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: 752 kWh (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

Global, diffuse and beam irradiation [kWh/m²]

Wind: 1533 EOH

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

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

Microgrid Configuration

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

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

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.
Construction completed in December 2014
In full operation since Q1 2015
• Renewables account for around 57% of the original Design Load Profile

• 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
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.
Ollagüe Project
Sustainable operation model

First level maintenance
Native Community
- Panels Cleaning
- Visual Inspection
- Payment collection

Operation Analysis And Monitoring
EGP – El Abra – Supervision Committee – Chile And Antofagasta University
- Supplier Qual./Dev.
- Remote Monitoring
- Plant Efficiency
- O&M Organization

Operation and Maintenance
Ollague Municipality
- Plant Operation
- Administration
- Fuel
- Grid
- Functioning Controls
- Visual controls

R&D
- Technological Transfer

Technical Management
- Administration
- Autonomy

Awareness
Involvement
Self-sustaining

Sustainable Operation Model involving directly communities, authorities and universities
Ollagüe Project

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.
Ollagüe Project

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

AMI (Advanced Meter Infrastructure)

| Keypad | SM-Keypad Connectivity | Smart Meter | Local Connectivity | Data Concentrator | WAN Connectivity | Head End System | Meter Data Management System | Vending Management System | Payment System Front-end |

MDM and Vending Systems

Metering infrastructure provided by Enel Infrastructure and Networks (EI&N) integrated with Third Party's prepayment and Billing system
Thank you

CLICK to watch YouTube video "Ollagüe Project, a new frontier for storage"