NSERC SMART MICROGRID NETWORK

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Can a Smarter Grid Slow Down Climate Change While Accelerating Energy Independence?

Symposium ID 4120, Organized by Dr. Hassan Farhangi, PI NSMG-Net

American Association for the Advancement of Science
Vancouver, BC, Canada, February 2012

www.smart-microgrid.ca

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Agenda

Smart Grid and its role in achieving energy independence (Speaker: Hassan Farhangi)

1. Smart Grid core concepts
2. Smart Grid Challenges
3. Evolution of Smart Grid
4. Smart Microgrids
5. BC-Hydro/BCIT Smart Microgrid
6. NSERC's NSMG-Net
7. Questions and Answers

Global Utility Industry

Source: Public Domain

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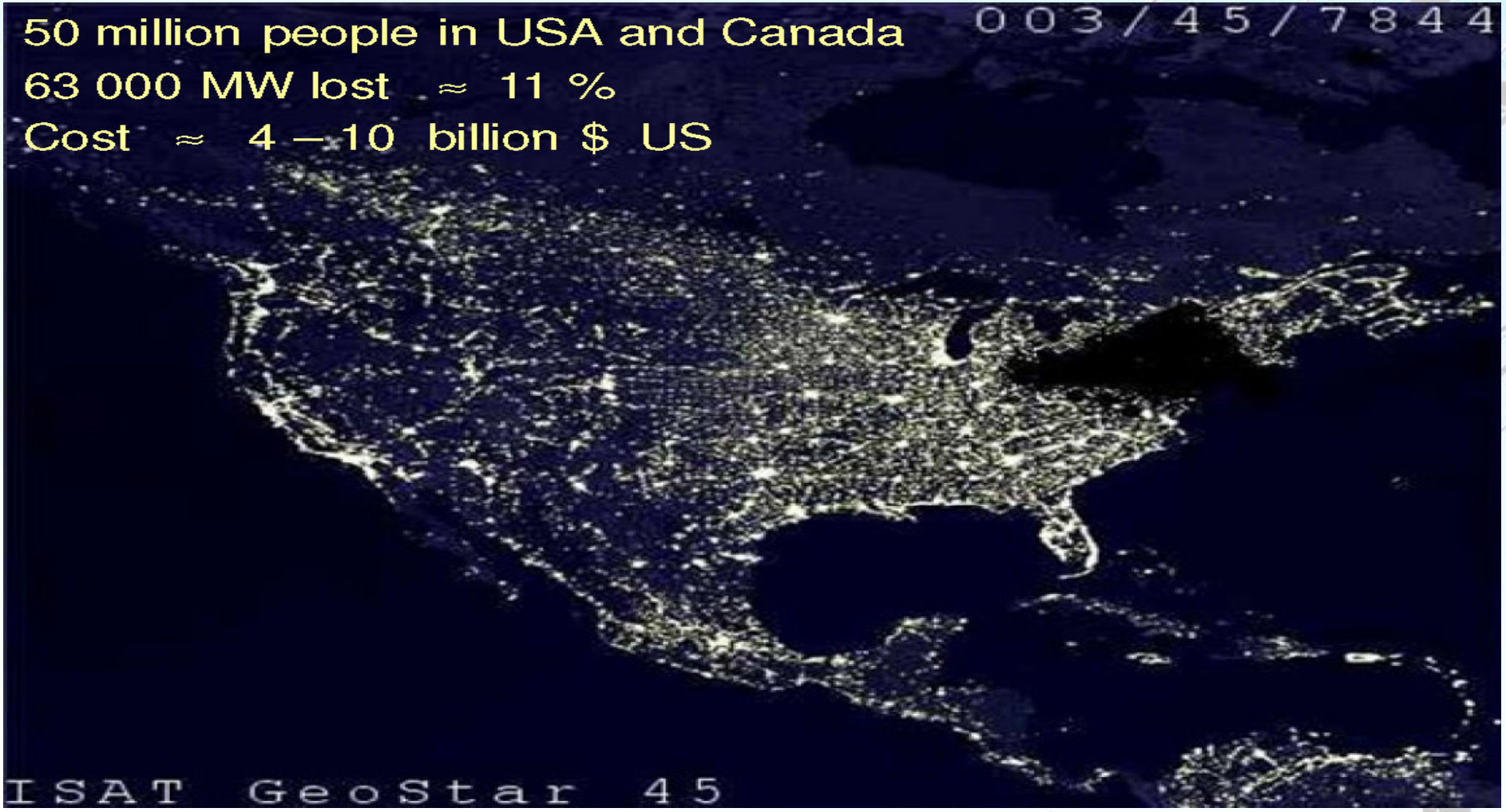
2003 Italian Blackout

Source: Public Domain

2003 US & Canada Blackout



Source: Public Domain

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2003 US & Canada Blackout

Source: Public Domain

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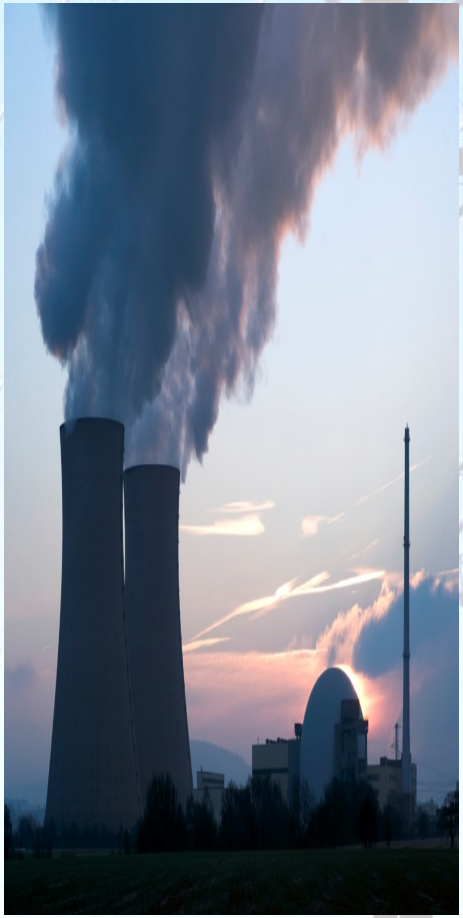
Problems & Solutions

Problems facing the Power Industry:

1. Rising cost of energy
2. Aging infrastructure
3. Mass Electrification
4. Financial & Regulatory Constraints
5. Climate Change

Solutions pursued by Utility companies:

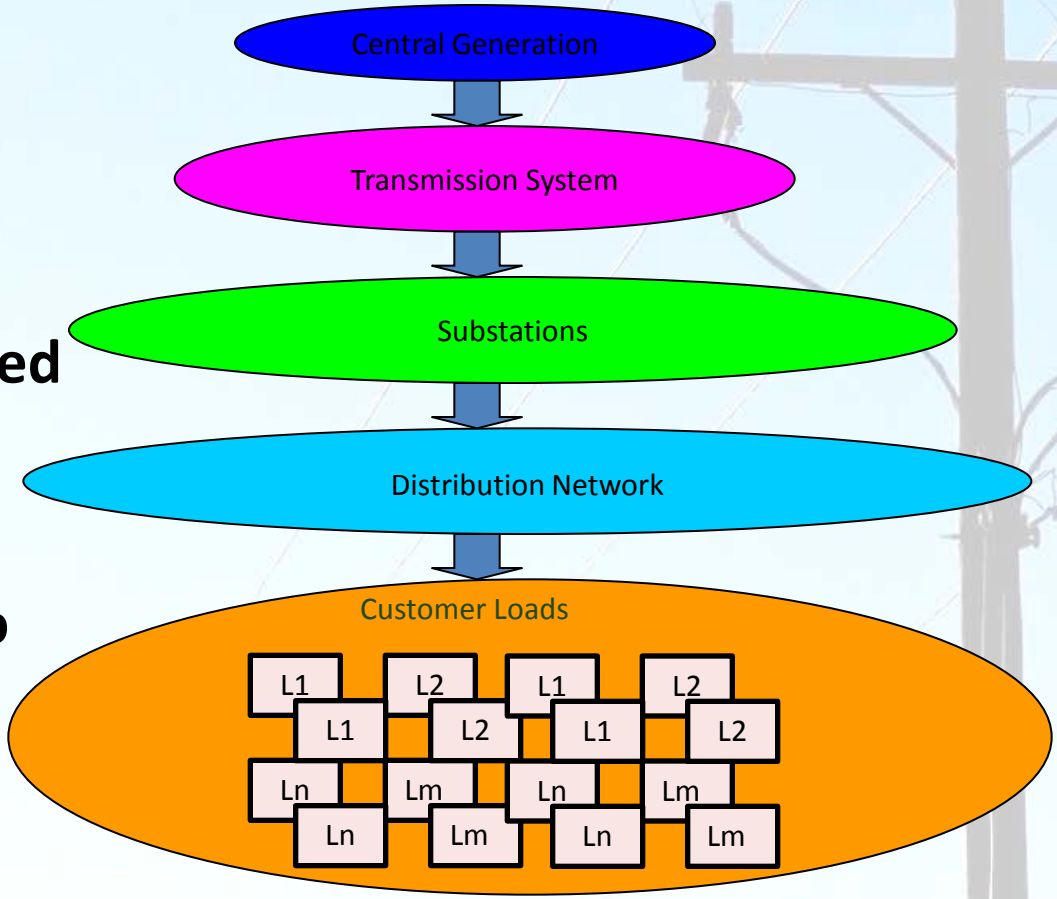
1. Optimize use of expensive assets
2. Manage end-user demand
3. Facilitate Co-Generation
4. Use renewable sources of energy
5. Empower Customers & Stakeholders



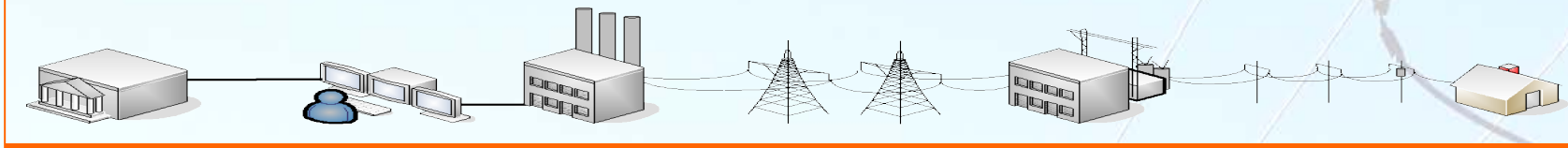
These require modernization of the electricity grid !

The existing Grid

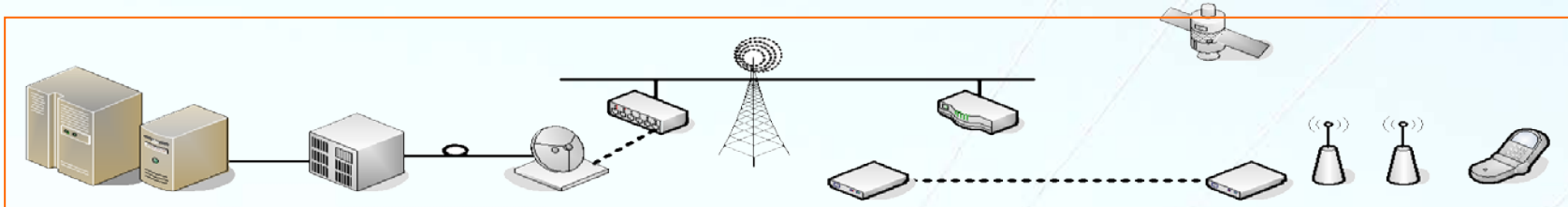
- Centralized Hierarchy
- Only 1/3 of fuel energy converted to electricity
- Waste heat is not recovered
- 8% is lost along the transmission lines
- 20% gen capacity exists to meet peak demand only (5% of time)
- Domino effect failures



Smart Grid Foundation



Electrical infrastructure



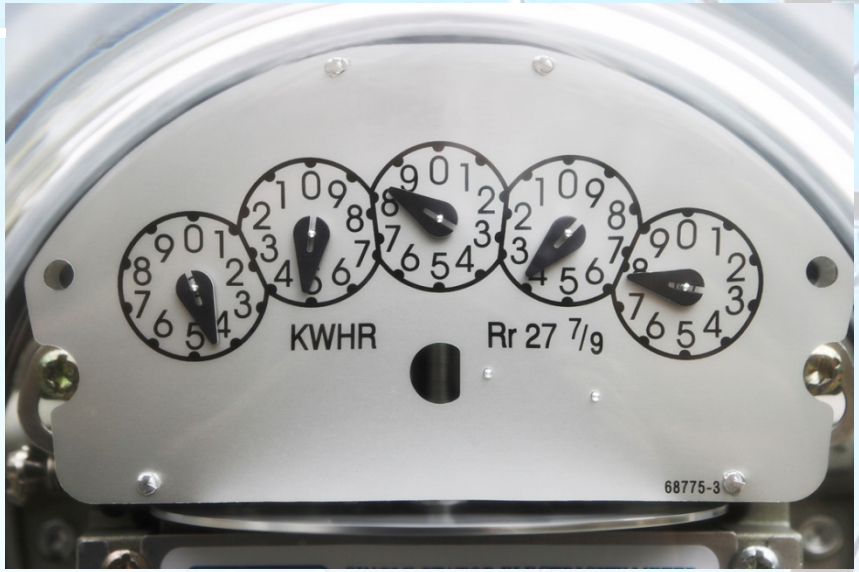
Information/Communication infrastructure

Source: EPRI

The Challenge

- **Modernize the grid without interruptions to critical services**
- **Manage interrelated technical, process and organizational risks**
- **Design a new system in absence of mature standards & technologies**
- **Justify investments in absence of clear business & revenue models**
- **Secure customer buy-in/support**

Need for a New Grid



The new grid has to be:

- **Smart & Adaptive**
- **Self-healing**
- **Self-monitoring**
- **Integrate alternative sources of energy**
- **Allow distributed generation (Co-Gens)**
- **Two-way communication between nodes and apps**
- **Smart, Secure and Reliable Distribution Network**
- **Provide end-customers with the ability to make choices on their usage pattern and carbon footprint**

Smart Grid Vision

Source: EPRI

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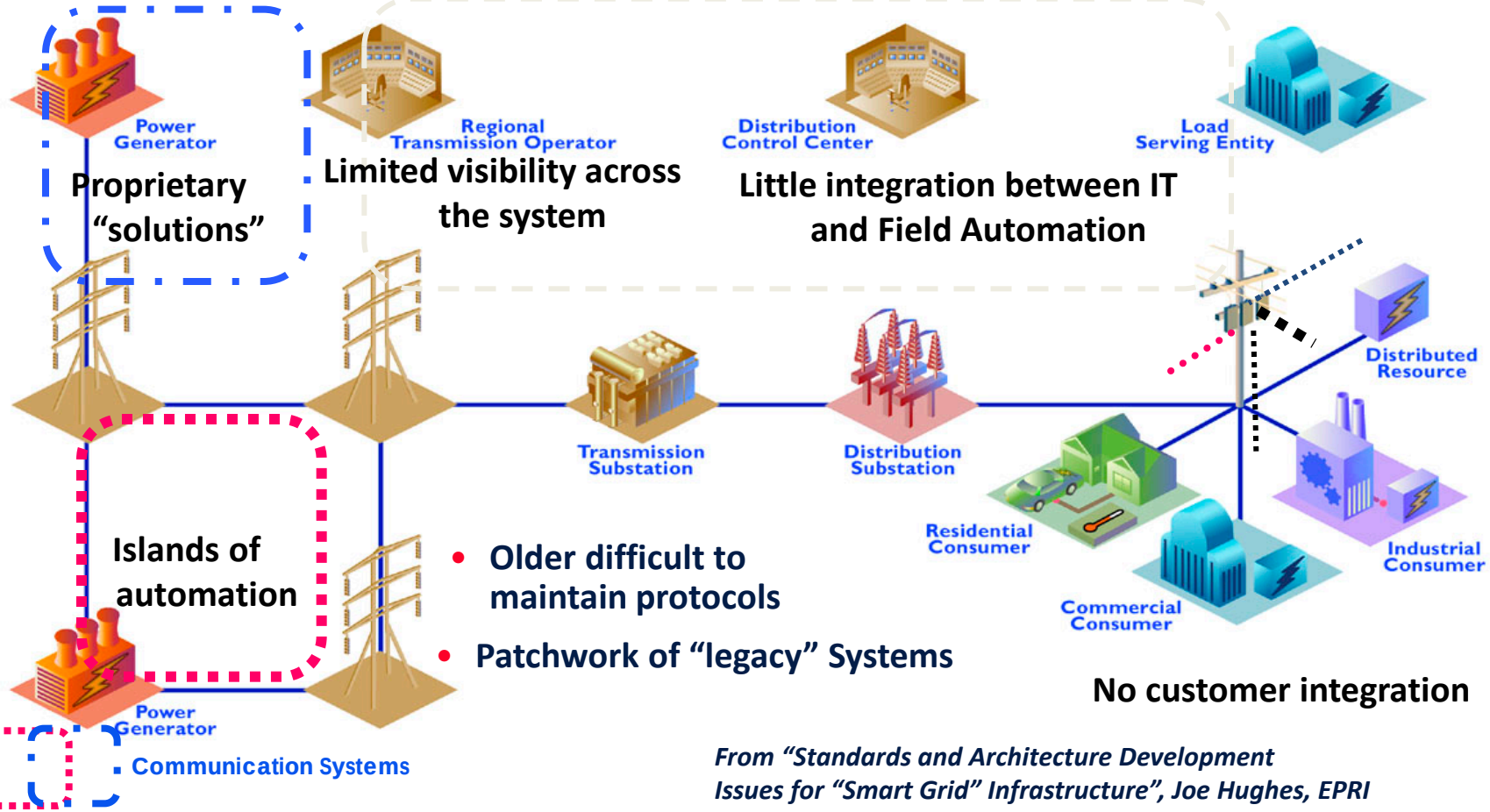
Where are we now?

- Little or no enterprise level integration



- Older difficult to maintain protocols
- Patchwork of "legacy" Systems

No customer integration

From "Standards and Architecture Development Issues for "Smart Grid" Infrastructure", Joe Hughes, EPRI

Where are we heading?

Source: EPRI

From "Standards and Architecture Development Issues for "Smart Grid" Infrastructure", Joe Hughes, EPRI

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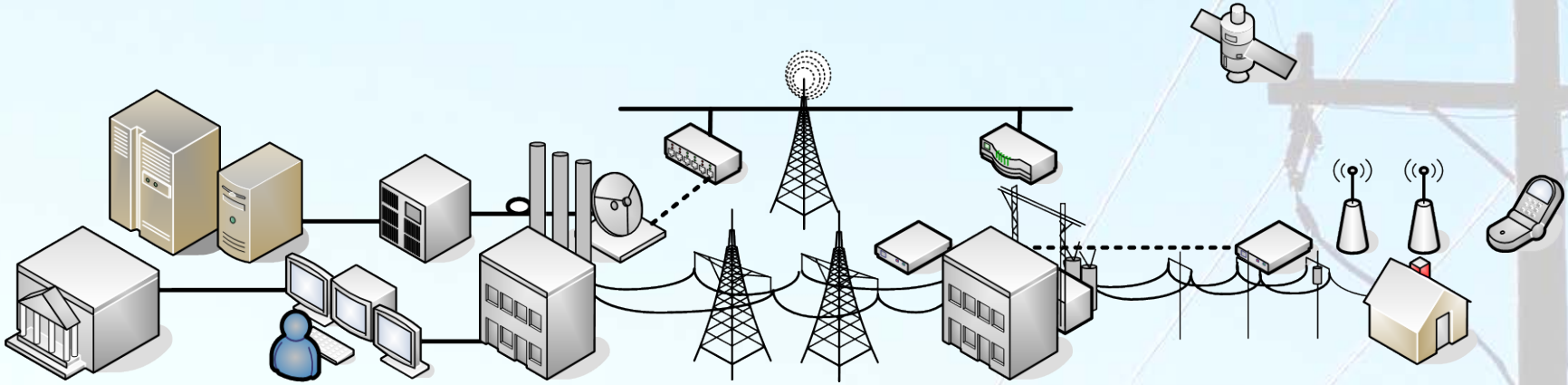
Smart Grid Applications



Real-time Simulation and Contingency Analysis

Distributed Generation and Alternate Energy Sources

Self-Healing Wide-Area Protection and Islanding

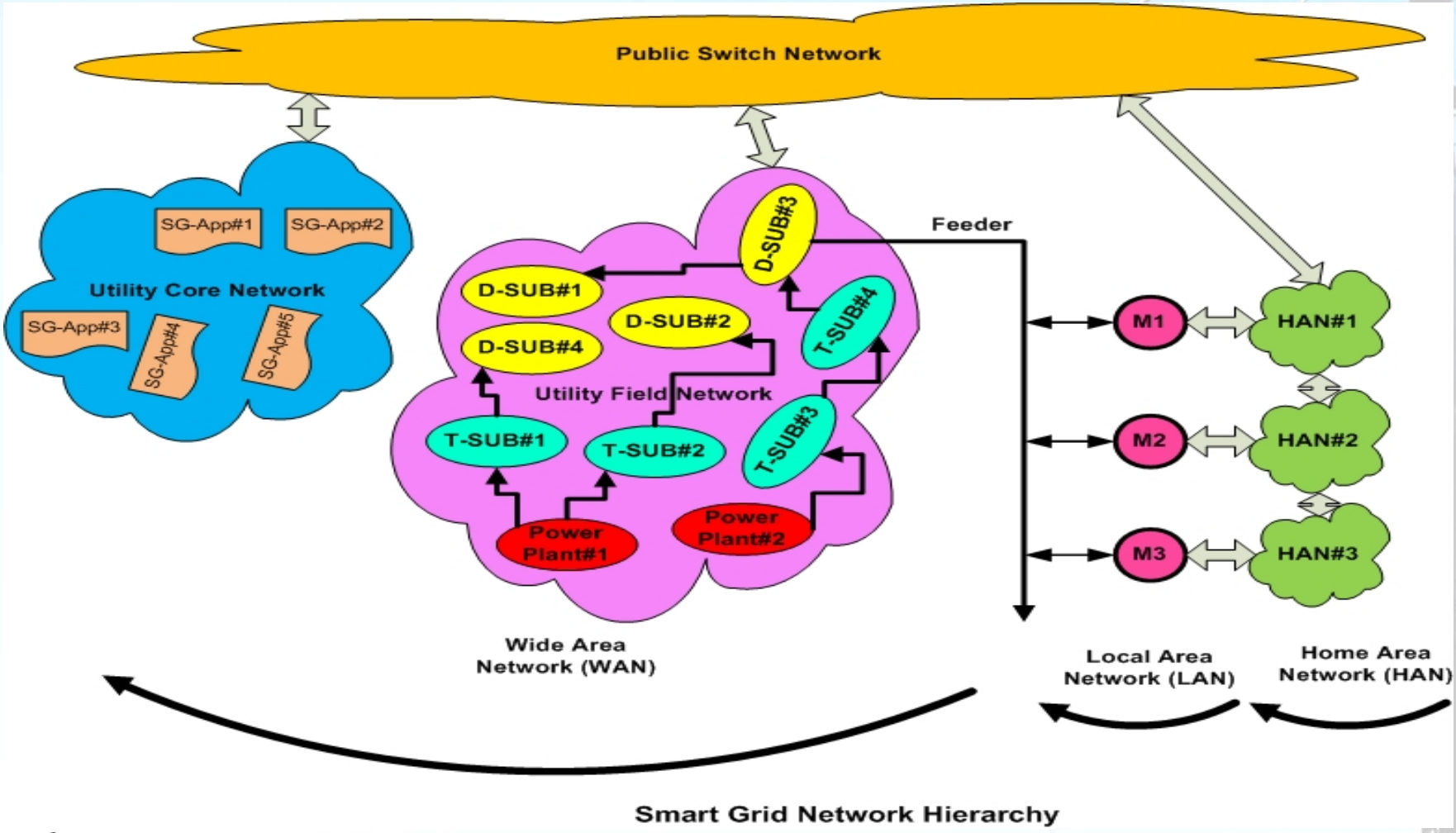
Asset Management and On-Line Equipment Monitoring

Demand Response and Dynamic Pricing

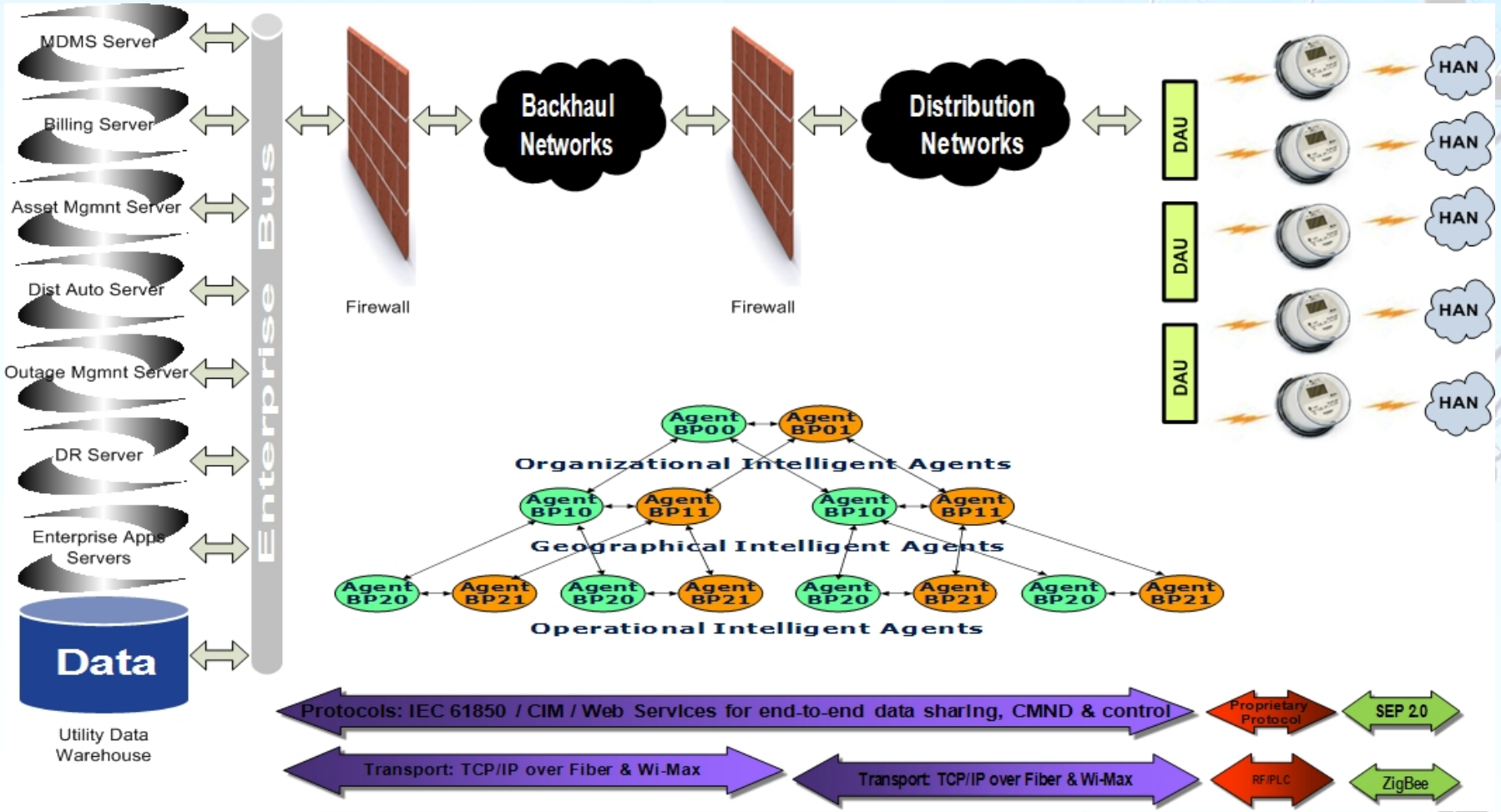
Participation in Energy Markets

Source: EPRI

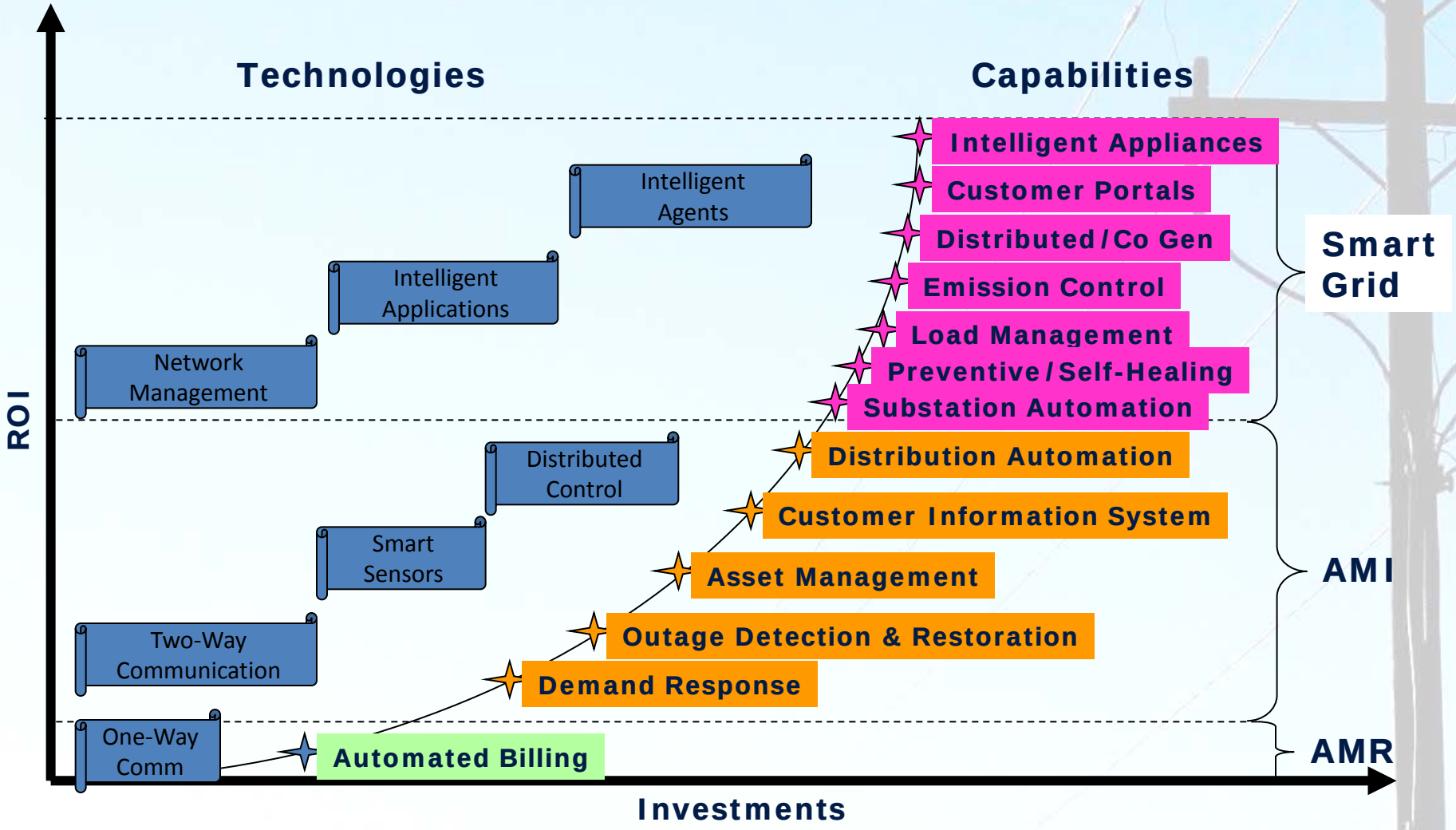
Smart Grid Network Hierarchy



Smart Grid Distributed Command and Control



Technologies vis-à-vis capabilities



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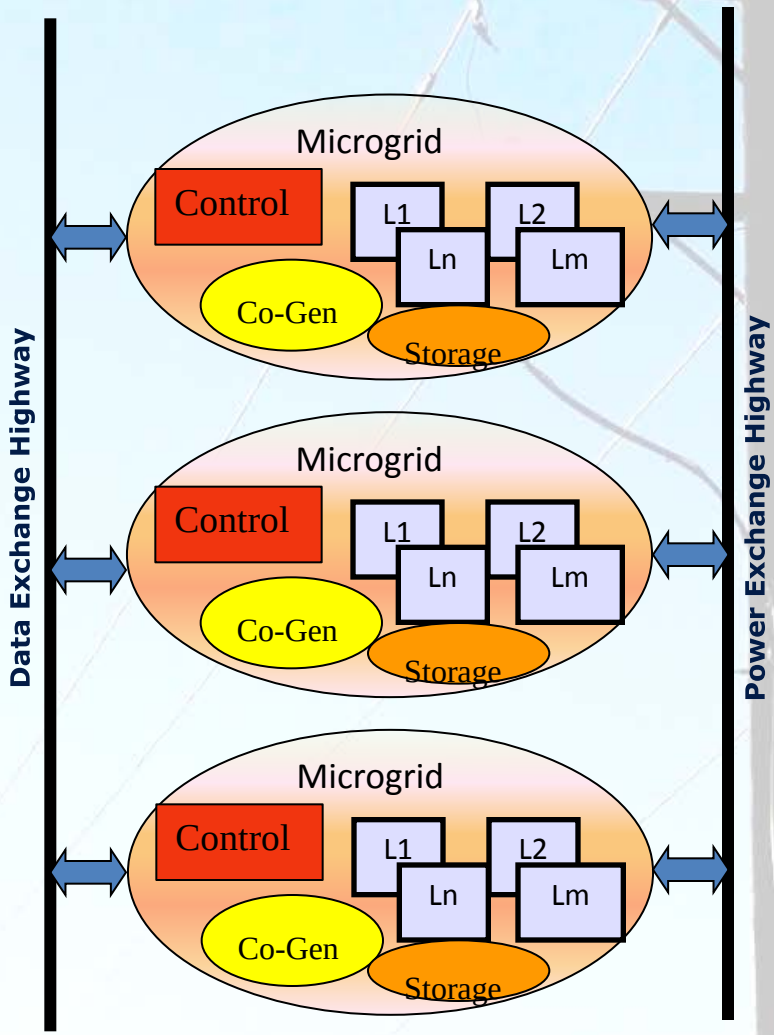
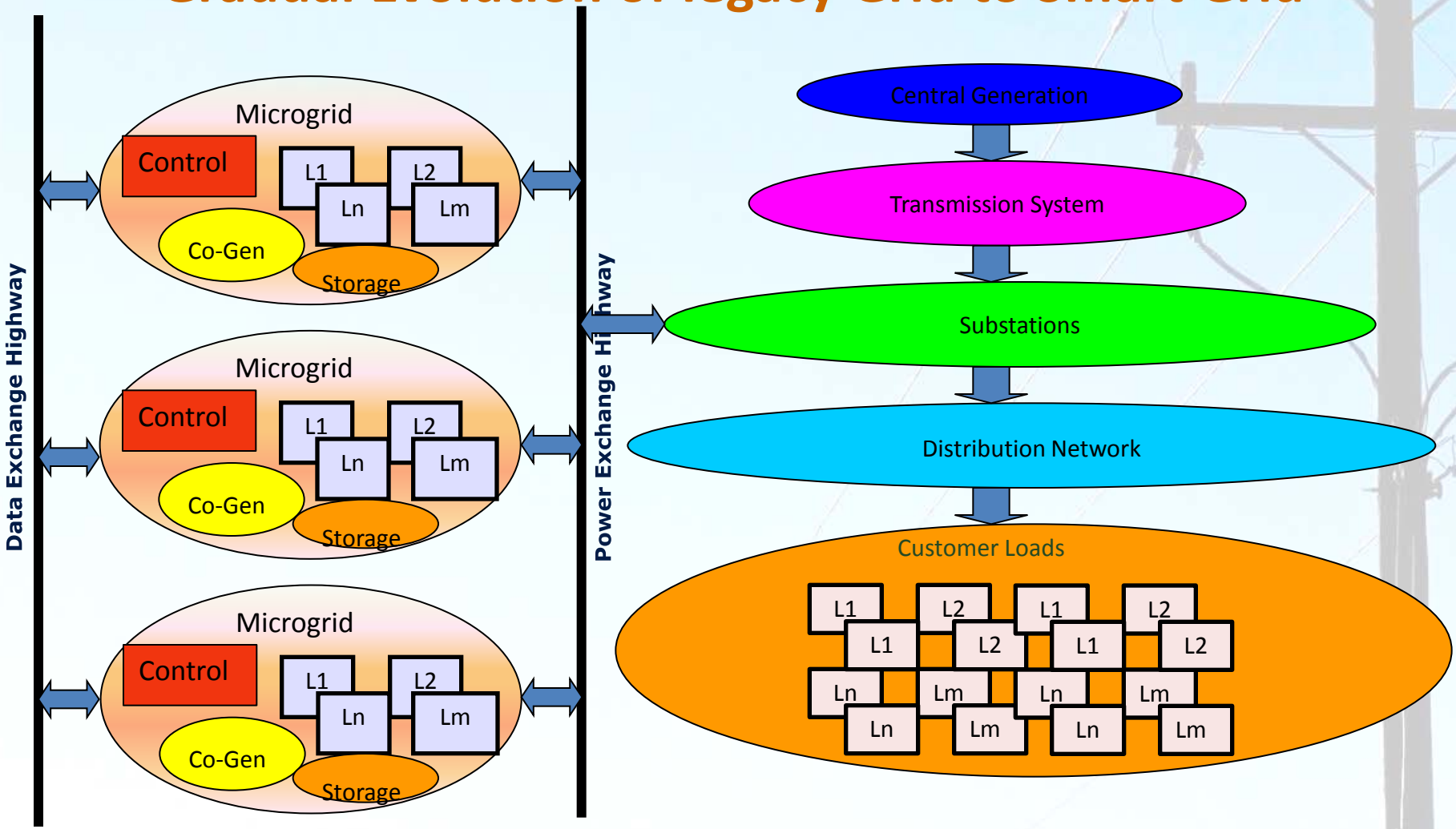
The future Grid

- Collection of integrated and Smart Microgrids
- Combined Heat/Power (CHP)
- Coordinates supply with demand
- Avoids transmission losses and vulnerabilities
- Integrates renewable sources of energy
- Resilient to failures
- Empowered customers



Gradual Evolution of legacy Grid to Smart Grid



Canada's first campus based Smart Microgrid at BCIT's Burnaby Campus; A joint BC Hydro and BCIT R&D Initiative

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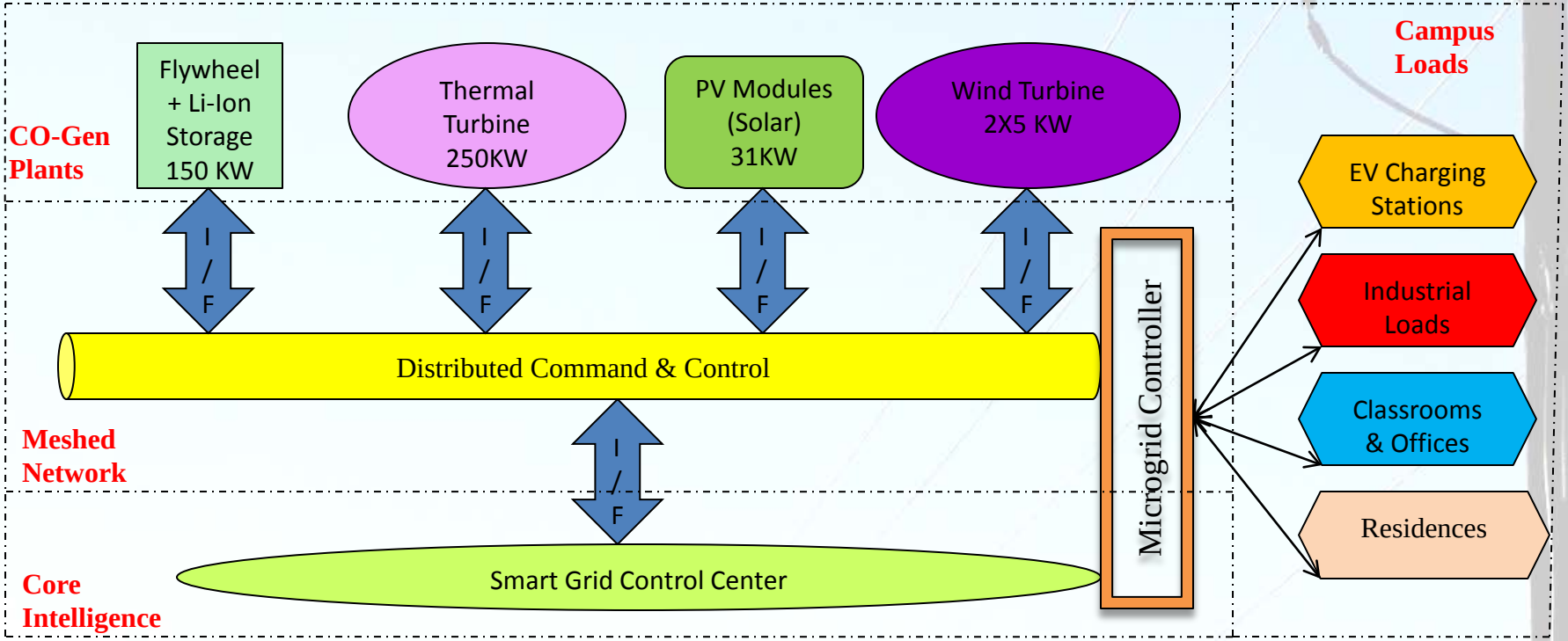
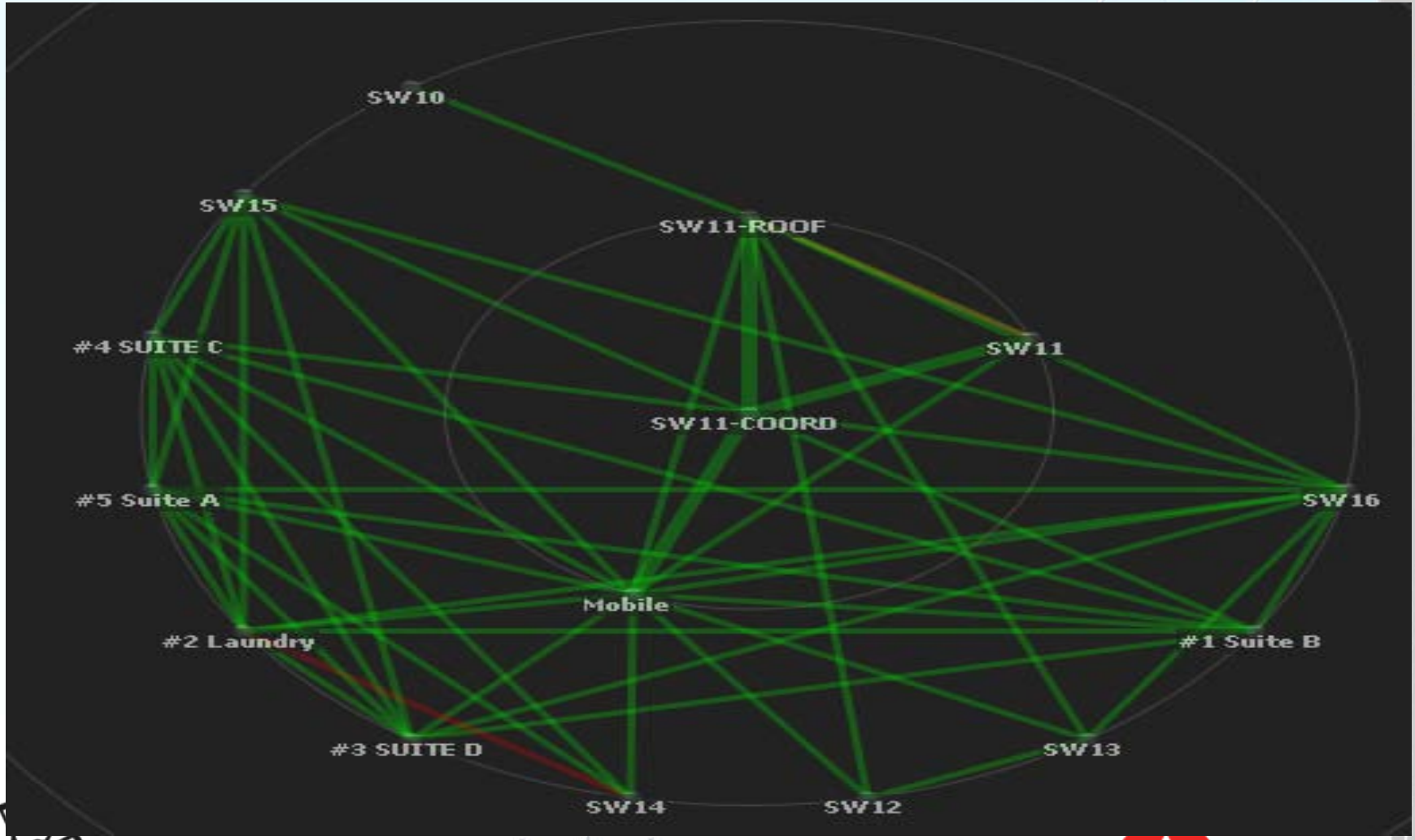
BC Hydro/BCIT Microgrid Topology



Frequency & Network Planning



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Network Status as of October 2010

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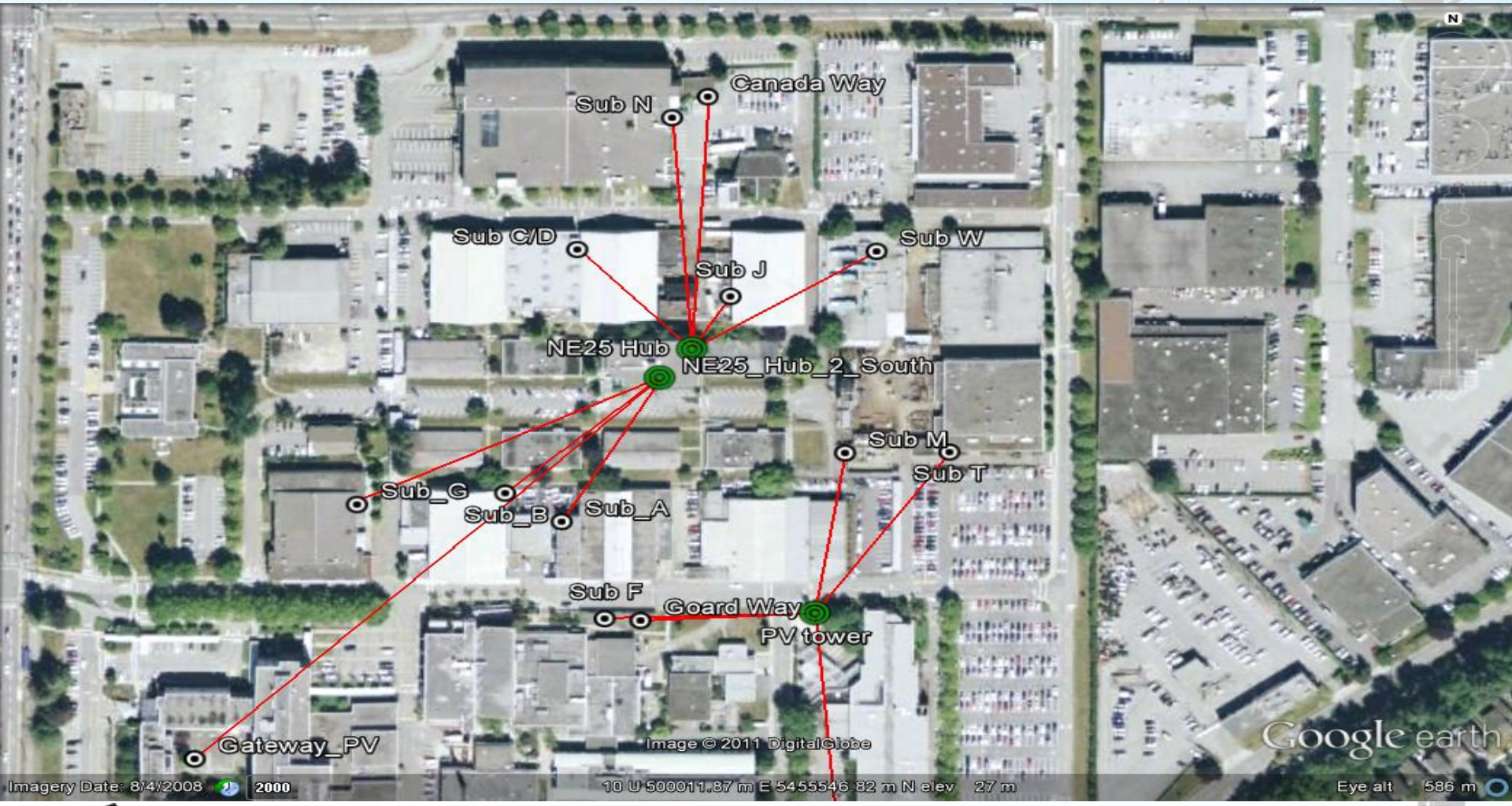
BC-Hydro/BCIT Smart Microgrid WAN



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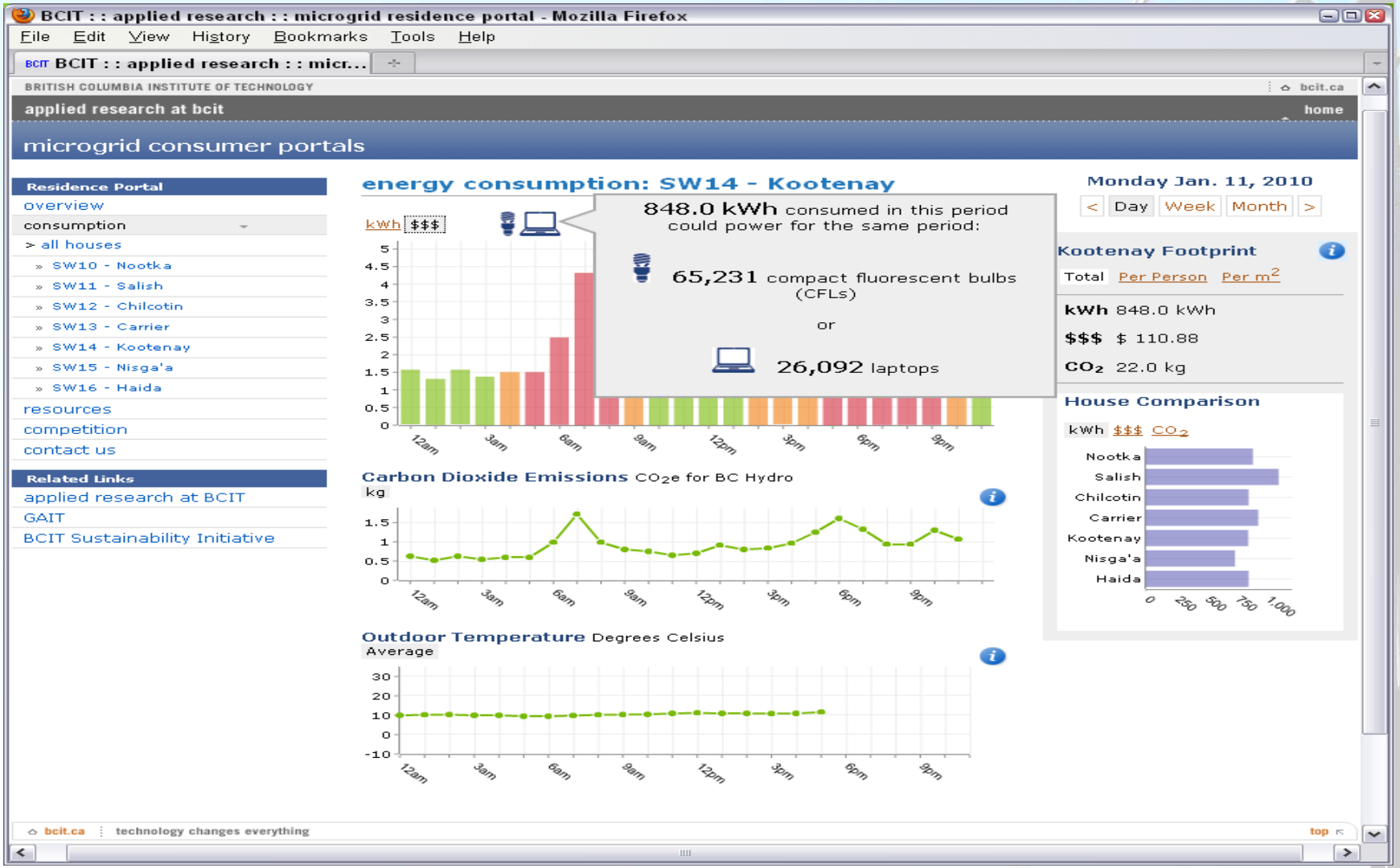
EMS Residence Portal



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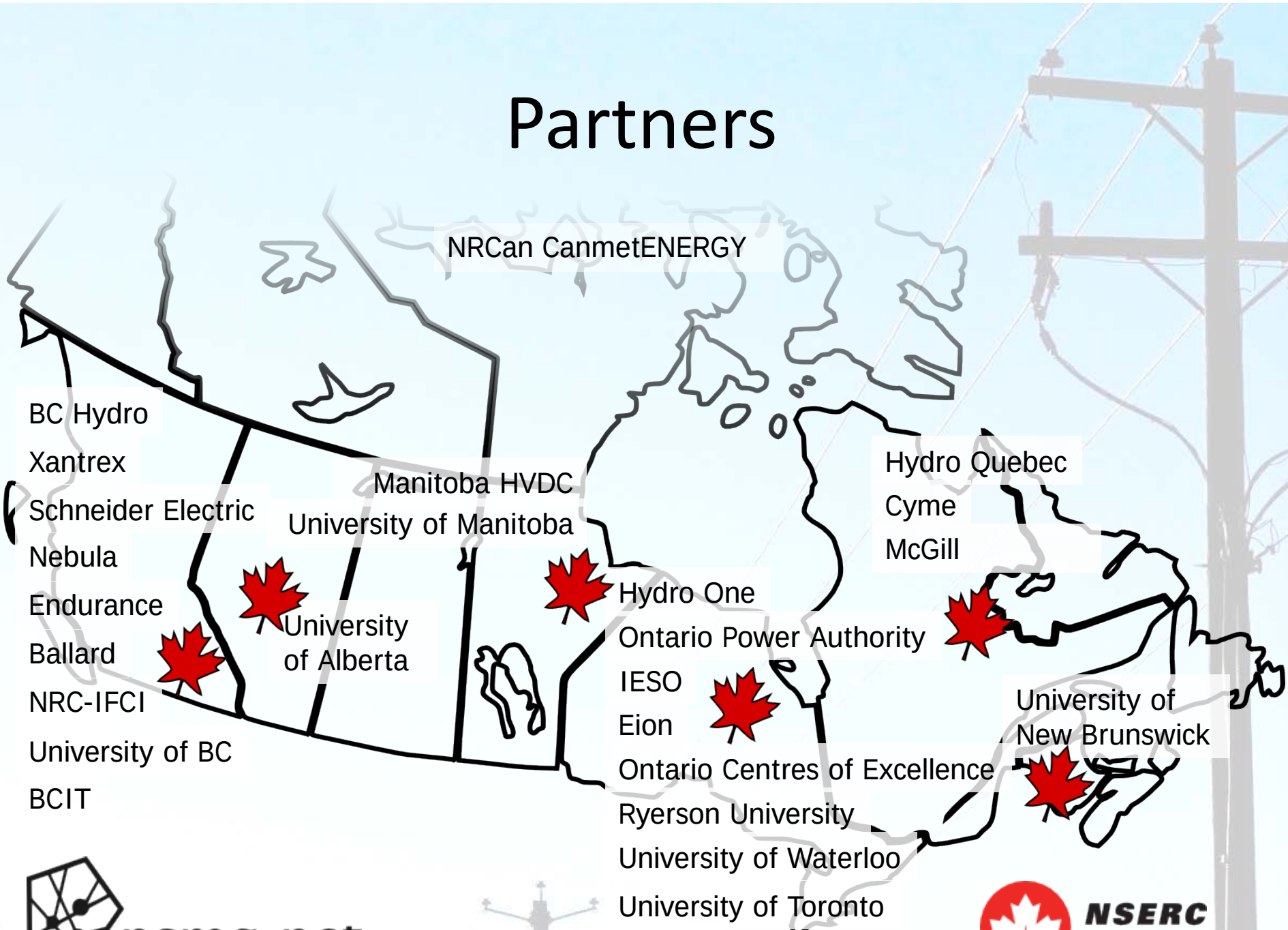
NSMG-Net Vision

- Canada's Smart Grid will be a network of integrated Smart Microgrids
- In preparation, NSMG-Net will
  - Develop technologies and strategies
  - Train skilled personnel
  - Study standards and policies
- The Smart Grid will enable
  - Operational efficiencies
  - More conservation
  - Increased resilience
  - Lower environmental impact

NSERC Smart Microgrid Network

- 5 year, Pan-Canadian
- Funded by NSERC and institutional partners.
- World-class researchers in distributed generation, security, demand response, sensors, communication, data management …
- Training over 140 undergraduate, masters and PhD students.

Partners



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