Microgrid as a tool for reliability and resiliency

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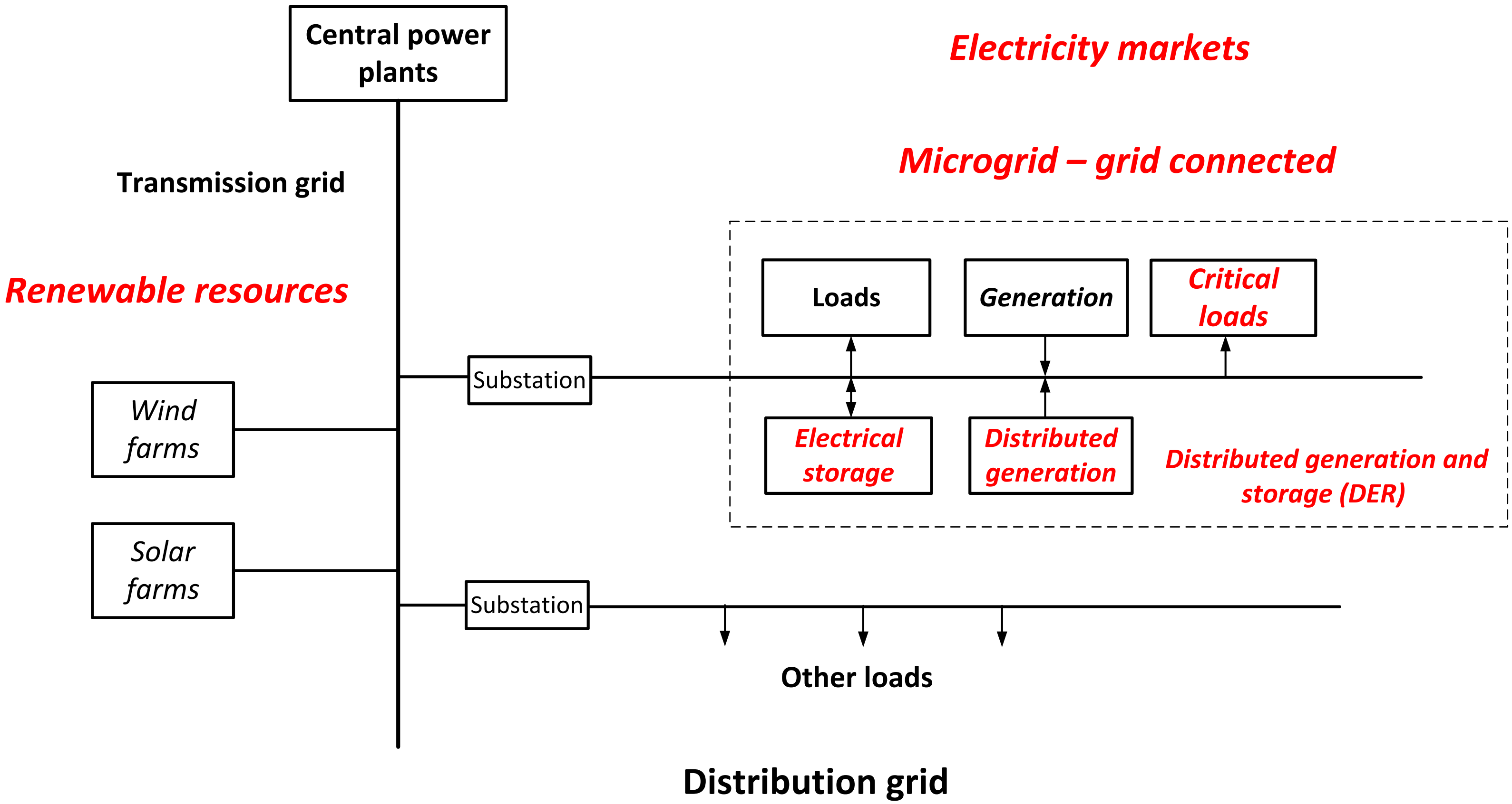
Session 5 - Planning for Reliability standards and Grid codes

Microgrids – CIGRE definition & description

“Electricity distribution systems containing loads and distributed energy resources – operated in a controlled, coordinated way either connected to the main power network or islanded”



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Resilience and reliability – a role for microgrids

- Resilience to natural disasters – maintaining operation in
  - Earthquakes – The Tohoku Region Pacific Coast Earthquake, the NTT Facilities Microgrid in Sendai, Japan – 2011
  - Earthquakes and Tsunamis – Chile (2010), Japan (2010, 2011), and New Zealand (2010)
  - Hurricanes – Ike (2008), Gustav (2008), Katrina (2005), and Superstorm Sandy (2012)
  - Floods – Queensland, Australia (2011)
  - Forest Fires – Greece (2007)
- Reliability of the electric grid and power supply
  - Reduction in the number of outages due to equipment failure
  - Reduction of the amount of load not served due to shortage of power
  - Ensuring that critical loads are served

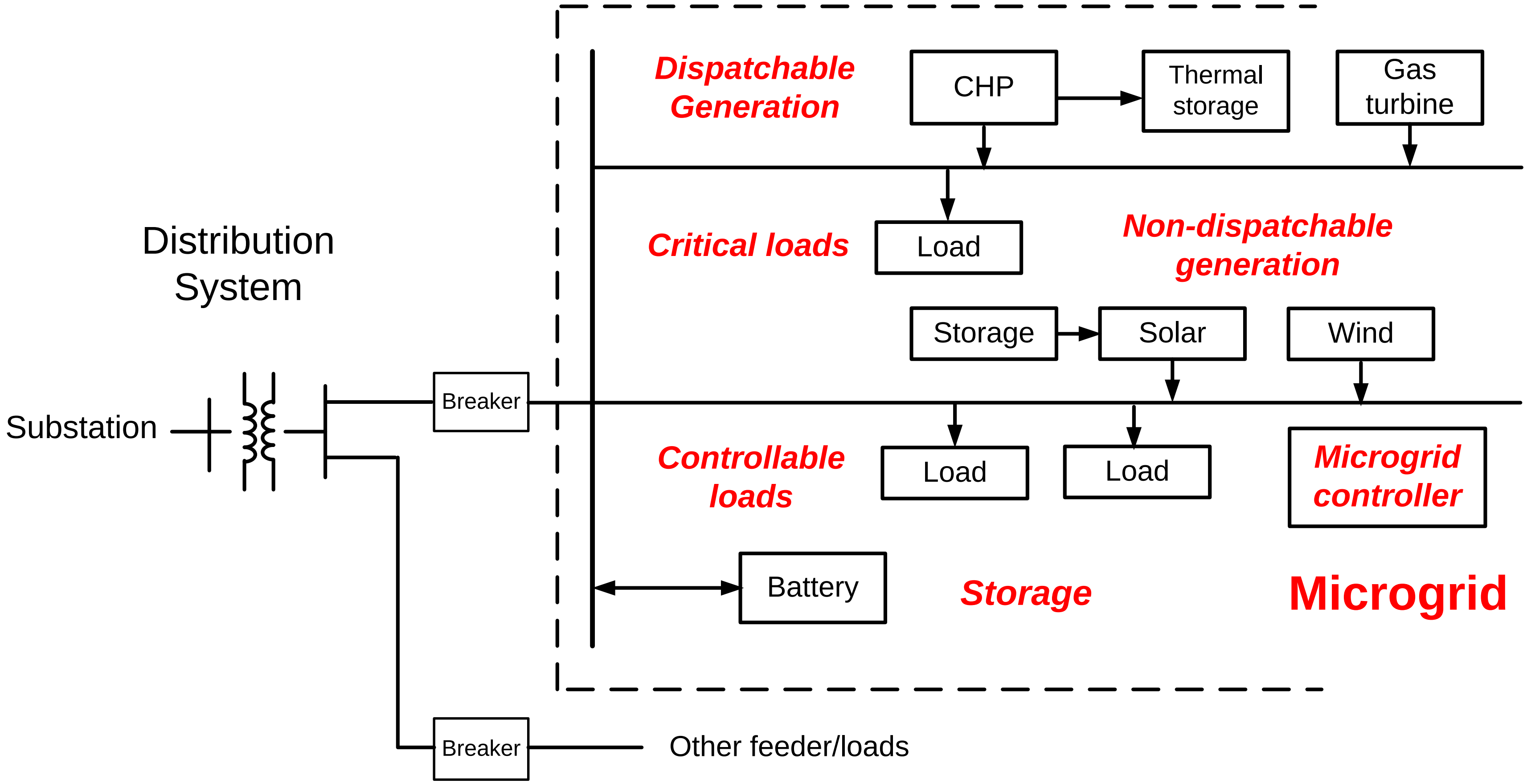
Campus microgrid – Princeton (2006)

Resilience (to super storms) – Combined heat and power – DER – Load shedding capability and control – Islandable

Source: C. Marnay

Microgrids – structure and operation

Grid resilience and stability – Islandable – Grid energy security – Integrating renewable sources — Grid ancillary services – Markets



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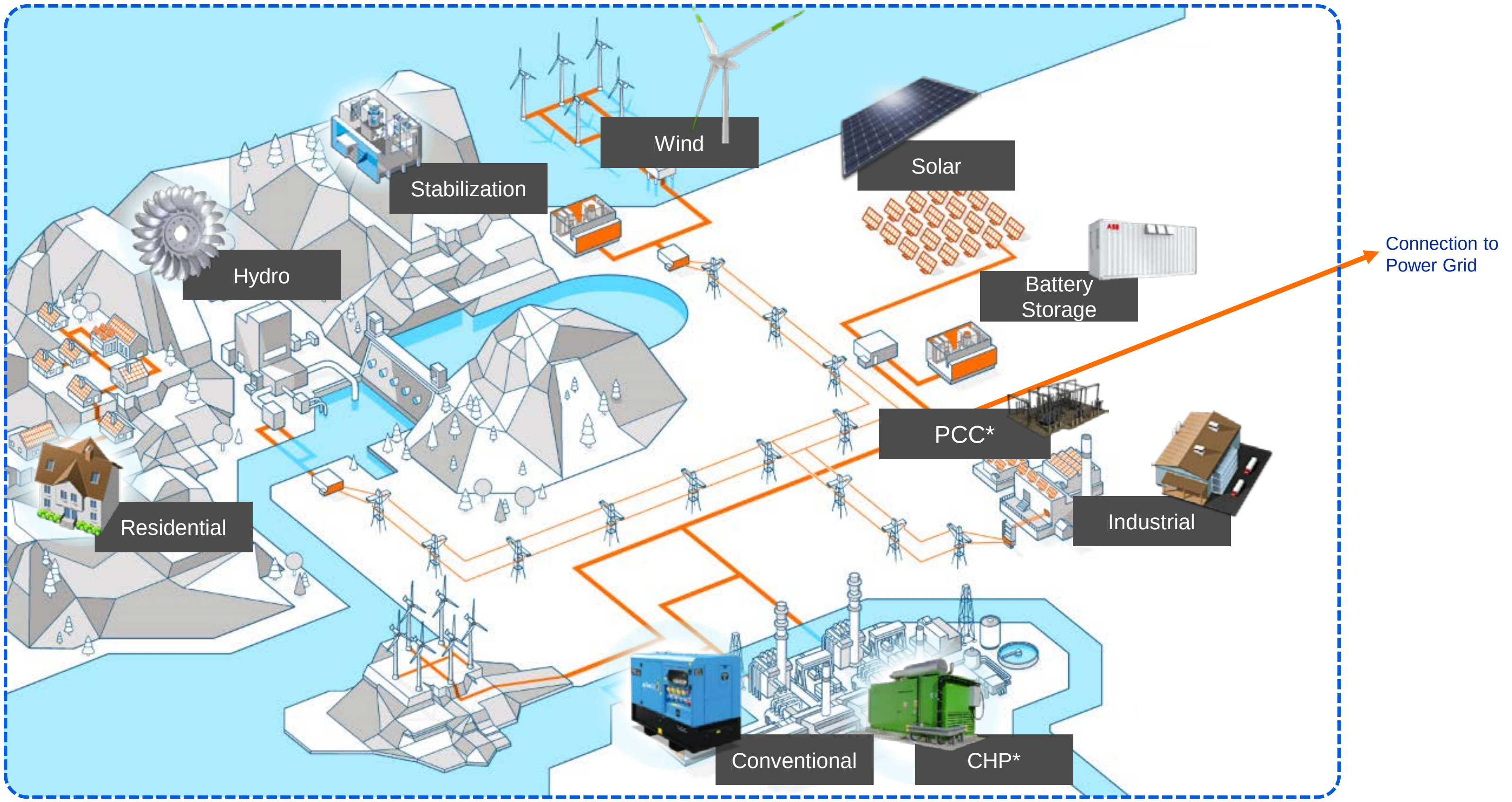
Microgrid controller – a key to reliable operation

- Microgrid controller functions related to resiliency
  - Coordinates, in an optimized manner, the integration and dispatch of local Distributed Energy Resources (DER) and loads
  - Allows seamless disconnection and reconnection to the grid – islanded operation in the event of a natural disaster
  - Enables the provision of ancillary services to the grid – grdi restoration after a black out
- Controller implementation – enabling technologies
  - A centralized controller sending commands to elements OR
  - A decentralized control system, with intelligent local controllers (agent based)
  - Sensing, monitoring, data management and information and communication technologies
  - Emergency dispatch of generators

Grid-connected microgrids

Improved resilience – Higher power quality – Increased self consumption – Increased efficiency – Lower carbon footprint



PCC: Point of Common Coupling
CHP: Combined Heat and Power

Source: ABB

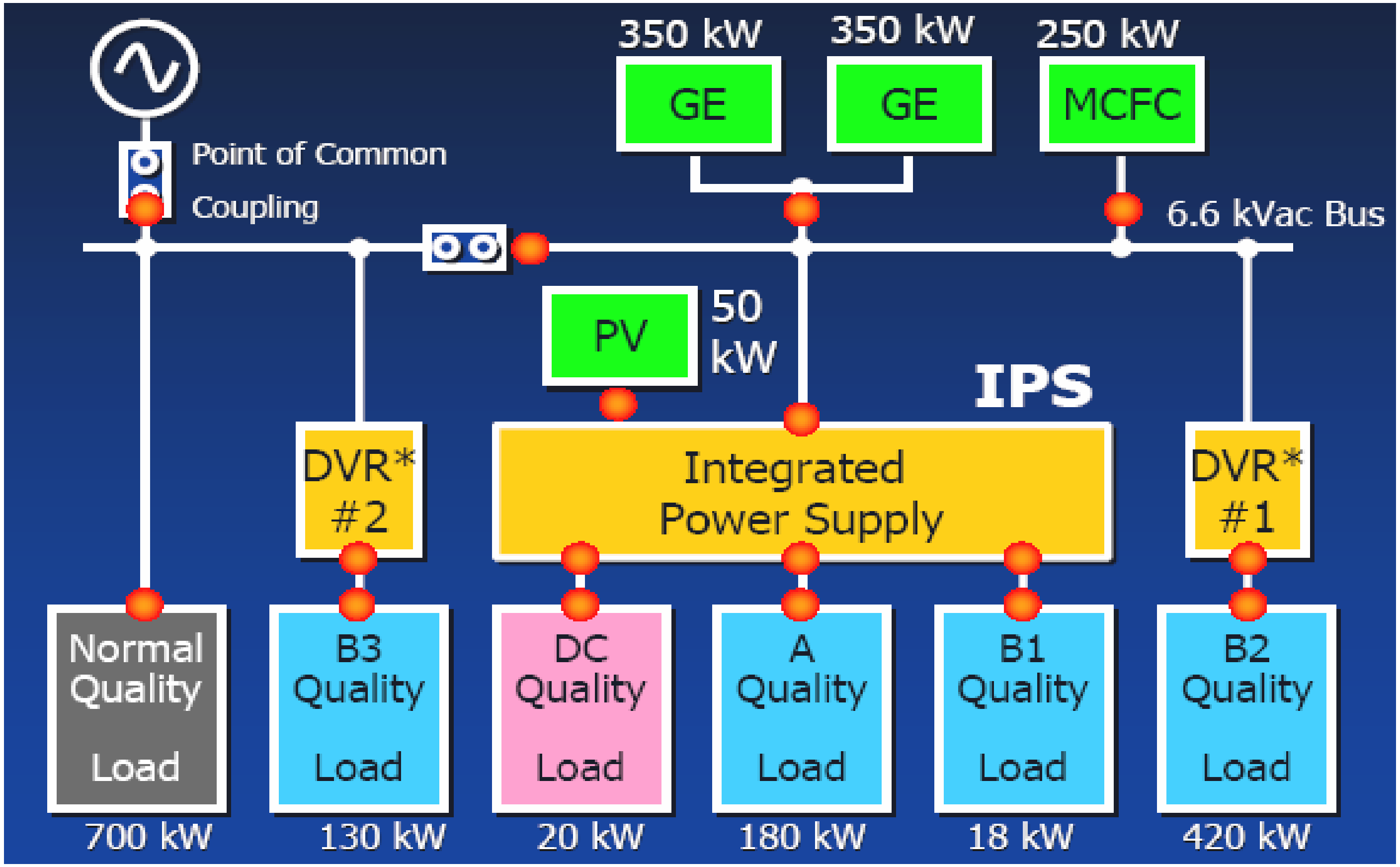
Critical infrastructure – Japan (2008)

Multiple power quality microgrid – Operation in islanded mode – Resilience in the event of disasters for critical infrastructure (hospital)

Source: NTT facilities

Teaching hospital microgrid – Japan (2008)

Resiliency through diversity of energy resources: natural gas generators, PV arrays, fuel cells, battery energy storage – Load prioritization



Source: NTT facilities

Need for standardization – microgrid controllers

- Microgrid technology – being deployed in a number of places and for different applications and contexts, including relability and resilience – new standards required to facilitate this deployment
- Standards – under development by the IEEE SA, taking into account the nature and configuration of microgrids, the integration of Distributed Energy Resources (DER), including generation and storage, and controllable loads (to implement Demand Response)
- Defining core functions – defining the requirements for the control of the microgrid and its components to simplify the design, configuration and operation of microgrids.
- Interoperability requirements – enabling/facilitating of the deployment

IEEE SA – microgrid controllers

- Standardization efforts – included in a series of 2 standards
  - P2030.7 – Specification of Microgrid Controllers
  - P2030.8 – Testing of Microgrid Controllers – based on the functional specification defined in P2030.8
- Interoperability requirements an integral requirement and a principle in the development of standards
- Participants
  - Manufacturers offering microgrid controller configuration platforms
  - Consultants configuring microgrids and service providers
  - Utilities and distribution system operators
  - Government and research laboratories

P2030.7 – Specification of Microgrid Controllers

- **New standard approved by IEEE SA, June 2014**
- **Officers:** Chair: Geza Joos, McGill University; Vice-Chair, Russell Neal, Consultant; Secretary: Jim Reilly, Consultant
- **Core functions**
  - Core functions – define the microgrid as system that manages itself, can operate autonomously or grid connected, and connects to and disconnects from the main distribution grid for the exchange of power and the supply of ancillary services
  - Scope of the standard
    - addresses the functions of the controller that are common to all microgrids, regardless of topology, configuration or jurisdiction
    - presents the control approaches required from the distribution system operator and the microgrid operator
    - links the functional specification with testing procedures

P2030.8 – Testing of Microgrid Controllers

- **New standard approved by IEEE SA, June 2015**
- **Officers:** Chair: Ward Bower, Ward Bower Innovations; Vice-Chair, Erik Limpaecher, MIT Lincoln Lab; Secretary: Geza Joos, McGill University
- **Elements under test – Core functions as a key to the operation of microgrids**
  - Functional specification and control functions – see P2030.7
  - Scope of the standard
    - Develop a set of testing procedures allowing the verification, the quantification and verification of the performance with expected/defined minimum requirements for the different functions of the microgrid controller common to all microgrids
    - Define a set of testing and performance metrics for design specification and product comparison purposes

Microgrid benefits – reliability and resilience

- Microgrids – an enabling technology for enhancing reliability by
  - Reconfiguring existing distribution systems
  - Integrating local Distributed Energy resources (DER)
  - Integrating DERs using renewable energy resources (green power)
  - Implementing redundancy
  - Implementing feeder reconfiguration and other techniques
- Quantifiable benefits – allow making a business case for
  - Enhancing grid resilience
  - Enhancing reliability of the energy delivery
  - Enhancing energy security using local energy resources
  - Enhancing grid stability
  - Providing reliability related ancillary services – system restoration