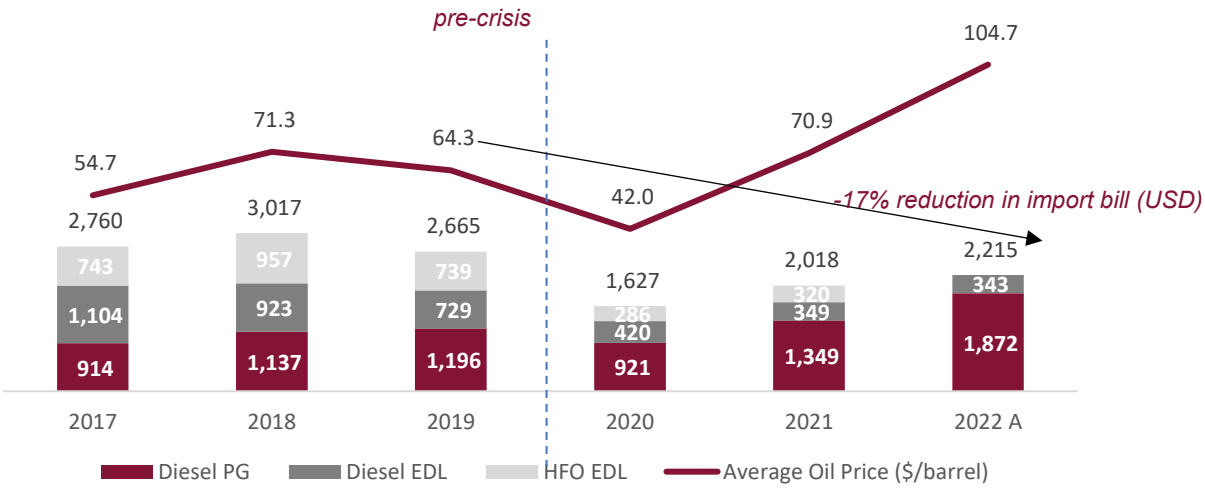
Imports of Fossil Fuels

Despite the forced suppression of demand due to unaffordability and the resulting estimated 67% decline in imported quantities of fossil fuels for electricity production in 2022 vs. 2019, the import bill only declined by 17% in 2022 compared to 2019 or around USD 2.2 billion. This was due to the increased cost of oil and inefficiency of private generators. It is worth noting that in 2020 and up until September 2021, BDL was still subsidizing the imports of diesel, which explains the subsequent sharp drop in 2022 consumption.

Imports of Fossil Fuels for Electricity Production (in thousand metric tons)



Imports of Fossil Fuels for Electricity Production (in USD millions)



Source: IPT Energy.
Notes: Out of the total imports of Diesel to the country (excluding EDL), 75% are assumed to be for private generators (electricity production). 2022 annualized figure using 8M 2022 data, for EDL it includes Iraqi fuel payments in local currency.

[6] https://www.unescwa.org/sites/default/files/news/docs/21-00634-_multidimentional_poverty_in_lebanon_-policy_brief_-_en.pdf

Estimating Demand: The Case of Suppressed Consumption

In 2019, annual demand reached 2,740 MW or 24 TWh, while peak demand reached 3,844 MW.[7] During 2020 and until June 2021, the BDL subsidized diesel imports at an exchange rate of 1,507.5 LBP/USD when the parallel market rate for the LBP reached 25,000 in June 2021. The exchange rate used for diesel imports was then gradually increased to 3,900 LBP/USD in June 2021, and 8,000 LBP/USD in August 2021, until the full lifting of subsidies in September 2021.

Therefore, the cost of electricity was subsidized until Q3 2021, making electricity consumption artificially high, due to the cheap cost of electricity, discouraging energy efficiency and renewable energy deployment.

The subsidy was also creating a price arbitrage when compared to the cost of fuel in Syria, which encouraged smuggling. An estimated 10-20% of imported quantities are estimated to have been smuggled to Syria, in order to normalize the volumes of imports of 2020 and first half of 2021 to 2019 levels. With the lifting of subsidies in 2021, smuggling of diesel in 2022 was no longer attractive.

In the below analysis, we assume that 10% of imported quantities in 2020 and 2021 were smuggled to Syria.

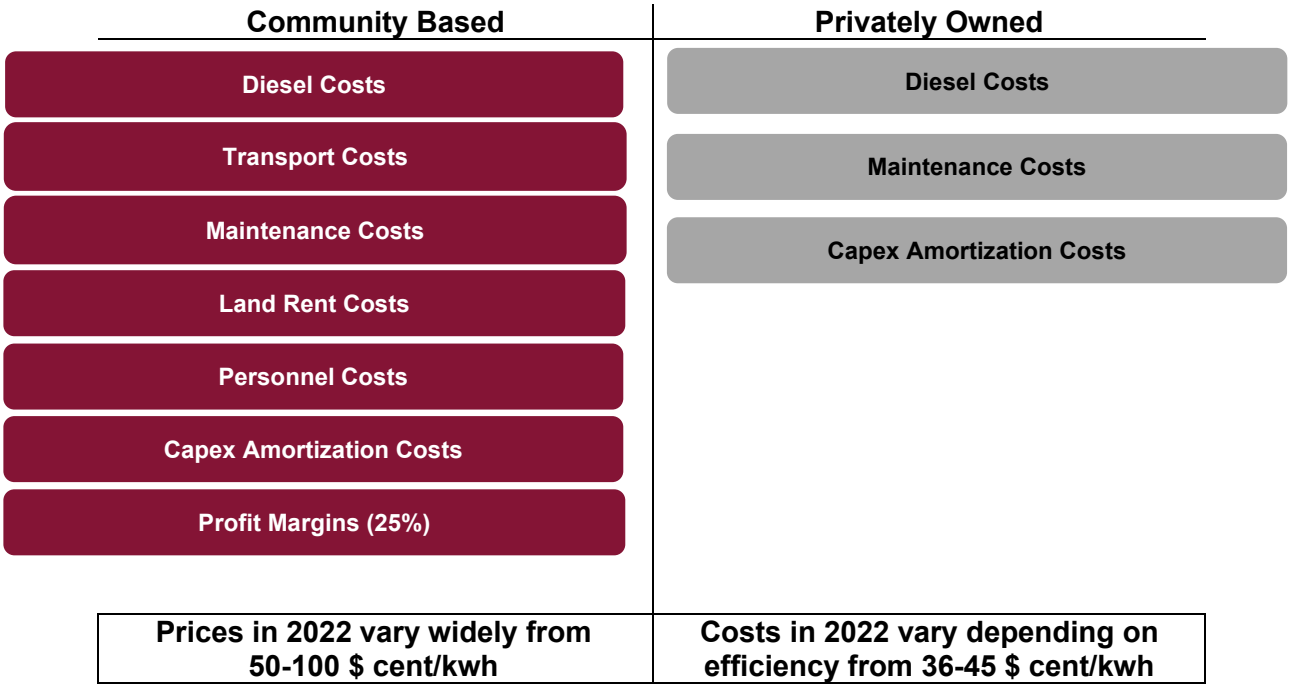
FX Subsidy Rate for Diesel Imports (LBP/USD)

Date Range	FX Rate Used for Diesel Imports (private sector)
01/01/2020 – 28/06/2021	1507.5
28/06/2021 – 23/08/2021	3,900
23/08/2021 – 07/09/2021	8,000
07/09/2021	Full lifting of subsidy on diesel imports, pricing at black market rate

The lifting of diesel subsidies led to the dollarization and sharp increase in generator costs in 2022, reaching 36-45 $ cent/kwh for privately-owned generators; and to 50-100 $ cent/kwh for community-based generators.

[7] EDL Least Cost Generation Plan – September 2021.

The price charged by generator includes:

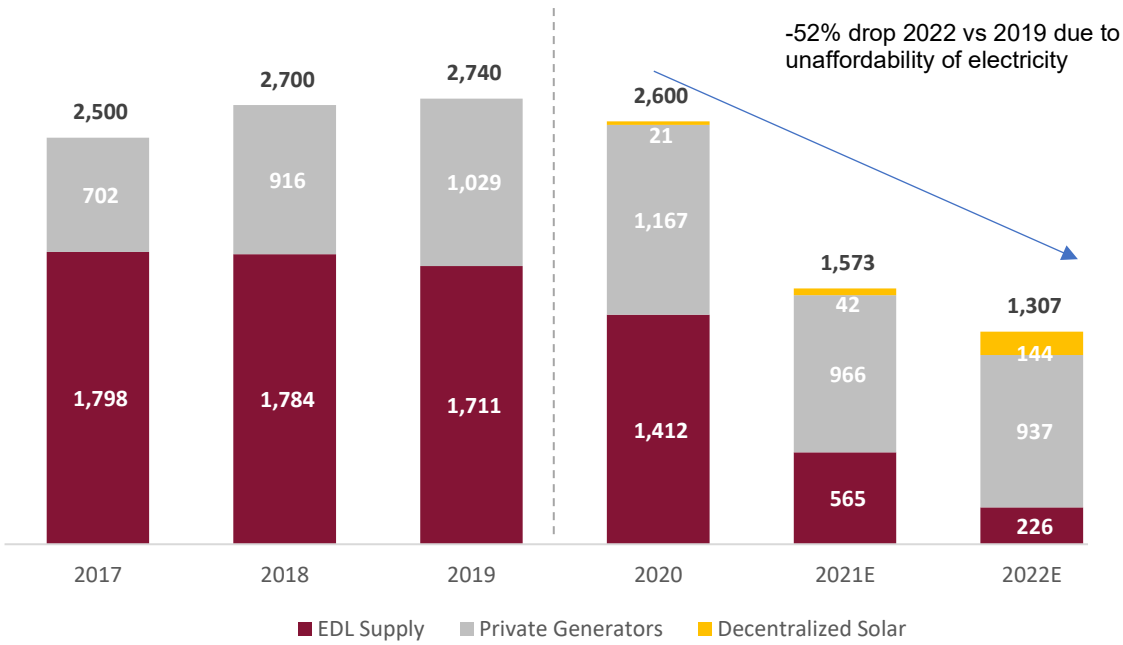


Based on the estimated cost of diesel for private generators (which is a part of the overall tariff/operating cost), and using the total diesel import bill estimate for private generators, one can calculate the estimated consumption from private generators in 2021 and 2022 as follows:

	2021	2022
Diesel imports for PG (USD million)	1,349	1,872
Estimated Syria Smuggling	10%	-
Net Diesel imports for Local PG Consumption (USD million)	1,214	1,872
Estimated cost of diesel for PG ($ cent/kwh)[8]	25	37
Consumption from PG (GwH)	4,935	5,129
Average Hours of Operation	14	15
Capacity from PG (MW)	966	937

[8] The figures represent the cost of diesel to operate a private generator, and not the overall tariff, which includes other cost items and profit margins.

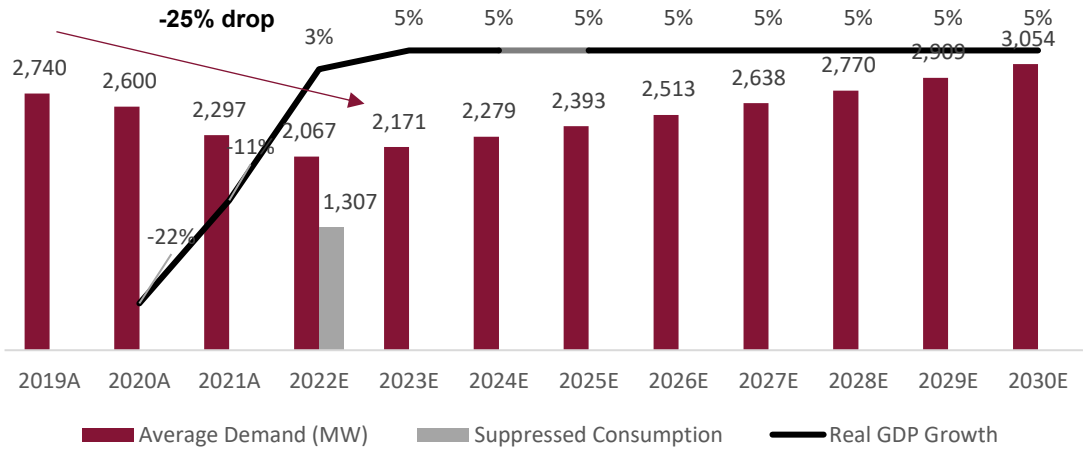
Estimated average demand (in MW)



Note: Solar production assumes a 21% annual average capacity factor, an installed capacity of 200MW for 2021 and 690MW for 2022.

- The above analysis shows that average demand was suppressed by 52% due to the unaffordability of electricity to more than 50% of the population (which is under extreme poverty levels).
- Average demand should have dropped with real GDP contraction, had the cost of electricity been accessible to the population. The chart below estimates a 25% contraction in real electricity average demand in 2022.
- Average demand is then expected to recover with a real GDP growth rate estimated at 5% until 2030, whereby average demand would reach 3GW in 2030, and peak demand to about 3,400 MW (mostly during the summer).

Estimated Average Demand (MW)



Today, the private sector's main challenge is the cost and availability of electricity. This is putting immense strains on its ability to survive the crisis, the competitiveness of their exports and companies' ability to maintain its labor force. It is clear that there can be no hope for economic recovery without undertaking comprehensive electricity sector reforms. Unfortunately, all efforts made to implement the approved reforms and plans were thwarted by political conflicts and instability. While there was a time when it was urgent to implement reforms, today, we are at the point of no return: an estimated 50% of Lebanon is in total darkness[9].

Much has been written about emergency measures to restructure the sector with no implementation. The sector has been portrayed as the epitome of the failed state by the World Bank.[10] Electricity reform should be prioritized and at the center of any reform program for Lebanon. If unaddressed, the electricity sector will derail any recovery program for the economy. Therefore, it is understandable why the IMF has requested an electricity reform plan prior to the adoption of any program.

[9] Assuming those under extreme poverty lines do not have access to electricity from private generators.
[10] World Bank, "Lebanon Public Finance Review: Ponzi Finance?" - August 2022.

5 KEY RECOMMENDATIONS TO RE-ENERGIZE LEBANON

SHORT TERM

1- GOVERNANCE AND TRANSPARENCY TO RESTORE TRUST

Perhaps the most fundamental crisis being faced by Lebanon is the confidence and trust crisis in the government and public administration from the population and the international community. Despite the severity of the economic and financial crisis, politicians have failed to enact any meaningful reform or steps to address it. These same reforms have been stalled for decades due to lack of political consensus preserving a political economic and financial system that benefited a few for very long. The blockage of reforms has led to the almost complete collapse of public services such as electricity, water, transport, education and social protection. It has also blocked access to international financing and development funding. Restoring confidence is a key pre-requisite to restructure the energy sector in Lebanon, which is in desperate need of financing.

IMF Program

The only way for Lebanon to emerge from the crisis and put itself on the path to economic recovery is through an IMF program. In fact, an IMF program is a prerequisite to unlock funding and financing to Lebanon, be it for the private sector, public sector or for PPP projects.

An IMF program would ensure:

- The implementation of overdue fiscal, monetary and legislative reforms, which will be monitored by the IMF
- The unlocking of funding from multilateral and bilateral institutions for investments and infrastructure projects, which will spur economic growth
- Macro-economic stabilization and government debt sustainability
- A sustainable restructuring of the financial sector for it to regain its role as the engine of the economy, by availing credit to the private sector
- The implementation of a new monetary policy framework to stabilize the LBP and unify the currently multiple exchange rates

Lebanon signed an SLA with the IMF in April 2022, and legislators need to pass the laws listed in the prior actions to be able to conclude a program with the Fund, most notably: the Capital Control Law, amendments to the Banking Secrecy Law, and the Bank Restructuring Law. To date, little progress has been made in this regard.

The Electricity Regulatory Authority (ERA)

Appoint an independent regulatory authority to manage the sector and allow the full implementation of Law No. 462 under its current form. This is paramount to unlock much-needed funding for the sector, including financing for the import of gas and electricity from Egypt and Jordan.

- An independent regulator is tasked with setting a cost reflective tariff, managing tenders and awarding generation licenses, managing the private sector participation in the generation and distribution sectors and the interface between all the sector's players while protecting consumers.

- No amendment should be accepted with regards to the powers of the regulator, which may impact the management of the sector according to good utility practice, transparency of tenders and increase political interference in the sector.
- In the medium term, as Lebanon embarks in scaling-up renewable energy with new utility scale IPPs, the formation of an independent and credible ERA along with the complete unbundling of the sector is imperative.

Least Cost Generation Plan

The sector vision and planning should follow a technical approach in assessing the country's electricity needs and energy mix, including the technology and location with the aim to provide the cheapest, cleanest and most sustainable source of electricity.

There has been various draft of such studies, including the Least Cost Generation Plan published in September 2021 by the Ministry of Energy and Water, which resulted in the following energy mix:

TYPE	DETAILS
Temporary Solutions	Rented Power for 1,030MW: 83 MW Jib Jinnine 83MW Bint Jbeil 504MW Deir Ammar 252MW Zahrani 108MW Jieh
Natural Gas Power Plants (Combined cycle power plants - CCGT)	New Plants for 2.475GW 825MW Deir Ammar II 825MW Zahrani II 825MW Selaata
Solar PV	2,000 MW
Wind Power	790 MW
Hydro	300MW
Decommissioned Plants	Zouk 1 Jieh 1
Total Temporary Power	1,030 MW
Total CCGT Plants	2,475 MW
Total Renewables	3,090 MW[11]

Source: Least Cost Generation Plan - September 2021, https://energyandwater.gov.lb/mediafiles/articles/doc-100797-2022_05_21_02_31_54.pdf

Such studies need to be constantly updated to reflect local and international developments in the sector, including: technology costs, fossil fuel prices, demand and supply dynamic, tariffs, etc.

In light of (1) the current drop in local demand, (2) the rapid scale up of renewable energy, especially decentralized solutions, (3) the increase in natural gas prices and (4) the new tariff proposal, the Least Cost Generation Plan needs an update, which would result in a

[11] Noting that the average capacity factor of renewables is around 30%, therefore the net capacity is 927MW.

cancellation of the need for short term rental solutions and a reduction in the amount of natural gas power plants from 3 to 2 plants.

Some of the key assumptions used in the plan that resulted in their proposed energy mix include:

Assumptions to derive the energy mix	Status	Needed Update
Inability to raise the tariff before achieving 21/24 supply, **requiring short term rental solutions to cater for short term demand**.	EDL Board and MOEW & MOF approved raising the tariff to an average of 27 $cent/kwh equivalent.	This assumption is no longer valid and should be updated to reflect new developments.
Current peak demand at 3,844MW reaching 4,232 MW in 2030; **requiring gas power plants with 2.4 GW capacity.**	Average demand currently dropped to 2,067MW and forecast to reach 3,054MW in 2030; while peak demand is estimated at 2,500MW to reach 3,500 MW in 2030.	This assumption is no longer valid and should be updated.
Using **E-Class technology for CCGT plants** that work on tri-fuel (NG, HFO and Diesel). This limited the size of each plant at Deir Ammar and Zahrani to 860 MW, requiring a third location to arrive to 2.4 GW capacity.	Lebanon is in discussions to conclude a gas import agreement with Egypt to Deir Ammar via the Arab Gas Pipeline. Local drilling could also start which, if successful, would result in local natural gas resources to the country, and could be used for local consumption.	The study should re-consider using F-Class turbines, which are more efficient and less costly. Using a gas-to-grid model can also transmit the risk of any interruption in gas supply to the developer.
Cost of natural gas	Following the Ukraine War, there has been a large surge in natural gas prices, which may alter the competitiveness of natural gas power plants compared to renewables.	This assumption needs to be updated.
Rollout of renewables: expansion of solar PV and wind limited at 250 MW/yr and 200MW/yr respectively.	Lebanon has already witnessed a rapid scale up of decentralized RE up to 690MW, estimated to be nil in the study. There is also a potential to deploy large scale RE IPP at a faster pace following an IMF program.	This assumption needs an update to cater for a more rapid uptake of renewable energy.

Others:

- Sector Vision and Consultations: publish a complete sector vision and plan that is time-bound with clear deliverables and hold stakeholder consultation sessions for comments and public participation.
- Transparency in Procurement: follow the Public Procurement Law in all public tenders and purchases.
- Complete the 3-year audit of EDL by a reputable audit firm and publish the reports.

2- RESTORE THE FINANCIAL BALANCE OF EDL

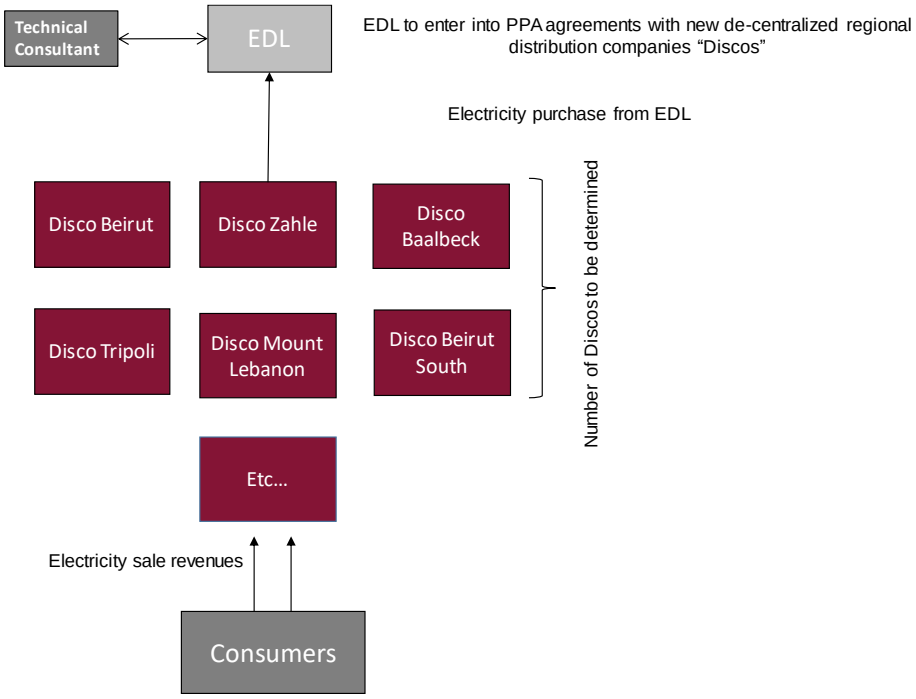
- It is imperative to restore EDL's financial stability to restore electricity supply. Price reform also leads to reduced consumption from more efficient utilization of energy. The new decision by the government to increase electricity tariffs to 10 $ cent/kwh for consumption up to 100 kwh, and 27 $ cent/kwh for the remaining brackets is a welcomed first step towards reforming EDL (after 28 years with the same tariff). However, this needs to be accompanied by other measures to deal with collection and losses to rebalance EDL's financials.

Necessary measures include:

- Adopt a **cost reflective tariff** while maintaining a social safety net for the lowest consumption brackets. The tariff should be linked to oil prices, the foreign exchange rate and the penetration of renewable energy power. It should also be automatically adjusted on a monthly basis.
- **Digitize bills** (e-bills) will improve efficiency of the billing process in terms of time and cost of collection. The experience of the COVAX application in Lebanon during the COVID-19 pandemic proves that the country is ready for digitization.
- Render the **billing cycle current**, with monthly issuance and 30-day payment terms. EDL is currently 1-2 years late on collections, whose values in USD equivalent have been eroding with the depreciation of the currency. Arrears should be rescheduled with incentives for early settlement. EDL arrears are currently estimated at LBP 2.3 trillion, including LBP 1.4 trillion from public administration and municipalities.
- **Improve collection efforts** and removing illegal connections with the support of the judicial and security apparatus. Ensure that public administration and municipalities settle their bills; electricity consumption for the public sector should be accounted for in the yearly public budget.
- **Re-tender the distribution contracts** to have a decentralized distribution model based on a PPP model as per Law No. 462, whereby the distribution companies (smaller than the current Distribution Service Providers) purchase electricity from EDL and on-sell to consumers via a PPA with clear performance KPIs. The collection performance[12] of the private generators and EDZ proved that a decentralized collection model is more attune with the Lebanese political economy reality.
- Accelerate the roll-out of **smart meters** and deployment of **pre-paid cards**.

[12] Collection of EDZ and private generators are estimated at 97-99% and technical losses at around 5%.

Decentralized Distribution Model based on PPP

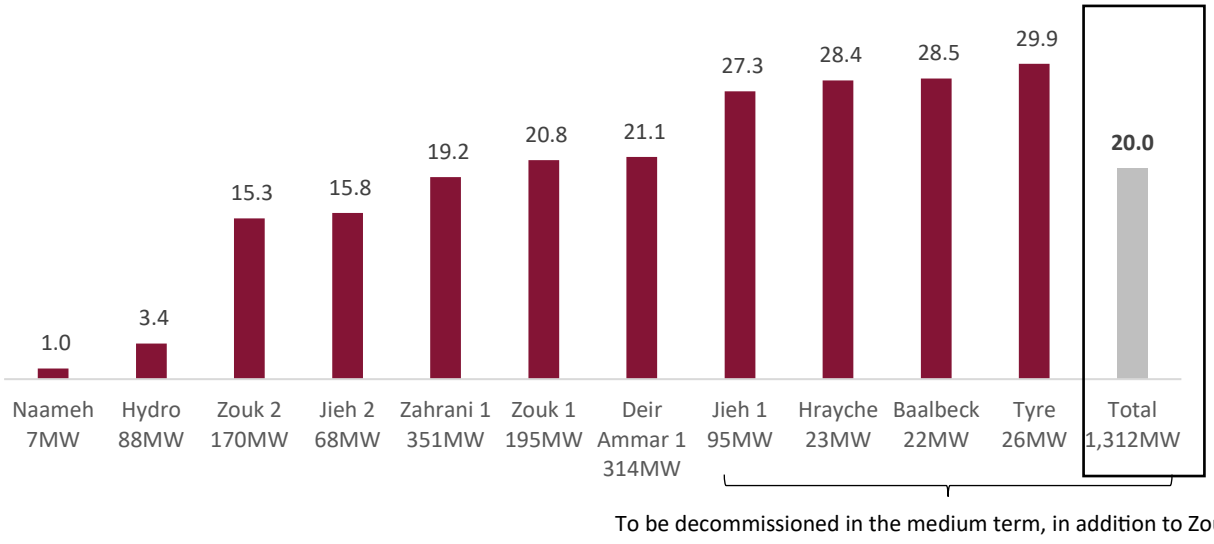


3- RESTORE EDL ELECTRICITY PRODUCTION

EDL has an existing power generation net capacity of 1,312 MW. After accounting for 17% technical losses on the grid, the net distributed power is 1,089 MW.

The weighted average cost of generation, before accounting for transmission and distribution losses is estimated at 20.0$cent/kwh at an average oil price of USD 100 per barrel.

EDL Fleet Capacity (in MW) and Cost of Generation (in $ cent/kwh)



Given the estimated average demand at 2,067MW (peak demand of 2,587 MW) and an estimated 144MW distributed solar, EDL existing power plants can provide up to

14 hours of supply due to the reduced demand at an average cost of 27 $ cent/kwh to the consumer (compared to 50-100 $ cent/kwh by private generators).

As at 2022	Fuel Type	Technology	Design Capacity (MW)	Derated Capactiy (MW)	Capacity Factor (%)	Net Power (MW)
Existing EDL						
Zouk	Fuel Oil (Grade A)	Steam Turbine	607	300	65%	195.0
Jieh	Fuel Oil (Grade A)	Steam Turbine	343	140	68%	95.2
Zouk Recip	Fuel Oil (Grade B)	Recip	194	194	88%	170.7
Jieh Recip	Fuel Oil (Grade B)	Recip	78	78	87%	67.9
Zahrani	Diesel	CCGT	469	395	89%	351.6
Deir Ammar	Diesel	CCGT	464	430	73%	313.9
Baalbeck		OCGT	64	60	36%	21.6
Sour		OCGT	72	60	44%	26.4
Safa	Hydro	Hydro	13	12	9%	1.1
Naameh	Biogas	Biogas	7	7	105%	7.4
Existing IPPs						
Litani		Hydro	199	47	45%	21.2
Nahr Ibrahim		Hydro	32	17	44%	7.5
Bared		Hydro	17	6	56%	3.4
Kadisha Hydro		Hydro	21	15	45%	6.8
Hrayche	Fuel Oil (Grade A)	Steam Turbine	75	45	51%	23.0
Total Generation Capacity			**2,655**	**1,806**		**1,312**
Technical Losses				-17%		-17%
Net Distributed Power				**1,499**		**1,089**
Decentralized Solar				688	21%	144
Peak Demand (2022)						2,500
Missing Generation						**1,411**

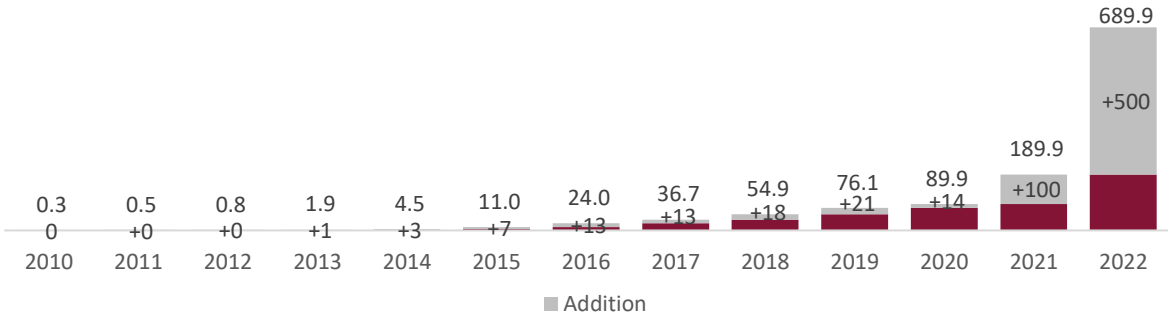
In order to restore EDL electricity production, the following steps are required:

- Launch a tender for new fuel supply contracts covering 2023 fuel needs and ensure a liquidity line from international donors preferably or the BDL to cover 3-months' worth of fuel imports (estimated at USD 450 million, with oil price at USD 100 per barrel).
- Conclude the gas import agreement with Egypt via the Arab Gas Pipeline, following the sanctions waiver approval from the United States to secure natural gas to Deir Ammar. Gas would help reduce the cost of fuel and the tariff to the end consumer.
- Conclude the electricity import agreement with Jordan to purchase up to 250 MW of electricity at 12 $ cent/kwh.
- EDL's enhanced revenues combined with some emergency funds from the international community would be used to support EDL's payment of fuel, maintenance and operating expenses, as well as electricity and gas purchases from Jordan and Egypt (if an agreement is reached to allow Lebanon to import power and gas via Syria).
- It is worth noting that EDL's revenues are denominated in LBP (as mandated by law, EDL cannot bill in USD). In November 2022, BDL approved the conversion of EDL LBP cash proceeds (in notes) to USD at the Sayrafa exchange rate + 20%. Therefore, EDL has requested the collection of bills in cash notes only and has stopped accepting LBP payments from bank accounts.
- Finally, EDL needs to implement a reconstruction plan to repair the damage from the Beirut blast, including but not limited to the National Control Center, nearby substations and EDL headquarters, the tender documents of which have been completed by the EBRD and are currently awaiting financing opportunities.

4- SUPPORT THE SCALE UP OF DISTRIBUTED SOLAR APPLICATIONS

- More than USD 500 million were invested during the crisis in decentralized solar applications by the private sector, whose gross capacity have reached 690 MW by end of 2022. This represents a net capacity of 144MW at an average efficiency of 21%.
- The chart below shows the estimated solar installation in MW, which estimates an additional capacity of 500MW in 2022, resulting in a total installed capacity at 690 MW by end of 2022.

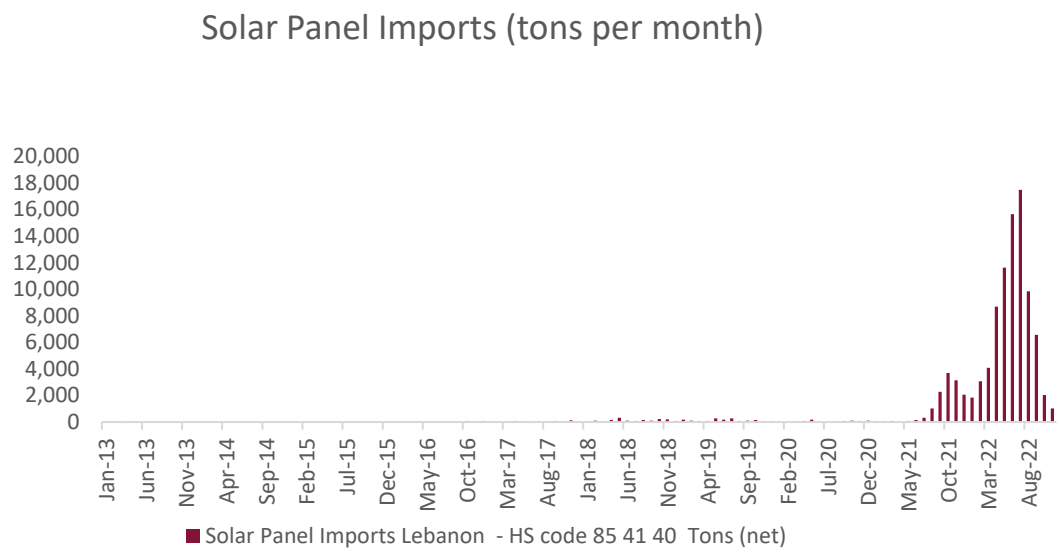
Decentralized Solar Installed Capacity (in MW)



Source: Lebanese Center for Energy Conservation (LCEC).

In parallel, Lebanese Customs data shows a total of 100,394 tons of solar panels imported between 2013 and November 2022, 80% of which were in 2022 alone. This data coincides with the rapid rise of solar installations depicted in the chart above.

Solar Panel Imports (in Tons)



Source: Lebanese Customs Administration, with the contribution of PhD candidate Camillo Stubenberg (Cornell University).

This surge in solar installations was a by-product of the crisis, with consumers looking to reduce and stabilize their cost of electricity and achieve energy security. This has been achieved despite the lack of enabling legislation and financing.

While distributed solar applications will not result in Lebanon's Paris Agreement commitment to achieve 30% renewable energy by 2030, it will certainly help in reducing energy demand and providing more energy security.

In order to scale up the deployment of distributed solar applications, the following should be achieved:

a- Enact the Distributed Renewable Energy Law to enable the scale up of distributed renewable energy, which permits installations of up to 10MW, including power wheeling, peer to peer trading of electricity, on-site and off-site net metering, etc.
b- Create a department within EDL to manage the renewable energy sector, including decentralized installations (for net metering, power wheeling and grid connectivity)
c- Create a transparent process to protect consumers against fraudulent practices
d- Work with development banks to secure intermediated loans through the BDL or banks (post-restructuring) for private sector - renewable energy projects
e- Develop the market for carbon credits

MEDIUM TERM

BASE LOAD POWER AND GASIFICATION

- In order to achieve a 24/7 electricity, enable the large deployment of renewable energy and stabilize the grid, Lebanon needs to add base load electricity (on demand electricity), which can be used to stabilize the intermittency of renewable energy.
- Lebanon requires an additional 1,500-megawatt capacity of new power plants to meet the current demand. The number, size and location of plants should be determined by the updated Least Cost Generation Plan.
- It is worth noting that the two sites in Deir Ammar and Zahrani are the most cost efficient, given the availability of land, grid connection and fuel infrastructure. Establishing these new plants next to the existing ones would also avoid changing the nature of the surrounding area from an environmental and social perspective.
- The most efficient type of base load power in the case of Lebanon are natural gas combined cycle power plants.
- In the last couple of years, select original equipment manufacturers (such as GE, Siemens, Mitsubishi and Ansaldo) have submitted proposals for full gas to grid solutions, whereby they would build a power plant, connect it to the grid, procure the natural gas and operate it for 20 years. The indicated all-in price would be around half the current cost of generation of EDL, at around 12 $ cent/kwh given the current cost of natural gas.
- The plants run on natural gas, which has much lower emissions than HFO and Diesel, significantly reducing pollution levels. Natural gas is considered the greenest of the fossil fuels and complimentary to renewable energy. Also, switching the current EDL plants to natural gas is expected to yield annual savings exceeding USD 300 million.
- The estimated cost of these projects stands at USD 2 billion: USD 1.5 billion for the power plants and USD 500 million for the needed grid and gas infrastructure. Given the current investment climate and the urgency for such projects, the financing could be sourced on a public financing basis initially.
- Once construction is completed, the projects can be privatized under a PPP scheme and the public debt would be then reimbursed. These projects achieve cost recovery to the economy in one year, given the resulting elimination of private generator bills and diesel imports.

THE GRID

Lebanon's grid needs refurbishment and investments to:

- Reduce technical losses from the current 17% to 10-12%; especially in the distribution network (medium and low voltage).
- An upgrade of the low and medium voltage network can be tasked to the new distribution companies, as a reduction in losses would increase their profitability.
- Allow the connection of the new thermal power plants
- Reinforce the grid for the connection of large-scale renewable energy projects,
- Prior to the crisis, the WB and EBRD approved financing for upgrading the north and south loops on the high voltage network.
- The grid reinforcement needs are outlined in EDL's Master Transmission Plan conducted by EDF in 2017.

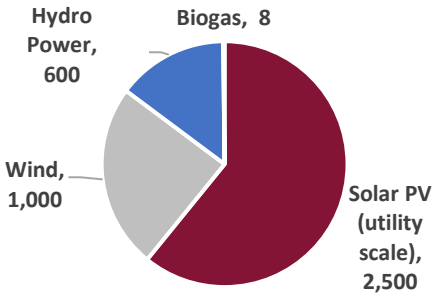
RENEWABLE ENERGY

- The energy market has witnessed a revolution in recent years. The cost of renewable energy technology has dropped multiple fold, making renewable energy often times more competitive than fossil fuel-based electricity. In fact, the cost of solar panels has dropped by 90% over the last 10 years.
- Moreover, Lebanon has excellent natural resources in wind, solar and hydro, making such technology very suitable.
- The first rounds of utility scale renewable projects in Lebanon have yielded prices that are a fraction of EDL's current generation costs at 20 $ cent/kwh. The lowest tariff achieved in the first round of solar tenders was 5.7 $ cent/kwh, while wind farms stood at 9.6 $ cent/kwh. These costs include the capital costs of the investment.
- The deployment of renewables also brings other benefits: renewable energy projects create jobs, reduce local air pollution and reduce consumption of fossil fuels. This would help insulate the Lebanese economy from external energy shocks and reduce the balance of payment deficit, a core and central cause of Lebanon's current economic demise. Since renewable energy is mostly located in rural areas, these investments also stimulate rural development.
- As part of the Paris Agreement, Lebanon committed to meet 30% of its electricity demand from renewable energy sources by 2030. This translates into the need to build around 4,100 MW of renewable energy capacity by that time (on a net basis, this would yield about 1,100 MW assuming an average efficiency of 27%).
- Renewable energy investments are capital intensive. The estimated cost of building 4,100 MW of renewable energy is around USD 6 billion, to be funded by development banks, export credit agencies and the private sector. With high political, credit, currency and policy risk, Lebanon's current investment climate is not attractive for private investment.

  The IRENA's Lebanon Renewable Energy Outlook report proposed the following renewable energy mix:

IRENA Expected Renewable Energy Mix (in MW)

Estimated **4,100 MW** of utility scale projects in Renewable Energy *(excluding distributed solar)*

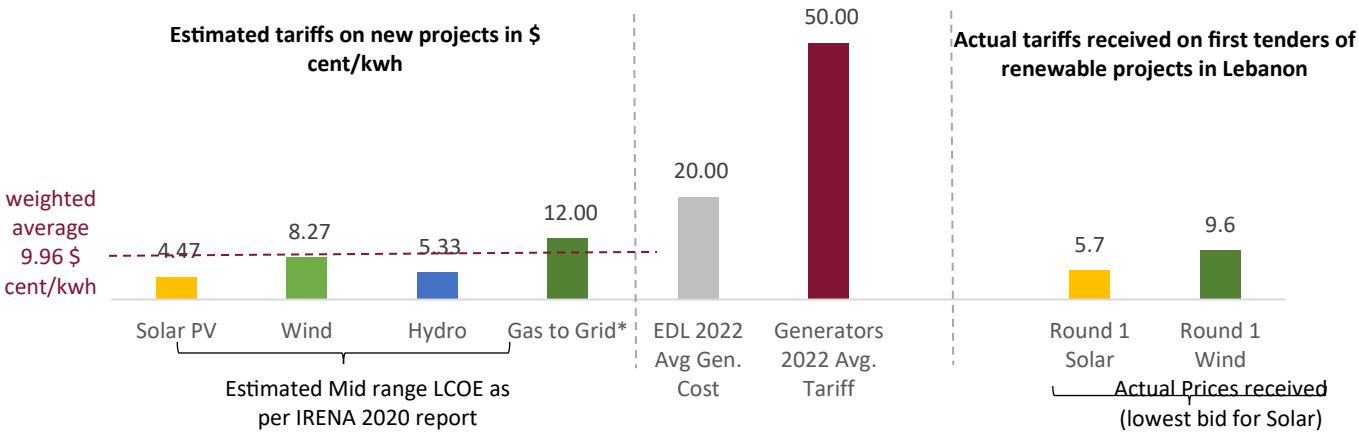


Source: IRENA – Lebanon 2020 Outlook report

In order to achieve these targets, Lebanon needs to launch large utility-scale projects following competitive procurement processes and be able to attract the needed investments and financing. Therefore, the following enabling action steps are required:

A. Streamline administrative processes and develop risk mitigation schemes to attract developers, including publicizing the list of required permits and licenses
B. Reduce the time between the launch of the tender and licensing
C. Following the Public Procurement Law for awarding licenses
D. Use public land when available to reduce tariffs and risks on the developers
E. Reinforce the grid to be able to connect the new renewable energy projects across the country
F. Develop credit enhancement tools (liquidity support and guarantee schemes) to enhance the bankability of Lebanese PPPs

Comparative Cost of Electricity (generation costs in $ cent/kwh)



Notes: Renewable energy mid-range levelized cost of electricity (LCOE) as per the IRENA Lebanon 2020 Outlook.
Gas to grid depicts the cost of electricity produced from the gas fired combined cycle power plants including the natural gas cost.
The generation costs of EDL exclude any transmission and distribution losses and assume an oil price at USD 100 per barrel.

ABOUT IFI

Inaugurated in 2006, the Issam Fares Institute for Public Policy & International Affairs at the American University of Beirut is an independent, research-based, policy-oriented institute. It aims to initiate and develop policy-relevant research in the Arab world.

The Institute aims to bridge the gap between academia and policymaking by conducting high quality research on the complex issues and challenges faced by Lebanese and Arab societies within shifting international and global contexts, by generating evidence-based policy recommendations and solutions for Lebanon and the Arab world, and by creating an intellectual space for an interdisciplinary exchange of ideas among researchers, scholars, civil society actors, media, and policy makers.

Through its work, Issam Fares Institute aspires to inform policy-making processes and influence the public debate, as well as to innovatively explore state of the art research methodologies and new ways for research dissemination. Issam Fares Institute also responds to emerging policy needs in Lebanon and the Arab world by attracting talented scholars and practitioners and building an agile organization.

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