National Conference on Circular Economy

A shared vision of shifting from the traditional linear economy to a circular economy

Smart Grid and Renewable Energy

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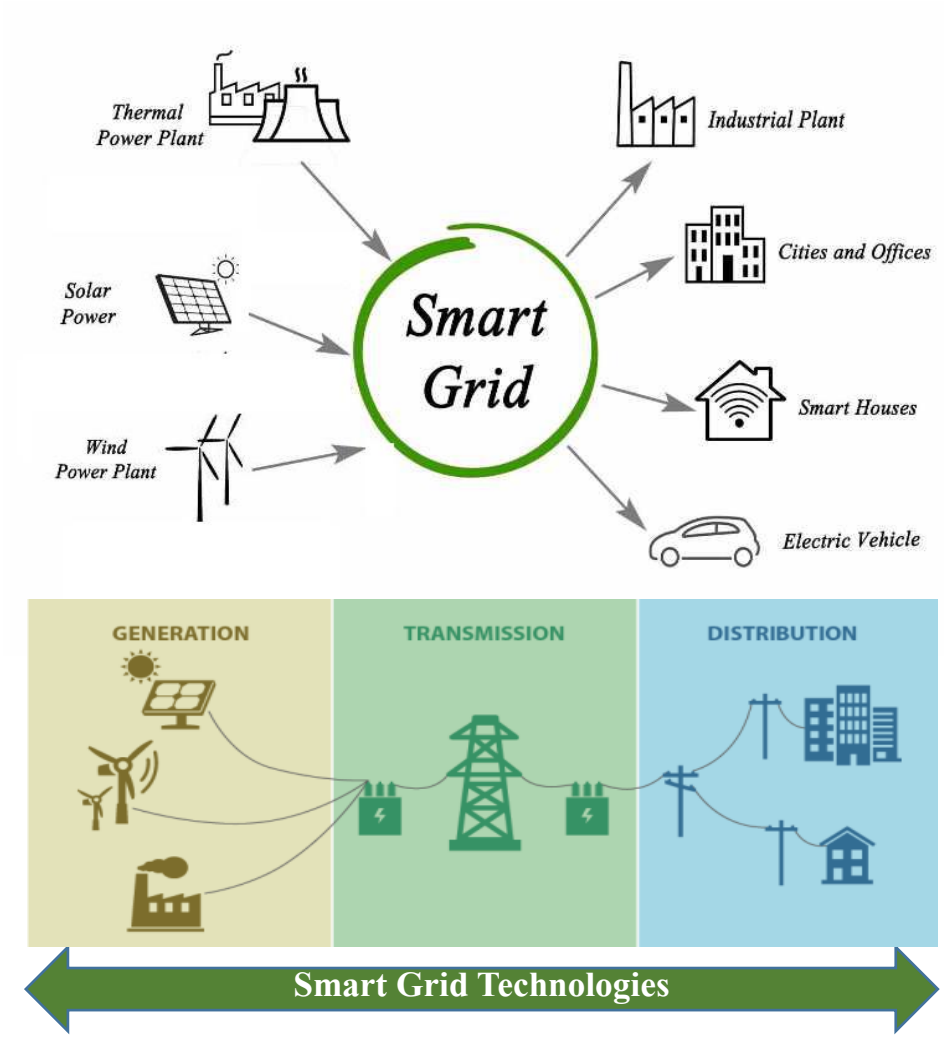
Overview of Presentation

- What is a Smart Grid?
- Why the Grid needs to be Smart?
- Some Benefits of Smart Grid
- Smart Grid Technologies

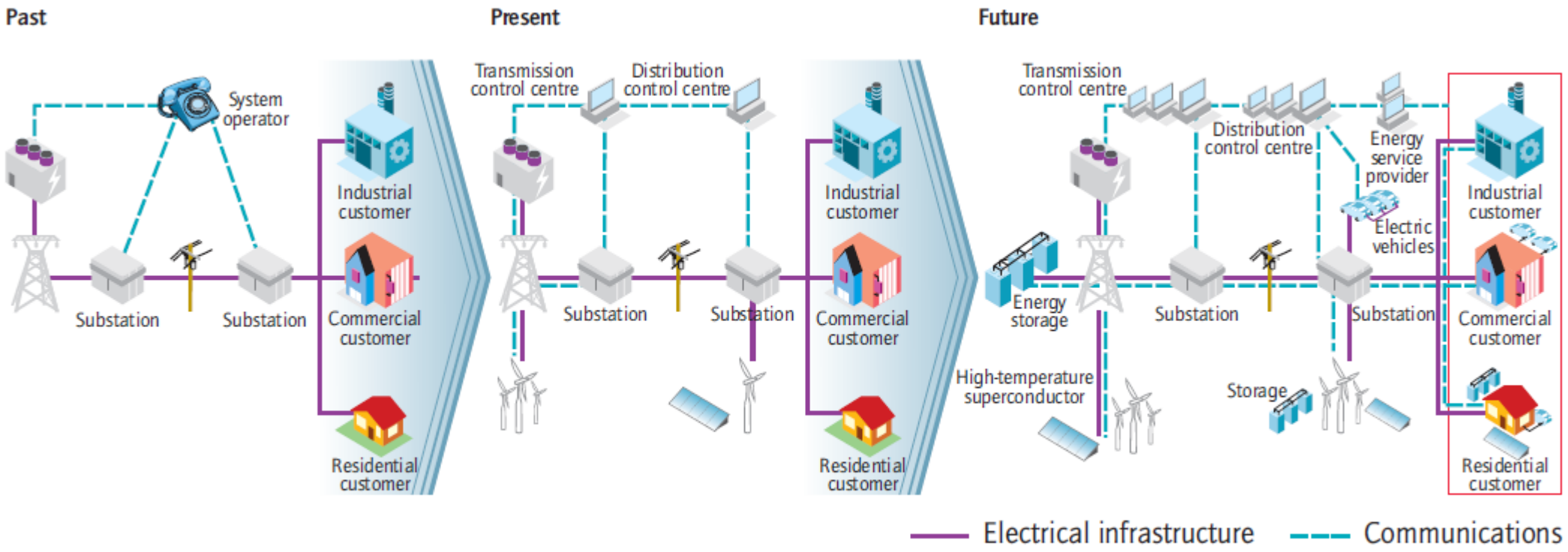
What is a Smart Grid?



- Smart Grid is an electricity network that uses **advanced technologies, and digital communication system** to monitor and control the flow of electricity from generation sources to end customers.

- Smart grids co-ordinate the operations of all components in an electricity network to operate as efficiently as possible while maximizing system reliability, resilience and stability.

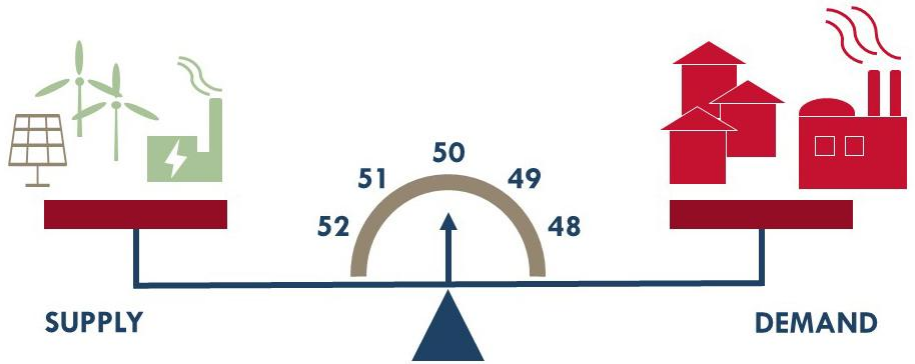
Past to Future Grid

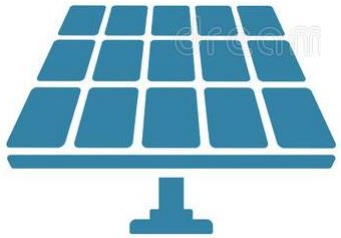


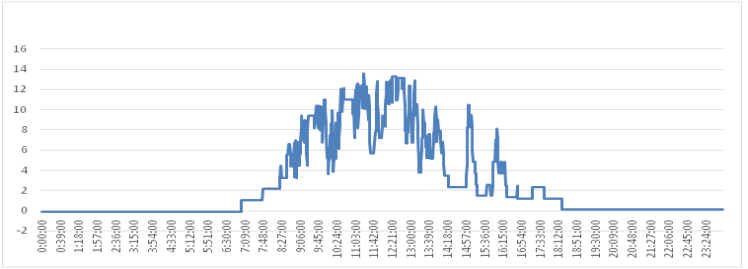
Source: IEA Technology Roadmap , Smart Grids. 2011

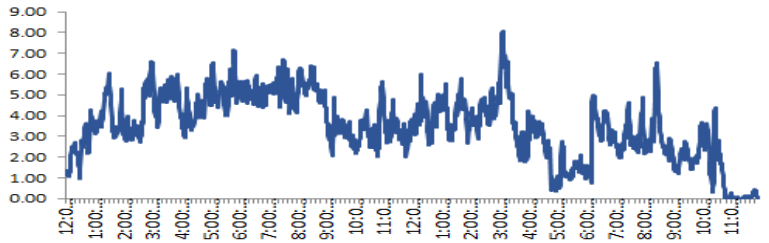
Why the Grid needs to be Smart?

Intermittent Generation Output (Wind and Solar)





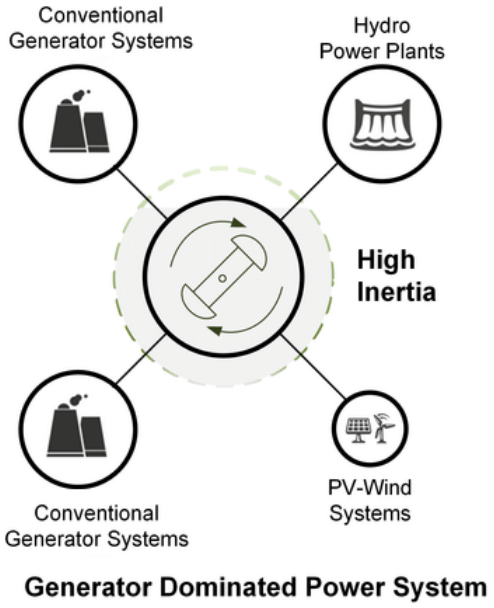


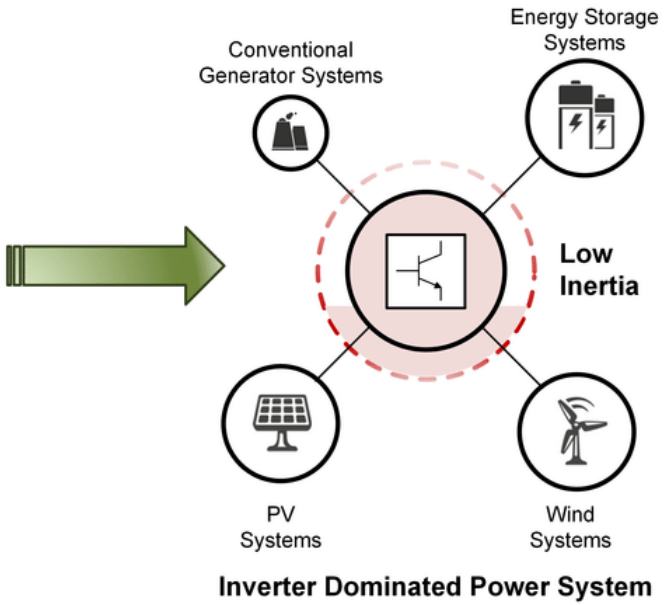


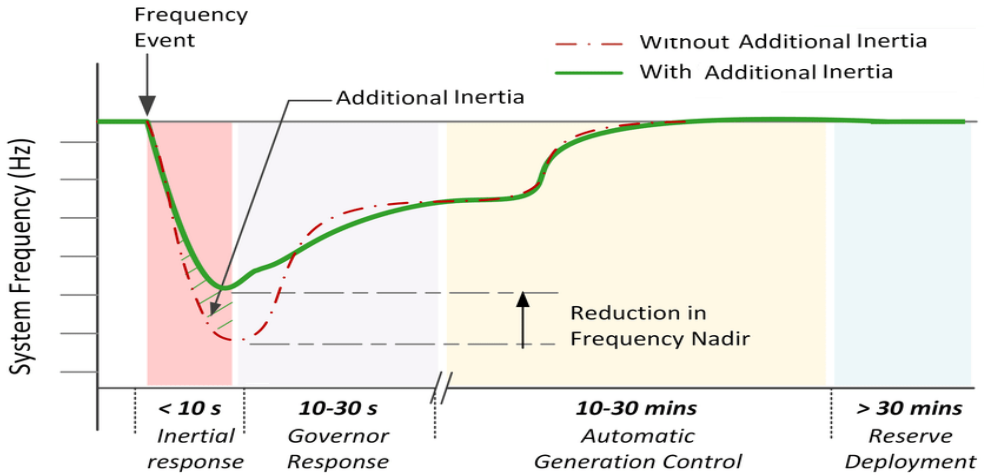
COMPENSATE RAPIDLY FOR DROP OR RISE IN GENERATION TO MAINTAIN THE STABILITY OF THE NETWORK

Why Smart Grid for RE?

System Inertia and Stability (Synchronous machine replaced by Converters)





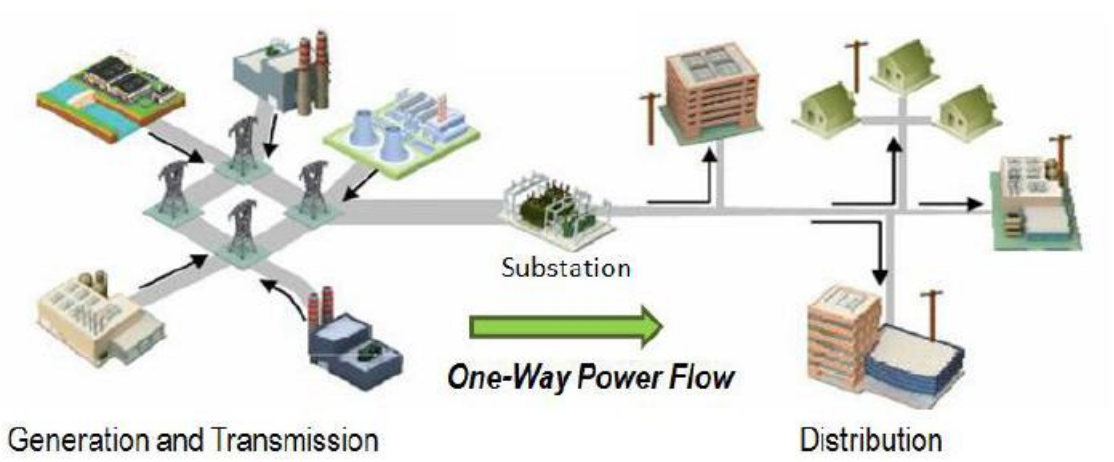


NEED TO COMPENSATE FOR REDUCTION IN INERTIA

Why Smart Grid for RE?

Power-flow inversion

Images Courtesy Electric Power Research Institute (EPRI)



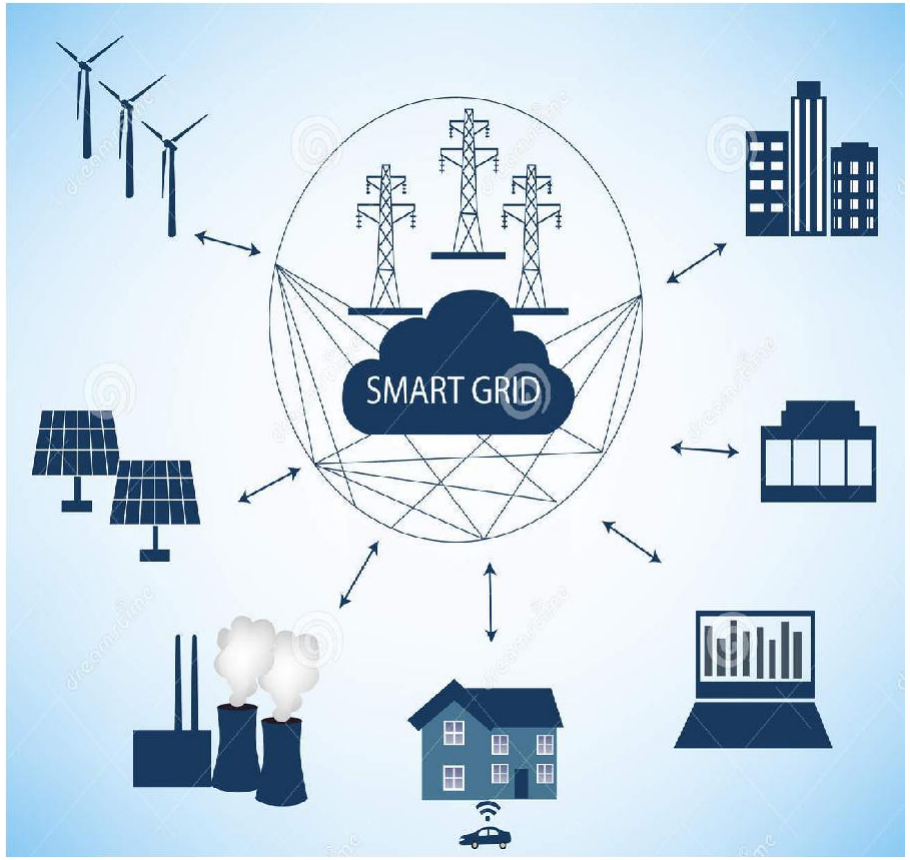
Voltage drops from source to end users

Voltage Profiles vary over the line

NEED TO MAINTAIN QUALITY OF ELECTRICITY SUPPLY

Some Benefits of Smart Grid

- Quicker restoration of electricity after power disturbances
- Reduced operations cost
- Provide real time and accurate data for grid management and planning
- Self-diagnosis
- Self-healing
- Efficient usage of electric vehicles
- Establishment of two-way communication with customers



SMART GRID TECHNOLOGIES

Smart Meters

Automatic Generation Control

Wide Area Monitoring System

Advanced Metering Infrastructure

Advanced Distribution Management System

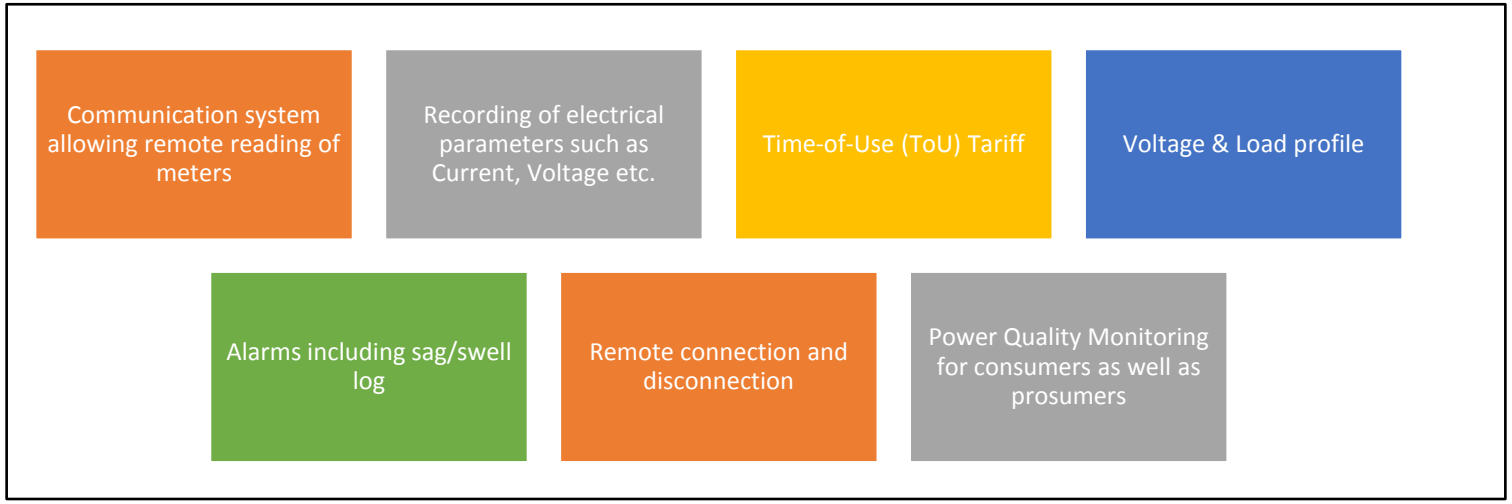
Modern Substations

Battery Energy Storage System

Smart Meters

Smart meters form the very core of a smart grid, supplying an abundance of data to optimise data-based analyses, planning, and diagnostics. It allows two-way communication between consumers and the Utility.

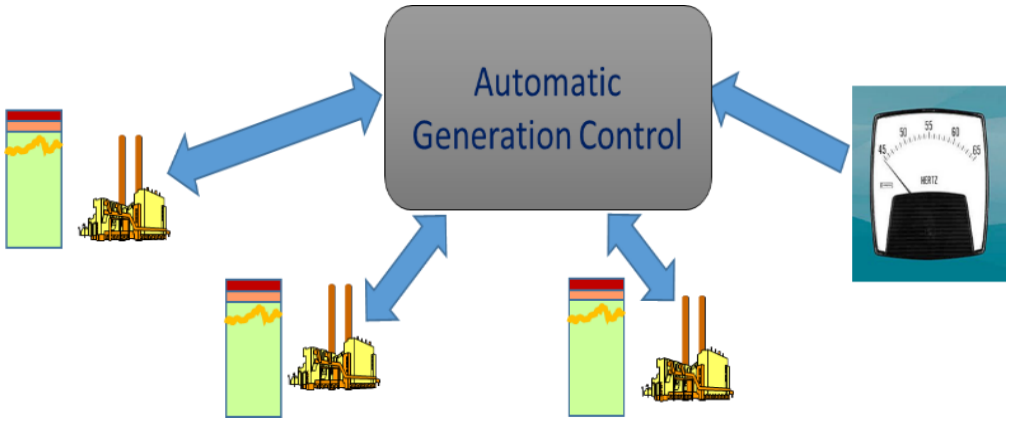
Functionalities of Smart Meter



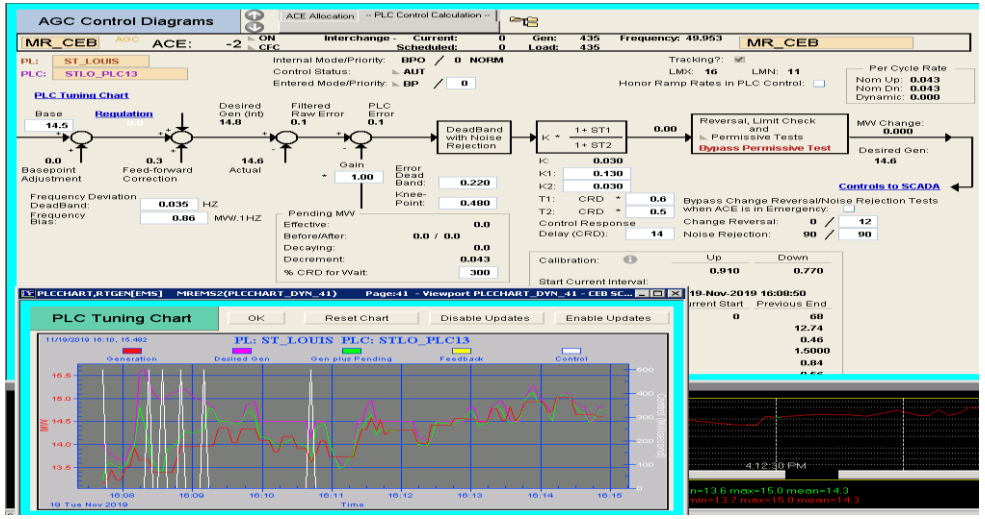
Presently, there are around **55,000** smart meters on the network and CEB is planning to deploy **50,000** smart meters annually to replace all electromechanical and electronic meters on the network.

Automatic Generation Control (AGC)

An **Automatic Generation Control** send signals to one or more generating units to either raise or lower their corresponding generating outputs to restore the frequency of a network to nominal frequency of 50Hz following a network disturbance.



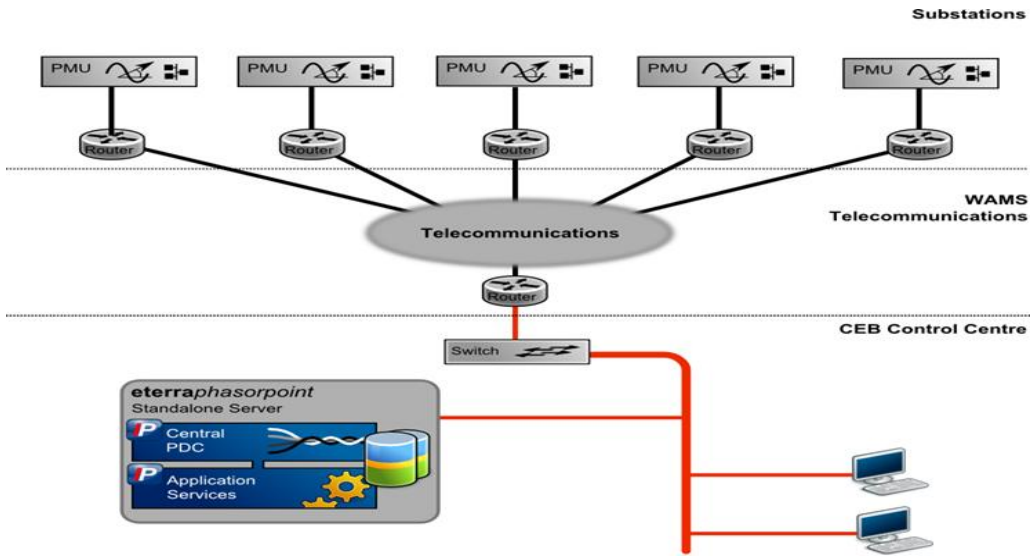
Rapid Secondary response through AGC as compare to System Operators calling power plant to raise or lower their respective generation output.

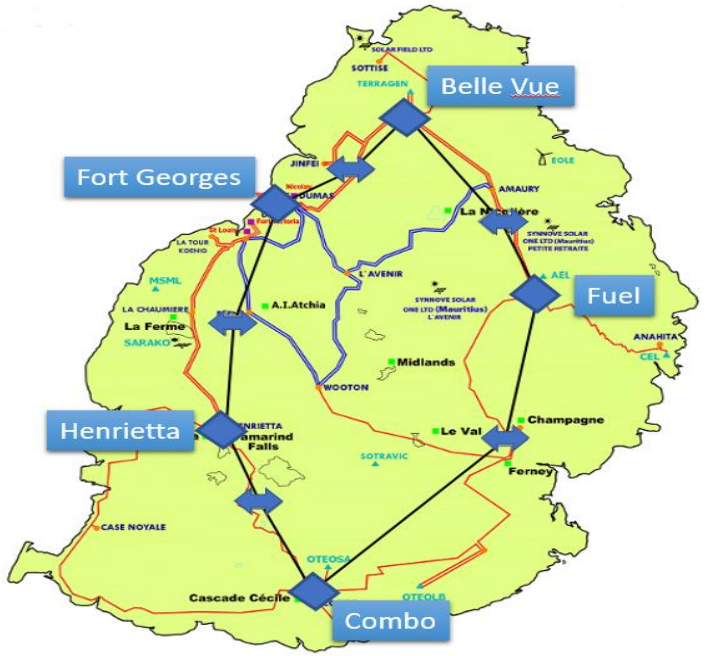


Wide Area Monitoring System

Wide area monitoring system (WAMS) is based on data acquisition using Phasor Measurement Units (PMU) installed at selected locations in a power system, in view of detecting grid instabilities. It can be regarded as a grid instabilities forecasting system

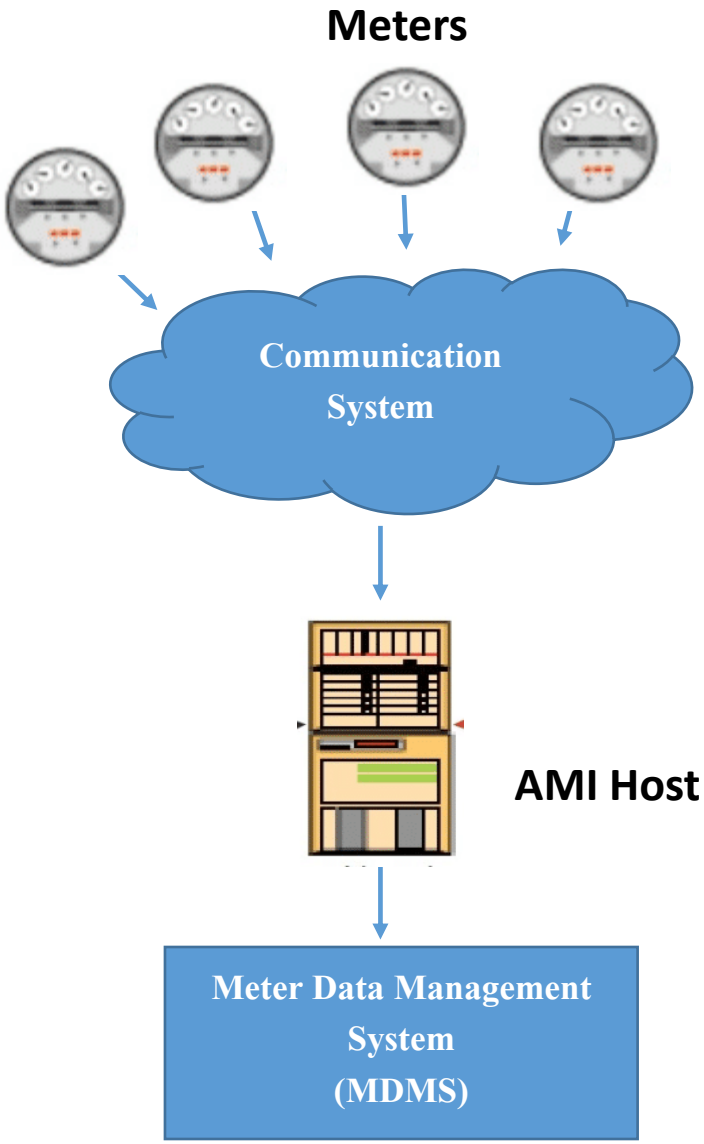
The WAMS can be set to control generating units in the event of anticipated grid instabilities.





Advanced Metering Infrastructure (AMI)

AMI – It is the whole infrastructure from Smart Meters to two way-communication network to control center equipment and all the applications that enable the gathering and transfer of information in near real-time. AMI is the backbone of smart grid.



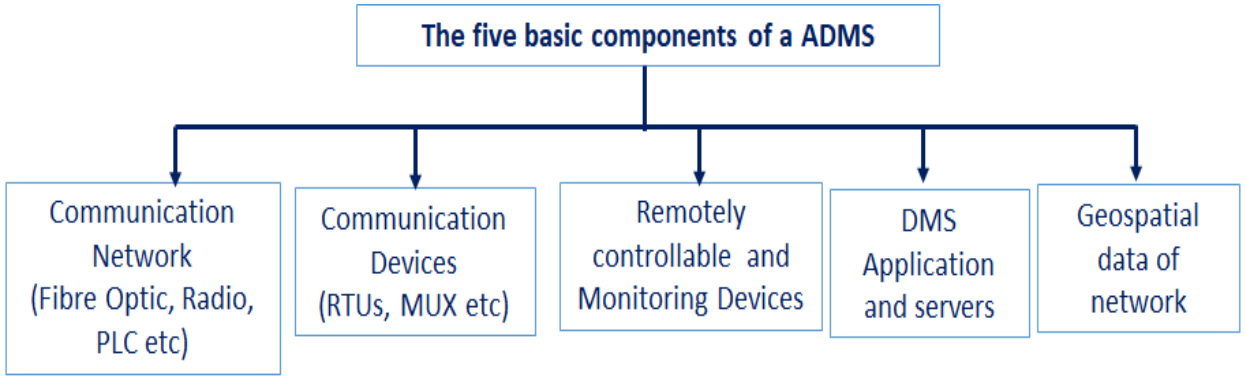
AMI provides a wide range of functionalities among which are:

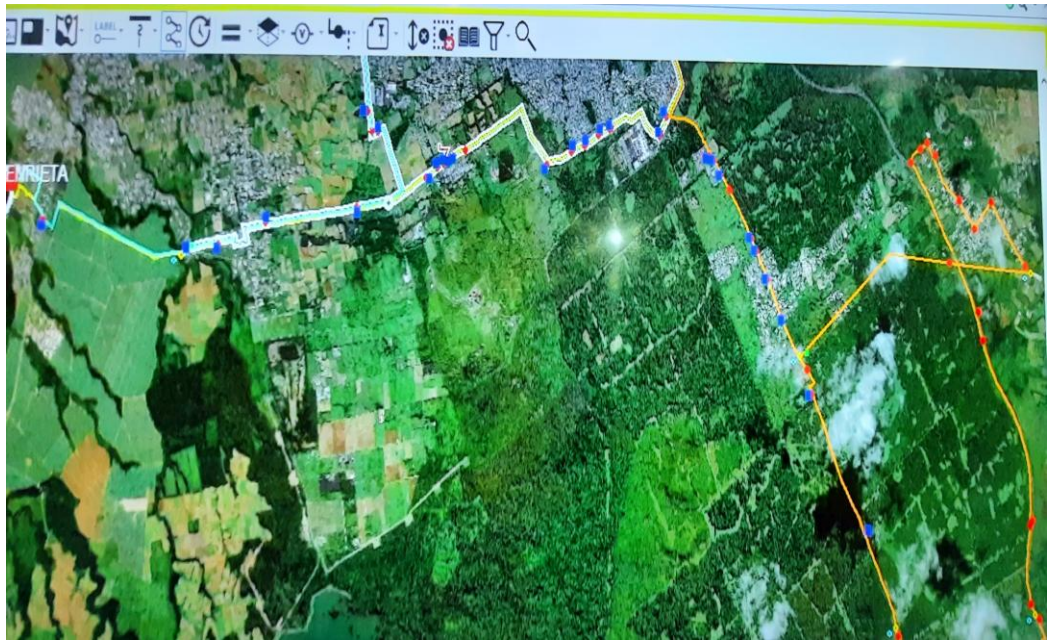
- Ability to collect store and data for any required time intervals or near real time.
- Power quality monitoring: voltage measurements, sags/swells, momentary interruption event data
- Enhanced distribution circuit information, such as transformer loading, circuit unbalance, etc.
- Improved diagnostics from more detailed and precise data.
- Ability to identify location and extent of outages remotely
- Two-way communication to all smart meters.
- Interface with other control systems and planning tools.

Advanced Distribution Management System (ADMS)

ADMS is a collection of applications designed to monitor & control the entire distribution network efficiently and reliably. It acts as a decision support system to assist the System Operator and field operating personnel with the monitoring and control of the electric distribution system.

ADMSs access real-time data and provide all information on a single console at the control center in an integrated manner





Some benefits of ADMS

- Reduce the duration of outages
- Reduce crew patrol and drive times through improved outage locating.
- Improve service reliability
- Improve management of Distributed Generation

Modern Substations (Gas Insulated Switchgear Substation)

Benefits of Gas Insulated Switchgear Technology

1. High reliability and high degree of safety
2. Long service life, little maintenance requirements, and low life cycle costs
3. Compact design and less space requirements.
4. Intelligent Electronic Device (IED)
5. IEC 61850 – Smart Grid Application

10 GIS Substations Project

Belle Vue, Henrietta, Chaumiere, Airport, Cote D'Or, L'Avenir, Ebene, Wooton, Fuel and Rose-Belle

Energy Storage System

ELECTROCHEMICAL
- Lead Acid
- Lithium Ion
- Other accumulator eg NaS
- Flow Batteries

CHEMICAL
- Hydrogen Cell
- Fuel Cell

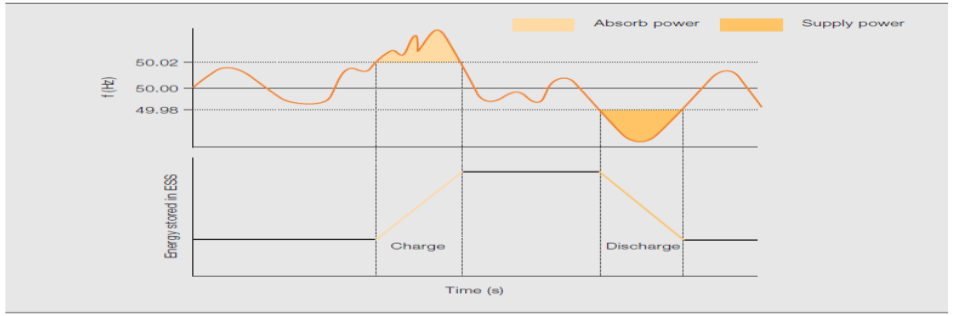
ELECTRICAL
- Super Capacitors
- Super Conducting Magnets

MECHANICAL
- Flywheel
- Pump Storage
- Compressed Air

Application of Energy Storage System

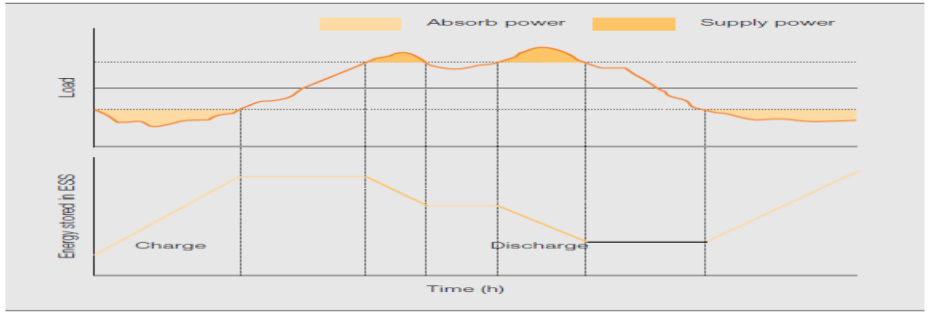
Frequency Control

- Absorbs and inject power on the grid to keep the frequency within statutory limits.
- Provide inertial response.



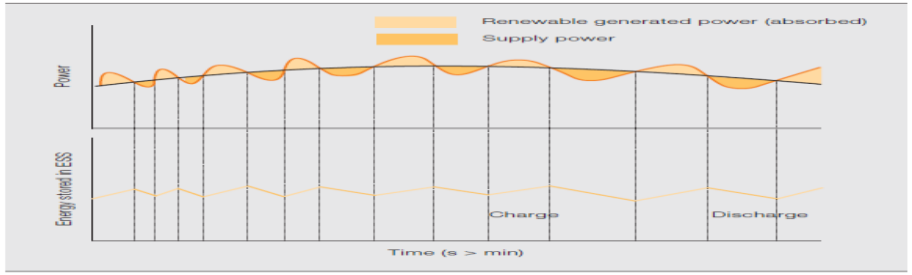
Peak Shaving

- Providing power to meet the peak demand
- Operating in all four quadrant i.e. being able to absorb and generate reactive and active power independently of each other.



Capacity Firming

- Smoothing the output of an RE Plant



Battery Energy Storage System Project

18 MW / 9 MWh

Location	Capacity
Amaury Substation	2MW, 1MWh
Henrietta Substation	2MW, 1MWh
Wooton Substation	4MW, 2MWh
Anahita Substation	4MW, 2MWh
La Tour Koenig Substation	2MW, 1MWh
Jin Fei Substation	4 MW, 2 MWh

20 MW / 10 MWh

Location	Capacity
Amaury	20 MW, 10 MWh

CENTRAL ELECTRICITY BOARD, Republic of Mauritius
A world class, commercial electricity utility enabling the social and economic development of the region.