Feasibility study Part 1:
Site survey preparation & planning

to RWE
and the Global Sustainable Electricity Partnership (GSEP)

Solar PV and additional wind for the Galapagos Islands

Integrating further renewables and storage in San Cristobal Island energy mix to reduce their dependence on diesel fuel and subsidies.

Document	**Feasibility Study Part 1 Report: Site survey preparation & planning**		
Prepared by:	Emeline Platel	**Date:**	16th June, 2016
Received by:		**Date:**	

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2. Introduction

In the 1990s, the United Nations (UN) and the Republic of Ecuador developed a plan to substitute energy produced from diesel generators with renewable energy. In January 2001, after the Jessica Tanker Ship spilled thousands of gallons of fuel oil and diesel that it was delivering to the islands, the Global Sustainable Electricity Partnership (GSEP) was asked by the UN to lead the mission towards a sustainable future.

This led GSEP to launch the Global Sustainable Electricity Partnership San Cristobal Wind Project. The project was commissioned in 2007 within the framework of the co-operation between the Government of the Republic of Ecuador, GSEP founders, the United Nations Foundation (UNF), external benefactors and world-wide private partners. The successful operation of the 2.4 MW wind farm on San Cristobal has provided 30% of the island power demand over the last 8 years.

As a second phase of this successful initiative to support of the President of Ecuador's declaration in February 2008, where he expressed his desire to roll out carbon-free power generation in Galapagos, GSEP is looking at integrating further renewable power capacity on the Galapagos Islands. RWE as one of the project leaders within the GSEP, has asked Enerwhere Sustainable Energy, a solar-hybrid solutions provider based in the Middle East, to identify and assess the potential for integration of additional solar PV, wind power and storage into the San Cristobal island energy mix.

Enerwhere has extensive expertise in the integration and management of stand-alone hybrid systems in remote locations. With their experience and the guidance of RWE, Enerwhere will consult on different options such as solar PV field configurations (fixed tilt vs. tracking systems), the addition of a fourth wind turbine and the financial viability of integrating storage into the system to push the share of renewables even further.

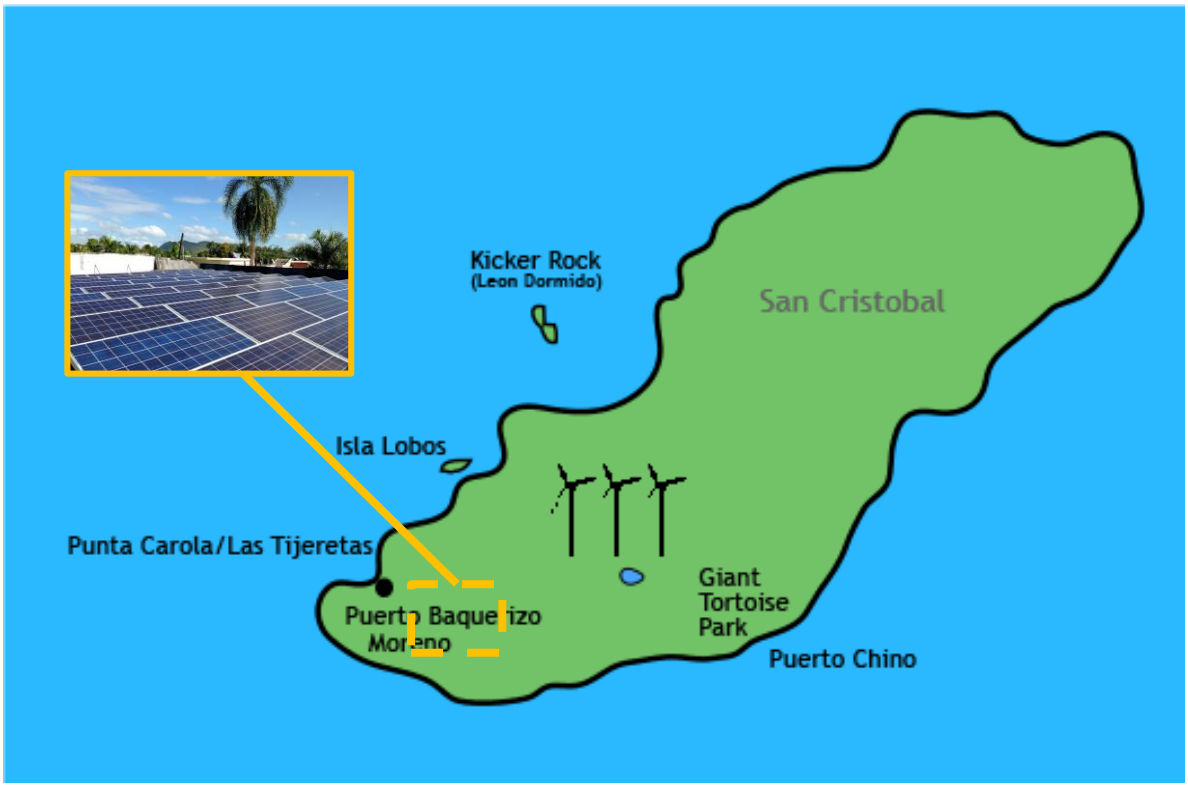


Figure 1: Diesel-wind-solar hybrid powered grid on San Cristobal (as of 2016).

3. Objectives of the site survey

Based on a preliminary analysis of the digital data set provided by ELECGALAPAGOS / EOLICSA, through RWE, Enerwhere has identified potentials for the integration of about 700 to 1,700 kWp solar PV (without storage). The solar field and fourth wind turbine sizing and financial viability depend on a number of factors which are mainly the electricity demand profile (day-time versus night time demand in the case of sizing of the solar PV field for instance), the present electrical network and the island-specific constraints.

The objective of the site survey is to collect the missing information regarding the following open topics:

- Electricity market and regulatory frameworks

The commercial viability of any renewable project with high capital investment is determined by the financial scheme and their stability in time (subsidies, taxes, exemptions, etc.). Study of the Phase 1 project viability and learnings is a very valuable base for the feasibility study of the second phase.

- Specific logistics and environmental limitations

Due to the extreme remote location of the project, logistics and local capacities are constraints that need to be assessed early on and accounted for in both the budget and the technical design of the systems. During the site visit, time is allocated to meet potential contractors and partners who have already experience working on the Galapagos Islands.

- Diesel generator plant efficiency

As per Enerwhere's experience with mini-grids, improvements of the diesel generators efficiency can lead to significant fuel savings at low investment costs. As the first objective of this entire project is to displace fuel consumption, Enerwhere assessment will start with an analysis of fuel savings potentials at the diesel generator plant itself.

- Integration and hybridization of additional generation capacity into the current system

The already high wind power production on the island raises the question of smart hybrid control philosophy between the diesel, wind and solar systems and therefore the question of setting priorities and curtailment to renewable power generation to keep to the minimum on-line diesel requirements. Understanding the current protection and hybrid control setup and their integration into a more complex system is an important objective of the site survey as it impacts the sizing of the solar, wind and battery systems as well as the financial viability of the project.

4. San Cristobal island specificities

4.1 The Galapagos' electricity market and its main stakeholders

Enerwhere has been asked to look into the commercial viability of the project under a suite of different project financing schemes promoting public-private partnerships. With this in mind, the consultants have on their agenda 2 days of meetings with the key stakeholders of San Cristobal power sector: ELECGALAPAGOS, Eolica San Cristobal S.A (EOLICSA) and if possible, San Cristobal Mayor.

The discussions will cover the following main topics:

- The tariff structure in place
- The regulatory framework set by the National Electricity Council (CONELEC) and the Internal Revenue Service (SRI)
- The local authorities agendas for the short and long-term horizons on the Galapagos islands
- Potential partners for the 1 MW solar PV and the fourth wind turbine projects

4.2 Logistics, local capabilities and environmental limitations

Visits of the main facilities of the island (airport, port, and construction companies if any) are to be performed to gather information about logistic costs (sea transportation, port handling fees, etc.), and the local capacities on the island. Relevant parameters to collect are the availability and cost of local manpower, land transportation and construction machinery, or the possibility of mobilizing them from the main land at which cost.

5. Technical Site Survey

Enerwhere allocated two engineers for 3 days to survey the existing power systems and assess the physical integration of additional solar and wind capacity on San Cristobal Island. The open questions and data to be collected are described below for each site. The survey guiding tables are in Appendixes.

5.1 Diesel Generator plant

The Enerwhere team needs to get a precise understanding of the six operating diesel generators and their set up:

- The gensets: their make, models, controllers, number of running hours
- The electrical layout and connections: are the units synchronized, stand alone or isolated to different loads, what equipment is present (totalizing panels, breakers, motorized breakers, transformers…)
- The fuel supply procedure: are the units fed from the same fuel tank or isolated tanks, do the units need to be switched off or alternated for refuelling, what is the current fuel monitoring procedure
- The power production monitoring: what is measured, at which frequency
- Overall space survey: is there space for more or larger units

Figure 2: Existing diesel generator plant on San Cristobal Island

Meetings with the management and operation teams are also required to identify the operation and maintenance costs of the system and the near-future and long-term plans for the power house.

The diesel generator plant survey guiding list is attached as an Appendix to this report. It summarized the data that has to be collected during the site visit of the plant.

5.2 Wind Park (GSEP San Cristobal Island Wind Project – Phase 1)

The existing wind park is located in “Cerro El Tropezón”, San Cristóbal Island. The installations comprise three wind turbines, 800 kW each, manufactured by the Spanish company MADE, TECNOLOGÍAS RENOVABLES S.A. (currently GAMESA group). The transmission line connects the wind park with the substation located at the diesel plant owned by ELECGALAPAGOS S.A.

Enerwhere engineers will visit the wind park and collect information related to the electrical setup and available area for a potential fourth turbine.

Figure 3: Existing 3D rendering of the three wind turbines on San Cristobal Island

5.3 Solar PV fields (existing and potential)

The engineers will visit the two existing PV plants at the generator plant and the school and meet the project engineers in charge in order to gather their insights on the project. They will then visit the potential solar field locations proposed below to check both the ground configuration and the closest connection point into the existing network.

Figure 4: Possible locations for the 1MWp solar installation on San Cristobal Island

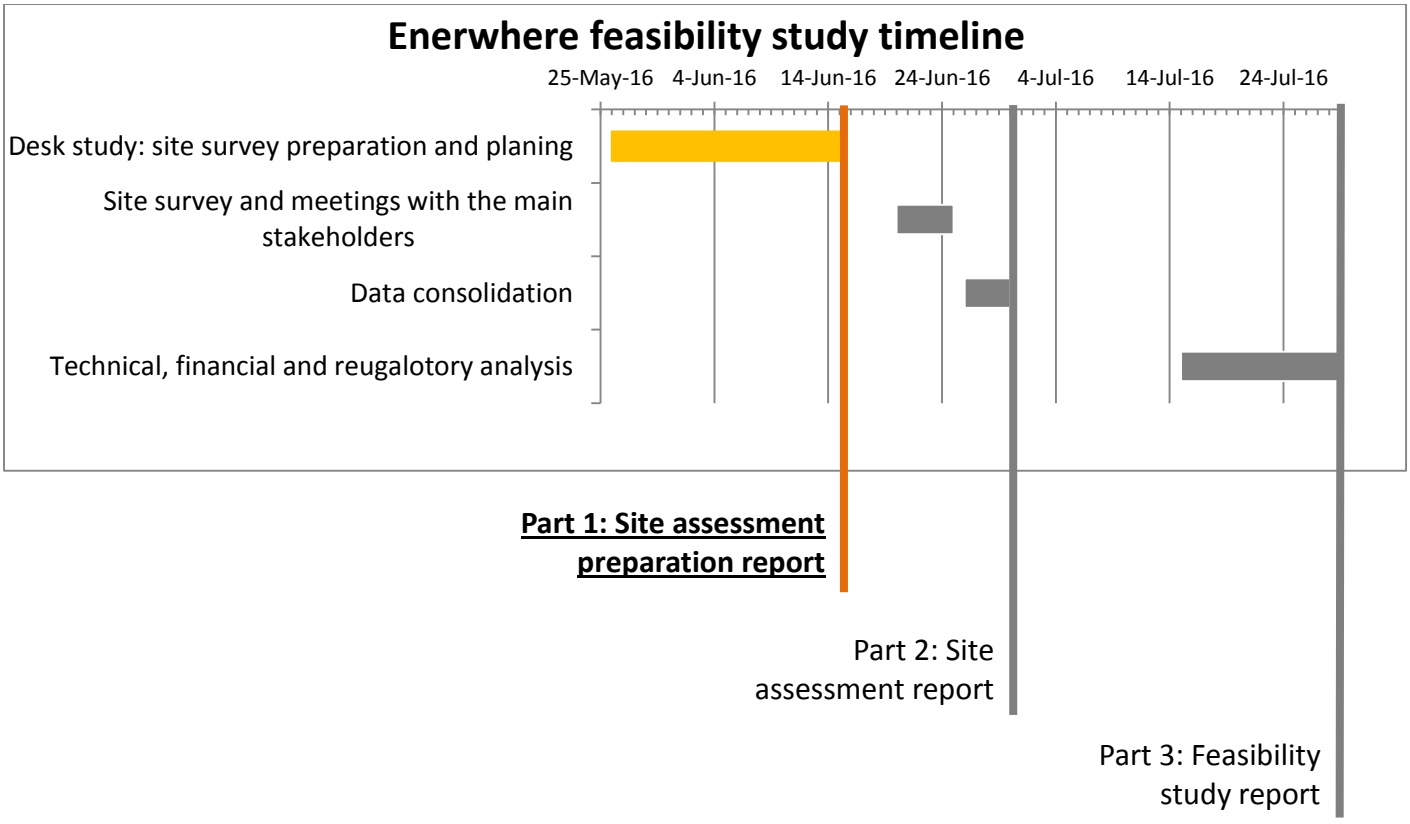
Option Number	Possible Advantages of each location
Option 1	Near the diesel generators, provides easy connection and control point between solar and diesel systems at the low voltage level
Option 2	Seems to be close to a main transmission line which would also be a practical connection point for the 1 MW solar field
Option 3	Near the wind turbines and the existing 13.2 kV transmission line Possibility to use the slope to increase the solar PV yield in the case of single axis trackers

6. Site survey planning

Below is the timetable as proposed and kindly organized by RWE representative in Ecuador.

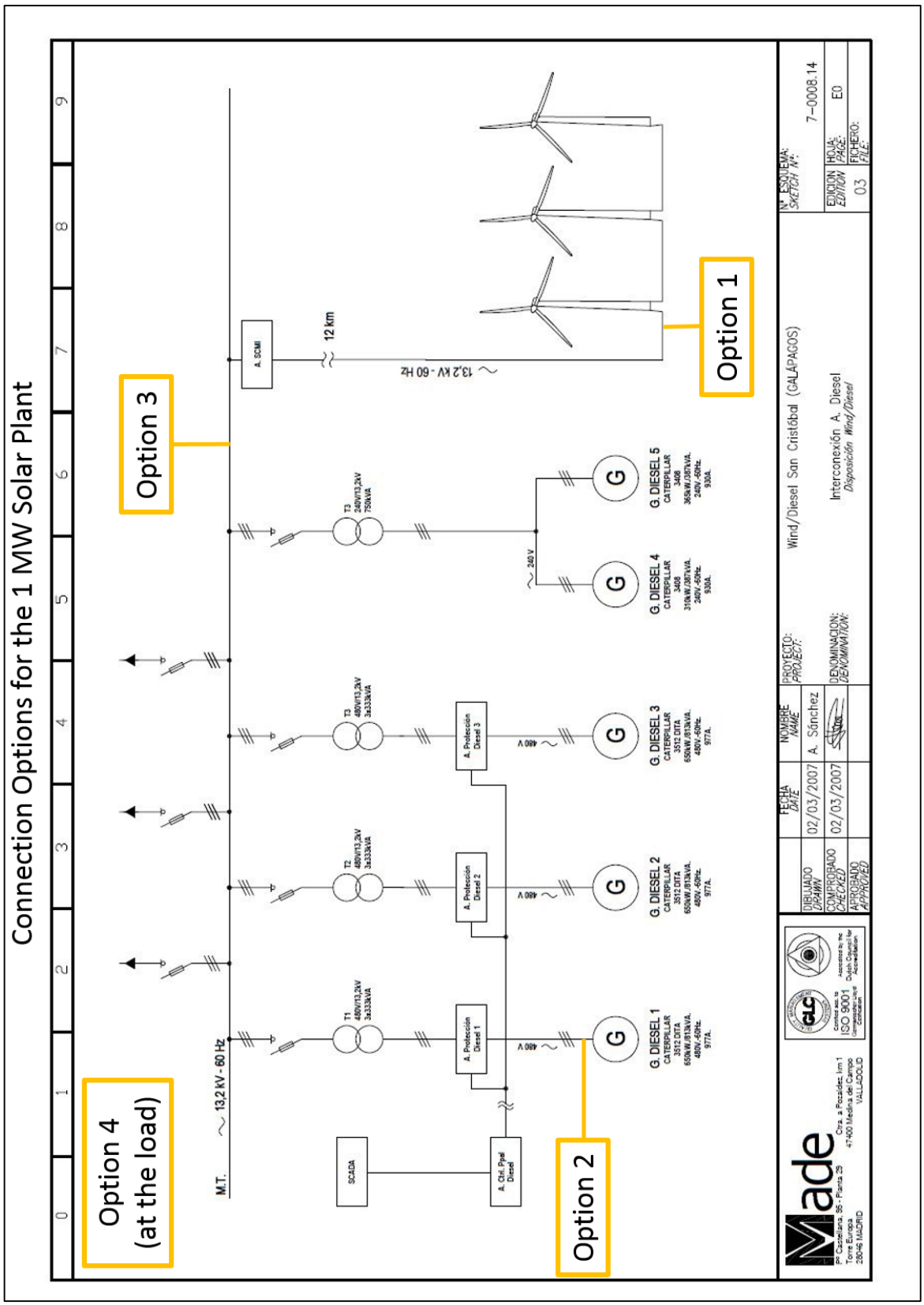
	Morning activities	Afternoon activities
Monday June 20	Introductory meeting with EOLICSA / ELECGALAPAGOS staff Visit the diesel plant / existing PV panels / Hybrid system control room and SCADA system. Discussions about daily operations and maintenance routines	Overall discussion about phase-1 of the wind project and overall context for the implementation of the second phase with solar and additional wind
Tuesday June 21	Visit to wind park and transmission line Visit to proposed new sites for additional wind unit and PV plant	Visit the distribution grid and identify electricity measuring points
Wednesday June 22	Visits to local authorities (ELECGALAPAGOS CEO / San Cristobal Mayor / Governor) (to be confirmed)	Summing up
Thursday June 23	Tour of the main facilities/electricity consumers on the island (Hospital and airport)	Flight San Cristobal - Quito
Friday June 24	Meetings with contractors in Quito	Departure to Dubai

Overall consulting project timeline and milestones:



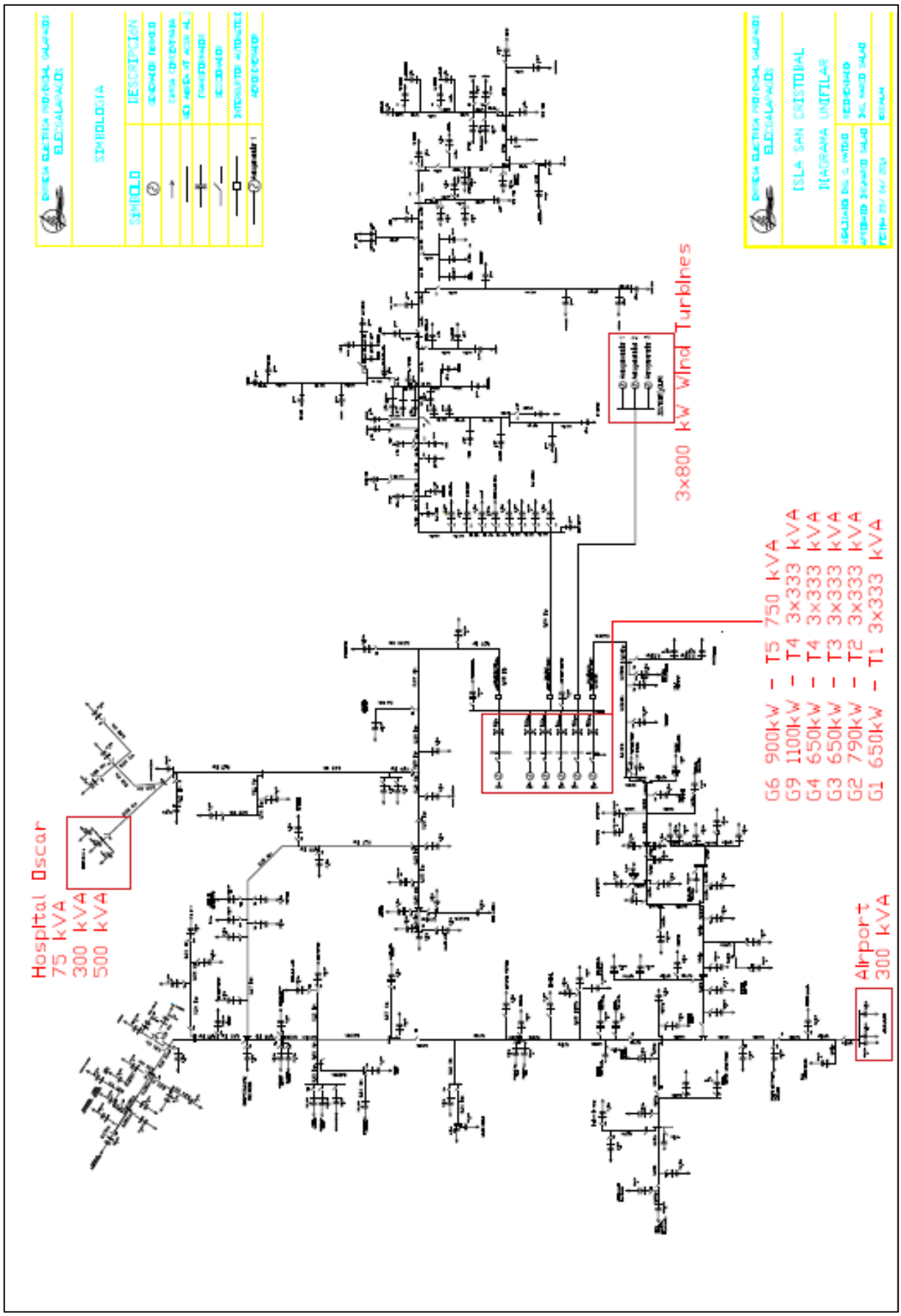
7. Appendixes

7.1 Connection Options of 1 MW Solar PV Plant



7.2 San Cristobal Island Single Line Diagram

Power generation systems and main consumers



7.3 Diesel generator plant survey list

	DG1	DG2	DG3	DG4	DG6	DG9
DG Type, model and prime capacity (kVA)	CATERPILLAR	PERKINS	CATERPILLAR	CATERPILLAR	MTU	CATERPILLAR
Engine Model and prime capacity (kVAm)	3512 DITA	PS1386E	3512 DITA	3512 DITA	16V2000 S52	3516
Breaker type and capacity (A)						
Transformer type and capacity (kVA)						
DG Controler type and operating mode (Sync/Auto/Manual)						
Maintenance, overhaul and replacement frequency						
Running Hours, next overhaul/replacement due date						
Maintenance (& depreciation) costs						
Overhaul/replacement cost						
Additional comments, problems encountered (type, frequency, cost)						

7.4 Wind power plant survey list

	3 Wind Turbines
Wind Farm Capacity (kWp)	3x800 kW = 2,400 kW
Developer	EOLISCA
Owner	ELECGALAPAGOS S.A.,
O&M Contractor	
Wind Turbine Module	MADE AE-59, class III-A, 800 serial
Generator Type	Synchronous three-phases
Maximum Active Power (kWac)	880
Transformer type and capacity (kVA)	
Mains Voltage	1000 V
Cycle Converter Type	
Maximum Active Power kW	840
Installation requirements (specific equipment, timelines)	
Additional notes, problems encountered (type, occurrence, cost)	

7.5 Solar PV Fields Survey List

	Central Termica	School
Developer	SolarQuest	SolarQuest
Owner		
O&M Contractor		
Solar PV field capacity (kWp)	5.088	6.36
PV Modules	Siemens - 53 WATTS (M55)	Siemens - 53 WATTS (M55)
Solar inverter capacity (kWac)		
Inverter(s) make and model	Sunny Boy SMA SB6000U	Sunny Boy SMA SB6000U
Connection Point (Breaker Rating, Voltage Level, Nearest Transformer)		
Configuration	Fixed Tilt	Fixed Tilt
Azimuth (S)	184°	112°
Tilt Angle	3°	3°
Cleaning Frequency		
Cleaning Cost		
Performance results (if known)		
Additional notes, problems encountered (type, occurrence, cost)		

7.6 Logistics and Construction Works Survey List

Items	Unit	Cost
Sea Transportation	USD per container per trip: Guayaquil-San Cristobal	
Handling fees	USD per container	
Taxes	USD and/or % of equipment value	
Land transportation	USD per container trip: Port-Project site	
Truck	USD per day or per month	
JCB	USD per day or per month	
Crane	USD per day/month for different capacity (25-ton; 50-ton; 100-ton;…)	
Other construction equipment	USD per day or per month	
Manpower (Electrician, technician, Supervisor)	USD per day or per month	
Accommodation	USD per man-day/man-month	
Site Office	USD per month	

Feasibility study Part 2:
Site survey data consolidation

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Solar PV and additional wind for the Galapagos Islands

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1. Introduction

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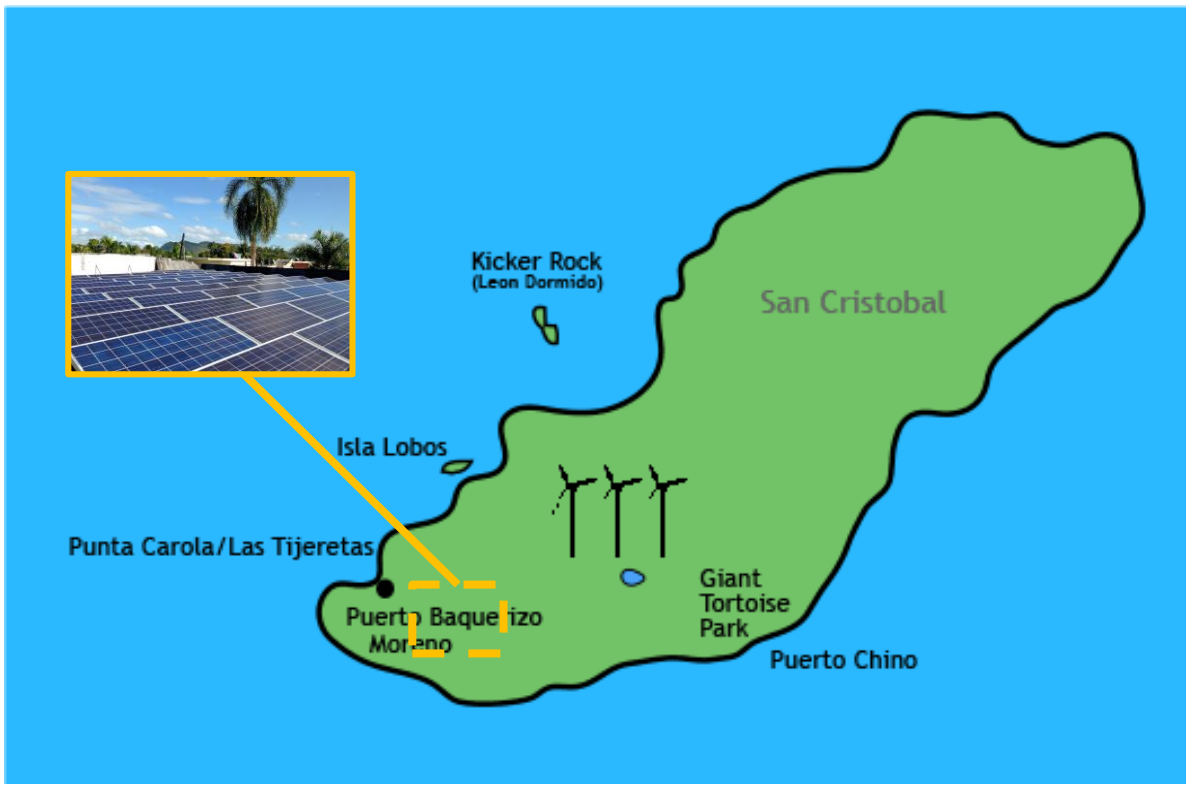


Figure 1: Diesel-wind-solar hybrid powered grid on San Cristobal (as of 2016).

2. Context and objectives

The site survey allowed Enerwhere team to build a deeper understanding of the project context, key objectives and main challenges.

2.1 Renewables in Ecuador and the particular case of the Galapagos archipelago

The Ecuadorian government has set the explicit objectives of promoting clean and alternative energy sources in 2008 Constitution. The target of reaching 60% renewable energy generation capacity by 2017 was further defined in the National Plan for Good Living 2013-2022. The majority of this renewable share is to be covered with 25 hydropower projects to reach about 4.2 GW of new capacity in 2020.[1]

With the commissioning in 2016 of the Coca Codo Sinclair hydroelectric facility, the he largest energy project in Ecuador's history, 1.5 GW of additional capacity is already online.[2]

Within the last decade, a few attempts were given to the promotion of other renewable sources. There was even the start in 2011 of a very attractive feed-in tarrif for solar PV and ocean power systems (USD 40-44.77 cts per kWh). This highly profitable market could however not be sustainably supported by the government and was abandonned two years later, except for small PV plant under 1 MWp which are currently in operation. [1]

In 2016, ARCONEL Resolution 031/16 limits the development of renewable energy projects to specific cases that have not yet been defined. Details are to be given in the coming By Law which publication date is not yet known. Electricity generation on the Galapagos archipelago will certainly be part of the sepcific cases for which renewables will be promoted, however it is not clear how.[3]

Indeed, if the main land benefits competitive hydropower generation, the Galapagos archipelago still relies mainly on diesel generators generating power at a unit cost of about USD 40 cts per kWh.[4] ELECGALÁPAGOS S.A. is operating at a considerable deficit while selling electricity at the national tariff of USD 12 cts per kWh (blended average for the Galapagos Islands). This deficit is currently shared between all Ecuadorian consumers through an artificial electricity tariff increase.

The successful Global Sustainable Electricity Partnership San Cristobal Wind Project commissioned in 2007, was responsible for the electricity generation of 21.5% in 2015 on San Cristobal Island. After 8 years of operations, the ownership of the wind park was transferred to ELEGALAPAGOS last March 2016. Since then, and due to the financial structure of the project that was grant funded, ELECGALÁPAGOS S.A. now generates over 20% of San Cristobal electricity demand at a cost of USD 8-9 cts per kWh, which covers only the operations and maintenance of the installation.

[1] IRENA, June 2015. Renewable Energy Policy Brief, ECUADOR.
[2] Coca Codo Sinclair Hydroelectric Project, Ecuador
[3] Discussion with Luis C. Vintimilla C. on San Cristobal Island, in June 2016
[4] Galalpagos electricity costs and tariffs were provided by ELECGALAPAGOS in June 2016, based on subsidized diesel fuel.8

2.2 Objectives and supportive entities to the project

The main objective of any power generation project on the Galapagos Islands is to replace diesel fuel and reduce the environmental risks associated with the transport, storage and burning of fossil fuels.

The Ministry of Electricity and ELECGALÁPAGOS S.A. also have a financial incentive in producing cleaner electricity from alternative energy, as long as it is competitive with diesel fuel and does not disadvantage the cheap wind power generation.

The Global Sustainable Electricity Partnership group is prepared to help ELECGALÁPAGOS S.A., in its plans to move towards the goal of converting the Galapagos into a zero fossil fuels territory.

In addition, the municipality, under the lead of the Mayor, is strongly supportive of all power generation projects that would make San Cristobal island cleaner and more self-sustainable. The use of wind, solar and also the locally available organic wastes as power generation resources are options considered and encouraged by the municipality.

2.3 Main challenges

- Uncertainty towards the evolution of diesel fuel price in Ecuador

With all oil-producing countries around the world, Ecuador is suffering a major revenue drop for the last two years. In that situation, the diesel fuel price can be affected by the reduction or suppression of current subsides for domestic use, and later on by the oil world-market price evolution. As diesel is still the main source of energy on San Cristobal Island, different pricing scenarios have to be modelled and unfortunately there will be a threshold at which diesel will be cheaper than renewable sources of energy. The question of how low and the threshold is and at which probability this price can be reached is to be answered by the study.

- Logistics constraints

The Galapagos Islands are very well known for their constrained accessibility. Only two ferry lines are reaching the archipelago with the necessary goods that are not otherwise locally available. Only small containerized equipment can be shipped on the regular lines. This results in either allocating a special barge just for the project (case of the first three wind turbines) or being able to plan for sequential shipment on a long timeframe. Both options considerably build up the logistics budget. Also, extraordinary long pieces of equipment might simply not be able to offload and handle in the current port and roads in Baquerizo Moreno. Both latter were to be upgraded uniquely for the mobilisation of the first wind park.

- Extreme seasonal variations on the remaining diesel generated energy to be replaced

The already high wind power production on the island artificially raises the seasonal variations on the power demand fed by the diesel generator plant. The objective of integrating further renewables on the island is however to replace the diesel-generated energy only. This technically and commercially challenging as wind generation is both highly variable and highly price competitive in San Cristobal mini-grid. Alternative sources of energy will not be preferred to the wind generation that covers already up to 90% of the load at windy hours of the month of August, when the demand is at its lowest. Curtailment in the offtake will definitely reduce the productivity and commercial viability of the future wind and/or solar facility.

3. Scope and Scenarios Covered by the Feasibility Study

3.1 Diesel generator plant

The diesel generator plant is undergoing renovation. The study will include the assessment of the current and expected fuel efficiency of the system (after commissioning of the new diesel generators) and how it would evolve with the integration of renewables, with good practice guidelines. The replacement and addition or further generators will be considered only in the case of an obvious need for a different generator unit size (generators running too often in minimum load for example).

Figure 2: Installation of two new diesel generators at the thermic plant

Figure 3: Temporary set up of a replacement generator next to the 13.2 kV main substation

3.2 Additional Wind Turbine

Many migration corridors of the protected petrel species have been identified in San Cristobal high lands, where wind resources are the most viable for power generation. As such, the potential locations for wind turbines are very restricted which was already a challenge faced for the first wind park project. Conveniently, there is space available for a fourth wind turbine in the alignment of the existing wind park. This location, approved by the Ministry of Environment in 2001, also has the advantage of reducing the cabling and trenching requirements as the current wind park 13.2 kV line still has capacity to transport another MW of power.

For this study, only the option of adding a fourth wind turbine to the existing wind park and within the existing transmission line capacity will be considered. Also, logistics requirement and expected performance will therefore be estimated on the information collected from the first three turbines installed in 2001.

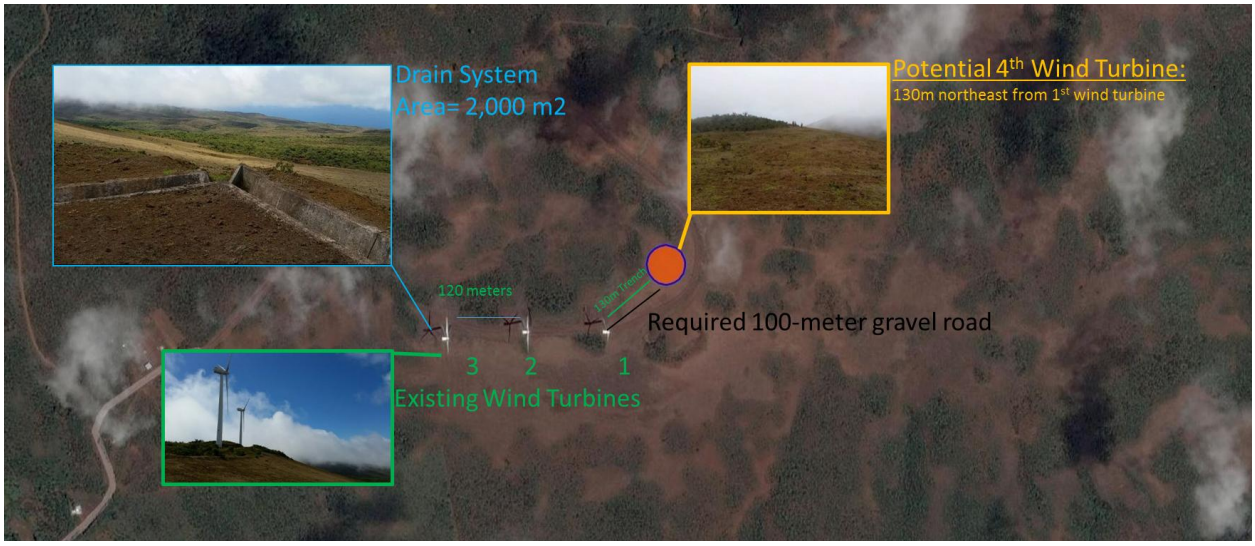


Figure 4: Location of Potential 4th Wind Turbine on San Cristobal Island

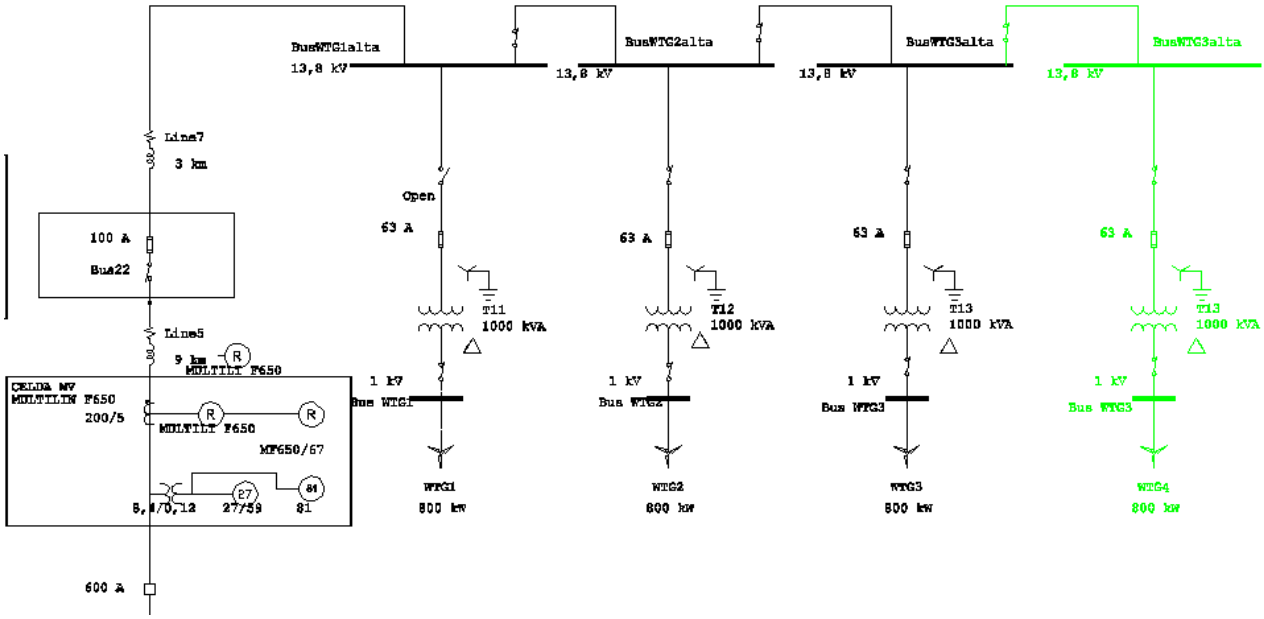


Figure 5: Modified SLD with the Addition of the 4th Wind Turbine

3.3 Solar PV Plant

The feasibility study will assess the viability of integrating a megawatt-scale solar PV plant on San Cristobal Island. The capacities considered will vary between 500 kWp and 2 MWp depending on the storage capacity assumed available for each scenario. Three locations would be readily available for a solar PV field of this size and have been identified as the preferred options on which the feasibility study will be focusing.

Options	Description
PV Option 1: Close to the central substation	The land is owned by ELECGALÁPAGOS S.A. and gave a verbal approval to the usage of the land for the solar PV installation. The area would require only reclaiming work and the extension of the approximately 130meters-away 13.2 kV central substation for the connection of the solar feeder.
PV Option 2: Former waste disposal area	This plot is owned by the municipality and was previously used as a waste disposal area. Therefore, it is crucial to reclaim the land and clearly set the responsibilities of the municipality regarding all activities hold on the ground before the installation of the solar plant. The solar feeder could then be connected to the 130meters-away wind park transmission line.
PV Option 3: Area closer to the airport	As per the solar radiation measured at the two existing solar system located at the school and at the central diesel generation plant, it appears that the solar irradiation is higher closer to the shore, and therefore to the consumers. However, it was found that there is not enough space near the hospital for a solar installation and the multiple locations near the airport are already affected to further urban developments.

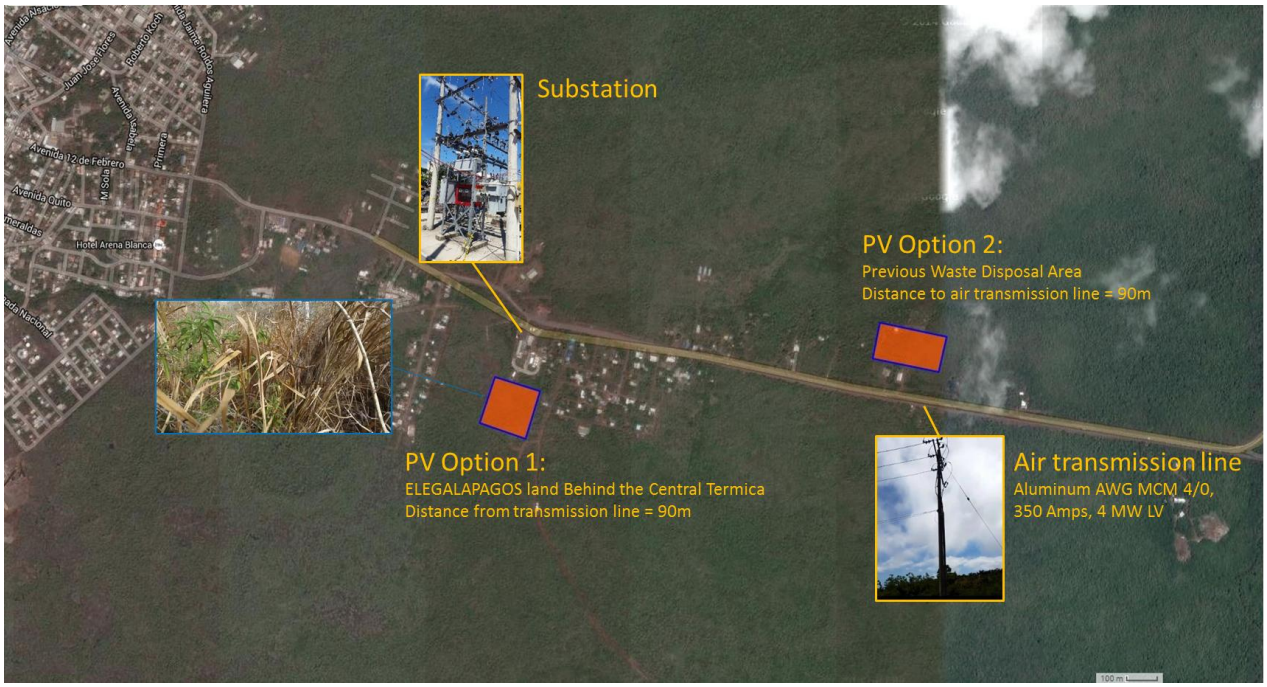


Figure 6: Proposed locations for the solar PV field (Options 1 and 2)

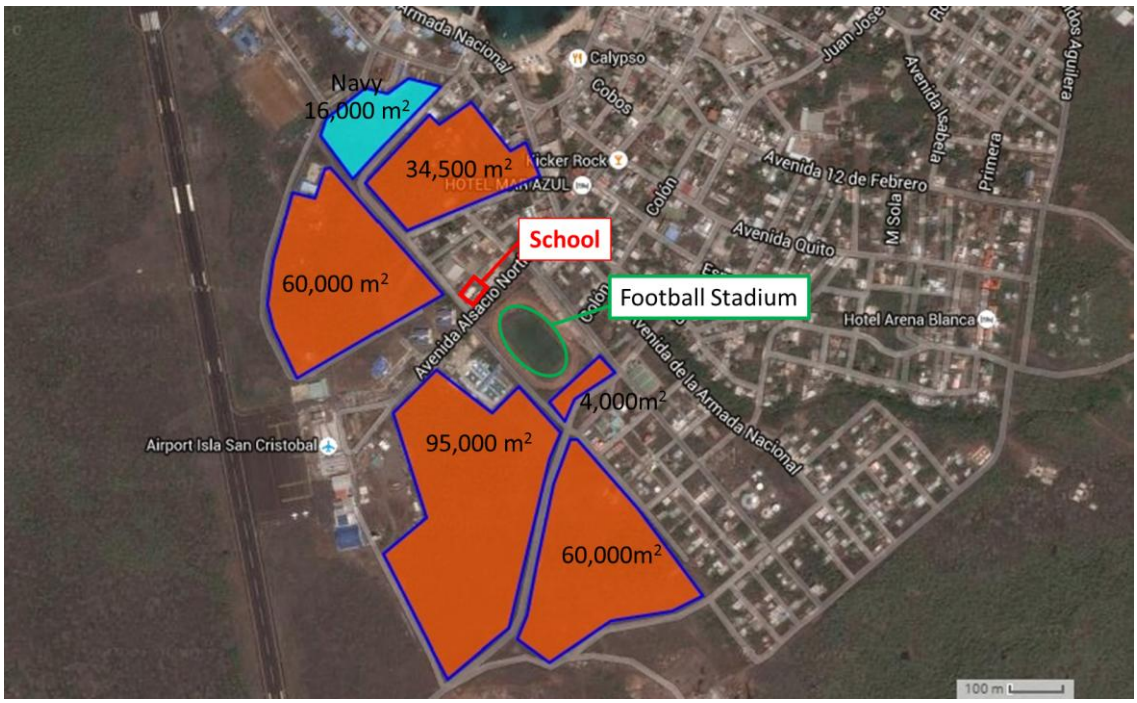


Figure 7: Proposed (but so far rejected) locations for the solar PV field (Option 3)

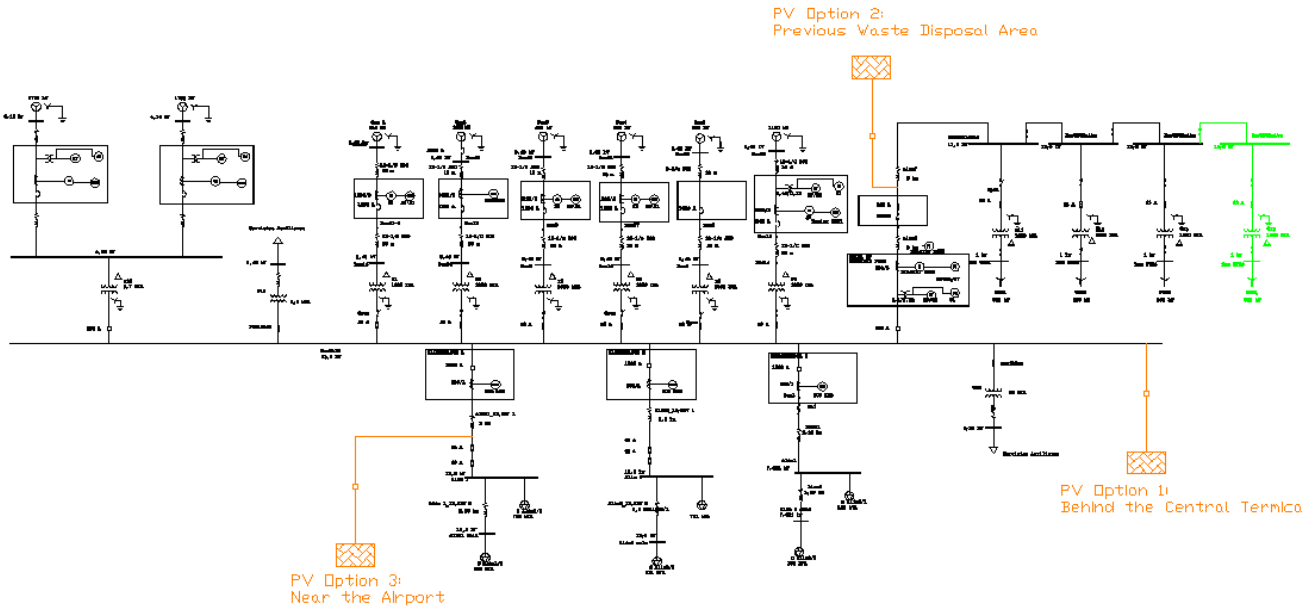


Figure 8: Modified SLD with proposed connection points for the solar PV field.

Due to the strong similitudes between locations option 1 and 2 both in size and distance to the nearest 13.2 kV connection point, the solar PV plant can be modelled in both cases based on the following asumptions:

- 20,000 to 50,000 m2 area available
- Both options of fix tilt (East-West rows) and single-axis tracking system (North-South row)
- Use of outdoor-rated string inverters with central or multiple AC combiner(s)
- Step-up transformer on the site of the solar field
- 130 meters transmission line to the connection point, with necessity to extend the bus

3.4 Storage system

Storage could play two different roles in the wind-solar-(diesel) power system:

- Buffering the variations of load, wind generation and solar generation to reduce or replace the required spinning reserve from the diesel generator plant
- Storing wind and/or solar surplus production and release it later in the day.

For both those application, the storage technology needs to be able to charge and discharge at a high C rate as both solar and particularly wind production are highly variable within minutes. As such, Lithium Iron Phospate (LiFePO4) batteries are the preferred technology for the integration on this project. Storage of 500 kWh to 2,500 kWh will be considered for the study and can be coupled with different battery inverter capacities (500-1,500 kW) according to the maximum instantaneous power requirements.

3.5 Small organic waste valorisation facility

Assessment of the potential power generation from municipal wastes and waste water treatment sludge.

3.6 Project Structure

Three main financing and legal schemes will be explored for the project:

- Solely private IPP

A private entity invests in the new facility and signs a PPA agreement with ELECGALÁPAGOS S.A. for the power generated. In that scheme, the private entity bares fully or partially (in the case of a grant received at the EPC phase of the project) the financial costs and is subjected to all applicable taxes (VAT and income tax after the fifth year of operation).

- Solely government-owned project

ELECGALÁPAGOS S.A. invests fully or partially into the project. The facility is owned by ELECGALÁPAGOS S.A. which leads to the avoidance of income tax. However VAT could apply to the EPC contractor.

- Public-private partnership on the model of the Global Sustainable Electricity Partnership San Cristobal Wind Project

The Global Sustainable Electricity Partnership group co-finances the project together with the government of Ecuador (the Ministry of Energy or other entity) through the foundation of Trust from which a private entity is created. This legal entity then contracts a PPA with ELECGALÁPAGOS S.A. for a set duration at the end of which the facility ownership is transferred to ELECGALÁPAGOS S.A.. In that case, VAT could be exempted (with the participation and support of the United Nations) but income tax applies after the fifth year of operation.

4. Proposed methodology for the study

4.1 Computational Tools

HOMER ENERGY has been selected to model the tri-hybrid system composed of the wind park, the solar PV field, the diesel generator plant and the battery system. Further excel modelling will be used to overcome possible limitations of the software and fine-tune the financial analysis of the project.

4.2 Main technical parameters and assumptions

Load and production curves are readily available at EOLICSA and ELECGALÁPAGOS S.A.. The latter are also able to provide irradiation and temperature data from sensors installed in 2 locations in Baquerizo Moreno. Those will be used to validate SolarGIS solar and temperature data sets.

Details described in the Table of main technical parameters in Appendix.

4.3 Main financial parameters and assumptions

The key financial parameters are based on information provided by:

- ELECGALÁPAGOS S.A., for their cost of power (generation and transmission), blended electricity tariff, and operation costs.
- EOLICSA, for all figures related to the wind park operation and maintenance costs
- Main local contractors, for logistics and implementation prices that are specific to San Cristobal island (quote requests for the logistics and implementation of the fourth wind turbine, solar field and storage system have been sent to three major contracting companies who had experience with similar projects)
- Enerwhere, for their database of solar and storage equipment and operation and maintenance costs based and regularly updated from suppliers quotes and manufacturers guidelines

Details described in the Table of main financial parameters in Appendix.

5. Questions to be answered by the study

5.1 Optimal Sizing of the Solar-Wind-Diesel Hybrid System

What energy mix for San Cristobal Island?

This question will be addressed based on the current situation but also with a critical eye on the next 10-20 years. ELECGALÁPAGOS S.A. forecasted 64% increase by 2014 for San Christobal electricity demand. Furthermore, solar PV and battery prices are falling rapidly every year. The optimal energy mix of today might not be optimal anymore 10 years from now.

5.2 Diesel Price Threshold

At what diesel price does it make sense? Finding the threshold at which renewable are not competitive anymore.

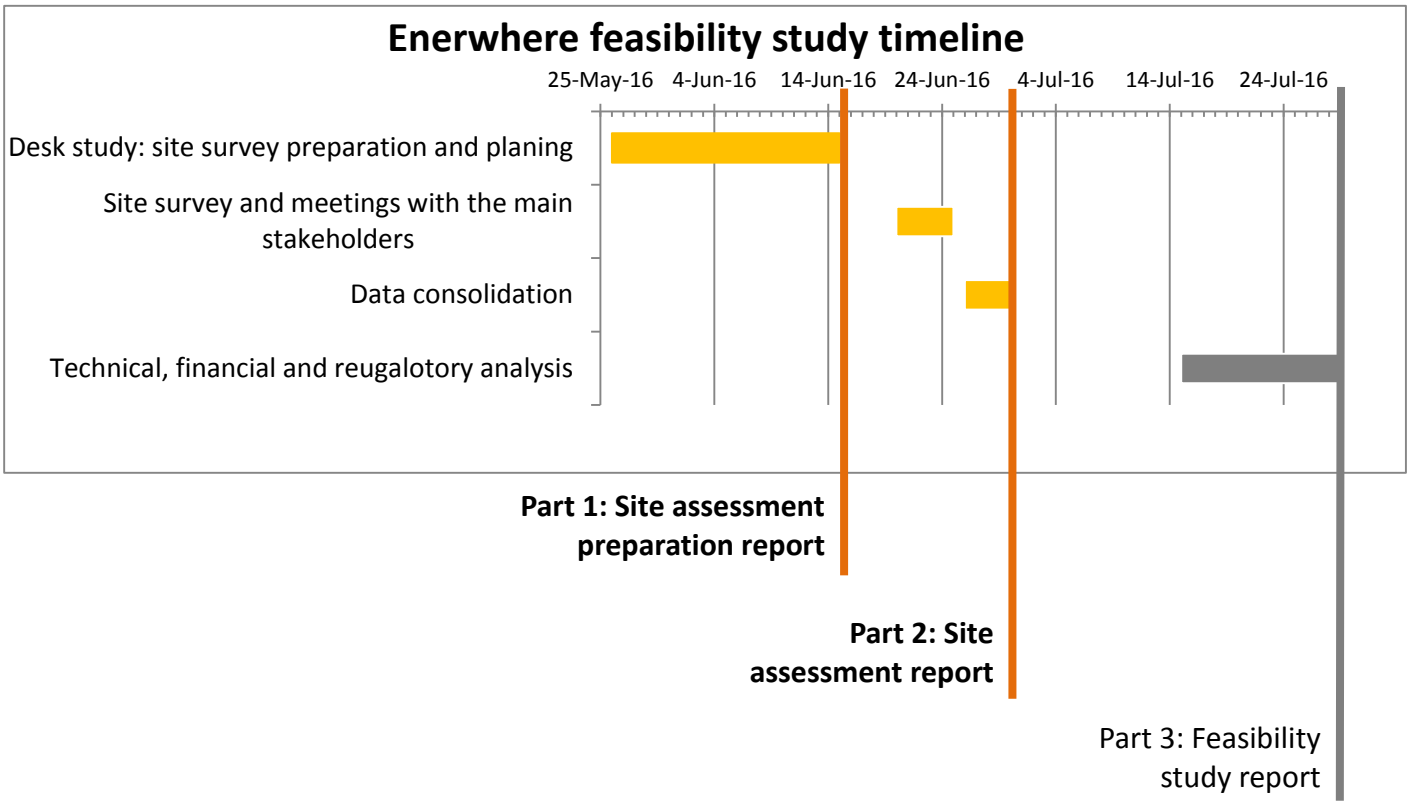
5.3 Partnership Options

What are the advantages and disadvantages of each option? Are they viable?

6. Next Steps and timeline

The site survey has been successfully conducted with the help of Luis Vintimilla. Sites have been visited, technical data was collected and consolidated. Key regulatory and financial information has been verified in meetings with the local utility and the Municipality of San Cristobal Island. Major players of the Ecuadorian logistics, electrical and construction industry have been visited and requested with budgetary figures on which will be based the systems pricing and sizing optimization. Those quotes should be received by mid-July so that the modelling, simulations and results analysis can be performed by the end of July.

Overall consulting project timeline and milestones:



7. Appendixes

7.1 Table of main technical parameters

Parameter	Unit	Description	Source
Demand			
Energy Consumption on the island **Power demand**	kWh kW	Monthly figures available from January 2013 up to August 2015, with a yearly demand forecast lead to 2024 From May 2014 to August 2015, data retrieved in a 10-minute interval for all the three feeders. Used for load curve for HOMER model: instantaneous dispatch of energy	ELECGALAPAGOS demand feeder 1,2&3 report ELECGALAPAGOS demand forecast ELECGALAPAGOS demand feeder 1,2&3 report
Generation			
Diesel Generator Energy Production	kWh	From September 2014 to August 2015 daily data retrieved in a 10-minutes interval for Diesel Generators 1, 3 and 4. Serves the purpose to study at what energy level does each generator switch on and how much energy does each one provide	ELECGALAPAGOS Combined report for the 3 wind turbines and diesel generators 1,3 and 4
Wind Turbine Energy Production	kWh	From January 2015 to May 2016 monthly data retrieved in an hourly basis for the size diesel generators	EOLICSA diesel generator and fuel figures report
Diesel Generators' Consumption of Diesel	Glns	From 2013 to May 2016 monthly values of the diesel consumption of the 6 diesel generators	EOLICSA and ELECGALAPAGOS Diesel Generation Reports
Diesel Generators Running Hours	Hours	From 2013 to 2015 monthly values of the running hours of the 6 diesel generators	EOLICSA and ELECGALAPAGOS Diesel Generation Reports
Wind Turbine Energy Production	kWh	2015 daily data retrieved in a 1-hour interval. Serves the understanding of variation of produced wind energy with the demand and the determination of the new system size	EOLICSA Energy for Wind Turbines Report
Wind Speed	m/s	2015 daily data retrieved in a 10-minutes interval for all the wind turbines. The average speed between the 3 turbines will be taken in order to calculate the energy that will be produced from the additional 4th wind turbine	EOLICSA wind speed report
Energy Produced from Solar Panels	kWh	From February 2015 to May 2016, data retrieved in a 10-minute interval for the solar system near the diesel generator plant. The solar plant at the school has a signal problem that stopped sending data	EOLICSA PV energy diesel generator plant report
Voltage and Current/phase for Solar Panels	V - Amps/phase	From July 2012 to July 2014, data retrieved in a 15-minute interval for the solar system near the diesel generator plant.	EOLICSA PV control room report

Solar Irradiation	W/m2	From February 2015 to June 2016, data retrieved in a 10-minute interval. And from August 2007 to June 2010, data retrieved in an hourly basis. Serves to validate the production of the modules design with the actual numbers	EOLICSA solar radiation report and EOLICSA PV control room report
Solar Panels Temperature	Degrees C	From February 2015 to June 2016, data retrieved in a 10-minute interval. And from August 2007 to June 2010, data retrieved in an hourly basis. Serves to study the temperature effect on the productivity of the solar panels	EOLICSA solar radiation report and EOLICSA PV control room report

7.2 Table of main financial parameters

Parameters	Unit	Value	Description	Source
Electricity Consumption Forecast of San Cristobal Island	kWh/year	1,200,000	The yearly increase in consumption	Elecgalapagos Forecast
Average Grid Price for end user	USD ¢/kWh	10.3		
Grid price inflation rate	%		The yearly inflation of electricity price for end user	Elecgalapagos Forecast
Solar Module Cost	USD/kWp	650	BYD Module 265 Wp	Enerwhere specified
Solar Inverter Cost	USD/kW	150	Sungrow 60 kWac	Enerwhere specified
Solar Mounting Structure Cost	USD/kWp	200-350	Fixed tilt and daily tracker, excluding transport and installation	Enerwhere specified
Lifetime of Solar Plant	years	30	For depreciation calculation	
Battery Cost	USD/kWh	700	Lithium Iron Phospate (LiFePO4) batteries	Enerwhere specified
Battery Inverter Cost	USD/kVA	400		Enerwhere specified
Battery Management and Control System	USD/system	30,000		Enerwhere specified
Battery Lifetime	cycles	6,000	At 80% depth of discharge	
Wind Equipment Cost	USD/kW	2,000	For financial modeling	Enerwhere specified
Lifetime of 4th Wind Turbine	years	20	For depreciation calculation	
IPP Inflation rate	%	1.5		
Logistics for PV	USD/40' container	5000	Includes international transportation, insurance, handling, import duty, VAT and local transportation	Provided by Ecuadorian contractor
Installation cost for PV	USD		Includes civil works and cabling	Provided by Ecuadorian contractor
O&M costs for PV	USD/kWp/year	20	Cleaning	Enerwhere specified
Logistics for Wind Turbine	USD		Includes international transportation, insurance, handling, import duty, VAT and local transportation	Provided by Ecuadorian contractor
Installation cost for Wind Turbine	USD		Includes civil works and cabling	Provided by Ecuadorian contractor
O&M costs for Wind Turbine	USD/year		Includes cleaning and technical work	Enerwhere specified
Logistics for Batteries	USD/40' container	5000	Includes international transportation, insurance, handling, import duty, VAT and local transportation	Provided by Ecuadorian contractor
Installation cost for batteries	USD		Includes cabling	Provided by Ecuadorian contractor
O&M costs for batteries	USD/year			Enerwhere specified

Feasibility study Part 3:
Analysis and Results

to RWE (INNOGY)
and the Global Sustainable Electricity Partnership (GSEP)

Solar PV and additional wind for the Galapagos Islands

Integrating further renewables and storage in San Cristobal Island energy mix to reduce their dependence on diesel fuel and subsidies.

Document	**Feasibility Study Part 3 Report: Analysis and Results**		
Prepared by:	Emeline Platel	**Date:**	27 September 2016
Approved by:	Daniel Zywietz	**Date:**	28 September 2016

Executive Summary

This feasibility study examines the technical and economic case for introduction of additional solar PV, battery storage, and wind generation capacity into the island grid of San Cristobal Island, Galapagos Islands, Ecuador. The island's peak load of around 3 MW is currently supplied by a combination of diesel generators (around 7.4 MW), with a significant wind component (3 x 800 kW turbines for a total of 2.4 MW), and two small solar plants (total ~13 kWp), with an overall renewables share of around 21% in 2015.

The study uses a detailed, multi-phase HOMER simulation to identify the optimal capacities for each system element under three fuel price scenarios. The simulations were run using 6% weighted average cost of capital, which is low but common for development fund projects, and historical load and generation data with 10 minute resolution, that was scaled to account for load growth over the 30 year simulation period.

The model results indicate that the optimal solar PV and battery storage capacity increase with higher fuel prices. Even at the current, extremely low, fuel prices (diesel fuel for power generation is provided at the subsidized rate of $0.24 / liter), there is an economic case for adding at least 2.5 MWp of solar PV capacity, together with 1.5 MWh of battery storage capacity and around 2 MW of battery inverter capacity for grid management in the near term. Implementation of this initial solar-battery plant would require around $6.0-6.5 million in capital expenditure, leading to a reduction of the fuel consumption of around 16%, and in turn reducing the levelized cost of electricity on the island by around 9%. At the current (subsidized) diesel price the payback time for this system is just over 8 years.

Over time, and at higher fuel prices (e.g. $0.50 / liter, equivalent to the current crude oil price world market price of around $50 / bbl or $0.90/liter, representative of the high oil price level of $100-120/bbl reached in 2013/2014), the optimal capacities for the solar PV plant and battery storage increase up to 8.5 MWp and 6 MWh respectively. Phasing the implementation of both solar PV and battery capacity over the next 10 years allows taking advantage of falling equipment costs and avoids overinvesting in generation capacity early on.

The economic models show few differences between different solar mounting options (fixed tilt vs. static tracking vs. single-axis tracking), however, the limited land space available on the island is best utilized in a high density "static tracking" configuration (e.g. East-West back-to-back rows at 10° tilt angle). With this setup, the available land close to the existing diesel power plant on San Cristobal could easily host the initial 2.5 MWp solar PV plant, without the need for additional land acquisition. Such a configuration also minimizes wind forces, making the use of ballasted or screw pile foundations viable and potentially drastically simplifying construction & logistics in the remote location. For the batteries, given the high-power configuration required to buffer the significant short-term fluctuations in load, wind & solar generation, lithium-based technologies (e.g. LiFePO or Li-NMC) currently appear to be the best and most economical choice.

The potential for integration of additional wind capacity into the San Cristobal island grid is limited by the already high wind share, particularly in the windy low load season (August), where wind generation is already curtailed. As such, adding further wind capacity (on top of the existing 2.4 MW installed in 2007) makes sense only after loads have grown significantly (at least 10 years from today, i.e. after 2026) and / or if land area for solar PV installations is not available.

While the simulation makes a clear case for the implementation of significant solar PV and battery storage capacity into the San Cristobal island grid in the near term, the high forecasted load growth rate (around 6.2% annual increase) appears unsustainable in the medium- to long-term. A separate program to increase energy efficiency and reduce electricity demand growth rate should therefore be considered.

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1 Introduction

In the 1990s, the United Nations (UN) and the Republic of Ecuador developed a plan to substitute energy produced from diesel generators with renewable energy. In January 2001, after the Jessica Tanker Ship spilled thousands of gallons of fuel oil and diesel that it was delivering to the islands, the Global Sustainable Electricity Partnership (GSEP) was asked by the UN to lead the mission towards a sustainable future.

This led GSEP to launch the Global Sustainable Electricity Partnership San Cristobal Wind Project. The project was commissioned in 2007 within the framework of the co-operation between the Government of the Republic of Ecuador, GSEP founders, the United Nations Foundation (UNF), external benefactors and world-wide private partners. The successful operation of the 2.4 MW wind farm on San Cristobal has provided 30% of the island power demand over the last 8 years.

As a second phase of this successful initiative to support of the President of Ecuador's declaration in February 2008, where he expressed his desire to roll out carbon-free power generation in Galapagos, GSEP is looking at integrating further renewable power capacity on the Galapagos Islands. RWE (INNOGY) as one of the project leaders within the GSEP, has asked Enerwhere, a solar-hybrid solutions provider based in the Middle East, to identify and assess the potential for integration of additional solar PV, wind power and storage into the San Cristobal island energy mix.

Enerwhere has extensive expertise in the integration and management of stand-alone hybrid systems in remote locations. With their experience and the guidance of INNOGY, Enerwhere will consult on different options such as solar PV field configurations (fixed tilt vs. tracking systems), the addition of a fourth wind turbine and the financial viability of integrating storage into the system to increase the share of renewables even further.

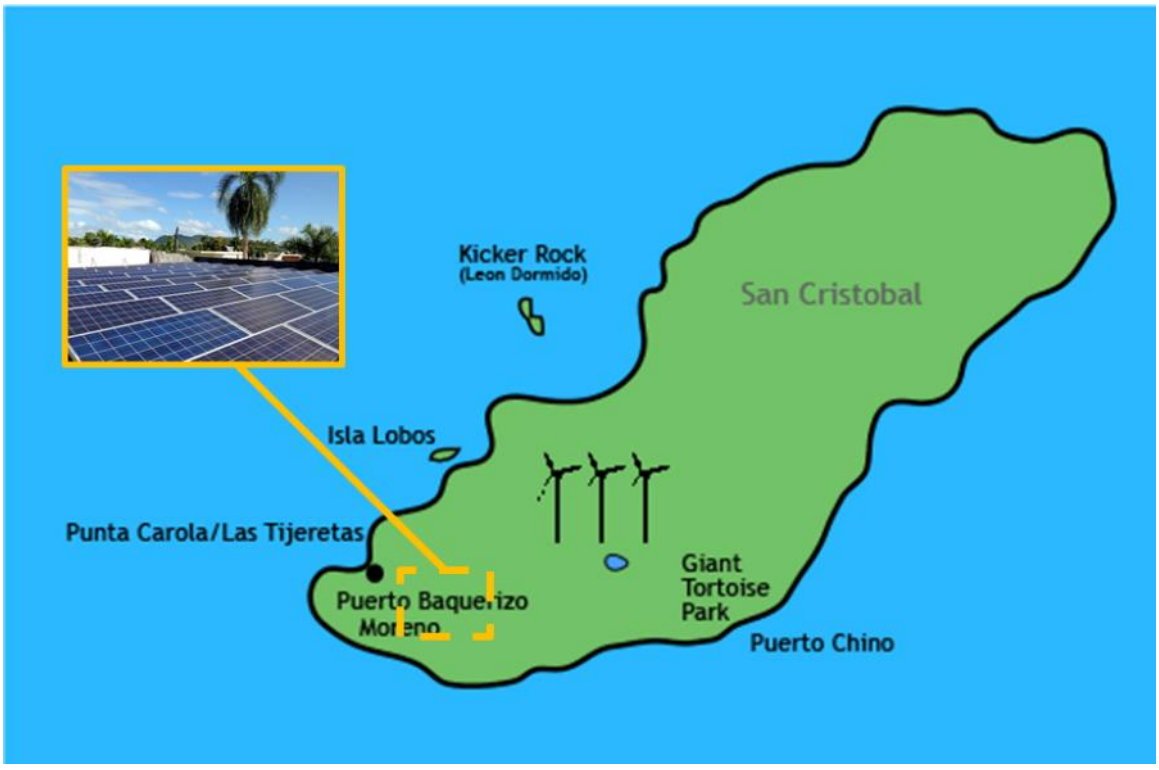


Figure 1: San Cristobal Island and its renewable energy facilities

1.1 Renewables in Ecuador and the Galapagos Archipelago

The Ecuadorian government has set explicit objectives of promoting clean and alternative energy sources in the 2008 Constitution. The target of reaching 60% renewable energy generation capacity by 2017 was further defined in the National Plan for Good Living 2013-2022. The majority of this renewable share is to be covered by 25 hydropower projects with a planned capacity of 4.2 GW by 2020.[1]

With the commissioning in 2016 of the Coca Codo Sinclair hydroelectric facility, the largest energy project in Ecuador's history, 1.5 GW of additional capacity is already online.[2]

Within the last decade, a few attempts were made to promote other renewable sources. In 2011 a very attractive feed-in tarrif for solar PV and ocean power systems was started (USD 40-44.77 cts per kWh), however this highly profitable scheme could not be sustainably supported by the government and was abandoned just two years later. Only a few small PV plant under 1 MWp are currently in operation on the main land under the scheme. [1]

In 2016, ARCONEL Resolution 031/16 limits the development of non-hydro renewable energy projects to specific cases that have not yet been defined. Details are to be given in the coming ByLaw the publication date of which is not yet known. Electricity generation on the Galapagos archipelago will certainly be part of the specific cases for which non-hydro renewables will be promoted, however it is not clear how.[3]

Indeed, while the mainland benefits from competitive hydro power, the Galapagos archipelago still relies mainly on diesel generators producing power at a unit cost of about USD 27 cts per kWh with another USD 13 cts per kWh spent on distribution.[4] ELECGALÁPAGOS S.A., is operating at a considerable deficit while selling electricity at the national tariff of USD 10.8 cts per kWh (blended average for the Galapagos Islands). This deficit is currently shared between all Ecuadorian consumers through a surcharge on the electricity tariff.

The successful Global Sustainable Electricity Partnership San Cristobal Wind Project commissioned by GSEP in 2007, was responsible for the supply of 21.5% of the total energy demand in 2015 on the island. After 8 years of operations, the ownership of the wind park was transferred to ELECGALÁPAGOS S.A. in March 2016. Since then, and due to the financial structure of the project that was grant funded, ELECGALÁPAGOS S.A. now generates electricity from the wind park at a cost of USD 8-9 cts per kWh. This cost represents the ongoing operations and maintenance activities for the wind park. Provisions for upcoming major overhauls or refurbishment works of the turbines are not included in this cost.

[1] IRENA, June 2015. Renewable Energy Policy Brief, ECUADOR.
[2] Coca Codo Sinclair Hydroelectric Project, Ecuador
[3] Discussion with Luis C. Vintimilla C., former EOLICSA General Manager, on San Cristobal Island in June 2016
[4] Galalpagos electricity costs and tariffs were provided by ELECGALAPAGOS in June 2016, based on subsidized diesel fuel.8

1.2 Objectives and Supportive Entities to the Project

The main objective of any power generation project on the Galapagos Islands is to replace diesel fuel and reduce the cost and environmental risks associated with the transport, storage and burning of fossil fuels.

The Ministry of Electricity and ELECGALÁPAGOS S.A. also have a financial incentive in producing cleaner electricity from alternative energy, as long as it is more competitive than diesel fuel and other variable operating costs of the diesel generators and it does not replace or curtail the ongoing wind power generation.

The Global Sustainable Electricity Partnership group is prepared to help ELECGALÁPAGOS S.A. in its plans to move towards the goal of converting the Galapagos into a zero fossil fuels territory.

In addition, the municipality, under the lead of the Mayor, is strongly supportive of all renewable power generation projects that would make San Cristobal island cleaner and more self-sustainable. The use of wind, solar and also the locally available organic waste as power generation resource are options considered and encouraged by the municipality.

1.3 Overview of Previous Renewable Energy Projects in the Galapagos

Since the commissioning of the San Cristobal wind park in 2007, several additional renewable projects were installed on the neighboring islands (Table 1). None of them was implemented on a commercial basis and therefore the cost figures are not comparable to the San Cristobal study.

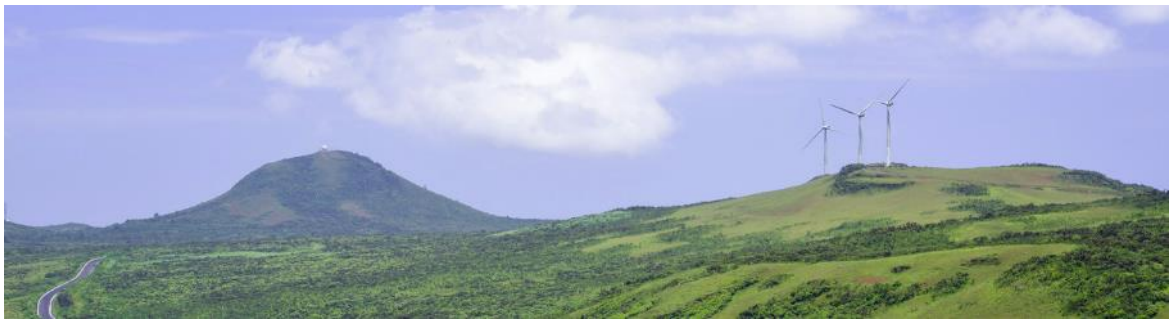
Project Name	Parque Eólico San Cristobal	Parque Eólico Baltra	Planta Fotovoltaica Baltra	Planta Fotovoltaica Puerto Ayora	Proyecto Sistema Híbrido Isabela
Location	San Cristobal	Baltra	Baltra	Santa Cruz	Isabela
Year of commissioning	2007	2014	2016	2014	2017
System	Wind turbines (3 x 800 kW)	Wind turbines (3 x 2,250 kW)	Solar PV (67 kWp) & Batteries (4.3 MWh / 1 MW)	Solar PV (1,500 kWp)	Solar PV (920 kWp) & Batteries (333 kWh – 900 kW)
Fraction of local energy production	31%	8.96%	Battery is mainly buffering wind generation	6.12%	

Table 1: Overview of renewable energy projects on the Galapagos Islands

San Cristobal remains the island with the highest renewable penetration as of today. Solar PV-battery systems have been installed on Baltra and will be installed on Isabella Island next year. The 4.3 MWh storage system in Baltra, developed through a Japanese government grant program, is composed of Lithium-ion and Lead-acid batteries connected to a 1 MW battery inverter. The Lithium-ion battery bank is designed mainly for the automatic compensation of rapidly changing wind power generation. The lead-acid battery bank is charged and discharged as per the operator requirements, mainly to store excess wind power production. This battery technology combination is interesting especially when looking at the integration of highly variable wind power and day-time solar PV production. The current rapid cost reduction of Lithium-ion battery technology will, however, likely lead to the selection of a single-technology battery system of Lithium-ion for future installations.

1.4 Current Power Supply Situation on San Cristobal Island

San Cristobal mini-grid is currently powered by the 2.4 MW wind park and the diesel generator plant with a small contribution of the 13 kWp PV plant.



Statistics	unit	Total year 2015
Total power generation	**kWh / year**	**15,867,095**
- Diesel generators	% of generation	78.5%
- Wind turbines	% of generation	21.4%
- Solar PV	% of generation	0.1%
Max load	**kW**	**3,061**
Diesel generators fuel efficiency	**Liter / kWh**	**0.302**
Consumers	**#**	**2,991**

Table 2: San Cristobal Island 2015 electricity mix (ELECGALÁPAGOS S.A.)

The wind turbines produce on average 400 kW, or 21% of the total generation. In 2015 the fuel efficiency of the diesel plant was 0.302 liter / kWh.

San Cristobal electricity demand has been increasing by 7% yearly on average since 2012, with a peak of 22% increase from 2013 to 2014 (Figure 2). The renewable energy power capacity has remained constant (2.4 MW) since 2007 when the San Cristobal Wind Project was inaugurated. The increase in electricity demand combines with constant renewable production effectively reduces the renewable penetration every year.

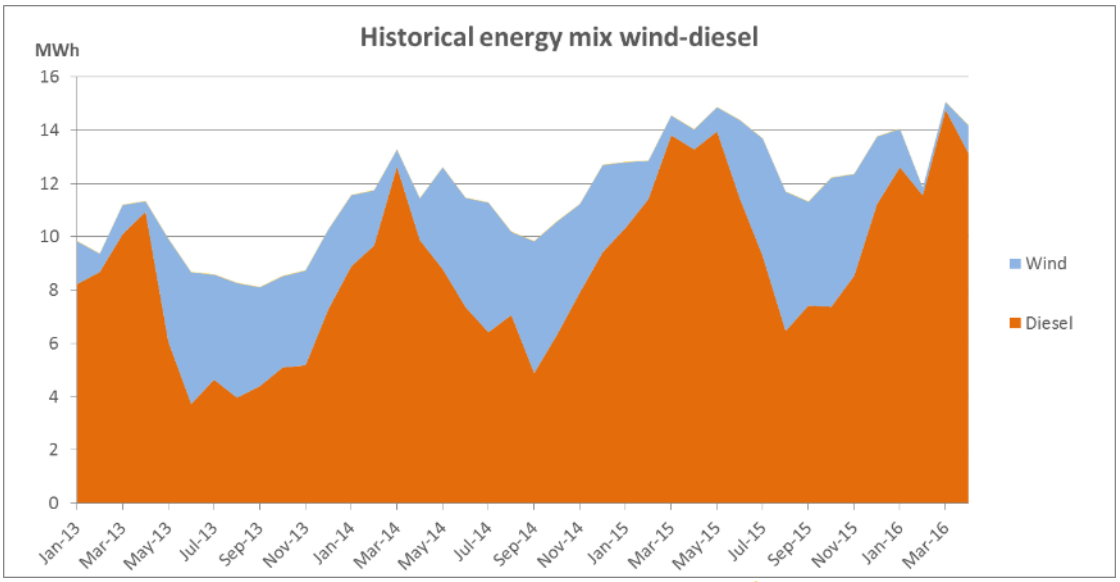


Figure 2: Historical energy mix 2013-2016 (ELECGALÁPAGOS S.A.)

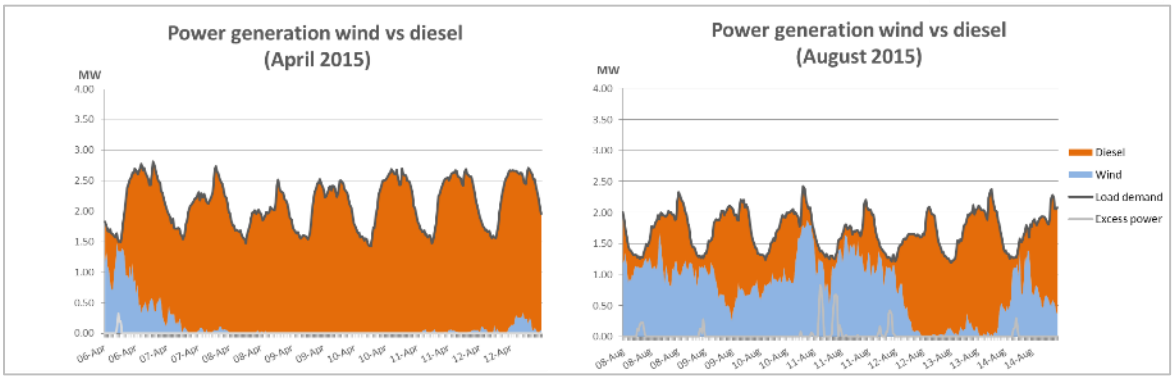


Figure 3: Power generation wind vs diesel in April and August 2015 (ELECGALÁPAGOS S.A.)

The seasonal load variation is around 30%. This is forecasted to increase in the next years with the economic growth and the addition of season-dependent loads, such as air conditioning. Even though the electricity demand does not vary largely due to seasonal changes, the load on the diesel generators is subject to bigger variation. This is due to the seasonality of wind speed on the island. Unfortunately, the data shows a negative correlation between load and wind speed on San Cristobal.

The peak electricity demand occurs in the least windy period of the year and vice versa. This causes the high load to be covered completely by diesel generators in April, while excess electricity produced by wind turbines is curtailed in August (Figure 3). The fact that curtailment is already present in the current configuration signals that the addition of a 4th wind turbine may not be optimal. However, a feasibility analysis for the expansion of the wind park is carried out.

1.5 Main Challenges

1.5.1 Uncertainty regarding diesel fuel price evolution in Ecuador

Like all oil-producing countries around the world, Ecuador has been suffering from a major drop in oil revenues for the last two years. In this situation, many other countries have chosen to reduce domestic fuel subsidies, significantly raising the price of diesel fuel in the process. Once subsidies are eliminated the diesel price is also affected by the world market price for crude oil, which has fluctuated over an extremely wide range of $27/bbl to $120/bbl over the past 3 years. As diesel is still the main source of primary energy on San Cristobal Island for electricity generation, different pricing scenarios therefore have to be modelled to provide meaningful results over a range of potential fuel prices.

1.5.2 Uncertainty on electricity demand growth on San Cristobal Island

The archipelago has experienced significant economic growth in the last decade and it is expected that this trend will continue. This growth is reflected in the electricity demand, due to the increase in the number of hotel rooms and other facilities dedicated to the tourism sector, as well as the expansion of the existing ones. In fact, to guarantee a high comfort level for the increased number of guests the number of electrical appliances is only likely to increase. An exact forecast of this evolution is impossible, since it is depending on economic, political and technical factors, however utilities around the world typically use historical load growth as a proxy. In the case of San Cristobal, historical load growth has been around 6-7% per year. Enerwhere believes that such a rapid growth is partially caused by the low energy prices and could be reduced significantly by energy efficiency measures and focus on raising environmental awareness. The implementation of this type of policy change depends on the local institutions and cannot be forecasted exactly but we have assumed that some energy efficiency measures will be used to reduce consumption growth rates.

1.5.3 Extreme seasonal variations of the remaining diesel-generated electricity to be replaced by renewable resources

The already high wind power production on the island dramatically increases the seasonal variations of the residual electricity generation by the diesel generator plant. The objective of integrating further renewables on the island is, however, to replace this diesel-generated energy. This proves technically and commercially challenging, as wind generation is both highly variable and highly price competitive in the San Cristobal mini-grid. There is for example little requirement for other alternative sources of energy during windy periods in the month of August, when the demand is at its lowest and the electricity produced by the wind park amounts to up to 90% of the total load demand of the island. Curtailment will therefore reduce the productivity and commercial viability of the future wind and/or solar facility.

1.5.4 Logistics constraints

Access to the Galapagos Islands is constrained by distance to the mainland and low transport volumes. Only two ferry lines are serving the archipelago with all necessary goods from the mainland. Only containerized equipment can be shipped on the regular lines. Transporting a wind turbine to the island will require a dedicated barge just for the project (similar to the case of the first three wind turbines). This requirement considerably increases the logistics costs. Also, extraordinary long pieces of equipment (e.g. the turbine blades) might simply not be able to be offloaded and handled in the current port and on the roads in Baquerizo Moreno. Both had to be upgraded solely for the mobilization of equipment for the first wind park. Solar PV and battery systems have the advantage of fitting into standard size shipping container, which helps on the logistics budget.

2 Methodology and Assumptions

The methodology followed for the feasibility study is the commercial optimization of the energy mix according to the electricity demand, the local renewable resources and the installed system costs. This is performed through the modeling of different capacities for each system component and sorting the results by the cheapest levelized cost of electricity (LCOE) calculated over 25 to 30 years.

2.1 Electricity Demand Forecast

The electricity demand was obtained from measurements given by ELECGALÁPAGOS S.A.. This data is available with 10 minutes time step. To obtain a full year load curve, measurements from September 1st, 2014 to August 31st, 2015 were used.

The electricity consumption forecast until 2024 was provided by ELECGALÁPAGOS S.A. This forecast appears to be based on an annual consumption growth rate of 6.2%. This figure is extremely high, and Enerwhere believes that this pace cannot be sustained by the island for the 30-year period of the study (dotted orange trend in Figure 4 below). For this reason, Enerwhere derived its own forecast for the period not covered by ELECGALÁPAGOS S.A.. The long term estimate accounts for energy efficiency measures, assumed to be undertaken by the Government, that will slow down the electricity demand growth to 1% per year starting 2025. These considerations lead to the forecast below (dotted trends in Figure 4).

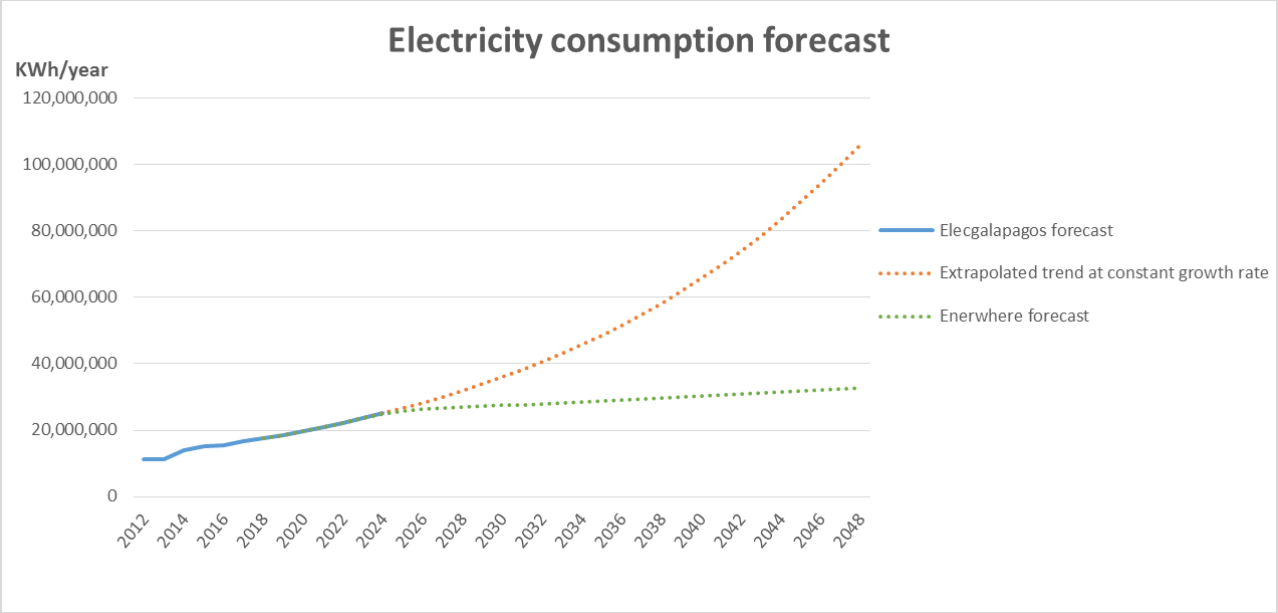


Figure 4: Electricity consumption forecast assumed for the study

2.2 Wind Resources

The wind speed profile used for the modelling of the wind park is taken directly from the actual site production for one actual year (SCADA files for 2015-2016). The wind production has been varying by +/- 5% over the years with 2015-2016 showing an average production. The advantage of modelling the system on actual wind measurements is to account for natural stochastic variations.

2.3 Solar Radiation

A dataset of the solar radiation, measured by EOLICSA on the island of San Cristobal, is available in 10-minutes interval from March 1st, 2015 to February 28th, 2016. Unfortunately, this dataset does not match well with either data from satellite sources (NASA Surface meteorology and Solar Energy database and SolarGIS database) or actual PV production on site. Based on the observations during the site visit, Enerwhere believes that this discrepancy is likely arising from error in the calibration of the sensor and or a not frequent enough cleaning scheme. The cleaning frequency of the solar panels was advised to be only once a year, hence it is likely that also the solar sensor is not cleaned on the required daily or at least weekly frequency to provide valid and accurate solar radiation data.

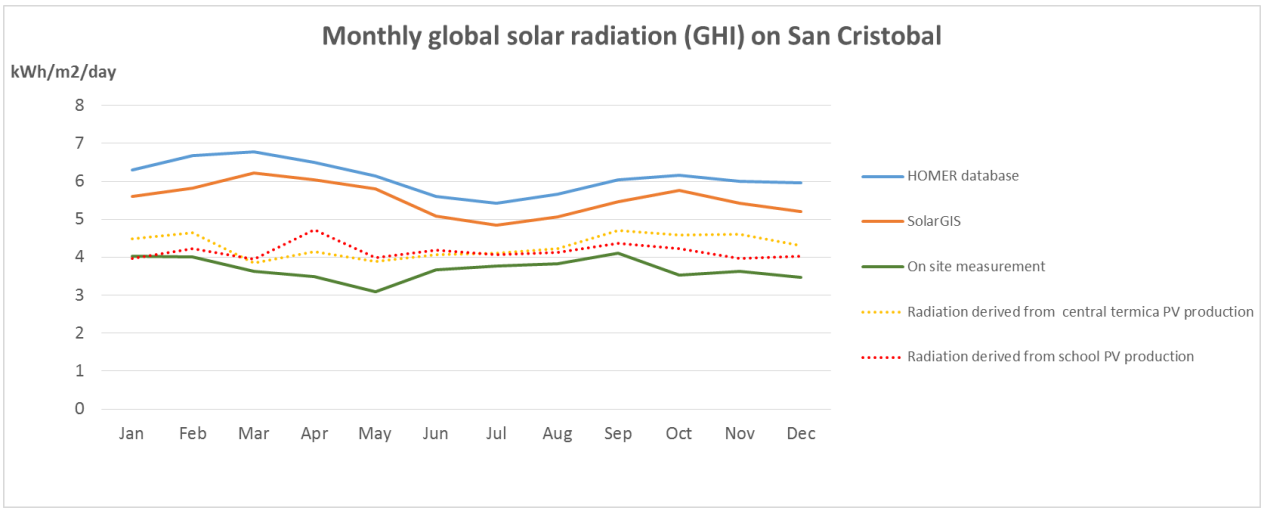


Figure 5: Monthly evolution of solar radiation (GHI) from different sources

Since there was no possibility to validate the site measurement with other radiation sensors on the island, it is advised to maintain a more frequent schedule on cleaning the sensors in order to obtain accurate readings. Due to lack of a robust on-site measurement data, other sources have been analysed (NASA Surface meteorology and Solar Energy database from Homer and SolarGIS database respectively). As shown in the graph in Figure 5, both the other sources show significantly higher results than the sensor. For this reason, we estimated the solar radiation figures from the actual production of the solar fields on the island (EOLICSA, PV control room report), assuming a typical performance ratio of 80%. The GHI estimates generated in this way are more solid than the other sources since they are based on actual PV production of two different sites on San Cristobal Island close to the potential location for solar field installation (Central Termica and school) with coherent monthly variation.

Satellite sources are likely to overestimate the GHI because their resolution is too low to return right values for an island in the middle of the ocean, whereas the sensor underestimate it. The fact that Enerwhere's estimation lays in between this two data sources validates the calculations. Furthermore, the assumed GHI remains on the safe side meaning that even if the actual radiation will end up being higher than expected the given recommendations will still be valid. Stochastic variations are introduced in the simulations on an hourly basis to account for the highly variable interactions between the load, wind and solar production.

2.4 Fuel Price Scenarios

Three diesel price scenarios are simulated to assess the commercial viability of renewable energy projects on San Cristobal Island. The first case is the current subsidized price of diesel for electricity generation purposes in Ecuador: $0.24/Liter (PETROECUADOR, July 2016). The other two scenarios assume diesel subsidies are eliminated and diesel is purchased at the world market price. As of today, a corresponding diesel price of $0.50/Liter is considered ($0.40/Liter bulk price + $0.10/Liter transportation and retail margin [Index mundi, July 2016]), based on a cost of crude oil in June 2016 ($48/bbl). A third diesel price, following a rebound in oil prices to the level of 2011-2014, is considered as $0.90/Liter.

Scenario	Price [$/Liter]	Description
Subsidized Price	0.24	Current subsidized price of diesel for electricity generation purposes
Market Price	0.50	World market price as of August 2016
Rebound Price	0.90	Diesel price in case of a rebound effect

Table 3: Diesel price scenarios

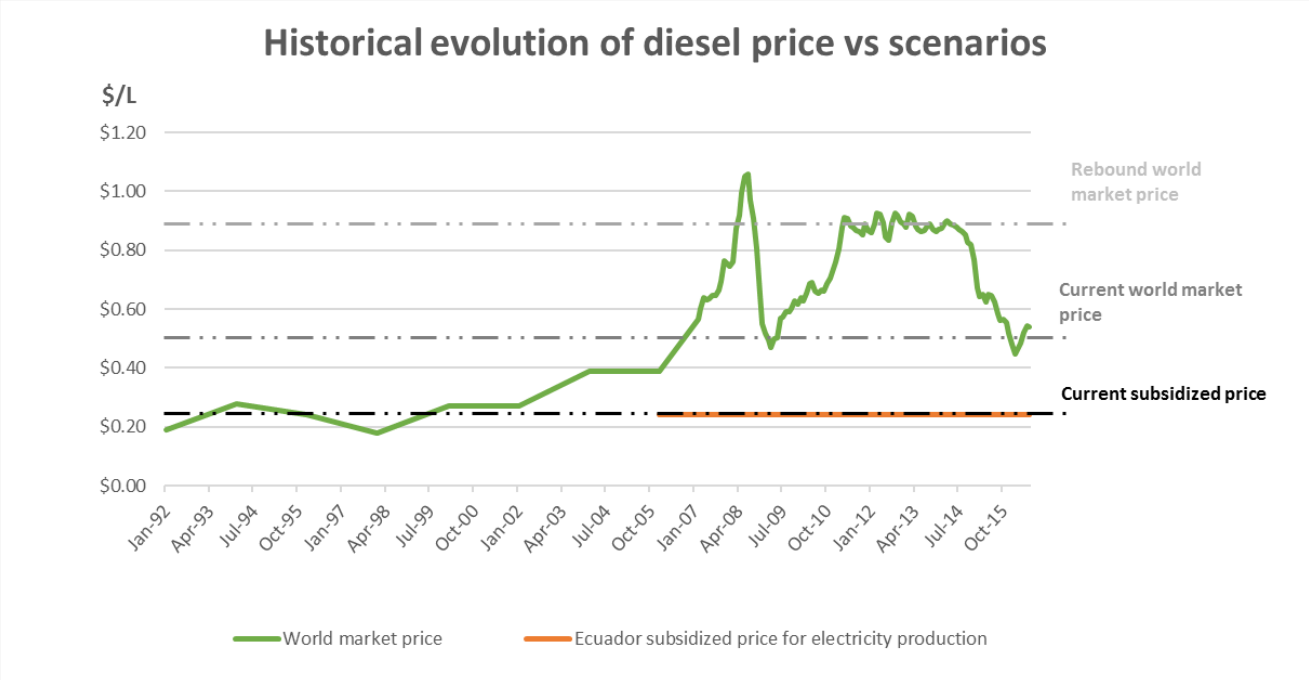


Figure 6: Historical evolution of diesel price vs scenarios

In Figure 6 the diesel pump price in Ecuador and diesel price for electricity generation purposes are compared to the historical world average diesel prices. These three fuel prices will allow decision makers to analyse a comprehensive set of scenarios of volatile fuel prices that is difficult to forecast over a time period of 30 years.

2.5 Sources of Main Financial Parameters and Assumptions

The key financial parameters are based on information provided by:

- ELECGALÁPAGOS S.A., for their cost of power (generation and transmission), blended electricity tariff, and operation costs.
- EOLICSA, for all figures related to the wind park operation and maintenance costs
- Local contractors, for logistics and implementation prices that are specific to San Cristobal island (quote requests for the logistics and implementation of the fourth wind turbine, solar field and storage system have been sent to three major contracting companies who had experience with similar projects)
- Enerwhere, for their database of solar and storage equipment and operation and maintenance costs based and regularly updated from suppliers quotes and manufacturers guidelines.

Detailed financial parameters and assumption are provided in the Appendix 6.2

2.6 Computation Tools and Limitations

HOMER Pro® microgrid software by HOMER Energy has been selected to model the tri-hybrid system composed of the wind park, the solar PV field, the diesel generator plant and the battery system. This software allows to simultaneously run simulation, optimization and sensitivity analysis. The integer non-linear optimization problem is solved with iterative direct search (computing the value of the objective function for all the decision variable in the feasible domain). In this way the algorithm is derivative-free, ensuring the convergence and significance of the result. On the other side this algorithm requires significant computational power and time. For each combination of the given equipment (type and size of PV panels, battery, inverter, wind turbine, diesel generators…) the system simulate a feasible operating solution and evaluates the corresponding result indicators.[5]

SolarGIS was used as solar radiation data source to compare and validate the available on-site measurement and the result of the simulations. The 'PV Planner' tool uses solar radiation database from satellite sources to evaluate the monthly PV yield of the system configuration inserted by the user (tilt and azimuth angle, shading, tracking axis, losses…).

Microsoft Excel was used to compare data from different sources and format it as input for HOMER. Also post-processing (graphs, tables and key performance parameter) was conducted in MS Excel.

[5] http://www.HOMERenergy.com/HOMER_pro

3 Scope of the Feasibility Study

3.1 Diesel Generator Plant

The diesel generator plant was undergoing renovation works during the time of the site visit in June 2016. The study includes the assessment of the current and expected fuel efficiency of the system (before and after commissioning of the new diesel generators) and how it would evolve with the integration of renewables. The replacement and addition of further generators will be considered only in the case of an obvious need for a different unit.

Figure 7: Installation of new diesel generators at the thermal plant

Brand	Model	Rated capacity	# of units	Specific fuel consumption at 50% load	Specific fuel consumption at 75% load	Specific fuel consumption at 100% load
		kW		L/kWh	L/kWh	L/kWh
Caterpillar	3512 DITA	650	3	0.299	0.278	0.269
MTU	16V2000	1,000	1	0.278	0.271	0.269
Caterpillar	3516	1,100	1	0.283	0.275	0.274
SKL	9VDS 29/24 AL	1,670	2	0.260	0.250	0.248

Table 4: List of diesel generators on San Cristobal with data sheet specific fuel consumption values

The analysis considers the 5 generators already present in the generator plant, as well as the two new SKL 1,670 kW units that are currently being installed (Table 4). Each generator was modelled in HOMER with its own specifications. Parameters such as rated capacity and specific fuel consumption are fundamental for the precision of the simulation and were obtained from the manufacturer datasheets for each generator.

3.2 Additional Wind Turbine

3.2.1 Location and sizing of the potential fourth wind turbine

Several bird migration corridors of the protected petrel species have been identified in the San Cristobal high lands, where wind resources are the most attractive for power generation. As such, potential locations for wind turbine installations are very restricted. This already represented a major challenge for the first wind park project.

There is, however, space available for a fourth wind turbine as part of the existing wind park. This location, already approved by the Ministry of Environment in 2001, also has the advantage of requiring only minimal cabling and trenching works as the current wind parks 13.2 kV transmission line still has available capacity to transport additional power.

Figure 8: Location of the potential 4th Wind Turbine on San Cristobal Island

3.2.2 Budgetary pricing for a single 800kW wind turbine

	Share of total price [%]	Price [$mln.]
Equipment cost: Turbine, converters, and 13.2 kV line (Ex-works)	39%	1.48
Transportation and logistics	17%	0.64
Civil works & installation	44%	1.66
		$ 3.78 mln.

Table 5: Costs estimate for implementation of additional 800 kW wind turbine on San Cristobal

3.2.3 Power output

The three existing 800 kW wind turbines are modelled based to their size, dimension and power curve (see Figure 9 below) in the energy model prepared by Enerwhere (HOMER simulation). A fourth turbine of the same characteristics was allowed as simulation option. Obviously today's turbines are significantly larger, however, the same unit size was selected for the simulation based on the limiting existing underground 13.2 kV line connecting the wind park to the city as well as to ease O&M activities and spare parts management.

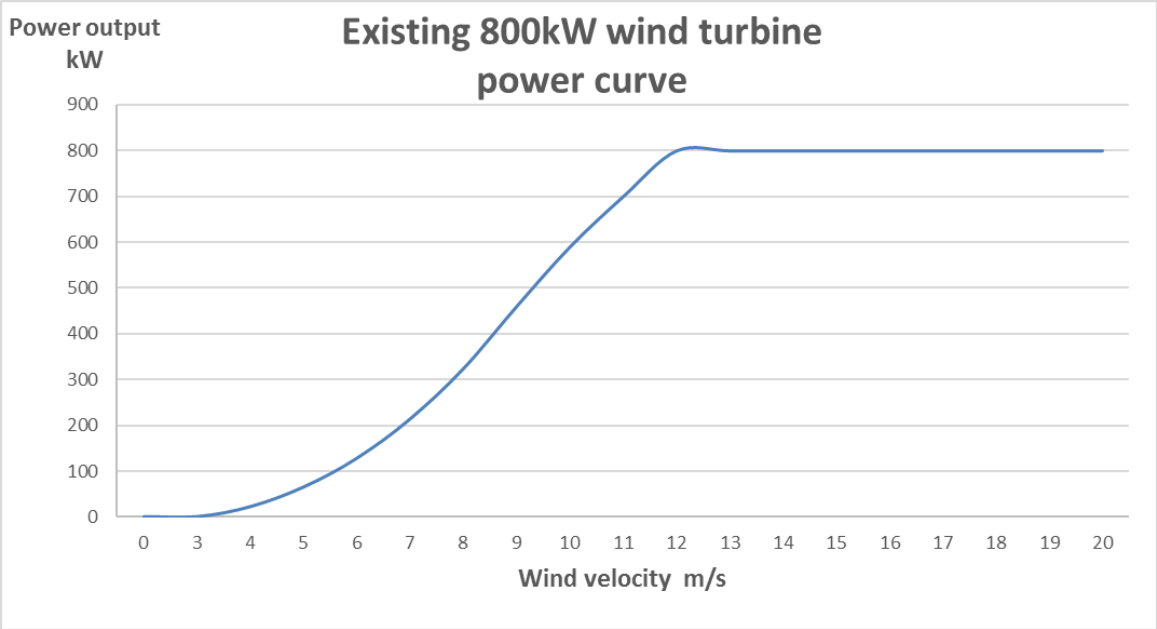


Figure 9: Power yield curve of MADE AE-59 800 kW wind turbine

3.3 Solar PV Plant

The main decision variables for the solar PV plants are size of the plant, mounting structure type, location and foundation options. The size optimization can be performed with a software tool while the remaining analysis requires in depth considerations of pros and cons of each option.

3.3.1 Mounting options

For four different system designs were considered for the mounting structure of the PV field:

1) Fixed tilt at 5 degrees, facing north: this is the optimal angle for a fixed-tilt plant on San Cristobal, due to the close proximity of the site location to the equator. This option has a very limited wind load, limiting the ballast requirement while still being suitably tilted to allow water to run off.

2) "Static tracking", i.e. the combination of two rows facing East and West, installed back to back at a 10-degree angle. This configuration has the advantage of generating more solar power in the morning and evening hours, and also minimizes wind loads, reducing structure and foundation costs. This configuration also has the highest density of all options, thereby reducing land usage.

3) Monthly/seasonally tilting structure (here -5 to 20 degrees North), with manual tilt angle adjustment. In principle this type of mounting structure combines the benefits of a simple structure with the higher yields of a tracker, however in the case of San Cristobal

the seasonal tilt variation generates only very limited benefits, which are not enough to justify the additional costs of the more expensive structure.

4) North-South single-axis tracking systems automatically follow the sun from East to West over the course of the day, thereby continuously optimizing the incidence angle of the solar radiation on the solar panels. Since this structure keeps the panel horizontal on the North-South axis it is generally attractive for locations close to the equator. The major downsides of this type of structure are the higher installation costs, additional mechanical complexity (potentially leading to higher O&M costs) and significantly higher land usage compared to other mounting options.

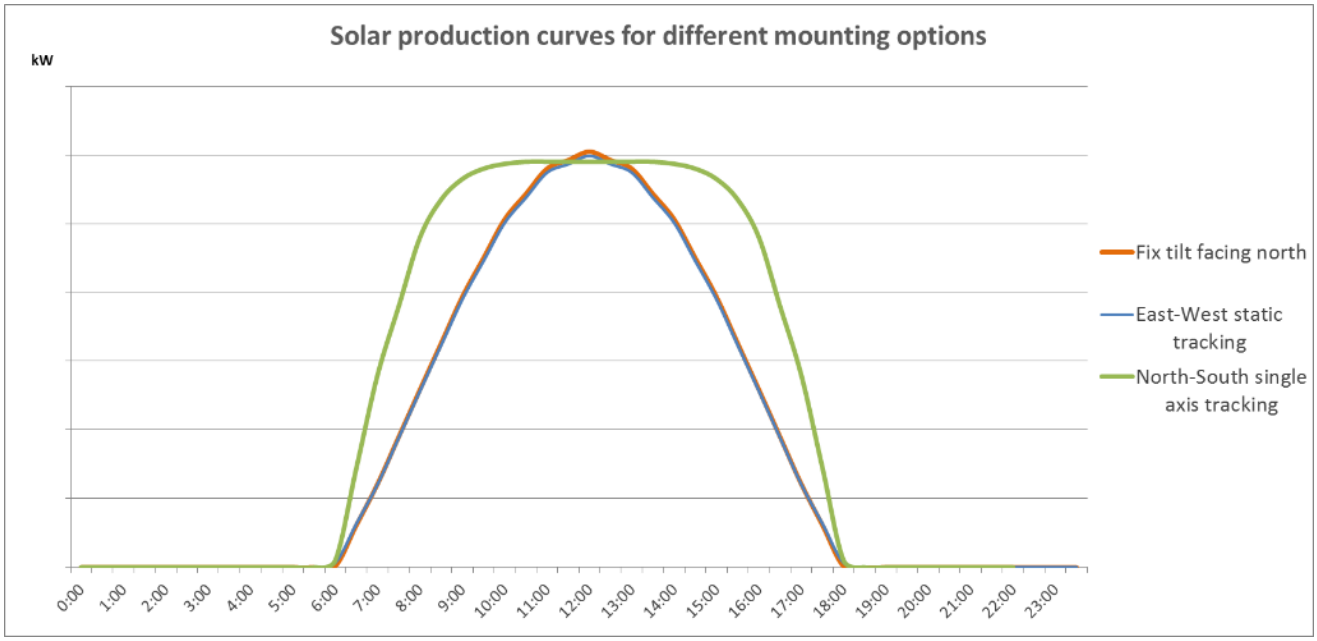


Figure 10: Solar production curves of different mounting options

The production curves for the different mounting options on a clear day are shown in Figure 10 above. The production from of the static tracking and fixed tilt options are almost equal, while single axis tracking option produces both more electricity and total, and a steady output over the course of the day (see Table 6 below). The temporal distribution of the solar PV production is of great importance in a solar-diesel only hybrid system. However it becomes less critical when storage is available in the mini grid.

Mounting options	**CAPEX** $/kWp	**Yield** kWh/kWp/year	**Approx. land requirement** m^2/kWp
Fixed tilt structure (5° N)	1,870	1,057	10
Static tracking (10° E-W)	1,860	1,046	8
Seasonally tilting structure (-5° to 20°N)	1,890	1,120	12
Single-axis tracking (N-S)	2,260	1,356	20

Table 6: Key parameters for different PV mounting option

3.3.2 Location options and space availability

Three potential locations for the PV plant were identified and discussed with ELECGALÁPAGOS S.A. and the municipality during the site visit. They have been identified as the preferred locations for the installation of a solar PV field.

Location options	Description	Available area
Solar field option 1: Close to the central substation	The land is owned by ELECGALÁPAGOS S.A. who gave their approval in principle to use the land for the solar PV field. The area would require only reclaiming work and the extension of a 13.2 kV feeder from the central substation for about 130 meters.	Over 20,000 m^2
Solar field option 2: Former waste disposal area	This plot is owned by the municipality and was previously used as a waste disposal area. Assessment of the ground conditions will be required in order to choose the right mounting option. The solar PV field could be connected to the wind park transmission line which is about 130 meters away.	Over 20,000 m^2
Solar field option 3: Area closer to the airport	Multiple locations near the airport could potentially be utilized for solar PV field installations, however it is presently unclear if such areas are reserved for other urban developments.	Depending on urban development plans

Table 7: Solar field options on San Cristobal Island

Figure 11: Proposed locations for the solar PV field (Options 1 and 2)

Figure 12: Potential locations for the solar PV field (Option 3)

Due to the similarities of the location options 1 and 2 both in size and distance to the nearest 13.2 kV connection point, the solar PV plant can be modelled in both cases based on the following assumptions:

- Area available: 20,000 to 50,000 m2
- Both options of fixed tilt (East-West rows) and single-axis tracking system (North-South)
- Use of outdoor-rated string inverters with central or multiple AC combiner panel(s)
- Step-up transformer located at the site of the solar field
- 130-meter transmission line to the connection point

3.3.3 Foundation options

Based on Enerwhere's experience in remotely located projects, the Enerwhere team compared different foundation options for the PV mounting structures. Three foundation options are presented below:

A) Concrete foundations poured in-situ: requires ground preparation and concrete mixing on site. This requires both heavy equipment and close supervision to ensure the quality of the concrete footings.

B) Ballasted: small solid concrete blocks to be placed on the ballast plates of the mounting structure. Ballast can be handled manually with the help of locally available boom-loaders and bobcats, so no additional heavy equipment needs to be brought to the islands. Ballasted structures also do not require extensive geotechnical studies, another advantage for a remote project location.

C) Screw piles or straight piles are driven into the soil by specially-equipped (semi-)automatic drilling machines or (manually) by boom-loaders with a special drilling extension. Screw piles have the advantage of reducing required ground preparation works, however geotechnical / soil studies are required to confirm whether the ground is suitable for this this alternative.

	Cost of PV mounting structure and installation $/kWp		
	Concrete foundations	Ballasted structure	Screw piles
Fixed tilt structure 5° slope	2,310	1,870	1,880
Static tracking 10° slope E-W facing	2,260	1,860	1,880
Monthly tiltable structure	2,370	1,890	1,890
N-S axis tracking	2,740	2,270	2,260

Table 8: Budgetary installed cost for different solar PV configurations (Enerwhere costs database plus logistics and implentation quotes from Ecuadorian contractors)

The system prices shown in Table 8 include installation and logistics costs, based on Enerwhere experience and local contractor quotes. The results show that concrete foundations are more expensive than the screw piles or ballasted structures. The final decision regarding whether to use ballast or screw piles will depend on a geotechnical assessment, which will have to be carried out for each of the chosen sites before project implementation.

3.3.4 Levelized Cost of Electricity (LCOE) and land requirement of different solar PV mounting options

The calculated LCOE (Table 9) that includes supply of equipment, transportation, logistics and installation costs shows no significant variation between the three systems types, however the same cannot be said for the land requirements. Due to the lower ground coverage ratio of the trackers the land usage increases significantly compared to a system of same capacity with a fixed tilt angle.

Mounting options	**Levelized cost of electricity** $/kWh	**Approx. land requirement** m^2/kWp	**Specific land requirement** m^2/kWh/year
Fixed tilt structure (5° N)	0.142	10	0.009
Static tracking (10° E-W)	0.144	10	0.008
Seasonally tiltable structure	0.143	12	0.011
N-S single-axis tracking	0.143	20	0.014

Table 9: LCOE and approximate land requirement of solar PV systems with different mounting options

As space limitation are an important constraint on any island, which is further exacerbated in the presence of natural reserves on San Cristobal, Enerwhere decided to perform the remaining simulations using the fixed tilt (5° North) mounting option. Nevertheless, due to the very small differences in economics the results will be still applicable for the other two mounting options. The results can be adapted for the single-axis tracking system by adjusting the solar system capacity downwards by about 20%, in line with the higher yield of this mounting option. The temporal distribution of the solar production has only little impact on the economics as storage is available in the system.

3.4 Storage System

Storage plays two different roles in the wind-solar-(diesel) power system:

- Buffering short-term variations of load, wind generation and solar generation (which otherwise need to be covered by spinning reserve at the diesel generator plant), i.e. system control, peak shaving, spinning reserve & frequency control.
- Storing surplus wind and/or solar production for use later in the day (time-shifting).

Due to the high short-term variability of both wind and solar resources on San Cristobal (a tropical island with rapidly changing wind speed & cloud cover), the storage technology needs to be able to charge and discharge at relatively high rates. Lithium-based battery chemistries (e.g. lithium iron phospate, LiFePO4 or lithium nickel manganese cobalt oxide, Li-NMC) are typically better at this than either lead-acid or flow batteries, and consequently were identified as the preferred technology for this project. Storage capacities of 500 kWh to 2,500 kWh are considered for the study and can be coupled with different battery inverter capacities (500-2,000 kW) depending on the maximum instantaneous power requirement.

3.5 Small Organic Waste Energy Facility

The feasibility of generating electricity out of waste was investigated due to the high interest shown to the Enerwhere engineering team when they met the mayor of the Galapagos Islands.

For the application and waste quantities at hand, there are two ways to generate electricity, direct combustion and production of biogas, with subsequent utilization in gas engines. The first option (direct combustion) is limited by the small quantities (about 60 tons / month) and low calorific value (about 800 cal/kg) of wet waste material available on San Cristobal. Most commonly used combustion processes require significantly larger quantities (tens to hundreds of tons per day) and much higher energy content (2,000-3,000 cal/kg) to be run economically. The second option (biogas) is widely used on all kinds of organic waste and does not face any technical hurdles from low quantities (biogas digesters are available even at household scale). However, with only 60 tons/month organic waste available for energy generation purposes the resulting ~5,000 kWh/month would only have an insignificant (<1%) impact on the island's energy balance.

Due to the limited potential of the waste valorisation, this source is not considered further in this study.

4 Model Results

4.1 Optimization of the Current Wind-Diesel Hybrid System

The base case scenario of the existing diesel generator plant with the three wind turbines was modelled to assess the efficiency of the current setup, and the available potential for improvement. Also, since two brand new SKL 1,670 kW generators are being installed, a second simulation was conducted including the two new units, in order to show the fuel efficiency gain of the new setup and propose an optimal load management philosophy. The two models were run for one year (2018). The following analysis focuses on the generator operating philosophy, wind power curtailment assessment and optimization of the overall fuel efficiency of the system.

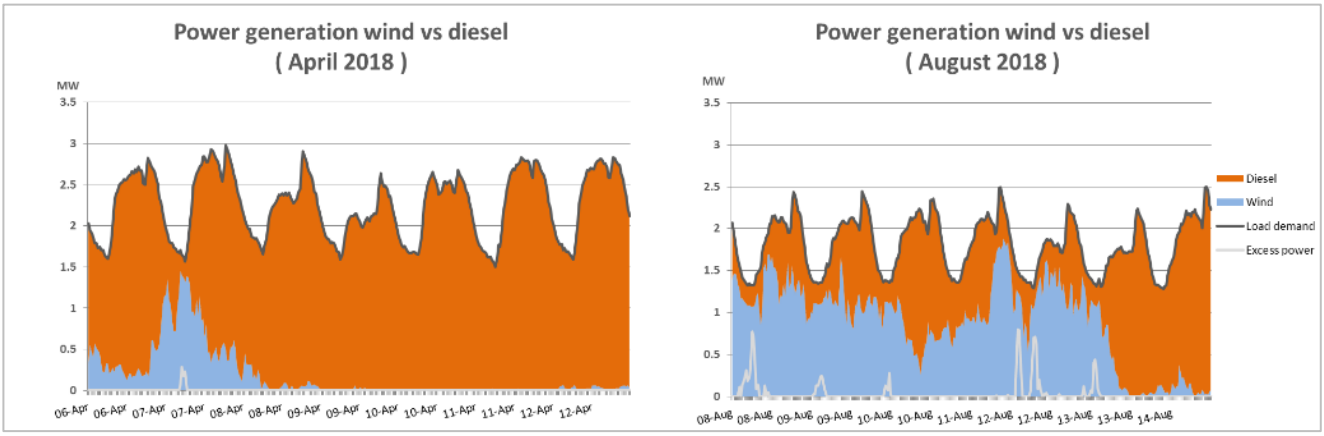


Figure 13: Baseline power generation from wind and diesel in April and August 2018

The old setup, composed of the existing 5 diesel generators, had a specific fuel consumption of 0.297 liters per kWh in 2015. This poor performance is explained by the manual operations of the diesel generator plant after the automatic control system stopped functioning in 2011. Indeed, with the highly variable wind power generation (see Figure 13 above), the residual load on the diesel generators is highly variable and requires generators to be switch on and off multiple times during the day. This is not happening fast enough in a manually operated setup (in which operators follow a schedule and safety guidelines) without continuous automatic optimization.

	System description	Average specific fuel consumption	Expected fuel savings
		[litres/kWh]	%
Old setup manually operated	3 wind turbines: 2.4 MW 5 diesel generators: 4 MW	0.297	
New setup automatic control	3 wind turbines: 2.4 MW 7 diesel generators: 7.4 MW	0.262	12%

Table 10: Expected improvement of specific fuel consumption after addition of new SKL 1,670 kW diesel generators and automation of the synchronization system

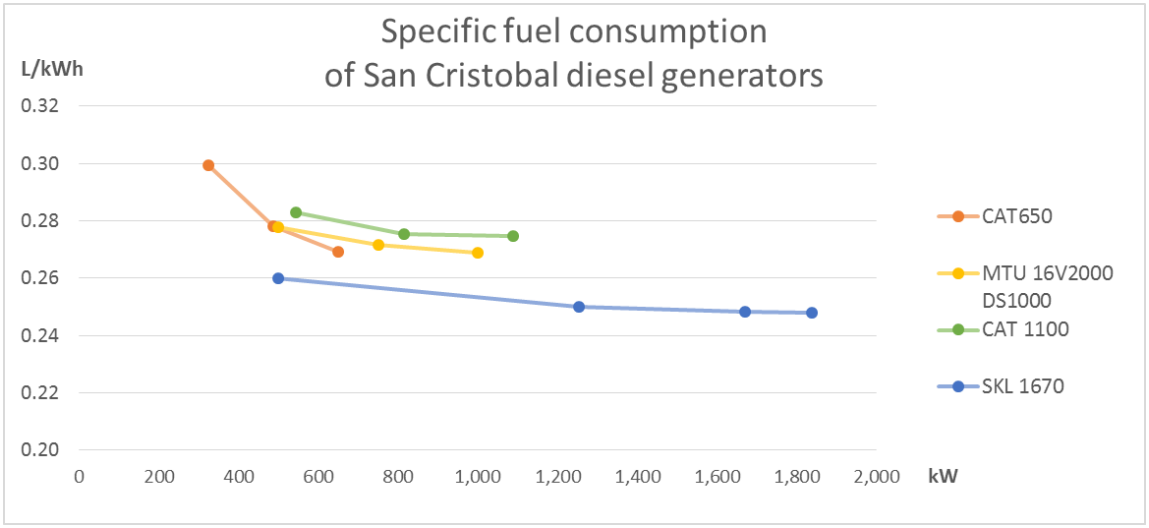


Figure 14: Fuel consumption curves of different generator models installed on San Cristobal

As shown in Figure 14, the two new units are about 8% more efficient than the older units at loads above 500 kW, which is the minimum load at which they should be operated. The Caterpillar 1,100 kW generator, on the other hand, always consumes more than the rest of the fleet. HOMER optimizes the operating sequence of the generators according to their fuel consumption and maintenance costs.

		Diesel generators running						
Brand & Capacity (kVA)		1st CAT 650	2nd CAT 650	3rd CAT 650	MTU 1,000	CAT 1,100	1st SKL 1,670	2nd SKL 1,670
Total load on diesel generators (kW)	160-450	X						
	450-1,200						X	
	1,200-1,600	X					X	
	1,600-1,900				X		X	
	1,900-2,100	X	X				X	
	2,100-2,300						X	X
	2,300-2,800	X					X	X
	2,800-3,000				X		X	X
	3,000-3,250	X	X				X	X
	3,250-3,500	X			X		X	X
	3,500-3,700	X	X	X			X	X
	3,700-4,000	X	X		X		X	X
	4,000-4,400	X	X	X	X		X	X
	4,400-5,200	X	X	X	X	X	X	X

Table 11: Optimal generator running philosophy for new generator setup

The optimal configuration will result in one of the new SKL generators providing the majority of the demand not met by wind turbines, with the balance provided by one of the older units. The highest efficiencies would be achieved by the two SKL units running together, however in the first years of the simulation the loads aren't generally high enough for this scenario to occur. The share of electricity produced by each generator in 2018 with and without the introduction of the new units is presented in Figure 15.

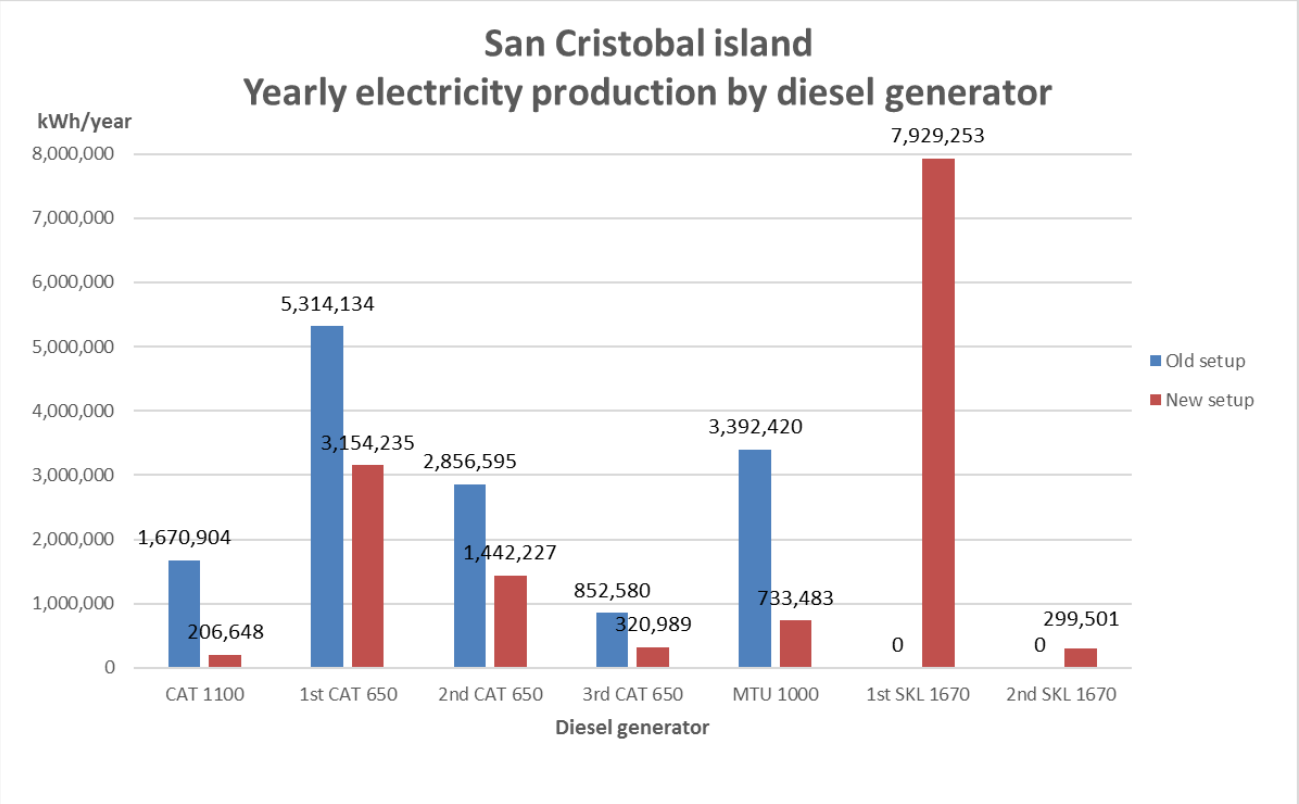


Figure 15: Electricity produced by each diesel generator in the old/new setup in 2018

In summary, the addition of the two new SKL 1,670 kW units together with the updating of the automatic control system is expected to improve the overall fuel efficiency by 12%, provided the synchronization and power settings are programmed correctly. This programming should ideally initially be performed by the contractor installing the system, and training should be provided to the operators to update the settings as required in case of changes in the situation (e.g. generator unit under maintenance). Even without a fully working automatic control system, the new, more efficient generators should improve the fuel economy of the system by about 8%. Therefore, there is no need for investment in new diesel generators nor major change in the current generation plant design.

All further simulations are based on the assumption that the 7 diesel generators are optimally and automatically synchronized.

4.2 Sizing the Future Solar-Wind-Diesel Hybrid System – Single-phase simulation

In order to test the technical and commercial viability of adding solar PV, storage and additional wind capacity to the San Cristobal power system, a HOMER model was initially run over a single, 30-year simulation run. The resulting optimal sizes for the solar PV, battery and wind park for each fuel price scenario are shown in Table 12 below.

	Optimal system configration					Results			
Fuel price scenario	**Wind turbines**	**PV capacity**	**Battery capacity**	**Battery inverter capacity**	**LCOE base case**	**LCOE**	**LCOE savings**	**Fuel consumption**	**Fuel savings**
	number	MWp	MWh	MW	$/kWh	$/kWh	%	Liters/year	%
Subsidized price	3	4.0	1.5	1.0	0.153	0.151	2%	4,967,000	19%
Market price	3	6.0	2.0	1.5	0.207	0.193	7%	4,522,929	26%
Rebound price	3	8.0	2.0	2.0	0.290	0.254	12%	3,976,296	34%

Table 12: Optimal sizing of wind-solar-diesel-battery hybrid system over a 30-year period

As can be seen from the table, the results indicate that the overall technical configuration is remarkably stable across the three fuel price scenarios. In all three scenarios, the optimal configuration includes both solar PV and storage capacity but no additional wind capacity. This result is not surprising given the already significant curtailment of the wind generation on the island, and the seasonal misalignment of the wind generation with the maximum loads during the peak tourist season.

4.2.1 Key results:

- Adding a hybrid PV-battery system generates significant fuel savings (19-34%) and moderate financial savings (2-12%) across fuel price scenarios.
- In a single-phase simulation (i.e. assuming all investments are made in year 1), the addition of a 4th wind turbine is not competitive in any of the considered scenarios. In fact, adding a turbine would result in 23% additional CAPEX and about 5% higher LCOE compared to the optimal solar-battery configuration, largely due to the curtailment during the windy but low-load season.
- In the initial years of the project the PV plant is subject to curtailment due to oversizing of the plant compared to the load (see Figure 16 below). This effect decreases over time as loads grow higher.
- Storage is required to reduce curtailment of both wind and solar PV generation, particularly in the windy season (August). Figure 16 below nicely shows the peaks where total renewable generation exceeds the load. In this situation HOMER compares simulations with lower solar capacity to alternatives with additional storage. The optimal solution then includes varying amount of solar PV and storage, with the capacity of both increasing with higher fuel prices.

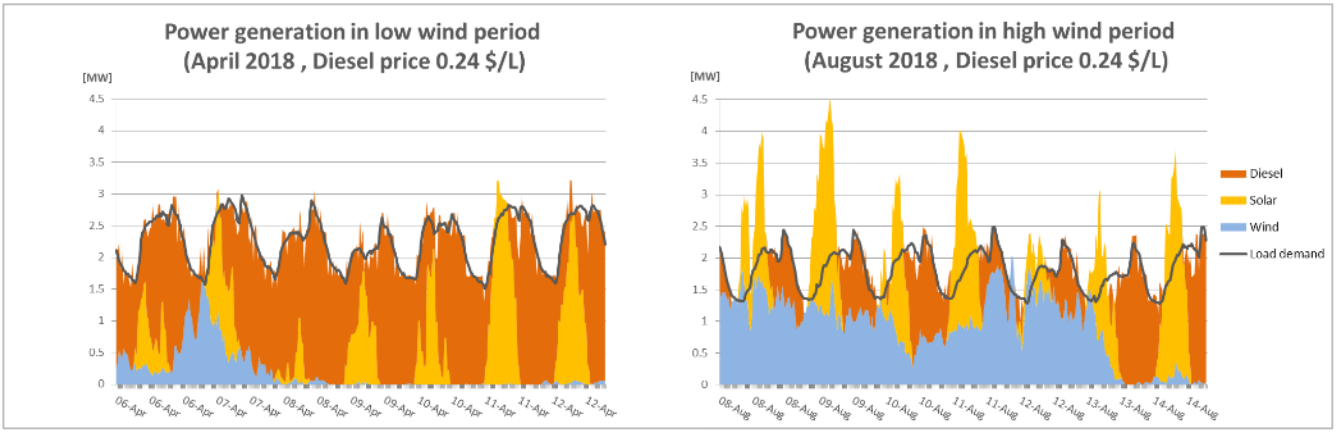


Figure 16: Power generation for April and August 2018 (single-phase simulation, subsidized diesel price scenario)

While this single-phase simulation produces reasonably consistent results across different fuel price scenarios, it suffers from a major weakness: It considers only one investment moment, and assumes that the configuration of the power system will subsequently remain stable for 30 years.

In reality this is highly unlikely, as demonstrated by the historical evolution of the existing power system, with additions of new diesel generators and renewable generation capacity over time. Considering only one investment moment is problematic for another reason, namely the rapidly falling costs of both solar PV and battery storage. In a situation with growing loads, it therefore makes financial sense to build up capacity over time, in order to benefit from the falling costs of new capacity during the period.

For this reasons a second simulation run was performed, this time assuming implementation of the renewables and storage capacity over time.

4.3 Sizing the Future Solar-Wind-Diesel Hybrid System – Multi-phase simulation

4.3.1 Advantages of a multiple-phase implementation

With the high load growth rate and falling equipment prices of solar PV, batteries and inverters (Figure 17)[6] [7], it makes sense to roll out the system capacity in phases. Dividing the project in stages allows to upsize the PV and battery capacity according to the load increase. This leads to a reduction of curtailment and the capital costs due to the price reduction of these technologies.

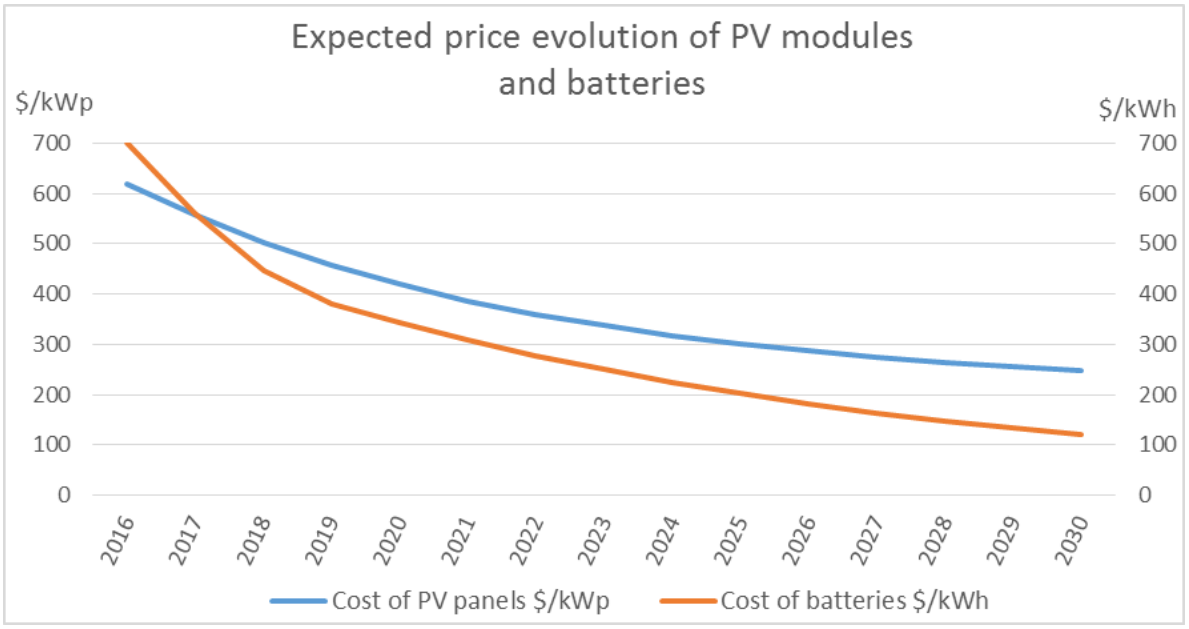


Figure 17: Expected price evolution of PV modules and batteries

It is worth keeping in mind that technology forecasting is inherently difficult, imprecise, and affected by events in the future. As such the cost forecasts in Figure 17 can only give a rough indication of expected cost trends. Nevertheless, given the historical track records of both the solar PV and battery industries in reducing costs, the overall conclusion of rapidly decreasing costs and increasing efficiencies is quite robust.

[6] Bloomberg NEF, 2016. 'NEW ENERGY OUTLOOK 2016'
[7] IRENA, 2015. 'BATTERY STORAGE FOR RENEWABLES: MARKET STATUS AND TECHNOLOGY OUTLOOK'

4.3.2 Parameters used for multi-phase simulations

Various simulations were run to assess the technical and commercial optimal sizing of the different components of the hybrid system. Finally, the model is implemented in three phases over 8 years to profit the most from the price evolution trends of PVs and batteries. A fourth phase has also been modeled in which the fourth wind turbine is installed as an alternative to the third phase.

Phase	Starting year	Duration	Load used for HOMER simulation
Phase 1	2018	30 years	ELECGALAPAGOS forecast is used from 2018 to 2022. The load is kept constant after 2022 to avoid oversizing equipment that could be implemented in phase 2
Phase 2	2022	30 years	Enerwhere forecast based on ELECGALAPAGOS data is used from 2022 to 2026. The load is kept constant after 2026 to avoid oversizing equipment that could be implemented in phase 3
Phase 3	2026	30 years	Enerwhere forecast based on ELECGALAPAGOS data is used from 2026 to the end of the project.

Table 13: Main parameters of multi-phase HOMER simulations

4.3.3 Results of multi-phase simulations

The optimal system compositions and the resulting key performance indicators for every phase at each diesel price scenario are summarized in Table 14. For comparison, the 2018 load forecast without implementation of further renewable energy sources (i.e. the current configuration of the power system) is shown as 'Phase 0'. The components capacity shows the total capacity operating including the capacity installed at the previous phases.

Also, as the fourth wind turbine was never part of the optimized system configuration at any phase and any fuel price scenario, the results of a fifth simulation are shown below as "Phase 3 + wind" for which four wind turbines are imposed to the model. This allows for a higher renewable fraction reached in phase 3, for a slightly higher LCOE.

		Optimal system composition				Results				
Diesel price scenario	Phase	Wind turbines	PV capacity	Battery capacity	Battery`s inverter capacity	Renewable fraction	LCOE	LCOE savings	Fuel consumption	Fuel savings
$/Liter		number	MWp	MWh	MW	%	$/kWh	%	Liters/year	%
0.24	Phase 0	3	0.0	0.0	0.0	16%	0.177	0%	4,729,338	0%
	Phase 1	3	2.5	1.5	1.0	29%	0.162	9%	3,979,728	16%
	Phase 2	3	3.5	1.5	1.0	33%	0.162	5%	3,796,109	34%
	Phase 3	3	4.5	2.0	1.5	29%	0.151	9%	5,320,156	20%
	Phase 3 + wind	4	4.5	2.0	1.5	33%	0.156	6%	5,068,910	24%
0.50	Phase 0	3	0.0	0.0	0.0	16%	0.233	0%	4,707,139	0%
	Phase 1	3	3.5	1.5	1.0	33%	0.206	12%	3,713,956	21%
	Phase 2	3	5.0	2.0	1.5	39%	0.205	10%	3,470,950	39%
	Phase 3	3	6.5	2.5	1.5	35%	0.194	13%	4,878,479	26%
	Phase 3 + wind	4	6.5	2.5	2.0	38%	0.198	11%	4,646,349	30%
0.90	Phase 0	3	0.0	0.0	0.0	16%	0.318	0%	4,691,516	0%
	Phase 1	3	5.5	2.0	1.5	40%	0.266	16%	3,320,863	29%
	Phase 2	3	6.0	2.0	1.5	41%	0.267	15%	3,318,958	42%
	Phase 3	3	8.5	2.0	1.5	39%	0.257	17%	4,606,782	30%
	Phase 3 + wind	4	8.5	2.0	1.5	41%	0.258	17%	4,397,493	34%

Table 14: Results of multi-phase HOMER simulation by diesel price scenario

All results above are based on the optimal configurations for a multiple-phase implementation, i.e. the table shows only the configuration with the lowest LCOE. A full listing of all simulations, including non-optimal configurations, can be found in the Appendix.

4.3.4 Key results:

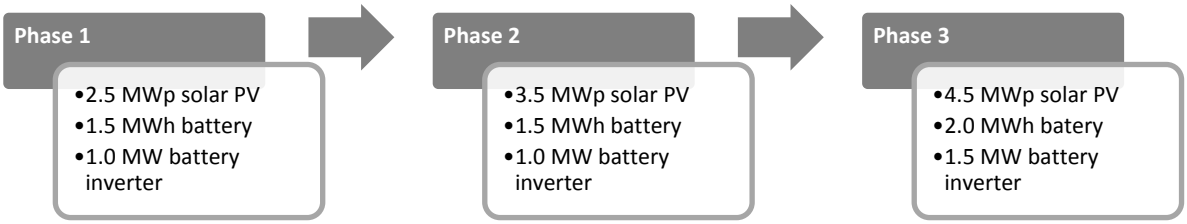
- Battery storage: In all diesel price scenarios, the optimal system configuration includes significant battery capacity (1.5-2.0 MWh with 1.0-1.5 MW of inverter capacity) even in Phase 1. This capacity then increases to 2.0 MWh and 1.5 MW inverter capacity or more in all scenarios. Interestingly this result holds even in simulations without any additional solar capacity, i.e. the current wind-diesel hybrid system would already benefit from at least some storage capacity to reduce curtailment.
- Solar PV: The implementation of solar PV delivers economic benefits in even the low fuel price scenarios, however, the optimal solar capacity increases rapidly at higher fuel prices.
- Firm capacity: Implementation of the solar + battery capacities under the phasing assumptions above obviates the need for additional diesel generator capacity (which would normally be required to cover load growth). Specifically, this means that the solar-battery combination does not only function as a fuel saver but also counts as dispatchable capacity.
- Wind: Adding additional wind capacity makes sense only in / after 2026 (at significant higher loads), or when a significant space constraint is assumed, limiting the capacity of the solar plant

4.3.5 Limitations of the HOMER model

While the multi-phase simulations address a critical weakness of the earlier, single-phase, simulation, these types of HOMER simulations nevertheless still have some limitations. In particular, the following parameters are not modeled, and have to be validated externally:

- Space availability and land costs have to be investigated further
- Electricity demand growth has to be watched closely in terms of intra-day and seasonal variation
- Long term forecast of pricing assumptions has to be re-evaluated over time
- Homer simulations do not account for short-term (seconds and minutes scales) variations, which are, however, critical when managing a hybrid power system with a very high (up to 100%) penetration of wind and solar resources. For this reason and based on their field experience, the Enerwhere team suggests to increase the battery inverter capacity to at least 50% of the load, to provide sufficient fast-response buffer capacity against sudden changes in wind speed or reduction in solar output due to clouds.

4.3.6 Multi-phase model results - Subsidized diesel price

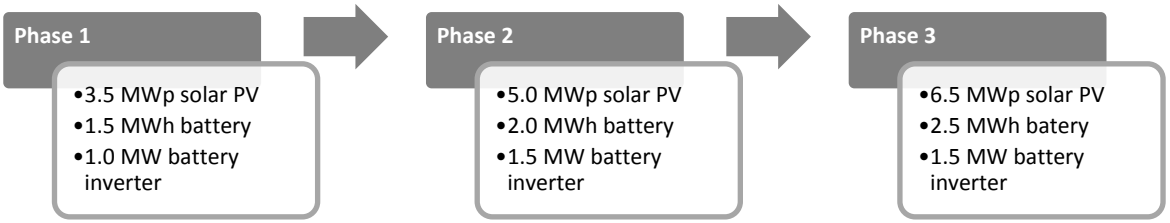


	Space required for PV plant	CAPEX	OPEX (except fuel)	Fuel cost	Payback time
	m^2	$	$/year	$/year	years
Phase 1	25,000	5,949,090	1,279,146	1,135,041	8.1
Phase 2	35,000	1,712,770	1,261,067	972,488	14.2
Phase 3	45,000	3,385,720	1,630,988	1,343,087	12.5
Phase 3 + wind	45,000	5,597,560	1,604,677	1,343,087	24.0

Table 15: Financial parameters of different phases for subsidized diesel price

The low diesel price scenario is the least attractive from a financial point of view. In fact, the savings derived from the implementation of the project come from fuel saving. Even if the subsidized diesel price of $0.24/Liter reduces the margins, the high curtailment of wind energy increases the benefits of a solar-battery system implemented before 2018. The addition of solar becomes more interesting as its cost decreases in later phases. The addition of the wind turbine on the other hand is not economically feasible in this scenario. The payback time of phase 3 with a bigger wind park would be 24 years, only one year less than the expected lifetime of the turbine.

4.3.7 Multi-phase model results - World market diesel price

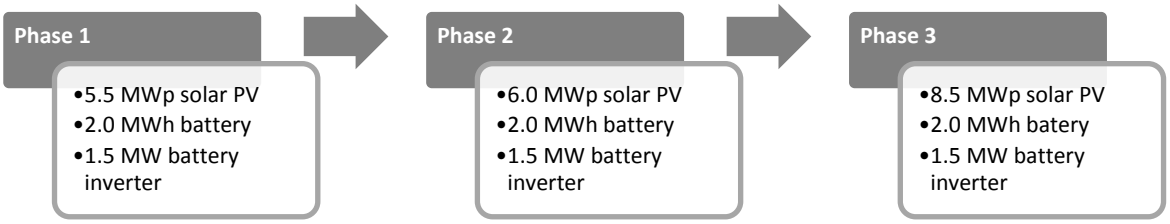


	Space required for PV plant	CAPEX	OPEX (except fuel)	Fuel cost	Payback time
	m^2	$	$/year	$/year	years
Phase 1	35,000	7,863,090	1,200,919	2,353,569	7.0
Phase 2	50,000	2,834,420	1,176,102	1,891,474	12.4
Phase 3	65,000	3,385,720	1,488,872	2,594,123	12.1
Phase 3 + wind	65,000	6,370,900	1,467,253	2,594,123	18.1

Table 16: Financial parameters of different phases for world market diesel price

If the subsidies on diesel are removed and the diesel price rises to the world market price of $0.50/Liter, the margin on the hybrid system would increase. As for the low fuel scenario, batteries are extremely attractive even in Phase 1. Higher fuel savings make higher PV installed capacity optimal. In this scenario, space availability could become a constraint. In this case a 4th wind turbine could be installed to increase the renewable penetration, however, the long payback time indicates that this were unlikely to happen under a pure private investment scenario.

4.3.8 Multi-phase model results - Rebound diesel price



	Space required for PV plant	CAPEX	OPEX (except fuel)	Fuel cost	Payback time
	m^2	$	$/year	$/year	years
Phase 1	55,000	12,099,370	1,097,418	4,222,365	6.2
Phase 2	60,000	957,010	1,140,829	3,044,264	14.5
Phase 3	85,000	3,385,720	1,381,829	5,036,574	12.2
Phase 3 + wind	85,000	7,675,360	1,369,293	5,036,574	14.7

Table 17: Financial parameters of different phases for rebound diesel price

In the scenario where the diesel price rises to $0.90/Liter, large battery and solar PV capacity could be installed with economic advantages. In this scenario, space could significantly limit the solar park capacity. In this case, an additional wind turbine could be feasible even with lower revenues than with PV panels. A possible alternative to overcome the limit of space would be to deploy distributed solar on rooftops of existing buildings.

5 Conclusions and Recommendations

5.1 High attractiveness of the solar PV technology

The model selects solar PV with batteries and no additional wind turbine from day one under any fuel price scenario. A 2.5 MWp solar PV with 1.5 MWh battery and 1 MW battery inverter system is a virtual no-brainer, under nearly any set of assumptions. Even if fuel subsidies are not removed for the whole duration of the project, the tri-hybrid power system will generate 9% savings on the cost of electricity. These savings would almost double in case of an increase of diesel price to $0.90/Liter.

5.2 Benefits of batteries in phase 1 for every fuel price scenario

Batteries are required from the first phase. HOMER recommends the implementation of batteries also when the possibility of implementing solar is turned off. They allow to store the wind energy that is currently curtailed. By buffering the wind park output, it would be possible to run generator-free when renewable sources can satisfy the full electricity demand. In the optimal phase 1 configuration for subsidized diesel, generators could be switched off for 332 hours every year with a peak during windy weeks of August, when generators would be running only 87% of the time (Figure 18). The running hours when the battery allows the electricity to be supplied 100% from renewable energy, would be even more in later stages. It would not make sense to install even a 1 MWp solar plant on the island without storage.

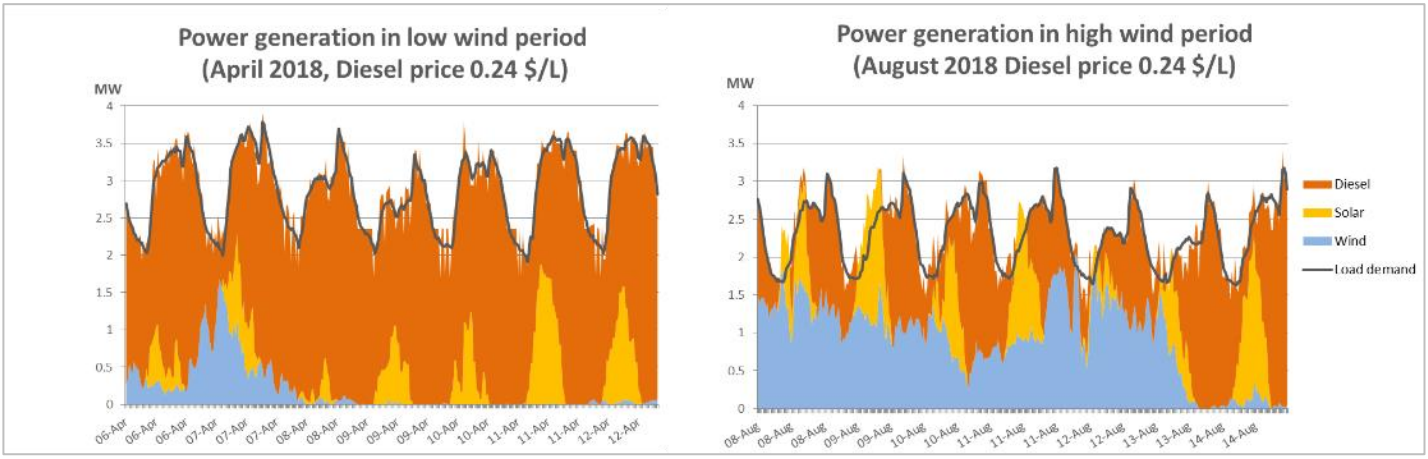


Figure 18: Power generation for April and August 2018 (phase 1 simulation, subsidized diesel price scenario)

5.3 Different optimized sizing depending on fuel price evolution scenarios

The optimal sizing of PV plant and battery storage is strongly dependent on fuel price evolution. In fact, the higher potential economic savings in a rebound scenario incentivize the investment to seek better fuel efficiencies. The PV capacity installed does involve high curtailment but helps saving fuel as it allows to switch off the generators for a few hours a day as long as come battery capacity is added to provide buffer against short-term fluctuations. In order to ensure sufficient short-term buffer and stop the diesel generators at day-time, Enerwhere encourages to increase the size of the battery inverter to cover about 80% of the peak load, which leads to about 2 MW.

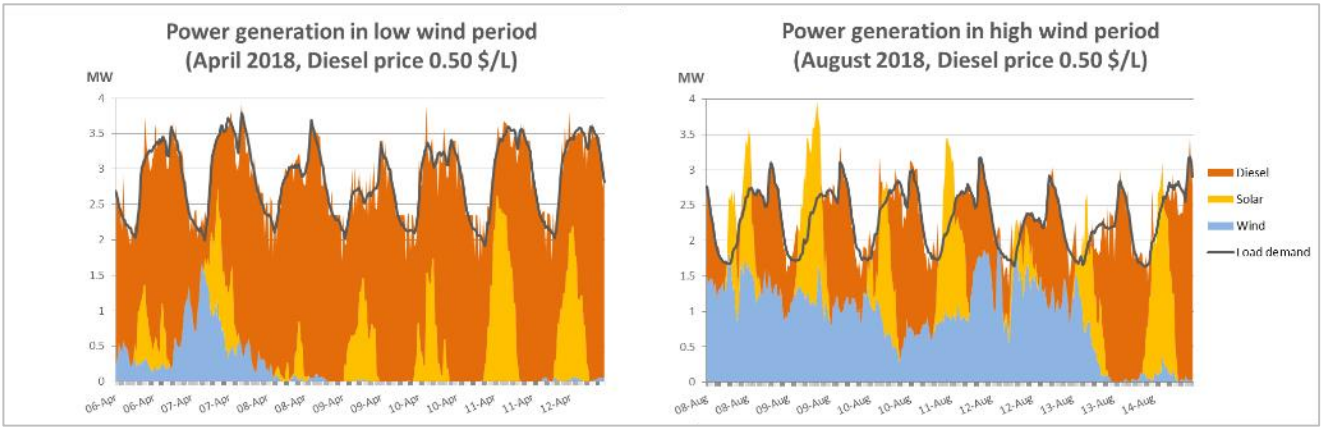


Figure 19: Power generation for April and August 2018 (phase 1 simulation, world market diesel price scenario)

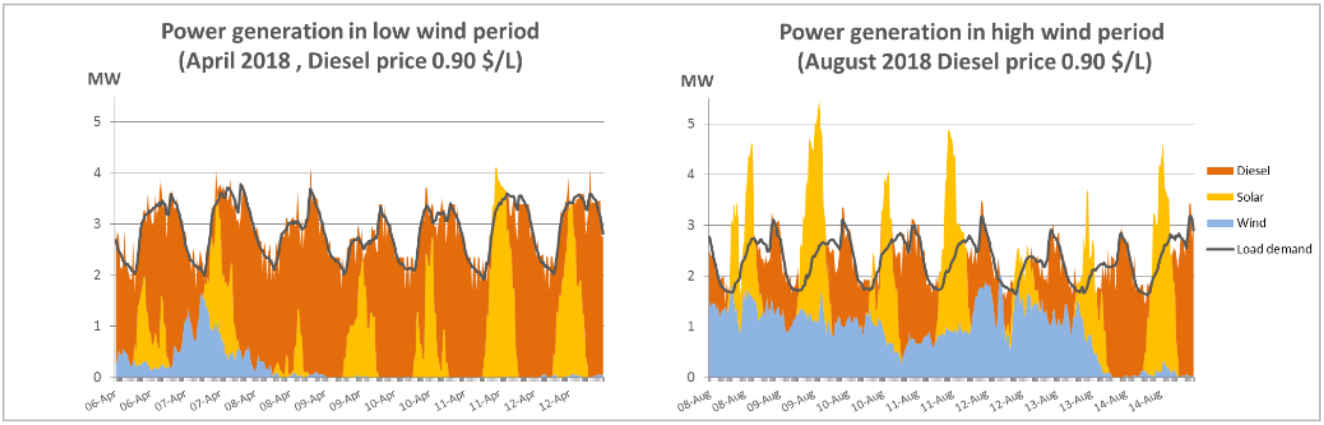


Figure 20: Power generation for April and August 2018 (phase 1 simulation, rebound diesel price scenario)

5.4 No need to upgrade the DG park

Without solar and battery storage, the DG park would need to be upgraded with an additional 2 MVA diesel generators by 2027. With the solar and battery systems, the existing diesel generator park is large enough to supply the loads up to 2048, according to the load forecast. Solar and batteries together therefore not only reduce fuel consumption but also count as firm capacity.

5.5 Potential addition of the fourth wind turbine in phase 3

On the one hand, given the difficult logistics in the Galapagos Islands wind is slightly more expensive than solar PV. On the other hand, wind has the definite advantage of space efficiency. Indeed, the area of the fourth wind turbine is already part of the existing wind park and will not require further land acquisition. Therefore, increasing the wind capacity is still a viable option towards the replacement of fuel on the island and the increase of renewable penetration. However, the inverse correlation between the electricity demand and wind velocity during the year makes the addition of a 4th wind turbine not economically attractive until around 2026. Only after this year, according to the forecasts, loads should be high enough and batteries cheap enough to generate benefits from larger wind park.

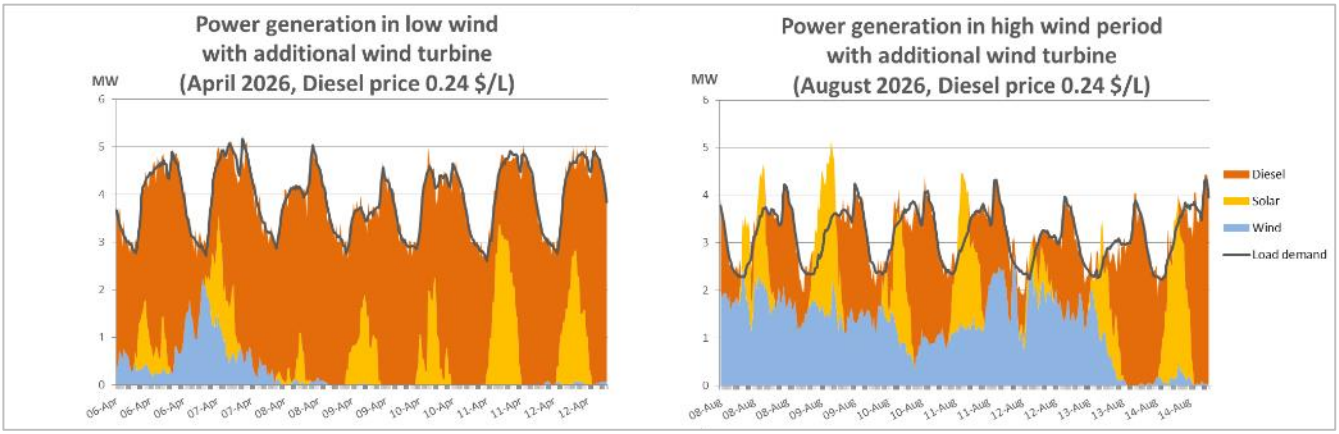


Figure 21: Power generation for April and August 2026 (phase 3 with 4th wind turbine simulation, subsidized diesel price scenario)

5.6 Potential financing structures

The high competitiveness of the existing wind park generation and necessary curtailment of the solar PV field production at instants when the electricity demand is low and the batteries are full make this project very risky from a commercial angle as the off-take is not guaranteed. For this reason and for the relatively small capacity size of the project compared to its logistical complexity the project is unattractive to private investors who would like to invest in a Power purchase agreement scheme. The real beneficiary of the fuel savings is the local utility and therefore the Ecuadorian inhabitants who are sharing ELECGALÁPAGOS S.A. deficits on their electricity bills. The most probable scheme is a public-NGOs partnership developing the project through a EPC+O&M tender process as a whole or in 3 separate phases. The ownership of the system laying with the local utility who would then operate the plants at their lowest cost of production.

5.7 Space availability and land costs to be investigated further

The space required by the late stages of the project exceeds the spaces that were shown to Enerwhere during the site visit. Further investigation should be carried out to assess if more land can be made available to build a solar park. Land provision cost are not included in the model but, given the big difference in cost of electricity from solar and diesel generators, this factor is not likely to change the outcome of the study.

5.8 Electricity demand growth to be watched closely in terms of intra-day and seasonal variation.

The evolution of intra-day and seasonal variation over the years is difficult to forecast. For this reason, if the load curve changes drastically, some change may occur to the optimal system configuration. Indeed, if the demand during the windy period (August) grows slower than the less windy one (April), additional battery capacity may be required to avoid excessive curtailment.

5.9 Revaluate the pricing assumptions over time

Prices of battery, PV, and related equipment for later stages of the study have been forecasted according to current trends and expectance. Long-term forecasts are inaccurate by definition. Enerwhere therefore recommends to check the validity of the forecasts presented with the actual value for the later phases of the project.

5.10 Next steps towards initiating a tendering process

Steps	Description	Timeline
Solar irradiation measurements	Validation of the solar irradiation by fixing the existing sensors and cleaning them on a daily or weekly basis to ensure reliable data acquisition for further analysis	Starting at the earliest and for a full year
Land usability	Validate the availability, soil properties and costs of the proposed solar PV field areas	Before the tendering process can be initiated
Diesel generator plant control	Ensure the diesel generator plant is upgraded as per the latest plans and all drawings are updated for provision in the tender documents	Documents to be provided together in the tendering

6 Appendixes

6.1 Data sources of key technical parameters

Parameter	Unit	Description	Source
Demand			
Energy Consumption	kWh	Monthly figures available from January 2013 up to August 2015, with a yearly demand forecast lead to 2024	ELECGALAPAGOS demand feeder 1, 2 & 3 report ELECGALAPAGOS demand forecast
Peak load	kW	From May 2014 to August 2015, data retrieved in a 10-minute interval for all the three feeders. Used for load curve in HOMER model: 10-minutes power average from 1st September 2014 to 31st August 2015	ELECGALAPAGOS demand feeder 1, 2 & 3 report
Generation			
Energy Production Diesel Generator	kWh	From September 2014 to August 2015 daily data retrieved in a 10-minutes interval for diesel Generators 1, 3 and 4. Serves the purpose to study at what energy level does each generator switch on and how much energy does each one provide	ELECGALAPAGOS Combined report for the 3 wind turbines and diesel generators 1,3 and 4
Energy Production Wind Turbine	kWh	From January 2015 to May 2016 monthly data retrieved in an hourly basis for the size diesel generators	EOLICSA diesel generator and fuel figures report
Diesel Generator Fuel Consumption	US Gallons	From 2013 to May 2016 monthly values of the diesel consumption of the 6 diesel generators	EOLICSA and ELECGALAPAGOS Diesel Generation Reports
Diesel Generator Running Hours	Hours	From 2013 to 2015 monthly values of the running hours of the 6 diesel generators	EOLICSA and ELECGALAPAGOS Diesel Generation Reports
Wind Speed	m/s	2015-2016 daily data retrieved in a 10-minutes interval for all the wind turbines. Used for wind resource in HOMER model: 10-minutes average speed between the 3 turbines from 1st September 2014 to 31st August 2015	EOLICSA wind speed report
Energy Production from Solar PV	kWh	From February 2015 to May 2016, data retrieved in a 10-minute interval for the solar system near the diesel generator plant. The solar plant at the school has a signal problem that stopped sending data	EOLICSA PV energy diesel generator plant report
Voltage and Current/phase for Solar PV	V - Amps/phase	From July 2012 to July 2014, data retrieved in a 15-minute interval for the solar system near the diesel generator plant.	EOLICSA PV control room report
Solar Irradiation	W/m2	From February 2015 to June 2016, data retrieved in a 10-minute interval. And from August 2007 to June 2010, data retrieved in an hourly basis. Serves to validate the production of the modules design with the actual numbers. Used for	EOLICSA solar radiation report and EOLICSA PV control room report

Parameter	Unit	Description	Source
		irradiation in HOMER model: 10-minutes average GHI from 1st March 2015 to 28th February 2016	
Solar Panel Temperature	Degrees C	From February 2015 to June 2016, data retrieved in a 10-minute interval. And from August 2007 to June 2010, data retrieved in an hourly basis. Serves to study the temperature effect on the productivity of the solar panels. Used for temperature in HOMER model: 10-minutes average temperature from 1st March 2015 to 28th February 2016	EOLICSA solar radiation report and EOLICSA PV control room report

6.2 Main input parameters for HOMER simulations

Type	Component	Parameter	Unit	Value	Source	Notes
General		Electricity consumption	kWh/year	17,456,528	ELECGALAPAGOS Forecast	Expected electricity consumption for 2018 (the 10-minute interval power curve for 2018 is scaled from 2014/15 values)
General		Electricity demand growth rate for San Cristobal Island	%	6.2% 1%	ELECGALAPAGOS Forecast Enerwhere assumption	Forecasted annual electricity demand growth for 2018-2024 Forecasted annual electricity demand growth for 2025-2048
General		Cost of Capital	%	6%	Enerwhere assumption	Similar projects in development
General		Grid tariff inflation rate	%	2.0%	Enerwhere assumption	Annual inflation of end user electricity tariffs
General		IPP inflation rate	%	1.5%	Enerwhere assumption	Annual inflation of IPP generation tariff
General	Scenario 1	Cost of diesel fuel (Subsidized scenario)	$/Liter	0.24	Ecuadorian Ministry of Electricity and Renewable Energy	Subsidized price of diesel for electricity generation purposes in Ecuador
General	Scenario 2	Cost of diesel fuel (Market scenario)	$/Liter	0.5	Indexmundi	Expected diesel price without subsidies associated to the actual crude oil price of 49 $/barrel
General	Scenario 3	Cost of diesel fuel (Rebound scenario)	$/Liter	0.9	Enerwhere assumption	Expected Diesel price without subsidies associated to an increase in crude oil price by 50%
Diesel generator	All	Capital cost	$/kW	250	Enerwhere specified	
Diesel generator	All	Replacement cost	$/unit	As capital	Enerwhere specified	
Diesel generator	All	O&M cost	$/kWp/h	0.07	ELECGALAPAGOS	
Diesel generator	All	Fuel consumption	From data sheets		Manufacturer data sheets	
Diesel generator	All	Minimum load ratio	%	25%	Manufacturer data sheets	
Diesel generator	All	Minimum runtime	Minutes	10	Enerwhere specified	
Diesel generator	All	Lifetime	Hours	60,000	Enerwhere specified	

Type	Component	Parameter	Unit	Value	Source	Notes
Wind turbine	AE-59	Capital cost	$/kW	1,800	INNOGY	For financial modelling
Wind turbine	AE-59	O&M cost	$/kW/year	54	EolicSA	
Wind turbine	AE-59	Lifetime	years	25	SCMI budgetary proposal	For depreciation calculation
Wind turbine	AE-59	Losses	Included in power curve		Enerwhere specified	
Solar PV	Panel	Capital cost	$/kWp	550	Enerwhere specified	BYD Module 265 Wp (expected price 2018)
Solar PV	Panel	Lifetime	years	30	Enerwhere specified	
Solar PV	Panel	Efficiency	%	16%	JA Solar	
Solar PV	Panel	NOCT	°C	45	JA Solar	
Solar PV	Panel	Temperature coefficient	%/C°	-0.41%	JA Solar	
Solar PV	Panel	Derating factor	%	85-90%	Enerwhere specified	
Solar PV	Panel	Ground reflectance	%	20%	Enerwhere specified	
Solar PV	Panel	O&M for fixed tilt	$/kWp/year	20	Enerwhere specified	
Solar PV	Panel	O&M for seasonal-tilt	$/kWp/year	27	Enerwhere specified	
Solar PV	Panel	O&M for single-axis tracking	$/kWp/year	30	Enerwhere specified	
Solar PV	Inverter	Capital Cost	$/kW	150	Enerwhere specified	Sungrow 60 kWac (expected price 2018)
Solar PV	Inverter	Replacement Cost	$/kW	100	Enerwhere specified	
Solar PV	Inverter	Lifetime	years	12	Sungrow 60 KTL	
Solar PV	Inverter	Efficiency	%	99%	Sungrow 60 KTL	
Battery	BYD 250	Battery Cost	$/kWh	560	Enerwhere specified	Lithium Iron Phospate (LiFePO4) batteries (expected price 2018)
Battery	BYD 250	Replacement cost	$/kWh	303	Enerwhere estimate	Expected battery replacement cost in 2028
Battery	BYD 250	Lifetime	cycles	5,000	Enerwhere specified	At 80% depth of discharge
Battery	BYD 250	O&M cost	$/kWh/year	5	Enerwhere estimate	NREL
Battery	Inverter	Capital cost	$/kVA	150	Enerwhere specified	(expected price 2018)
Battery	Inverter	Lifetime	years	10	BYD	
Battery	Inverter	Efficiency	%	95%	BYD	
Battery	Rectifier	Capacity	%	100%	BYD	
Battery	Rectifier	Efficiency	%	97%	BYD	

6.3 Single line diagrams

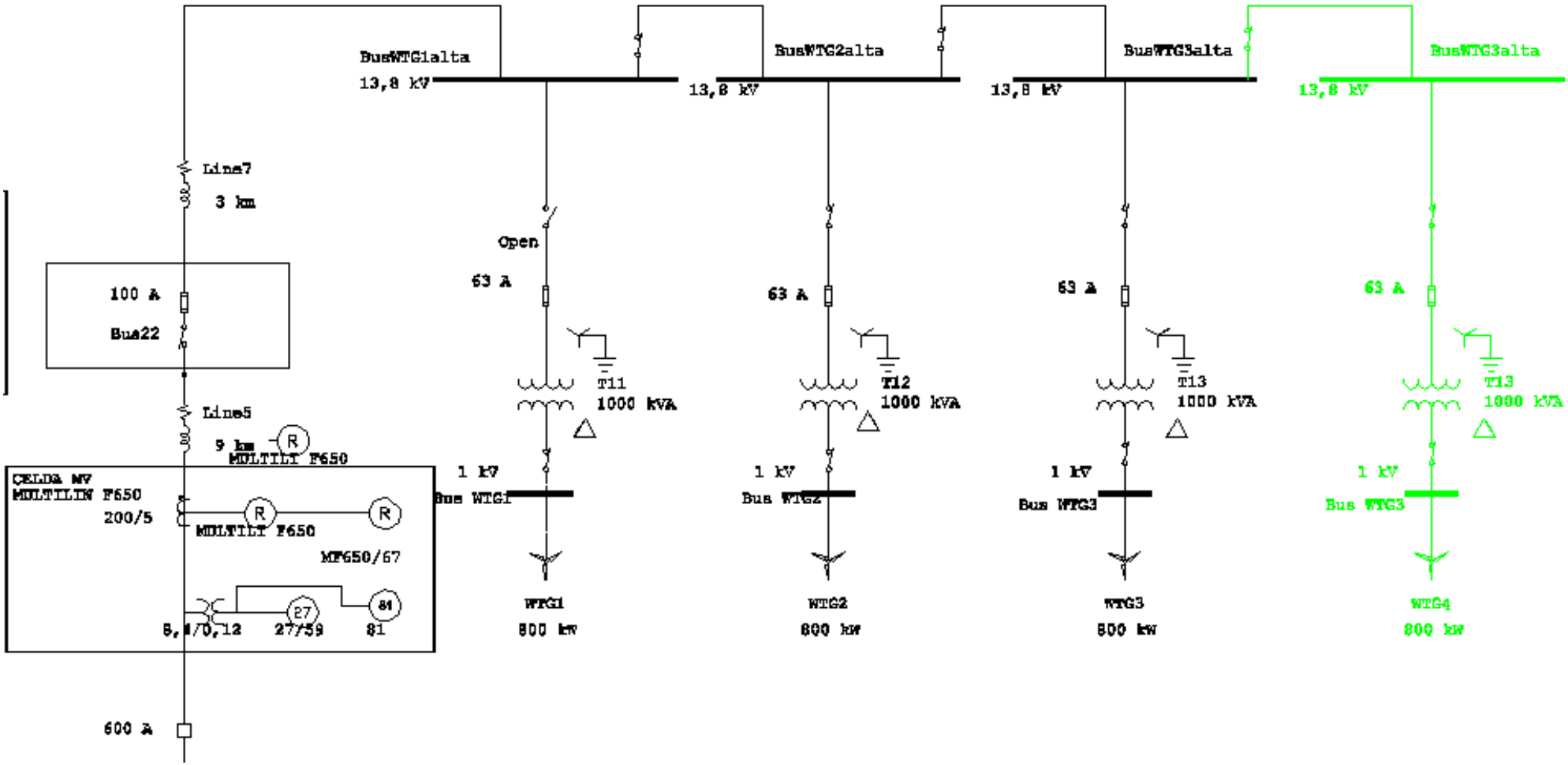


Figure 22: Single Line diagram of the current wind-diesel mini-grid with proposed connection point for the fourth wind turbine

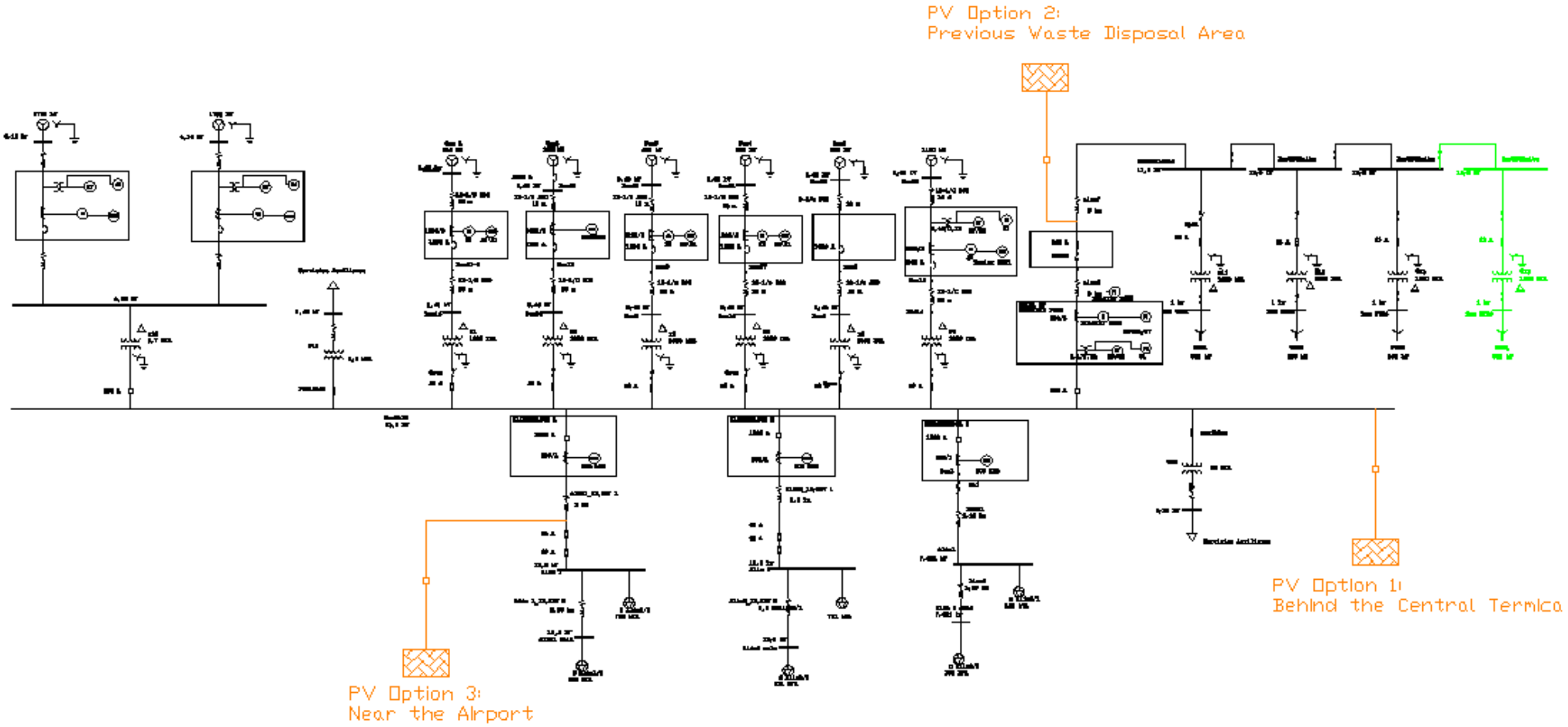


Figure 23: Single Line diagram of the current wind-diesel mini-grid with proposed connection points for the solar PV field(s)

6.4 HOMER solutions for multi-phase simulation model

The following table contains all solutions from the HOMER multi-phase simulation model. The optimal solution for each phase and scenario is highlighted.

Diesel Fuel Price Scenario	Phase	PV capacity	Wind turbines	Battery capacity	Battery`s inverter capacity	LCOE	Net present cost	Operating cost	Initial capital	Renewable fraction	1. Cat 650 Electricity production	3. Cat 650 Electricity production	4. Cat 650 Electricity production	9. Cat 1100 Electricity production	10. MTU 900 Electricity production	11. SKL 1670 Electricity production	12. SKL 1700 Electricity production	PV Capital Cost	PV electricity production	Wind turbine Electricity production	Wind turbine O&M Cost	Battery autonomy	Battery annual Throughput
$/L		kWp	Number	kWp	kWp	$/kWh	$	$	$	%	kWh/Year	kWh/Year	kWh/Year	kWh/Year	kWh/Year	kWh/Year	$/Year	$	kWh/Year	kWh/Year	$/Year	Hours	kWh/Year
0.24	**1**	**2500**	**3**	**1500**	**1000**	**0.1618**	**52,444,390**	**2,234,281**	**19,086,050**	**29**	**2,975,952**	**1,268,394**	**364,166**	**106,518**	**1,620,461**	**8,554,138**	**575,280**	**4,785,000**	**3,037,421**	**3,407,982**	**130,647**	**0.5**	**590,790**
0.24	1	3000	3	1500	1000	0.1618	52,472,650	2,172,076	20,043,050	31	2,928,779	1,239,911	360,604	108,542	1,571,444	8,183,010	552,058	5,742,000	3,644,904	3,407,982	130,647	0.5	596,614
0.24	1	2000	3	1500	1000	0.1620	52,517,630	2,303,284	18,129,050	26	3,050,569	1,347,155	394,310	114,539	1,645,485	8,866,066	605,472	3,828,000	2,429,937	3,407,982	130,647	0.5	578,976
0.24	1	3000	3	1500	1000	0.1777	57,624,600	2,517,144	20,043,050	32	2,927,382	1,222,496	356,401	151,989	603,216	8,289,256	1,264,711	5,742,000	3,644,904	3,407,982	130,647	0.5	133,500
0.24	1	2500	3	1500	1000	0.1784	57,834,670	2,595,312	19,086,050	29	2,976,611	1,261,300	366,614	156,636	623,619	8,643,596	1,318,371	4,785,000	3,037,421	3,407,982	130,647	0.5	88,870
0.24	1	2000	3	1500	1000	0.1791	58,083,600	2,676,083	18,129,050	27	3,032,301	1,314,853	380,538	164,151	632,754	8,999,339	1,388,052	3,828,000	2,429,937	3,407,982	130,647	0.5	54,817
0.24	**2**	**3500**	**3**	**1500**	**1000**	**0.1619**	**53,229,280**	**2,172,133**	**20,798,830**	**33**	**2,840,178**	**1,177,902**	**341,692**	**107,264**	**1,556,942**	**8,133,260**	**590,206**	**6,497,774**	**4,256,016**	**3,407,982**	**130,647**	**0.5**	**602,713**
0.24	2	3000	3	1500	1000	0.1619	53,230,940	2,229,603	19,942,440	31	2,941,185	1,245,435	361,434	107,254	1,571,979	8,392,748	607,104	5,641,390	3,648,016	3,407,982	130,647	0.5	596,005
0.24	2	3500	3	1500	1500	0.1620	53,250,780	2,170,658	20,842,340	33	2,847,445	1,193,552	342,959	107,780	1,545,870	8,111,088	591,702	6,497,774	4,256,016	3,407,982	130,647	0.5	610,451
0.24	2	3000	3	1500	1500	0.1620	53,260,490	2,228,668	19,985,960	31	2,943,430	1,254,293	362,099	111,524	1,561,444	8,379,706	608,804	5,641,390	3,648,016	3,407,982	130,647	0.5	602,869
0.24	2	3500	3	2000	1500	0.1621	53,269,050	2,157,029	21,064,100	33	2,872,195	1,254,625	388,019	123,948	1,484,451	7,959,431	602,310	6,497,774	4,256,016	3,407,982	130,647	0.7	680,022
0.24	2	3000	3	2000	1500	0.1622	53,305,520	2,216,830	20,207,710	31	2,947,311	1,305,432	397,587	118,734	1,523,861	8,275,380	617,678	5,641,390	3,648,016	3,407,982	130,647	0.7	653,125
0.24	2	2500	3	1500	1000	0.1622	53,314,330	2,292,547	19,086,060	29	2,987,551	1,273,607	366,923	106,753	1,624,098	8,762,639	632,094	4,785,006	3,040,011	3,407,982	130,647	0.5	590,561
0.24	2	3500	3	2000	1000	0.1623	53,346,920	2,165,159	21,020,580	33	2,870,248	1,183,828	348,792	113,805	1,565,606	8,061,225	571,064	6,497,774	4,256,016	3,407,982	130,647	0.7	649,642
0.24	2	2500	3	1500	1500	0.1623	53,354,460	2,292,320	19,129,570	29	3,004,860	1,286,765	368,311	108,825	1,599,019	8,745,464	638,078	4,785,006	3,040,011	3,407,982	130,647	0.5	597,856
0.24	2	4000	3	1500	1000	0.1623	53,356,680	2,123,306	21,655,210	35	2,749,194	1,142,322	332,653	106,414	1,532,466	7,882,102	579,258	7,354,158	4,864,019	3,407,982	130,647	0.5	605,407
0.24	2	4000	3	2000	1500	0.1623	53,360,370	2,105,787	21,920,480	35	2,795,213	1,212,639	387,873	133,760	1,453,868	7,673,044	587,520	7,354,158	4,864,019	3,407,982	130,647	0.7	704,232
0.24	2	3000	3	2000	1000	0.1624	53,364,510	2,223,696	20,164,200	31	2,959,648	1,243,571	364,539	110,488	1,590,250	8,348,463	591,124	5,641,390	3,648,016	3,407,982	130,647	0.7	631,928
0.24	2	4000	3	1500	1500	0.1624	53,376,080	2,121,691	21,698,730	35	2,765,101	1,156,485	335,295	111,312	1,514,458	7,852,085	581,230	7,354,158	4,864,019	3,407,982	130,647	0.5	615,847
0.24	2	2500	3	2000	1500	0.1626	53,440,710	2,283,244	19,351,330	29	3,000,306	1,339,858	398,724	119,790	1,588,249	8,647,595	636,548	4,785,006	3,040,011	3,407,982	130,647	0.7	633,735
0.24	2	4000	3	2000	1000	0.1626	53,458,950	2,115,304	21,876,960	35	2,784,000	1,143,123	339,680	116,402	1,550,790	7,790,715	554,200	7,354,158	4,864,019	3,407,982	130,647	0.7	667,666
0.24	2	2500	3	2000	1000	0.1627	53,466,970	2,287,918	19,307,810	29	3,006,220	1,276,267	372,410	109,454	1,636,508	8,723,177	621,078	4,785,006	3,040,011	3,407,982	130,647	0.7	614,995
0.24	2	4000	3	1500	1000	0.1766	58,040,670	2,437,032	21,655,210	36	2,803,709	1,170,992	363,264	141,663	587,518	7,880,294	1,224,199	7,354,158	4,864,019	3,407,982	130,647	0.5	221,224
0.24	2	4000	3	1500	1500	0.1768	58,105,220	2,438,441	21,698,730	36	2,800,794	1,161,687	359,009	141,827	587,712	7,888,301	1,230,218	7,354,158	4,864,019	3,407,982	130,647	0.5	221,038

Diesel Fuel Price Scenario	Phase	PV capacity	Wind turbines	Battery capacity	Battery's inverter capacity	LCOE	Net present cost	Operating cost	Initial capital	Renewable fraction	1. Cat 650 Electricity production	3. Cat 650 Electricity production	4. Cat 650 Electricity production	9. Cat 1100 Electricity production	10. MTU 900 Electricity production	11. SKL 1670 Electricity production	12. SKL 1700 Electricity production	PV Capital Cost	PV electricity production	Wind turbine Electricity production	Wind turbine O&M Cost	Battery autonomy	Battery annual Throughput
$/L		kWp	Number	kWp	kWp	$/kWh	$	$	$	%	kWh/Year	kWh/Year	kWh/Year	kWh/Year	kWh/Year	kWh/Year	$/Year	$	kWh/Year	kWh/Year	$/Year	Hours	kWh/Year
0.24	2	3500	3	1500	1000	0.1771	58,213,130	2,505,942	20,798,830	34	2,867,940	1,195,914	361,488	144,112	602,690	8,152,351	1,281,706	6,497,774	4,256,016	3,407,982	130,647	0.5	176,140
0.24	2	3500	3	1500	1500	0.1773	58,268,990	2,506,769	20,842,340	34	2,870,526	1,189,757	359,995	144,843	598,623	8,158,338	1,282,444	6,497,774	4,256,016	3,407,982	130,647	0.5	176,173
0.24	2	3000	3	1500	1000	0.1779	58,489,750	2,581,828	19,942,440	31	2,935,386	1,228,327	365,773	151,405	609,654	8,459,882	1,347,558	5,641,390	3,648,016	3,407,982	130,647	0.5	128,431
0.24	2	3000	3	1500	1500	0.1781	58,548,000	2,582,815	19,985,960	31	2,941,885	1,228,328	365,679	151,002	609,801	8,452,916	1,347,473	5,641,390	3,648,016	3,407,982	130,647	0.5	127,908
0.24	2	4000	3	2000	1500	0.1789	58,789,290	2,469,406	21,920,480	36	2,653,095	1,100,747	326,951	144,601	599,300	7,987,698	1,305,843	7,354,158	4,864,019	3,407,982	130,647	0.7	274,755
0.24	2	2500	3	1500	1000	0.1789	58,798,780	2,659,885	19,086,060	29	2,981,883	1,270,270	378,043	155,931	629,652	8,815,782	1,403,944	4,785,006	3,040,011	3,407,982	130,647	0.5	84,104
0.24	2	4000	3	2000	1000	0.1790	58,852,560	2,476,558	21,876,960	36	2,663,732	1,100,435	326,059	145,247	612,687	7,970,996	1,305,614	7,354,158	4,864,019	3,407,982	130,647	0.7	276,367
0.24	2	2500	3	1500	1500	0.1791	58,860,440	2,661,101	19,129,570	29	2,987,375	1,271,376	377,880	156,444	628,907	8,808,757	1,404,090	4,785,006	3,040,011	3,407,982	130,647	0.5	84,016
0.24	2	3500	3	2000	1500	0.1792	58,908,460	2,534,747	21,064,100	34	2,736,160	1,141,937	337,243	148,226	613,394	8,254,208	1,337,058	6,497,774	4,256,016	3,407,982	130,647	0.7	213,821
0.24	2	3500	3	2000	1000	0.1793	58,944,650	2,540,085	21,020,580	34	2,744,360	1,140,462	336,474	149,032	625,299	8,240,487	1,336,810	6,497,774	4,256,016	3,407,982	130,647	0.7	215,478
0.24	2	3000	3	2000	1500	0.1799	59,139,320	2,607,568	20,207,710	32	2,827,150	1,185,162	347,593	154,360	625,236	8,561,877	1,374,111	5,641,390	3,648,016	3,407,982	130,647	0.7	150,017
0.24	2	3000	3	2000	1000	0.1799	59,141,630	2,610,638	20,164,200	32	2,833,895	1,183,701	346,975	154,776	632,820	8,552,040	1,374,054	5,641,390	3,648,016	3,407,982	130,647	0.7	152,309
0.24	2	2500	3	2000	1000	0.1807	59,382,210	2,684,110	19,307,810	29	2,904,568	1,233,356	364,300	161,285	650,192	8,893,613	1,417,237	4,785,006	3,040,011	3,407,982	130,647	0.7	98,345
0.24	2	2500	3	2000	1500	0.1808	59,411,690	2,683,170	19,351,330	29	2,900,539	1,234,052	364,568	161,040	645,378	8,900,009	1,417,237	4,785,006	3,040,011	3,407,982	130,647	0.7	97,388
0.24	**3**	**4500**	**3**	**2000**	**1500**	**0.1505**	**66,056,200**	**2,907,826**	**22,641,670**	**29**	**2,962,947**	**1,252,027**	**352,092**	**110,208**	**1,793,792**	**10,755,980**	**3,624,482**	**8,106,278**	**5,472,019**	**3,407,982**	**130,647**	**0.5**	**672,180**
0.24	3	5000	3	2000	1500	0.1505	66,067,740	2,854,732	23,445,920	31	2,904,775	1,225,780	350,483	108,581	1,766,968	10,497,930	3,525,408	8,910,530	6,080,021	3,407,982	130,647	0.5	692,240
0.24	3	4000	3	2000	1500	0.1507	66,135,900	2,967,032	21,837,420	28	3,014,094	1,290,757	360,632	106,438	1,814,623	11,035,840	3,741,800	7,302,026	4,864,019	3,407,982	130,647	0.5	650,209
0.24	3	5000	3	2500	1500	0.1507	66,148,990	2,847,097	23,641,160	31	2,928,943	1,249,985	369,354	120,268	1,758,551	10,423,160	3,487,931	8,910,530	6,080,021	3,407,982	130,647	0.7	732,752
0.24	3	5500	3	2000	1500	0.1507	66,162,350	2,807,201	24,250,180	33	2,857,386	1,206,843	350,053	112,485	1,729,738	10,258,510	3,436,330	9,714,782	6,688,023	3,407,982	130,647	0.5	707,027
0.24	3	4500	3	2500	1500	0.1508	66,164,570	2,902,008	22,836,910	30	2,976,253	1,276,289	371,614	114,993	1,780,965	10,696,480	3,606,060	8,106,278	5,472,019	3,407,982	130,647	0.7	699,949
0.24	3	5500	3	2500	1500	0.1509	66,226,760	2,798,439	24,445,410	33	2,892,186	1,239,341	372,898	129,497	1,721,544	10,155,550	3,385,715	9,714,782	6,688,023	3,407,982	130,647	0.7	762,015
0.24	3	4000	3	2500	1500	0.1510	66,273,400	2,963,165	22,032,660	28	3,029,021	1,314,423	375,624	111,302	1,798,850	10,993,470	3,723,802	7,302,026	4,864,019	3,407,982	130,647	0.7	666,594
0.24	3	4500	3	1500	1500	0.1510	66,283,980	2,936,158	22,446,440	29	2,921,471	1,215,836	328,637	103,376	1,781,664	10,853,380	3,705,402	8,106,278	5,472,019	3,407,982	130,647	0.4	577,556
0.24	3	3500	3	2000	1500	0.1511	66,301,600	3,031,997	21,033,170	26	3,051,651	1,327,612	372,881	108,986	1,844,197	11,343,970	3,861,658	6,497,774	4,256,016	3,407,982	130,647	0.5	629,838
0.24	3	4500	3	1500	1000	0.1511	66,306,170	2,940,264	22,407,330	29	2,917,045	1,212,230	328,070	100,694	1,774,547	10,865,130	3,717,487	8,106,278	5,472,019	3,407,982	130,647	0.4	562,226
0.24	3	4000	3	1500	1500	0.1511	66,306,590	2,991,540	21,642,190	28	2,963,705	1,245,576	337,213	100,536	1,820,724	11,130,600	3,806,304	7,302,026	4,864,019	3,407,982	130,647	0.4	577,221
0.24	3	4000	3	1500	1000	0.1511	66,322,740	2,995,241	21,603,080	28	2,960,660	1,241,526	335,941	101,175	1,811,501	11,140,300	3,817,060	7,302,026	4,864,019	3,407,982	130,647	0.4	562,444
0.24	3	5000	3	1500	1500	0.1511	66,333,890	2,885,634	23,250,690	31	2,871,172	1,191,459	324,574	101,310	1,748,074	10,602,410	3,617,295	8,910,530	6,080,021	3,407,982	130,647	0.4	576,671
0.24	3	5000	3	1500	1000	0.1512	66,360,780	2,890,055	23,211,580	31	2,867,422	1,185,814	322,954	100,678	1,740,720	10,613,130	3,632,660	8,910,530	6,080,021	3,407,982	130,647	0.4	560,971

Diesel Fuel Price Scenario	Phase	PV capacity	Wind turbines	Battery capacity	Battery's inverter capacity	LCOE	Net present cost	Operating cost	Initial capital	Renewable fraction	1. Cat 650 Electricity production	3. Cat 650 Electricity production	4. Cat 650 Electricity production	9. Cat 1100 Electricity production	10. MTU 900 Electricity production	11. SKL 1670 Electricity production	12. SKL 1700 Electricity production	PV Capital Cost	PV electricity production	Wind turbine Electricity production	Wind turbine O&M Cost	Battery autonomy	Battery annual Throughput
$/L		kWp	Number	kWp	kWp	$/kWh	$	$	$	%	kWh/Year	kWh/Year	kWh/Year	kWh/Year	kWh/Year	kWh/Year	$/Year	$	kWh/Year	kWh/Year	$/Year	Hours	kWh/Year
0.24	3	4500	3	2000	1000	0.1513	66,385,300	2,932,487	22,602,560	29	2,945,782	1,212,307	333,055	105,910	1,780,699	10,845,220	3,670,552	8,106,278	5,472,019	3,407,982	130,647	0.5	629,322
0.24	3	3500	3	1500	1500	0.1513	66,400,360	3,051,688	20,837,930	26	3,007,840	1,280,734	350,974	106,768	1,850,457	11,418,450	3,919,420	6,497,774	4,256,016	3,407,982	130,647	0.4	574,304
0.24	3	3500	3	1500	1000	0.1513	66,409,030	3,054,888	20,798,830	26	3,006,466	1,278,111	350,137	108,417	1,839,830	11,428,460	3,925,064	6,497,774	4,256,016	3,407,982	130,647	0.4	560,100
0.24	3	4000	3	2000	1000	0.1513	66,413,860	2,988,268	21,798,310	28	2,986,890	1,239,836	341,228	104,432	1,816,213	11,123,930	3,782,786	7,302,026	4,864,019	3,407,982	130,647	0.5	621,381
0.24	3	5000	3	2000	1000	0.1514	66,428,340	2,881,503	23,406,820	31	2,901,110	1,192,560	328,313	102,616	1,743,383	10,593,270	3,571,223	8,910,530	6,080,021	3,407,982	130,647	0.5	633,130
0.24	3	5500	3	1500	1500	0.1514	66,456,910	2,840,007	24,054,940	32	2,816,696	1,167,000	319,250	99,432	1,713,855	10,380,140	3,548,374	9,714,782	6,688,023	3,407,982	130,647	0.4	576,725
0.24	3	3500	3	2500	1500	0.1514	66,458,880	3,029,455	21,228,400	26	3,061,859	1,346,008	383,200	114,580	1,832,620	11,313,360	3,849,201	6,497,774	4,256,016	3,407,982	130,647	0.7	638,962
0.24	3	5500	3	1500	1000	0.1515	66,485,240	2,844,523	24,015,830	32	2,818,497	1,164,306	316,961	100,939	1,705,290	10,391,100	3,555,502	9,714,782	6,688,023	3,407,982	130,647	0.4	560,680
0.24	3	4500	3	2500	1000	0.1515	66,498,550	2,926,997	22,797,800	29	2,970,810	1,215,593	337,025	106,018	1,775,620	10,838,050	3,631,044	8,106,278	5,472,019	3,407,982	130,647	0.7	685,765
0.24	3	3500	3	2000	1000	0.1515	66,514,900	3,048,902	20,994,060	26	3,029,846	1,278,522	354,550	108,361	1,845,824	11,413,240	3,900,787	6,497,774	4,256,016	3,407,982	130,647	0.5	610,292
0.24	3	5000	3	2500	1000	0.1516	66,534,270	2,875,522	23,602,050	31	2,933,210	1,201,633	332,491	109,605	1,732,995	10,571,350	3,521,966	8,910,530	6,080,021	3,407,982	130,647	0.7	697,558
0.24	3	4000	3	2500	1000	0.1516	66,539,860	2,983,631	21,993,550	28	3,006,314	1,237,592	342,946	104,099	1,814,735	11,122,100	3,756,714	7,302,026	4,864,019	3,407,982	130,647	0.7	668,948
0.24	3	5500	3	2000	1000	0.1516	66,547,740	2,835,633	24,211,070	32	2,855,042	1,173,881	325,355	106,231	1,703,464	10,360,170	3,489,091	9,714,782	6,688,023	3,407,982	130,647	0.5	638,096
0.24	3	5500	3	2500	1000	0.1518	66,644,410	2,829,031	24,406,300	32	2,889,916	1,195,738	332,745	110,282	1,693,598	10,329,230	3,423,131	9,714,782	6,688,023	3,407,982	130,647	0.7	706,850
0.24	3	3500	3	2500	1000	0.1519	66,656,580	3,045,316	21,189,300	26	3,047,418	1,278,291	355,666	111,758	1,845,866	11,410,640	3,876,411	6,497,774	4,256,016	3,407,982	130,647	0.7	646,678
0.24	3	5500	3	1500	1000	0.1633	71,670,180	3,191,801	24,015,830	33	3,026,583	1,463,060	454,540	152,134	683,142	10,041,880	4,048,807	9,714,782	6,688,023	3,407,982	130,647	0.4	222,455
0.24	3	5500	3	1500	1500	0.1634	71,732,200	3,193,336	24,054,940	33	3,028,939	1,459,769	455,430	152,370	682,301	10,031,920	4,056,641	9,714,782	6,688,023	3,407,982	130,647	0.4	222,304
0.24	3	5000	3	1500	1000	0.1636	71,810,700	3,255,080	23,211,580	31	3,086,395	1,489,960	463,578	154,641	697,635	10,246,570	4,156,288	8,910,530	6,080,021	3,407,982	130,647	0.4	188,336
0.24	3	5000	3	1500	1500	0.1638	71,878,090	3,256,974	23,250,690	31	3,088,139	1,487,539	464,637	155,087	696,610	10,235,880	4,164,880	8,910,530	6,080,021	3,407,982	130,647	0.4	188,070
0.24	3	4500	3	1500	1000	0.1642	72,054,060	3,325,248	22,407,330	30	3,145,743	1,509,467	469,088	157,425	711,140	10,483,600	4,286,252	8,106,278	5,472,019	3,407,982	130,647	0.4	150,312
0.24	3	4500	3	1500	1500	0.1643	72,119,600	3,327,018	22,446,440	30	3,149,449	1,510,502	470,318	157,136	710,452	10,471,910	4,291,136	8,106,278	5,472,019	3,407,982	130,647	0.4	150,143
0.24	3	4000	3	1500	1000	0.1649	72,375,600	3,400,651	21,603,080	28	3,208,750	1,537,150	479,723	160,626	723,599	10,732,920	4,427,780	7,302,026	4,864,019	3,407,982	130,647	0.4	111,690
0.24	3	4000	3	1500	1500	0.1650	72,435,250	3,402,027	21,642,190	28	3,209,407	1,533,554	479,762	160,741	722,917	10,730,350	4,432,451	7,302,026	4,864,019	3,407,982	130,647	0.4	111,526
0.24	3	5500	3	2000	1500	0.1654	72,579,160	3,236,987	24,250,180	33	2,943,690	1,403,655	439,758	156,637	697,386	9,956,866	4,206,953	9,714,782	6,688,023	3,407,982	130,647	0.5	281,038
0.24	3	5000	3	2000	1500	0.1656	72,662,800	3,296,457	23,445,920	32	3,009,615	1,435,861	450,149	158,839	707,896	10,189,670	4,292,742	8,910,530	6,080,021	3,407,982	130,647	0.5	232,748
0.24	3	5500	3	2500	1500	0.1656	72,666,580	3,229,766	24,445,410	33	2,935,001	1,398,978	438,765	156,288	695,831	9,934,143	4,203,522	9,714,782	6,688,023	3,407,982	130,647	0.7	326,327
0.24	3	5500	3	2000	1000	0.1656	72,682,200	3,246,508	24,211,070	33	2,957,844	1,403,792	439,840	159,940	704,332	9,952,213	4,200,689	9,714,782	6,688,023	3,407,982	130,647	0.5	283,584
0.24	3	3500	3	1500	1000	0.1657	72,734,460	3,478,554	20,798,830	26	3,270,722	1,560,965	489,449	163,274	737,263	11,016,690	4,574,222	6,497,774	4,256,016	3,407,982	130,647	0.4	75,906
0.24	3	5000	3	2000	1000	0.1657	72,741,460	3,304,344	23,406,820	32	3,019,132	1,435,815	450,296	161,783	714,786	10,184,650	4,288,697	8,910,530	6,080,021	3,407,982	130,647	0.5	235,985

Diesel Fuel Price Scenario	Phase	PV capacity	Wind turbines	Battery capacity	Battery's inverter capacity	LCOE	Net present cost	Operating cost	Initial capital	Renewable fraction	1. Cat 650 Electricity production	3. Cat 650 Electricity production	4. Cat 650 Electricity production	9. Cat 1100 Electricity production	10. MTU 900 Electricity production	11. SKL 1670 Electricity production	12. SKL 1700 Electricity production	PV Capital Cost	PV electricity production	Wind turbine Electricity production	Wind turbine O&M Cost	Battery autonomy	Battery annual Throughput
$/L		kWp	Number	kWp	kWp	$/kWh	$	$	$	%	kWh/Year	kWh/Year	kWh/Year	kWh/Year	kWh/Year	kWh/Year	$/Year	$	kWh/Year	kWh/Year	$/Year	Hours	kWh/Year
0.24	3	5000	3	2500	1500	0.1658	72,769,640	3,290,536	23,641,160	32	3,002,951	1,432,478	449,860	158,653	706,591	10,172,510	4,290,708	8,910,530	6,080,021	3,407,982	130,647	0.7	265,930
0.24	3	3500	3	1500	1500	0.1659	72,794,600	3,479,963	20,837,930	26	3,271,406	1,560,815	489,603	162,712	736,310	11,014,980	4,575,927	6,497,774	4,256,016	3,407,982	130,647	0.4	75,724
0.24	3	5500	3	2500	1000	0.1659	72,799,100	3,241,261	24,406,300	33	2,956,799	1,400,005	438,042	160,143	704,246	9,926,784	4,190,355	9,714,782	6,688,023	3,407,982	130,647	0.7	330,472
0.24	3	4500	3	2000	1500	0.1660	72,838,100	3,362,065	22,641,670	30	3,079,960	1,468,011	460,386	160,732	718,672	10,448,510	4,390,968	8,106,278	5,472,019	3,407,982	130,647	0.5	181,476
0.24	3	5000	3	2500	1000	0.1660	72,877,600	3,300,386	23,602,050	32	3,018,081	1,432,199	449,148	162,140	714,380	10,165,120	4,282,503	8,910,530	6,080,021	3,407,982	130,647	0.7	271,031
0.24	3	4500	3	2000	1000	0.1661	72,883,490	3,367,724	22,602,560	30	3,085,672	1,467,728	460,315	162,699	725,454	10,443,590	4,388,866	8,106,278	5,472,019	3,407,982	130,647	0.5	184,960
0.24	3	4500	3	2500	1500	0.1663	72,972,570	3,357,995	22,836,910	30	3,074,511	1,465,625	460,094	160,458	717,783	10,437,780	4,390,102	8,106,278	5,472,019	3,407,982	130,647	0.7	203,857
0.24	3	4500	3	2500	1000	0.1664	73,039,580	3,365,102	22,797,800	30	3,084,431	1,465,552	460,076	162,958	724,998	10,429,520	4,385,190	8,106,278	5,472,019	3,407,982	130,647	0.7	208,918
0.24	3	4000	3	2000	1500	0.1665	73,088,560	3,432,708	21,837,420	28	3,156,987	1,502,727	473,524	163,479	729,927	10,721,580	4,499,789	7,302,026	4,864,019	3,407,982	130,647	0.5	131,553
0.24	3	4000	3	2000	1000	0.1666	73,101,110	3,436,168	21,798,310	28	3,160,873	1,502,764	473,518	164,509	735,381	10,716,300	4,499,100	7,302,026	4,864,019	3,407,982	130,647	0.5	134,778
0.24	3	4000	3	2500	1500	0.1669	73,249,410	3,430,404	22,032,660	28	3,153,437	1,501,700	473,383	163,367	729,190	10,714,590	4,499,639	7,302,026	4,864,019	3,407,982	130,647	0.7	145,171
0.24	3	4000	3	2500	1000	0.1670	73,275,810	3,434,792	21,993,550	28	3,159,681	1,501,747	473,450	164,610	734,809	10,707,030	4,497,676	7,302,026	4,864,019	3,407,982	130,647	0.7	149,683
0.24	3	3500	3	2000	1000	0.1671	73,356,940	3,507,170	20,994,060	26	3,237,112	1,539,452	486,862	165,943	746,271	11,004,590	4,622,139	6,497,774	4,256,016	3,407,982	130,647	0.5	90,023
0.24	3	3500	3	2000	1500	0.1672	73,373,190	3,505,640	21,033,170	26	3,234,431	1,539,466	486,927	165,013	743,020	11,008,530	4,622,330	6,497,774	4,256,016	3,407,982	130,647	0.5	87,830
0.24	3	3500	3	2500	1000	0.1676	73,544,400	3,506,649	21,189,300	26	3,235,970	1,538,479	486,762	165,978	746,016	10,999,700	4,621,697	6,497,774	4,256,016	3,407,982	130,647	0.7	98,638
0.24	3	3500	3	2500	1500	0.1676	73,551,970	3,504,537	21,228,400	26	3,231,993	1,538,665	486,830	164,992	742,654	11,004,960	4,622,190	6,497,774	4,256,016	3,407,982	130,647	0.7	95,817
0.24	3	4500	4	2000	1500	0.1561	68,517,790	2,821,215	26,396,390	33	2,895,325	1,209,871	332,986	103,228	1,766,194	10,213,480	3,329,506	8,106,278	5,472,019	4,543,970	174,196	0.5	674,678
0.24	3	4000	4	2000	1500	0.1562	68,536,660	2,876,346	25,592,140	31	2,951,104	1,243,273	339,525	103,172	1,789,395	10,473,540	3,432,296	7,302,026	4,864,019	4,543,970	174,196	0.5	657,317
0.24	3	5000	4	2000	1500	0.1562	68,575,510	2,771,213	27,200,640	34	2,835,874	1,179,000	327,020	103,360	1,741,387	9,973,378	3,246,660	8,910,530	6,080,021	4,543,970	174,196	0.5	689,263
0.24	3	4500	4	2000	2000	0.1563	68,581,620	2,822,870	26,435,500	33	2,895,325	1,209,871	332,986	103,228	1,766,194	10,213,480	3,329,506	8,106,278	5,472,019	4,543,970	174,196	0.5	674,678
0.24	3	4500	4	2500	1500	0.1563	68,587,020	2,812,775	26,591,630	33	2,920,115	1,234,993	350,271	110,767	1,752,870	10,138,090	3,301,245	8,106,278	5,472,019	4,543,970	174,196	0.7	719,574
0.24	3	4000	4	2000	2000	0.1563	68,600,490	2,878,002	25,631,250	31	2,951,104	1,243,273	339,525	103,172	1,789,395	10,473,540	3,432,296	7,302,026	4,864,019	4,543,970	174,196	0.5	657,317
0.24	3	4500	4	2500	2000	0.1563	68,614,530	2,811,998	26,630,740	33	2,910,231	1,256,842	359,515	111,215	1,724,944	10,122,120	3,317,483	8,106,278	5,472,019	4,543,970	174,196	0.7	723,118
0.24	3	5000	4	2500	1500	0.1564	68,624,670	2,761,429	27,395,880	35	2,867,928	1,207,665	346,731	117,175	1,728,134	9,883,547	3,202,124	8,910,530	6,080,021	4,543,970	174,196	0.7	745,732
0.24	3	4000	4	2500	1500	0.1564	68,629,870	2,869,512	25,787,380	31	2,965,502	1,257,566	352,608	110,276	1,781,964	10,425,970	3,408,806	7,302,026	4,864,019	4,543,970	174,196	0.7	692,183
0.24	3	3500	4	2000	1500	0.1564	68,638,440	2,937,030	24,787,890	29	2,988,051	1,272,618	346,157	103,378	1,818,669	10,767,090	3,555,479	6,497,774	4,256,016	4,543,970	174,196	0.5	643,523
0.24	3	5000	4	2000	2000	0.1564	68,639,340	2,772,868	27,239,750	34	2,835,874	1,179,000	327,020	103,360	1,741,387	9,973,378	3,246,660	8,910,530	6,080,021	4,543,970	174,196	0.5	689,263
0.24	3	5000	4	2500	2000	0.1564	68,644,440	2,760,134	27,434,990	35	2,861,059	1,228,137	359,565	119,666	1,698,627	9,848,357	3,229,991	8,910,530	6,080,021	4,543,970	174,196	0.7	749,495
0.24	3	4000	4	2500	2000	0.1565	68,665,860	2,869,304	25,826,480	31	2,957,106	1,280,678	361,713	109,974	1,754,527	10,410,070	3,424,008	7,302,026	4,864,019	4,543,970	174,196	0.7	695,749

Diesel Fuel Price Scenario	Phase	PV capacity	Wind turbines	Battery capacity	Battery's inverter capacity	LCOE	Net present cost	Operating cost	Initial capital	Renewable fraction	1. Cat 650 Electricity production	3. Cat 650 Electricity production	4. Cat 650 Electricity production	9. Cat 1100 Electricity production	10. MTU 900 Electricity production	11. SKL 1670 Electricity production	12. SKL 1700 Electricity production	PV Capital Cost	PV electricity production	Wind turbine Electricity production	Wind turbine O&M Cost	Battery autonomy	Battery annual Throughput
$/L		kWp	Number	kWp	kWp	$/kWh	$	$	$	%	kWh/Year	kWh/Year	kWh/Year	kWh/Year	kWh/Year	kWh/Year	$/Year	$	kWh/Year	kWh/Year	$/Year	Hours	kWh/Year
0.24	3	3500	4	2000	2000	0.1565	68,702,260	2,938,685	24,827,000	29	2,988,051	1,272,618	346,157	103,378	1,818,669	10,767,090	3,555,479	6,497,774	4,256,016	4,543,970	174,196	0.5	643,523
0.24	3	5500	4	2000	1500	0.1566	68,720,340	2,727,046	28,004,900	36	2,793,463	1,166,194	325,858	105,813	1,699,104	9,748,994	3,164,570	9,714,782	6,688,023	4,543,970	174,196	0.5	701,321
0.24	3	5500	4	2500	1500	0.1566	68,750,630	2,715,999	28,200,130	36	2,831,221	1,202,217	351,783	117,806	1,696,810	9,639,504	3,100,276	9,714,782	6,688,023	4,543,970	174,196	0.7	770,596
0.24	3	3500	4	2500	1500	0.1567	68,754,430	2,931,722	24,983,120	30	3,000,623	1,290,698	358,887	107,902	1,807,810	10,729,840	3,535,232	6,497,774	4,256,016	4,543,970	174,196	0.7	666,997
0.24	3	5500	4	2500	2000	0.1567	68,764,990	2,714,341	28,239,240	36	2,822,861	1,219,587	364,914	121,985	1,673,367	9,591,819	3,135,467	9,714,782	6,688,023	4,543,970	174,196	0.7	775,910
0.24	3	5500	4	2000	2000	0.1567	68,784,170	2,728,702	28,044,000	36	2,793,463	1,166,194	325,858	105,813	1,699,104	9,748,994	3,164,570	9,714,782	6,688,023	4,543,970	174,196	0.5	701,321
0.24	3	3500	4	2500	2000	0.1567	68,794,800	2,931,806	25,022,230	30	2,990,926	1,308,750	364,132	108,063	1,787,587	10,721,590	3,546,419	6,497,774	4,256,016	4,543,970	174,196	0.7	668,863
0.24	3	5500	4	2000	1500	0.1717	75,342,530	3,170,588	28,004,900	36	2,849,586	1,343,193	420,394	148,873	665,054	9,496,081	3,921,447	9,714,782	6,688,023	4,543,970	174,196	0.5	311,390
0.24	3	5000	4	2000	1500	0.1717	75,380,400	3,226,992	27,200,640	35	2,911,482	1,373,012	430,454	150,415	675,020	9,715,319	4,001,388	8,910,530	6,080,021	4,543,970	174,196	0.5	268,345
0.24	3	5500	4	2500	1500	0.1718	75,402,520	3,161,530	28,200,130	36	2,840,475	1,338,137	419,190	148,554	662,762	9,468,074	3,916,837	9,714,782	6,688,023	4,543,970	174,196	0.7	364,750
0.24	3	5500	4	2500	2000	0.1718	75,406,160	3,159,155	28,239,240	37	2,835,791	1,338,414	419,552	147,104	657,718	9,474,082	3,919,445	9,714,782	6,688,023	4,543,970	174,196	0.7	364,439
0.24	3	5500	4	2000	2000	0.1718	75,406,350	3,172,244	28,044,000	36	2,849,586	1,343,193	420,394	148,873	665,054	9,496,081	3,921,447	9,714,782	6,688,023	4,543,970	174,196	0.5	311,390
0.24	3	5000	4	2000	2000	0.1719	75,444,220	3,228,647	27,239,750	35	2,911,482	1,373,012	430,454	150,415	675,020	9,715,319	4,001,388	8,910,530	6,080,021	4,543,970	174,196	0.5	268,345
0.24	3	5000	4	2500	1500	0.1719	75,461,330	3,219,336	27,395,880	35	2,903,237	1,369,000	429,782	150,139	672,581	9,693,760	3,998,363	8,910,530	6,080,021	4,543,970	174,196	0.7	310,562
0.24	3	5000	4	2500	2000	0.1720	75,469,890	3,217,290	27,434,990	35	2,898,950	1,369,700	430,115	149,027	667,473	9,699,819	4,000,248	8,910,530	6,080,021	4,543,970	174,196	0.7	310,145
0.24	3	4500	4	2000	1500	0.1720	75,488,690	3,288,113	26,396,390	33	2,982,320	1,403,536	438,913	152,669	684,699	9,955,843	4,092,668	8,106,278	5,472,019	4,543,970	174,196	0.5	221,671
0.24	3	4500	4	2000	2000	0.1721	75,552,510	3,289,768	26,435,500	33	2,982,320	1,403,536	438,913	152,669	684,699	9,955,843	4,092,668	8,106,278	5,472,019	4,543,970	174,196	0.5	221,671
0.24	3	4500	4	2500	1500	0.1722	75,593,350	3,282,046	26,591,630	33	2,975,149	1,400,843	438,568	152,334	682,973	9,939,627	4,091,005	8,106,278	5,472,019	4,543,970	174,196	0.7	253,234
0.24	3	4500	4	2500	2000	0.1723	75,611,690	3,280,655	26,630,740	33	2,971,772	1,401,563	438,750	151,338	678,488	9,945,478	4,091,931	8,106,278	5,472,019	4,543,970	174,196	0.7	252,884
0.24	3	4000	4	2000	1500	0.1724	75,684,280	3,355,080	25,592,140	32	3,053,810	1,438,233	451,747	154,755	695,334	10,214,510	4,194,623	7,302,026	4,864,019	4,543,970	174,196	0.5	175,431
0.24	3	4000	4	2000	2000	0.1726	75,748,100	3,356,736	25,631,250	32	3,053,810	1,438,233	451,747	154,755	695,334	10,214,510	4,194,623	7,302,026	4,864,019	4,543,970	174,196	0.5	175,431
0.24	3	4000	4	2500	1500	0.1727	75,815,380	3,350,784	25,787,380	32	3,048,670	1,436,291	451,439	154,392	694,002	10,203,600	4,193,661	7,302,026	4,864,019	4,543,970	174,196	0.7	197,245
0.24	3	4000	4	2500	2000	0.1728	75,845,820	3,350,204	25,826,480	32	3,045,260	1,436,589	451,578	153,801	690,942	10,208,720	4,194,355	7,302,026	4,864,019	4,543,970	174,196	0.7	196,969
0.24	3	3500	4	2000	1500	0.1730	75,937,030	3,425,876	24,787,890	30	3,127,228	1,470,946	464,418	155,945	708,133	10,492,130	4,311,026	6,497,774	4,256,016	4,543,970	174,196	0.5	131,943
0.24	3	3500	4	2000	2000	0.1732	76,000,860	3,427,531	24,827,000	30	3,127,228	1,470,946	464,418	155,945	708,133	10,492,130	4,311,026	6,497,774	4,256,016	4,543,970	174,196	0.5	131,943
0.24	3	3500	4	2500	1500	0.1734	76,091,260	3,423,129	24,983,120	30	3,123,860	1,469,761	464,311	155,736	707,183	10,484,610	4,310,665	6,497,774	4,256,016	4,543,970	174,196	0.7	146,055
0.24	3	3500	4	2500	2000	0.1735	76,132,750	3,423,289	25,022,230	30	3,121,441	1,469,920	464,437	155,260	705,343	10,488,300	4,310,948	6,497,774	4,256,016	4,543,970	174,196	0.7	145,784
0.50	**1**	**3500**	**3**	**1500**	**1000**	**0.2056**	**66,655,180**	**3,057,897**	**21,000,050**	**33**	**2,559,562**	**803,970**	**136,318**	**76,657**	**1,652,739**	**8,616,855**	**635,164**	**6,699,000**	**4,252,390**	**3,407,982**	**130,647**	**0.5**	**651,705**
0.50	1	3500	3	1500	1500	0.2057	66,686,900	3,055,953	21,060,800	33	2,563,120	816,810	134,837	77,769	1,636,766	8,608,508	637,150	6,699,000	4,252,390	3,407,982	130,647	0.5	662,159

Diesel Fuel Price Scenario	Phase	PV capacity	Wind turbines	Battery capacity	Battery's inverter capacity	LCOE	Net present cost	Operating cost	Initial capital	Renewable fraction	1. Cat 650 Electricity production	3. Cat 650 Electricity production	4. Cat 650 Electricity production	9. Cat 1100 Electricity production	10. MTU 900 Electricity production	11. SKL 1670 Electricity production	12. SKL 1700 Electricity production	PV Capital Cost	PV electricity production	Wind turbine Electricity production	Wind turbine O&M Cost	Battery autonomy	Battery annual Throughput
$/L		kWp	Number	kWp	kWp	$/kWh	$	$	$	%	kWh/Year	kWh/Year	kWh/Year	kWh/Year	kWh/Year	kWh/Year	$/Year	$	kWh/Year	kWh/Year	$/Year	Hours	kWh/Year
0.50	1	3500	3	1500	2000	0.2060	66,776,400	3,057,878	21,121,550	33	2,563,120	816,810	134,837	77,769	1,636,766	8,608,508	637,150	6,699,000	4,252,390	3,407,982	130,647	0.5	662,159
0.50	1	3500	3	2000	1500	0.2060	66,776,970	3,038,708	21,408,330	34	2,577,338	874,015	145,353	88,770	1,569,139	8,521,463	643,212	6,699,000	4,252,390	3,407,982	130,647	0.7	739,977
0.50	1	3500	3	2000	2000	0.2062	66,866,460	3,040,634	21,469,080	34	2,577,338	874,015	145,353	88,770	1,569,139	8,521,463	643,212	6,699,000	4,252,390	3,407,982	130,647	0.7	739,977
0.50	1	3500	3	2000	1000	0.2063	66,872,540	3,049,178	21,347,580	34	2,589,017	799,750	130,037	79,088	1,647,419	8,585,426	617,022	6,699,000	4,252,390	3,407,982	130,647	0.7	700,336
0.50	1	3000	3	1500	1000	0.2066	66,995,380	3,144,781	20,043,050	31	2,633,986	832,880	141,834	76,248	1,676,894	8,926,863	666,160	5,742,000	3,644,904	3,407,982	130,647	0.5	649,502
0.50	1	3500	3	2500	1500	0.2067	67,016,400	3,031,468	21,755,860	34	2,580,995	892,073	144,183	92,371	1,556,160	8,483,844	637,908	6,699,000	4,252,390	3,407,982	130,647	0.9	771,873
0.50	1	3000	3	1500	1500	0.2068	67,038,310	3,143,587	20,103,800	31	2,635,601	845,077	143,258	77,984	1,662,669	8,918,548	666,434	5,742,000	3,644,904	3,407,982	130,647	0.5	659,130
0.50	1	3500	3	2500	2000	0.2070	67,111,450	3,033,766	21,816,610	34	2,557,776	905,320	146,731	92,906	1,547,320	8,499,139	638,826	6,699,000	4,252,390	3,407,982	130,647	0.9	777,151
0.50	1	3500	3	2500	1000	0.2070	67,117,240	3,042,291	21,695,110	34	2,610,004	799,919	127,578	84,051	1,647,743	8,546,756	604,582	6,699,000	4,252,390	3,407,982	130,647	0.9	736,467
0.50	1	3000	3	1500	2000	0.2070	67,127,810	3,145,513	20,164,550	31	2,635,601	845,077	143,258	77,984	1,662,669	8,918,548	666,434	5,742,000	3,644,904	3,407,982	130,647	0.5	659,130
0.50	1	3000	3	2000	1500	0.2072	67,175,160	3,129,476	20,451,330	31	2,611,297	884,042	153,595	78,884	1,634,503	8,876,170	675,274	5,742,000	3,644,904	3,407,982	130,647	0.7	717,642
0.50	1	3000	3	2000	1000	0.2074	67,242,770	3,138,074	20,390,580	31	2,646,289	819,488	138,542	76,132	1,682,142	8,915,491	656,540	5,742,000	3,644,904	3,407,982	130,647	0.7	686,824
0.50	1	3000	3	2000	2000	0.2075	67,264,660	3,131,402	20,512,080	31	2,611,297	884,042	153,595	78,884	1,634,503	8,876,170	675,274	5,742,000	3,644,904	3,407,982	130,647	0.7	717,642
0.50	1	3000	3	2500	1500	0.2080	67,449,510	3,124,576	20,798,860	32	2,612,273	895,206	153,699	81,459	1,622,940	8,854,319	674,832	5,742,000	3,644,904	3,407,982	130,647	0.9	737,045
0.50	1	2500	3	1500	1000	0.2081	67,473,800	3,240,923	19,086,050	29	2,658,984	850,436	150,212	72,014	1,744,741	9,305,616	693,362	4,785,000	3,037,421	3,407,982	130,647	0.5	646,330
0.50	1	3000	3	2500	1000	0.2082	67,512,820	3,132,885	20,738,110	31	2,658,628	812,068	135,926	76,183	1,682,824	8,898,809	655,112	5,742,000	3,644,904	3,407,982	130,647	0.9	712,995
0.50	1	2500	3	1500	1500	0.2083	67,529,340	3,240,574	19,146,800	29	2,670,103	862,256	148,742	70,631	1,719,675	9,303,467	698,972	4,785,000	3,037,421	3,407,982	130,647	0.5	656,834
0.50	1	3000	3	2500	2000	0.2083	67,542,560	3,126,739	20,859,610	32	2,586,530	903,773	155,558	82,390	1,626,280	8,865,529	675,138	5,742,000	3,644,904	3,407,982	130,647	0.9	741,338
0.50	1	2500	3	1500	2000	0.2086	67,618,830	3,242,500	19,207,550	29	2,670,103	862,256	148,742	70,631	1,719,675	9,303,467	698,972	4,785,000	3,037,421	3,407,982	130,647	0.5	656,834
0.50	1	2500	3	2000	1500	0.2089	67,727,160	3,230,547	19,494,330	29	2,638,143	896,785	157,976	75,394	1,713,209	9,268,428	703,800	4,785,000	3,037,421	3,407,982	130,647	0.7	701,145
0.50	1	2500	3	2000	1000	0.2089	67,747,050	3,235,948	19,433,580	29	2,665,040	834,697	146,723	70,535	1,755,735	9,305,110	688,602	4,785,000	3,037,421	3,407,982	130,647	0.7	673,419
0.50	1	2500	3	2000	2000	0.2092	67,816,660	3,232,473	19,555,080	29	2,638,143	896,785	157,976	75,394	1,713,209	9,268,428	703,800	4,785,000	3,037,421	3,407,982	130,647	0.7	701,145
0.50	1	2500	3	2500	1500	0.2098	68,025,170	3,227,230	19,841,860	29	2,631,779	901,277	157,313	77,455	1,711,300	9,260,800	703,528	4,785,000	3,037,421	3,407,982	130,647	0.9	711,946
0.50	1	2500	3	2500	1000	0.2099	68,043,250	3,232,510	19,781,110	29	2,675,923	831,724	147,499	70,772	1,751,281	9,295,832	685,882	4,785,000	3,037,421	3,407,982	130,647	0.9	691,145
0.50	1	2500	3	2500	2000	0.2101	68,116,900	3,229,305	19,902,610	29	2,618,489	910,104	157,729	77,213	1,709,580	9,268,115	702,406	4,785,000	3,037,421	3,407,982	130,647	0.9	713,310
0.50	1	3500	3	1500	1000	0.2228	72,229,110	3,431,229	21,000,050	34	2,625,408	683,201	176,004	236,012	616,636	8,737,062	1,255,084	6,699,000	4,252,390	3,407,982	130,647	0.5	185,858
0.50	1	3500	3	1500	1500	0.2230	72,298,680	3,431,819	21,060,800	34	2,623,751	682,988	176,004	235,541	615,126	8,739,356	1,255,084	6,699,000	4,252,390	3,407,982	130,647	0.5	185,682
0.50	1	3500	3	1500	2000	0.2233	72,388,180	3,433,745	21,121,550	34	2,623,751	682,988	176,004	235,541	615,126	8,739,356	1,255,084	6,699,000	4,252,390	3,407,982	130,647	0.5	185,682
0.50	1	3500	3	2000	1500	0.2234	72,443,940	3,418,272	21,408,330	34	2,607,061	682,941	176,004	234,238	607,295	8,729,376	1,254,928	6,699,000	4,252,390	3,407,982	130,647	0.7	220,934

Diesel Fuel Price Scenario	Phase	PV capacity	Wind turbines	Battery capacity	Battery's inverter capacity	LCOE	Net present cost	Operating cost	Initial capital	Renewable fraction	1. Cat 650 Electricity production	3. Cat 650 Electricity production	4. Cat 650 Electricity production	9. Cat 1100 Electricity production	10. MTU 900 Electricity production	11. SKL 1670 Electricity production	12. SKL 1700 Electricity production	PV Capital Cost	PV electricity production	Wind turbine Electricity production	Wind turbine O&M Cost	Battery autonomy	Battery annual Throughput
$/L		kWp	Number	kWp	kWp	$/kWh	$	$	$	%	kWh/Year	kWh/Year	kWh/Year	kWh/Year	kWh/Year	kWh/Year	$/Year	$	kWh/Year	kWh/Year	$/Year	Hours	kWh/Year
0.50	1	3500	3	2000	1000	0.2235	72,474,280	3,424,373	21,347,580	34	2,615,618	683,344	176,004	236,651	619,323	8,710,575	1,254,751	6,699,000	4,252,390	3,407,982	130,647	0.7	222,595
0.50	1	3500	3	2000	2000	0.2237	72,533,440	3,420,197	21,469,080	34	2,607,061	682,941	176,004	234,238	607,295	8,729,376	1,254,928	6,699,000	4,252,390	3,407,982	130,647	0.7	220,934
0.50	1	3500	3	2500	1500	0.2242	72,685,510	3,411,175	21,755,860	34	2,597,527	682,252	176,001	233,813	605,815	8,715,249	1,254,902	6,699,000	4,252,390	3,407,982	130,647	0.9	249,947
0.50	1	3500	3	2500	1000	0.2244	72,742,230	3,419,043	21,695,110	34	2,610,697	683,754	176,001	237,006	619,091	8,688,282	1,254,629	6,699,000	4,252,390	3,407,982	130,647	0.9	252,331
0.50	1	3500	3	2500	2000	0.2244	72,749,340	3,411,382	21,816,610	34	2,593,137	682,322	176,001	233,857	605,622	8,719,623	1,254,929	6,699,000	4,252,390	3,407,982	130,647	0.9	250,023
0.50	1	3000	3	1500	1000	0.2244	72,764,240	3,531,169	20,043,050	32	2,708,811	708,799	181,789	243,797	624,822	9,056,642	1,289,514	5,742,000	3,644,904	3,407,982	130,647	0.5	137,059
0.50	1	3000	3	1500	1500	0.2247	72,840,260	3,532,191	20,103,800	32	2,707,875	708,550	181,789	243,488	623,623	9,058,558	1,289,514	5,742,000	3,644,904	3,407,982	130,647	0.5	136,575
0.50	1	3000	3	1500	2000	0.2249	72,929,760	3,534,117	20,164,550	32	2,707,875	708,550	181,789	243,488	623,623	9,058,558	1,289,514	5,742,000	3,644,904	3,407,982	130,647	0.5	136,575
0.50	1	3000	3	2000	1000	0.2253	73,046,640	3,526,806	20,390,580	32	2,701,351	708,777	181,789	244,037	626,633	9,042,025	1,289,513	5,742,000	3,644,904	3,407,982	130,647	0.7	159,295
0.50	1	3000	3	2000	1500	0.2253	73,053,350	3,523,187	20,451,330	32	2,694,275	708,769	181,789	242,975	618,855	9,055,270	1,289,514	5,742,000	3,644,904	3,407,982	130,647	0.7	157,244
0.50	1	3000	3	2000	2000	0.2256	73,142,860	3,525,113	20,512,080	32	2,694,275	708,769	181,789	242,975	618,855	9,055,270	1,289,514	5,742,000	3,644,904	3,407,982	130,647	0.7	157,244
0.50	1	3000	3	2500	1500	0.2262	73,334,730	3,518,757	20,798,860	32	2,687,762	708,647	181,789	242,997	618,368	9,047,232	1,289,514	5,742,000	3,644,904	3,407,982	130,647	0.9	173,941
0.50	1	3000	3	2500	1000	0.2262	73,345,580	3,523,552	20,738,110	32	2,697,376	709,109	181,789	244,649	627,368	9,028,864	1,289,513	5,742,000	3,644,904	3,407,982	130,647	0.9	176,438
0.50	1	3000	3	2500	2000	0.2264	73,407,700	3,519,575	20,859,610	32	2,684,900	708,665	181,789	242,890	618,543	9,049,974	1,289,514	5,742,000	3,644,904	3,407,982	130,647	0.9	173,986
0.50	1	2500	3	1500	1000	0.2264	73,410,820	3,638,573	19,086,050	29	2,777,773	743,515	194,613	253,535	641,482	9,404,242	1,330,766	4,785,000	3,037,421	3,407,982	130,647	0.5	91,966
0.50	1	2500	3	1500	1500	0.2267	73,491,840	3,639,931	19,146,800	29	2,777,600	743,523	194,613	253,530	640,444	9,404,872	1,330,766	4,785,000	3,037,421	3,407,982	130,647	0.5	91,737
0.50	1	2500	3	1500	2000	0.2269	73,581,340	3,641,857	19,207,550	29	2,777,600	743,523	194,613	253,530	640,444	9,404,872	1,330,766	4,785,000	3,037,421	3,407,982	130,647	0.5	91,737
0.50	1	2500	3	2000	1000	0.2274	73,721,180	3,636,083	19,433,580	30	2,773,429	743,554	194,613	253,321	643,184	9,395,892	1,330,766	4,785,000	3,037,421	3,407,982	130,647	0.7	104,350
0.50	1	2500	3	2000	1500	0.2275	73,761,790	3,634,736	19,494,330	30	2,768,904	743,564	194,613	253,110	638,399	9,403,740	1,330,766	4,785,000	3,037,421	3,407,982	130,647	0.7	103,311
0.50	1	2500	3	2000	2000	0.2278	73,851,290	3,636,661	19,555,080	30	2,768,904	743,564	194,613	253,110	638,399	9,403,740	1,330,766	4,785,000	3,037,421	3,407,982	130,647	0.7	103,311
0.50	1	2500	3	2500	1000	0.2284	74,042,110	3,634,303	19,781,110	30	2,770,540	743,657	194,613	253,910	643,891	9,389,283	1,330,766	4,785,000	3,037,421	3,407,982	130,647	0.9	113,330
0.50	1	2500	3	2500	1500	0.2285	74,076,220	3,632,519	19,841,860	30	2,766,402	743,459	194,613	253,248	638,190	9,398,550	1,330,766	4,785,000	3,037,421	3,407,982	130,647	0.9	112,074
0.50	1	2500	3	2500	2000	0.2287	74,155,090	3,633,732	19,902,610	30	2,764,007	743,570	194,613	253,027	638,222	9,401,029	1,330,766	4,785,000	3,037,421	3,407,982	130,647	0.9	112,104
0.50	**2**	**5000**	**3**	**2000**	**1500**	**0.2048**	**67,305,010**	**2,911,577**	**23,834,480**	**39**	**2,531,589**	**899,180**	**126,155**	**121,528**	**1,407,656**	**7,845,098**	**598,536**	**9,268,161**	**6,080,021**	**3,407,982**	**130,647**	**0.7**	**785,632**
0.50	2	4500	3	2000	1500	0.2048	67,323,620	2,970,182	22,978,100	37	2,558,481	899,398	130,636	115,456	1,448,618	8,091,772	620,670	8,411,777	5,472,019	3,407,982	130,647	0.7	772,482
0.50	2	4500	3	1500	1000	0.2052	67,462,600	2,997,258	22,712,830	37	2,478,566	799,433	119,741	80,963	1,544,512	8,292,322	648,240	8,411,777	5,472,019	3,407,982	130,647	0.5	644,968
0.50	2	5000	3	1500	1000	0.2052	67,464,580	2,940,032	23,569,210	38	2,437,194	797,964	113,933	82,304	1,500,528	8,087,017	626,365	9,268,161	6,080,021	3,407,982	130,647	0.5	641,274
0.50	2	4500	3	1500	1500	0.2053	67,467,090	2,994,644	22,756,340	37	2,486,589	811,412	120,692	85,575	1,529,017	8,280,858	641,036	8,411,777	5,472,019	3,407,982	130,647	0.5	657,153
0.50	2	5000	3	1500	1500	0.2053	67,472,500	2,937,648	23,612,730	38	2,454,789	812,458	113,755	86,103	1,470,763	8,078,531	620,514	9,268,161	6,080,021	3,407,982	130,647	0.5	653,434

Diesel Fuel Price Scenario	Phase	PV capacity	Wind turbines	Battery capacity	Battery's inverter capacity	LCOE	Net present cost	Operating cost	Initial capital	Renewable fraction	1. Cat 650 Electricity production	3. Cat 650 Electricity production	4. Cat 650 Electricity production	9. Cat 1100 Electricity production	10. MTU 900 Electricity production	11. SKL 1670 Electricity production	12. SKL 1700 Electricity production	PV Capital Cost	PV electricity production	Wind turbine Electricity production	Wind turbine O&M Cost	Battery autonomy	Battery annual Throughput
$/L		kWp	Number	kWp	kWp	$/kWh	$	$	$	%	kWh/Year	kWh/Year	kWh/Year	kWh/Year	kWh/Year	kWh/Year	$/Year	$	kWh/Year	kWh/Year	$/Year	Hours	kWh/Year
0.50	2	5000	3	2000	1000	0.2053	67,489,840	2,926,871	23,790,970	38	2,518,885	832,375	106,563	102,500	1,493,524	7,953,322	568,514	9,268,161	6,080,021	3,407,982	130,647	0.7	716,944
0.50	2	4500	3	2000	1000	0.2054	67,500,820	2,984,965	22,934,580	37	2,553,203	828,090	112,537	100,925	1,543,091	8,174,638	592,110	8,411,777	5,472,019	3,407,982	130,647	0.7	713,866
0.50	2	4000	3	2000	1500	0.2054	67,501,000	3,039,422	22,121,710	35	2,585,681	899,939	142,675	101,618	1,503,530	8,367,389	652,222	7,555,393	4,864,019	3,407,982	130,647	0.7	756,060
0.50	2	4000	3	1500	1000	0.2057	67,597,420	3,063,648	21,856,440	35	2,508,155	796,441	129,093	75,257	1,619,991	8,540,858	663,471	7,555,393	4,864,019	3,407,982	130,647	0.5	648,653
0.50	2	4000	3	1500	1500	0.2057	67,603,340	3,061,129	21,899,960	35	2,520,478	813,535	128,831	80,734	1,600,976	8,514,997	665,206	7,555,393	4,864,019	3,407,982	130,647	0.5	660,958
0.50	2	4000	3	2000	1000	0.2058	67,659,730	3,052,967	22,078,200	35	2,573,600	821,740	124,320	87,429	1,610,566	8,446,288	624,308	7,555,393	4,864,019	3,407,982	130,647	0.7	708,374
0.50	2	3500	3	2000	1500	0.2064	67,839,900	3,119,480	21,265,330	33	2,608,560	893,111	146,276	92,686	1,566,196	8,692,561	696,150	6,699,009	4,256,016	3,407,982	130,647	0.7	736,105
0.50	2	3500	3	1500	1000	0.2065	67,887,110	3,140,409	21,000,060	33	2,565,554	801,711	137,176	75,335	1,662,914	8,816,081	698,542	6,699,009	4,256,016	3,407,982	130,647	0.5	651,772
0.50	2	3500	3	1500	1500	0.2066	67,898,870	3,138,282	21,043,580	33	2,574,391	817,475	136,502	77,557	1,642,598	8,800,013	702,190	6,699,009	4,256,016	3,407,982	130,647	0.5	661,721
0.50	2	3500	3	2000	1000	0.2068	67,970,400	3,131,135	21,221,810	33	2,620,246	818,676	131,064	82,075	1,644,234	8,760,458	668,201	6,699,009	4,256,016	3,407,982	130,647	0.7	697,271
0.50	2	5000	3	2000	1500	0.2206	72,500,510	3,259,562	23,834,480	39	2,411,598	643,990	176,322	215,805	572,889	8,101,452	1,260,426	9,268,161	6,080,021	3,407,982	130,647	0.7	375,469
0.50	2	5000	3	1500	1000	0.2208	72,572,540	3,282,153	23,569,210	39	2,432,639	647,610	176,345	217,106	585,529	8,139,432	1,260,573	9,268,161	6,080,021	3,407,982	130,647	0.5	301,644
0.50	2	5000	3	2000	1000	0.2209	72,610,390	3,269,836	23,790,970	39	2,417,568	644,761	176,274	219,923	584,765	8,089,842	1,258,194	9,268,161	6,080,021	3,407,982	130,647	0.7	376,847
0.50	2	5000	3	1500	1500	0.2209	72,614,540	3,282,051	23,612,730	39	2,432,144	647,260	176,345	218,498	582,561	8,139,240	1,260,615	9,268,161	6,080,021	3,407,982	130,647	0.5	301,571
0.50	2	4500	3	2000	1500	0.2212	72,706,390	3,330,710	22,978,100	38	2,478,319	662,041	179,137	222,608	582,756	8,318,612	1,280,649	8,411,777	5,472,019	3,407,982	130,647	0.7	330,683
0.50	2	4500	3	1500	1000	0.2213	72,745,810	3,351,118	22,712,830	37	2,498,916	663,506	179,124	225,083	597,083	8,345,892	1,280,452	8,411,777	5,472,019	3,407,982	130,647	0.5	267,778
0.50	2	4500	3	1500	1500	0.2214	72,789,080	3,351,101	22,756,340	37	2,498,440	663,224	179,124	224,922	594,676	8,346,951	1,280,493	8,411,777	5,472,019	3,407,982	130,647	0.5	267,467
0.50	2	4500	3	2000	1000	0.2215	72,805,390	3,340,256	22,934,580	38	2,486,649	663,226	179,095	225,739	597,275	8,300,082	1,279,944	8,411,777	5,472,019	3,407,982	130,647	0.7	332,142
0.50	2	4000	3	1500	1000	0.2223	73,053,630	3,429,094	21,856,440	36	2,559,778	679,047	187,038	227,514	612,837	8,597,677	1,305,861	7,555,393	4,864,019	3,407,982	130,647	0.5	226,473
0.50	2	4000	3	2000	1500	0.2223	73,070,480	3,412,456	22,121,710	36	2,538,404	677,782	187,054	225,244	599,321	8,584,583	1,305,843	7,555,393	4,864,019	3,407,982	130,647	0.7	274,766
0.50	2	4000	3	1500	1500	0.2224	73,098,610	3,429,192	21,899,960	36	2,559,168	678,721	187,038	227,198	609,836	8,599,936	1,305,949	7,555,393	4,864,019	3,407,982	130,647	0.5	225,983
0.50	2	4000	3	2000	1000	0.2225	73,150,300	3,420,716	22,078,200	36	2,548,144	679,256	187,038	227,973	612,707	8,564,033	1,305,614	7,555,393	4,864,019	3,407,982	130,647	0.7	276,379
0.50	2	3500	3	1500	1000	0.2238	73,556,870	3,520,159	21,000,060	34	2,633,634	700,407	191,506	233,676	622,907	8,885,269	1,337,214	6,699,009	4,256,016	3,407,982	130,647	0.5	180,356
0.50	2	3500	3	1500	1500	0.2239	73,606,400	3,520,562	21,043,580	34	2,632,171	700,231	191,506	233,367	621,241	8,887,294	1,337,214	6,699,009	4,256,016	3,407,982	130,647	0.5	180,232
0.50	2	3500	3	2000	1500	0.2240	73,636,750	3,507,742	21,265,330	34	2,616,412	700,125	191,506	232,141	613,404	8,877,582	1,337,058	6,699,009	4,256,016	3,407,982	130,647	0.7	213,828
0.50	2	3500	3	2000	1000	0.2242	73,686,750	3,514,006	21,221,810	34	2,624,340	700,440	191,506	234,150	625,309	8,860,372	1,336,810	6,699,009	4,256,016	3,407,982	130,647	0.7	215,485
0.50	**3**	**6500**	**3**	**2500**	**1500**	**0.1938**	**85,063,610**	**3,928,112**	**26,415,960**	**35**	**2,683,227**	**946,295**	**122,723**	**119,713**	**1,661,117**	**10,153,880**	**3,464,420**	**11,680,920**	**7,904,028**	**3,407,982**	**130,647**	**0.7**	**859,047**
0.50	3	6500	3	2500	2000	0.1938	85,074,580	3,926,524	26,450,660	35	2,679,667	962,469	127,803	126,435	1,646,275	10,100,740	3,500,219	11,680,920	7,904,028	3,407,982	130,647	0.7	864,174
0.50	3	7000	3	2500	1500	0.1938	85,080,280	3,875,362	27,220,210	36	2,668,724	954,075	121,881	132,437	1,618,694	9,951,719	3,382,849	12,485,170	8,512,032	3,407,982	130,647	0.7	871,869

Diesel Fuel Price Scenario	Phase	PV capacity	Wind turbines	Battery capacity	Battery's inverter capacity	LCOE	Net present cost	Operating cost	Initial capital	Renewable fraction	1. Cat 650 Electricity production	3. Cat 650 Electricity production	4. Cat 650 Electricity production	9. Cat 1100 Electricity production	10. MTU 900 Electricity production	11. SKL 1670 Electricity production	12. SKL 1700 Electricity production	PV Capital Cost	PV electricity production	Wind turbine Electricity production	Wind turbine O&M Cost	Battery autonomy	Battery annual Throughput
$/L		kWp	Number	kWp	kWp	$/kWh	$	$	$	%	kWh/Year	kWh/Year	kWh/Year	kWh/Year	kWh/Year	kWh/Year	$/Year	$	kWh/Year	kWh/Year	$/Year	Hours	kWh/Year
0.50	3	7000	3	2500	2000	0.1939	85,086,120	3,873,429	27,254,910	36	2,661,610	970,481	127,385	137,434	1,613,868	9,892,075	3,417,970	12,485,170	8,512,032	3,407,982	130,647	0.7	881,779
0.50	3	6500	3	3000	1500	0.1939	85,108,260	3,919,803	26,584,670	35	2,733,643	979,683	126,597	144,368	1,638,636	10,079,000	3,388,926	11,680,920	7,904,028	3,407,982	130,647	0.8	940,422
0.50	3	6500	3	2000	1500	0.1939	85,108,670	3,942,431	26,247,240	35	2,606,700	887,818	123,329	94,345	1,695,984	10,261,640	3,556,972	11,680,920	7,904,028	3,407,982	130,647	0.5	765,446
0.50	3	6500	3	3000	2000	0.1939	85,113,060	3,917,800	26,619,370	35	2,694,205	995,085	137,332	156,806	1,615,553	9,994,602	3,489,956	11,680,920	7,904,028	3,407,982	130,647	0.8	944,830
0.50	3	7000	3	3000	2000	0.1940	85,126,540	3,864,835	27,423,630	37	2,672,202	992,904	136,552	165,247	1,580,924	9,784,962	3,419,787	12,485,170	8,512,032	3,407,982	130,647	0.8	979,684
0.50	3	7000	3	2000	1500	0.1940	85,130,030	3,889,995	27,051,490	36	2,585,609	888,183	119,126	99,957	1,654,757	10,075,310	3,490,283	12,485,170	8,512,032	3,407,982	130,647	0.5	770,128
0.50	3	6500	3	2500	2500	0.1940	85,133,010	3,928,112	26,485,360	35	2,679,667	962,469	127,803	126,435	1,646,275	10,100,740	3,500,219	11,680,920	7,904,028	3,407,982	130,647	0.7	864,174
0.50	3	7000	3	3000	1500	0.1940	85,136,350	3,867,817	27,388,930	37	2,712,273	986,110	126,877	156,394	1,601,769	9,883,733	3,295,294	12,485,170	8,512,032	3,407,982	130,647	0.8	970,900
0.50	3	7000	3	2500	2500	0.1940	85,144,540	3,875,017	27,289,610	36	2,661,610	970,481	127,385	137,434	1,613,868	9,892,075	3,417,970	12,485,170	8,512,032	3,407,982	130,647	0.7	881,779
0.50	3	6000	3	2500	1500	0.1940	85,149,500	3,987,733	25,611,700	34	2,706,269	943,483	128,118	110,265	1,704,322	10,362,200	3,553,826	10,876,670	7,296,031	3,407,982	130,647	0.7	838,290
0.50	3	6000	3	2500	2000	0.1940	85,164,680	3,986,425	25,646,400	34	2,693,899	958,125	131,755	112,695	1,685,551	10,320,970	3,599,588	10,876,670	7,296,031	3,407,982	130,647	0.7	840,047
0.50	3	6500	3	2000	2000	0.1940	85,167,090	3,944,020	26,281,940	35	2,606,700	887,818	123,329	94,345	1,695,984	10,261,640	3,556,972	11,680,920	7,904,028	3,407,982	130,647	0.5	765,446
0.50	3	6500	3	3000	2500	0.1941	85,169,080	3,919,229	26,654,070	35	2,685,967	995,943	138,203	155,265	1,611,212	9,998,791	3,498,185	11,680,920	7,904,028	3,407,982	130,647	0.8	946,533
0.50	3	6000	3	2000	1500	0.1941	85,180,650	4,001,119	25,442,990	34	2,635,972	892,069	127,541	89,965	1,737,073	10,454,120	3,636,831	10,876,670	7,296,031	3,407,982	130,647	0.5	760,860
0.50	3	7000	3	3000	2500	0.1941	85,185,470	3,866,459	27,458,330	37	2,662,336	995,020	137,423	165,501	1,578,186	9,788,750	3,425,685	12,485,170	8,512,032	3,407,982	130,647	0.8	981,804
0.50	3	7000	3	2000	2000	0.1941	85,188,460	3,891,583	27,086,190	36	2,585,609	888,183	119,126	99,957	1,654,757	10,075,310	3,490,283	12,485,170	8,512,032	3,407,982	130,647	0.5	770,128
0.50	3	6000	3	3000	1500	0.1941	85,203,100	3,980,022	25,780,420	34	2,747,016	970,173	128,379	130,209	1,687,660	10,300,450	3,493,248	10,876,670	7,296,031	3,407,982	130,647	0.8	905,214
0.50	3	6000	3	3000	2000	0.1942	85,218,340	3,978,719	25,815,120	34	2,714,379	996,268	138,775	137,369	1,651,160	10,233,990	3,579,448	10,876,670	7,296,031	3,407,982	130,647	0.8	907,495
0.50	3	6000	3	2500	2500	0.1942	85,223,100	3,988,014	25,681,110	34	2,693,899	958,125	131,755	112,695	1,685,551	10,320,970	3,599,588	10,876,670	7,296,031	3,407,982	130,647	0.7	840,047
0.50	3	6500	3	2000	2500	0.1942	85,225,510	3,945,609	26,316,640	35	2,606,700	887,818	123,329	94,345	1,695,984	10,261,640	3,556,972	11,680,920	7,904,028	3,407,982	130,647	0.5	765,446
0.50	3	6000	3	2000	2000	0.1942	85,239,070	4,002,708	25,477,690	34	2,635,972	892,069	127,541	89,965	1,737,073	10,454,120	3,636,831	10,876,670	7,296,031	3,407,982	130,647	0.5	760,860
0.50	3	7000	3	2000	2500	0.1942	85,246,870	3,893,172	27,120,900	36	2,585,609	888,183	119,126	99,957	1,654,757	10,075,310	3,490,283	12,485,170	8,512,032	3,407,982	130,647	0.5	770,128
0.50	3	6000	3	3000	2500	0.1943	85,275,540	3,980,226	25,849,820	34	2,703,276	997,282	139,854	136,358	1,649,714	10,239,500	3,585,382	10,876,670	7,296,031	3,407,982	130,647	0.8	909,213
0.50	3	6000	3	2000	2500	0.1943	85,297,490	4,004,297	25,512,390	34	2,635,972	892,069	127,541	89,965	1,737,073	10,454,120	3,636,831	10,876,670	7,296,031	3,407,982	130,647	0.5	760,860
0.50	3	5500	3	2500	1500	0.1945	85,348,570	4,054,934	24,807,450	33	2,722,306	934,994	131,169	102,807	1,747,287	10,601,100	3,666,725	10,072,410	6,688,023	3,407,982	130,647	0.7	812,874
0.50	3	5500	3	2000	1500	0.1945	85,366,880	4,067,460	24,638,730	32	2,665,909	892,110	132,041	87,219	1,777,840	10,675,570	3,729,606	10,072,410	6,688,023	3,407,982	130,647	0.5	752,447
0.50	3	5500	3	2500	2000	0.1945	85,374,780	4,054,365	24,842,150	33	2,708,835	951,282	136,825	105,425	1,729,008	10,565,730	3,704,890	10,072,410	6,688,023	3,407,982	130,647	0.7	813,170
0.50	3	5500	3	3000	1500	0.1946	85,422,220	4,048,566	24,976,170	33	2,753,882	958,358	130,253	113,692	1,731,241	10,561,550	3,616,464	10,072,410	6,688,023	3,407,982	130,647	0.8	867,984
0.50	3	5500	3	2000	2000	0.1946	85,425,300	4,069,049	24,673,440	32	2,665,909	892,110	132,041	87,219	1,777,840	10,675,570	3,729,606	10,072,410	6,688,023	3,407,982	130,647	0.5	752,447

Diesel Fuel Price Scenario	Phase	PV capacity	Wind turbines	Battery capacity	Battery's inverter capacity	LCOE	Net present cost	Operating cost	Initial capital	Renewable fraction	1. Cat 650 Electricity production	3. Cat 650 Electricity production	4. Cat 650 Electricity production	9. Cat 1100 Electricity production	10. MTU 900 Electricity production	11. SKL 1670 Electricity production	12. SKL 1700 Electricity production	PV Capital Cost	PV electricity production	Wind turbine Electricity production	Wind turbine O&M Cost	Battery autonomy	Battery annual Throughput
$/L		kWp	Number	kWp	kWp	$/kWh	$	$	$	%	kWh/Year	kWh/Year	kWh/Year	kWh/Year	kWh/Year	kWh/Year	$/Year	$	kWh/Year	kWh/Year	$/Year	Hours	kWh/Year
0.50	3	5500	3	2500	2500	0.1947	85,433,210	4,055,954	24,876,850	33	2,708,835	951,282	136,825	105,425	1,729,008	10,565,730	3,704,890	10,072,410	6,688,023	3,407,982	130,647	0.7	813,170
0.50	3	5500	3	3000	2000	0.1947	85,450,460	4,048,134	25,010,870	33	2,723,353	986,219	137,514	121,818	1,695,984	10,511,550	3,684,763	10,072,410	6,688,023	3,407,982	130,647	0.8	867,841
0.50	3	5500	3	2000	2500	0.1948	85,483,720	4,070,637	24,708,140	32	2,665,909	892,110	132,041	87,219	1,777,840	10,675,570	3,729,606	10,072,410	6,688,023	3,407,982	130,647	0.5	752,447
0.50	3	5500	3	3000	2500	0.1948	85,509,190	4,049,743	25,045,570	33	2,717,492	989,443	138,632	119,681	1,691,551	10,513,360	3,691,071	10,072,410	6,688,023	3,407,982	130,647	0.8	869,488
0.50	3	5000	3	2500	1500	0.1952	85,670,940	4,130,392	24,003,200	31	2,729,667	927,040	135,609	89,437	1,798,969	10,869,000	3,798,160	9,268,160	6,080,021	3,407,982	130,647	0.7	784,305
0.50	3	5000	3	2000	1500	0.1952	85,672,070	4,141,769	23,834,480	31	2,689,744	890,351	135,537	80,786	1,825,520	10,926,680	3,840,242	9,268,160	6,080,021	3,407,982	130,647	0.5	740,574
0.50	3	5000	3	2500	2000	0.1953	85,703,520	4,130,251	24,037,900	31	2,721,851	946,446	139,555	92,925	1,771,861	10,847,810	3,824,312	9,268,160	6,080,021	3,407,982	130,647	0.7	782,297
0.50	3	5000	3	2000	2000	0.1953	85,730,490	4,143,358	23,869,180	31	2,689,744	890,351	135,537	80,786	1,825,520	10,926,680	3,840,242	9,268,160	6,080,021	3,407,982	130,647	0.5	740,574
0.50	3	5000	3	2500	2500	0.1954	85,761,940	4,131,840	24,072,600	31	2,721,851	946,446	139,555	92,925	1,771,861	10,847,810	3,824,312	9,268,160	6,080,021	3,407,982	130,647	0.7	782,297
0.50	3	5000	3	3000	1500	0.1954	85,773,900	4,125,989	24,171,910	31	2,759,227	944,590	134,054	101,353	1,784,642	10,838,020	3,755,874	9,268,160	6,080,021	3,407,982	130,647	0.8	825,017
0.50	3	5000	3	2000	2500	0.1955	85,788,910	4,144,946	23,903,880	31	2,689,744	890,351	135,537	80,786	1,825,520	10,926,680	3,840,242	9,268,160	6,080,021	3,407,982	130,647	0.5	740,574
0.50	3	5000	3	3000	2000	0.1955	85,809,900	4,126,075	24,206,610	31	2,728,430	976,326	140,647	102,125	1,747,505	10,810,470	3,809,490	9,268,160	6,080,021	3,407,982	130,647	0.8	823,652
0.50	3	5000	3	3000	2500	0.1956	85,868,820	4,127,698	24,241,320	31	2,723,230	977,925	140,985	103,310	1,744,965	10,814,280	3,810,357	9,268,160	6,080,021	3,407,982	130,647	0.8	824,544
0.50	3	7000	3	3000	2000	0.2074	91,031,640	4,260,348	27,423,630	37	2,578,093	1,048,367	362,055	254,636	659,207	9,607,050	4,079,949	12,485,170	8,512,032	3,407,982	130,647	0.8	538,262
0.50	3	7000	3	3000	2500	0.2075	91,070,940	4,260,656	27,458,330	37	2,576,380	1,048,557	362,326	254,324	657,463	9,609,081	4,081,170	12,485,170	8,512,032	3,407,982	130,647	0.8	538,318
0.50	3	7000	3	2500	2000	0.2076	91,115,850	4,277,289	27,254,910	37	2,589,941	1,052,326	363,507	256,563	663,018	9,641,693	4,086,788	12,485,170	8,512,032	3,407,982	130,647	0.7	467,064
0.50	3	7000	3	3000	1500	0.2076	91,125,610	4,268,967	27,388,930	37	2,593,166	1,046,924	358,741	258,595	666,636	9,601,007	4,067,020	12,485,170	8,512,032	3,407,982	130,647	0.8	538,437
0.50	3	7000	3	2500	1500	0.2077	91,138,300	4,281,117	27,220,210	37	2,597,296	1,052,334	361,998	258,477	667,269	9,637,641	4,081,260	12,485,170	8,512,032	3,407,982	130,647	0.7	467,234
0.50	3	7000	3	2500	2500	0.2077	91,174,260	4,278,877	27,289,610	37	2,589,941	1,052,326	363,507	256,563	663,018	9,641,693	4,086,788	12,485,170	8,512,032	3,407,982	130,647	0.7	467,064
0.50	3	7000	3	2000	1500	0.2078	91,208,170	4,297,097	27,051,490	37	2,606,744	1,056,495	364,228	259,330	668,581	9,680,410	4,091,483	12,485,170	8,512,032	3,407,982	130,647	0.5	391,302
0.50	3	6500	3	3000	2000	0.2078	91,212,410	4,326,323	26,619,370	36	2,626,485	1,068,265	369,665	259,064	667,229	9,793,665	4,144,562	11,680,920	7,904,028	3,407,982	130,647	0.8	489,255
0.50	3	6500	3	3000	2500	0.2079	91,253,640	4,326,761	26,654,070	36	2,624,133	1,067,868	369,738	258,927	665,687	9,796,645	4,145,904	11,680,920	7,904,028	3,407,982	130,647	0.8	489,285
0.50	3	7000	3	2000	2000	0.2079	91,266,580	4,298,684	27,086,190	37	2,606,745	1,056,495	364,228	259,334	668,581	9,680,393	4,091,483	12,485,170	8,512,032	3,407,982	130,647	0.5	391,314
0.50	3	6500	3	2500	2000	0.2080	91,273,430	4,341,711	26,450,660	36	2,636,872	1,071,714	370,697	260,386	671,119	9,824,313	4,150,052	11,680,920	7,904,028	3,407,982	130,647	0.7	427,077
0.50	3	6500	3	2500	1500	0.2080	91,288,710	4,345,059	26,415,960	36	2,643,011	1,071,045	369,319	262,503	675,562	9,819,824	4,145,704	11,680,920	7,904,028	3,407,982	130,647	0.7	427,360
0.50	3	6500	3	3000	1500	0.2080	91,292,520	4,334,014	26,584,670	36	2,638,530	1,066,904	367,083	262,102	675,393	9,786,920	4,134,082	11,680,920	7,904,028	3,407,982	130,647	0.8	489,433
0.50	3	7000	3	2000	2500	0.2081	91,324,990	4,300,273	27,120,900	37	2,606,745	1,056,495	364,228	259,334	668,581	9,680,393	4,091,483	12,485,170	8,512,032	3,407,982	130,647	0.5	391,314
0.50	3	6500	3	2500	2500	0.2081	91,331,850	4,343,299	26,485,360	36	2,636,872	1,071,714	370,697	260,386	671,119	9,824,313	4,150,052	11,680,920	7,904,028	3,407,982	130,647	0.7	427,077
0.50	3	6500	3	2000	1500	0.2081	91,341,560	4,359,899	26,247,240	36	2,652,319	1,075,483	371,365	263,177	677,169	9,856,799	4,153,335	11,680,920	7,904,028	3,407,982	130,647	0.5	360,461

Diesel Fuel Price Scenario	Phase	PV capacity	Wind turbines	Battery capacity	Battery's inverter capacity	LCOE	Net present cost	Operating cost	Initial capital	Renewable fraction	1. Cat 650 Electricity production	3. Cat 650 Electricity production	4. Cat 650 Electricity production	9. Cat 1100 Electricity production	10. MTU 900 Electricity production	11. SKL 1670 Electricity production	12. SKL 1700 Electricity production	PV Capital Cost	PV electricity production	Wind turbine Electricity production	Wind turbine O&M Cost	Battery autonomy	Battery annual Throughput
$/L		kWp	Number	kWp	kWp	$/kWh	$	$	$	%	kWh/Year	kWh/Year	kWh/Year	kWh/Year	kWh/Year	kWh/Year	$/Year	$	kWh/Year	kWh/Year	$/Year	Hours	kWh/Year
0.50	3	6500	3	2000	2000	0.2082	91,399,980	4,361,487	26,281,940	36	2,652,319	1,075,483	371,365	263,177	677,169	9,856,797	4,153,335	11,680,920	7,904,028	3,407,982	130,647	0.5	360,464
0.50	3	6500	3	2000	2500	0.2084	91,458,390	4,363,076	26,316,640	36	2,652,319	1,075,483	371,365	263,177	677,169	9,856,797	4,153,335	11,680,920	7,904,028	3,407,982	130,647	0.5	360,464
0.50	3	6000	3	3000	2000	0.2084	91,483,220	4,398,329	25,815,120	35	2,673,649	1,090,242	379,464	262,564	678,022	10,005,150	4,217,456	10,876,670	7,296,031	3,407,982	130,647	0.8	431,626
0.50	3	6000	3	2500	2000	0.2085	91,508,860	4,411,347	25,646,400	35	2,684,258	1,093,366	380,224	263,580	681,357	10,029,070	4,221,326	10,876,670	7,296,031	3,407,982	130,647	0.7	380,093
0.50	3	6000	3	2500	1500	0.2085	91,516,020	4,414,151	25,611,700	35	2,689,134	1,093,030	379,455	265,004	686,271	10,023,810	4,217,705	10,876,670	7,296,031	3,407,982	130,647	0.7	380,348
0.50	3	6000	3	3000	2500	0.2085	91,527,000	4,398,937	25,849,820	35	2,671,883	1,090,172	379,542	262,350	676,853	10,007,550	4,218,178	10,876,670	7,296,031	3,407,982	130,647	0.8	431,642
0.50	3	6000	3	3000	1500	0.2086	91,547,370	4,404,950	25,780,420	35	2,685,164	1,089,743	377,632	265,214	686,426	9,994,687	4,209,100	10,876,670	7,296,031	3,407,982	130,647	0.8	431,870
0.50	3	6000	3	2500	2500	0.2086	91,567,290	4,412,936	25,681,110	35	2,684,258	1,093,366	380,224	263,580	681,357	10,029,070	4,221,326	10,876,670	7,296,031	3,407,982	130,647	0.7	380,093
0.50	3	6000	3	2000	1500	0.2087	91,578,220	4,429,616	25,442,990	34	2,697,020	1,096,669	380,770	265,959	688,105	10,055,760	4,223,189	10,876,670	7,296,031	3,407,982	130,647	0.5	323,731
0.50	3	6000	3	2000	2000	0.2088	91,636,630	4,431,205	25,477,690	34	2,697,019	1,096,669	380,770	265,959	688,105	10,055,760	4,223,189	10,876,670	7,296,031	3,407,982	130,647	0.5	323,731
0.50	3	6000	3	2000	2500	0.2089	91,695,060	4,432,794	25,512,390	34	2,697,019	1,096,669	380,770	265,959	688,105	10,055,760	4,223,189	10,876,670	7,296,031	3,407,982	130,647	0.5	323,731
0.50	3	5500	3	2000	1500	0.2094	91,918,500	4,506,276	24,638,730	33	2,752,266	1,120,292	388,719	270,692	697,495	10,275,460	4,300,003	10,072,410	6,688,023	3,407,982	130,647	0.5	281,048
0.50	3	5500	3	2500	1500	0.2094	91,925,250	4,495,428	24,807,450	33	2,744,588	1,116,933	387,998	269,868	695,940	10,250,610	4,296,579	10,072,410	6,688,023	3,407,982	130,647	0.7	326,335
0.50	3	5500	3	2500	2000	0.2094	91,926,980	4,493,220	24,842,150	33	2,740,365	1,117,450	388,470	268,756	691,016	10,256,930	4,298,730	10,072,410	6,688,023	3,407,982	130,647	0.7	326,031
0.50	3	5500	3	3000	2000	0.2095	91,937,810	4,482,644	25,010,870	33	2,731,343	1,114,857	387,926	267,988	688,013	10,238,720	4,296,546	10,072,410	6,688,023	3,407,982	130,647	0.8	366,210
0.50	3	5500	3	2000	2000	0.2096	91,976,930	4,507,865	24,673,440	33	2,752,266	1,120,292	388,719	270,692	697,495	10,275,460	4,300,003	10,072,410	6,688,023	3,407,982	130,647	0.5	281,048
0.50	3	5500	3	3000	1500	0.2096	91,983,370	4,488,020	24,976,170	33	2,741,366	1,114,774	386,887	269,910	695,930	10,226,480	4,290,851	10,072,410	6,688,023	3,407,982	130,647	0.8	366,629
0.50	3	5500	3	2500	2500	0.2096	91,985,410	4,494,808	24,876,850	33	2,740,365	1,117,450	388,470	268,756	691,016	10,256,930	4,298,730	10,072,410	6,688,023	3,407,982	130,647	0.7	326,031
0.50	3	5500	3	3000	2500	0.2096	91,985,510	4,483,515	25,045,570	33	2,729,958	1,115,083	388,112	267,844	687,075	10,240,300	4,297,008	10,072,410	6,688,023	3,407,982	130,647	0.8	366,215
0.50	3	5500	3	2000	2500	0.2097	92,035,340	4,509,453	24,708,140	33	2,752,266	1,120,292	388,719	270,692	697,495	10,275,460	4,300,003	10,072,410	6,688,023	3,407,982	130,647	0.5	281,048
0.50	3	5000	3	2000	1500	0.2106	92,422,900	4,593,927	23,834,480	32	2,812,632	1,144,638	397,542	275,688	708,015	10,517,880	4,388,359	9,268,160	6,080,021	3,407,982	130,647	0.5	232,758
0.50	3	5000	3	2500	1500	0.2107	92,468,690	4,585,693	24,003,200	32	2,807,021	1,142,459	397,361	275,005	706,710	10,498,850	4,386,334	9,268,160	6,080,021	3,407,982	130,647	0.7	265,938
0.50	3	5000	3	2500	2000	0.2107	92,481,070	4,584,199	24,037,900	32	2,803,223	1,142,759	397,503	274,178	702,506	10,505,370	4,387,709	9,268,160	6,080,021	3,407,982	130,647	0.7	265,674
0.50	3	5000	3	2000	2000	0.2107	92,481,330	4,595,516	23,869,180	32	2,812,632	1,144,638	397,542	275,688	708,015	10,517,880	4,388,359	9,268,160	6,080,021	3,407,982	130,647	0.5	232,758
0.50	3	5000	3	3000	2000	0.2108	92,533,800	4,576,430	24,206,610	32	2,795,874	1,141,169	397,289	273,752	699,945	10,492,880	4,386,280	9,268,160	6,080,021	3,407,982	130,647	0.8	294,530
0.50	3	5000	3	2500	2500	0.2108	92,539,490	4,585,788	24,072,600	32	2,803,223	1,142,759	397,503	274,178	702,506	10,505,370	4,387,709	9,268,160	6,080,021	3,407,982	130,647	0.7	265,674
0.50	3	5000	3	2000	2500	0.2108	92,539,740	4,597,105	23,903,880	32	2,812,632	1,144,638	397,542	275,688	708,015	10,517,880	4,388,359	9,268,160	6,080,021	3,407,982	130,647	0.5	232,758
0.50	3	5000	3	3000	1500	0.2109	92,557,320	4,580,330	24,171,910	32	2,804,238	1,140,734	396,815	275,168	706,497	10,481,330	4,382,875	9,268,160	6,080,021	3,407,982	130,647	0.8	294,873
0.50	3	5000	3	3000	2500	0.2109	92,584,310	4,577,489	24,241,320	32	2,794,366	1,141,194	397,335	273,564	699,555	10,494,540	4,386,627	9,268,160	6,080,021	3,407,982	130,647	0.8	294,540

Diesel Fuel Price Scenario	Phase	PV capacity	Wind turbines	Battery capacity	Battery's inverter capacity	LCOE	Net present cost	Operating cost	Initial capital	Renewable fraction	1. Cat 650 Electricity production	3. Cat 650 Electricity production	4. Cat 650 Electricity production	9. Cat 1100 Electricity production	10. MTU 900 Electricity production	11. SKL 1670 Electricity production	12. SKL 1700 Electricity production	PV Capital Cost	PV electricity production	Wind turbine Electricity production	Wind turbine O&M Cost	Battery autonomy	Battery annual Throughput
$/L		kWp	Number	kWp	kWp	$/kWh	$	$	$	%	kWh/Year	kWh/Year	kWh/Year	kWh/Year	kWh/Year	kWh/Year	$/Year	$	kWh/Year	kWh/Year	$/Year	Hours	kWh/Year
0.50	3	6500	4	2500	2000	0.1978	86,797,340	3,790,427	30,205,380	38	2,637,540	944,846	118,418	121,891	1,614,128	9,584,027	3,206,933	11,680,920	7,904,028	4,543,970	174,196	0.7	871,693
0.50	3	6500	4	2500	1500	0.1978	86,815,750	3,793,984	30,170,680	38	2,641,717	924,747	111,659	115,264	1,623,043	9,646,449	3,178,547	11,680,920	7,904,028	4,543,970	174,196	0.7	856,336
0.50	3	6500	4	3000	2000	0.1978	86,822,590	3,780,818	30,374,090	39	2,652,118	972,671	125,814	149,128	1,582,764	9,477,808	3,201,685	11,680,920	7,904,028	4,543,970	174,196	0.8	962,557
0.50	3	6000	4	2500	2000	0.1978	86,827,130	3,846,289	29,401,120	37	2,657,809	939,355	120,592	112,944	1,645,859	9,797,068	3,291,336	10,876,670	7,296,031	4,543,970	174,196	0.7	850,307
0.50	3	6000	4	2500	1500	0.1979	86,838,370	3,849,366	29,366,420	37	2,662,475	920,735	115,374	105,111	1,663,072	9,846,374	3,263,434	10,876,670	7,296,031	4,543,970	174,196	0.7	840,466
0.50	3	6000	4	3000	2000	0.1979	86,855,720	3,836,904	29,569,840	37	2,669,250	971,451	127,777	136,377	1,619,053	9,702,330	3,281,170	10,876,670	7,296,031	4,543,970	174,196	0.8	926,102
0.50	3	6500	4	2500	2500	0.1979	86,855,770	3,792,016	30,240,080	38	2,637,540	944,846	118,418	121,891	1,614,128	9,584,027	3,206,933	11,680,920	7,904,028	4,543,970	174,196	0.7	871,693
0.50	3	6500	4	3000	1500	0.1979	86,858,600	3,785,553	30,339,390	39	2,692,274	959,232	114,958	138,159	1,607,205	9,570,494	3,095,197	11,680,920	7,904,028	4,543,970	174,196	0.8	945,522
0.50	3	7000	4	2500	2000	0.1979	86,861,250	3,740,839	31,009,630	39	2,611,701	941,550	116,969	129,873	1,584,994	9,395,394	3,144,452	12,485,170	8,512,032	4,543,970	174,196	0.7	888,469
0.50	3	6500	4	3000	2500	0.1979	86,879,030	3,782,273	30,408,790	39	2,643,400	972,517	126,828	150,469	1,578,962	9,480,363	3,209,516	11,680,920	7,904,028	4,543,970	174,196	0.8	964,426
0.50	3	6000	4	3000	1500	0.1980	86,883,130	3,841,063	29,535,140	37	2,710,007	950,668	117,411	128,776	1,645,333	9,775,064	3,192,973	10,876,670	7,296,031	4,543,970	174,196	0.8	913,164
0.50	3	6000	4	2500	2500	0.1980	86,885,550	3,847,878	29,435,820	37	2,657,809	939,355	120,592	112,944	1,645,859	9,797,068	3,291,336	10,876,670	7,296,031	4,543,970	174,196	0.7	850,307
0.50	3	7000	4	2500	1500	0.1980	86,887,390	3,744,915	30,974,930	39	2,620,113	927,883	110,216	124,207	1,590,641	9,461,938	3,105,285	12,485,170	8,512,032	4,543,970	174,196	0.7	869,847
0.50	3	7000	4	3000	2000	0.1980	86,904,860	3,732,461	31,178,350	40	2,624,183	972,510	126,672	155,587	1,539,398	9,299,381	3,134,317	12,485,170	8,512,032	4,543,970	174,196	0.8	1,000,170
0.50	3	6000	4	3000	2500	0.1980	86,912,740	3,838,399	29,604,540	37	2,661,568	974,519	128,570	135,946	1,612,570	9,707,166	3,287,188	10,876,670	7,296,031	4,543,970	174,196	0.8	927,730
0.50	3	7000	4	2500	2500	0.1980	86,919,660	3,742,428	31,044,330	39	2,611,701	941,550	116,969	129,873	1,584,994	9,395,394	3,144,452	12,485,170	8,512,032	4,543,970	174,196	0.7	888,469
0.50	3	7000	4	3000	1500	0.1981	86,954,160	3,738,086	31,143,640	40	2,668,892	960,771	114,971	146,061	1,562,930	9,401,903	3,014,584	12,485,170	8,512,032	4,543,970	174,196	0.8	976,628
0.50	3	7000	4	3000	2500	0.1981	86,956,620	3,733,602	31,213,050	40	2,614,466	970,748	127,231	156,032	1,534,930	9,300,606	3,147,832	12,485,170	8,512,032	4,543,970	174,196	0.8	1,001,392
0.50	3	7000	4	3000	2000	0.2119	92,992,070	4,140,171	31,178,350	40	2,481,584	992,893	343,408	244,984	627,601	9,182,224	3,809,651	12,485,170	8,512,032	4,543,970	174,196	0.8	570,572
0.50	3	7000	4	3000	2500	0.2120	93,029,140	4,140,329	31,213,050	40	2,480,114	993,014	343,710	244,569	625,796	9,184,041	3,811,073	12,485,170	8,512,032	4,543,970	174,196	0.8	570,573
0.50	3	7000	4	2500	2000	0.2121	93,098,980	4,158,631	31,009,630	40	2,494,080	997,152	344,928	246,535	633,169	9,219,744	3,816,181	12,485,170	8,512,032	4,543,970	174,196	0.7	494,459
0.50	3	7000	4	3000	1500	0.2121	93,108,760	4,150,310	31,143,640	40	2,496,896	991,726	340,316	248,765	636,695	9,176,476	3,795,698	12,485,170	8,512,032	4,543,970	174,196	0.8	570,913
0.50	3	6500	4	3000	2000	0.2122	93,124,060	4,202,878	30,374,090	39	2,527,257	1,013,003	350,952	247,233	635,714	9,356,928	3,870,770	11,680,920	7,904,028	4,543,970	174,196	0.8	524,681
0.50	3	7000	4	2500	1500	0.2122	93,134,150	4,163,312	30,974,930	40	2,502,205	997,033	343,281	248,686	637,169	9,215,810	3,811,234	12,485,170	8,512,032	4,543,970	174,196	0.7	494,605
0.50	3	7000	4	2500	2500	0.2123	93,157,410	4,160,220	31,044,330	40	2,494,080	997,152	344,928	246,535	633,169	9,219,744	3,816,181	12,485,170	8,512,032	4,543,970	174,196	0.7	494,459
0.50	3	6500	4	3000	2500	0.2123	93,162,100	4,203,102	30,408,790	39	2,524,994	1,012,944	351,130	247,047	634,168	9,359,402	3,872,112	11,680,920	7,904,028	4,543,970	174,196	0.8	524,690
0.50	3	6500	4	2500	2000	0.2124	93,207,860	4,219,791	30,205,380	39	2,538,191	1,017,130	352,063	248,753	640,732	9,390,158	3,876,421	11,680,920	7,904,028	4,543,970	174,196	0.7	457,017
0.50	3	6500	4	3000	1500	0.2124	93,227,120	4,212,105	30,339,390	39	2,539,750	1,012,074	348,354	250,748	644,846	9,349,536	3,860,019	11,680,920	7,904,028	4,543,970	174,196	0.8	525,147
0.50	3	6500	4	2500	1500	0.2124	93,235,780	4,223,985	30,170,680	39	2,545,288	1,016,963	350,869	251,055	645,141	9,385,270	3,871,887	11,680,920	7,904,028	4,543,970	174,196	0.7	457,365

Diesel Fuel Price Scenario	Phase	PV capacity	Wind turbines	Battery capacity	Battery's inverter capacity	LCOE	Net present cost	Operating cost	Initial capital	Renewable fraction	1. Cat 650 Electricity production	3. Cat 650 Electricity production	4. Cat 650 Electricity production	9. Cat 1100 Electricity production	10. MTU 900 Electricity production	11. SKL 1670 Electricity production	12. SKL 1700 Electricity production	PV Capital Cost	PV electricity production	Wind turbine Electricity production	Wind turbine O&M Cost	Battery autonomy	Battery annual Throughput
$/L		kWp	Number	kWp	kWp	$/kWh	$	$	$	%	kWh/Year	kWh/Year	kWh/Year	kWh/Year	kWh/Year	kWh/Year	$/Year	$	kWh/Year	kWh/Year	$/Year	Hours	kWh/Year
0.50	3	6500	4	2500	2500	0.2125	93,266,280	4,221,380	30,240,080	39	2,538,191	1,017,130	352,063	248,753	640,732	9,390,158	3,876,421	11,680,920	7,904,028	4,543,970	174,196	0.7	457,017
0.50	3	6000	4	3000	2000	0.2126	93,320,940	4,269,932	29,569,840	38	2,575,817	1,034,945	360,264	251,819	644,643	9,551,256	3,937,338	10,876,670	7,296,031	4,543,970	174,196	0.8	471,869
0.50	3	6000	4	3000	2500	0.2127	93,362,180	4,270,370	29,604,540	38	2,573,845	1,034,836	360,314	251,486	643,230	9,554,009	3,938,311	10,876,670	7,296,031	4,543,970	174,196	0.8	471,907
0.50	3	6000	4	3000	1500	0.2128	93,408,540	4,278,124	29,535,140	38	2,587,107	1,033,627	358,006	254,521	653,998	9,542,395	3,929,282	10,876,670	7,296,031	4,543,970	174,196	0.8	472,331
0.50	3	6000	4	2500	2000	0.2129	93,423,630	4,288,111	29,401,120	38	2,585,872	1,037,974	361,138	253,144	648,861	9,580,288	3,941,975	10,876,670	7,296,031	4,543,970	174,196	0.7	413,444
0.50	3	6000	4	2500	1500	0.2129	93,444,310	4,291,820	29,366,420	38	2,591,125	1,037,751	360,253	254,928	654,056	9,575,294	3,938,366	10,876,670	7,296,031	4,543,970	174,196	0.7	413,778
0.50	3	6000	4	2500	2500	0.2130	93,482,060	4,289,700	29,435,820	38	2,585,872	1,037,974	361,138	253,144	648,861	9,580,288	3,941,975	10,876,670	7,296,031	4,543,970	174,196	0.7	413,444
0.90	**1**	**5500**	**3**	**2000**	**1500**	**0.2660**	**86,244,180**	**4,086,194**	**25,236,330**	**40**	**2,043,046**	**438,041**	**-**	**7,332**	**1,557,138**	**8,220,779**	**743,410**	**10,527,000**	**6,682,326**	**3,407,982**	**130,647**	**0.7**	**893,184**
0.90	1	6000	3	2000	1500	0.2660	86,260,160	4,023,167	26,193,330	41	2,033,535	461,078	-	10,197	1,484,418	8,049,954	724,404	11,484,000	7,289,808	3,407,982	130,647	0.7	906,819
0.90	1	5500	3	2000	2000	0.2663	86,333,680	4,088,120	25,297,080	40	2,043,046	438,041	-	7,332	1,557,138	8,220,779	743,410	10,527,000	6,682,326	3,407,982	130,647	0.7	893,184
0.90	1	6000	3	2000	2000	0.2663	86,349,660	4,025,092	26,254,080	41	2,033,535	461,078	-	10,197	1,484,418	8,049,954	724,404	11,484,000	7,289,808	3,407,982	130,647	0.7	906,819
0.90	1	5000	3	2000	1500	0.2665	86,403,420	4,160,958	24,279,330	39	2,060,310	418,980	-	5,173	1,616,499	8,429,098	763,504	9,570,000	6,074,843	3,407,982	130,647	0.7	882,809
0.90	1	6500	3	2000	1500	0.2667	86,461,880	3,972,579	27,150,330	42	2,020,327	478,595	-	17,434	1,374,085	7,936,431	723,792	12,441,000	7,897,292	3,407,982	130,647	0.7	942,143
0.90	1	5000	3	2000	2000	0.2668	86,492,920	4,162,884	24,340,080	39	2,060,310	418,980	-	5,173	1,616,499	8,429,098	763,504	9,570,000	6,074,843	3,407,982	130,647	0.7	882,809
0.90	1	6500	3	2000	2000	0.2669	86,551,380	3,974,505	27,211,080	42	2,020,327	478,595	-	17,434	1,374,085	7,936,431	723,792	12,441,000	7,897,292	3,407,982	130,647	0.7	942,143
0.90	1	5000	3	2500	1500	0.2672	86,643,480	4,153,760	24,626,860	39	2,112,273	484,718	-	16,849	1,501,101	8,348,341	767,584	9,570,000	6,074,843	3,407,982	130,647	0.9	992,223
0.90	1	5500	3	2500	1500	0.2673	86,652,330	4,090,255	25,583,860	40	2,103,014	519,649	-	36,040	1,279,157	8,243,914	767,380	10,527,000	6,682,326	3,407,982	130,647	0.9	1,086,143
0.90	1	5500	3	2500	2000	0.2674	86,699,420	4,089,340	25,644,610	40	2,083,025	530,166	-	33,170	1,279,586	8,243,708	779,314	10,527,000	6,682,326	3,407,982	130,647	0.9	1,087,948
0.90	1	5000	3	2500	2000	0.2674	86,708,080	4,154,018	24,687,610	39	2,088,846	490,087	-	15,252	1,484,556	8,378,965	773,976	9,570,000	6,074,843	3,407,982	130,647	0.9	999,862
0.90	1	6000	3	2500	1500	0.2677	86,785,970	4,035,107	26,540,860	42	2,086,422	542,662	-	52,790	1,088,495	8,165,672	769,590	11,484,000	7,289,808	3,407,982	130,647	0.9	1,168,328
0.90	1	6000	3	2500	2000	0.2678	86,837,340	4,034,480	26,601,610	42	2,061,178	556,582	-	51,189	1,100,983	8,151,332	783,870	11,484,000	7,289,808	3,407,982	130,647	0.9	1,174,840
0.90	1	6500	3	2500	1500	0.2683	86,983,970	3,984,271	27,497,860	43	2,067,396	563,069	-	66,574	962,717	8,046,220	780,572	12,441,000	7,897,292	3,407,982	130,647	0.9	1,219,905
0.90	1	6500	3	2500	2000	0.2685	87,043,730	3,984,204	27,558,610	43	2,044,768	569,790	-	64,667	972,102	8,035,408	800,598	12,441,000	7,897,292	3,407,982	130,647	0.9	1,233,029
0.90	1	6500	3	2500	1500	0.2801	90,830,850	4,241,928	27,497,860	44	2,106,667	334,436	85	290,966	541,990	7,684,391	1,312,032	12,441,000	7,897,292	3,407,982	130,647	0.9	565,381
0.90	1	6500	3	2500	2000	0.2802	90,838,920	4,238,399	27,558,610	44	2,099,406	334,702	98	288,061	533,814	7,699,129	1,315,232	12,441,000	7,897,292	3,407,982	130,647	0.9	565,252
0.90	1	6500	3	2000	1500	0.2803	90,894,970	4,269,499	27,150,330	43	2,121,744	337,812	107	290,853	545,341	7,745,677	1,317,280	12,441,000	7,897,292	3,407,982	130,647	0.7	467,913
0.90	1	6000	3	2500	1500	0.2804	90,909,100	4,311,267	26,540,860	43	2,151,849	341,342	244	296,061	551,006	7,828,781	1,332,115	11,484,000	7,289,808	3,407,982	130,647	0.9	534,974
0.90	1	6000	3	2500	2000	0.2804	90,914,080	4,307,532	26,601,610	43	2,142,762	342,379	250	293,721	542,984	7,846,009	1,333,204	11,484,000	7,289,808	3,407,982	130,647	0.9	535,129
0.90	1	6000	3	2000	1500	0.2805	90,941,970	4,336,745	26,193,330	42	2,167,791	344,508	244	297,381	554,789	7,883,372	1,334,524	11,484,000	7,289,808	3,407,982	130,647	0.7	445,077

Diesel Fuel Price Scenario	Phase	PV capacity	Wind turbines	Battery capacity	Battery's inverter capacity	LCOE	Net present cost	Operating cost	Initial capital	Renewable fraction	1. Cat 650 Electricity production	3. Cat 650 Electricity production	4. Cat 650 Electricity production	9. Cat 1100 Electricity production	10. MTU 900 Electricity production	11. SKL 1670 Electricity production	12. SKL 1700 Electricity production	PV Capital Cost	PV electricity production	Wind turbine Electricity production	Wind turbine O&M Cost	Battery autonomy	Battery annual Throughput
$/L		kWp	Number	kWp	kWp	$/kWh	$	$	$	%	kWh/Year	kWh/Year	kWh/Year	kWh/Year	kWh/Year	kWh/Year	$/Year	$	kWh/Year	kWh/Year	$/Year	Hours	kWh/Year
0.90	1	6500	3	2000	2000	0.2806	90,984,460	4,271,425	27,211,080	43	2,121,744	337,812	107	290,853	545,341	7,745,677	1,317,280	12,441,000	7,897,292	3,407,982	130,647	0.7	467,913
0.90	1	6000	3	2000	2000	0.2808	91,031,460	4,338,671	26,254,080	42	2,167,791	344,508	244	297,381	554,789	7,883,372	1,334,524	11,484,000	7,289,808	3,407,982	130,647	0.7	445,077
0.90	1	5500	3	2500	1500	0.2811	91,129,580	4,390,133	25,583,860	41	2,192,926	349,014	325	300,121	558,465	8,009,810	1,352,603	10,527,000	6,682,326	3,407,982	130,647	0.9	497,324
0.90	1	5500	3	2000	1500	0.2811	91,136,540	4,413,876	25,236,330	41	2,209,112	351,634	325	302,597	562,009	8,055,809	1,354,772	10,527,000	6,682,326	3,407,982	130,647	0.7	416,728
0.90	1	5500	3	2500	2000	0.2811	91,141,990	4,386,895	25,644,610	41	2,185,678	349,571	325	298,937	551,422	8,023,526	1,353,794	10,527,000	6,682,326	3,407,982	130,647	0.9	497,395
0.90	1	5500	3	2000	2000	0.2814	91,226,040	4,415,801	25,297,080	41	2,209,112	351,634	325	302,597	562,009	8,055,809	1,354,772	10,527,000	6,682,326	3,407,982	130,647	0.7	416,728
0.90	1	5000	3	2000	1500	0.2823	91,522,580	4,503,831	24,279,330	40	2,271,844	363,715	263	310,804	567,340	8,240,116	1,374,349	9,570,000	6,074,843	3,407,982	130,647	0.7	380,301
0.90	1	5000	3	2500	1500	0.2824	91,550,620	4,482,431	24,626,860	40	2,255,790	361,490	228	309,949	564,162	8,199,143	1,373,482	9,570,000	6,074,843	3,407,982	130,647	0.9	451,256
0.90	1	5000	3	2500	2000	0.2824	91,572,660	4,479,839	24,687,610	40	2,250,670	362,074	228	308,272	558,666	8,210,195	1,374,058	9,570,000	6,074,843	3,407,982	130,647	0.9	451,206
0.90	1	5000	3	2000	2000	0.2826	91,612,090	4,505,756	24,340,080	40	2,271,844	363,715	263	310,804	567,340	8,240,116	1,374,349	9,570,000	6,074,843	3,407,982	130,647	0.7	380,301
0.90	**2**	**6000**	**3**	**2000**	**1500**	**0.2672**	**87,823,740**	**4,127,891**	**26,193,350**	**41**	**2,040,741**	**455,098**	**-**	**7,160**	**1,516,060**	**8,188,502**	**796,824**	**11,484,010**	**7,296,031**	**3,407,982**	**130,647**	**0.7**	**893,681**
0.90	2	5500	3	2000	1500	0.2673	87,852,420	4,193,911	25,236,340	40	2,044,686	430,980	-	4,490	1,589,682	8,370,347	815,830	10,527,010	6,688,023	3,407,982	130,647	0.7	883,859
0.90	2	6000	3	2000	2000	0.2674	87,892,970	4,129,613	26,236,860	41	2,040,741	455,098	-	7,160	1,516,060	8,188,502	796,824	11,484,010	7,296,031	3,407,982	130,647	0.7	893,681
0.90	2	5500	3	2000	2000	0.2675	87,921,650	4,195,632	25,279,860	40	2,044,686	430,980	-	4,490	1,589,682	8,370,347	815,830	10,527,010	6,688,023	3,407,982	130,647	0.7	883,859
0.90	2	6000	3	2000	2500	0.2676	87,962,190	4,131,336	26,280,380	41	2,040,741	455,098	-	7,160	1,516,060	8,188,502	796,824	11,484,010	7,296,031	3,407,982	130,647	0.7	893,681
0.90	2	5500	3	2000	2500	0.2677	87,990,880	4,197,355	25,323,380	40	2,044,686	430,980	-	4,490	1,589,682	8,370,347	815,830	10,527,010	6,688,023	3,407,982	130,647	0.7	883,859
0.90	2	6500	3	2000	1500	0.2677	87,991,810	4,075,050	27,150,350	42	2,024,069	469,339	-	14,047	1,411,921	8,072,214	795,702	12,441,020	7,904,028	3,407,982	130,647	0.7	928,584
0.90	2	6500	3	2000	2000	0.2679	88,061,030	4,076,772	27,193,860	42	2,024,069	469,339	-	14,047	1,411,921	8,072,214	795,702	12,441,020	7,904,028	3,407,982	130,647	0.7	928,584
0.90	2	6500	3	2000	2500	0.2681	88,130,260	4,078,494	27,237,380	42	2,024,069	469,339	-	14,047	1,411,921	8,072,214	795,702	12,441,020	7,904,028	3,407,982	130,647	0.7	928,584
0.90	2	5500	3	2500	1500	0.2684	88,222,610	4,203,852	25,458,100	40	2,119,151	526,175	-	39,447	1,232,726	8,434,670	851,156	10,527,010	6,688,023	3,407,982	130,647	0.9	1,109,335
0.90	2	5500	3	2500	2000	0.2685	88,242,810	4,202,290	25,501,610	40	2,100,072	539,604	-	36,810	1,235,737	8,427,263	863,022	10,527,010	6,688,023	3,407,982	130,647	0.9	1,111,731
0.90	2	7000	3	2000	1500	0.2685	88,267,830	4,029,439	28,107,350	43	2,004,411	480,080	-	19,533	1,297,792	8,006,701	786,114	13,398,020	8,512,032	3,407,982	130,647	0.7	967,515
0.90	2	6000	3	2500	1500	0.2686	88,301,980	4,145,070	26,415,100	41	2,106,903	556,517	-	57,493	1,050,757	8,329,345	851,647	11,484,010	7,296,031	3,407,982	130,647	0.9	1,185,019
0.90	2	5500	3	2500	2500	0.2687	88,312,030	4,204,013	25,545,130	40	2,100,072	539,604	-	36,810	1,235,737	8,427,263	863,022	10,527,010	6,688,023	3,407,982	130,647	0.9	1,111,731
0.90	2	6000	3	2500	2000	0.2687	88,331,860	4,144,157	26,458,620	41	2,082,689	570,869	-	56,152	1,057,693	8,314,107	870,928	11,484,010	7,296,031	3,407,982	130,647	0.9	1,193,813
0.90	2	7000	3	2000	2000	0.2688	88,337,060	4,031,162	28,150,860	43	2,004,411	480,080	-	19,533	1,297,792	8,006,701	786,114	13,398,020	8,512,032	3,407,982	130,647	0.7	967,515
0.90	2	6000	3	2500	2500	0.2689	88,401,080	4,145,878	26,502,130	41	2,082,689	570,869	-	56,152	1,057,693	8,314,107	870,928	11,484,010	7,296,031	3,407,982	130,647	0.9	1,193,813
0.90	2	7000	3	2000	2500	0.2690	88,406,290	4,032,884	28,194,380	43	2,004,411	480,080	-	19,533	1,297,792	8,006,701	786,114	13,398,020	8,512,032	3,407,982	130,647	0.7	967,515
0.90	2	6500	3	2500	1500	0.2691	88,454,770	4,091,206	27,372,100	42	2,083,753	565,773	-	70,557	948,955	8,196,493	862,957	12,441,020	7,904,028	3,407,982	130,647	0.9	1,232,236

Diesel Fuel Price Scenario	Phase	PV capacity	Wind turbines	Battery capacity	Battery's inverter capacity	LCOE	Net present cost	Operating cost	Initial capital	Renewable fraction	1. Cat 650 Electricity production	3. Cat 650 Electricity production	4. Cat 650 Electricity production	9. Cat 1100 Electricity production	10. MTU 900 Electricity production	11. SKL 1670 Electricity production	12. SKL 1700 Electricity production	PV Capital Cost	PV electricity production	Wind turbine Electricity production	Wind turbine O&M Cost	Battery autonomy	Battery annual Throughput
$/L		kWp	Number	kWp	kWp	$/kWh	$	$	$	%	kWh/Year	kWh/Year	kWh/Year	kWh/Year	kWh/Year	kWh/Year	$/Year	$	kWh/Year	kWh/Year	$/Year	Hours	kWh/Year
0.90	2	6500	3	2500	2000	0.2692	88,492,420	4,090,813	27,415,620	42	2,062,903	576,953	-	69,362	950,957	8,181,855	886,784	12,441,020	7,904,028	3,407,982	130,647	0.9	1,245,738
0.90	2	5500	3	3000	2000	0.2693	88,506,430	4,205,095	25,723,370	40	2,127,812	607,971	-	87,719	1,003,934	8,412,718	909,301	10,527,010	6,688,023	3,407,982	130,647	1.1	1,293,213
0.90	2	5500	3	3000	1500	0.2693	88,507,010	4,208,048	25,679,850	40	2,171,526	587,191	-	94,959	1,012,227	8,399,468	882,611	10,527,010	6,688,023	3,407,982	130,647	1.1	1,283,221
0.90	2	6500	3	2500	2500	0.2694	88,561,660	4,092,535	27,459,130	42	2,062,903	576,953	-	69,362	950,957	8,181,855	886,784	12,441,020	7,904,028	3,407,982	130,647	0.9	1,245,738
0.90	2	5500	3	3000	2500	0.2695	88,571,650	4,206,548	25,766,880	40	2,108,409	606,619	-	87,940	1,006,488	8,432,177	908,361	10,527,010	6,688,023	3,407,982	130,647	1.1	1,295,145
0.90	2	5500	4	2000	1500	0.2695	88,579,670	3,991,136	28,991,060	44	2,004,556	407,993	-	4,260	1,560,087	7,708,463	742,356	10,527,010	6,688,023	4,543,970	174,196	0.7	864,827
0.90	2	6000	3	3000	2000	0.2695	88,587,570	4,146,431	26,680,370	42	2,104,921	619,313	-	114,652	858,609	8,244,580	949,203	11,484,010	7,296,031	3,407,982	130,647	1.1	1,387,655
0.90	2	6000	3	3000	1500	0.2696	88,602,410	4,150,340	26,636,850	42	2,158,303	601,394	-	123,005	852,355	8,245,657	909,311	11,484,010	7,296,031	3,407,982	130,647	1.1	1,376,922
0.90	2	7500	3	2000	1500	0.2697	88,639,240	3,990,217	29,064,350	44	1,994,281	489,032	-	28,728	1,167,722	7,962,973	777,206	14,355,020	9,120,035	3,407,982	130,647	0.7	1,012,307
0.90	2	5500	4	2000	2000	0.2697	88,648,900	3,992,858	29,034,580	44	2,004,556	407,993	-	4,260	1,560,087	7,708,463	742,356	10,527,010	6,688,023	4,543,970	174,196	0.7	864,827
0.90	2	6000	3	3000	2500	0.2697	88,655,800	4,148,086	26,723,890	41	2,082,896	619,827	-	114,815	863,464	8,263,465	947,473	11,484,010	7,296,031	3,407,982	130,647	1.1	1,389,553
0.90	2	6000	4	2000	1500	0.2698	88,677,540	3,933,593	29,948,060	45	1,998,935	427,348	-	9,718	1,461,015	7,568,341	733,414	11,484,010	7,296,031	4,543,970	174,196	0.7	886,234
0.90	2	7500	3	2000	2000	0.2699	88,708,340	3,991,931	29,107,860	44	1,994,573	489,201	-	28,692	1,167,878	7,962,259	777,376	14,355,020	9,120,035	3,407,982	130,647	0.7	1,012,149
0.90	2	7000	3	2500	1500	0.2699	88,709,380	4,044,161	28,329,100	43	2,060,351	568,982	-	81,581	857,243	8,078,033	883,378	13,398,020	8,512,032	3,407,982	130,647	0.9	1,273,234
0.90	2	5500	4	2000	2500	0.2699	88,718,130	3,994,581	29,078,100	44	2,004,556	407,993	-	4,260	1,560,087	7,708,463	742,356	10,527,010	6,688,023	4,543,970	174,196	0.7	864,827
0.90	2	7000	3	2500	2000	0.2700	88,743,220	4,043,513	28,372,620	43	2,043,987	581,581	-	81,891	858,605	8,048,467	915,057	13,398,020	8,512,032	3,407,982	130,647	0.9	1,282,479
0.90	2	6000	4	2000	2000	0.2700	88,746,900	3,935,324	29,991,580	45	1,998,924	427,296	-	9,711	1,461,025	7,568,409	733,414	11,484,010	7,296,031	4,543,970	174,196	0.7	886,260
0.90	2	6500	3	3000	2000	0.2701	88,766,340	4,094,307	27,637,370	43	2,070,704	603,429	-	128,970	748,769	8,121,413	990,939	12,441,020	7,904,028	3,407,982	130,647	1.1	1,469,530
0.90	2	7500	3	2000	2500	0.2701	88,777,560	3,993,653	29,151,380	44	1,994,573	489,201	-	28,692	1,167,878	7,962,259	777,376	14,355,020	9,120,035	3,407,982	130,647	0.7	1,012,149
0.90	2	6500	3	3000	1500	0.2701	88,783,220	4,098,352	27,593,850	43	2,111,789	592,201	-	138,857	732,807	8,141,860	945,992	12,441,020	7,904,028	3,407,982	130,647	1.1	1,456,062
0.90	2	7000	3	2500	2500	0.2702	88,812,390	4,045,231	28,416,130	43	2,043,987	581,555	-	81,891	858,596	8,048,501	915,057	13,398,020	8,512,032	3,407,982	130,647	0.9	1,282,472
0.90	2	6000	4	2000	2500	0.2702	88,816,130	3,937,046	30,035,100	45	1,998,924	427,296	-	9,711	1,461,025	7,568,409	733,414	11,484,010	7,296,031	4,543,970	174,196	0.7	886,260
0.90	2	6500	3	3000	2500	0.2702	88,827,950	4,095,519	27,680,890	43	2,050,983	603,793	-	130,005	755,214	8,132,287	992,334	12,441,020	7,904,028	3,407,982	130,647	1.1	1,470,984
0.90	2	6500	4	2000	1500	0.2706	88,929,910	3,886,398	30,905,070	46	1,984,721	442,392	-	18,843	1,324,816	7,497,813	729,742	12,441,020	7,904,028	4,543,970	174,196	0.7	933,035
0.90	2	6500	4	2000	2000	0.2708	88,999,230	3,888,126	30,948,580	46	1,984,682	442,483	-	18,800	1,324,638	7,497,950	729,776	12,441,020	7,904,028	4,543,970	174,196	0.7	933,073
0.90	2	5500	4	2500	1500	0.2708	89,018,860	4,005,699	29,212,820	44	2,065,147	498,725	-	50,314	1,118,876	7,854,661	783,088	10,527,010	6,688,023	4,543,970	174,196	0.9	1,155,583
0.90	2	7000	3	3000	2000	0.2708	89,026,900	4,047,661	28,594,370	43	2,027,262	589,351	-	141,305	661,805	8,007,851	1,033,951	13,398,020	8,512,032	3,407,982	130,647	1.1	1,532,805
0.90	2	7000	3	3000	1500	0.2709	89,038,940	4,051,381	28,550,860	43	2,070,024	578,250	-	154,797	639,507	8,038,261	979,341	13,398,020	8,512,032	3,407,982	130,647	1.1	1,513,990
0.90	2	5500	4	2500	2000	0.2709	89,040,060	4,004,205	29,256,330	44	2,047,050	511,527	-	49,257	1,101,821	7,859,291	798,456	10,527,010	6,688,023	4,543,970	174,196	0.9	1,176,855

Diesel Fuel Price Scenario	Phase	PV capacity	Wind turbines	Battery capacity	Battery`s inverter capacity	LCOE	Net present cost	Operating cost	Initial capital	Renewable fraction	1. Cat 650 Electricity production	3. Cat 650 Electricity production	4. Cat 650 Electricity production	9. Cat 1100 Electricity production	10. MTU 900 Electricity production	11. SKL 1670 Electricity production	12. SKL 1700 Electricity production	PV Capital Cost	PV electricity production	Wind turbine Electricity production	Wind turbine O&M Cost	Battery autonomy	Battery annual Throughput
$/L		kWp	Number	kWp	kWp	$/kWh	$	$	$	%	kWh/Year	kWh/Year	kWh/Year	kWh/Year	kWh/Year	kWh/Year	$/Year	$	kWh/Year	kWh/Year	$/Year	Hours	kWh/Year
0.90	2	7500	3	2500	1500	0.2709	89,046,730	4,002,657	29,286,100	44	2,036,326	567,486	-	92,900	767,294	7,971,016	915,016	14,355,020	9,120,035	3,407,982	130,647	0.9	1,312,336
0.90	2	6500	4	2000	2500	0.2710	89,068,460	3,889,849	30,992,100	46	1,984,682	442,483	-	18,800	1,324,638	7,497,950	729,776	12,441,020	7,904,028	4,543,970	174,196	0.7	933,073
0.90	2	7000	3	3000	2500	0.2710	89,082,440	4,048,466	28,637,890	43	2,008,829	593,738	-	139,483	665,797	8,018,494	1,035,295	13,398,020	8,512,032	3,407,982	130,647	1.1	1,532,445
0.90	2	7500	3	2500	2000	0.2710	89,092,420	4,002,803	29,329,620	44	2,010,238	572,221	-	94,397	776,133	7,946,113	951,274	14,355,020	9,120,035	3,407,982	130,647	0.9	1,327,452
0.90	2	5500	4	2500	2500	0.2711	89,109,300	4,005,927	29,299,850	44	2,047,050	511,527	-	49,257	1,101,821	7,859,291	798,456	10,527,010	6,688,023	4,543,970	174,196	0.9	1,176,855
0.90	2	6000	4	2500	1500	0.2712	89,156,900	3,950,847	30,169,820	45	2,054,363	523,638	-	66,766	991,735	7,722,368	780,640	11,484,010	7,296,031	4,543,970	174,196	0.9	1,204,287
0.90	2	7500	3	2500	2500	0.2713	89,161,660	4,004,526	29,373,130	44	2,010,238	572,221	-	94,397	776,133	7,946,113	951,274	14,355,020	9,120,035	3,407,982	130,647	0.9	1,327,452
0.90	2	6000	4	2500	2000	0.2713	89,183,970	3,949,745	30,213,330	45	2,035,284	531,817	-	68,115	985,862	7,713,544	801,788	11,484,010	7,296,031	4,543,970	174,196	0.9	1,228,802
0.90	2	6000	4	2500	2500	0.2715	89,253,200	3,951,468	30,256,850	45	2,035,284	531,817	-	68,115	985,862	7,713,544	801,788	11,484,010	7,296,031	4,543,970	174,196	0.9	1,228,802
0.90	2	5500	4	3000	2000	0.2716	89,277,060	4,005,226	29,478,090	44	2,073,678	571,779	-	104,238	904,028	7,808,336	845,097	10,527,010	6,688,023	4,543,970	174,196	1.1	1,359,504
0.90	2	7000	4	2000	1500	0.2716	89,279,860	3,845,739	31,862,070	46	1,962,412	450,451	-	26,397	1,209,645	7,450,805	720,528	13,398,020	8,512,032	4,543,970	174,196	0.7	975,124
0.90	2	5500	4	3000	1500	0.2717	89,314,990	4,010,681	29,434,570	44	2,123,866	551,365	-	109,699	917,358	7,797,124	810,258	10,527,010	6,688,023	4,543,970	174,196	1.1	1,336,021
0.90	2	7500	3	3000	2000	0.2718	89,343,870	4,004,792	29,551,370	44	1,990,614	578,973	-	159,910	586,707	7,902,842	1,060,171	14,355,020	9,120,035	3,407,982	130,647	1.1	1,577,029
0.90	2	5500	4	3000	2500	0.2718	89,345,220	4,006,877	29,521,600	44	2,049,226	571,974	-	104,771	906,388	7,831,717	843,486	10,527,010	6,688,023	4,543,970	174,196	1.1	1,362,685
0.90	2	7000	4	2000	2000	0.2718	89,349,090	3,847,461	31,905,580	46	1,962,412	450,451	-	26,397	1,209,645	7,450,805	720,528	13,398,020	8,512,032	4,543,970	174,196	0.7	975,124
0.90	2	7500	3	3000	1500	0.2718	89,354,550	4,008,422	29,507,860	44	2,043,902	567,684	-	179,594	566,500	7,921,083	996,845	14,355,020	9,120,035	3,407,982	130,647	1.1	1,552,679
0.90	2	6500	4	2500	1500	0.2720	89,398,650	3,902,941	31,126,820	46	2,028,777	535,637	-	80,004	889,363	7,605,899	793,730	12,441,020	7,904,028	4,543,970	174,196	0.9	1,247,479
0.90	2	7500	3	3000	2500	0.2720	89,401,270	4,005,722	29,594,890	44	1,976,276	582,722	-	158,062	586,309	7,913,092	1,062,978	14,355,020	9,120,035	3,407,982	130,647	1.1	1,577,049
0.90	2	7000	4	2000	2500	0.2720	89,418,320	3,849,183	31,949,100	46	1,962,412	450,451	-	26,397	1,209,645	7,450,805	720,528	13,398,020	8,512,032	4,543,970	174,196	0.7	975,124
0.90	2	6500	4	2500	2000	0.2721	89,423,700	3,901,704	31,170,340	46	2,013,153	544,713	-	79,620	886,519	7,583,598	822,834	12,441,020	7,904,028	4,543,970	174,196	0.9	1,272,319
0.90	2	6000	4	3000	2000	0.2721	89,426,700	3,951,151	30,435,090	45	2,033,123	575,990	-	121,675	778,985	7,672,966	887,956	11,484,010	7,296,031	4,543,970	174,196	1.1	1,444,108
0.90	2	6000	4	3000	1500	0.2722	89,470,600	3,957,005	30,391,570	45	2,092,227	554,349	-	128,421	777,366	7,683,612	837,127	11,484,010	7,296,031	4,543,970	174,196	1.1	1,420,830
0.90	2	6500	4	2500	2500	0.2723	89,492,970	3,903,428	31,213,850	46	2,013,049	544,726	-	79,629	886,418	7,583,768	822,834	12,441,020	7,904,028	4,543,970	174,196	0.9	1,272,353
0.90	2	6000	4	3000	2500	0.2723	89,493,600	3,952,717	30,478,600	45	2,017,146	576,857	-	122,057	778,117	7,690,611	886,005	11,484,010	7,296,031	4,543,970	174,196	1.1	1,447,177
0.90	2	6500	4	3000	2000	0.2728	89,671,020	3,903,416	31,392,090	46	1,997,206	562,364	-	133,048	679,854	7,564,351	924,678	12,441,020	7,904,028	4,543,970	174,196	1.1	1,511,450
0.90	2	7500	4	2000	1500	0.2729	89,705,810	3,810,169	32,819,070	47	1,946,506	459,228	-	34,910	1,095,753	7,410,102	713,150	14,355,020	9,120,035	4,543,970	174,196	0.7	1,016,132
0.90	2	6500	4	3000	1500	0.2729	89,713,490	3,909,175	31,348,570	46	2,045,130	549,859	-	139,685	667,602	7,589,787	871,478	12,441,020	7,904,028	4,543,970	174,196	1.1	1,485,692
0.90	2	7000	4	2500	1500	0.2729	89,714,100	3,859,971	32,083,820	47	2,001,668	529,398	-	88,323	807,026	7,511,132	812,655	13,398,020	8,512,032	4,543,970	174,196	0.9	1,288,801
0.90	2	6500	4	3000	2500	0.2730	89,729,200	3,904,398	31,435,610	46	1,984,104	562,376	-	133,414	678,247	7,579,726	923,527	12,441,020	7,904,028	4,543,970	174,196	1.1	1,513,672

Diesel Fuel Price Scenario	Phase	PV capacity	Wind turbines	Battery capacity	Battery's inverter capacity	LCOE	Net present cost	Operating cost	Initial capital	Renewable fraction	1. Cat 650 Electricity production	3. Cat 650 Electricity production	4. Cat 650 Electricity production	9. Cat 1100 Electricity production	10. MTU 900 Electricity production	11. SKL 1670 Electricity production	12. SKL 1700 Electricity production	PV Capital Cost	PV electricity production	Wind turbine Electricity production	Wind turbine O&M Cost	Battery autonomy	Battery annual Throughput
$/L		kWp	Number	kWp	kWp	$/kWh	$	$	$	%	kWh/Year	kWh/Year	kWh/Year	kWh/Year	kWh/Year	kWh/Year	$/Year	$	kWh/Year	kWh/Year	$/Year	Hours	kWh/Year
0.90	2	7000	4	2500	2000	0.2731	89,750,200	3,859,474	32,127,340	47	1,988,294	535,626	-	88,440	799,023	7,490,056	846,962	13,398,020	8,512,032	4,543,970	174,196	0.9	1,314,650
0.90	2	7500	4	2000	2000	0.2731	89,775,060	3,811,893	32,862,580	47	1,946,493	459,228	-	34,910	1,095,765	7,410,068	713,184	14,355,020	9,120,035	4,543,970	174,196	0.7	1,016,140
0.90	2	7000	4	2500	2500	0.2733	89,819,430	3,861,196	32,170,850	47	1,988,294	535,626	-	88,440	799,023	7,490,056	846,962	13,398,020	8,512,032	4,543,970	174,196	0.9	1,314,650
0.90	2	7500	4	2000	2500	0.2733	89,844,290	3,813,616	32,906,100	47	1,946,493	459,228	-	34,910	1,095,765	7,410,068	713,184	14,355,020	9,120,035	4,543,970	174,196	0.7	1,016,140
0.90	2	7000	4	3000	2000	0.2738	89,982,150	3,860,157	32,349,090	47	1,962,718	551,721	-	145,888	603,539	7,468,766	942,405	13,398,020	8,512,032	4,543,970	174,196	1.1	1,558,392
0.90	2	7000	4	3000	1500	0.2739	90,024,900	3,865,935	32,305,580	47	2,012,835	544,034	-	150,761	596,897	7,480,237	892,492	13,398,020	8,512,032	4,543,970	174,196	1.1	1,528,351
0.90	2	7000	4	3000	2500	0.2739	90,044,740	3,861,435	32,392,610	47	1,949,758	552,572	-	143,916	602,575	7,479,727	946,670	13,398,020	8,512,032	4,543,970	174,196	1.1	1,563,036
0.90	2	7500	4	2500	1500	0.2742	90,129,360	3,823,686	33,040,820	47	1,985,107	528,144	-	97,709	715,281	7,426,765	832,239	14,355,020	9,120,035	4,543,970	174,196	0.9	1,333,893
0.90	2	7500	4	2500	2000	0.2742	90,140,090	3,821,490	33,084,340	47	1,963,450	529,168	-	98,939	715,346	7,408,180	868,088	14,355,020	9,120,035	4,543,970	174,196	0.9	1,355,342
0.90	2	7500	4	2500	2500	0.2744	90,209,320	3,823,213	33,127,850	47	1,963,450	529,168	-	98,939	715,346	7,408,180	868,088	14,355,020	9,120,035	4,543,970	174,196	0.9	1,355,342
0.90	2	7500	4	3000	2000	0.2749	90,355,420	3,821,059	33,306,090	48	1,925,732	541,665	-	163,590	547,846	7,362,623	964,100	14,355,020	9,120,035	4,543,970	174,196	1.1	1,594,080
0.90	2	7500	4	3000	1500	0.2750	90,397,350	3,826,783	33,262,580	48	1,982,759	531,259	-	170,953	541,411	7,377,716	903,483	14,355,020	9,120,035	4,543,970	174,196	1.1	1,563,166
0.90	2	7500	4	3000	2500	0.2751	90,415,100	3,822,143	33,349,610	48	1,913,477	541,831	-	160,364	549,382	7,375,423	965,446	14,355,020	9,120,035	4,543,970	174,196	1.1	1,597,555
0.90	2	6500	3	3000	2000	0.2804	92,174,810	4,322,600	27,637,370	44	2,097,327	333,908	72	280,735	532,264	7,782,537	1,398,548	12,441,020	7,904,028	3,407,982	130,647	1.1	653,527
0.90	2	7000	3	3000	2000	0.2804	92,180,000	4,258,849	28,594,370	45	2,054,510	327,890	163	274,923	526,014	7,650,241	1,377,773	13,398,020	8,512,032	3,407,982	130,647	1.1	684,654
0.90	2	6500	3	3000	2500	0.2806	92,221,650	4,322,823	27,680,890	44	2,093,040	334,633	78	280,732	531,652	7,786,087	1,399,171	12,441,020	7,904,028	3,407,982	130,647	1.1	653,539
0.90	2	7000	3	3000	2500	0.2806	92,223,130	4,258,823	28,637,890	45	2,049,947	328,365	163	275,373	524,020	7,655,040	1,378,607	13,398,020	8,512,032	3,407,982	130,647	1.1	684,658
0.90	2	6500	3	3000	1500	0.2807	92,261,790	4,331,340	27,593,850	44	2,107,702	333,501	72	286,115	547,762	7,761,068	1,389,495	12,441,020	7,904,028	3,407,982	130,647	1.1	653,421
0.90	2	7000	3	3000	1500	0.2807	92,268,310	4,267,679	28,550,860	45	2,068,278	328,534	163	280,728	541,058	7,627,553	1,365,692	13,398,020	8,512,032	3,407,982	130,647	1.1	684,301
0.90	2	7500	3	3000	2000	0.2808	92,287,530	4,201,953	29,551,370	45	2,016,457	321,873	241	274,402	520,133	7,529,991	1,358,401	14,355,020	9,120,035	3,407,982	130,647	1.1	709,717
0.90	2	6000	3	3000	2000	0.2809	92,317,170	4,396,233	26,680,370	43	2,143,494	341,382	234	288,321	542,749	7,931,923	1,420,070	11,484,010	7,296,031	3,407,982	130,647	1.1	615,209
0.90	2	7500	3	3000	2500	0.2809	92,331,080	4,201,956	29,594,890	45	2,012,628	322,170	241	273,954	518,212	7,534,539	1,359,753	14,355,020	9,120,035	3,407,982	130,647	1.1	709,719
0.90	2	6000	3	3000	2500	0.2810	92,367,440	4,396,685	26,723,890	43	2,139,415	341,916	234	287,851	543,078	7,935,309	1,420,370	11,484,010	7,296,031	3,407,982	130,647	1.1	615,211
0.90	2	6500	3	2500	2000	0.2810	92,370,250	4,350,543	27,415,620	43	2,111,415	336,603	107	283,692	540,372	7,832,726	1,403,567	12,441,020	7,904,028	3,407,982	130,647	0.9	561,351
0.90	2	7500	3	3000	1500	0.2811	92,382,170	4,211,206	29,507,860	45	2,034,864	321,534	234	279,139	533,306	7,509,559	1,343,598	14,355,020	9,120,035	3,407,982	130,647	1.1	709,131
0.90	2	6500	3	2500	1500	0.2811	92,383,010	4,354,312	27,372,100	43	2,118,764	336,552	94	286,449	548,605	7,818,287	1,399,857	12,441,020	7,904,028	3,407,982	130,647	0.9	561,516
0.90	2	7000	3	2500	2000	0.2811	92,402,560	4,288,608	28,372,620	44	2,072,743	330,562	163	278,326	532,032	7,703,460	1,383,496	13,398,020	8,512,032	3,407,982	130,647	0.9	585,622
0.90	2	6000	3	3000	1500	0.2811	92,403,010	4,404,897	26,636,850	43	2,156,543	340,866	215	292,570	557,021	7,907,665	1,413,386	11,484,010	7,296,031	3,407,982	130,647	1.1	615,052
0.90	2	7000	3	2500	1500	0.2811	92,410,620	4,292,063	28,329,100	44	2,077,265	330,490	163	280,530	541,058	7,692,804	1,378,680	13,398,020	8,512,032	3,407,982	130,647	0.9	585,609

Diesel Fuel Price Scenario	Phase	PV capacity	Wind turbines	Battery capacity	Battery's inverter capacity	LCOE	Net present cost	Operating cost	Initial capital	Renewable fraction	1. Cat 650 Electricity production	3. Cat 650 Electricity production	4. Cat 650 Electricity production	9. Cat 1100 Electricity production	10. MTU 900 Electricity production	11. SKL 1670 Electricity production	12. SKL 1700 Electricity production	PV Capital Cost	PV electricity production	Wind turbine Electricity production	Wind turbine O&M Cost	Battery autonomy	Battery annual Throughput
$/L		kWp	Number	kWp	kWp	$/kWh	$	$	$	%	kWh/Year	kWh/Year	kWh/Year	kWh/Year	kWh/Year	kWh/Year	$/Year	$	kWh/Year	kWh/Year	$/Year	Hours	kWh/Year
0.90	2	6500	3	2500	2500	0.2812	92,439,480	4,352,265	27,459,130	43	2,111,415	336,603	107	283,692	540,372	7,832,726	1,403,567	12,441,020	7,904,028	3,407,982	130,647	0.9	561,351
0.90	2	7000	3	2500	2500	0.2813	92,471,780	4,290,331	28,416,130	44	2,072,743	330,562	163	278,326	532,032	7,703,460	1,383,496	13,398,020	8,512,032	3,407,982	130,647	0.9	585,622
0.90	2	6000	3	2500	2000	0.2814	92,483,140	4,422,202	26,458,620	42	2,156,120	344,365	254	290,635	549,326	7,980,659	1,422,998	11,484,010	7,296,031	3,407,982	130,647	0.9	530,690
0.90	2	6000	3	2500	1500	0.2814	92,499,160	4,426,190	26,415,100	42	2,165,086	343,357	247	293,026	557,765	7,963,287	1,421,669	11,484,010	7,296,031	3,407,982	130,647	0.9	530,578
0.90	2	7500	3	2500	2000	0.2815	92,528,530	4,232,947	29,329,620	45	2,035,895	324,046	241	277,862	524,624	7,587,456	1,365,041	14,355,020	9,120,035	3,407,982	130,647	0.9	605,841
0.90	2	7500	3	2500	1500	0.2815	92,537,380	4,236,455	29,286,100	45	2,039,788	324,153	234	280,509	532,646	7,578,463	1,359,691	14,355,020	9,120,035	3,407,982	130,647	0.9	605,673
0.90	2	6000	3	2500	2500	0.2816	92,552,370	4,423,924	26,502,130	42	2,156,120	344,365	254	290,635	549,326	7,980,659	1,422,998	11,484,010	7,296,031	3,407,982	130,647	0.9	530,690
0.90	2	6500	3	2000	1500	0.2816	92,575,650	4,382,067	27,150,350	43	2,132,687	339,903	117	286,685	551,776	7,878,993	1,406,118	12,441,020	7,904,028	3,407,982	130,647	0.7	464,774
0.90	2	7500	3	2500	2500	0.2817	92,597,760	4,234,670	29,373,130	45	2,035,895	324,046	241	277,862	524,624	7,587,456	1,365,041	14,355,020	9,120,035	3,407,982	130,647	0.9	605,841
0.90	2	7000	3	2000	1500	0.2818	92,618,700	4,320,852	28,107,350	44	2,088,719	333,879	182	281,675	545,387	7,756,782	1,387,517	13,398,020	8,512,032	3,407,982	130,647	0.7	482,958
0.90	2	5500	3	3000	2000	0.2818	92,626,350	4,481,040	25,723,370	41	2,185,522	349,842	361	294,058	552,657	8,119,012	1,443,202	10,527,010	6,688,023	3,407,982	130,647	1.1	566,866
0.90	2	6500	3	2000	2000	0.2819	92,644,870	4,383,789	27,193,860	43	2,132,687	339,903	117	286,685	551,776	7,878,993	1,406,118	12,441,020	7,904,028	3,407,982	130,647	0.7	464,774
0.90	2	6000	3	2000	1500	0.2819	92,658,820	4,451,735	26,193,350	42	2,180,357	346,415	244	294,243	561,605	8,017,439	1,424,421	11,484,010	7,296,031	3,407,982	130,647	0.7	441,734
0.90	2	5500	3	3000	2500	0.2820	92,677,410	4,481,544	25,766,880	41	2,182,388	350,439	361	294,100	552,275	8,121,674	1,443,417	10,527,010	6,688,023	3,407,982	130,647	1.1	566,866
0.90	2	7000	3	2000	2000	0.2820	92,687,930	4,322,575	28,150,860	44	2,088,719	333,879	182	281,674	545,387	7,756,782	1,387,517	13,398,020	8,512,032	3,407,982	130,647	0.7	482,959
0.90	2	5500	3	3000	1500	0.2820	92,695,750	4,488,603	25,679,850	41	2,197,180	347,954	371	296,202	566,179	8,096,551	1,440,237	10,527,010	6,688,023	3,407,982	130,647	1.1	566,756
0.90	2	6500	3	2000	2500	0.2821	92,714,100	4,385,511	27,237,380	43	2,132,687	339,903	117	286,685	551,776	7,878,993	1,406,118	12,441,020	7,904,028	3,407,982	130,647	0.7	464,774
0.90	2	6000	3	2000	2000	0.2821	92,728,040	4,453,458	26,236,860	42	2,180,357	346,415	244	294,243	561,605	8,017,439	1,424,421	11,484,010	7,296,031	3,407,982	130,647	0.7	441,734
0.90	2	5500	3	2500	2000	0.2822	92,751,380	4,504,267	25,501,610	41	2,199,566	352,051	361	295,027	557,597	8,162,085	1,445,376	10,527,010	6,688,023	3,407,982	130,647	0.9	492,065
0.90	2	7500	3	2000	1500	0.2822	92,753,710	4,265,797	29,064,350	45	2,052,834	326,966	234	281,084	537,686	7,644,247	1,368,923	14,355,020	9,120,035	3,407,982	130,647	0.7	499,238
0.90	2	7000	3	2000	2500	0.2822	92,757,160	4,324,297	28,194,380	44	2,088,719	333,879	182	281,674	545,387	7,756,782	1,387,517	13,398,020	8,512,032	3,407,982	130,647	0.7	482,959
0.90	2	5500	3	2500	1500	0.2822	92,761,500	4,507,859	25,458,100	41	2,206,965	351,422	361	296,423	564,678	8,148,100	1,444,119	10,527,010	6,688,023	3,407,982	130,647	0.9	491,983
0.90	2	6000	3	2000	2500	0.2823	92,797,270	4,455,180	26,280,380	42	2,180,357	346,415	244	294,243	561,605	8,017,439	1,424,421	11,484,010	7,296,031	3,407,982	130,647	0.7	441,734
0.90	2	5500	3	2500	2500	0.2824	92,820,620	4,505,989	25,545,130	41	2,199,566	352,051	361	295,027	557,597	8,162,085	1,445,376	10,527,010	6,688,023	3,407,982	130,647	0.9	492,065
0.90	2	7500	3	2000	2000	0.2824	92,822,880	4,267,515	29,107,860	45	2,052,830	326,963	234	281,089	537,686	7,644,246	1,368,923	14,355,020	9,120,035	3,407,982	130,647	0.7	499,241
0.90	2	5500	3	2000	1500	0.2826	92,889,810	4,531,305	25,236,340	41	2,222,949	354,147	364	298,775	568,507	8,192,538	1,446,541	10,527,010	6,688,023	3,407,982	130,647	0.7	412,755
0.90	2	7500	3	2000	2500	0.2826	92,892,100	4,269,238	29,151,380	45	2,052,830	326,963	234	281,089	537,686	7,644,246	1,368,923	14,355,020	9,120,035	3,407,982	130,647	0.7	499,241
0.90	2	5500	3	2000	2000	0.2828	92,959,030	4,533,027	25,279,860	41	2,222,949	354,147	364	298,775	568,507	8,192,538	1,446,541	10,527,010	6,688,023	3,407,982	130,647	0.7	412,755
0.90	2	5500	3	2000	2500	0.2830	93,028,260	4,534,750	25,323,380	41	2,222,949	354,147	364	298,775	568,507	8,192,538	1,446,541	10,527,010	6,688,023	3,407,982	130,647	0.7	412,755

Diesel Fuel Price Scenario	Phase	PV capacity	Wind turbines	Battery capacity	Battery's inverter capacity	LCOE	Net present cost	Operating cost	Initial capital	Renewable fraction	1. Cat 650 Electricity production	3. Cat 650 Electricity production	4. Cat 650 Electricity production	9. Cat 1100 Electricity production	10. MTU 900 Electricity production	11. SKL 1670 Electricity production	12. SKL 1700 Electricity production	PV Capital Cost	PV electricity production	Wind turbine Electricity production	Wind turbine O&M Cost	Battery autonomy	Battery annual Throughput
$/L		kWp	Number	kWp	kWp	$/kWh	$	$	$	%	kWh/Year	kWh/Year	kWh/Year	kWh/Year	kWh/Year	kWh/Year	$/Year	$	kWh/Year	kWh/Year	$/Year	Hours	kWh/Year
0.90	2	6500	4	3000	2000	0.2831	93,055,460	4,130,100	31,392,090	47	2,006,016	331,384	273	263,696	494,668	7,242,410	1,276,044	12,441,020	7,904,028	4,543,970	174,196	1.1	688,737
0.90	2	6000	4	3000	2000	0.2832	93,100,980	4,197,247	30,435,090	46	2,052,330	338,395	322	268,891	502,878	7,377,874	1,295,388	11,484,010	7,296,031	4,543,970	174,196	1.1	655,835
0.90	2	6500	4	3000	2500	0.2833	93,103,540	4,130,406	31,435,610	47	2,002,763	331,990	276	263,661	493,410	7,245,736	1,276,655	12,441,020	7,904,028	4,543,970	174,196	1.1	688,753
0.90	2	7000	4	3000	2000	0.2833	93,134,620	4,071,304	32,349,090	48	1,961,396	321,944	205	260,002	489,447	7,127,400	1,259,320	13,398,020	8,512,032	4,543,970	174,196	1.1	714,504
0.90	2	6000	4	3000	2500	0.2834	93,149,360	4,197,573	30,478,600	46	2,047,617	338,829	322	268,947	502,563	7,382,190	1,295,614	11,484,010	7,296,031	4,543,970	174,196	1.1	655,850
0.90	2	6500	4	3000	1500	0.2834	93,165,460	4,140,382	31,348,570	47	2,020,204	330,879	322	266,581	511,658	7,219,454	1,266,708	12,441,020	7,904,028	4,543,970	174,196	1.1	687,718
0.90	2	7000	4	3000	2500	0.2835	93,182,450	4,071,593	32,392,610	48	1,959,070	322,382	224	260,320	487,161	7,130,360	1,260,201	13,398,020	8,512,032	4,543,970	174,196	1.1	714,533
0.90	2	6000	4	3000	1500	0.2836	93,204,440	4,207,091	30,391,570	46	2,062,838	337,465	364	272,968	519,593	7,355,522	1,288,182	11,484,010	7,296,031	4,543,970	174,196	1.1	655,151
0.90	2	7000	4	3000	1500	0.2837	93,254,120	4,082,222	32,305,580	48	1,980,780	322,054	244	263,152	504,864	7,103,531	1,246,553	13,398,020	8,512,032	4,543,970	174,196	1.1	713,461
0.90	2	6500	4	2500	2000	0.2838	93,298,090	4,161,204	31,170,340	47	2,024,438	335,523	299	265,386	502,073	7,295,173	1,281,025	12,441,020	7,904,028	4,543,970	174,196	0.9	589,651
0.90	2	5500	4	3000	2000	0.2839	93,308,300	4,275,230	29,478,090	45	2,096,165	348,811	497	272,169	512,018	7,543,062	1,317,886	10,527,010	6,688,023	4,543,970	174,196	1.1	611,754
0.90	2	7500	4	3000	2000	0.2839	93,311,520	4,019,054	33,306,090	49	1,927,751	315,959	198	255,207	484,627	7,019,095	1,242,419	14,355,020	9,120,035	4,543,970	174,196	1.1	736,774
0.90	2	6000	4	2500	2000	0.2839	93,314,110	4,226,375	30,213,330	46	2,068,176	341,939	439	271,372	510,366	7,427,750	1,298,763	11,484,010	7,296,031	4,543,970	174,196	0.9	564,238
0.90	2	6500	4	2500	1500	0.2839	93,319,320	4,165,540	31,126,820	47	2,032,136	335,861	267	267,030	511,104	7,281,315	1,277,138	12,441,020	7,904,028	4,543,970	174,196	0.9	589,246
0.90	2	6000	4	2500	1500	0.2840	93,333,700	4,230,601	30,169,820	46	2,075,243	341,094	338	273,283	519,225	7,413,450	1,296,747	11,484,010	7,296,031	4,543,970	174,196	0.9	564,029
0.90	2	5500	4	3000	2500	0.2840	93,357,010	4,275,579	29,521,600	45	2,091,173	349,313	497	272,161	512,082	7,547,371	1,318,010	10,527,010	6,688,023	4,543,970	174,196	1.1	611,755
0.90	2	7500	4	3000	2500	0.2840	93,358,060	4,019,257	33,349,610	49	1,924,337	315,913	195	254,789	482,798	7,023,449	1,243,781	14,355,020	9,120,035	4,543,970	174,196	1.1	736,814
0.90	2	6500	4	2500	2500	0.2841	93,367,320	4,162,926	31,213,850	47	2,024,438	335,523	299	265,386	502,073	7,295,173	1,281,025	12,441,020	7,904,028	4,543,970	174,196	0.9	589,651
0.90	2	6000	4	2500	2500	0.2841	93,383,340	4,228,097	30,256,850	46	2,068,176	341,939	439	271,372	510,366	7,427,750	1,298,763	11,484,010	7,296,031	4,543,970	174,196	0.9	564,238
0.90	2	7000	4	2500	2000	0.2842	93,401,230	4,104,014	32,127,340	48	1,984,224	325,139	221	262,191	494,611	7,182,679	1,265,085	13,398,020	8,512,032	4,543,970	174,196	0.9	609,938
0.90	2	5500	4	3000	1500	0.2842	93,402,710	4,284,469	29,434,570	45	2,107,139	347,515	471	275,374	528,977	7,518,383	1,313,267	10,527,010	6,688,023	4,543,970	174,196	1.1	611,530
0.90	2	7000	4	2500	1500	0.2842	93,421,540	4,108,288	32,083,820	48	1,989,901	325,177	202	264,163	505,225	7,170,209	1,260,279	13,398,020	8,512,032	4,543,970	174,196	0.9	609,421
0.90	2	7500	4	3000	1500	0.2843	93,438,090	4,030,446	33,262,580	49	1,949,690	315,102	172	259,145	498,406	6,994,876	1,229,158	14,355,020	9,120,035	4,543,970	174,196	1.1	736,012
0.90	2	7000	4	2500	2500	0.2844	93,470,460	4,105,736	32,170,850	48	1,984,224	325,139	221	262,191	494,611	7,182,679	1,265,085	13,398,020	8,512,032	4,543,970	174,196	0.9	609,938
0.90	2	5500	4	2500	2000	0.2844	93,480,980	4,301,650	29,256,330	45	2,109,676	351,682	510	273,865	518,899	7,589,586	1,319,663	10,527,010	6,688,023	4,543,970	174,196	0.9	530,605
0.90	2	5500	4	2500	1500	0.2845	93,501,840	4,305,961	29,212,820	45	2,117,291	350,778	536	276,874	527,740	7,572,236	1,318,894	10,527,010	6,688,023	4,543,970	174,196	0.9	530,584
0.90	2	6000	4	2000	1500	0.2846	93,539,750	4,259,255	29,948,060	46	2,094,514	344,736	403	274,131	519,597	7,473,099	1,300,780	11,484,010	7,296,031	4,543,970	174,196	0.7	467,818
0.90	2	6500	4	2000	1500	0.2846	93,544,360	4,195,465	30,905,070	46	2,050,109	339,530	250	269,196	511,152	7,343,825	1,284,138	12,441,020	7,904,028	4,543,970	174,196	0.7	486,538
0.90	2	5500	4	2500	2500	0.2846	93,550,220	4,303,372	29,299,850	45	2,109,676	351,682	510	273,865	518,899	7,589,586	1,319,663	10,527,010	6,688,023	4,543,970	174,196	0.9	530,605

Diesel Fuel Price Scenario	Phase	PV capacity	Wind turbines	Battery capacity	Battery's inverter capacity	LCOE	Net present cost	Operating cost	Initial capital	Renewable fraction	1. Cat 650 Electricity production	3. Cat 650 Electricity production	4. Cat 650 Electricity production	9. Cat 1100 Electricity production	10. MTU 900 Electricity production	11. SKL 1670 Electricity production	12. SKL 1700 Electricity production	PV Capital Cost	PV electricity production	Wind turbine Electricity production	Wind turbine O&M Cost	Battery autonomy	Battery annual Throughput
$/L		kWp	Number	kWp	kWp	$/kWh	$	$	$	%	kWh/Year	kWh/Year	kWh/Year	kWh/Year	kWh/Year	kWh/Year	$/Year	$	kWh/Year	kWh/Year	$/Year	Hours	kWh/Year
0.90	2	7500	4	2500	2000	0.2847	93,591,010	4,052,626	33,084,340	49	1,949,644	318,021	166	258,250	489,487	7,077,896	1,249,188	14,355,020	9,120,035	4,543,970	174,196	0.9	628,947
0.90	2	6000	4	2000	2000	0.2848	93,608,980	4,260,977	29,991,580	46	2,094,514	344,736	403	274,131	519,597	7,473,099	1,300,780	11,484,010	7,296,031	4,543,970	174,196	0.7	467,818
0.90	2	7500	4	2500	1500	0.2848	93,613,180	4,057,025	33,040,820	49	1,954,781	317,978	150	260,003	499,822	7,067,126	1,243,673	14,355,020	9,120,035	4,543,970	174,196	0.9	628,605
0.90	2	6500	4	2000	2000	0.2848	93,613,580	4,197,188	30,948,580	46	2,050,109	339,530	250	269,196	511,152	7,343,825	1,284,138	12,441,020	7,904,028	4,543,970	174,196	0.7	486,538
0.90	2	7000	4	2000	1500	0.2849	93,656,410	4,138,872	31,862,070	47	2,004,804	328,494	218	267,353	507,041	7,235,668	1,268,889	13,398,020	8,512,032	4,543,970	174,196	0.7	502,497
0.90	2	7500	4	2500	2500	0.2849	93,660,230	4,054,348	33,127,850	49	1,949,644	318,021	166	258,250	489,487	7,077,896	1,249,188	14,355,020	9,120,035	4,543,970	174,196	0.9	628,947
0.90	2	5500	4	2000	1500	0.2850	93,671,210	4,332,158	28,991,060	44	2,137,243	354,001	494	276,659	530,472	7,624,157	1,320,734	10,527,010	6,688,023	4,543,970	174,196	0.7	443,537
0.90	2	6000	4	2000	2500	0.2850	93,678,220	4,262,700	30,035,100	46	2,094,514	344,736	403	274,131	519,597	7,473,099	1,300,780	11,484,010	7,296,031	4,543,970	174,196	0.7	467,818
0.90	2	6500	4	2000	2500	0.2850	93,682,820	4,198,910	30,992,100	46	2,050,109	339,530	250	269,196	511,152	7,343,825	1,284,138	12,441,020	7,904,028	4,543,970	174,196	0.7	486,538
0.90	2	7000	4	2000	2000	0.2851	93,725,640	4,140,594	31,905,580	47	2,004,804	328,494	218	267,353	507,041	7,235,668	1,268,889	13,398,020	8,512,032	4,543,970	174,196	0.7	502,497
0.90	2	5500	4	2000	2000	0.2852	93,740,440	4,333,880	29,034,580	44	2,137,243	354,001	494	276,659	530,472	7,624,157	1,320,734	10,527,010	6,688,023	4,543,970	174,196	0.7	443,537
0.90	2	7000	4	2000	2500	0.2854	93,794,860	4,142,316	31,949,100	47	2,004,804	328,494	218	267,353	507,041	7,235,668	1,268,889	13,398,020	8,512,032	4,543,970	174,196	0.7	502,497
0.90	2	5500	4	2000	2500	0.2854	93,809,670	4,335,603	29,078,100	44	2,137,243	354,001	494	276,659	530,472	7,624,157	1,320,734	10,527,010	6,688,023	4,543,970	174,196	0.7	443,537
0.90	2	7500	4	2000	1500	0.2855	93,854,060	4,088,012	32,819,070	48	1,971,592	321,337	228	263,381	501,361	7,132,420	1,253,315	14,355,020	9,120,035	4,543,970	174,196	0.7	518,699
0.90	2	7500	4	2000	2000	0.2857	93,923,290	4,089,734	32,862,580	48	1,971,592	321,337	228	263,381	501,361	7,132,418	1,253,315	14,355,020	9,120,035	4,543,970	174,196	0.7	518,701
0.90	2	7500	4	2000	2500	0.2860	93,992,520	4,091,457	32,906,100	48	1,971,592	321,337	228	263,381	501,361	7,132,418	1,253,315	14,355,020	9,120,035	4,543,970	174,196	0.7	518,701
0.90	3	8500	3	2000	1500	0.2567	112,647,300	5,527,932	30,113,990	39	2,147,777	478,597	8,112	24,935	1,688,206	10,059,600	3,742,918	15,404,660	10,336,030	3,407,982	130,647	0.5	867,422
0.90	3	9000	3	2000	1500	0.2567	112,661,400	5,475,008	30,918,250	39	2,127,562	483,636	7,384	27,565	1,650,635	9,937,417	3,698,923	16,208,920	10,944,040	3,407,982	130,647	0.5	877,856
0.90	3	8500	3	2000	2000	0.2568	112,705,500	5,529,506	30,148,700	39	2,147,872	478,571	8,112	24,906	1,688,244	10,059,530	3,742,918	15,404,660	10,336,030	3,407,982	130,647	0.5	867,337
0.90	3	8000	3	2000	1500	0.2568	112,719,000	5,586,601	29,309,740	38	2,160,722	466,427	8,164	22,596	1,734,914	10,199,760	3,793,614	14,600,410	9,728,038	3,407,982	130,647	0.5	858,896
0.90	3	9000	3	2000	2000	0.2568	112,719,800	5,476,597	30,952,950	39	2,127,562	483,636	7,384	27,565	1,650,635	9,937,417	3,698,923	16,208,920	10,944,040	3,407,982	130,647	0.5	877,856
0.90	3	8500	3	2000	2500	0.2569	112,764,000	5,531,094	30,183,400	39	2,147,872	478,571	8,112	24,906	1,688,244	10,059,530	3,742,918	15,404,660	10,336,030	3,407,982	130,647	0.5	867,337
0.90	3	8000	3	2000	2000	0.2570	112,777,500	5,588,196	29,344,440	38	2,160,816	466,440	8,164	22,581	1,734,903	10,199,690	3,793,614	14,600,410	9,728,038	3,407,982	130,647	0.5	858,893
0.90	3	9000	3	2000	2500	0.2570	112,778,300	5,478,186	30,987,650	39	2,127,562	483,636	7,384	27,565	1,650,635	9,937,417	3,698,923	16,208,920	10,944,040	3,407,982	130,647	0.5	877,856
0.90	3	8000	3	2000	2500	0.2571	112,836,000	5,589,784	29,379,140	38	2,160,816	466,440	8,164	22,581	1,734,903	10,199,690	3,793,614	14,600,410	9,728,038	3,407,982	130,647	0.5	858,893
0.90	3	7500	3	2000	1500	0.2573	112,907,100	5,653,067	28,505,490	37	2,178,967	461,458	8,333	22,302	1,772,464	10,351,770	3,849,919	13,796,160	9,120,035	3,407,982	130,647	0.5	854,568
0.90	3	8500	3	2500	2000	0.2574	112,965,000	5,535,582	30,317,410	39	2,227,985	590,974	8,892	72,323	1,354,927	9,990,889	3,823,333	15,404,660	10,336,030	3,407,982	130,647	0.7	1,171,957
0.90	3	7500	3	2000	2000	0.2574	112,965,500	5,654,656	28,540,190	37	2,178,967	461,458	8,333	22,302	1,772,464	10,351,770	3,849,919	13,796,160	9,120,035	3,407,982	130,647	0.5	854,568
0.90	3	8000	3	2500	2000	0.2574	112,969,800	5,589,775	29,513,160	38	2,243,988	578,916	9,139	61,364	1,447,954	10,119,310	3,843,328	14,600,410	9,728,038	3,407,982	130,647	0.7	1,126,176

Diesel Fuel Price Scenario	Phase	PV capacity	Wind turbines	Battery capacity	Battery's inverter capacity	LCOE	Net present cost	Operating cost	Initial capital	Renewable fraction	1. Cat 650 Electricity production	3. Cat 650 Electricity production	4. Cat 650 Electricity production	9. Cat 1100 Electricity production	10. MTU 900 Electricity production	11. SKL 1670 Electricity production	12. SKL 1700 Electricity production	PV Capital Cost	PV electricity production	Wind turbine Electricity production	Wind turbine O&M Cost	Battery autonomy	Battery annual Throughput
$/L		kWp	Number	kWp	kWp	$/kWh	$	$	$	%	kWh/Year	kWh/Year	kWh/Year	kWh/Year	kWh/Year	kWh/Year	$/Year	$	kWh/Year	kWh/Year	$/Year	Hours	kWh/Year
0.90	3	8500	3	2500	1500	0.2574	112,972,900	5,538,438	30,282,710	39	2,232,265	579,957	8,112	72,571	1,355,627	10,041,660	3,787,459	15,404,660	10,336,030	3,407,982	130,647	0.7	1,141,459
0.90	3	8000	3	2500	1500	0.2574	112,982,000	5,592,915	29,478,460	38	2,245,875	565,384	7,930	60,827	1,453,581	10,175,670	3,804,488	14,600,410	9,728,038	3,407,982	130,647	0.7	1,098,960
0.90	3	8500	3	2500	2500	0.2575	113,023,400	5,537,170	30,352,110	39	2,227,985	590,974	8,892	72,323	1,354,927	9,990,889	3,823,333	15,404,660	10,336,030	3,407,982	130,647	0.7	1,171,957
0.90	3	7500	3	2000	2500	0.2575	113,024,000	5,656,244	28,574,890	37	2,178,967	461,458	8,333	22,302	1,772,464	10,351,770	3,849,919	13,796,160	9,120,035	3,407,982	130,647	0.5	854,568
0.90	3	8000	3	2500	2500	0.2575	113,028,200	5,591,364	29,547,860	38	2,243,988	578,916	9,139	61,364	1,447,954	10,119,310	3,843,328	14,600,410	9,728,038	3,407,982	130,647	0.7	1,126,176
0.90	3	9000	3	2500	2000	0.2576	113,048,500	5,487,312	31,121,660	40	2,207,174	595,571	9,022	81,465	1,274,255	9,877,710	3,808,039	16,208,920	10,944,040	3,407,982	130,647	0.7	1,217,242
0.90	3	9000	3	2500	1500	0.2576	113,050,400	5,489,765	31,086,960	40	2,214,921	589,469	8,073	80,820	1,269,625	9,922,371	3,776,111	16,208,920	10,944,040	3,407,982	130,647	0.7	1,186,638
0.90	3	7500	3	2500	2000	0.2576	113,070,400	5,650,378	28,708,910	37	2,259,633	567,467	9,555	51,335	1,539,945	10,261,260	3,874,128	13,796,160	9,120,035	3,407,982	130,647	0.7	1,079,879
0.90	3	7500	3	2500	1500	0.2576	113,076,600	5,653,122	28,674,200	37	2,255,039	546,389	8,034	51,807	1,553,238	10,322,490	3,835,280	13,796,160	9,120,035	3,407,982	130,647	0.7	1,055,943
0.90	3	9000	3	2500	2500	0.2577	113,106,900	5,488,895	31,156,370	40	2,207,214	595,519	9,022	81,549	1,274,144	9,877,778	3,808,006	16,208,920	10,944,040	3,407,982	130,647	0.7	1,217,255
0.90	3	7500	3	2500	2500	0.2578	113,128,800	5,651,966	28,743,610	37	2,259,633	567,467	9,555	51,335	1,539,945	10,261,260	3,874,128	13,796,160	9,120,035	3,407,982	130,647	0.7	1,079,879
0.90	3	8500	3	3000	2000	0.2582	113,338,100	5,549,271	30,486,130	39	2,257,631	645,745	11,570	137,681	1,098,270	9,915,974	3,942,878	15,404,660	10,336,030	3,407,982	130,647	0.8	1,457,335
0.90	3	8000	3	3000	2000	0.2582	113,340,500	5,603,300	29,681,870	38	2,279,283	642,742	10,868	121,044	1,181,650	10,050,650	3,964,065	14,600,410	9,728,038	3,407,982	130,647	0.8	1,399,958
0.90	3	8500	3	3000	1500	0.2583	113,383,200	5,554,617	30,451,430	39	2,276,498	629,877	8,593	140,316	1,092,569	10,013,560	3,857,905	15,404,660	10,336,030	3,407,982	130,647	0.8	1,409,463
0.90	3	8000	3	3000	1500	0.2583	113,383,800	5,608,528	29,647,170	38	2,294,363	617,259	8,216	125,795	1,185,008	10,154,730	3,873,807	14,600,410	9,728,038	3,407,982	130,647	0.8	1,357,123
0.90	3	8000	3	3000	2500	0.2583	113,388,700	5,604,206	29,716,580	38	2,274,953	647,873	11,011	119,959	1,175,978	10,037,310	3,983,205	14,600,410	9,728,038	3,407,982	130,647	0.8	1,402,672
0.90	3	8500	3	3000	2500	0.2583	113,389,000	5,550,358	30,520,830	39	2,252,394	650,747	11,180	136,736	1,100,333	9,899,008	3,959,580	15,404,660	10,336,030	3,407,982	130,647	0.8	1,459,753
0.90	3	9000	3	3000	2000	0.2584	113,395,400	5,499,244	31,290,380	40	2,240,431	652,481	12,519	144,739	1,030,146	9,788,709	3,920,150	16,208,920	10,944,040	3,407,982	130,647	0.8	1,503,751
0.90	3	7500	3	3000	2000	0.2584	113,415,000	5,662,162	28,877,620	37	2,292,886	631,539	10,595	106,795	1,283,924	10,200,740	3,985,306	13,796,160	9,120,035	3,407,982	130,647	0.8	1,327,192
0.90	3	9000	3	3000	1500	0.2585	113,449,400	5,505,188	31,255,680	40	2,256,469	633,576	9,399	151,474	1,018,662	9,885,855	3,843,224	16,208,920	10,944,040	3,407,982	130,647	0.8	1,454,561
0.90	3	9000	3	3000	2500	0.2585	113,449,800	5,500,564	31,325,080	40	2,233,735	654,026	12,285	144,816	1,027,810	9,773,208	3,943,112	16,208,920	10,944,040	3,407,982	130,647	0.8	1,508,947
0.90	3	7500	3	3000	1500	0.2585	113,456,600	5,667,273	28,842,920	37	2,308,745	607,653	8,229	109,490	1,296,021	10,303,340	3,886,312	13,796,160	9,120,035	3,407,982	130,647	0.8	1,292,541
0.90	3	7500	3	3000	2500	0.2585	113,466,600	5,663,294	28,912,320	37	2,286,831	634,429	10,725	105,225	1,280,062	10,190,040	4,004,790	13,796,160	9,120,035	3,407,982	130,647	0.8	1,329,876
0.90	3	9000	3	3000	2000	0.2678	117,521,100	5,775,576	31,290,380	41	2,338,829	625,654	64,942	328,105	634,304	9,344,239	4,186,738	16,208,920	10,944,040	3,407,982	130,647	0.8	670,179
0.90	3	9000	3	3000	2500	0.2678	117,554,900	5,775,517	31,325,080	41	2,336,554	625,327	64,948	327,649	632,680	9,345,849	4,189,711	16,208,920	10,944,040	3,407,982	130,647	0.8	670,247
0.90	3	9000	3	3000	1500	0.2681	117,665,800	5,787,590	31,255,680	41	2,359,104	626,883	65,127	331,960	641,670	9,347,246	4,156,176	16,208,920	10,944,040	3,407,982	130,647	0.8	668,892
0.90	3	8500	3	3000	2000	0.2682	117,697,700	5,841,273	30,486,130	40	2,367,703	632,918	65,546	331,730	640,953	9,477,335	4,237,037	15,404,660	10,336,030	3,407,982	130,647	0.8	644,507
0.90	3	8500	3	3000	2500	0.2682	117,731,600	5,841,219	30,520,830	40	2,365,978	632,591	65,546	331,255	639,370	9,478,853	4,239,580	15,404,660	10,336,030	3,407,982	130,647	0.8	644,554
0.90	3	9000	3	2500	2000	0.2684	117,810,100	5,806,230	31,121,660	40	2,354,861	628,509	64,994	330,123	638,085	9,393,632	4,200,357	16,208,920	10,944,040	3,407,982	130,647	0.7	573,776

Diesel Fuel Price Scenario	Phase	PV capacity	Wind turbines	Battery capacity	Battery's inverter capacity	LCOE	Net present cost	Operating cost	Initial capital	Renewable fraction	1. Cat 650 Electricity production	3. Cat 650 Electricity production	4. Cat 650 Electricity production	9. Cat 1100 Electricity production	10. MTU 900 Electricity production	11. SKL 1670 Electricity production	12. SKL 1700 Electricity production	PV Capital Cost	PV electricity production	Wind turbine Electricity production	Wind turbine O&M Cost	Battery autonomy	Battery annual Throughput
$/L		kWp	Number	kWp	kWp	$/kWh	$	$	$	%	kWh/Year	kWh/Year	kWh/Year	kWh/Year	kWh/Year	kWh/Year	$/Year	$	kWh/Year	kWh/Year	$/Year	Hours	kWh/Year
0.90	3	8500	3	3000	1500	0.2685	117,838,900	5,853,054	30,451,430	40	2,387,404	633,766	65,683	336,045	648,085	9,477,006	4,209,899	15,404,660	10,336,030	3,407,982	130,647	0.8	643,691
0.90	3	9000	3	2500	1500	0.2685	117,858,800	5,811,819	31,086,960	40	2,364,115	629,435	65,111	331,832	641,742	9,394,165	4,188,304	16,208,920	10,944,040	3,407,982	130,647	0.7	572,913
0.90	3	9000	3	2500	2500	0.2686	117,868,500	5,807,819	31,156,370	40	2,354,861	628,509	64,994	330,123	638,085	9,393,632	4,200,357	16,208,920	10,944,040	3,407,982	130,647	0.7	573,776
0.90	3	8500	3	2500	2000	0.2688	117,969,400	5,870,767	30,317,410	40	2,383,160	635,604	65,614	333,918	645,160	9,524,085	4,249,019	15,404,660	10,336,030	3,407,982	130,647	0.7	552,856
0.90	3	8000	3	3000	2000	0.2688	117,974,400	5,913,674	29,681,870	39	2,401,570	642,173	66,105	335,349	648,387	9,620,974	4,291,008	14,600,410	9,728,038	3,407,982	130,647	0.8	614,704
0.90	3	8000	3	3000	2500	0.2689	118,009,600	5,913,708	29,716,580	39	2,400,239	641,967	66,121	335,060	646,581	9,622,546	4,293,012	14,600,410	9,728,038	3,407,982	130,647	0.8	614,738
0.90	3	8500	3	2500	1500	0.2689	118,017,600	5,876,326	30,282,710	40	2,391,935	636,531	65,676	336,180	648,039	9,523,226	4,238,725	15,404,660	10,336,030	3,407,982	130,647	0.7	552,254
0.90	3	8500	3	2500	2500	0.2689	118,027,800	5,872,356	30,352,110	40	2,383,160	635,604	65,614	333,918	645,160	9,524,085	4,249,019	15,404,660	10,336,030	3,407,982	130,647	0.7	552,856
0.90	3	8000	3	3000	1500	0.2691	118,110,800	5,925,135	29,647,170	39	2,419,675	643,520	66,225	339,166	655,452	9,618,229	4,267,456	14,600,410	9,728,038	3,407,982	130,647	0.8	614,197
0.90	3	9000	3	2000	1500	0.2691	118,125,900	5,841,012	30,918,250	40	2,376,029	632,637	65,215	333,091	643,554	9,447,680	4,208,953	16,208,920	10,944,040	3,407,982	130,647	0.5	473,645
0.90	3	9000	3	2000	2000	0.2693	118,184,200	5,842,588	30,952,950	40	2,375,981	632,589	65,215	333,099	643,563	9,447,686	4,208,939	16,208,920	10,944,040	3,407,982	130,647	0.5	473,738
0.90	3	8000	3	2500	2000	0.2694	118,223,800	5,941,678	29,513,160	39	2,416,243	644,762	66,141	337,161	652,421	9,665,557	4,301,244	14,600,410	9,728,038	3,407,982	130,647	0.7	528,758
0.90	3	9000	3	2000	2500	0.2694	118,242,600	5,844,177	30,987,650	40	2,375,981	632,589	65,215	333,099	643,563	9,447,686	4,208,939	16,208,920	10,944,040	3,407,982	130,647	0.5	473,738
0.90	3	8500	3	2000	1500	0.2695	118,269,600	5,904,501	30,113,990	39	2,403,254	639,727	65,777	336,585	650,477	9,576,030	4,257,122	15,404,660	10,336,030	3,407,982	130,647	0.5	457,236
0.90	3	8000	3	2500	1500	0.2695	118,270,100	5,947,102	29,478,460	39	2,424,532	646,196	66,238	339,160	655,783	9,662,930	4,292,141	14,600,410	9,728,038	3,407,982	130,647	0.7	528,486
0.90	3	8000	3	2500	2500	0.2695	118,282,200	5,943,267	29,547,860	39	2,416,243	644,762	66,141	337,161	652,421	9,665,557	4,301,244	14,600,410	9,728,038	3,407,982	130,647	0.7	528,758
0.90	3	8500	3	2000	2000	0.2696	118,327,700	5,906,072	30,148,700	39	2,403,276	639,740	65,777	336,591	650,487	9,575,952	4,257,101	15,404,660	10,336,030	3,407,982	130,647	0.5	457,290
0.90	3	7500	3	3000	2000	0.2697	118,366,600	5,993,810	28,877,620	38	2,439,205	651,471	66,703	340,438	655,591	9,780,437	4,348,964	13,796,160	9,120,035	3,407,982	130,647	0.8	579,748
0.90	3	8500	3	2000	2500	0.2697	118,386,200	5,907,660	30,183,400	39	2,403,276	639,740	65,777	336,591	650,487	9,575,952	4,257,101	15,404,660	10,336,030	3,407,982	130,647	0.5	457,290
0.90	3	7500	3	3000	2500	0.2698	118,403,200	5,993,938	28,912,320	38	2,438,333	651,579	66,697	340,217	653,595	9,781,737	4,350,596	13,796,160	9,120,035	3,407,982	130,647	0.8	579,808
0.90	3	7500	3	3000	1500	0.2700	118,494,100	6,004,671	28,842,920	38	2,455,476	653,252	66,788	344,512	662,884	9,774,258	4,329,400	13,796,160	9,120,035	3,407,982	130,647	0.8	579,453
0.90	3	8000	3	2000	1500	0.2700	118,503,300	5,974,024	29,309,740	39	2,435,056	648,855	66,310	339,570	657,972	9,714,251	4,308,764	14,600,410	9,728,038	3,407,982	130,647	0.5	438,730
0.90	3	8000	3	2000	2000	0.2701	118,561,800	5,975,616	29,344,440	39	2,435,066	648,855	66,310	339,570	657,972	9,714,227	4,308,751	14,600,410	9,728,038	3,407,982	130,647	0.5	438,761
0.90	3	7500	3	2500	2000	0.2702	118,592,400	6,020,235	28,708,910	38	2,452,160	654,065	66,732	342,796	659,575	9,821,592	4,357,891	13,796,160	9,120,035	3,407,982	130,647	0.7	500,336
0.90	3	8000	3	2000	2500	0.2703	118,620,200	5,977,205	29,379,140	39	2,435,066	648,855	66,310	339,570	657,972	9,714,227	4,308,751	14,600,410	9,728,038	3,407,982	130,647	0.5	438,761
0.90	3	7500	3	2500	1500	0.2703	118,633,800	6,025,327	28,674,200	38	2,460,282	655,197	66,797	344,435	663,691	9,817,267	4,350,208	13,796,160	9,120,035	3,407,982	130,647	0.7	500,336
0.90	3	7500	3	2500	2500	0.2703	118,650,900	6,021,823	28,743,610	38	2,452,160	654,065	66,732	342,796	659,575	9,821,592	4,357,891	13,796,160	9,120,035	3,407,982	130,647	0.7	500,336
0.90	3	7500	3	2000	1500	0.2708	118,843,600	6,050,679	28,505,490	38	2,470,569	658,270	66,849	345,612	665,319	9,864,711	4,364,305	13,796,160	9,120,035	3,407,982	130,647	0.5	416,992
0.90	3	7500	3	2000	2000	0.2709	118,901,900	6,052,259	28,540,190	38	2,470,561	658,263	66,849	345,623	665,324	9,864,690	4,364,304	13,796,160	9,120,035	3,407,982	130,647	0.5	417,016

Diesel Fuel Price Scenario	Phase	PV capacity	Wind turbines	Battery capacity	Battery`s inverter capacity	LCOE	Net present cost	Operating cost	Initial capital	Renewable fraction	1. Cat 650 Electricity production	3. Cat 650 Electricity production	4. Cat 650 Electricity production	9. Cat 1100 Electricity production	10. MTU 900 Electricity production	11. SKL 1670 Electricity production	12. SKL 1700 Electricity production	PV Capital Cost	PV electricity production	Wind turbine Electricity production	Wind turbine O&M Cost	Battery autonomy	Battery annual Throughput
$/L		kWp	Number	kWp	kWp	$/kWh	$	$	$	%	kWh/Year	kWh/Year	kWh/Year	kWh/Year	kWh/Year	kWh/Year	$/Year	$	kWh/Year	kWh/Year	$/Year	Hours	kWh/Year
0.90	3	7500	3	2000	2500	0.2710	118,960,300	6,053,848	28,574,890	38	2,470,561	658,263	66,849	345,623	665,324	9,864,690	4,364,304	13,796,160	9,120,035	3,407,982	130,647	0.5	417,016
0.90	**3**	**8500**	**4**	**2000**	**1500**	**0.2584**	**113,402,600**	**5,327,037**	**33,868,710**	**41**	**2,103,257**	**461,261**	**7,228**	**26,316**	**1,654,314**	**9,608,561**	**3,452,226**	**15,404,660**	**10,336,030**	**4,543,970**	**174,196**	**0.5**	**846,197**
0.90	3	8000	4	2000	1500	0.2584	113,412,200	5,381,543	33,064,460	41	2,127,948	458,365	7,501	24,677	1,687,041	9,733,928	3,494,882	14,600,410	9,728,038	4,543,970	174,196	0.5	835,905
0.90	3	8500	4	2000	2000	0.2585	113,461,100	5,328,625	33,903,420	41	2,103,257	461,261	7,228	26,316	1,654,314	9,608,561	3,452,226	15,404,660	10,336,030	4,543,970	174,196	0.5	846,197
0.90	3	8000	4	2000	2000	0.2585	113,471,300	5,383,180	33,099,160	41	2,128,106	458,482	7,501	24,737	1,686,486	9,734,166	3,494,848	14,600,410	9,728,038	4,543,970	174,196	0.5	836,050
0.90	3	9000	4	2000	1500	0.2585	113,474,400	5,277,979	34,672,960	42	2,087,668	467,846	6,656	28,929	1,611,318	9,494,310	3,413,179	16,208,920	10,944,040	4,543,970	174,196	0.5	856,551
0.90	3	8500	4	2000	2500	0.2586	113,519,500	5,330,214	33,938,120	41	2,103,257	461,261	7,228	26,316	1,654,314	9,608,561	3,452,226	15,404,660	10,336,030	4,543,970	174,196	0.5	846,197
0.90	3	7500	4	2000	1500	0.2587	113,527,200	5,443,113	32,260,210	40	2,146,159	450,009	7,501	22,672	1,725,097	9,879,347	3,547,223	13,796,160	9,120,035	4,543,970	174,196	0.5	831,583
0.90	3	8000	4	2000	2500	0.2587	113,529,700	5,384,769	33,133,860	41	2,128,106	458,482	7,501	24,737	1,686,486	9,734,166	3,494,848	14,600,410	9,728,038	4,543,970	174,196	0.5	836,050
0.90	3	9000	4	2000	2000	0.2587	113,532,700	5,279,555	34,707,670	42	2,087,630	467,781	6,656	28,905	1,611,396	9,494,378	3,413,179	16,208,920	10,944,040	4,543,970	174,196	0.5	856,525
0.90	3	7500	4	2000	2000	0.2588	113,585,600	5,444,701	32,294,910	40	2,146,159	450,009	7,501	22,672	1,725,097	9,879,347	3,547,223	13,796,160	9,120,035	4,543,970	174,196	0.5	831,583
0.90	3	9000	4	2000	2500	0.2588	113,591,100	5,281,143	34,742,370	42	2,087,630	467,781	6,656	28,905	1,611,396	9,494,378	3,413,179	16,208,920	10,944,040	4,543,970	174,196	0.5	856,525
0.90	3	7500	4	2000	2500	0.2589	113,644,000	5,446,289	32,329,610	40	2,146,159	450,009	7,501	22,672	1,725,097	9,879,347	3,547,223	13,796,160	9,120,035	4,543,970	174,196	0.5	831,583
0.90	3	8000	4	2500	2000	0.2590	113,662,200	5,384,662	33,267,880	41	2,200,426	557,737	8,268	64,538	1,374,970	9,685,967	3,554,072	14,600,410	9,728,038	4,543,970	174,196	0.7	1,151,225
0.90	3	7500	4	2500	2000	0.2590	113,688,900	5,440,323	32,463,620	40	2,218,438	548,019	8,788	52,954	1,467,755	9,813,863	3,577,815	13,796,160	9,120,035	4,543,970	174,196	0.7	1,105,479
0.90	3	8000	4	2500	1500	0.2590	113,692,400	5,389,014	33,233,180	41	2,203,799	543,686	7,241	62,808	1,392,268	9,734,729	3,514,711	14,600,410	9,728,038	4,543,970	174,196	0.7	1,107,357
0.90	3	8500	4	2500	2000	0.2591	113,713,200	5,334,211	34,072,130	42	2,180,252	562,864	8,034	76,119	1,288,907	9,573,621	3,536,014	15,404,660	10,336,030	4,543,970	174,196	0.7	1,195,257
0.90	3	8000	4	2500	2500	0.2591	113,720,600	5,386,250	33,302,580	41	2,200,426	557,737	8,268	64,538	1,374,970	9,685,967	3,554,072	14,600,410	9,728,038	4,543,970	174,196	0.7	1,151,225
0.90	3	7500	4	2500	1500	0.2591	113,723,900	5,444,986	32,428,920	40	2,219,368	528,274	7,553	54,346	1,481,078	9,867,316	3,542,981	13,796,160	9,120,035	4,543,970	174,196	0.7	1,067,709
0.90	3	8500	4	2500	1500	0.2592	113,743,300	5,338,556	34,037,430	42	2,184,207	550,681	7,293	73,495	1,300,312	9,618,613	3,503,116	15,404,660	10,336,030	4,543,970	174,196	0.7	1,151,555
0.90	3	7500	4	2500	2500	0.2592	113,747,400	5,441,912	32,498,330	40	2,218,438	548,019	8,788	52,954	1,467,755	9,813,863	3,577,815	13,796,160	9,120,035	4,543,970	174,196	0.7	1,105,479
0.90	3	8500	4	2500	2500	0.2592	113,771,600	5,335,799	34,106,830	42	2,180,252	562,864	8,034	76,119	1,288,907	9,573,621	3,536,014	15,404,660	10,336,030	4,543,970	174,196	0.7	1,195,257
0.90	3	9000	4	2500	2000	0.2594	113,854,400	5,289,805	34,876,380	42	2,159,653	572,792	8,359	84,207	1,205,865	9,469,740	3,521,204	16,208,920	10,944,040	4,543,970	174,196	0.7	1,238,775
0.90	3	9000	4	2500	1500	0.2595	113,873,000	5,293,371	34,841,680	42	2,162,698	561,463	6,903	83,522	1,217,214	9,511,902	3,489,847	16,208,920	10,944,040	4,543,970	174,196	0.7	1,195,279
0.90	3	9000	4	2500	2500	0.2595	113,912,800	5,291,393	34,911,080	42	2,159,654	572,792	8,359	84,207	1,205,865	9,469,740	3,521,204	16,208,920	10,944,040	4,543,970	174,196	0.7	1,238,775
0.90	3	8000	4	3000	2000	0.2598	114,013,200	5,396,875	33,436,590	41	2,233,839	614,393	10,413	125,167	1,102,272	9,627,720	3,673,044	14,600,410	9,728,038	4,543,970	174,196	0.8	1,437,435
0.90	3	7500	4	3000	2000	0.2598	114,041,500	5,452,637	32,632,340	40	2,246,353	603,510	9,334	111,701	1,210,521	9,760,211	3,691,810	13,796,160	9,120,035	4,543,970	174,196	0.8	1,371,448
0.90	3	8000	4	3000	2500	0.2599	114,068,200	5,398,233	33,471,300	41	2,223,906	614,965	10,361	124,670	1,109,186	9,614,734	3,689,181	14,600,410	9,728,038	4,543,970	174,196	0.8	1,441,340
0.90	3	8500	4	3000	2000	0.2599	114,068,500	5,346,707	34,240,850	42	2,215,433	621,143	11,063	137,604	1,029,533	9,499,527	3,646,642	15,404,660	10,336,030	4,543,970	174,196	0.8	1,487,580

Diesel Fuel Price Scenario	Phase	PV capacity	Wind turbines	Battery capacity	Battery`s inverter capacity	LCOE	Net present cost	Operating cost	Initial capital	Renewable fraction	1. Cat 650 Electricity production	3. Cat 650 Electricity production	4. Cat 650 Electricity production	9. Cat 1100 Electricity production	10. MTU 900 Electricity production	11. SKL 1670 Electricity production	12. SKL 1700 Electricity production	PV Capital Cost	PV electricity production	Wind turbine Electricity production	Wind turbine O&M Cost	Battery autonomy	Battery annual Throughput
$/L		kWp	Number	kWp	kWp	$/kWh	$	$	$	%	kWh/Year	kWh/Year	kWh/Year	kWh/Year	kWh/Year	kWh/Year	$/Year	$	kWh/Year	kWh/Year	$/Year	Hours	kWh/Year
0.90	3	7500	4	3000	2500	0.2599	114,091,300	5,453,651	32,667,040	40	2,239,190	606,819	9,438	110,499	1,212,228	9,746,617	3,708,886	13,796,160	9,120,035	4,543,970	174,196	0.8	1,374,639
0.90	3	8000	4	3000	1500	0.2600	114,105,800	5,405,398	33,401,890	41	2,249,541	594,384	7,462	129,623	1,111,396	9,718,992	3,589,264	14,600,410	9,728,038	4,543,970	174,196	0.8	1,378,067
0.90	3	8500	4	3000	2500	0.2600	114,117,300	5,347,655	34,275,550	42	2,205,664	624,478	11,180	135,689	1,030,151	9,484,194	3,669,537	15,404,660	10,336,030	4,543,970	174,196	0.8	1,491,875
0.90	3	7500	4	3000	1500	0.2600	114,118,400	5,460,110	32,597,640	40	2,263,209	582,974	7,605	113,974	1,224,134	9,851,765	3,603,141	13,796,160	9,120,035	4,543,970	174,196	0.8	1,316,213
0.90	3	8500	4	3000	1500	0.2601	114,152,100	5,354,636	34,206,140	42	2,228,725	606,298	7,709	143,272	1,038,136	9,585,206	3,565,908	15,404,660	10,336,030	4,543,970	174,196	0.8	1,424,419
0.90	3	9000	4	3000	2000	0.2602	114,185,900	5,300,704	35,045,100	43	2,194,992	622,512	11,752	146,171	967,176	9,382,900	3,628,111	16,208,920	10,944,040	4,543,970	174,196	0.8	1,533,917
0.90	3	9000	4	3000	2500	0.2603	114,235,400	5,301,700	35,079,800	43	2,185,229	624,613	11,726	145,309	970,134	9,369,030	3,647,927	16,208,920	10,944,040	4,543,970	174,196	0.8	1,537,864
0.90	3	9000	4	3000	1500	0.2604	114,271,200	5,308,745	35,010,400	43	2,209,471	607,540	8,086	153,493	969,893	9,466,586	3,551,877	16,208,920	10,944,040	4,543,970	174,196	0.8	1,470,342
0.90	3	9000	4	3000	2000	0.2698	118,413,400	5,583,855	35,045,100	44	2,263,931	599,279	60,362	307,266	603,739	8,941,039	3,904,432	16,208,920	10,944,040	4,543,970	174,196	0.8	693,850
0.90	3	9000	4	3000	2500	0.2699	118,443,100	5,583,521	35,079,800	44	2,261,536	599,309	60,349	306,096	602,688	8,942,420	3,907,502	16,208,920	10,944,040	4,543,970	174,196	0.8	693,903
0.90	3	8500	4	3000	2000	0.2701	118,529,400	5,645,493	34,240,850	43	2,291,911	606,805	61,016	309,995	610,533	9,064,788	3,951,331	15,404,660	10,336,030	4,543,970	174,196	0.8	669,906
0.90	3	8500	4	3000	2500	0.2701	118,561,000	5,645,283	34,275,550	43	2,289,904	606,503	61,003	309,237	609,279	9,066,580	3,953,756	15,404,660	10,336,030	4,543,970	174,196	0.8	669,952
0.90	3	9000	4	3000	1500	0.2702	118,583,800	5,597,593	35,010,400	44	2,284,970	600,739	60,804	311,113	611,960	8,942,988	3,874,612	16,208,920	10,944,040	4,543,970	174,196	0.8	692,551
0.90	3	8500	4	3000	1500	0.2704	118,696,900	5,659,038	34,206,140	43	2,311,798	608,138	61,389	313,644	618,940	9,064,246	3,924,621	15,404,660	10,336,030	4,543,970	174,196	0.8	669,138
0.90	3	9000	4	2500	2000	0.2705	118,727,700	5,616,205	34,876,380	43	2,280,963	603,134	60,479	309,219	607,646	8,992,441	3,917,726	16,208,920	10,944,040	4,543,970	174,196	0.7	593,866
0.90	3	8000	4	3000	2000	0.2705	118,740,000	5,713,469	33,436,590	42	2,321,665	613,564	61,461	314,037	618,185	9,202,070	4,002,297	14,600,410	9,728,038	4,543,970	174,196	0.8	642,063
0.90	3	8000	4	3000	2500	0.2706	118,772,000	5,713,288	33,471,300	42	2,320,297	613,663	61,441	313,090	616,691	9,203,566	4,004,433	14,600,410	9,728,038	4,543,970	174,196	0.8	642,095
0.90	3	9000	4	2500	2500	0.2706	118,786,100	5,617,793	34,911,080	43	2,280,963	603,134	60,479	309,219	607,646	8,992,441	3,917,726	16,208,920	10,944,040	4,543,970	174,196	0.7	593,866
0.90	3	9000	4	2500	1500	0.2707	118,792,800	5,622,895	34,841,680	43	2,290,570	603,736	60,788	311,221	612,313	8,992,316	3,906,117	16,208,920	10,944,040	4,543,970	174,196	0.7	592,949
0.90	3	8500	4	2500	2000	0.2707	118,831,000	5,676,991	34,072,130	43	2,307,466	610,199	61,146	312,155	614,939	9,114,288	3,963,703	15,404,660	10,336,030	4,543,970	174,196	0.7	574,353
0.90	3	8500	4	2500	2500	0.2709	118,889,400	5,678,580	34,106,830	43	2,307,466	610,199	61,146	312,155	614,939	9,114,288	3,963,703	15,404,660	10,336,030	4,543,970	174,196	0.7	574,353
0.90	3	8500	4	2500	1500	0.2709	118,893,600	5,683,511	34,037,430	43	2,317,129	610,902	61,331	314,297	619,188	9,112,929	3,953,084	15,404,660	10,336,030	4,543,970	174,196	0.7	573,734
0.90	3	8000	4	3000	1500	0.2709	118,901,000	5,726,573	33,401,890	42	2,341,301	615,158	61,789	317,631	625,892	9,197,881	3,979,301	14,600,410	9,728,038	4,543,970	174,196	0.8	641,825
0.90	3	8000	4	2500	2000	0.2712	119,019,200	5,743,469	33,267,880	42	2,337,313	616,675	61,571	315,898	622,188	9,248,277	4,013,449	14,600,410	9,728,038	4,543,970	174,196	0.7	552,271
0.90	3	7500	4	3000	2000	0.2713	119,064,600	5,789,074	32,632,340	41	2,356,010	623,118	62,251	318,207	625,672	9,351,635	4,057,350	13,796,160	9,120,035	4,543,970	174,196	0.8	609,126
0.90	3	8000	4	2500	2500	0.2713	119,077,700	5,745,058	33,302,580	42	2,337,313	616,675	61,571	315,898	622,188	9,248,277	4,013,449	14,600,410	9,728,038	4,543,970	174,196	0.7	552,271
0.90	3	8000	4	2500	1500	0.2713	119,080,400	5,749,890	33,233,180	42	2,346,351	618,194	61,711	317,807	626,363	9,245,409	4,004,218	14,600,410	9,728,038	4,543,970	174,196	0.7	551,937
0.90	3	9000	4	2000	1500	0.2713	119,083,000	5,653,630	34,672,960	43	2,303,625	607,139	60,798	312,649	613,709	9,048,385	3,927,053	16,208,920	10,944,040	4,543,970	174,196	0.5	490,252
0.90	3	7500	4	3000	2500	0.2714	119,097,000	5,788,921	32,667,040	41	2,354,121	622,670	62,238	317,801	623,628	9,354,273	4,059,453	13,796,160	9,120,035	4,543,970	174,196	0.8	609,116

Diesel Fuel Price Scenario	Phase	PV capacity	Wind turbines	Battery capacity	Battery`s inverter capacity	LCOE	Net present cost	Operating cost	Initial capital	Renewable fraction	1. Cat 650 Electricity production	3. Cat 650 Electricity production	4. Cat 650 Electricity production	9. Cat 1100 Electricity production	10. MTU 900 Electricity production	11. SKL 1670 Electricity production	12. SKL 1700 Electricity production	PV Capital Cost	PV electricity production	Wind turbine Electricity production	Wind turbine O&M Cost	Battery autonomy	Battery annual Throughput
$/L		kWp	Number	kWp	kWp	$/kWh	$	$	$	%	kWh/Year	kWh/Year	kWh/Year	kWh/Year	kWh/Year	kWh/Year	$/Year	$	kWh/Year	kWh/Year	$/Year	Hours	kWh/Year
0.90	3	9000	4	2000	2000	0.2715	119,141,100	5,655,194	34,707,670	43	2,303,633	607,155	60,801	312,640	613,716	9,048,291	3,927,015	16,208,920	10,944,040	4,543,970	174,196	0.5	490,369
0.90	3	8500	4	2000	1500	0.2715	119,171,400	5,713,417	33,868,710	42	2,329,711	614,634	61,477	315,477	620,699	9,167,269	3,972,434	15,404,660	10,336,030	4,543,970	174,196	0.5	474,878
0.90	3	9000	4	2000	2500	0.2716	119,199,500	5,656,782	34,742,370	43	2,303,633	607,155	60,801	312,640	613,716	9,048,291	3,927,015	16,208,920	10,944,040	4,543,970	174,196	0.5	490,369
0.90	3	7500	4	3000	1500	0.2716	119,217,500	5,801,640	32,597,640	41	2,372,590	624,613	62,455	321,843	634,265	9,345,920	4,037,589	13,796,160	9,120,035	4,543,970	174,196	0.8	609,145
0.90	3	8500	4	2000	2000	0.2717	119,229,500	5,714,983	33,903,420	42	2,329,717	614,647	61,477	315,478	620,699	9,167,200	3,972,427	15,404,660	10,336,030	4,543,970	174,196	0.5	474,938
0.90	3	8500	4	2000	2500	0.2718	119,287,900	5,716,572	33,938,120	42	2,329,717	614,647	61,477	315,478	620,699	9,167,200	3,972,427	15,404,660	10,336,030	4,543,970	174,196	0.5	474,938
0.90	3	7500	4	2500	2000	0.2719	119,320,000	5,817,482	32,463,620	41	2,371,461	626,006	62,260	319,769	630,164	9,394,314	4,066,530	13,796,160	9,120,035	4,543,970	174,196	0.7	525,648
0.90	3	8000	4	2000	1500	0.2719	119,342,000	5,778,712	33,064,460	41	2,358,320	621,297	61,805	318,808	628,582	9,298,379	4,021,160	14,600,410	9,728,038	4,543,970	174,196	0.5	458,007
0.90	3	7500	4	2500	1500	0.2720	119,375,800	5,823,545	32,428,920	41	2,378,880	627,212	62,423	322,209	634,664	9,390,351	4,058,921	13,796,160	9,120,035	4,543,970	174,196	0.7	525,597
0.90	3	7500	4	2500	2500	0.2720	119,378,400	5,819,071	32,498,330	41	2,371,461	626,006	62,260	319,769	630,164	9,394,314	4,066,530	13,796,160	9,120,035	4,543,970	174,196	0.7	525,648
0.90	3	8000	4	2000	2000	0.2720	119,400,400	5,780,298	33,099,160	41	2,358,340	621,294	61,805	318,830	628,572	9,298,340	4,021,138	14,600,410	9,728,038	4,543,970	174,196	0.5	458,043
0.90	3	8000	4	2000	2500	0.2722	119,458,800	5,781,887	33,133,860	41	2,358,340	621,294	61,805	318,830	628,572	9,298,340	4,021,138	14,600,410	9,728,038	4,543,970	174,196	0.5	458,043
0.90	3	7500	4	2000	1500	0.2725	119,616,100	5,850,941	32,260,210	41	2,390,453	630,165	62,504	323,460	636,647	9,440,919	4,073,106	13,796,160	9,120,035	4,543,970	174,196	0.5	437,963
0.90	3	7500	4	2000	2000	0.2727	119,674,400	5,852,522	32,294,910	41	2,390,466	630,162	62,504	323,448	636,647	9,440,901	4,073,105	13,796,160	9,120,035	4,543,970	174,196	0.5	437,987
0.90	3	7500	4	2000	2500	0.2728	119,732,900	5,854,110	32,329,610	41	2,390,466	630,162	62,504	323,448	636,647	9,440,901	4,073,105	13,796,160	9,120,035	4,543,970	174,196	0.5	437,987