



Integrated control system for the energy supply of isolated communities in Cuba, using Hybrid Systems

Presenter: Luis Arribas

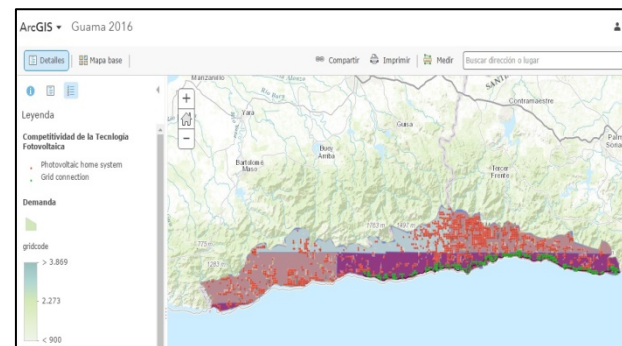
CIEMAT

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Introduction

- Background
 - CIEMAT has a long history of cooperation and research on issues related to rural electrification in Cuba.
 - GIS in Guamá region
 - Cooperation agreement with CUBASOLAR.
 - The project as an opportunity to put these concerns and synergies into practice.
- Layout of the presentation
 - The HYBRIDUS Project
 - The HIBRI2 Project
 - Design of the system
 - Conclusions

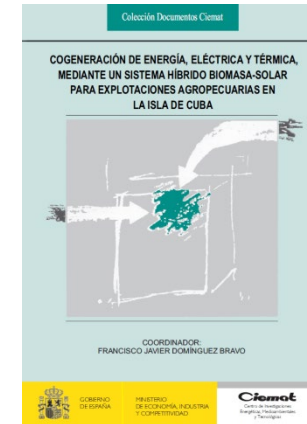


The HYBRIDUS Project

Cogeneration of electrical and thermal energy by means of a hybrid biomass-solar system for agricultural and livestock farms on the Island of Cuba

- Commitment for the development of hybrid systems focused on universal access to energy
- 2015-2017
- Background:
 - HIBRILEC Project (CYTED)
 - Bioeléctrica La Veguera (EU)
- Two strategies:
 - Adapting the proposed technology (the biomass gasification and PV hybrid system) to local conditions
 - **La Veguera case study**
 - Creation of local capacity
 - 4 workshops (3 in Cuba, 1 in Spain)

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Project web page: <http://projects.ciemat.es/web/hybridus/inicio> (in Spanish)



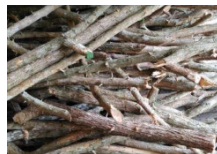
5th International
Hybrid Power Systems Workshop
18 – 19 May 2021

Energy supply of isolated
communities in Cuba

HYBRIDUS: Adapting technology to local conditions

Case study: La Veguera

- Isolated 35 HH community in Camagüey province
- Existing gasifier
 - Biomass resource: marabú
 - 50 kWe
 - Downdraft, ANKUR made
- Hybrid system design



The HIBRI2 Project

Integrated control system for energy supply through hybrid systems in isolated communities in Cuba. Phase II

- 2019 - 2021
- Implementation of a microgrid
- Local capacity building (design, O&M of the microgrid)
 - Three months training stay of two Cuban technicians in Spain
 - 1st Workshop (February 2020, Playa Girón):
 - 20 UNE (National Utility) technicians
 - Technological status of renewable sources.
 - Hybridisation of systems for rural electrification.
 - Individual design cases
 - 2nd Workshop (to be programmed):
 - Design and implementation of hybrid systems
 - Sustainability and replicability of hybrid systems for rural electrification
- Ensuring the replicability and sustainability of the system in its social, economic, environmental and geographical aspects.

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SODEPAZ

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Project web page: <http://hibri2.ciemat.es/>



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HIBRI2: Implementation of the microgrid

Case study: Guasasa

- Implementation of a microgrid:
 - Originally: La Veguera
 - Second proposal: **Guasasa**
 - Different configurations
 - Final option: capacity building microgrid
- Isolated village in Matanzas province
 - 214 inhabitants in 85 HH
 - Other collective buildings
- Existing 100 kVA diesel genset
 - 12 hours supply
 - Low voltage feeder distribution

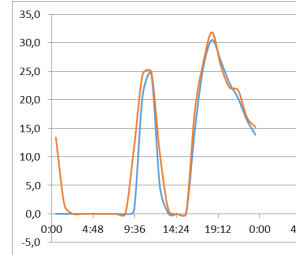
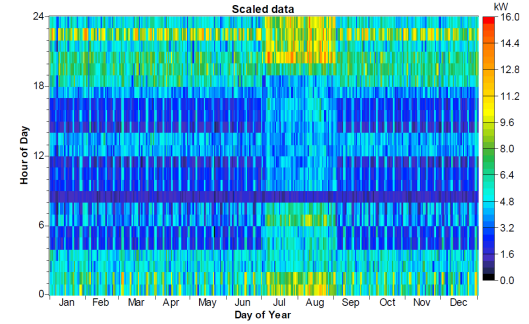


Design of the system

- Made both for La Veguera and Guasasa sites
- Some technical considerations only (24/7 supply objective)
- Stages:
 - Data collection
 - Characterization of the site:
 - loads,
 - available resources, i.e., biomass, solar and wind
 - Characterization of the components:
 - biomass gasifier, generator set,
 - PV generator, wind turbine,
 - batteries and electronic converter
 - Economic parameters
 - Sizing study and
 - Implementation project

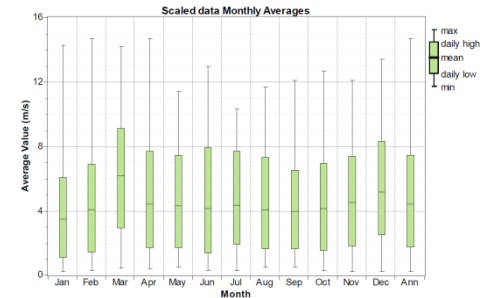
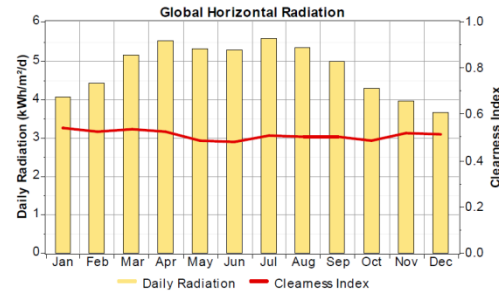
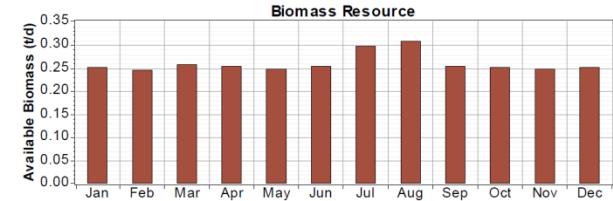
Characterization of the loads

- La Veguera: no pre-existing grid
 - No data available
 - Based on demographical and similar sites information
 - 108 kWh/day
- Guasasa: existing grid
 - Field visits
 - Measurement campaigns
 - 437 kWh/day



Characterization of resources

- Hourly data series (solar and wind)
- Biomass resource (No restrictions)
 - La Veguera: Marabú
 - Guasasa: local vegetation
 - 5 USD/Ton
- Solar resource
 - Solar maps and databases
- Wind resource
 - Wind maps and databases



Data collection

Characterization of components

Economic parameters

- Particular country situation
- Common for both case studies
- Parameters:
 - inflation rate: 2.8%;
 - discount rate: 10%;
 - project life time: 15 years

Component	Parameters	La Veguera	Guasasa
Gasifier	Manufacturer	Ankur	Ankur
	Nominal power (kW) Cost (€/kW)	50, existing 3500	10, new 3500
Genset	Manufacturer	(Ankur)	DENYO
	Fuel Nominal power (kWe)	Syngas 40	Diesel 80
Solar PV generator	Nominal power (kWp) Cost (€/kWp)	6 1750	40 1750
	Wind Turbine	Nominal power (kW) Cost (€/kW)	3 3500
Battery storage		Nominal capacity (kWh) Technology	100 Lead-acid
	Cost (€/kWh)	200	200
Grid forming power converter	Nominal power (kW)	20	30
	Technology	bidirectional	bidirectional
	Cost (€/kW)	300	300

Sizing Study

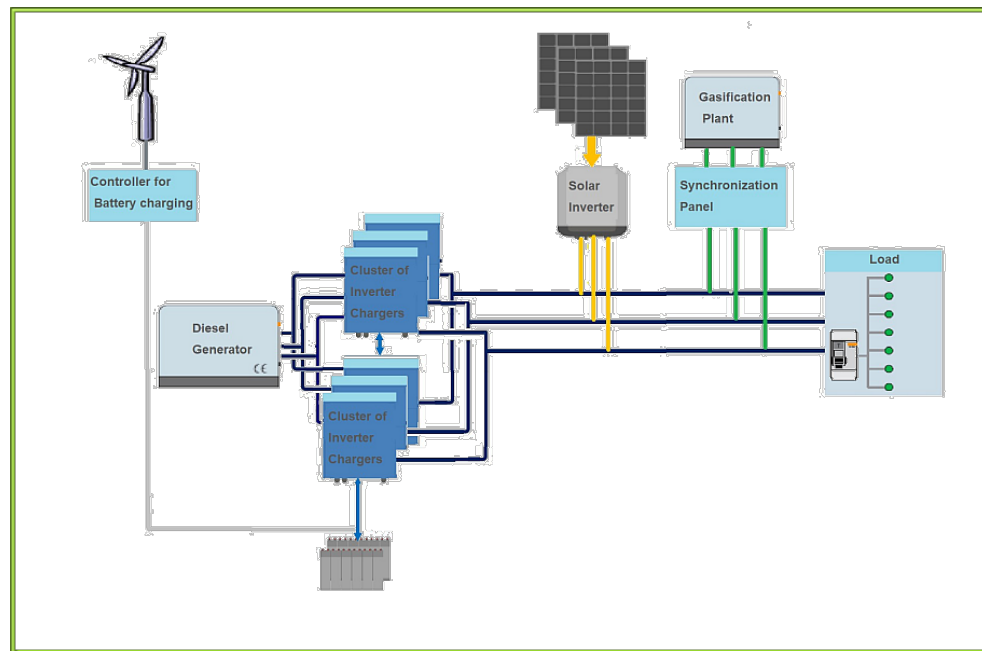
- Software:
 - La Veguera: HOMER Legacy
 - Guasasa: HOMER Pro
- Scenarios definition:
 - Base case: existing installation (for 24/7)
 - Design case: Optimal configuration (within design restrictions)

Results for Guasasa

Parameter	Base case	Proposed design
Generation share	Genset 100%	Genset: 39,7% Gasifier: 10,4% Solar PV: 47,5% Wind Turbine: 2,3%
Renewable Fraction	0%	53,2 %
Excess electricity	0 %	12,3 %
Fuel consumption	63.540 l/año	20.693 l/año
Capital investment	0 \$	140.750 \$
LCOE (\$/kWh)	0,991	0,536
Payback period (years)	-	2.5

Implementation Project

- HYBRIDUS:
 - didn't reach this stage
- HIBRI2:
 - Guasasa: only partly
 - Final solution:
 - Different scope
 - Ongoing

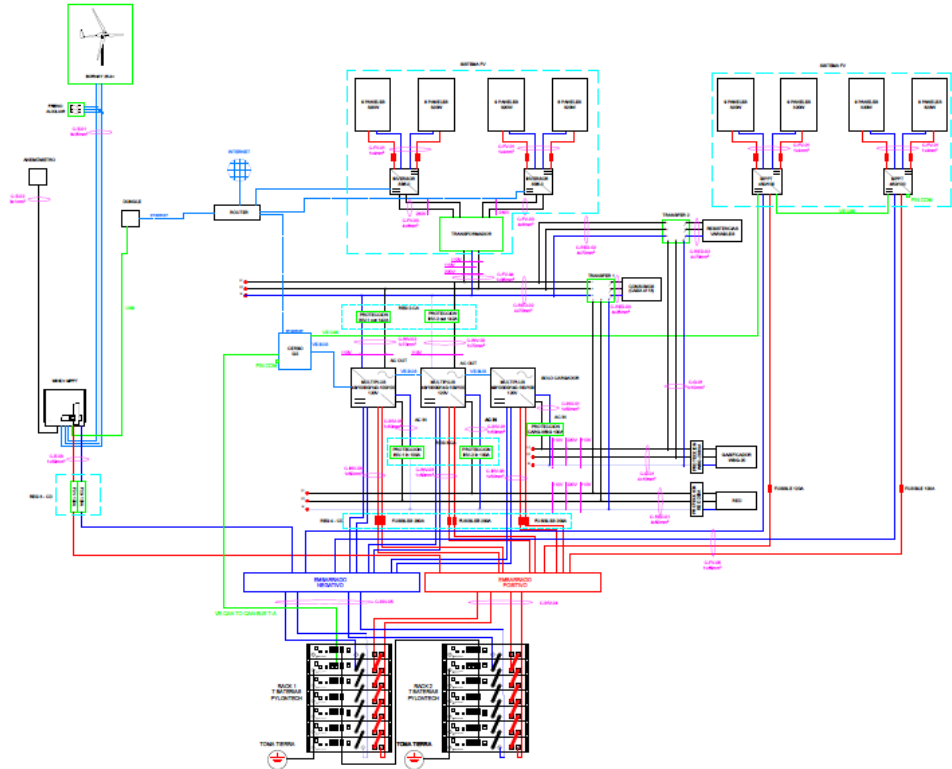


Implementation Project

Final solution

- Proposed design:
 - Gasifier: 10kW
 - Solar PV: 22 kW
 - Wind Turbine: 5kW
 - Battery: 49 kWh
 - Grid forming Converter: 30kW
- Cost*:
 - Estimated: 93000 €
 - Overall deviation: +6%
 - More significant by components

* *WT cost not included as it is a Bornay's in-kind contribution to the Project*



Conclusions

- Steady collaboration in rural electrification in Cuba
- Two phase project collaboration in hybrid systems
- Local capacity building
- Demonstration Project
 - Different sites
 - Different obstacles, derived from lack of confidence
 - Eventually, training installation to overcome lack of confidence
- Methodology for the design of the system
- At the acquisition of materials stage
- The Future: open opportunities

Thank you for your attention

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This work has been developed with funding from the Spanish Agency for International Development Cooperation (AECID), under the HIBRI2 Project. Its content is the sole responsibility of the authors and does not necessarily reflect the opinion of AECID. Our gratitude to all the people involved in these two projects as well, both in Cuba and in Spain.