Beyond Energy Action Strategies

BEAST

D.3.1.c – Business Plan of Microgrid for La Graciosa

Title of the project: Microgrid for La Graciosa
Location: La Graciosa, Canary Islands, Spain

Submission date: 10.12.2015

Co-funded by the Intelligent Energy Europe Programme of the European Union

Contents

1 Summary of the Project/Project at a Glance

The objective of this project is to develop a high penetration RES microgrid with capacity to supply 80 % of the yearly electricity demand of La Graciosa, from RES. The microgrid will have capacity to operate either in stand-alone mode with a combination of RES generation, energy storage capacity and diesel backup, but also with capacity to switch and connect to the central Lanzarote grid, through the existing submarine cable interconnection. Higher RES penetrations levels, although possible, are not advisable given the increase in the investment cost, primarily due to the need for energy storage capacity. The project idea is being promoted by the Canary Islands Institute of Technology (ITC). The project has been analysed assuming a life span of 20 years.

The proposed project aims at reducing street lighting energy consumption via the replacement of existing light bulbs with new more efficient. Also electricity for heating will be reduced with solar thermal collectors. Water produced locally will be more efficient that the one being currently supplied from neighbouring Lanzarote (fresh water production in Lanzarote is also through RO desalination).

2 Details of the Proposed Project

La Graciosa is a small island located in the north of Lanzarote. The island has a small resident population, and during the summer the island population increases due to tourism, which together with fishing represents the main economic activities. Currently the population of this small island it is being provided of electric power and water from neighbouring Lanzarote, through a submarine cable and a submarine water pipe.

To develop a high penetration RES microgrid with capacity to supply 80 % of the yearly electricity demand of La Graciosa, from RES. The microgrid will have capacity to operate either in standalone mode with a combination of RES generation, energy storage capacity and diesel backup, but also with capacity to switch and connect to the central Lanzarote grid, through the existing submarine cable interconnection.

Higher RES penetrations levels, although possible, are not advisable given the increase in the investment cost, primarily due to the need for energy storage capacity.

The microgrid proposed for La Graciosa would include a photovoltaic system distributed in the roofs of existing houses, small wind turbines scattily installed across the village, a diesel engine for back-up and batteries for energy storage.

Although RES conditions, especially solar, are excellent in La Graciosa, photovoltaic system and small powered wind turbines will not be able by themselves to guarantee 100 % electricity supply to the island all the time. On the hourly energy balance there will be moments of excess electricity production from the RES systems, energy that will be either used for water desalination, mobility with electric vehicles, or be sold to the central Lanzarote grid through the existing submarine cable interconnection (by switching momentarily the operation mode of the microgrid from stand alone to grid connected). On the other hand there will also moments of power deficit from the RES generation systems which will be either supplied by the diesel genet or by switching and connecting the microgrid to purchase electricity from the central Lanzarote grid.

The proposed microgrid will integrate photovoltaic, small wind turbines and diesel backup for power generation. To assure autonomy of RES generation, battery energy storage will be included, but storage capacity will be limited given the existence of a submarine cable connecting La Graciosa to the electrical grid of neighbouring Lanzarote. In order to achieve peak shaving of the electrical demand curve, the microgrid will also include Demand Management, to optimally displace in time manageable loads such as water RO desalination plant or cooling cameras for storing fish. Reliable weather forecasting models will also be integrated in the microgrid solution. The possibility to know in advanced the generation capacity of the PV and small wind turbines, will contribute to improve Demand Management.

The distribution of the microgrid will deliver electricity to all the houses of the village of Caleta del Sebo, and to the local businesses, made basically by restaurants and fishing.

3 Internal aspects

Weaknesses

- A high RES penetration small microgrid. Such high levels of variable and intermittent wind energy, induces grid stability problems, which is an important restriction to the percentage of RES that can be integrated into the small electrical system.
- The random nature of wind, solar and other RES sources makes it necessary to have conventional power systems in stand-by for when the wind does not blow or the sun do not shine.
- Renewable energy investments generally require higher amounts of financing for the same capacity. Initial capital costs for renewable energy technologies are often higher on a cost-per-unit basis (i.e., $/kW).
- Unequal tax burdens and subsidies between renewables and other energy sources
- Long lead time to obtain necessary permits. Exact time to obtain a license is legislative set but always much more time is needed. Especially spatial planning related to permits can take many years. Permits for new renewable energy plants are difficult to obtain due to not optimized administrative processes. They often include unnecessary requirements and lack transparency of information
- Proven, cost-effective technologies may still be perceived as risky if there is little experience with them in a new application or region.
- The initial high investment cost associated to renewable energy systems, makes it necessary to dispose of an stable price framework to guarantee that the investment can be recover in a reasonable time period
- Conventional generating technologies have a lower tax burden and subsidies. Fuel expenditures can be deducted from taxable income, but few renewables benefit from this deduction, since they do not use market-supplied fuels. Income and property taxes are higher for renewables, which require large capital investments but have low fuel and operating expenses.
- Externalities are not internalised in energy/fuel prices. Without internalising environmental and other costs, renewable generation is more expensive than conventional technologies. Many of the benefits of renewables are "public goods" which not always motivate everyone who benefits to pay for them. The environmental impacts of fossil fuels often result in real costs to society, although environmental impacts and associated dollar costs are often included in economic comparisons between renewable and conventional energy, investors rarely include such environmental costs in the bottom line used to make decisions. Renewables will be unable to compete on a level playing field with conventional generation until new policies are adopted to internalize the public costs of these fossil fuel sources. As well as the economic benefit, there are social and environmental benefits associated with renewable energy such as reduced noise, clean air, no risk of spillage of fuel, attraction of eco-tourists, and reduction of greenhouse gas emissions.
- Grid connection and access is not fairly provided. Utilities may not allow favourable transmission access to renewable energy producers, or may charge high prices for transmission access.
- Proven, cost-effective technologies may still be perceived as risky if there is little experience with them in a new application or region.

Strengths

- Outstanding levels of solar radiation would allow the photovoltaic systems to work 1,800 hours a year. This means that 1 kWp of PV could produce 1,800 kWh/yr. With current investment cost of around 1.500 €/kWp, we are past "grid parity" since PV could be produced at a cost of below 0.09 €/kWh, while conventional fossil generation has a cost of 0.22 €/kWh.
- The territorial protection of t La Graciosa is very high, which welcomes any action to improve environmental sustainability of the human activity developing in this small island.

4 External environment

Threats

- The initial high investment cost associated to renewable energy systems, makes it necessary to dispose of an stable price framework to guarantee that the investment can be recover in a reasonable time period.
- In the absence of a legal framework, independent power producers may not be able to invest in renewable energy facilities and sell power to the utility or to third parties under so-called "power purchase agreements.

Opportunities

La Graciosa offers unique and outstanding conditions for demonstrating the technical and economic feasibility of the new paradigm of distributed generation based on autonomous high RES penetration microgrids.

5 Market Potential

High RES penetration microgrids like the one proposed for La Graciosa represent excellent technological solutions for rural electrification of remote areas of less developed countries. These countries lack proper electrical infrastructure, so the microgrids will operate stand-alone, without a connection to the national transport and distribution grids. In the case of more advanced countries of Europe and North America, the market perspectives indicate a development of microgrids, but not operating stand-alone, but connected to the national grids. In this case the solution will be justified because of the need to advance in the new paradigm of distributed generation, where electricity from small wind turbines and PV will be generated in a decentralized way close to the consumption. These microgrids will reduce the need for new expensive and inefficient transport grids, reducing energy losses.

6 Risk analysis

A major risk associated to electrification will high RES penetration microgrids, comes from the fact that they rely of a primary source that is variable, and not always behaves with the same profile as the electricity demand. Energy storage systems are included in the microgrid solution to manage this variability. Such high levels of variable and intermittent wind energy, induces grid stability problems, which is an important restriction to the percentage of RES that can be integrated into the small electrical system. In the case of the microgrid foreseen for La Graciosa this risk is greatly reduced due to the fact that the current submarine interconnection with neighbouring Lanzarote will remain in place as a back-up. Actually some power flow is expected daily through the cable, although one of the objectives is to maintain it at a minimum.

A risk of the microgrid for La Graciosa, as in any other RES project, is the initial capital requirements, which are usually higher than for the same capacity in conventional power generation. Initial capital costs for renewable energy technologies are often higher on a cost-per-unit basis (i.e., $/kW). The initial high investment cost associated to renewable energy systems, makes it necessary to dispose of an stable price framework to guarantee that the investment can be recover in a reasonable time period.

Long lead time to obtain necessary permits. Exact time to obtain a license is legislative set but always much more time is needed. Especially spatial planning related to permits can take many years. Permits for new renewable energy plants are difficult to obtain due to not optimized administrative processes. They often include unnecessary requirements and lack transparency of information

Another risk is the unfavourable tax framework. Conventional generating technologies have a lower tax burden and subsidies. Fuel expenditures can be deducted from taxable income, but few renewables benefit from this deduction, since they do not use market-supplied fuels. Income and property taxes are higher for renewables, which require large capital investments but have low fuel and operating expenses.

7 Financial Analysis

The project objective is to generate locally the electric power demanded in the island of La Graciosa, by a high RES penetration microgrid. The electricity of La Graciosa is currently being supplied through a submarine cable from neighbouring Lanzarote; the installed electric demand power in the small island is of 629 kW, and yearly consumption of approximately 1.617 MWh/yr. The system should also cover heat and water (RO desalination) needs of the island.

7.1 Cost

The investment cost

The unit cost of each of the energy generation components of the microgrid have been estimated. When multiplying by the estimated power of each component, a total investment cost is calculated to be 4,060,900 €:

SYSTEM COMPONENT	UNIT COST INVESTMENT	UNITS	TOTAL COST	ECONOMIC USEFUL LIFE
Genset	400 €/kW	500 kW	200,000 €	20 yr
Wind	3.500 €/kW	50 kW	175,000 €	20 yr
Solar Thermal	600 €/m²	64 m²	38,400 €	20 yr
Solar PV	3.000 €/kWp	913 kWp	2,737,500 €	30 yr
Batteries	200 €/batt	500 batt	100,000 €	5 yr*
Flywheel	120,000 €/un	1 un	120,000 €	20 yr
RO desalination	250,000 €/un	1 un	250,000 €	20 yr
Energy efficiency			440,000	
INVESTMENT COMPONENTS			**4,060,900 €**	

* Batteries' economic life has been estimated to be 5 years. Therefore in a 20 year time horizon of the project, they will have to be substituted 3 times (years 5, 10 and 15)

Total yearly depreciation has been estimated at 268,350 €/yr

Other fixed cost includes:

- Personnel cost = 60,000 €/yr
- Insurance (1% of investment) = 40,609 €/yr
- Other O&M cost (9 % on income) = 24,570 €/yr

The variable cost of the system (marginal cost), is associated to the fossil fuel consumption. Although the propose solution aims at supplying maximum electricity demand, by the high RES microgrid, in the yearly balance there will always exist the need to support with diesel generation (cloudy days with little wind, when the PV and small power wind-turbines will not be able to supply totally de demand of the loads). Preliminary calculations point-out that in the yearly balance the system will be able to substitute 93.8 % on fossil fuels. Savings of 478 Ton/yr of fossil fuels are expected. Nevertheless still 33 Ton/yr of fossil fuels will be needed. Assuming the cost of the fuel to be 1 €/kg, the yearly variable cost would be

Variable Cost = 33,000 kg fuel/yr * 1 €/kg fuel = 33,000 €/yr

The interest rate has been estimated at 4 %. This rate should be used to discount cash flows in the financial feasibility analysis.

7.2 Income

Income will come from sales of electricity produced by the microgrid. The microgrid will also provide electricity to the RO water desalination system, which will also generate an income from each cubic meter of water sold. Bot services, electricity and water supply, are currently being provided from neighbouring Lanzarote, through submarine cable connection, and a water pipe. Solar thermal heat collectors will also be deployed, and have been considered as part of the investment cost of the proposed system for La Graciosa. Although the thermal energy that will be produced will not be sold, it will help reduced current electricity consumption. We will consider this savings as an income.

	ENERGY UNITS	*UNIR PRICE*	*INCOME*
Income from sales of electricity	1,617,000 kWhe/yr	0.15 €/kWhe	242,550 €/yr
Income from sales of water	40,000 m^3/yr	1.30 €/m^3	52,000 €/yr
Income from heat (savings on electricity thanks to solar collectors)	328,500 kWht/yr	0.02 €/kWht	6,570 €/yr
Expected subsidies			133,020 €/yr
TOTAL INCOME			**434,140 €/yr**

7.3 Feasibility assessment

The life span of the project has been considered to be 20 years. The feasibility analysis has considered that prices of energy and water will suffer a yearly increase of 8 %, throughout the 20 years of the project lifespan. Variable cost will be affected by a similar 10 % yearly increment.

When carrying-out the cash flow analysis, considering the values for the different cost and incomes stated previously, and using a discount rate of 4 %, the Net Present Value estimated is:

NPV = 4,078,512 € €

The return on investment, expressed in terms of the Internal Rate of Return, is:

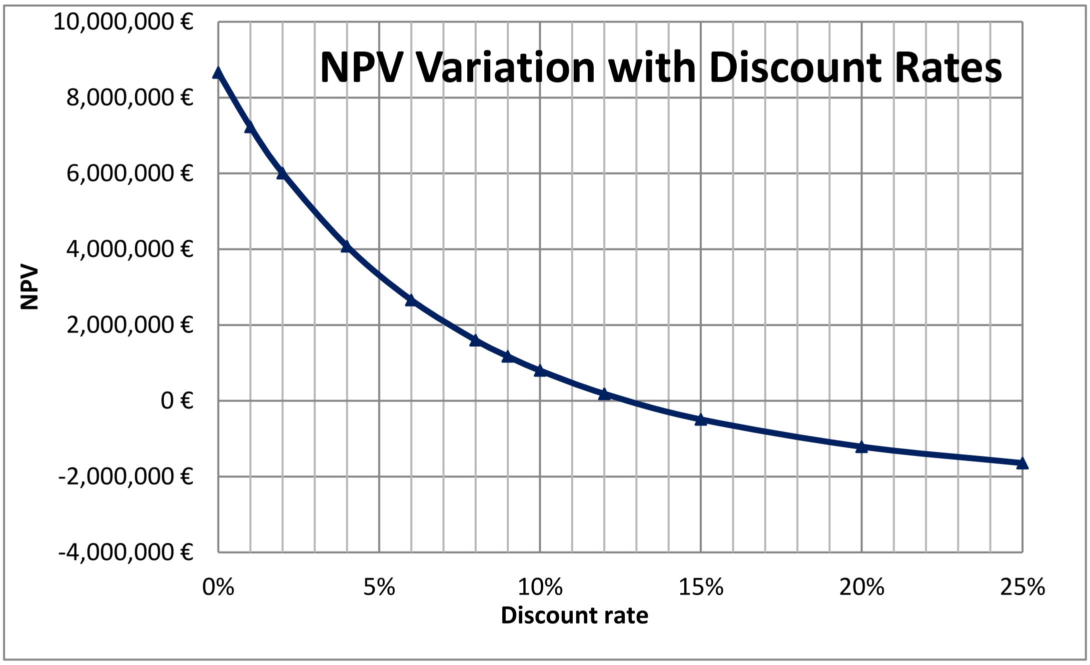
IRR = 12.7 %

The estimated period to recover the investment is 11 years, for a project that has a life of 20 years.

PAYBACK = 11 years

7.4 Sensitivity analysis

The sensitivity of the Net Present Value to the interest rate used for discounting the cash flows has been analysed. The graph shows the impact of variations of the discount rate:



7.5 Social benefits and Public support

The project gives a reasonable return of investment to the private investor, thanks to the yearly public subsidies. Otherwise the NPV would be negative. The justification for the public subsidies are the public benefits that the project. These benefits are considered positive externalities, and it is important that they are monetized, and introduced in a broader economic analysis to estimate the Social IRR of the project.

In the case of the Microgrid project for La Graciosa, the social benefits include reduction of emissions, local employment, improvements of the sustainable image of La Graciosa as a tourist destination, energy independence, etc.

CO2 reductions = 35,605 Ton/yr

Jobs during construction = 6 jobs during a year

Jobs during 20 years = 1 job/year

8 Implementation roadmap

(Use a Gantt chart to show the timeline for key activities and milestones throughout the project implementation phase.)

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<tr><td></td><td>1st</td><td>2nd</td><td>3rd</td><td>4th</td><td>5th</td><td>6th</td><td>Year 1-20</td></tr>
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<tr><td>Design of system</td><td></td><td style="background:#b8cce4"></td><td style="background:#b8cce4"></td><td></td><td></td><td></td><td></td></tr>
<tr><td>Modelling</td><td></td><td></td><td style="background:#b8cce4"></td><td></td><td></td><td></td><td></td></tr>
<tr><td>Final system design</td><td></td><td></td><td style="background:#b8cce4"></td><td></td><td></td><td></td><td></td></tr>
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<tr><td>Business model</td><td></td><td></td><td></td><td style="background:#b8cce4"></td><td></td><td></td><td></td></tr>
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<tr><td>Operation and maintenance</td><td></td><td></td><td></td><td></td><td></td><td></td><td style="background:#b8cce4"></td></tr>
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9 Conclusion

(Is it a good or bad idea? Why should investors put their money in this project?)

The microgrid project for La Graciosa, will allow for substitution of electricity being currently supplied by a submarine cable from neighbouring Lanzarote. Through a RO water desalination system, supplied electrically by the microgrid, water will also be produced in the island, with no need for maintaining current supply of water from Lanzarote (submarine water pipe).

The project has the potential to reduce emissions of GHG and the current energy dependence of La Graciosa, by creating the needed infrastructure to make maximum use of local available clean RES. The benefits for the islands, besides the reduction of the energy bill, comes from all positive externalities associated to the use of RES, and reductions of fossil fuel consumption.

It is an interesting investment opportunity for investors interested in earning a reasonable payback, in a project with small technical risk. This return on investment is possible thanks to the public subsidies, in terms of job creation, GHG emission reductions, and better image of a sustainable tourist destination.