Secondary Distribution Automation & Microgrid

The Smart Grid – Constant Energy in a World of Constant Change

Warner Priest, Infrastructure & Cities Sector, Smart Grid Division

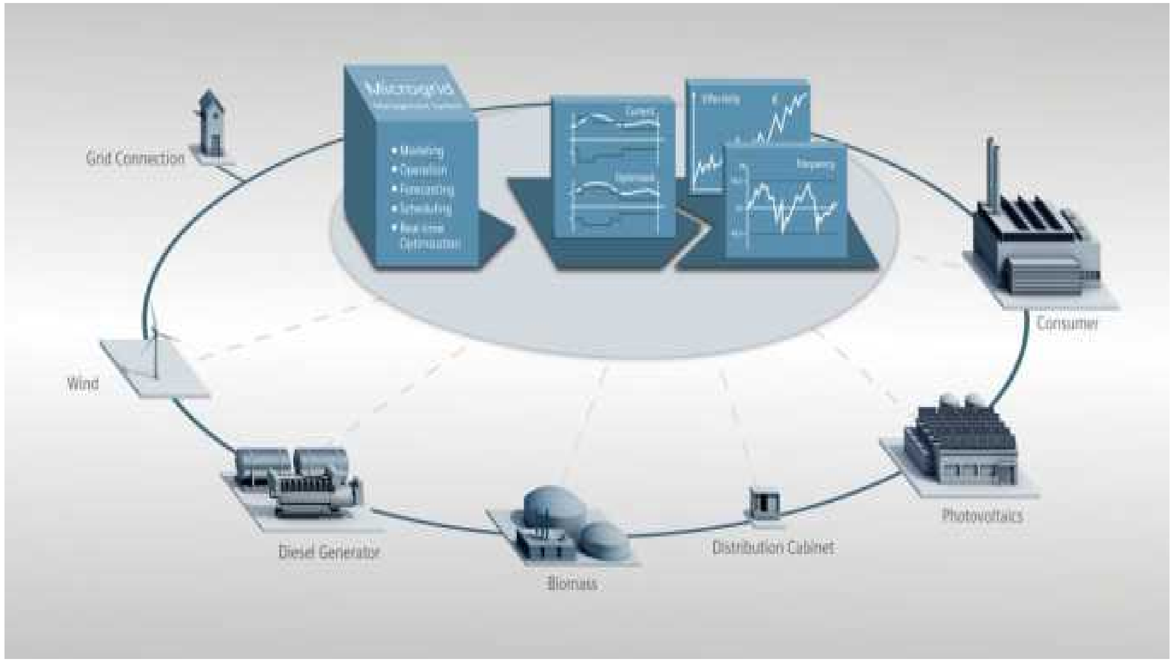
SIEMENS

CONTENT

INTRODUCTION – DEFINITION OF A MICROGRID

Microgrid - Definition

A Microgrid is an electrical grid that is responsible for its own consumption, storage, conversion, and use of energy, managed collectively within a network. Besides electricity, Microgrids may include other vectors such as heat, gas and water. Microgrids manage energy resources according to a given set of criteria. They may be operated in off-grid-, on-grid as well as in dual mode to optimize both technical (e.g. power quality, frequency) and economic (e.g. optimal use of renewable energy) factors. Microgrids create autonomy while increasing control and potentially preserving and enhancing privacy. Microgrids are the means to eliminate the de-motivators for smart energy.



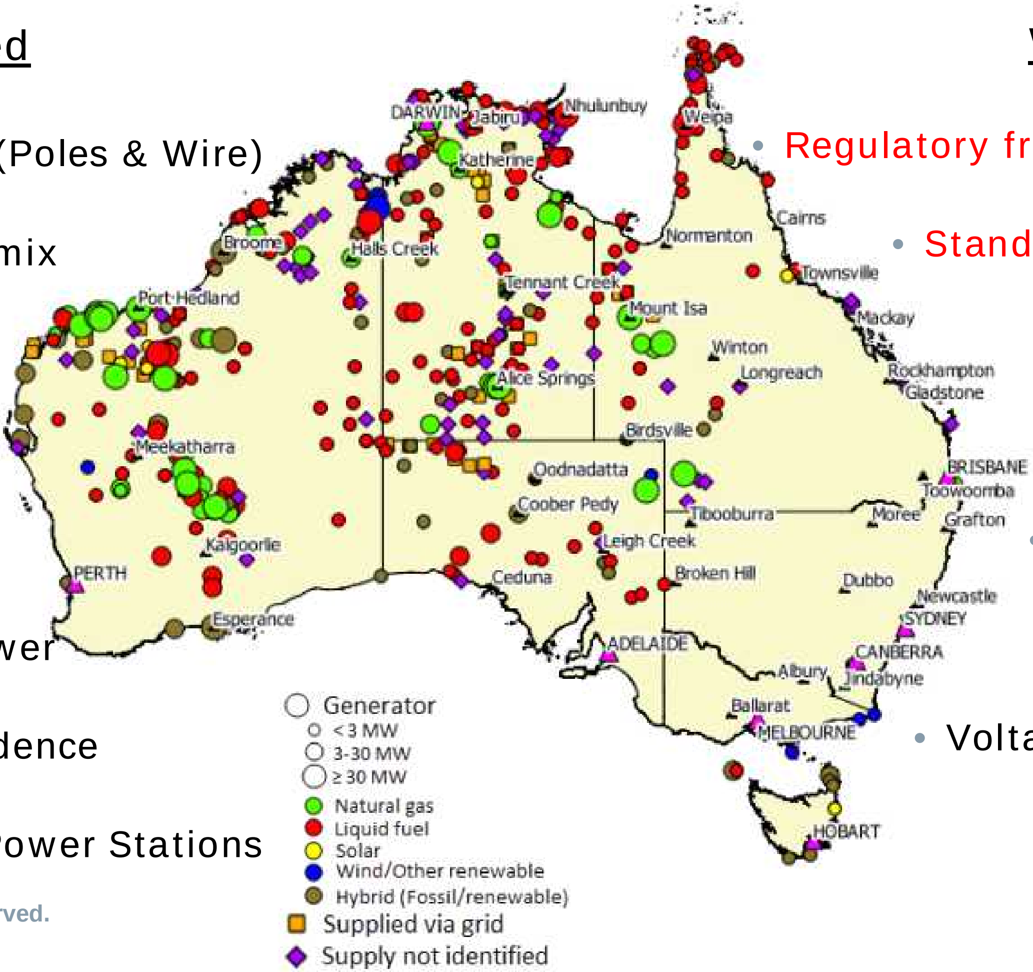
... optimized use of intermittent generation and increased efficiency by combining heat and electricity generation.

... increased stability of supply and grid resilience through on- and off-grid functionality.

... optimized energy management for reduced or better controlled energy costs and CO^2 footprint.

... optimized economic performance of energy system through peak load management and limitation of grid extensions.

OVERVIEW - WHY MICROGRIDS?



What is driving the need

- Cuts in utility spending (Poles & Wire)
- Optimization of energy mix
- Diesel offsetting
- Distributed Generation
- Aging Infrastructure
- More secure reliable power
- Remote power Independence
- Large fossil fuel based Power Stations

What are some of the challenges

- Regulatory framework renewable (feed-in tariffs)
- Standardization – Technical & Commercial
- Positive Business Case ROI
- Power Quality – Volt / Var Control
- Advanced Protection – Fault Levels
- Hosting Capacity – Thermal rating
- Voltage Rise / Drop – Voltage Regulation

OVERVIEW - THE MOST EFFICIENT SOLUTION?

SIEMENS

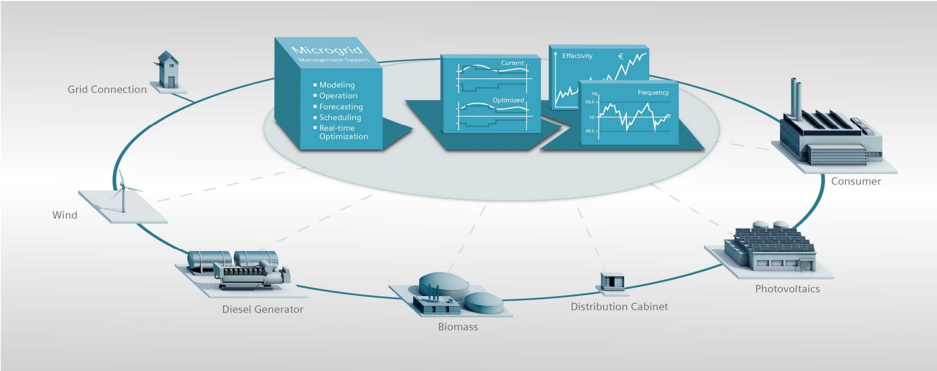
INDEPENDENT GENERATION SETS

?

Enabling Technology

- ✓ Backup diesel generators

MICROGRID SOLUTION



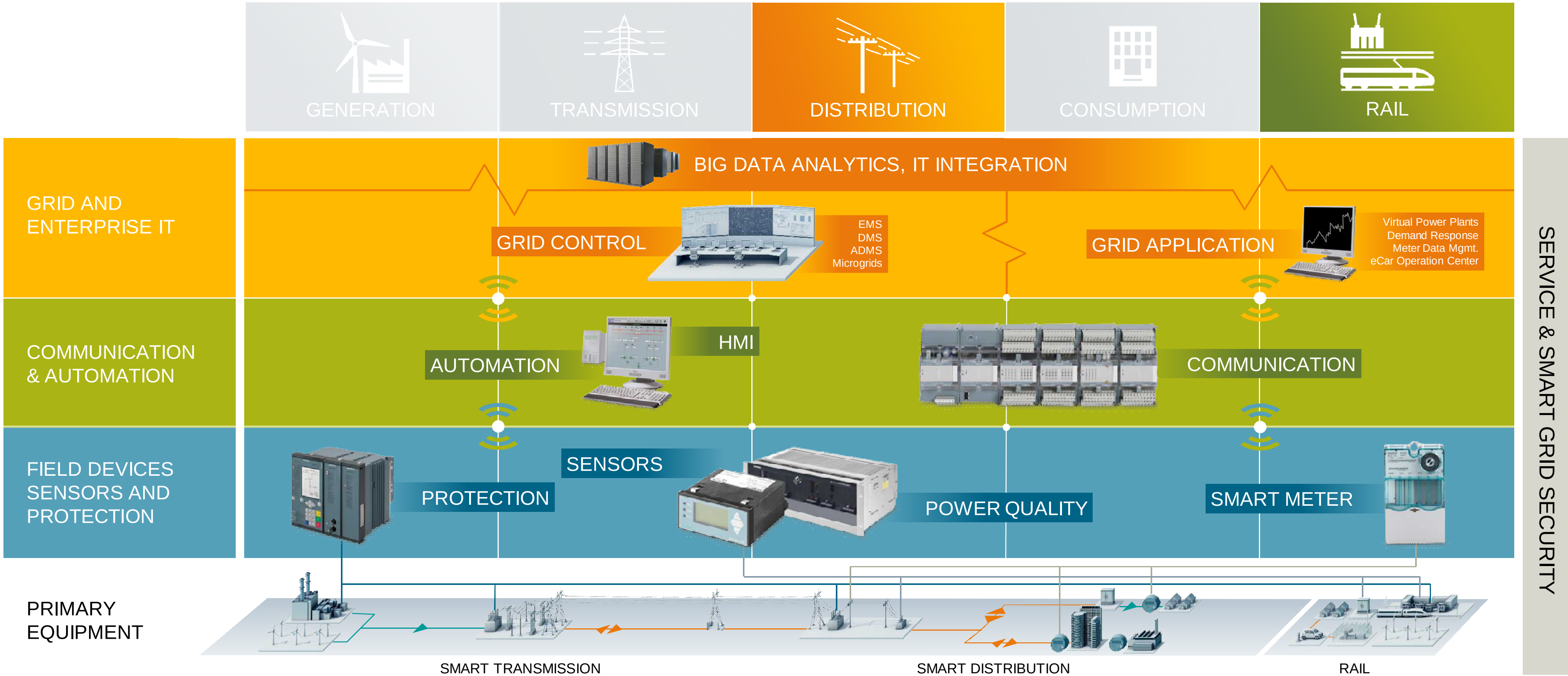
Enabling Technology

- ✓ Distributed Generation (Renewables, Combined Heating Plants, diesel, ...)
- ✓ MicroGrid Manager
- ✓ Storage Systems

OVERVIEW - MICROGRID CUSTOMER SEGEMENTS

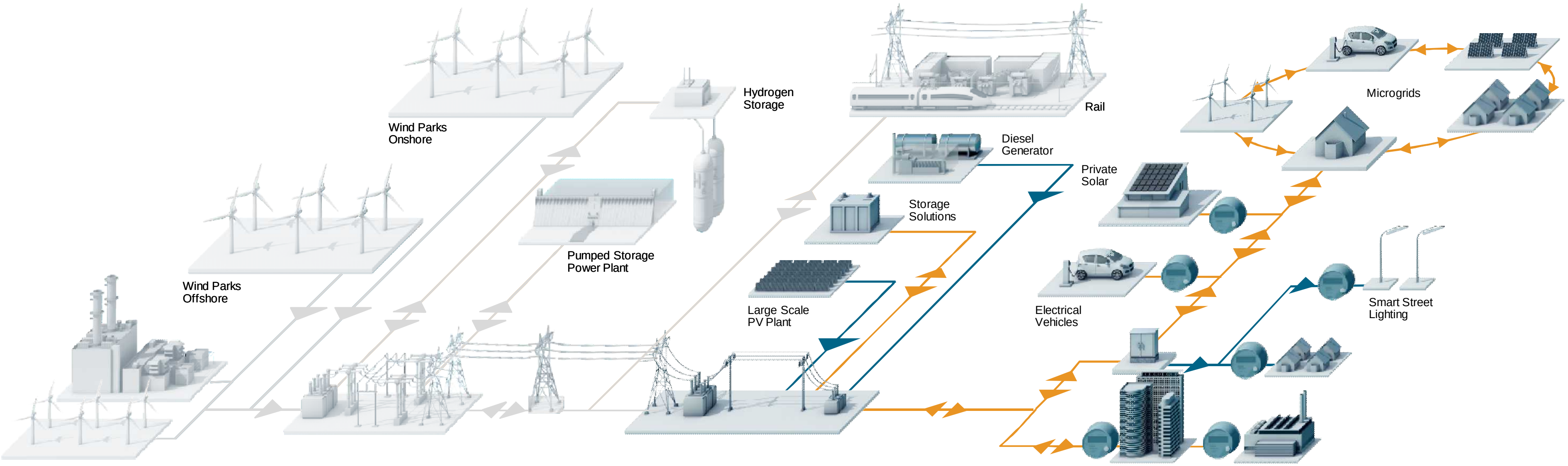
THE SMART GRID / MICROGRID SUIT

SIEMENS



THE MAIN APPLICATION AREA

SIEMENS



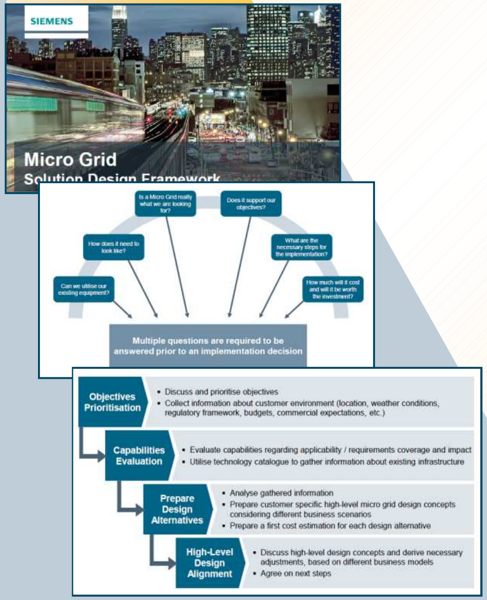
Flexible Power Balancing	Optimal Operational Efficiency	Advanced Fault Management	Management for Isolated Grids
For secure integration of distributed generation, flexible load and storage	For a more reliable supply at reduced operational cost, and optimal asset utilization	For shorter outage restoration times at a reduced cost	For reliable electrification of critical infrastructure and remote areas.

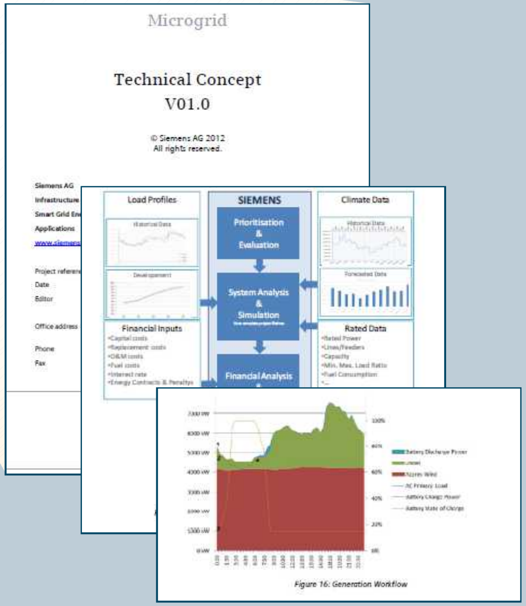
THE MICROGRID DELIVERY MODEL & PORTFOLIO

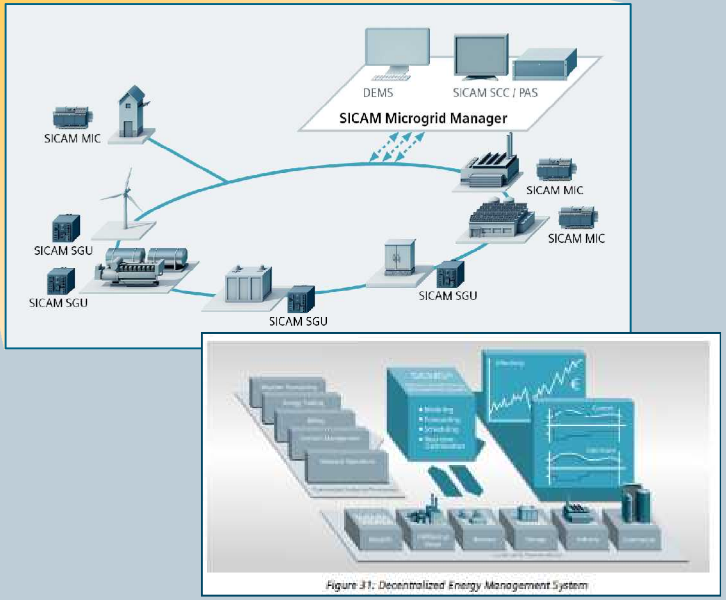
SIEMENS

Components

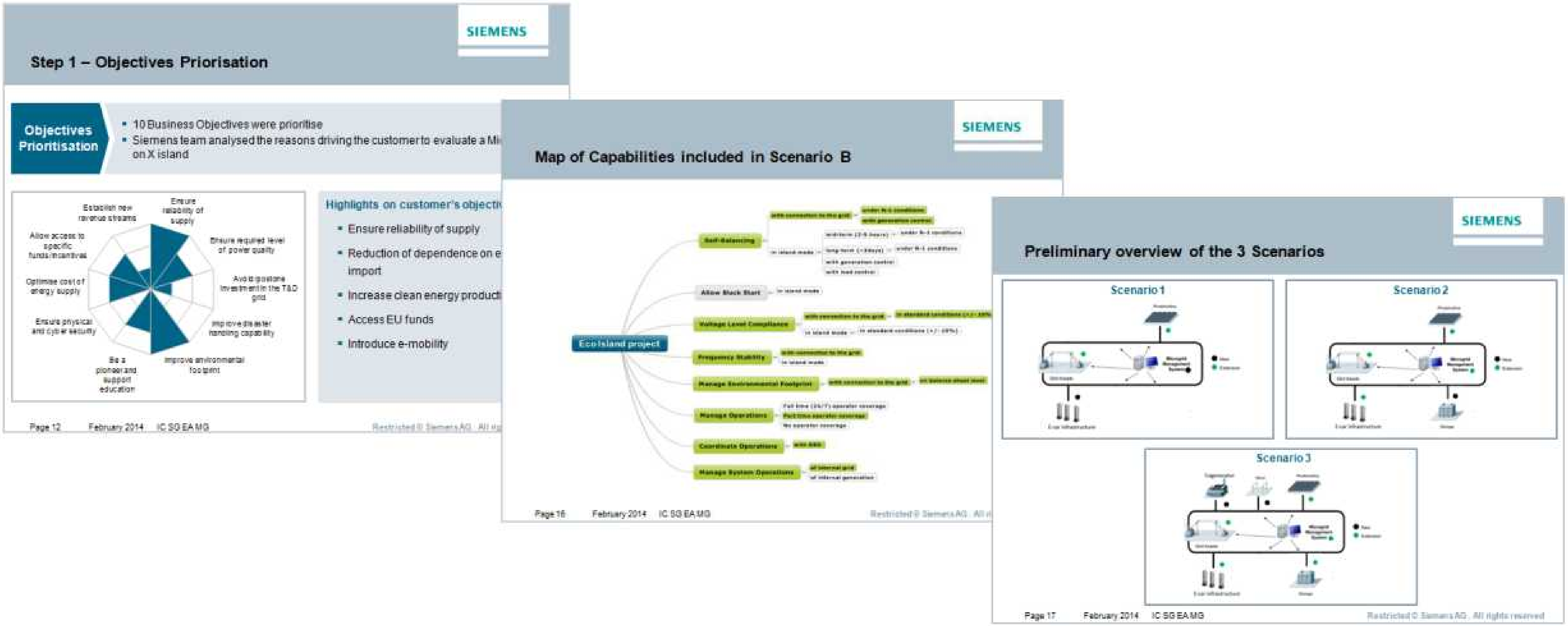
Consulting | Design | Field Level | System level | Comms | Supervisory level | System Integration | - Civil - Mech. - Elec. | Project Management | Operation & Maintenance







SOLUTION DESIGN FRAMEWORK



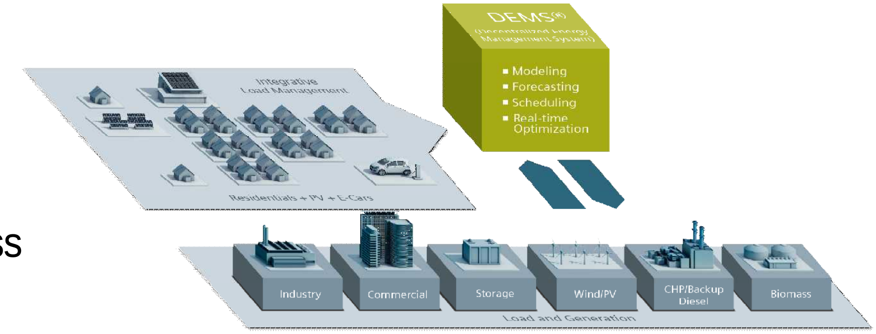
VILLIAGE MICROGRID SYSTEM

SIEMENS

<u>The Village Microgrid is controlled by a MMS</u>

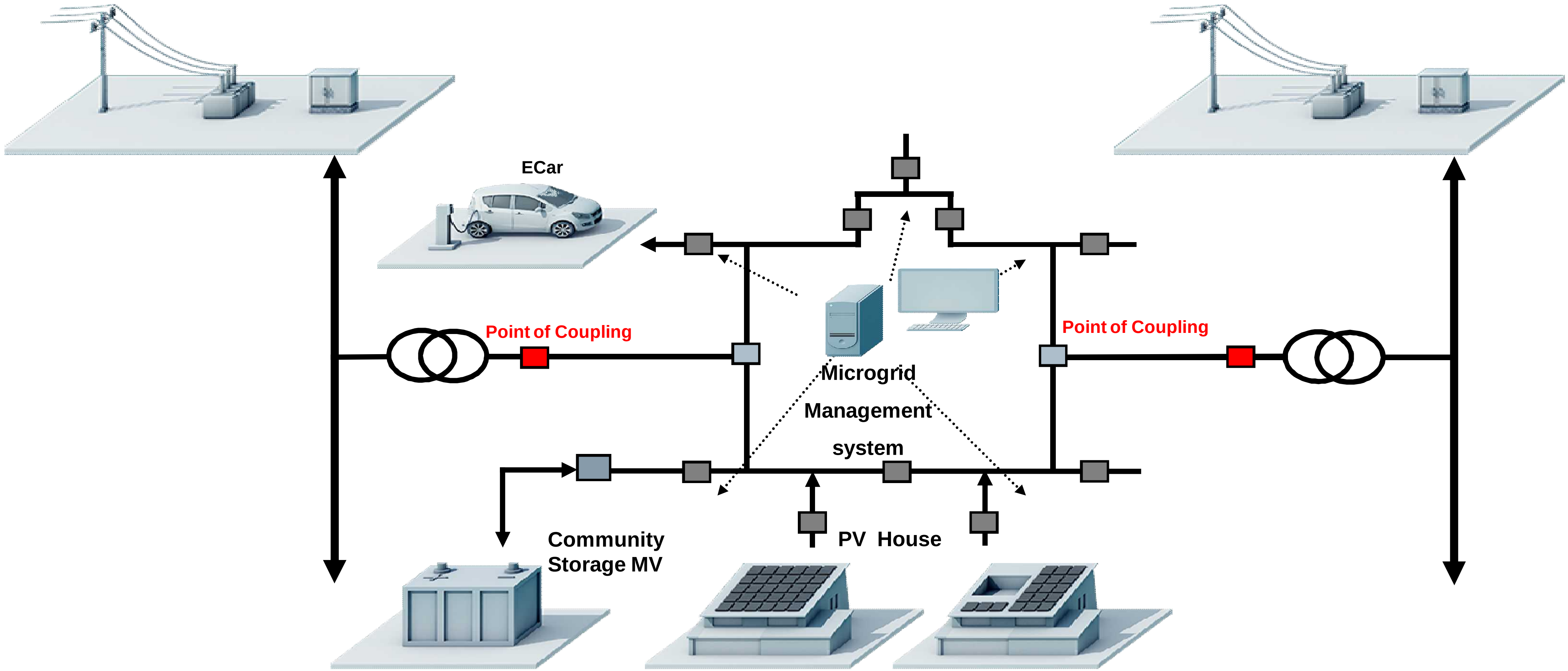
The MMS monitors the energy flow

- From domestic PV as 'excess Gen'
- Charging of eCars
- Charge / discharge Battery storage
- Import / export of energy from Microgrid to the Grid across PoC.
- Balancing the load with the Generation
- Management of battery critical reserve & battery life
- Domestic load control during emergencies.
- Management of essential & non-essential load during island mode
- Protection Setting groups & Reverse Power Protection at PoC
- Data to utility SCADA – DNP3 or other



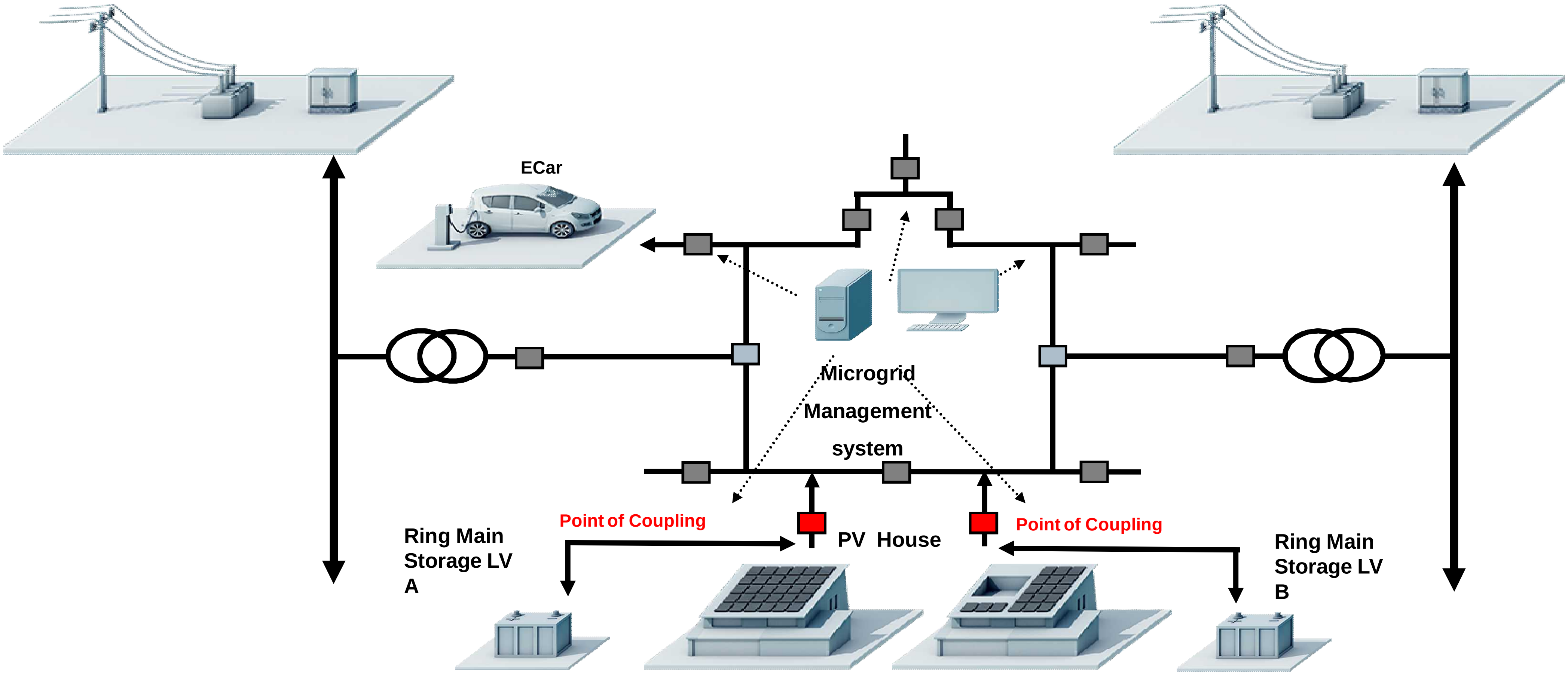
- Modelling
- Forecasting, i.e weather, energy
- Scheduling
- Real-time optimization

VILLIAGE MICROGRID – TYPE 1 – USE MV NETWORK

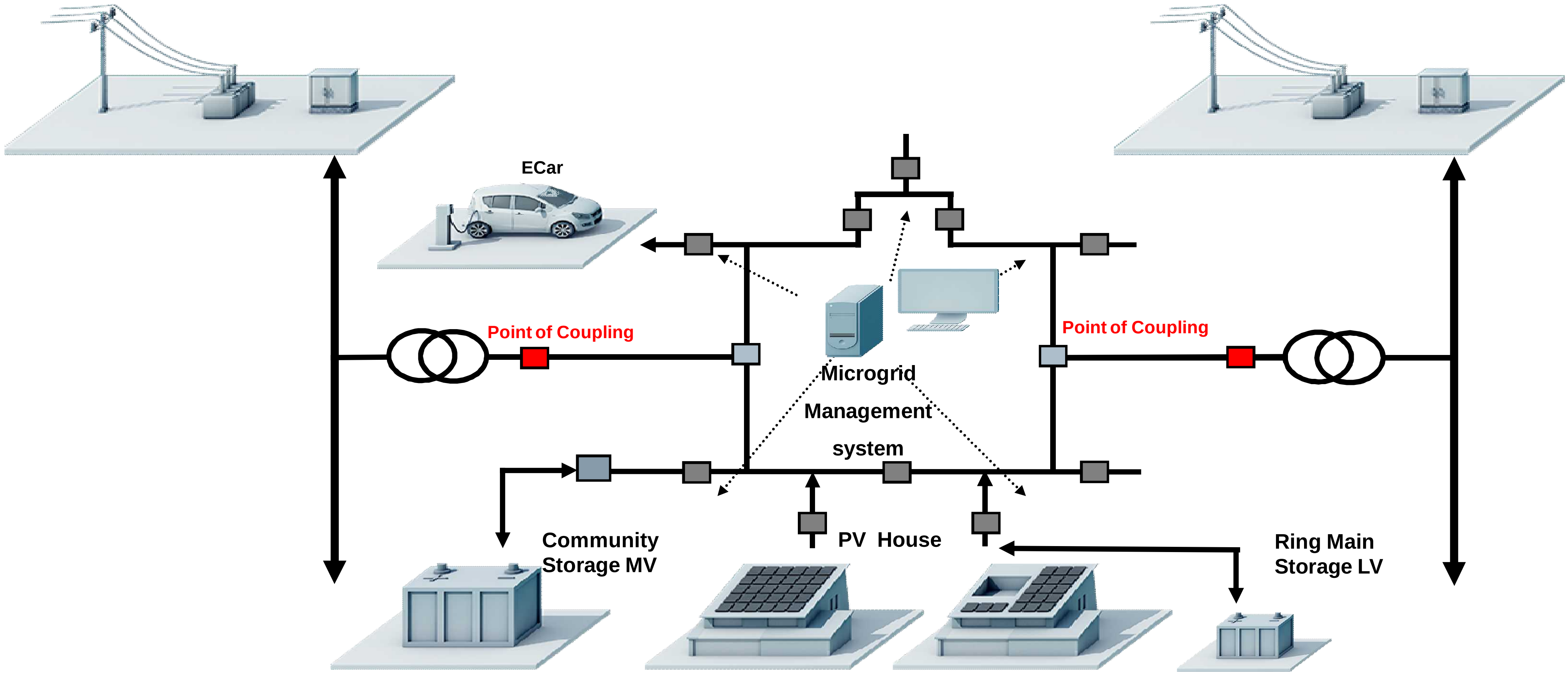


VILLIAGE MICROGRID – TYPE 2 – USE LV NETWORK

SIEMENS



VILLIAGE MICROGRID – TYPE 1 – USE MV & LV NETWORK



ENERGY STORAGE GENERAL OVERVIEW

SIEMENS

The optimum combination of power electronics and storage system based on Li-ion batteries provides power in milliseconds for:

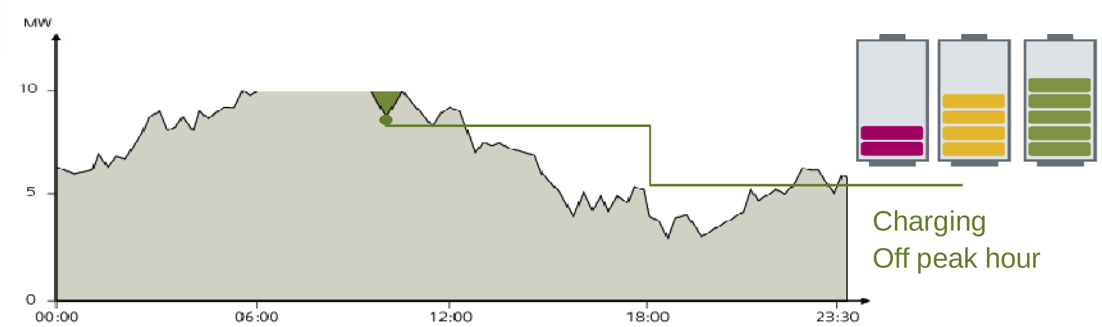
- Sufficient available balancing power
- Additional spinning reserve
- Active and reactive power control
- Uniformly distributed network load
- Adequate short-circuit power
- Black start

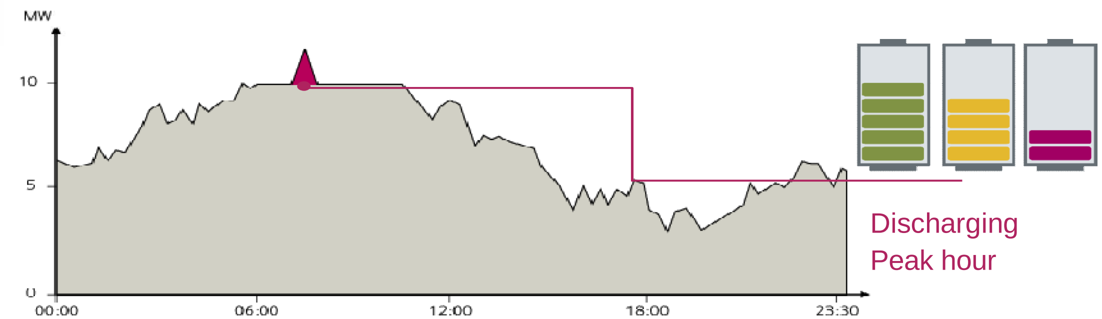
On the AC side with SIESTORAGE

- Parallel connection of the inverters on the AC-side:
  No synchronization between the battery cabinets
- Very high redundancy (single point of failure has no influence on the availability of the storage system)
- High availability and power reliability
- Individual balancing of battery cabinets
- Best use of the available energy content and installed battery capacity with lowest maintenance

APPLICATION EXAMPLE: PEAK LOAD MANAGEMENT

SIEMENS





Challenges

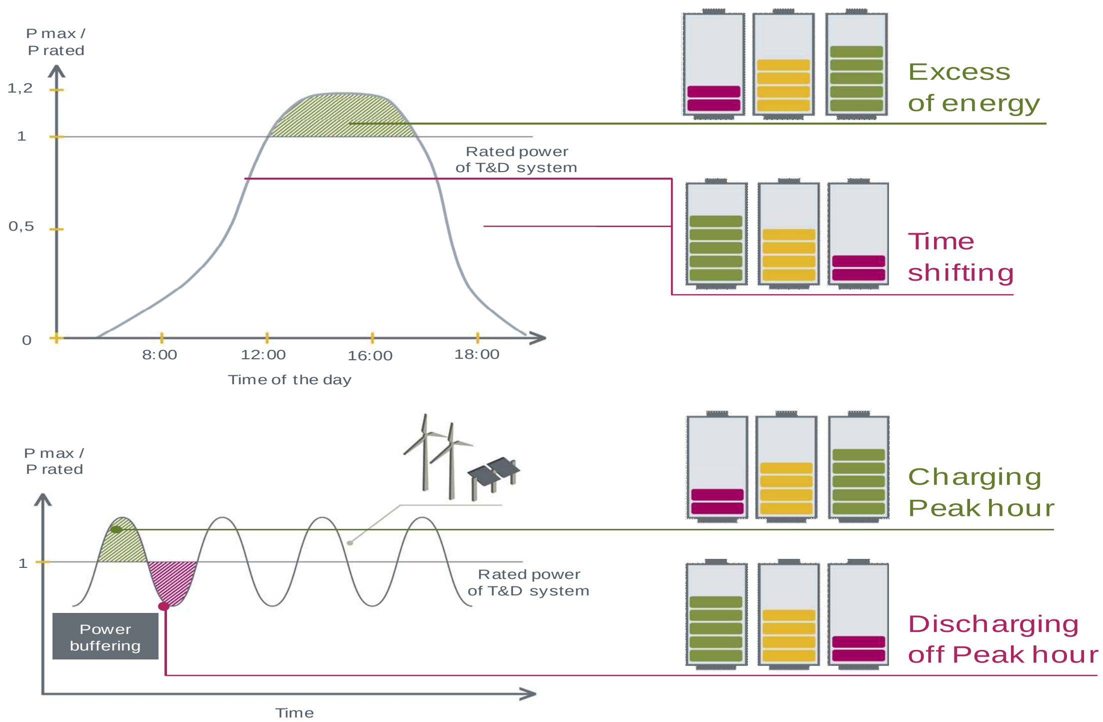
- The need for continuous available power (Industry, network operators…)
- Volatile load curve (production peaks, time shifting…)
- Need to prevent expensive peak loads (required by the supplying utility)
- Limits of the power capacity (regulation of permitted peak loads)

Solution and benefits

- Avoiding of the major surcharge for peak power (batch processing)
- Contract of power supply with lower feedback rates
- Protection of the components (transformers, cables…) and related cost saving
- Availability of power supply 24/7 for continuous operation

APPLICATION EXAMPLE: T&D DEFERRAL (GRID RELIEF)

SIEMENS



Challenges

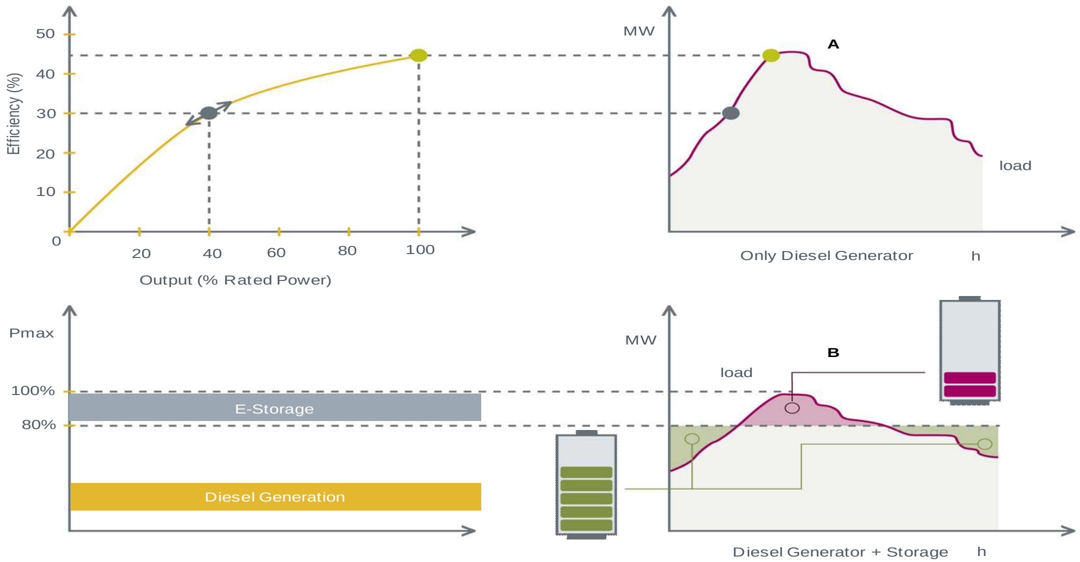
- Volatile infeed from PV or wind generation
- Overload capacity of the power plants at certain times
- Loss of power generated by PV or wind power plant
- Grid components are not designed for distributed generation: Extending the Grid capacity may be necessary

Solution and benefits

- Power buffering: SIESTORAGE recognizes the unplanned peak load and provides the available energy at off-peak times (low-load periods)
- Avoids bottlenecks in the grid
- Protection of the grid's LV and MV components
- No expensive grid extensions, reduced approval procedures associated costs
- Additional power buffering for fast charging stations (e.g. e-car)

APPLICATION EXAMPLE: OFFSET DIESEL

SIEMENS



Challenges

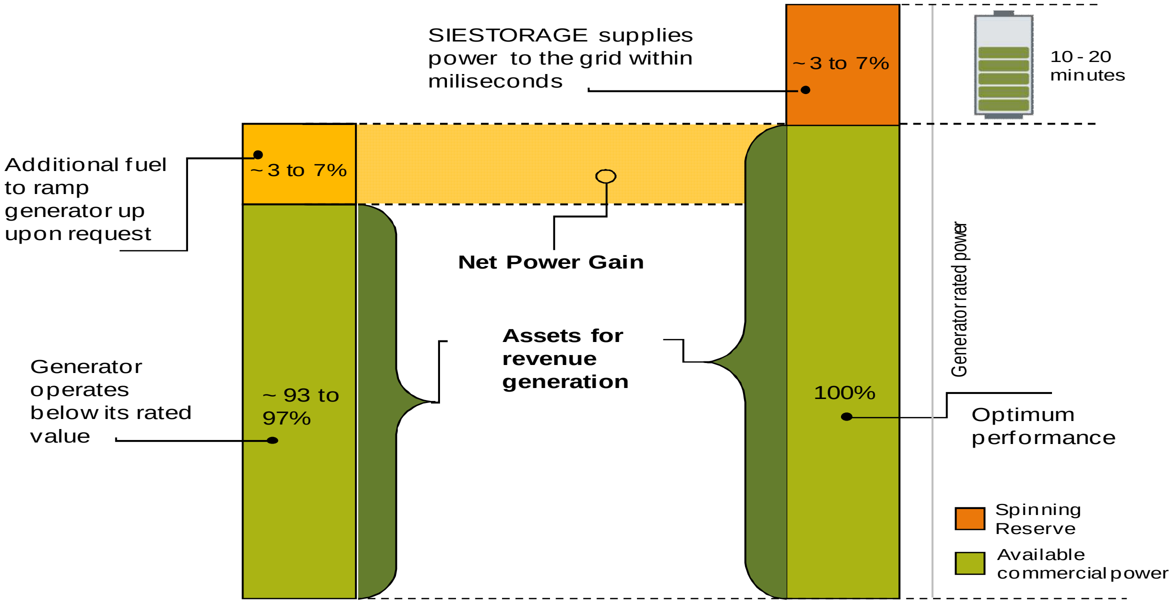
- Grids supplied only by diesel generators (island grids, isolated grids, microgrids)
- Volatile load curve of supplied areas due to integration of renewables
- No regulatory power to improve efficiency
- High diesel prices
- Large diesel generators influence the environmental footprint (high fuel consumption and gas emissions)

Solution and benefits

- Optimize generator size / capacity (SIESTORAGE as a “range-extender” for smaller generators for operating during periods of increased load
- Switch off at lower loads
- Improved Generator fuel efficiency
- Reduced generator run time
- Reduced gas emissions

APPLICATION EXAMPLE: SPINNING RESERVE

SIEMENS



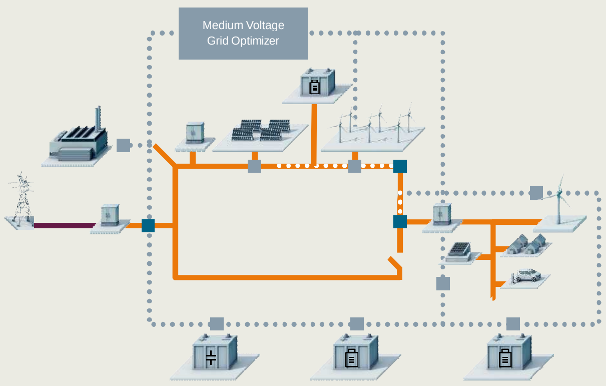
Challenges

- Power plant capacity is not always sufficient to cover the peak power demand requirements
- Spinning reserve is required to maintain the system frequency (regulation)
- Generator operates below its rated capacity (non-optimal operation) during off peak times
- Additional fuel is necessary to ramp generator up upon request (incremental emissions and fuel consumption)
- and gas emissions)

Solution and benefits

- Energy storage has the means to provide additional power to power plant operators if required
- Increased system stability, SIESTORAGE supplies power to the grid within milliseconds
- Increased availability of standby power
- Revenue stream, selling reserve power to the grid

NORTHERN POWER GRID (NPG) – GRAND UNIFIED SCHEME



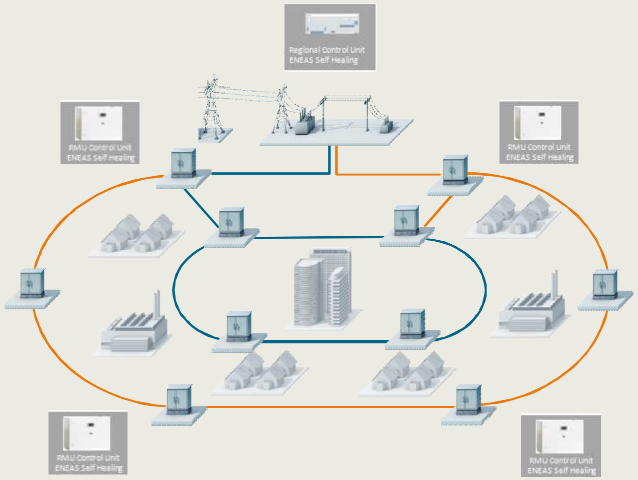
Project partner: Northern Power Grid
Country: United Kingdom

Challenge
- Integration of renewable sources push the existing distribution network to it's boundaries by causing
  - Voltage violations
  - Thermal overload of primary equipment

Solution
- Multi-level hierarchical solution incorporating a central Application system with a data warehouse and an autonomous substation controller using a wide area communications system
- The Grand Unified Scheme (GUS) brings together battery storage, enhanced voltage control, demand response and real-time thermal rating in closed loop for optimal grid operation

Benefits
- Integrated Multi-level hierarchical solution
- Cost reduction and accelerated delivery by using a combination of network technologies and flexible customer response

STEDIN – “SELF HEALING GRID”



An example configuration

Project partner: Stedin
Country: Netherlands

Challenge

- Reduce SAIDI (System Average Interruption Duration Index) in Medium Voltage Grid significantly in order to avoid contractual penalties

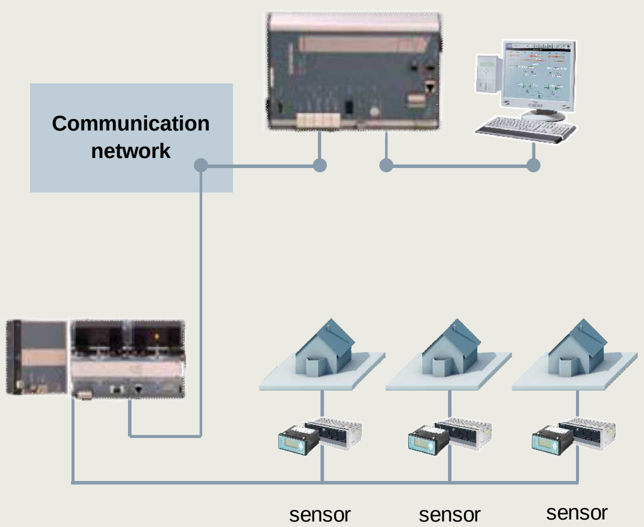
Solution

- Self Healing Grid application is placed at Regional Controller in primary station:
  - Components:
    1x Central Regional Controller on SICAM TM
    6x Decentralized RMU Automation on SICAM emic
  - Application:
    Regional Controller indicates the current status and automate the service restoration and indicates the decision to the control center

Benefits

- Re-supply as many customers as possible within less than 1 min
- Quickly localization and de-energization of downed wires
- Faster restoration will reduce the impact to “life-support” systems

STRADTWERKE KREFELD – “A TRANSPARENT GRID”



Project partner: Stadtwerke Krefeld
Country: Germany

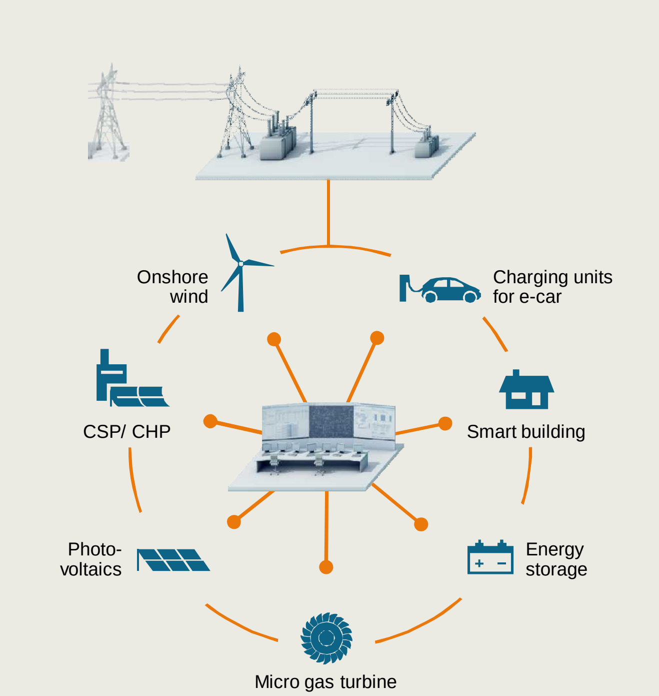
Challenge
- Reconstruction of energy infrastructure due to the take over of network concession
- Public intention and readiness to build up the Image of the City of Wachtendonk as an ecological city
- Target to build up a smart grid for the supply area of Wachtendonk

Solution
- Build up an intelligence for secondary transformer substations with the target to coordinate the control of voltage regulators Transfer of short-circuit indicator information, U/I measurements, and power-quality meter information
- Power snapshot analysis with smart metering and PLC communication to get information about the distribution network

Benefits
- From blind spot to full visibility in secondary distribution networks
- Handle a high an volatile infeed by renewable power generation at lowest costs
- Flexibility to increase the reliability in the distribution grid and to better serve customers

UNIVERSITY OF GENOA - MICROGRID USING RENEWABLES

SIEMENS



Project partner: University of Genoa
Country: Italy

Challenge

- Turn Savona campus into a Smart Polygeneration Microgrid
- Different types of generation has to be combined
- Pilot project to demonstrate independent grids (island grids)
- First Microgrid in Italy

Solution

- Siemens DEMS application for optimization of university microgrid, managing renewable and traditional power generation, electric storage and integrating an e-car operation center

Benefits

- Minimization of energy cost
- Reduction of CO_2 emissions
- Provide special services at grid connection point

SIEMENS

CONCLUSION

MicroGrids are a key solution to addressing the current energy challenges within the Australian market.

Reduced spend on large Non Renewable Base Load Power Stations, Overhead Lines, Substations and Transformers will lead to there being more reliance on small distributed generation.

Australia has an abundant renewable energy resource, wind, solar, hydro, etc, this can be used to reduce CO^2 emissions and reduce energy production lifecycle costs, diesel offset, peaks, etc.

The technology to fulfill most if not all the MicroGrid requirements today is readily available and is being successfully deployed worldwide and locally.

The biggest concern is the business case and the regulatory framework under which MicroGrids could effectively operate in Australia.