

*Introduction:*

*The National Energy Efficiency and Renewable Energy Action (NEEREA) is a national financing mechanism dedicated to the financing of loans in energy efficiency, renewable energy, and green buildings. NEEREA is a joint initiative between the Central Bank of Lebanon (BDL) and the Ministry of Energy and Water (MEW). NEEREA receives the technical support of the United Nations Development Programme (UNDP) through funding by the Global Environment Facility (GEF).*

*The Technical Support Unit to the Central Bank of Lebanon (BDL) at LCEC is dedicated to offer BDL technical assistance to evaluate the eligibility of submitted loans to benefit from the EU-funded subsidy. This task is financed by the European Union (EU).*

*Important Notes:*

***1. All sentences written in italic format in these Guidelines are for instructions purposes only. These sentences should be removed from the technical feasibility study.***

*2. This guide is for instructional purposes. It is designed to help potential beneficiaries and contractors in preparing comprehensive technical reports and proposals about photovoltaic systems installation.*

*3. This guide is a mandatory requirement towards facilitating the green loan applications and ensures sufficient and proper technical and financial analysis.*

*4. This guide is prepared by the Lebanese Center for Energy Conservation- Technical Support Unit to the Central Bank of Lebanon, and is available for public use.*

*5. This guide is divided into 10 sections that would ideally be available in the submitted technical report of a loan application. The last section offers general notes on the format of the report.*

*6. For questions, clarifications, or suggestions, please contact the LCEC: 01-569101 or by email:* [*energy@lcec.org.lb*](mailto:energy@lcecp.org.lb)

|  |
| --- |
| ***Evaluation of projects requesting financing of Decentralized Photovoltaic Systems under NEEREA will be based on these issued PV Guidelines. Contractors are entailed to abide by the requirements set in these guidelines and must submit the technical reports following the steps and regulations clearly identified.*** |

# PV Study Content

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## Introduction

*[This section should include the objective of the proposed PV system installation, the financial criteria and technical/operational limitations, the conclusions on the technical assessment and economic evaluation of the project, a summary of recommended energy conservation measures, annual energy savings and cost savings using in a table format]*

A detailed summary of the proposed project is provided in this section in the table here below:

*[Supplier’s Signature] [Client’s Signature]*

|  |  |  |
| --- | --- | --- |
| **PV system supplier** | |  |
| **Nominal array rating (kWp)** | |  |
| **Estimated installed cost of PV system ($)** | |  |
| **Total Energy provided by PV system (kWh/y)** | |  |
| **Energy estimated use on site (kWh/y)** | |  |
| **Estimated Annual Energy savings (kWh/y)** | | South Façade  Total |
| **Estimated Annual cost savings ($/y)** | |  |
| **Payback period (years)** | |  |
| **System rating** | **W/m2 (array)** |  |
| **W/m2 (floor area)** |  |
| **Total avoided CO2/y due to PV (kg)** | |  |
| **Battery Bank size (n° x V x Ah)** | |  |
| **Estimated Battery Autonomy** | |  |
| **Estimated Battery Bank life (years)** | |  |
| **Inverter size (VA – VDC)** | |  |
| **Inverter size (VA – VDC)\*** | |  |
| **Charge Controller size (A MPPT)** | |  |

* In case of using two inverters

1. Overview of Current Systems in Place

*[This section should include dates of preliminary study or audit and data collected from facility or building owner. A general description of the relation between the existing appliances at the facility and the PV system to be installed is required]*

1. Solar PV System Sizing

*[Multiple factors play an important role in determining the PV system size (budget, shading, roof space, electricity need, etc…)]*

*[In addition to an array of photovoltaic modules, a number of other components are required in any PV system to conduct, control, convert, distribute, and store the energy produced by the array. The specific components required depend on the functional and operational requirements for the system. The major components for solar PV system are solar charge controller, inverter, battery bank, auxiliary energy sources and loads (appliances).*

* *PV module: solar photovoltaic module used for converting sunlight into electrical energy.*
* *Solar charge controller: maintain batteries at the proper charge level and protect them from overcharging.*
* *Inverter: converse the variable DC output of the PV modules into a utility frequency AC current that can be used within the home or fed to the grid.*
* *Battery bank: batteries connected in series or parallel that allows power storage.*
* *Auxiliary energy sources: EDL, diesel generator or other renewable energy sources.*
* *Load: domestically used electrical devices like television, computer, lights etc…]*

*[An accurate system of the customer’s needs is the starting point for specifying, designing and installing PV systems. Developing and planning PV projects requires an understanding of the customer’s expectations from both financial and energy perspectives]*

*[The following sub-sections must be followed, described and completed to achieve a full technical PV project proposal. All the tables in these sub-sections are not shown as examples, they must be filled and completed in such technical feasibility studies and should include these minimum required information and details needed to assess the solar PV systems]*

4.1 Power Consumption Demands

*[The first step in designing a solar PV system is the Electricity Audit to get an idea how much of the electricity will be generated from the PV system. This can be accomplished by examining the electricity bills (EDL and Diesel Generators) for at least 12 months, 24 months is better to conclude the average electricity usage per day, per week, per month or per year; then by finding out the total load energy consumption by evaluating how much power each appliance consumes when operating to calculate the total Watt-Hours/day used by all AC and DC loads in the system]*

*[The following table presents the AC and DC loads description. This table must be filled and clearly presented. Occupancy of the Facility should be presented also in this sub-section.]*

*Description of the Appliances in the Facility*

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
| **Description of AC Loads Run by an Inverter** | **Description of DC Load** | **Power (Watts)** | **X** | **Hrs/day** | **=** | **Wh/day** |
|  |  |  | **X** |  | **=** |  |
|  |  |  | **X** |  | **=** |  |
|  |  |  | **X** |  | **=** |  |
|  |  |  | **X** |  | **=** |  |
|  | South Façade  Total |  | **X** |  | **=** |  |
| **A1** | **A2** | **Total loads Wh/day AC/DC**  **=** | | | | |
|  |  |  | | | | |

*[Add additional rows for additional appliances as needed]*

*[The below table must be filled according to clearly made assumptions]*

*Total Daily Power Demands*

|  |  |
| --- | --- |
| **Correction Factor** |  |
| **Total Average Daily Loads** |  |

4.2 Site Analysis

*[An energy audit may be accomplished to reduce the power needs as much as possible. Some tips are to be mentioned and taken into account looking to optimizing the power system demands:*

* *Which appliances consume the most of the electricity*
* *Which appliances are old enough to be replaced in the near future*
* *If some appliances are too energy inefficient, not wait until they break to replace them*
* *Don’t wait for light bulbs to break before you replace them with CFLs.*
* *From the energy audit you can determine what to do for reducing the electricity bill]*

*[Description of the site location (latitude and longitude), physical structure and layout of the roof space should be clearly mentioned in this sub-section. Suitability of the site for PV and availability of surface area must be justified]*

4.3 Meteorological Analysis

*[This sub-section should include on-site description of all the different factors that affect the sun power the PV module will be exposed to. Some examples of these factors are the location of the PV array, roof area & orientation (Google Earth, Roof Ray), roof slope of the building, exact shading (depending on the geography of the site, neighboring buildings and self-shading by the architectural form), roof conditions and special mounting system]*

*[This sub-section should also present the monthly and yearly averages for at least the horizontal incident solar irradiation values. References of Solar Data shall be mentioned]*

*[If you use your system primarily in the summer, use the summer value, if you are using your system year-round, especially for a critical application, use the winter value. If you are using the system most of the year (spring, summer and fall) or the application is not critical, use the average value. Between the chart and the map, you should be able to determine a reasonable estimate of the sun's availability in your area]*

*Solar Irradiation Data*

|  |  |
| --- | --- |
| **Month** | **Average Daily Irradiation (kWh/m2)** |
| January |  |
| February |  |
| **Average** |  |

*[Add additional rows for all months of the year. The normal irradiation to be used is only the one provided in annex; tilted irradiation should be calculated according to the conversion table also in annex. Graph of annual irradiation on site must be included in this sub-section]*

4.4 Sizing the PV Array

*[The selection of PV modules for a given project may be based on any number of factors, including the physical characteristics (dimension and weight), the electrical specifications (power tolerance and guaranteed power output), warranties, reliability and reputation of the manufacturer, manufacturer certification to quality standards, module warranty and design qualification, customer satisfaction and field results, costs and availability]*

*[The peak Watts of the module you will be using can be found in the module specifications. You can also determine peak wattage if you multiply the module's peak power point amperage by the peak power point voltage]*

*[The table below includes most of important technical required values for the sizing of the PV array and must be filled]*

*Array Sizing information*

|  |  |
| --- | --- |
| **Operating Voltage (VDC)** |  |
| **Total required Power (Ppeak)** |  |
| **Module Voltage (Vm)** |  |
| **String Length** |  |
| **Watts peak of solar module** |  |
| **Number of Strings** |  |
| **Number of solar modules** |  |
| **Total Area (m2)** |  |

*[The operating voltage selected for a stand-alone PV system depends on the voltage requirements of the loads and the total current]*

*[Result of the calculation is the minimum number of PV panels. If more PV modules are installed, the system will perform better and battery life will be improved. If fewer PV modules are used, the system may not work at all during cloudy periods and battery life will be shortened]*

*[Photovoltaic system losses shall be provided and considered for maximizing the size of the system suitable with energy production demand and use; as possible types of losses there’s shading, panel dirtiness, panel tolerance, mismatch and transport losses]*

*Energy Production by the PV*

|  |  |  |
| --- | --- | --- |
| **Month** | **Monthly Irradiation (kWh/m2)** | **Monthly Production (kWh)** |
| January |  |  |
| February |  |  |
| **Yearly TOTAL** |  |  |

*[Add additional rows for all months of the year]*

*[Graphs of the monthly energy consumption by the facility and the monthly energy production by the PV system installed in this site must be included in this sub-section]*

4.5 Battery Bank Sizing

*[Determining how much storage the battery bank would provide is the first thing to decide. The usage pattern and the critical nature of the application expected should also be considered]*

*[Deep Cycle Batteries type is the one accepted for Photovoltaic Applications]*

*[The table below includes most of important technical required values for the sizing of the Battery Bank and must be filled]*

*Battery bank Sizing information*

|  |  |
| --- | --- |
| **hrs/days of Autonomy** |  |
| **Storage need (kWh/day)** |  |
| **Maximum DOD** |  |
| **Loss Factor** |  |
| **Battery Capacity (Wh)** |  |
| **Number of Batteries** |  |
| **System Voltage (V)** |  |
| **Batteries in parallel** |  |
| **Batteries in series** |  |

*[Location of the battery bank where it will be placed is to be mentioned in this sub-section]*

4.6 Charge Controller Sizing

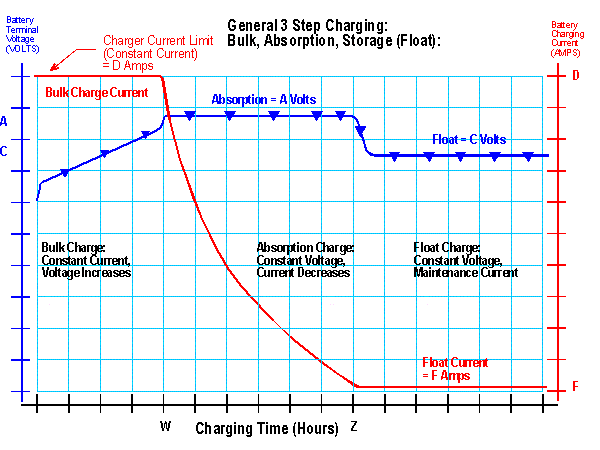
*[The output of the PV array should be connected to a controller that controls the charging and discharging of the batteries, the temperature, the state of charge, and the discharge velocity]*

*Choice of the Controller*

|  |  |
| --- | --- |
| **Bulk Charge** |  |
| **Absorption Charge** |  |
| **Float Charge** |  |
| **Equalization** | Yes/No |
| **Combined Short Circuit Current of the PV Array** |  |
| **Battery Bank Total Voltage** |  |
| **Charger Controller Power** |  |

*[Detailed data showing the three phases of charge of the batteries is required in this sub-section. An example of this graph is presented as follows]*

*Charging State of the Controller*



*[Make sure that solar charge controller has enough capacity to handle the current from PV array. You can use a larger solar charge controller, but never a smaller one, as the panels can overload the controller and ruin it]*

4.7 Power Inverter Sizing

*[The inverter is responsible for the conversion of the DC into AC and for the regulation of the voltage and frequency]*

*[The input rating of the DC/AC Power Inverter should never be less than the total Watts of the appliances and must have same voltage as operating voltage: Vin = VDC]*

*[Regarding system sizing, there are many parameters that have to be taken into account. The nominal power, the MPPT range, the maximum input voltage, the maximum DC current are parameters that are commonly used for system design]*

*[To determine the size of the needed inverter of the system, the maximum demand must be identified. How many home appliances will be in use at the same time? What are their individual loads? By adding these together, the combined load can be determined]*

*[All features concerning the specific site and PV project must be detailed and provided in this sub-section; such as battery charging capability, remote control operation, load transfer switch, capability for transfer operation, etc…]*

*[For grid tie systems or grid connected systems, the input rating of the inverter should be same as PV array rating to allow for safe and efficient operation]*

*[The following table should be filled considering the PV system size]*

*Inverter important information*

|  |  |
| --- | --- |
| **Input Voltage (V)** |  |
| **Shape of the output waveform** |  |
| **Power Conversion Efficiency** |  |
| **Rated Power** |  |
| **Power Factor** |  |

*[Environment where the inverter will be installed is to be mentioned. Protection of input and output circuits and surge protection device availability should be detailed in this sub-section]*

4.8 Summary of the PV system Components

*[Use manufacturer’s specifications to fill in the PV system components blocks]*

* + 1. Solar Panels (PV)

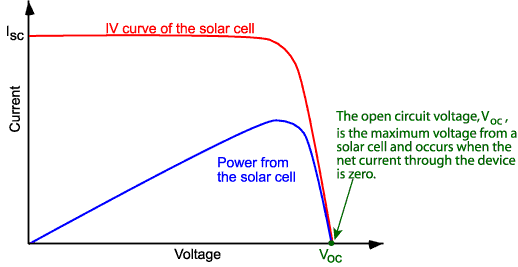
*[PV module specifications and information will be summarized in the following table]*

*PV module information*

|  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| **Make/Model** |  | | | | | | **Nominal Volts** | | |  |
| **Module Type** |  | | | | | | **Number of modules** | | |  |
| **Length** |  | **Width** | | | |  | **Thickness** | | |  |
| **Weight** |  | | | | | | **Bypass Diode** | | | Yes/No |
| **Voltage (V)** | **At STC** | | **Open Circuit** | | | | **At Highest Expected Temperature** | | | |
|  | |  | | | |  | | | |
| **Current (A)** | **At STC** | | | **Short Circuit** | | | **% Pout warranty for 20 years** | | | |
|  | | |  | | |  | | | |
| **Estimated Eout** |  | | | | | | **Conversion Efficiency** | |  | |
| **System losses** | **Shading** | | | | **Transport** | | **Mismatch** | **Others** | | |
| Yes/No | | | | Yes/No | | Yes/No |  | | |
| **Tilt/Orientation** |  | | | | | | **Cost ($)** |  | | |

*[Detailed data showing I-V curve should be supplied in this sub-section. An example of this graph is presented as follows]*

*I-V Curve of the Solar Panel*



* + 1. Battery Bank

*[Battery Bank specifications and information will be summarized in the following table]*

*Battery Bank Information*

|  |  |  |  |
| --- | --- | --- | --- |
| **Make/ Model** |  | **Manufacturer** |  |
| **Type** |  | **Maximum DOD** |  |
| **Nominal Voltage (V)** |  | **Number of batteries** |  |
| **Rated Capacity (Ah)** |  | **Battery bank Lifetime** |  |
| **Cost ($)** |  | **Manufacturing Date** |  |

*[Batteries type must be Deep Cycle and nothing else]*

*[Storage capacity shall not exceed 7800Wh per kWpeak (at C10) as per the updated version of the first Memorandum M13-001.2 issued by LCEC]*

* + 1. Charge Controller

*[Charge Controller specifications and information will be summarized in the following table]*

*Charge Controller Information*

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| **Make/Model** |  | **MPPT** | | Yes/No |
| **Input Voltage (V)** |  | **Capacity (W)** | |  |
| **Output Voltage** |  | **Features** | | |
| **Rated Power** |  | 1- | | |
| **Manufacturer** |  | **Cost ($)** |  | |

*[Features can be such as automatic dusk/ dawn switch, temperature compensation and timer module]*

*[Protections for overcharging, over discharging, overload and reverse current must be presented and specified]*

* + 1. Power Inverter

*[Power Inverter specifications and information will be summarized in the following table]*

*Power Inverter Information*

|  |  |  |  |
| --- | --- | --- | --- |
| **System Requirements** | | **Inverter Specifications** | |
| **Wave Form** |  | **Make/ Model** |  |
| **DC System Voltage (V)** |  | **Wave Form** |  |
| **AC System Voltage (V)** |  | **Input Voltage (DC) (V)** |  |
| **Surge Capacity (W)** |  | **Input Voltage (AC) (V)** |  |
| **Total AC Watts (W)** |  | **Surge Capacity (W)** |  |
| **Maximum Simultaneous AC Load (W)** |  | **Frequency (range)** |  |
| **Cost ($)** |  |
| **Inverter Run Time at Maximum Simultaneous Load (min)** |  | **FEATURES:** | |
| Maximum Power Tracking | Yes/No |
| Battery Charging | Yes/No |
| **Inverter Continuous Duty Rating (W)** |  | Voltmeter | Yes/No |
| Remote Control | Yes/No |
| **Required Inverter Efficiency at Load (%)** |  | Generator Start | Yes/No |
| Transfer Switch | Yes/No |
| **Installation Requirements** |  | | |

*[Efficiency of the Inverter should be greater than 85% and efficiency curve must be supplied]*

*[The input rating of the inverter should never be less than the Total Watt of the appliances]*

* + 1. Auxiliary Energy Sources

*[Auxiliary energy required (sources) and sometimes the specific electrical load are to be mentioned]*

* + 1. Balance Of System

*[In this part, all required additional items for the installation o f the whole PV system must be added: Wiring systems, Terminations, Ground-fault protection, Overcurrent protection, Disconnect devices and other power processing equipment, Thunder]*

*[The inverter should be protected in case of overvoltage on the grid especially during thunder storms]*

*[It is important to select wire, connectors, and protection components such as switches and fuses that will last for twenty years or more]*

*[Wires must be protected from the sun if possible: underground feeder]*

*[All connections must be protected. System failures are caused by poorly made connections than by component failure]*

*[Earthing, width of the ground wire, location of surge protection devices are to be specified and mentioned]*

*[In addition, the below tables must be filled accordingly]*

*Protection Components Specifications*

|  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- |
| **Protected Circuit** | **Protection Device** | | | | **Rated Current** | **Rated Voltage** | **Description** |
| **Switch** | **Diode** | **Fuse** | **Movistor** |
| 1- Array Output |  |  |  |  |  |  |  |
| 2-Battery |  |  |  |  |  |  |  |
| 3- |  |  |  |  |  |  |  |
| 4- |  |  |  |  |  |  |  |

*[Add additional rows for all additional circuits of the installed PV system]*

*BOS Summary Table*

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
| **Wire Runs** | **System Voltage (V)** | **Maximum Current** | **One Way Length (m)** | **Allowed Voltage Drop (%)** | **AWG N°** | **Wire Type** |
| **Array Circuit** |  |  |  |  |  |  |
| **Array to Controller or Inverter** |  |  |  |  |  |  |
| **Battery or Controller to DC Loads** |  |  |  |  |  |  |
| **Battery to Inverter or Converter** |  |  |  |  |  |  |
| **System Grounding** | **Wire Type** | | **Type of Earth Ground** | | **AWG Number** | |
| **System Ground** |  | |  | |  | |

*[Any additional design notes must be presented after filling the tables above]*

* + 1. Mounting Structure

*[Mounting materials should be specified and detailed in this sub-section]*

*[The foundation for the array should be designed to meet the wind load requirements of the region]*

*[PV system must be Water, Wind and Corrosion resistant and if possible a monitoring system is to be included to measure and record system performance parameters]*

* + 1. Electrical Drawings and Connections

*[Electrical Drawings and Connections must be attached to the proposal in this sub-section]*

*[Shop drawings must be clear to check the global view of installation of the real system, distance between panels and approximate locations of the other equipment]*

1. Financial Analysis

*[The detailed financial proposal of all the products of the PV system must be provided in the below table format]*

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| **Ref. No.** | **Item** | **Item Description** | **Quantity** | **Amount Needed (USD)** |
| **1** | Solar Panels |  |  |  |
| **2** | Batteries |  |  |  |
| **3** | Charge Controller |  |  |  |
| **4** | Power Inverter |  |  |  |
| **5** | Protection Devices |  |  |  |
| **6** | Mounting Structure |  |  |  |
| **7** | Accessories |  |  |  |
| **8** | Installation |  |  |  |
| **9** | VAT |  |  |  |
|  | **Total Amount of the PV system (USD)** | |  |  |

*[Add additional rows for more detailed accessories items]*

*[Details on system life and maintenance are to be mentioned in this section such as expectancy, yearly degradation factor, yearly maintenance cost, etc…]*

*[In order to compare the different PV system options and to determine the most cost-effective system designs and to give the client a global view of the advantages and benefits of his investment in such projects, the life cycle cost analysis of the PV system should be provided in this section showing the total cost of ownership for this renewable action including energy cost, replacement cost and maintenance cost over the lifetime of the system]*

*[Three different parts must be studied to achieve a complete and clear financial analysis: the first one about all the parameters to take into consideration in the life cycle cost analysis, the second about the cash out-flows and the third discussing the cash in-flows]*

*[The following is an example to facilitate the financial analysis of the proposed system:*

* *Parameters of the PV LCC: total investment, interest rate, loan period, grace period, monthly payments through the loan’s period.*
* *Cash out-flows: file fees, insurance, grace payments, lease payments, batteries replacement, etc…*
* *Cash in-flows: Cost savings from EDL, generator or any auxiliary energy source]*

*[All the information to be provided for the financial analysis must be clear, comprehensible and detailed]*

*[The net cumulative savings will be the essential data for concluding on the profitability and the return on investment. The following tables should be used in such analysis and more detailed tables can be provided according to the contractor or consultant detailed analysis:*

*Yearly Energy and Cost Savings*

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| **Month** | **PVout (kWh)** | **Consumption (kWh)** | **EDL Savings (USD)** | **Generator Savings (USD)** | **Total Savings (USD)** |
| January |  |  |  |  |  |
| February |  |  |  |  |  |
| **Year** |  |  |  |  |  |

*[Energy and Cost Savings must be detailed]*

*Net Cumulative Savings*

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| **Year** | **Cash Out-Flows** | **Cash In-Flows** | **Total Cash Flow** | **Total Cumulative Cash Flow** |
| Year 1 |  |  |  |  |
| Year 2 |  |  |  |  |
| **Net Present Value (NPV)** | |  | **IRR** |  |

*[Add additional rows for additional years as needed]*

1. Green House Gas Emissions Reduction

*[This section is dedicated to the environmental part of the project to be implemented. The calculation of the avoided greenhouse gas emissions must be provided and detailed]*

1. Post-installation monitoring

*[In case of data logging and monitoring, include in this section the most important parameters that will be measured, such as Monthly Total Output Energy, Monthly difference between Total generating Power and the load demanded, Daily battery charging state, etc…]*

1. Conclusions

*[The conclusion of the PV study proposal must include the following:*

* *Summary of recommendations, estimated annual kWh produced, estimated cost savings, projected investment cost and payback period in the table format below:*

*Summary Table of the proposed PV system*

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| ***PV System Description*** | ***Energy Savings (kWh/year)*** | ***Cost Savings ($/year)*** | ***Implementation Cost*** | ***Payback Period*** | ***tCO2 reduced*** |
|  |  |  |  |  |  |

* *ESCO’s or Solar Energy Company’s recommended action plan and implementation schedule*
* *Statement by the client on which recommendations will be implemented and timeframe for implementation]*

1. Appendices

*[Information of significant importance, which cannot be presented as a part of the text report (because of number of pages, quality of presentation, etc.) shall be presented as appendices]*

*[The appendices should include:*

* *Details of all products specifications (PV test Certificate is required)*
* *Details on simulation tools employed and calculations method*
* *Construction and physical characteristics and warranties conditions for concerned products]*

1. General Notes

*[Documentation – All numbers related to the results should be supported by information showing how they were derived. This includes all energy produced; cost savings, investment and payback information]*

*[Mathematical accuracy – All calculations in the report should be checked for mathematical accuracy]*

*[SI units must be used in all parts of the report]*

*[Grammar and style – The report should be written in proper prose. The language should be clear, concise and understandable]*

*[All graphs and plots should be properly labelled and show the dates and conditions when the data was taken]*

**ANNEX**

1. **Solar Irradiation Data per climatic zone according to TSBL**

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| **Month** | **Average Daily Direct Normal Irradiation (Wh/m2)** | | | | |
| **Zone** | **Coastal (Beirut)** | **Coastal (Bayssour)** | **Western Mid-Mountain** | **Inland** | **High Mountain** |
| January | 2981.7 | 3737.0 | 3714 | 4445 | 2963.4 |
| February | 3364.5 | 3369.6 | 3357.6 | 4190.2 | 3352.3 |
| March | 4587.2 | 3672.3 | 3666.3 | 4579.6 | 3663.5 |
| April | 4761 | 4761.3 | 4760.3 | 4760 | 3807.9 |
| May | 4829.7 | 4827.8 | 4832.2 | 4834.1 | 4834.1 |
| June | 6740.1 | 7698.8 | 6744.6 | 7712.1 | 7712.1 |
| July | 6586.6 | 7523.5 | 7532.6 | 7536.7 | 7536.7 |
| August | 7240.3 | 7239.0 | 7242.2 | 8149.2 | 7243.8 |
| September | 6960.9 | 6964.4 | 6956.2 | 7821.5 | 6952.4 |
| October | 4959 | 4965.9 | 4949.9 | 4942.9 | 4119.2 |
| November | 4514.7 | 4524.4 | 3751.5 | 5241.2 | 3743.9 |
| December | 3529.8 | 3539.6 | 2813.3 | 3507.1 | 2805.7 |
| **Average** | 5094.9 | 5242.5 | 5034.7 | 5647.1 | 4900 |

*LCEC recommend the use of Bayssour irradiation data for areas above 200m of altitude in Climatic Zone 1.*

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| --- | --- | --- | --- | --- | --- |
| **Month** | **Average Daily Global Horizontal Irradiation (Wh/m2)** | | | | |
| **Zone** | **Coastal (Beirut)** | **Coastal (Bayssour)** | **Western Mid-Mountain** | **Inland** | **High Mountain** |
| January | 2387.6 | 2503.6 | 2471.8 | 2522.2 | 2357.3 |
| February | 3195.8 | 3208.1 | 3165.9 | 3282.2 | 3153.3 |
| March | 4898.1 | 4777.7 | 4734.8 | 4861.2 | 4718.4 |
| April | 6012 | 6018.3 | 5991.8 | 5979.5 | 5817.1 |
| May | 6837 | 6833.2 | 6834.1 | 6837.6 | 6837.6 |
| June | 7192 | 7209.7 | 7192.7 | 7211.3 | 7211.3 |
| July | 7010.4 | 7024 | 7032.8 | 7037.5 | 7037.5 |
| August | 6343.7 | 6353.2 | 6337.4 | 6405.2 | 6327.6 |
| September | 5374.6 | 5389.1 | 5362 | 5466.1 | 5347.2 |
| October | 3873.5 | 3896.9 | 3851.8 | 3828.4 | 3750.2 |
| November | 2757.2 | 2770.7 | 2669.5 | 2765.4 | 2656.3 |
| December | 2273.4 | 2287.3 | 2162.4 | 2241.2 | 2149.2 |
| **Average** | 4854.6 | 4864.1 | 4825.6 | 4877.6 | 4788.4 |

*LCEC recommend the use of Bayssour irradiation data for areas above 200m of altitude in Climatic Zone 1.*

* 1. ***Climatic Zone 1: Coastal***

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| **Mohafaza** | **Qadaa** | **Real-estate District** |
| Beirut | Beirut | All |
| Mount Leb | Baabda | Chiyah; Furn Ech-Chebbak; Haret Hreik; Laylaki; Bourj El-Brajneh; Tahouitat El Ghadir; Baabda; Hadath Beyrouth; Boutchay; Merdache; zire; Kfar Chima; Ouadi Chahrour Es-Souf; Ouadi Chahrour El Aaou; Haret Es-Sit; Bsaba Baabda; Chouit; Aaraiya |
| Mount Leb | El Metn | Bourj Hammoud; Sinn El-Fil; Jdaidet El-Matn; Baouchariat ; Deir mar Roukoz; Dekouanet; Mkalles; Antelias; Menqlet Mezher; Jall Ed-Did; Naqqach; Aamaret Chalhoub; Zalqa; Byaqout; Mazraat El-Hdaira; dbaye; Haret El-Ballane; Mazraat Deir Aaoukar; Mansouriyet El-Matn; El-Dechouniyeh; Fanar; kafra ain saade; Roumieh; Bqennaya; Majzoub; Bsalim; Nabay; Mtayleb; Beit El-Kekko; Qornet Chehouane; Beit Ech-Chaar; Dik El-Mehdi; Zouk El-Kharab; Aain Aar; Mazraat Yachouaa; Deir Tamich; Zakrit; Deir Mar Aabda el Mcha; Beit Chabab; bherzoq; frayke; Hbous; Qornet El-Hamra; Jouret El-Ballout; Qennabet Broummana; Beit Meri |
| Mount Leb | Chouf | Damour; Naamat; Mechref; Chhim; mazboud; Dalhoun; Chammis Ech-Chouf; Ketermaya; El-Maaniyeh; Ouadi Abou Youssef; Sibline; Bourjein; Barja; Bkechtine Ouel Mcheiaa;Baassir;Debbiyeh; Benouati Ech-Chouf; El Jiyeh; Jadra; Chmaarine; Dahr Ech-Chouf; Aalmane Ech-Chouf; Jmeiliyeh; Rmeilet Ech-Chouf; Majdalouna; El-Wardaniyeh; Joun; mghayriye ech chouf; Deir El-Moukhalles; reiaa; Bkifa Ech-Chouf; Mazmoura; Kfar Faqoud; Deir Baba; Sirjbal; GHabet Jaafar; Kfar Him; Ouadi Ed-Deir; Dmit; Bqaiaa Ech-Chouf; Moughayret Ech-Chouf; Deir Dourit; Ouadi bnehlay; El-Jahliyeh |
| Mount Leb | Aley | Chouaifat Amroussyat; Chouaifat Qobbat; Choueifat El-Oumara; Deir Qoubel; Aaramoun Aaley; Aain Drafil; Sirhmoul; Baaouerta; Bchamoun; Daqqoun; Aain Aanoub; Blaybel; Houmal; Bdadoun; Bsous; rjoum; Aaytat; Aaley Bsatine; Aabey; Kfar Matta |
| Mount Leb | Kasrouane | jounieh kaslik; Zouk Mkayel; Jounie Ghadir; Zouk Mousbeh; Jounie Haret Sakhr; Sahel Aalma; Ouata Sillam; Kfar Yassine; Tabarja; Adma Oua Dafine; Safra Kesrouane; Bouar; kfar shihham; Bqaq Ed-Dine; Kharayeb Nahr Ibrahim; Balloune; Souhailet El; Faouka; Aain Er-Rihane; Jaaita; Aintoura Kesrouane; Mazraat Er-Ras; Ghazir; Bourj El-Ftouh; Chnanaair; Batha; Ghidras; Deir Baqlouch; Harissa Kesrouane; Nammoura; Kesrouane; Daraaoun; Maaysra Kesrouane; Bizhel; Zaitoun |
| Mount Leb | Jubail | Jbayl; Mastita; Qartaboun; Blat Jbeil; edde jbail; Aamchit; Halate; Hasrayel; Rihanet Jbayl; Jeoddayel Jbayl; Nahr Ibrahim; Mounsef; Berbara Jbayl; kfar kidde; Aalita; Bchille Jbayl; Zibdine Jbayl; Brayj Jbayl; Behdaydat; Ramout; Saqiet El-Khayt; Kfar Qouas; Fatre; Kfoun; Bintaael; Beit Habbaq; kafr; jlisse; mhammara bejje; Ghalboun; Chamate; Hbaline; Bmehrayn; Hboub; Hsarat; Kfar Mashoun; Aain Kfaa; Ghofrine; Maad; Gharzouz; Chikhane; Chmout; Bekhaaz; Fghal |
| North | Tripoli | All |
| North | Koura | All |
| North | Zgharta | Zgharta; Aardat; Kfardlaqous; Rachaaine; Qarah Bach; Kfarhata Zgharta; Arde; Asnoun; Mazraat Ajbeaa; Mejdlaiya Zgharta; Hariq Zgharta; Aalma; Mazraat Jnaid; Deir Jdeide; khaldiye; Iaal; Kfarhoura; Kfarzaina; Kfarchakhna; Bsebaal; Sakhra; Houakir; Kfaryachit; Morh Kfarsghab; Bchannine; Bnechaai; Aarjis; Daraiya Zgharta; Kfarfou; Ras Kifa; karm sadde; Tallet Zgharta; Sebaal Zgharta; Danha; Aachach; Miriata; Hailan; Boussit; Mzraat Kefraya; Hraiqis |
| North | Batroun | Litige; Batroun; Rachana; Thoum; Kfar Aabida; Koubba; Selaata; Heri; Chikka;  Dahr Abi Yaghi; Toula El-Batroun; Daraya El-Batroun; AAbdelli; Jrabta El-Batroun; Chibtine; Deir Kfifane; Sghar; Deir Mar Youssef Jrabt; Mrah Ez Ziyat; Ghouma; Kfifane; Jrane El-Batroun; Smar Jbayl; Kfar Hatna; Zane; Ftahat El-Batroun; Kour; Basbina; Aartiz; Harbouna; Mrah Chdid; Kfarb Shlaimane; Edde El-Batroun; Sourat El-Batroun; Bijdarfil; Ijdabra; Helta; Aabrine; Kfar Hay; Jebla; Rachkida; Boqsmaiya; Daael; Kfar Khollos; Qatnaaoun; Ras Nahhach; Ouajh El-Hajjar; Hamat |
| North | Akkar | Litige; Halba; Cheikh Mohammad; nfisse; Idbil; Kroum El-Aarab; Cheikh Taba  Es-Sahl; Cheikh Taba; Jdidet Ej-Joumeh; Zouarib; Majdel Akkar Minyara; Hakour; Karm Aasfour; Mazraat Beit Ghattas; Qantarat Aakkar; Machha; Hayzouq; Aarqa; Souaisset Aakkar; Ilat; Bqerzla; Deir Dalloum; Zouk-El-Hosmieh; Zouq El-Hbalsa; Dahr Laissine; Kfar Harra; balde; Zouq El-Hadara; Zouq El-Moqachrine; Jebrayel; Mar Touma; Hedd; Tikrit; Tallet Chattaha; Beit Mellat; Beino; Aayoun Aakkar; Qboula; Chaqdouf; Borj Aakkar; Tall Aabbas El-Gharbi; Tall Aabbas Ech-Charqi; Koueikhat; Khreibet Ej-Jindi; Saadine; Haouchab; Hayssa; Hokr Etti; Chir mairine; Darine; sammouniye; massaoudiye; Tall Meaayan Tall Kiri; Qaabrine; Kfar Melki Aakkar; tall bireh; Tall Hmayra; Hokr Jouret Srar; Barcha; Qleiaat Aakkar; Kneisset Aakkar; Tall Sebaal; aabboudiye; Mighraq Aakkar; Hokr Ed-Dahri; Marlaya; Melhem; Kharnoubet Aakkar; Semmaqli; Mqaiteaa; Janine; Aamaret Aakkar; Cheikh Zennad; Qoubber Chamra; sammaqiye; AAridet Cheikh Zennad; Bebnine; Mhammaret; Rmoul; Sayssouq; Berqayel; Bzal; Kloud El-Bakia; Dinbou; Chane; Houaich; Sfaynet El-Qaitaa; Qabaait; Habchit; Homeira; Qardaf; Jdeidet El-Qaitaa;  Aayoun El-Ghizlane; Majdala; rahbe; Ouadi El-Jamous; Beit El-Haouch; Fraydes Aakkar; Khirbet Daoud Aakkar; daghle; Aamriyet Aakkar; Kafr; Bsatine Aakkar; Aain Ez-Zeit; Kouachra; Khirbet Char; dibbabiye; Berbara Aakkar; Aain Tinta; Baghdadi; Deir Jannine; douair aadouiye; Noura Et-Tahta; Sfinet Ed-Draib; Aamaret El-Baykat; Msalla; Qachlaq; Ouadi El-Haour; Charbila; Tleil; mzeihme; Haytla; knisse; Rihaniyet Aakkar; Saidnaya; Hmaiss Aakkar; Srar; El-Ghozaili; El-Armeh |
| North | Minieh-Danie | Beddaoui; Deir Aammar; bourj el yahoudieh; Nabi Youcheaa; Minie; rihaniet-minieh; Zouq Bhannine; Btermaz; Harf Es-Sayad; Harf Es-Sayad; Beit Zoud; Mrah Es-Srayj; Debaael; Qarhaiya; Aazqai; Aasaymout; Kfar Chellane; Kfar Habou; Deir Nbouh; Merkebta; Raouda-Aadoua; Tourbol; Bakhaaoun |
| South | Saida | All |
| South | Sour | All |
| South | Jezzine | Kfar Falous; A'ain El-Mir; Mrah El-Hbasse; Bayssour Jezzine; haytoule ; Lebaa ;  mharbiye; Ouadi El-Laymoun; Sfaray; hassaniye; Karkha; Choualiq Jezzine;  Ouadi Baanqoudaine; Mjaydel Jezzine; Dahr Ed-Deir; Jensnaya; Rimat; Kfar Jarra; Anane; baanoub; Jernaya |
| Nabatiye | Nabatiye | All |
| Nabatiye | Bint Jubail | All |
| Nabatiye | Marjaayoun | All |

* 1. ***Climatic Zone 2: Western Mid-Mountain***

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| **Mohafaza** | **Qadaa** | **Real-estate District** |
| Mount Lebanon | Baabda | Baalchmay; Aain Mouaffaq; Rouaysset El-Ballout; Mzairaa Baabda; El Halaliyeh haret hamze, kahlounieh; Qtale baabda, deir mar youhanna; Ras El-Href; Deir Khouna; El-Abadiyeh; Qrayet Baabda; Chmeisset Baabda; Ras El Matn; Qobbayaa; Qordata; El-Ksaibeh; Deir El-harf; Zandouqa; Kneisset Baabda; El-Erbaniyeh; dlaybeh; Salima Baabda; Hasbaiya El-Matn; Qalaat Baabda; chbaniyeh; Khreibet Baabda; Bmaryam; Btekhnay; Btibyat; Qornayel; Jouar El-Haouz; Bzebdine; Arsoun; Jouret Arsoun |
| Mount Lebanon | El Metn | Bikfaya; Mhaidset Matn; Ouadi Chahine; Aain El-Qach; Mar Boutros Karm; Bhersaf; mayassa; ain el kharroubeh; Himlaya; aain Aalaq; aatchaneh; Aain Et-Teffaha; Sfeilet Bikfaya; Abou Mizane; Deir Chamra; Jouar El-Matn; Chrine; Broummana El-Matn; Masqa; Aayoun El-Matn; Mar Chaya et Mzakki; Baabdat; Dahr Es-Souane El-Matn; Qannebet; Salima; Bsifrine; aain ezzeitouneh; Khillet El-Mtain; Bnabil; Aain es-Sofsaf El-Matn; Ouata El-Mrouj; Mrouj; Marjaba; Aain Es-Sindiane; Zaraaoun; Qaaqour; Khinchara; Choueir; Bteghrine; Douar El-Matn; Chouaya El-Matn; Aayroun; Zighrine El-Matn; Aain El-Qabu; Kfar Aaqab; Mar Moussa Ed-Douar; Machraah El-Matn; Ouadi El-Karm El-Matn; Zabbougha; Kfar Tay El-Matn |
| Mount Lebanon | Chouf | Daraiya Ech-Chouf; Aanout; Debbiyeh; mtallet ech chouf, bzina; Mazraat Es-Dahr; Khirbet Bisri; El-Jleiliyeh; Zaarouriyeh; Bsaba Ech-Chouf; Beit Ed-Dine; Deir El-Qamar; Kfar Hamal; El-Samkanieh; Kfar Qatra; Maasser Beit Ed-Dine; Bchtfine; Kneisset Ech-Chouf; Aammiq Ech-Chouf; deir koucheh; Mazraat Ed-Douair; Ouadi Es-Sitt; Majdel El-Meouch; Faouarat Jaafar; Biret Ech-Chouf; Chourit; Kfar hay; Kfar Niss; Brih; El-Werhaniyeh; Fraudis Ech-Chouf; Aain Zhalta; Baaqline; Aainbal; Aathrine; gharifeh Hasrout; Moukhtara; botmeh; Aain Qania; Jdeidet Ech-Chouf; Niha El-Chouf; Aain Ouzain; Baadarane; Khereibet Ech-Chouf; Aammatour; Kahlouniet Ech-Chouf; Haret Jandal; Mazraat Ech-Chouf; Kfar Nabrakh; Mristi; Batloun; Maasser Ech-Chouf; Jbaa Ech-Chouf; Bater; Barouk; Bayqoun |
| Mount Lebanon | Aley | Aaley; El-Kamatiyeh; aain erroumaneh aaley; Bmakine; Bkhichtay; Ghaboune; aain el jdideh aaley; Behouara; Souq El-Gharb; Bteezanieh; El-Rejmeh; Keyfoun; Chimlane; Kfar Aamay; Bayssour Aaley; Douair El-Roummane; Rouayssat En-Naamane; Mejdlaiya; Aaynab; Chartoun; bou zrideh; Dfoun; Richmaiya; Aain Traz; Selfaya; Rimhala; Binnay; Aain Ksour; Jisr El Qadi; Bhamdoun El-Mhatta; Bhamdoun Ed-Dayaa; Chanay; Btalloun; Majdel Baana; Saoufar; Aain El Halazoun; Bedghan Oua Ouadi Bedg Bedghan Oua Ouadi Bedg; Homs Oua Hama; Mansouriyet Bhamdoun; Mchekhti; Charoun; Btater; Ighmid; EL-Azouniyeh; El-Mechrefeh; Habramoun; Bserrine; El-Ramliyeh; Maasrati; Mazraat En-Nahr Aaley; Mrayjat Aaley |
| Mount Lebanon | Kasrouane | Litige; Aajaltoun; Daraiya Kesrouane; Jdaidet Ghazir; Ghosta; Maarab; Dlebta; Aaramoun Kesrouane; Kfour Kesrouane; Ghidras; Harharaya; Bzoummar; souhoum el ghineh, aain abeaal; Hsayn; Hayata; Chahtoul; zaaitre; Jouret E-Tourmos; Jouret Mhad; Aazra ouel Aazr; jaayel ghbaleh, mashhat; Jouret Bedrane; El-Mradiyeh; Nahr Ed-Dahab; yahchouch; Eghbeh; Rayfoun; Qleiaat Kesrouane; Mazraat Mrah El-Mir; Aachqout; Faytroun; Beqaata Aachqout; Raachine; Kfar Dibiane; Beqaata Kanaan; Kfar Tay Kesrouane; Kfar Tay Kesrouane; Bqaatouta; Ouata El-Jaouz; Mayrouba; aain el delbeh kesrwan; Mghayer; Chouane |
| Mount Lebanon | Jubail | Ehmej; Almate El-Chemaliat; Mazraat El-Maaden; Almate El-Jenoubiat; Tourzaiya; Ferhet; Michmich Jbayl; Souanet Jbayl; aain el delbeh jbeil; Frat; Kfar Baal; Hjoula; Aain Jrain; Hsoun; Mechane; Lehfed; Habil; Jouret El-Qattine; Birket Hjoula; Adonis Jbayl; Ras Osta; Bichtlida; Haqel; Kharbet Jbayl; Qottara Jbayl; Sebrine; Aabaydat; Mayfouq; Bayzoun; Qartaba; janneh; Lassa; Qorqraiya; Boulhos; Qahmez; Saqi Richmaya; Jaj; Tartij |
| North | Zgharta | Beslouqit; Aintourine; Aarbet Qozhaiya; Toula Zgharta ; Mazraat Et-Teffah ; Bhairet Toula; Ayto; Miziara; Seraal; Ijbaa |
| North | Batroun | Masrah; Douq; Mar Mama; Mehmarch; Aalali; Racha; Mrah El-Hajj; Assia; Nahla; Douma; Bcheaali; Beit Chlala; Deir Mar Youhanna; Bechtoudar; Kfar Hilda; Kfour El-Aarbi; Ram El-Batroun; Hadtoun; Tannourine Et-Tahta; Hardine; Beit Kassab; Deir Billa; Niha El-Batroun |
| North | Akkar | Daouret Aakkar; Aaiyat; Aain Yaaqoub; Bezbina; Aakkar El-Aatiqa; Beit Younes; Sadaqa Hrar; Khreibet Aakkar; Qraiyat; Beit Ayoub; Michmich Aakkar; Qornet Aakkar; Fnaydeq; Tshea; Menneaa; Cheikhlar; Rmah; Kfar Noun; bardeh, beit jaalouk; Khirbet Er Remmane; Sindianet Zeidane; Mounjez; Qsair Aakkar; Biret Aakkar; Aaouaainat Aakkar; Khalsa; Machta Hammoud; Mazraet-El-Nahrieh; Qbaiyat Aakkar; Aandqet; Dayret Nahr El-Kabir; Aamayer; Hnaider; Kneisset Hnaider; Mazareaa Jabal Akroum; Qarha Aakkar |
| North | Bcharre | Qnayouer; Billa; Aabdine; Tourza; Qnat; Mazraat Bani Saab; Berhalioun; Ouadi Qannoubine; Mazraat Aassaf; Blaouza; Moghr El-Ahoual; Metrit; Beit Menzer |
| North | Minieh-Danieh | Sir; Aassoun; Mazraat Ketrane; qattine-md; Bqarsouna; El-Hazmieh; tarane; Mimrine; haql el aazimeh; Beit El-Faqs; Mrah Es-Sfire; aain ettineh-md; Kharnoub; sfireh; Qarsaita; Izal; Qemmamine; Karm El-Mohr; Qraine; Hawara; Beit Haouik; Jayroun; Aaymar; Zaghartaghrine; Behouaita; Kahf El-Malloul; Jarjour; Bechehhara; Qarne; Mazraat El-Kreme; Kfar Bibnine |
| South | Jezzine | Jezzine; Wadi Jezzine; Qabaa Jezzine; qaytouleh, mrah bou chdid, tayoun; Bkassine; homsiyeh; Aaray; Sabbah; Haytoura; El-Ghabbatieh; Benouati Jezzine; Maknounet Jezzine; Btedine El-Leqch; Roummanet; machmoucheh; Midane Jezzine; Jabal Toura; kfar houne, mazrat btediniye, mza; Harf Jezzine; Baba; Zhilta; Bhannine; Aazour; Taaid; Bisri; Mazraat Er-Rouhbane; Saydoun; Roum; Hidab; Deir El Qattine; Sanaya; Mazraat El-Mathane; Srayri; Aaramta; Mlikh; Rihane Jezzine; Mazraat; Qatrani; Louayzet Jezzine; Mazraat Khallet Khazen; Mazraat Qrouh; Mazraat Zighrine Jezzi; Chbail; mazrat louzid (awzieh); Soujoud; aaychiyeh, mazrat souwairi; mazrat wazaiyyeh; wardiyeh; Mazraat El-Aarqoub; El-Mahmoudiyeh; Jarmaq; Mazraat Daraya; El-Demachkiyeh; Mazraat Tamra; Bouslaya |
| Nabatiye | Hasbaiya | Hasbaiya; Abou Qamha; Aain Jarfa; Fardis Hasbaiya; Rachaiya El-Foukhar; Kfar Hamam; hebbarieh; Chouaya Hasbaiya; Aain Qinia; Meimes; Chebaa; marj ezzouhour (hawsh qinnabe); Kaoukaba Hasbaiya; Salaiyeb; Bourghos; Meri; Kfar Chouba; Khalouet Hasbaiya; Kfayr Ez-Zait; majidieh, khirbet doueir hasbayya; dellafeh; Khreibet Hasbaiya |

* 1. ***Climatic Zone 3: Inland***

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| **Mohafaza** | **Qadaa** | **Real-estate District** |
| Bekaa | Zahle | All |
| Bekaa | West Bekaa | All |
| Bekaa | Baalbek | Baalbek; Aain Bourday; Douris; Iaat; Aadous; Haouche El-Tal Safyat; Taibet Baalbek; Majdaloun; Haouche Barada; maqneh; haouch El-Dehab; saaideh; Jebaa; Kfar Dane; Hadath Baalbek; Ras Baalbek Es-Sahel; Fekehe; Aain Baalbek; Bajjaje; Nabi Osmane; Ras Baalbek Ech-Charqi; Al-Labouat; Zabboud; Qaa Baalbek; Deir Mar Maroun Baalbek; Moqraq; Qaa Wadi El-Khanzir; Qaa Baayoun; Sbouba; Al-Qa Jouar Mekie; Chaat; Qarha Baalbek; Ram Baalbek; Youmine; Deir El-Ahmar; Kneisset Baalbek; Bechouat; Riha; Dar El-Ouassaa; Btedaai; Bednayel Baalbak; Qsarnaba; Temnine El-Faouqa; Beit Chama; Haouch Er-Rafqa; Misraya; Slouqi; Temnine Et-Tahta; Kfar Dabach; Chmistar; Haouch En-Nabi Chite; Haouch Snaid; Taraiya; Serraaine Et-Tahta; Talia; Hizzine; Khodr Baalbek; Nabi Chit; Jenta; Kharayeb El-Hermel; Yahfoufa; Haour Taala; Brital; Khreibet Baalbek; Bouday; Chlifa |
| Bekaa | Hermel | Hermel; Ras Baalbek Wadi Faara |
| Bekaa | Rachiaya | Rachaiya el wadi; Aaqabet Rachaya; Bakkifac Rachaya; Dahr El-Ahmar; Beit Lahia; Tannoura; Kfar Denis; mhaydseh rachaya; Kaoukaba Bou Arab; Aain Rouha; Khirbet Rouha; Kfar Lichki; Rafid Rachaiya; hawsh qinnabe, mazraat jaafar; Biret Rachaiya; Aain Aarab Rachaiya; Aain Aata; Majdel Balhis; Mdoukha; Yanta; Aayta El-Foukhar Nabi Safa |

* 1. ***Climatic Zone 4: High Mountain***

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| **Mohafaza** | **Qadaa** | **Real-estate District** |
| Mount Lebanon | Baabda | Hammana; Khalouat Baabda; Falougha; Kfar Selouane; Tarchich |
| Mount Lebanon | El Metn | Mtain; Mchikha; Aintoura El-Matn; Majdel tarchich; Baskinta; Kfar Tay El-Matn |
| Mount Lebanon | Aley | Aain Dara; Bmahray |
| Mount Lebanon | Kasrouane | Hrajel; Faraya; Mchaa Kfar Dibiane; Mchaa Faraya; Mchaa El Ftouh |
| Mount Lebanon | Jubail | Mar Sarkis; aain el ghouaybe; Mazraat Es Siyad; Hdeine; Seraaiita; Ghabat; mghayre jbayl; Yanouh Jbayl; Majdel El-Aqoura; Laqlouq; Afqa Jbayl; Aaqoura; Aarab El-Lahib; Hema Mar Maroun Aannaya; Hema Er-Rehban; Aarasta |
| North | Zgharta | Ehden; Kfarsghab |
| North | Batroun | Chatine; Ouata Houb; Tannourine El-Faouqa |
| North | Bcharre | mchaa ej jibbeh; bcharre; hadath ej jebbeh; Bane; Breissat; Dimane; Hasroun; Hadchit; Bazaaoun; Bqerqacha; Bqaa Kafra |
| North | Minieh-Danieh | Bqaa Sefrine; Bechnnata; Mrebbine |
| Bekaa | Baalbek | Aamchki; nahleh baalbek; Aain Es-Siyaa Chadoura; Aarsal; Halbata; Harabta; Nabha Ed-Damdoum; Barqa; Aaynata Baalbek; yammoune; Mazraat beit Mchaik; Maaraboun; Ham; Aain El-Barnaya; chaaibe; Nabi Chbay; Aain Ej-Jaouz Baalbek; Tfail; Ouadi El-Aaoss |
| Bekaa | Hermel | mchaa marjhine, saaidiy; Zighrine; Charbine El-Hermel; Ras Baalbek El Gharbi; Ouadi Faara; Hermel Jbab; Maaysra El-Hermel |
| Bekaa | Rachiaya | Rachaiya el wadi; Aayha; Kfar Qouq; Bakka; Yanta; Deir El-Aachayer; Selsata; Helouet Rachaiya |

***\*Source: TSBL – Climatic Zoning 2005***

1. **Tilt Angle Conversion Table**

*Transposition Factors for Beirut (Lebanon)*

|  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| **Tilt** | **Azimuth** | **Jan.** | **Feb.** | **Mar.** | **Apr.** | **May** | **June** | **July** | **Aug.** | **Sep.** | **Oct.** | **Nov.** | **Dec.** | **Year** |
| 0° | +/- 0° | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 |
| 15°  15°  15°  15° | +/- 0°  +/- 30°  +/- 60°  +/- 90° | 1.24  1.20  1.11  0.99 | 1.19  1.16  1.08  0.99 | 1.11  1.09  1.05  0.99 | 1.04  1.04  1.02  0.99 | 1.01  1.00  1.00  0.99 | 0.98  0.98  0.99  0.99 | 0.99  0.99  0.99  0.99 | 1.03  1.03  1.01  0.99 | 1.10  1.08  1.04  0.99 | 1.18  1.15  1.08  0.99 | 1.25  1.21  1.12  0.99 | 1.30  1.25  1.14  0.99 | 1.08  1.07  1.03  0.99 |
| 30°  30°  30°  30° | +/- 0°  +/- 30°  +/- 60°  +/- 90° | 1.41  1.35  1.17  0.96 | 1.31  1.26  1.12  0.95 | 1.17  1.13  1.06  0.95 | 1.03  1.02  1.00  0.94 | 0.96  0.96  0.96  0.94 | 0.91  0.92  0.94  0.94 | 0.93  0.94  0.95  0.94 | 1.01  1.01  0.99  0.94 | 1.13  1.10  1.04  0.94 | 1.29  1.24  1.11  0.95 | 1.43  1.36  1.18  0.95 | 1.52  1.44  1.23  0.96 | 1.10  1.08  1.03  0.94 |
| 45°  45°  45°  45° | +/- 0°  +/- 30°  +/- 60°  +/- 90° | 1.51  1.42  1.18  0.90 | 1.36  1.29  1.11  0.89 | 1.16  1.12  1.02  0.88 | 0.97  0.97  0.94  0.88 | 0.87  0.88  0.89  0.86 | 0.80  0.82  0.86  0.86 | 0.82  0.84  0.87  0.86 | 0.93  0.94  0.92  0.87 | 1.10  1.07  1.00  0.88 | 1.32  1.26  1.10  0.89 | 1.53  1.44  1.19  0.89 | 1.66  1.55  1.25  0.91 | 1.07  1.05  0.98  0.88 |
| 60°  60°  60°  60° | +/- 0°  +/- 30°  +/- 60°  +/- 90° | 1.53  1.41  1.14  0.83 | 1.34  1.25  1.05  0.81 | 1.09  1.04  0.94  0.80 | 0.86  0.86  0.85  0.79 | 0.73  0.75  0.78  0.77 | 0.65  0.69  0.75  0.77 | 0.68  0.71  0.76  0.77 | 0.81  0.82  0.83  0.78 | 1.02  0.99  0.91  0.79 | 1.29  1.21  1.04  0.81 | 1.55  1.43  1.14  0.82 | 1.70  1.56  1.22  0.84 | 0.98  0.96  0.90  0.79 |
| 90°  90°  90°  90° | +/- 0°  +/- 30°  +/- 60°  +/- 90° | 1.31  1.18  0.90  0.62 | 1.08  0.98  0.80  0.60 | 0.78  0.75  0.68  0.57 | 0.53  0.57  0.60  0.57 | 0.37  0.44  0.53  0.54 | 0.29  0.38  0.50  0.54 | 0.31  0.40  0.50  0.53 | 0.45  0.51  0.57  0.56 | 0.69  0.68  0.65  0.56 | 1.00  0.92  0.78  0.59 | 1.31  1.17  0.89  0.59 | 1.50  1.34  0.98  0.62 | 0.66  0.67  0.64  0.56 |
| **Tracking**  **Tracking** | 2-axis  Axis=latit. | 1.76  1.69 | 1.63  1.60 | 1.46  1.46 | 1.36  1.34 | 1.35  1.29 | 1.36  1.28 | 1.36  1.28 | 1.41  1.38 | 1.45  1.44 | 1.65  1.64 | 1.81  1.74 | 1.94  1.83 | 1.48  1.83 |

***\*Source: PVSyst Software.***