October 22, 2013

CIGRE Grid of The Future Symposium

Solutions for Smart Transmission Panel Session

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Power and productivity for a better world™

Smarter Grids – Integration of OT and IT

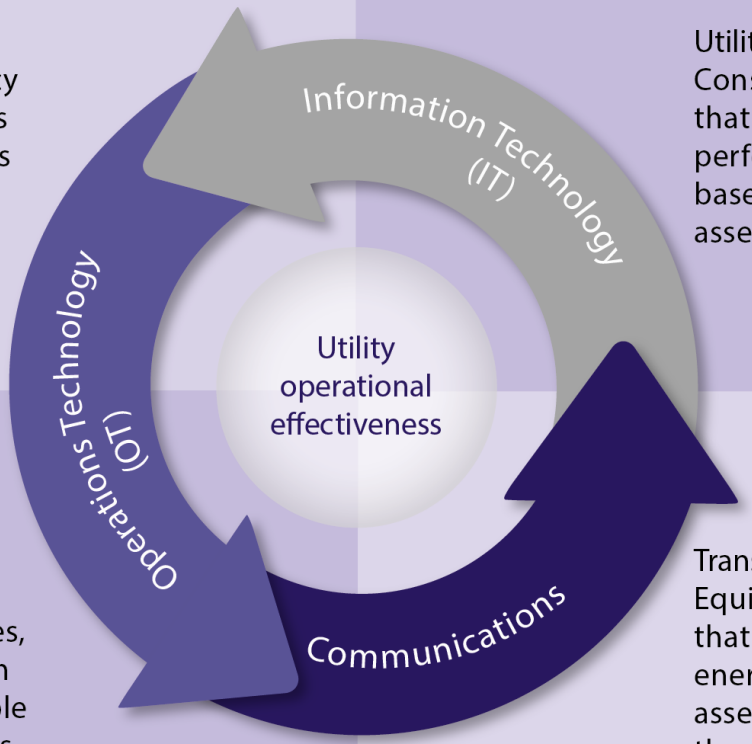
Smart grid investment for improved operational effectiveness
ABB smart grid solutions help control costs and meet consumer demand with fewer resources

Distribution grid management
Increase reliability and efficiency while reducing operations costs through better communications and control

Distribution

Utility analytics
Consumer and grid analytics that improve operational performance and condition-based maintenance to improve asset life-cycle management

Analytics



DERs

Distributed energy resources
Enable groundbreaking operational flexibility for utilities, providing utility customers with lower costs and more sustainable electricity-consumption options

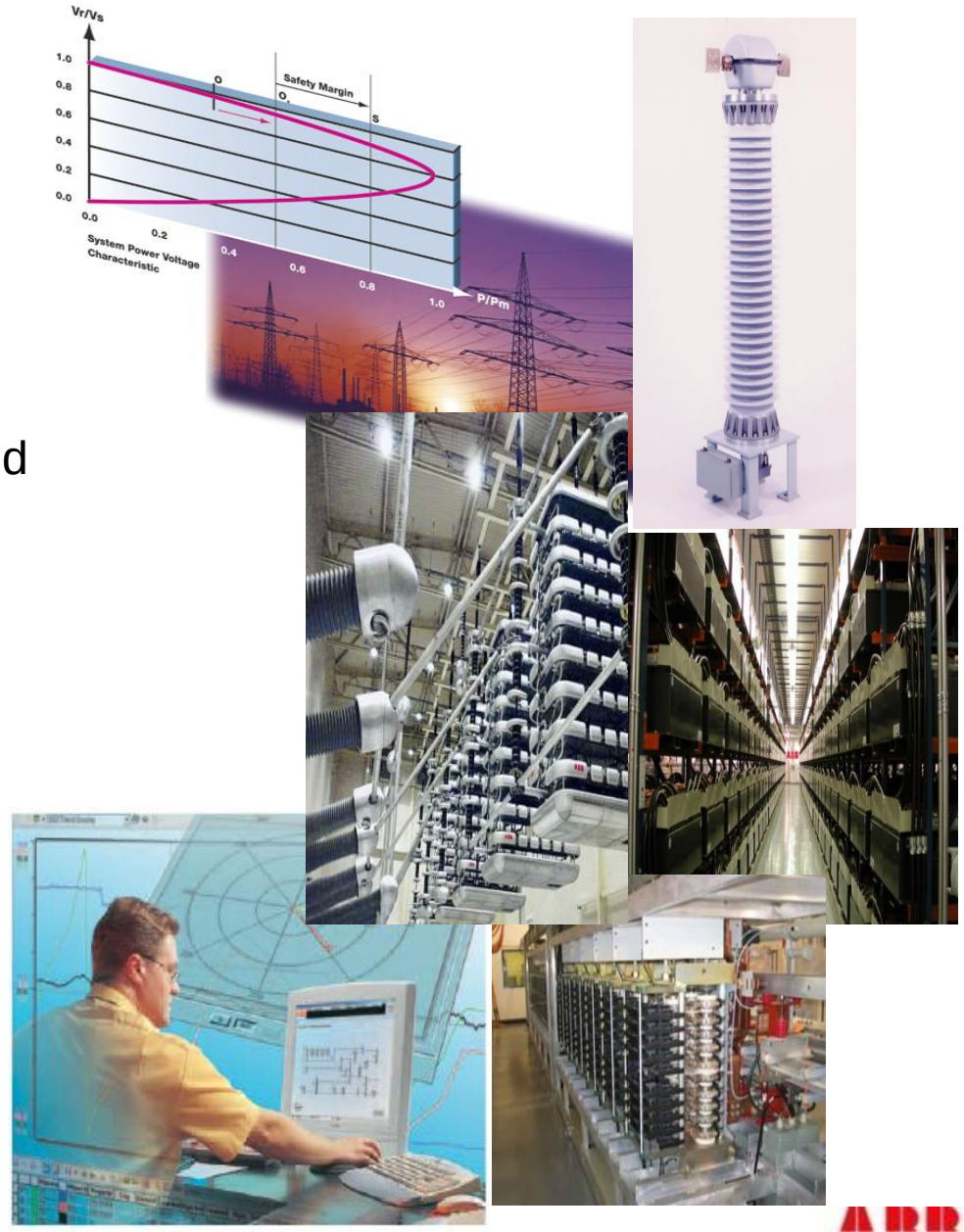
Transmission

Transmission grid management
Equipment, process and tools that interconnect renewable energy sources to legacy grid assets from transmission through distribution

The convergence of operations technology (OT) and information technology (IT) integrates enterprise-level IT applications with grid systems and equipment, elevating overall system performance.

Smart Transmission

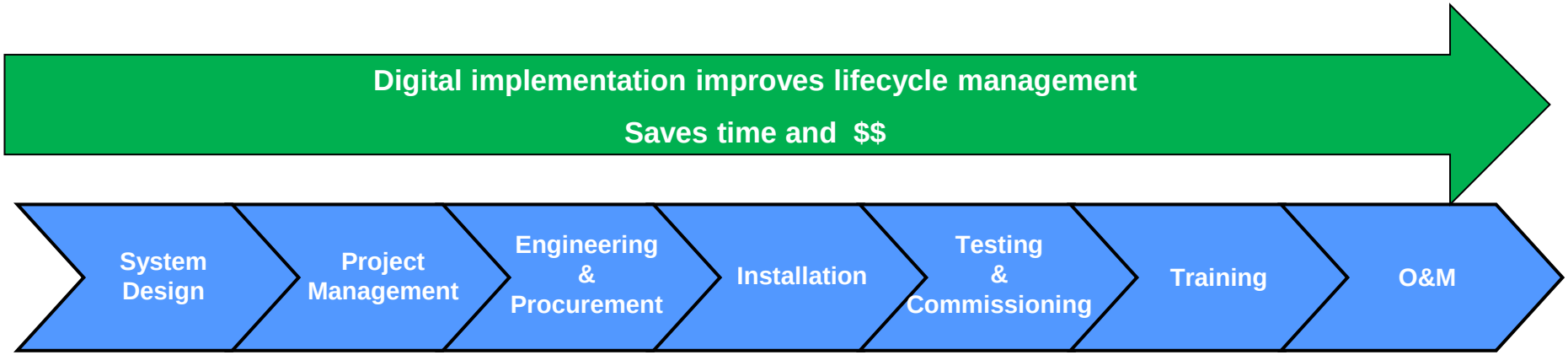
- Digital Substations
- Asset Health Management
- Phasor Measurement Units and Wide-Area Monitoring
- HVDC
- FACTS – SVCs and Series Capacitors
- Utility Scale Energy Storage
- SCADA/EMS



The Digital Substation
Simplicity improves efficiency and reliability

Electronic configuration of substations reduces engineering, installation and commissioning time

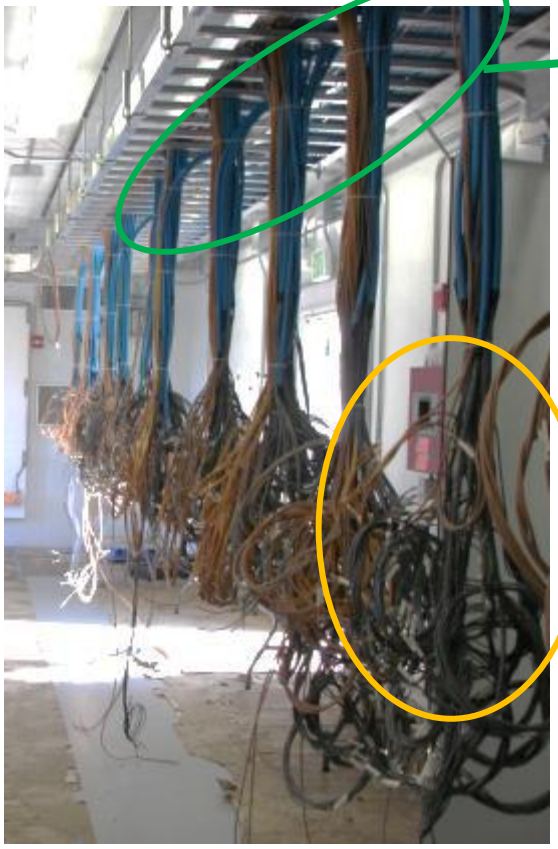
- Significant reduction in configuration time up to 75%
- Reductions in configuration errors (error check mechanisms in software tools)
- Open standard information model facilitates testing and maintenance
- Self-monitoring, remote diagnostics, and reporting capability of all devices
- Enhanced safety and functional consolidation



Enhanced Safety
Reducing the risks in the control house

Digital substation reduces complexity with wiring and reduces risk for Operations & Maintenance personnel in the control house

Before



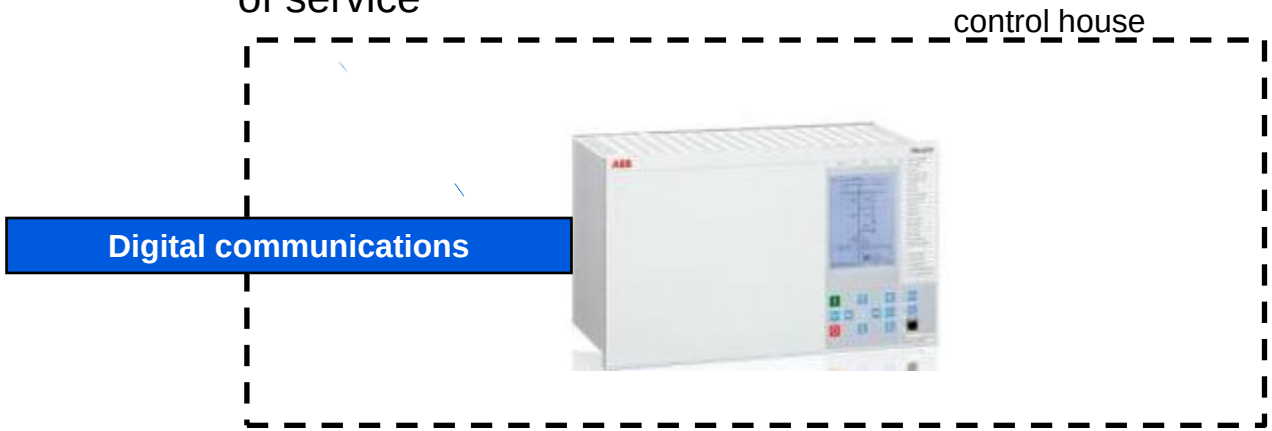
After

No cable tray

Single conduit to carry fibers

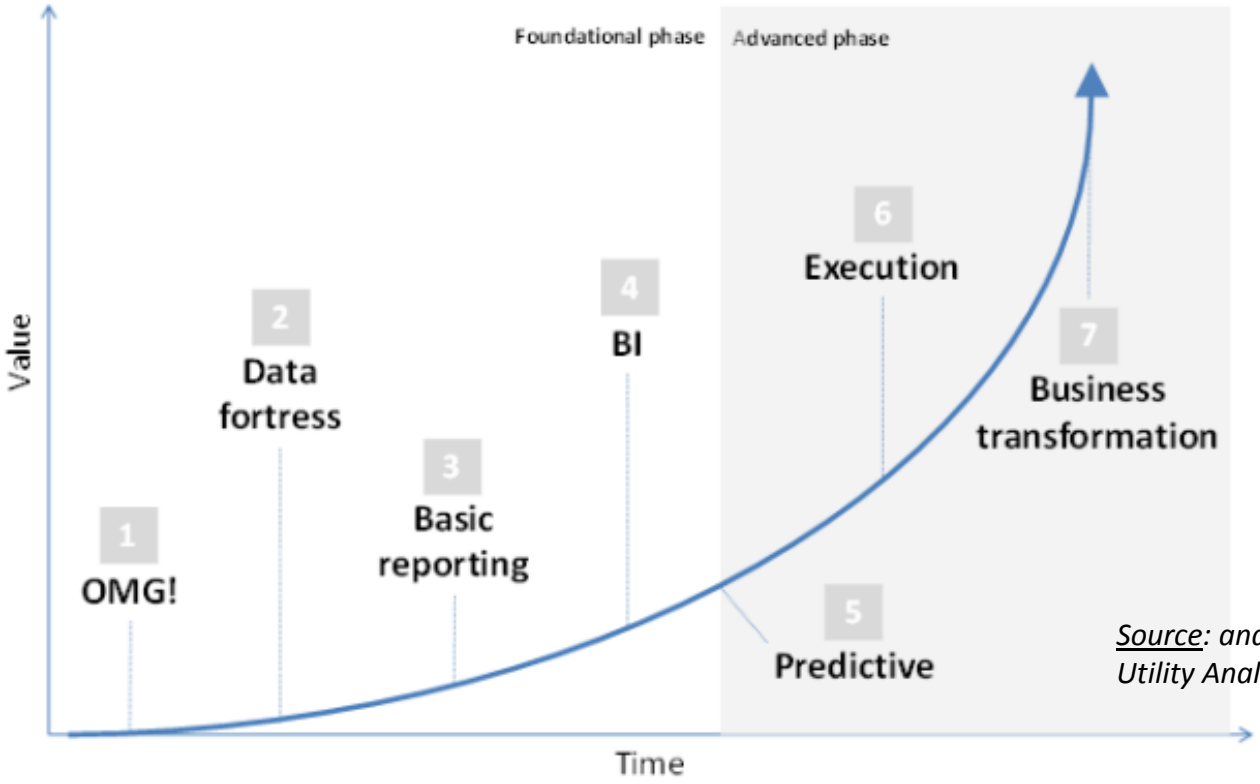
Substation Asset Monitoring

- Reduce risk of injury when conventional Instrument Transformers, voltage and current signals are connected to a digital interface at the primary equipment safely away from control room maintenance personnel
- Safely replace relays without taking the substation out of service



Increased safety and reduced risk of personnel injury in the control house

Predicting Future Problems



Source: analytics value curve from the Utility Analytics Institute

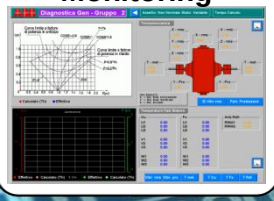
- Analytics uses past data to forecast, predict, and optimize
- Anticipating future problems improves decision-making
- Five Vs of big data: Volume, Variation, Velocity, Verasity >>> Value

Algorithm and Design Improvement

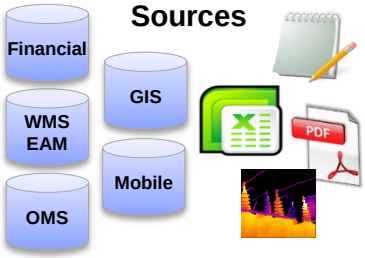
Solution Approach – Actionable Intelligence

Historian

Condition Monitoring

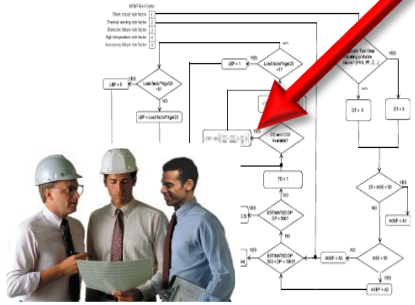


Enterprise Data Sources



Data Processing and Analytics

Subject Matter Experts



Advanced Operational BI

Actionable Intelligence

Complete Information
Fleet to Equipment Health
Actionable Notifications
Optimization & Planning

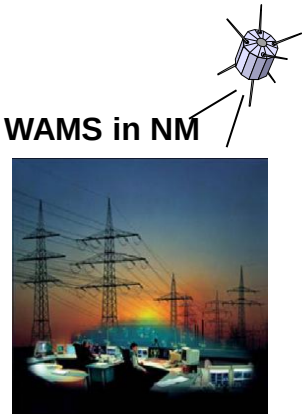
Enterprise Asset and Work Management

WAMS Applications

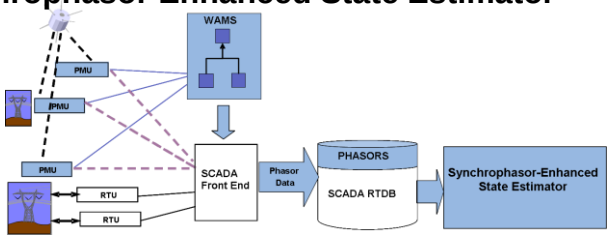
- PMU-assisted State Estimation
- Power Oscillation Monitoring (POM)
- Voltage Stability Monitoring (VSM)
- Phase Angle Monitoring (PAM)
- Line Thermal Monitoring (LTM)
- Event-driven Data Archiving (EDDA)
- User-defined Signal Processing

RES670

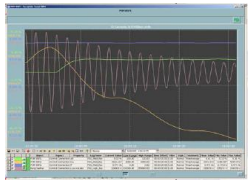
WAMS in NM



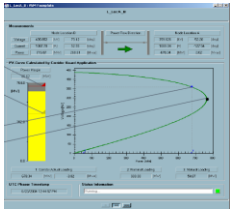
Synchrophasor Enhanced State Estimator



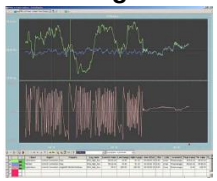
Oscillations Monitoring



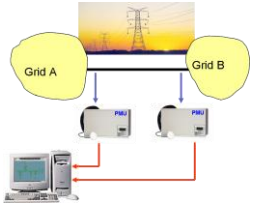
Corridor Voltage Stability Monitoring



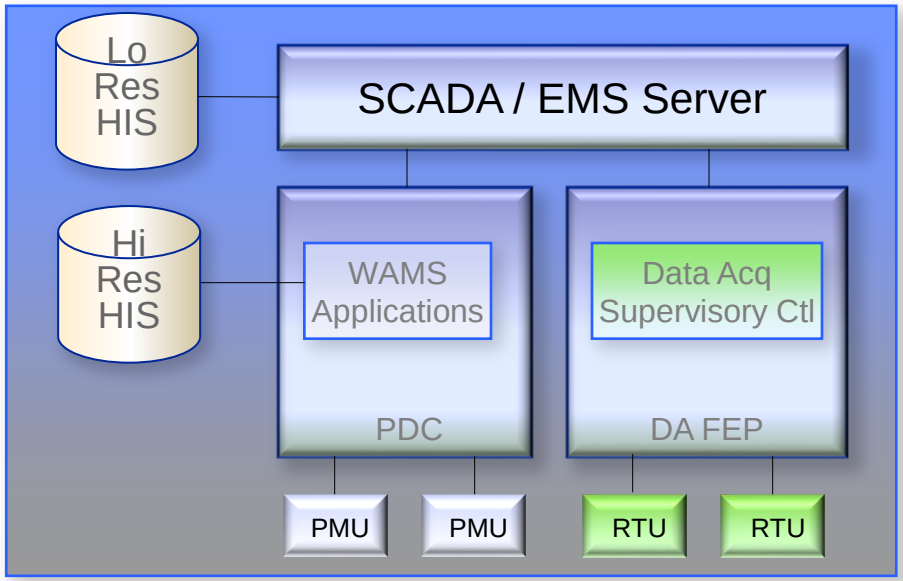
Phase Angle Monitoring



Line Thermal Monitoring



WAMS integrated with SCADA/EMS



- Phasor Measurement Units
- Phasor Data Concentrator (PDC)
  - PDC is integrated with SCADA/EMS
- Hierarchical system design – flexible and redundant
- PDC handles PMU scanning and data synchronization
- WAMS Applications may be deployed on PDC or SCADA/EMS server
- Existing PMU data can be used for analysis, reporting and archive
- Powerful fault analysis tools for engineers
- SCADA, WAMS, and TFR data are always synchronized

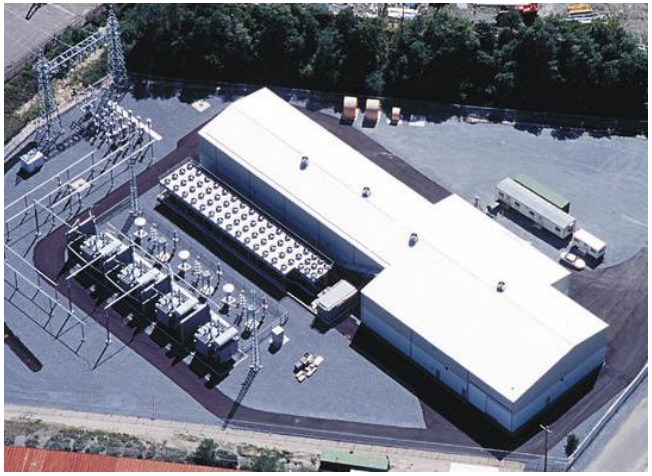
HVDC Technologies

600 MW
200 x 120 x 22 m
6 acres
73 feet high

HVDC Classic: 300 – 6,400 MW

- Thyristor controlled
- Switched reactive power control
- Typical design: valve building plus switchyard
- Overhead lines or mass impregnated cables

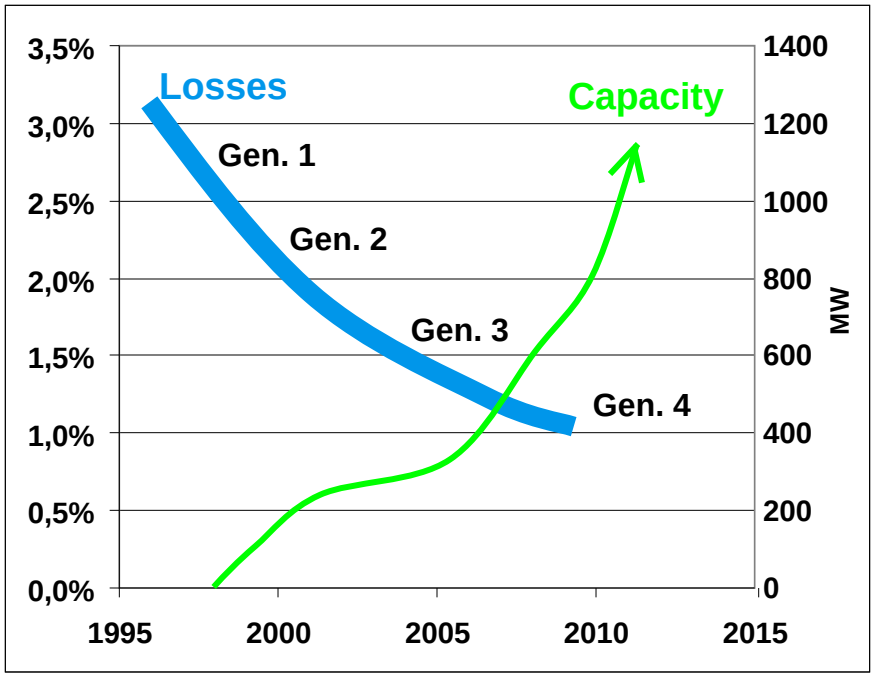
550 MW
120 x 50 x 11 m
1.5 acre
36 feet high



HVDC Light: 50 – 1,200 MW

- Transistor (IGBT) controlled
- Continuous reactive power control
- Easily expandable to more terminals
- Dynamic voltage regulation
- Black start capability
- Typical design: all equipment (excluding transformers) in compact building
- Extruded cables

Voltage Source Converter technology break throughs



- Losses in the level of classic HVDC
- Only solution for offshore
- VSC properties that grid operators value
  - Net stability
  - Black-start capability
  - Compactness
  - DC grid enabled

FACTS – Flexible AC Transmission Systems
Two Main Areas

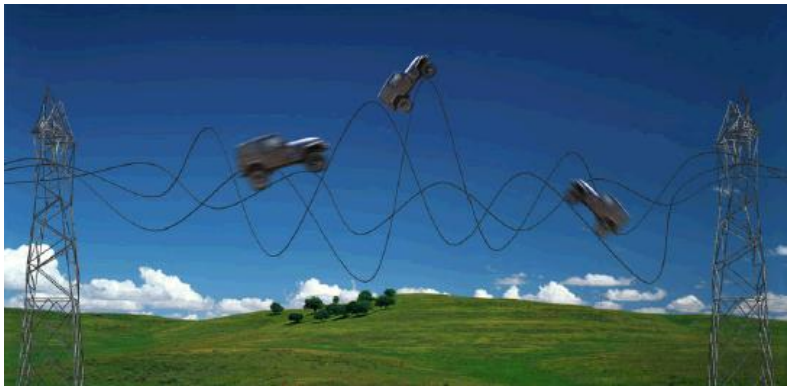
Shunt Compensation

- SVC
- STATCOM (SVC Light)
- DynaPeaQ BESS

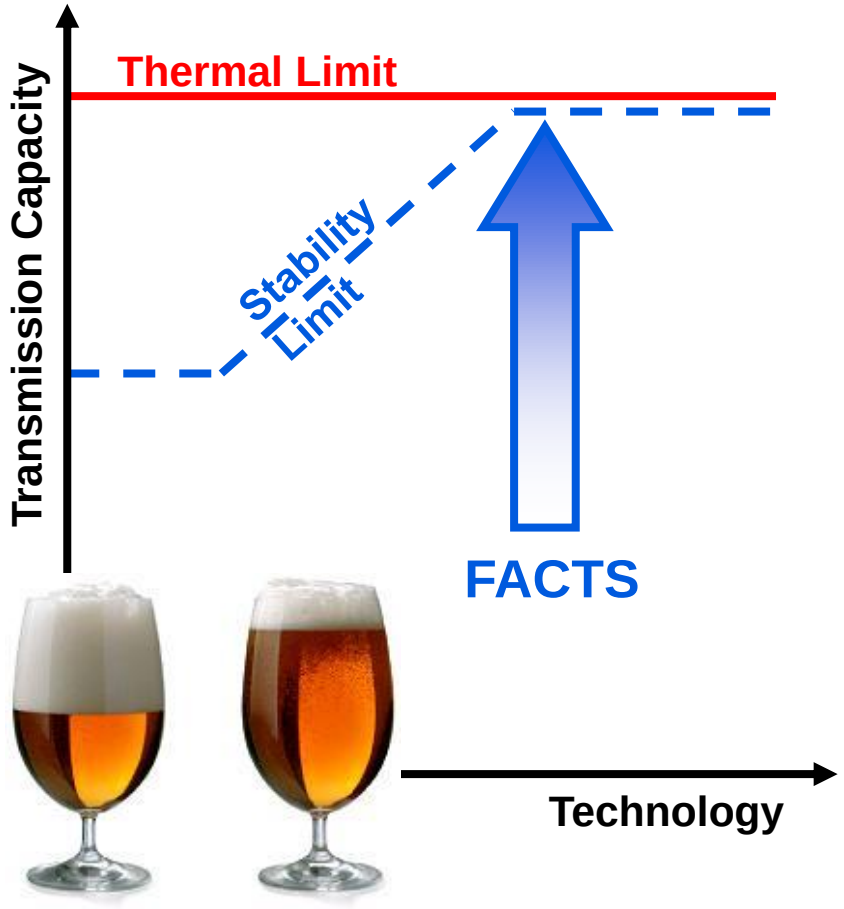
Series Compensation
Fixed (SC)
Controllable (TCSC)
230-765 kV

ABB FACTS
FACTS – Transmission under Optimized Conditions

WITHOUT FACTS



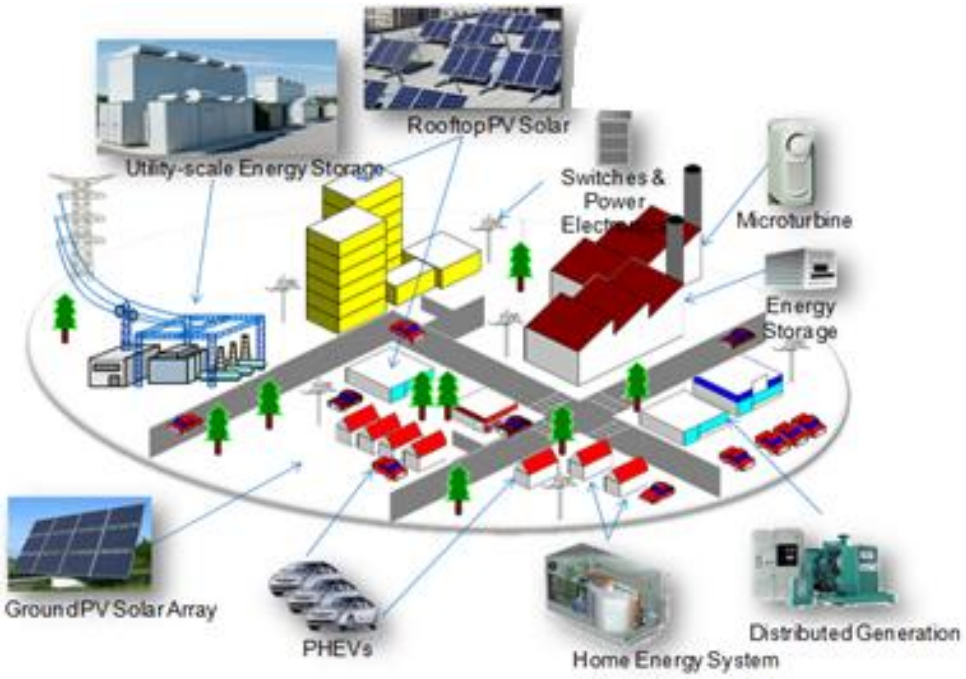
WITH FACTS



Microgrids

Microgrid Definition

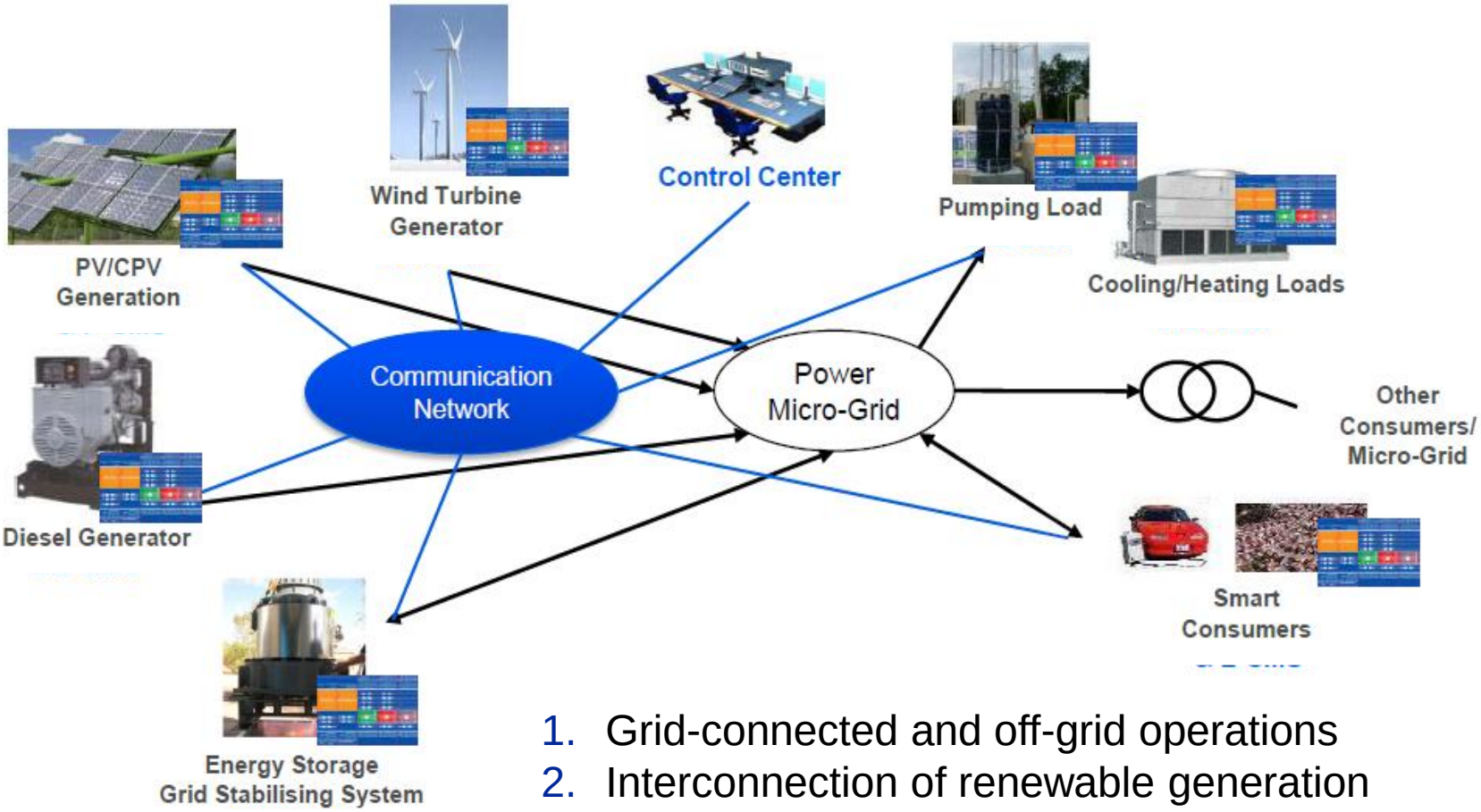
A microgrid is an integrated energy system consisting of interconnected loads and distributed energy resources which, as an integrated system, can operate either in parallel to or "islanded" from the existing utility power grid.



Microgrid Applications

- Microgrids can range widely in size, source of electricity, heating and cooling, etc.
- Given this diversity and versatility, it is virtually impossible to map out a "typical" microgrid configuration
- End-use applications being developed today:
  - Institutional/campus microgrids
  - Data center microgrids
  - Military base microgrids
  - Community microgrids (private investment)
  - Remote "off-grid" microgrids
  - Microgrids for integration of renewable generation

Microgrid technologies – grid resiliency



1. Grid-connected and off-grid operations
2. Interconnection of renewable generation
3. Islanded operations during storm response

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