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BANKABILITY OF A LARGE-SCALE SOLAR POWER PLANT IN TFAIL-LEBANON

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Summary

High penetration of renewables, particularly Solar Photovoltaics (PV), could play a role in alleviating the economic and social burden of Lebanon's power sector. However, achieving such a target is faced by a set of technical, policy and financing challenges. This policy brief focuses on the financing side by assessing the bankability of a proposed utility-scale, grid-connected, solar PV power project located in the inland Tfail region in the Bekaa Valley. Our examination is conducted through a techno-economic modelling that proposes corresponding financial and capital structures.

KEY RECOMMENDATIONS

- A simulation of a 300 MW solar PV plant located in Tfail appears to offer robust technical and financial incentives with Levelized Cost of Electricity (LCOE) ranges between 4.2 to 5.3 cents/kWh of electricity produced.
- Lowest prices are expected to be achieved via multi-stage, well-planned, transparent and flexible auctioning and competitive bidding.
- Given its geography, this project could play a role in possible electricity swap deals and/or trading with Syrian grid in the future.
- Project's finances are particularly sensitive to solar yield value. Therefore, installing climatic measurement stations in Tfail is imperative even for a pre-feasibility assessment phase.

Introduction

The deployment of Renewable Energy (RE) has a great potential to resolve the dire state of Lebanon's power sector through offering fast capacity addition, reduced financial burden, and environmental and health benefits. A powerful combination of technological advancements, cost reductions, and enabling policies and financing mechanisms, is helping renewables, particularly solar and wind, becoming cost effective options across the world.

One of the perceived obstacles for a high penetration of RE in Lebanon is land availability. Tfail, an inland region on the Eastern border between Lebanon and Syria, has been shown to include around 13 km^2 of elevated flat lands with high levels of solar irradiation. Therefore, conducting a pre-feasibility assessment that includes components like those presented in this policy brief would be highly beneficial. Given its geography, any solar project in Tfail could be utilized for possible electricity swap deals and/or trading with Syria in the future.

Method

The techno-financial simulation was conducted using the System Advisory Model (SAM), a tool developed by the National Renewable Energy Laboratory (NREL). SAM makes performance predictions and cost of energy estimates for grid-connected power projects, based on installation, operating costs and system design parameters. The tool is designed to facilitate conducting pre-feasibility examination of potential renewable energy projects. The case study presented in this policy brief modeled the technical and financial features of a 300 MW solar plant with 1-axis tracking in Tfail and its corresponding sensitivity analysis (see Table 1 on this link)[1].

Before conducting the Tfail analysis, the model has been benchmarked with the Cestas project, an existing and operating solar plant in Bordeaux – France. Cestas is also a 300MW solar PV project developed by Neoen.

The only available weather data for Lebanon is for Beirut, which is coastal, low in altitude, and far from Tfail. Consequently, Tfail weather data was acquired via the European Commission's Photovoltaic Geographical Information System (PVGIS). Real measurements were also acquired from the other side of the Syrian borders.

No reserve accounts were provided in our modelling, and a 7% cost of debt was considered.[2] The above financial parameters have followed a conservative approach that took into consideration the country's credit risk rates and fiscal challenges, the grid's situation in Lebanon and the several costs that might arise at this level such as Engineering, Procurement, and Construction (EPC) as well as labor costs. As a result, the total installed cost per capacity in the simulation varied between 0.75 & 1.0 $/Wdc and resulted in a Weighted Average Cost of Capital (WACC) value around 7.8%.

Project financial and capital structures

In principle, such a project can be tendered out through the Lebanese higher consul for privatization and Public Private Partnership (PPP) as provided for under law 48/2017. For unknown reasons, procuring power projects have been carved out of this PPP process and are being tendered out directly by the Ministry of Energy and Water. Irrespective of the ultimate path chosen by government, the winning consortium will be "licensed" to produce power and supply electricity under a "bankable" Power Purchase Agreement (PPA). It is common for these projects to be funded on a "no recourse or limited recourse" basis.

Lebanese debt to equity benchmark for PPP currently stands at 70/30 split. For a $300m project, the sponsors will have to inject $90m in equity and the lenders to fund $210m. This quantum of capital is unheard of in the Lebanese business landscape and the country never witnessed injections of equity of such a magnitude by any sponsor. Given that senior lender will not fund more than what their risk limit allows them - which in this case is 70% cap in senior lending i.e. $210m - this leaves us with a $90m subordinated tranche, assuming that a sponsor is willing to inject $50m leaving a $40m gap in funding.

Therefore, mezzanine funding could be a solution. A mezzanine tranche of $40m can be structured into the transaction. Such a tranche should pay investors a rate which is benchmarked to the sovereign Eurobonds yield for the same maturity plus a construction risk premium.

In the current yield environment (10.5% for 10-years government bonds), such a mezzanine would have to pay 12% to 13%.

PPP projects are usually characterized by two subsequent, distinct, well defined and not overlapping phases: The construction phase and the operating phase. Operating phase starts only once the construction phase is successfully implemented. From a risk perspective, these two phases differ totally in the challenges they pose to the various investors. The construction phase is a situation with binary outcome during which a failure means the loss of the equity and conversely a success transports the project into operating phase and hence a different risk profile. The remuneration of construction period risk profile is akin to an insurance premium. During the construction phase, equity risk is equal to construction risk: Re = construction risk premium = Cp. The required return (Re) changes upon commencement of operations to become: ***Re = Rf + Beta x (Rm-Rf).*** With Rf being the risk-free rate in the country for similar maturity. Rm being the market risk returns for a -diversified portfolio/exposure in the economy, and Beta, the correlation of the project to the overall performance of the economy. If the project benefits from a full off-take agreement (with pre-set quantities and prices) on a take or pay basis, one could assume that the project is decoupled or uncorrelated to the overall performance of the economy. In financial terms, this means that Beta = 0. As such, required return equation during such period becomes: Re = Rf. The project Re becomes Re = Rf + Cp. Assuming a risk-free rate for similar maturity (weighted average life WAL) of 10.5% as benchmarked to governments Eurobonds and assuming a construction risk premium Cp of 5%, the required return (Re) for the entire project and including both periods would be Re = 10.5% + 5% = 15.5%.

We have modelled in our simulation two scenarios which mainly differ in Capital Expenditures (CAPEX) and consequently, PPA price assumptions. Scenario 1 considers 0.75 $/Wdc as total installed cost per capacity and an off-take price (PPA Price) of 4.70 cents/kWh. Scenario 2 considers 1.0 $/Wdc as total installed cost per capacity and an off-take price of 6.00 cents/kWh. Both scenarios (which for the time being do not include any mezzanine financing) give an equity Internal Rate of Return (IRR) at 15.5% for the relevant off take prices indicated above. Thus, required return Re (as calculated previously at 15.5%), equates the project equity IRR in both scenarios. This means that equity investors are properly compensated for the risks they are taking (there is no difference between what the investors are receiving i.e. effective IRR and what they are satisfied with i.e. the Required Return Re) and consequently, the price of the KWh is adequately set in each scenario to ensure an equity IRR that equals the required return (Re) on equity.

As a result, the LCOE values emerging from both

1 https://www.aub.edu.lb/ifi/Documents/publications/policy_briefs/2018-2019/20190314_table_1_system_design_and_financial_parameters.pdf

2. This is mainly a weighted average value between 3 sources of debt: Development banks rates (around 7%), local banks rates (9%), and export credit agencies (around 5%).

scenarios range between 4.2 and 5.32 cents/kWh.

Simulation results and sensitivity analysis

The simulated model in SAM has shown an encouraging annual energy generation/year ranging between 620 & 720 GWh/year (depending on the variations in the module, inverter types, and weather files) which peak in spring and summer seasons and narrow in winter and autumn times. In addition, the average annual energy generation over the project's lifetime is around 600 GWh/year.

Financial Results

Table 2 summarizes a set of SAM's modelling outputs other than the electricity generation. The results show encouraging ranges of energy yield and a remarkable number in the land needed for project implementation which fits within the 13 km^2 identified in the Tfail region. Promising results are also noted for the project's capacity factor and IRR (%) that usually attract investors to project financing.

lower impact on the LCOE, ±5, ±4%, ±3.5%, respectively.

Despite the promising results obtained for such a pilot project in the Bekaa region, lowest prices are expected to be achieved via multi-stage, well-planned, transparent and flexible auctioning and competitive bidding. This will align both industry and government knowledge and will offer a wide range of benefits such as ensuring the cost-effectiveness of renewable energy projects, through the level of fair competition in the auction, the mitigation of speculative over- or under-bidding and the minimization of the bidders' risks; guarantee the lowest prices that vendors can endure and create a price track record for future projects; and encourage high project implementation rates and timely delivery dates through commitment and transparency.

SIMULATION RESULTS

Total Installed Costs (Direct & Indirect)	225 to 300 Million USD (0.75 to 1.0 $/Wdc per capacity)
Area/Land needed	5.2 Km^2
Energy Yield	2100 to 2400 kWh/kW
Capacity Factor	24 to 28
Performance Ratio	0.82-0.83
IRR	15.50 %
LCOE	4.2 – 5.32 cents/kWh

Table 2: Modelling Results in SAM

The Total installed costs and LCOE ranges, although being slightly higher than the global trends and more specifically the recent regional lowest prices in UAE and Jordan (below 3 cents/kWh), align with the modelling's conservative approach, especially on the financial level.

Sensitivity Analysis

In the sensitivity analysis, we identified and varied in SAM 5 parameters which have influence on the LCOE, namely the CAPEX, Operational Expenditure (OPEX), Yield (using several weather files and irradiation values), discount rate and system lifetime. Each on these inputs is varied by ±20%, and for simplicity, each input was treated as if it is an independent parameter from the others. The resulting effects on LCOE values showed a strong dependency on the yield and investment capital expenditures, ±20% and ±15%, respectively. On the other hand, discount Rate, system lifetime and OPEX appear to have much

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The Energy Policy and Security Program

The Energy Policy and Security Program at the Issam Fares Institute for Public Policy and International Affairs at AUB was launched in 2016 as a Middle East-based, interdisciplinary platform to examine, inform and impact energy and security policies, regionally and globally. The Program closely monitors the challenges and opportunities of the shift towards alternative energy sources with focus on nuclear power and the Middle East. The Program has been established with a seed grant support from the John D. and Catherine T. MacArthur Foundation to investigate the prospects of nuclear power in the Middle East and its potential to promote regional cooperation as a way to address the security concerns associated with the spread of nuclear power.

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We are committed to expanding and deepening policy-relevant knowledge production in and about the Arab region; and to creating a space for the interdisciplinary exchange of ideas among researchers, civil society and policy-makers.

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