Microgrids Overview Europe and Africa

Microgrids Symposium, Newcastle, November 2017

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Microgrids Overview Europe and Africa
Agenda

Microgrids with focus on „Mature markets“ vs. „Emerging Markets“

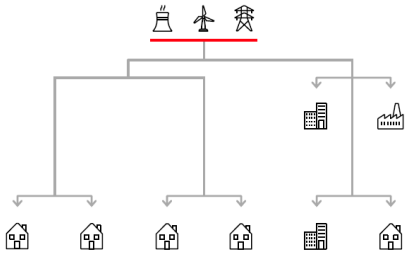
African latest microgrid deployments

European microgrids

Power systems of the future

Grid evolution today and in the future

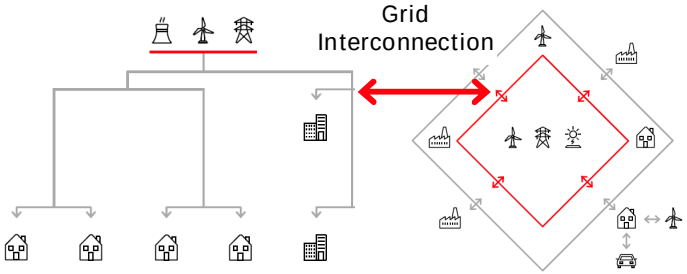
Yesterday



2000

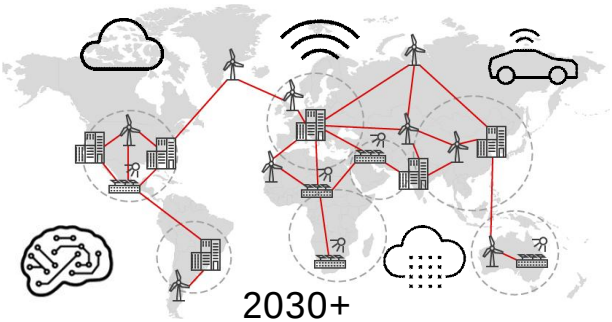
Factors:
- Global warming – ecological threats
- Stimulated, regional introduction of renewables
- Exponential reduction of photovoltaics & battery storage costs
- Consumer to Prosumer development
- Digitalization trend
- Interconnection technology development

Today



2020

Tomorrow



2030+

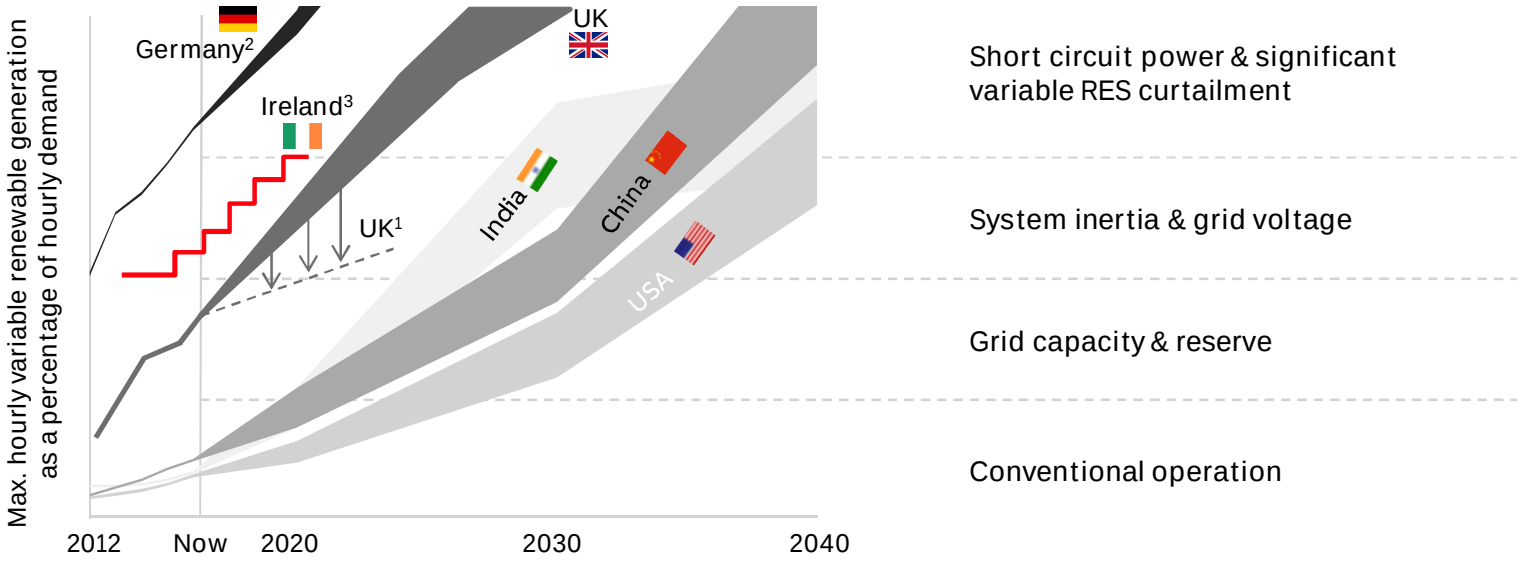
Factors:
- Full scale deployment of renewables across all regions
- Increased share of energy by wire
- Massive introduction of grid connected Electrical Vehicles
- Utilities adopting to changing environment
- Fully flexible power exchange with related data transfer («Internet of Energy»)
- Artificial Intelligence enabling complex autonomous processes

 Sources: ABB

Power systems of the future

Grid – enabler or bottleneck…

Technical challenges countries encounter



Grid investments and technologies required to address challenges

[1] UK in case all planned subsea interconnectors in ENTSO-E TYNDP 2016 will be in operation by 2022-2025. It is assumed that ATC is used 100%
[2] Germany may operate at very high V-RES levels due to strong connections to the ENTSO-E grid
[3] Ireland limits instantaneous percentage of non-synchronous resources (SNSP) by 60% in 2017. The plan is to reach SNSP=75% in 2020
Sources: UK official statistics, NG Future energy scenarios, ENTSO-E TYNDP, BNEF, Energiewende, Governmental plans, ABB analysis

Power systems of the future

Changing power generation balance

Power generation

Power balance tipping towards renewables, driven by policy & disruptive technology cost reduction

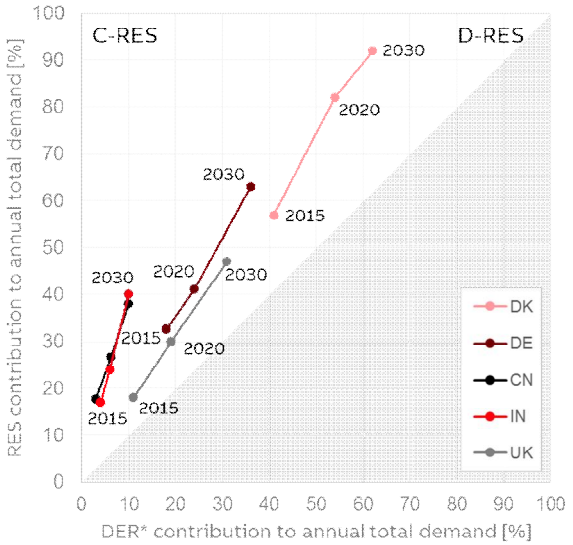
Main growth in variable renewables such as wind and solar

Two growth paths

– Mainly centralized renewables

– Mainly distributed renewables

Centralized vs decentralized

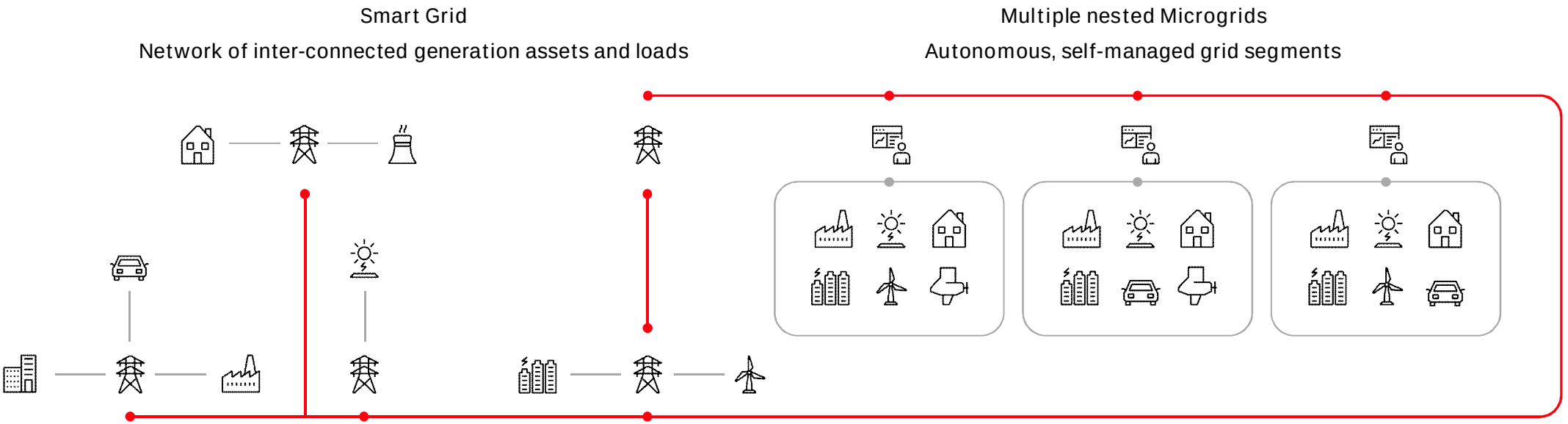


Renewables expected to be dominant source for electrical power generation

- units <50 MW connected to MV/LV grids, source: governmental plants, ABB analysis
- Sources: ABB analysis

Power systems of the future

Flexible grid evolution – microgrids and integration of renewables



 Sources: ABB

Mature markets versus emerging markets

Mature economies

- Increase in renewables
- Participation in markets together with storage
- Long feeders to villages

Fast growing, emerging economies

- Fuel saving in weak grids by using storage and renewable energy
- Stabilizing power quality

Under developed regions

- As technology cost decrease, Microgrids become affordable

Microgrids Classification

The two branches

Grid connected microgrids

Microgrid is connected to weaker (unstable) power grid

Technical Advantage

- Stabilization of grid
- Improved power quality
- Integration of renewables

Customer Benefits

- Stable and uninterrupted high-quality power supply
- Less reliance on conventional power sources (fossil fuels)
- Lower environmental impact

Off-grid microgrids

Microgrid is not connected to power grid and generates power independently

Technical Advantage

- Improved power quality
- High integration of renewables

Customer Benefits

- High-quality power supply using local energy resources
- Negligible or no reliance on conventional power sources (fossil fuels)
- Lower environmental impact

Microgrids experiences from different segments

Market segments and drivers

Off-grid / Weak grid / Grid-connected

		Main drivers				
		Social	Economic	Environmental	Operational	
Segments	Typical customers	Access to electricity	Fuel & cost savings	Reduce CO_2 footprint and pollution	Fuel independence	Uninterrupted supply
Island utilities	(Local) utility, IPP*		P	P	P	(P)
Remote communities	(Local) utility, IPP, Governmental development institution, development bank	P	P		P	
Industrial and commercial	Mining company, IPP, Oil & Gas company, Datacenter, Hotels & resorts, Food & Beverage		P	(P)	P	P
Defense	Governmental defense institution		(P)	(P)	P	P
Urban communities	(Local) utility, IPP			(P)		P
Institutions and campuses	Private education institution, IPP, Government education institution		(P)	P		(P)

* *Independent Power Producer* **P**: *Main driver* (**P**) : *Secondary driver*

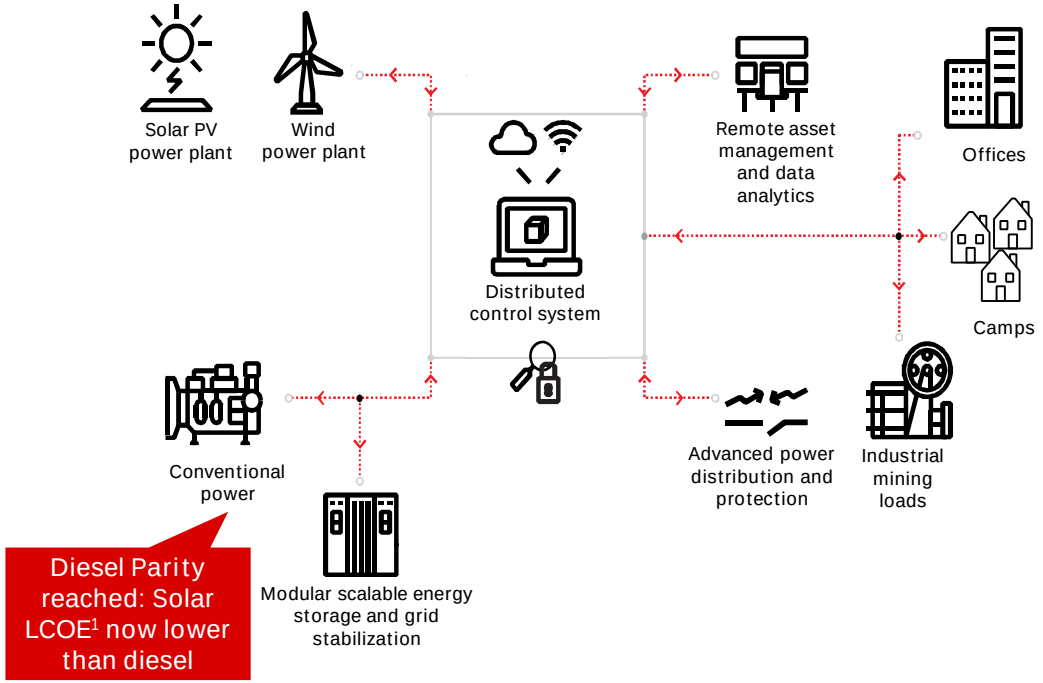
How microgrids create value in off-grid applications

Key drivers of value creation and cost savings

Operational goals

- Providing essential off-grid quality power with blackstart capability
- Improving resiliency by having storage, generation and loads optimally coordinated
- Reducing reliance on diesel and associated supply chain risk and CO2 emissions

Lower operating costs, higher up-times and higher gross margins for mines



1 LCOE: Levelized Cost of Energy per kWh over the life of the asset including all installation, financing and running costs

Island utilities

Robben Island, PowerStore/PV/Diesel

About the Project

- Project name: Robben Island
- Location: South Africa
- Customer: Department of Tourism, South Africa
- Completion date: 2017

Solution

The microgrid captures solar power from an array of photovoltaic panels and have a peak capacity of 667 kilowatts. 12 solar inverters convert the direct current (DC) output from the solar panels into the alternating current (AC) needed to provide electrical power to the island. The microgrid can run on solar power through the day, bolstered by a PowerStore™ battery technology that can provide power for approximately seven hours after the sun goes down

Customer Benefits

- Lower fuel costs and carbon emissions by 75 %
- Enabling the island to run on solar power for at least 9 months of the year
- Remote monitoring of the entire system from Cape Town
- Remote set-up eliminates the need to maintain a workforce on the island

tourism
Department:
Tourism
REPUBLIC OF SOUTH AFRICA

SOLA
FUTURE ENERGY

Press Release
Web Story
Video

ABB's microgrid solution enables the Robben Island to run on solar power for at least 9 months in a year

Industrial and Commercial Sites

Longmeadow, PowerStore/PV/Diesel

About the Project

- Project name: Longmeadow
- Location: South Africa
- Customer: Longmeadow Business Estate
- Completion date: 2016

Solution

The resulting Microgrid system consists of:

- PowerStore Battery (1 MW/380 kWh)
- Microgrid Plus Control System
- Solar PV (1 x 750 kW_p)
- Diesel (2 x 600 kW)
- Remote Monitoring

Customer Benefits

- Stabilizing the grid for reliable and stable power supply
- Optimized renewable energy contribution to the facility
- Seamless transition from grid connection to islanding in case of an outage
- CO_2 reduction: over 1,000 tons/year
- Up to 100% renewable energy penetration

LONGMEADOW
Business Estate

Press Release
Infographic
Video
Data Sheet

The microgrid solution is for the 96,000 sqm facility in Johannesburg that houses both ABB South Africa's headquarters, as well as a manufacturing facility employing close to 1,000 employees

Microgrids for NGO

International Committee of Red Cross

ABB CEO's Message on ICRC Project

– "We are delighted to partner and support the humanitarian work of the International Committee of the Red Cross."

– "Microgrids have enormous potential in Africa, where more than 600 million people live without access to electricity. Reliable access to electricity is essential to speed up economic development."

– Ulrich Spiesshofer, CEO, ABB

Island utilities

La Gomera Island, PowerStore

About the Project

- Project name: La Gomera Island
- Location: Canary Islands, Spain
- Customer: Endesa

Solution

ABB has delivered PowerStore flywheel-based microgrid solution. The solution would stabilize grid system, by absorbing frequency and voltage fluctuations introduced into the system by renewable energy sources

Customer Benefits

- Stable electricity to 22,000 Islanders
- Stabilizing - frequency and voltage regulation

endesa

Press Release
Video

Stable, reliable and uninterrupted supply of clean electricity to 22,000 people in the Island

Island utilities

Faial Island, Wind / Heavy Fuel Oil

About the Project

- Project name: Faial Island
- Location: The Azores, Portugal
- Customer: Electricidade dos Acores (EDA)

Solution

ABB has delivered a microgrid solution that will ensure balance between supply and demand, maximize integration of wind energy and optimize the generators so that the entire system performs at peak potential

Customer Benefits

- Minimize diesel consumption - 3.5 million liters of fuel saved annually
- Minimum environmental impact - 9,400 tons CO_2 avoided annually

EDA Electricidade dos Açores

Press Release
Infographic
Video

The microgrid solution helps to save cost (minimize diesel consumption) and protect the environment (reduction in CO_2 gas emissions)

EDF R&D

Newcastle Microgrids Symposium

Dr Maria Brucoli, Research engineer, EDF Energy R&D UK Centre.

15 November 2017

European Research Activities

Multiple research and development projects within EU have been founded by the **European Commission** under **FP7** and **Horizon202**0 frameworks.
The latest projects just completed and/or in the pipeline on microgrids are:

- **CoSSMic - Collaborating Smart Solar-powered Micro-grids (2013-2016):** Development of Information and Communication Technology (ICT) tools for smart sharing of renewable, distributed generation and storage within neighbourhoods. Case study areas: Konstanz in Germany and the Province of Caserta in Italy. http://cossmic.eu/

- **DCNextEve - LV DC microgrids for evolved energy communities (2016-2018):** Creation and analysis of models for management and control of multiple building scale DC microgrids operating on a specified area. Project is a collaboration between Politehnica University of Bucharest and Aalborg University. https://www.openenergyprojects.ro/

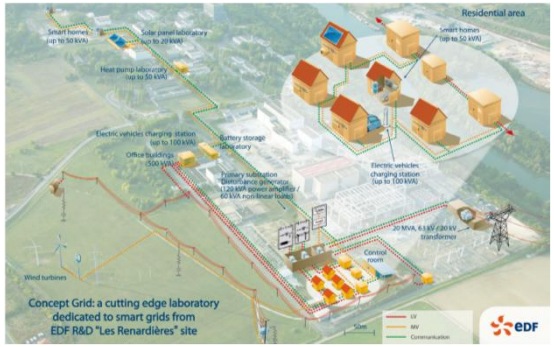
- **RDC²MT - Demonstration, and Commercialisation of DC Microgrid Technologies (2017-2021):** Investigation on technology, control systems, modelling, demonstration and commercialisation of DC microgrids including DC powered dwellings and DC distribution networks. Coordinated in United Kingdom the project includes partners from China and Canada. https://www.rdc2mt.org/

- Various project mainly focusing on battery storage technology for microgrids and island systems (e.g. Project **TILOS** on molten-salt batteries and Project **GREENERNET** on flow batteries).

EDF Activities – Concept Grid

About the Facilities

- Name: Concept Grid
- Location: South of Paris, France
- Size: 3 hectares of EDF R&D's Renardières site
- Key Technologies: Please contact maria.brucoli@edfenergy.com



A full-scale smart grid test facility with cutting edge equipment designed to anticipate and facilitate the transition from electricity distribution systems to smart grids. Open to external industrial and academic research, the site is built to represent and test a full scale real distribution network including MV (3km 20kV overhead and underground lines, 120km MV simulated network) and LV (7km) lines, loads (including one office building, 5 houses, EV charging points), PV panels, wind turbines, various storage systems etc.

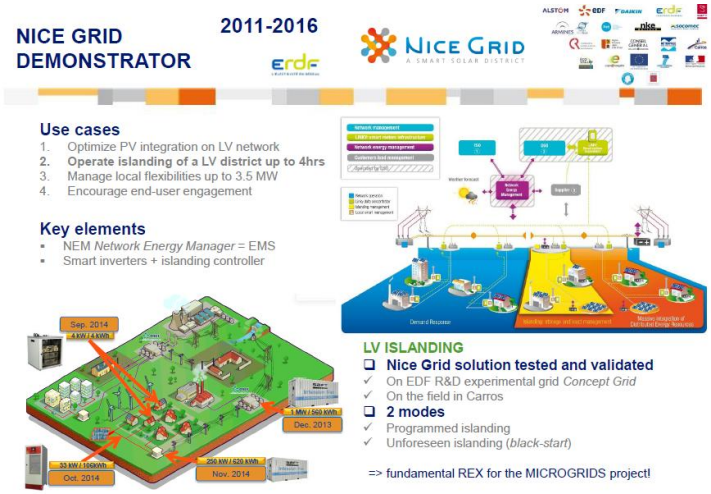
Its unique design places it mid-way between laboratory tests and experiments in the field. Concept Grid makes it possible to conduct, in complete safety, complex testing campaigns that would be impossible to perform on a real network.

A number of **research** and **commercial project support activities** on **microgrids** have been carried out at Concept Grid. More recent work includes testing of flywheel energy storage and work carried out together with NREL on microgrid controllers evaluation.

EDF Activities – Nice Grid

About the Project:

- Project name: Nice Grid
- Location: The Carros, Alpes-Maritimes, France
- Date: 2014
- Key Technologies: PV, several distributed Li-ion batteries of different sizes and locations (i.e. MV primary and secondary substations, LV network and customer level), and load shedding



Solution

A smart solar district pilot project combining of 1,500 households and 100 commercial buildings in the city of Carros. NICEGRID is one of the six demonstrators of the European project GRID4EU. Aimed at demonstrating how high penetration of PV installation can be integrated into the existing distribution network by using battery storage and demand flexibility (5MW of potential load shedding). The project tested how storage devices can provide high flexibility (charge/discharge) and services when properly sized (power & energy) and controlled. Assets and load were integrated through forecasting and optimisation tools.

The pilot project included also demonstration of **full islanding of a microgrid** based on a **LV feeder**, PV and battery storage. Prior to field installation, the whole LV microgrid set-up and islanding were tested at **Concept Grid**.

EDF Activities – Mafate Microgrid

About the Project

- Project name: Mafate Microgrid
- Location: Cirque of Mafate, Réunion Island, Africa
- Date: 2017
- Key Technologies: PV, fuel cell, hydrogen storage

Solution

The microgrid combines solar panels, a fuel cell and a hydrogen storage system, covering local demand and delivering 100% carbon free electricity. The hydrogen storage system stores energy up to 10 days and an additional lithium battery also allows for short-term storage. Buildings are supplied with electricity around the clock, including at night and in bad weather.

Benefits

- Reduction in fuel consumption for diesel generators
- Air quality improvement
- 100% renewable generation microgrid demonstrator