Quality Control Applied to the Photovoltaic Systems of the Galapagos Islands: The Case of Baltra and Santa Cruz

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3rd International Hybrid Power Systems Workshop

Tenerife, Spain

May, 8th 2018

AGENDA

1. INTRODUCTION
2. METHODOLOGY AND DATA ACQUISITION
3. QUALITY CONTROL ASSESSMENT OF PV SYSTEMS
4. INSTITUTIONAL AND SOCIAL PERCEPTIONS
5. CONCLUSIONS

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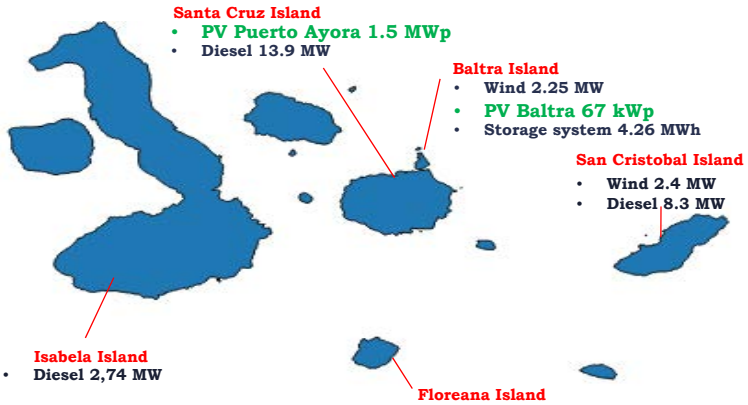
1. Introduction



Santa Cruz Island
- **PV Puerto Ayora 1.5 MWp**
- Diesel 13.9 MW

Baltra Island
- Wind 2.25 MW
- **PV Baltra 67 kWp**
- Storage system 4.26 MWh

San Cristobal Island
- Wind 2.4 MW
- Diesel 8.3 MW

Isabela Island
- Diesel 2,74 MW

Floreana Island
- Diesel 150 kW
- Biodiesel 138 kW
- PV 21 kWp
- Storage system 4.26 MWh

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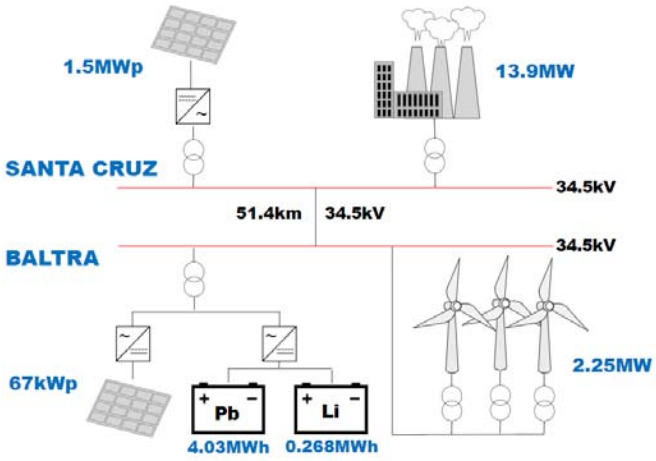

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1. Introduction

Quality control assessment is carried out in PV systems **(IEC 61829):**

Baltra: 67 kWp - 136 MWh/year,
Santa Cruz : 1.5 MWp - 2,430 MWh/year

IES–UPM has established a **partnership** with the **Ecuadorian Ministry of Electricity and Renewable Energy (MEER)** and the Provincial Electricity Company Galapagos **ELECGALAPAGOS** to support in compliance of **"The Galapagos Islands Zero Fossil Fuel Initiative".**

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2. Methodology and Data Acquisition

- **Technical Information and Visual Inspection Review**

- **Characterization of PV Generator**

  The measured parameters are:

  V_{OC}, I_{SC}, P_{mpp}, V_{mpp}, I_{mpp} and *I-V* curve

  Acceptable Test Conditions

  Global in plane irradiance, $G \geq 500$ W/m2

  Diffuse fraction of *G, D/G* < 0.2 (clear day)

  Review Data and Extrapolation Method

  STC: Tc* = 25 °C; G* = 1,000 W/m2; AM 1.5G

  Uncertainty: **5%**

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2. Methodology and Data Acquisition

- **Mismatch Losses in PV Power Plants**

$$\text{Series losses } (\%) \propto \sigma^2_{Impp}$$

$$\text{Parallel losses } (\%) \propto \sigma^2_{Vmpp}$$

- **Interviews and Surveys**
  - ✓Interviews had been held with the management and technical staff of ELECGALAPAGOS. We used a focus group method.
  - ✓30 customers from Santa Cruz Island have been surveyed to know the social perception about the use of renewable sources of energy to electricity generation, electricity services and energy prices.

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3. Quality Control Assessment

Description	Baltra	Santa Cruz
Installed power (MWp)	0.067	1.5
Module	Monocrystalline silicon	
Maximum power rating (Wp)	265	250
Number of modules	14 x 18 = 252	22 x 273 = 6,006
Inverter (kW)	100	17
Number of inverters	1	91

Installed capacity measured:

- Baltra: 33% (22.26 kWp)
- Santa Cruz: 10% (150 kWp)

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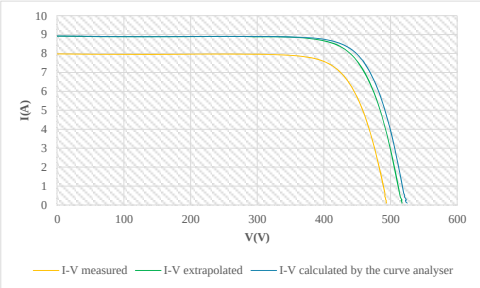
3. Quality Control Assessment: Baltra



- **Mean power differences: 3.39% per array**
- This PV generator has **high levels of technical quality**

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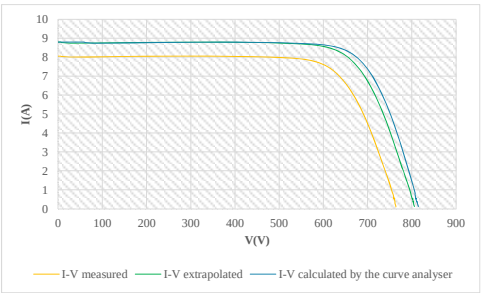
3. Quality Control Assessment: Santa Cruz



- **Mean power differences**: **5.31% per array**
  Power differences per array: 1 – 10%
- **Mismatch losses: 0.33%**
- **Performance ratio (PR): 0.793**

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3. Quality Control Assessment

Field results:

- **Operating conditions**: stable in Baltra and variable in Santa Cruz.
- **Tilt angle** of the arrays is between: 10° and 12° in Baltra and between 5° and 8° in Santa Cruz. Energy losses are negligible.
- In **Santa Cruz, the power losses**, in some arrays near to 10%, **seem to indicate** a possible potential **damage of the modules.**
- **Hot spots** were **not detected** in Santa Cruz.
- Both power plants have good status from DC facilities, electrical protections, cabling, control system and cleaning of the modules.

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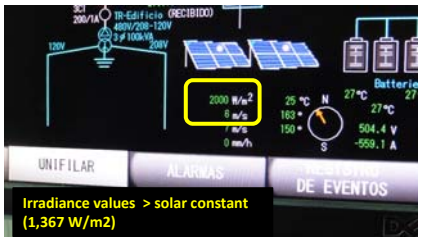
3. Quality Control Assessment

Field results:

- The **weaknesses** are: wrong registered data, information is not evaluated, lack of knowledge of PV systems, equipment is unused, missing coding and labelling of the arrays, missing the Flashing Report in Baltra.



Irradiance values > solar constant (1,367 W/m2)


Training in quality control


I-V curve analyser is unused

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3. Quality Control Assessment

Field results:

In Santa Cruz:

- The **maintenance staff** had replaced several inverters and modules without prior **technical assessment.**
- The **snail tracks** do not produce a power reduction in the modules.
- **Sorting the modules by I_{mpp}** could reduce the mismatch losses up to 0.33%, but this **is not important in terms of total power.**

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4. Institutional and Social Perceptions

- The **second phase** of implementation of **renewable energy projects** (Santa Cruz – Baltra, Floreana) and **the integration of new systems** in Isabela and San Cristobal are **planned**.
- It will **be hard to reach "Galapagos Islands Zero Fossil Fuel Initiative"** due to the investment this kind of projects require.
- The **investment** is provided by the **local Government** and the **international cooperation**.
- Although the **population** seems to have an **acceptable knowledge** about renewable energy and energy efficiency**, educational campaigns should be carried out**. It is necessary to **improve the capacities** in the local institutions.

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5. Conclusions

- It is **not possible to comply** with the established technical measurement by standard **IEC 61289** to measure the *I-V* curve under operating varying conditions.
- To **ensure the sustainability of projects:** improve O&M plans, training staff, campaigns and contractual requirements.
- The **lack of knowledge** could affect the **economic resources.**
- The **population is interested in the electricity services quality** more than the technologies used to generate the electricity.
- The **international cooperation** makes **complex to demand** solar technology complies with international standards.


Thank you for your attention

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Acknowledgment:

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