

Ollagüe: Advanced Hybrid Microgrid in the Chilean Desert



10/20/2016 Niagara 2016 Symposium on Microgrids



Ollagüe Project

Executive Summary



Microgrid Characteristics:

- Hybrid off-grid project
- **Solar PV:** 205 kWp (Thin film modules)
- **Storage:** 752kWh (Sodium Nickel Chloride tech.)
- Mini **Wind** turbine: 30 kW
- Backup **Diesel Generator:** 410 kVA
- Separate Dish Stirling Engines (2): providing warm water to school

AIM OF THE PROJECT:

- **Supply 24hs/day 7 days/week energy** to an off-grid village placed at 3700 AMSL in a desert area of Chile, removing the restriction of the village to having access to energy during night time (no supply from 1 to 8 AM)
- **Minimizing the consumption of fuel** from existing diesel generator
- **Testing advanced renewable technologies** and storage system in a harsh environment, with large temperature range between day and night and extreme solar radiation in rarefied atmosphere, in collaboration with project partners and research centers.
- Develop **technical solutions for fast growing market**

RESULTS:

- The aim of project completely reached.
- The installations of the hybrid system drastically changed the habits of the inhabitants, with also promising economical benefits.
- Meanwhile, the operation of such advanced plant is giving deep inside knowledge about such kind of systems and possible business model in remote area.

Ollagüe Project

Project description



- Ollagüe, II Region, Antofagasta, small village along the railway Antofagasta - Bolivia
- Altitude: 3,700 amsl
- Climate: marginal desert climate with strong temperature range along the day (delta up to 22 °C), with absolute minimum temperature reaching -20°C
- No connection to the national grid: microgrid circuit powered by a 250 kW diesel generator. No supply of electricity from 1:00-8:00 am.



Aim of the project

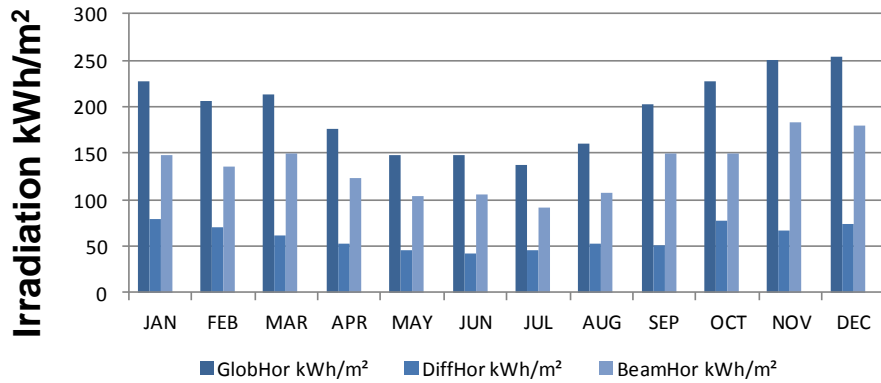
- **Supply 24hs/day 7 days/week energy, removing** the restriction of the village to having access to energy during night time
- **Minimizing the consumption of fuel** from existing diesel generator
- **Testing advanced renewable technologies and energy storage system** in the off-grid harsh environment, with extreme solar radiation in low density air, in collaboration with project partners and research centers.
- **Develop technical solutions for fast growing market**

Ollagüe Project

Resources and load profiles of Ollagüe

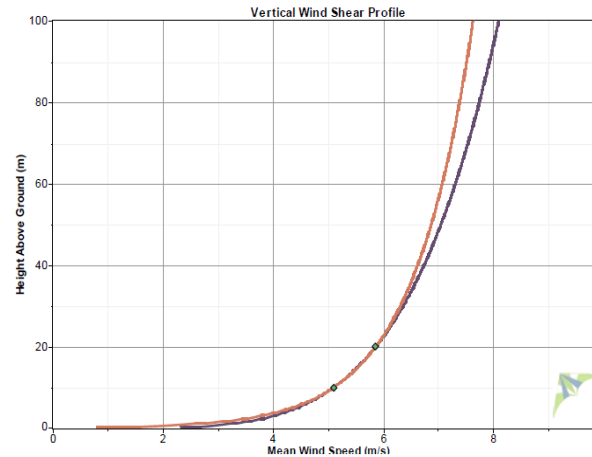


Solar: 2015 EOH



Mean Wind Speed vs Height

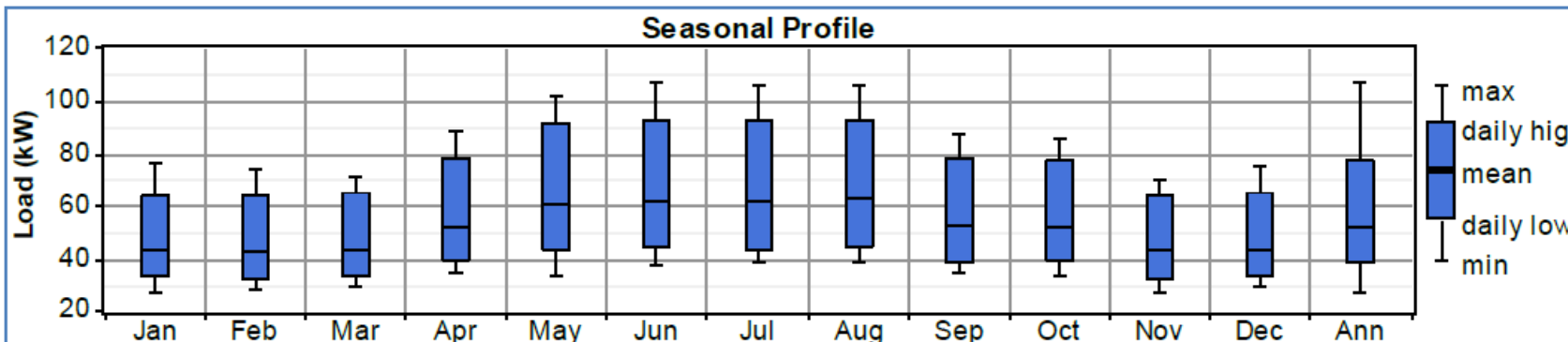
Wind: 1533 EOH



Reference conditions (resource assessment) well known at time of design

Load profile:

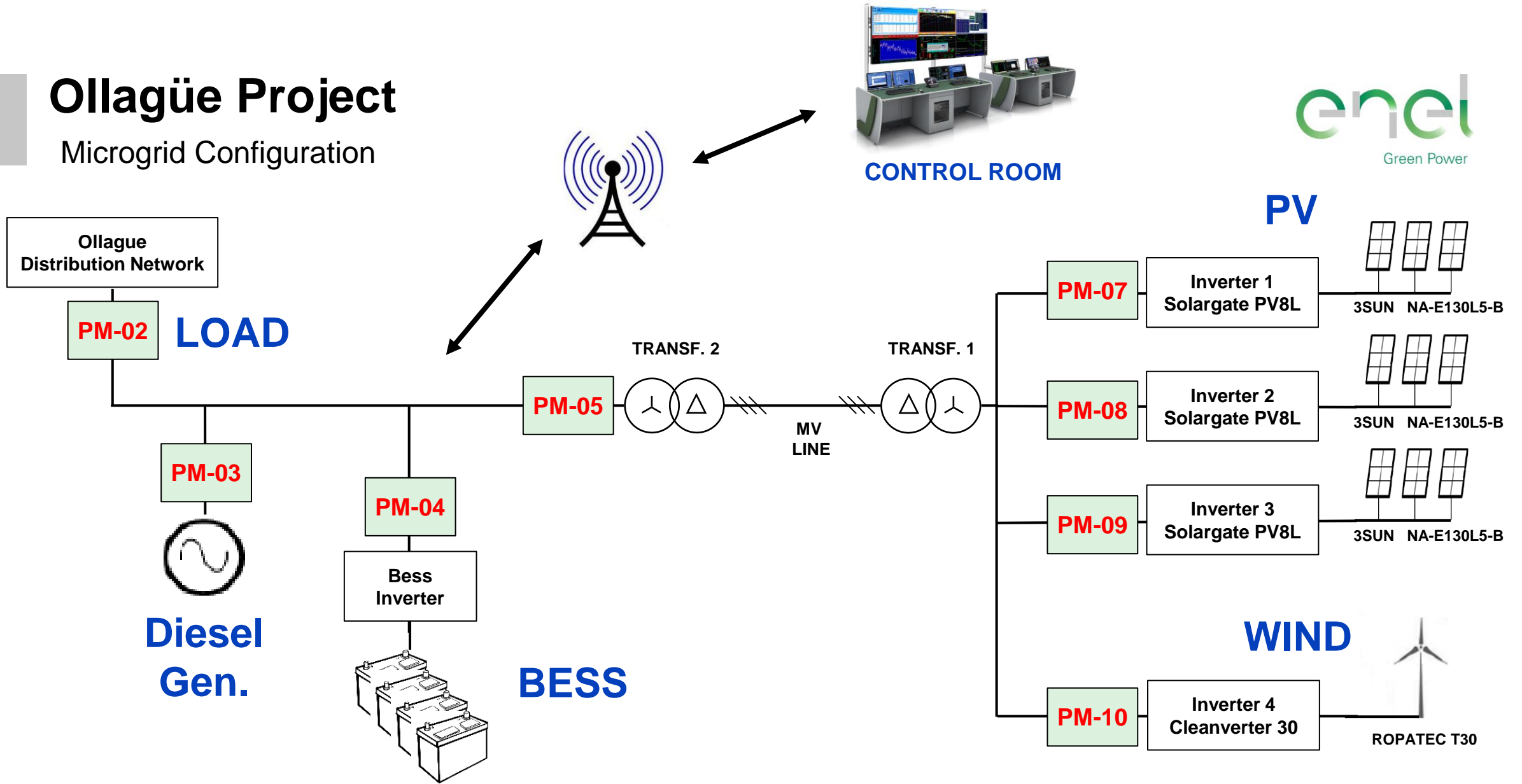
Seasonal Profile



Load profile used for design was based on real consumptions of community (17 h/day power supply)

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Microgrid Configuration



Advanced technology, fully monitored and managed remotely with local community for O&M support

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Operation of the Hybrid Plant



PV and Wind generation directly feeds Ollague grid. Excess energy is stored in the BESS that supply energy overnight.

GenSet operates to:

- sustain the load as backup generator
- provide safety charge, when BESS SOC falls below threshold values
- perform BESS equalization, to reach top of charge

Hour	00	01	02	03	04	05	06	07	08	09	10	11	12	13	14	15	16	17	18	19	20	21	22	23
PV									■	■	■	■	■	■	■	■	■	■						
DIESEL																			■	■	■	■	■	
BESS	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■
WIND															■	■	■	■	■	■	■	■	■	■

The Hybrid Plant is operated trying to minimize the use of diesel generator and therefore the fuel consumption.

Nevertheless, it is also important to accurately charge/discharge batteries in order to extend as much as possible their lifetime.

■	BESS SUPLYING OLLAGUE LOAD
■	BESS CHARGED BY RENEWABLES
■	BESS CHARGED BY DIESEL

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Milestones

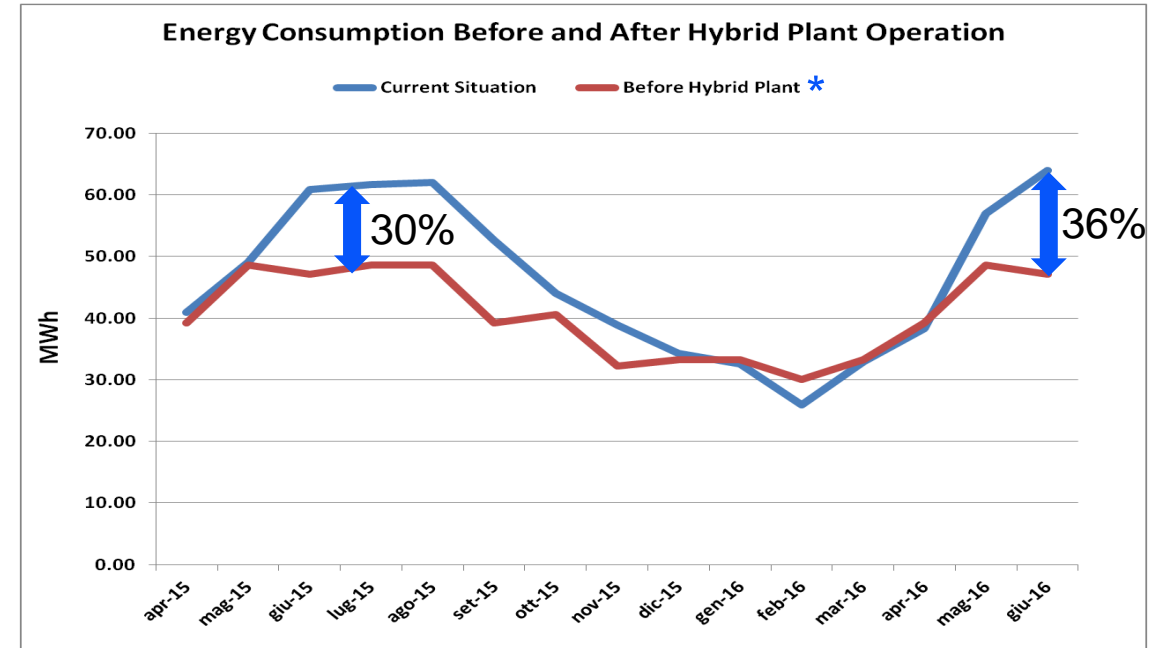
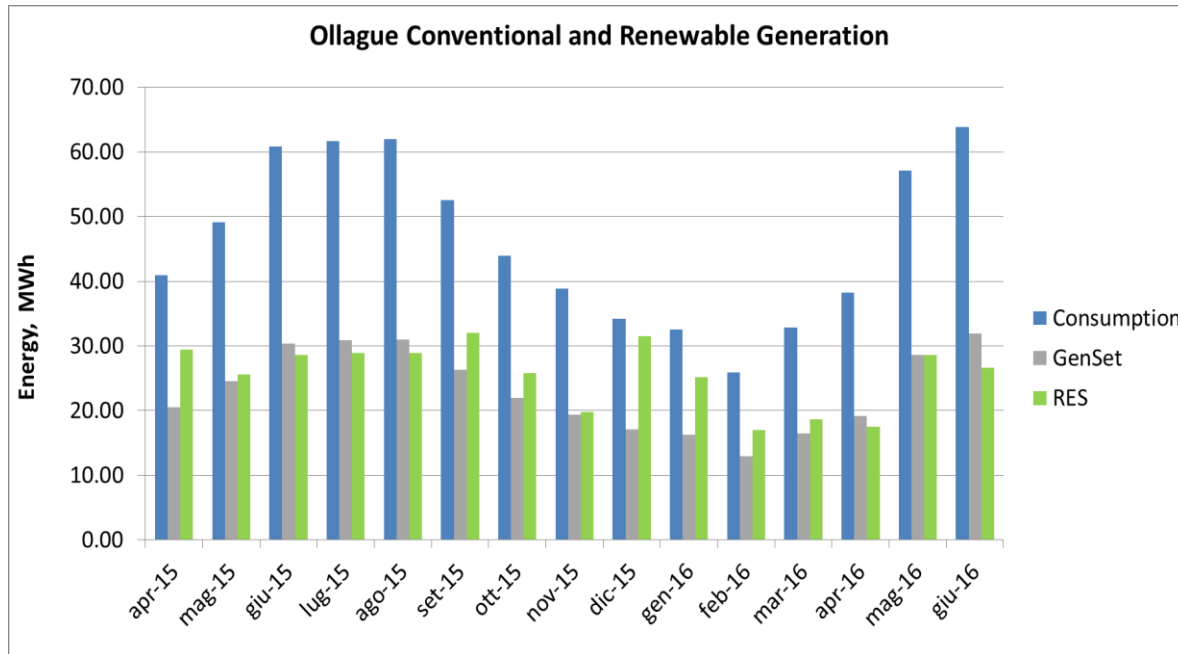


- **Construction completed in December 2014**
- **In full operation since Q1 2015**



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Performance Analysis: Energy Consumption and Microgrid Generation Trends



- Renewables account for around 57% of the original Design Load Profile

* Hypothetical consumption calculated over 24 hours using 17 hours average load

- Current monthly energy consumption is higher than it was before plant operation, but only in wintertime.
- The heating is the main cause of electricity consumption increase.
- Winter 2016: +6% vs 2015 due to operation of 2 new laundromats → creation of new small businesses

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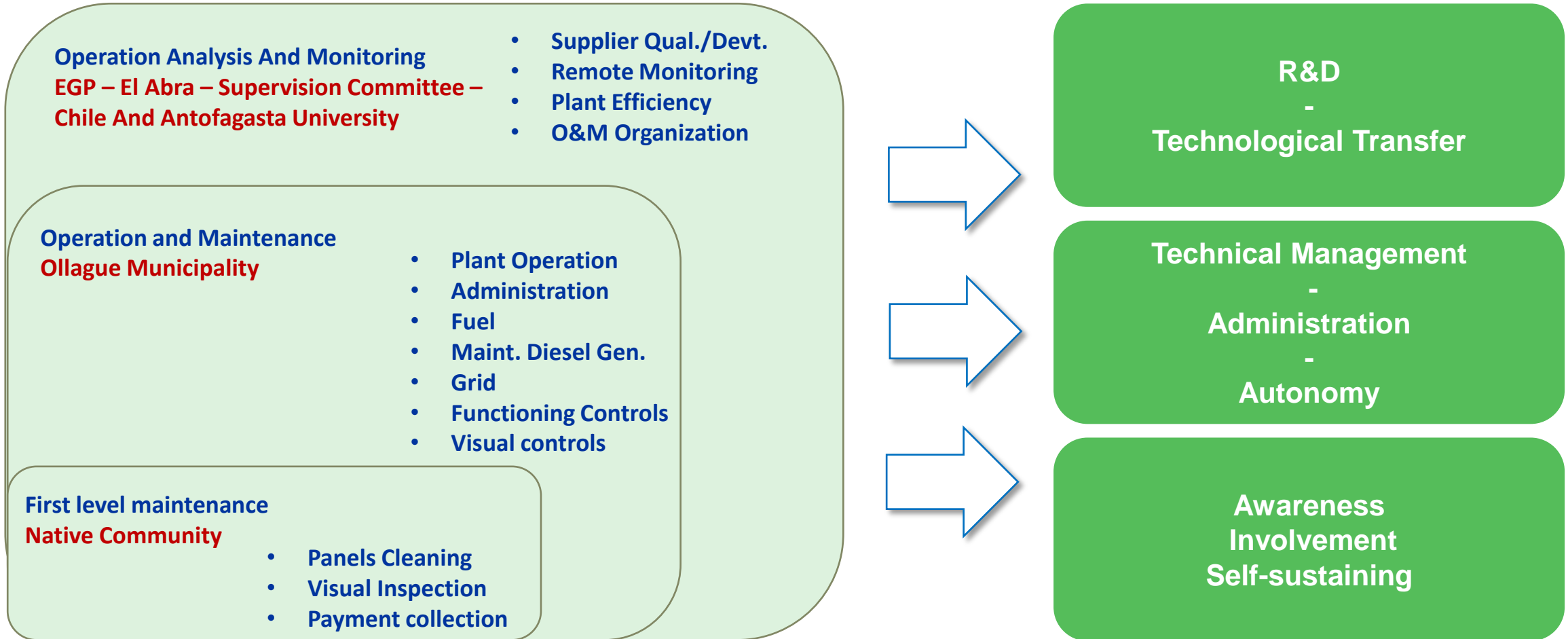
Main results



- ❑ The aim of project has been completely reached, dramatically reducing the consumption of fossil fuel.
- ❑ The installations of the hybrid system drastically changed the habits of the inhabitants, with also promising economic benefits:
 - Economic: Development of existing and creation of small businesses (1 new hostel, 2 new laundromats, better situation for restaurants due to possibility of a refrigerator, 1-person business offering street food at the border with Bolivia)
 - Health and Safety: Possibility for the 30 students of the school of hot showers, possibility to maintain refrigerated medicines
- ❑ Meanwhile, the operation of such advanced plant is giving deep inside knowledge about such kind of systems and possible business model in remote area.

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Sustainable operation model



Sustainable Operation Model involving directly communities, authorities and universities

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Lessons Learned



- ❑ **Microgrid has to be highly modular** in order to manage any increase in consumption that cannot be easily forecasted (e.g. socio-economic impact of new energy systems vary by country, areas, culture, etc...)
- ❑ **Sizing** procedures should carefully balance overall system efficiency and reliability
- ❑ Proper criteria for **utility rate tariffs** should be defined during the design phase to create awareness and appropriate incentives
- ❑ **Dynamic/advanced EMS** (Energy Management System) under analysis could optimize the microgrid energy flows using external variables such as demand forecast and weather observation/forecast.

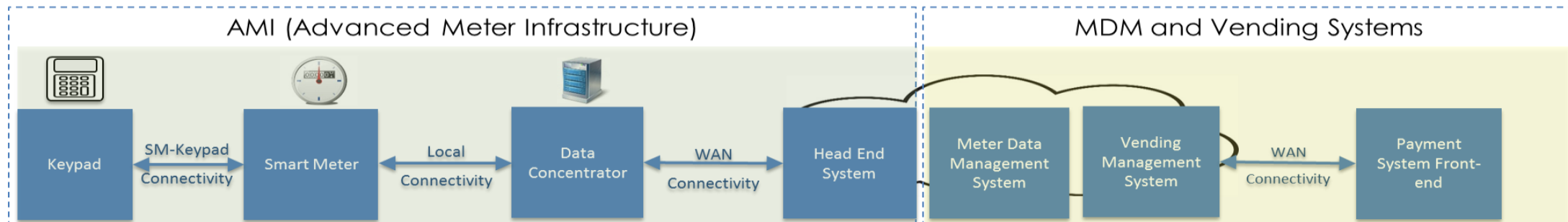
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Next steps

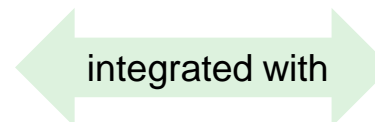


Possible further optimizations of the Energy management system:

- Advanced weather forecast and nowcast technologies
 - Real time monitoring of the loads (for Load forecast)
 - Looking to possible improvements of the genset management strategy
 - Evaluate further equipment making optimal usage of the available resource
- Integrate meters and provide innovative billing system: Enhance the system performance and services by installing a metering system in order to monitor the customer electricity usage and provide a prepaid service based on consumption



Metering infrastructure provided by Enel Infrastructure and Networks (EI&N)



Third Party's prepayment and Billing system

Thank you



[CLICK to watch YouTube video "Ollagüe Project, a new frontier for storage"](#)