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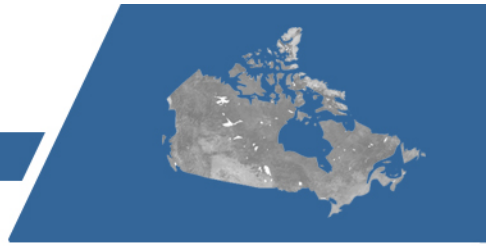

Canada Overview Microgrid Research and Applications

Contributors:

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B. Cullen and M. Wrinch (Pulse Energy),

H. Farhangi (BCIT),

J. Peralta (BC Hydro)

San Diego 2009 Symposium on Microgrids

September 17-18th , 2009

Presentation Plan

- Introduction
- Guideline for planned islanding
  - Draft Guideline Standard 1547.4
  - BC Hydro Guideline June 2006 and project experience
- Development of Simulation Tools and case studies
- Remote Community Application Project
- Campus Microgrid Research Project
- Conclusion

SYMPOSIUM ON MICROGRIDS
JUNE 23, 2006, MONT-TREMBLANT, QUÉBEC, Canada

2006 Participation:
Canada (10), Japan (12),
USA (15), and EU (11)

- Invitation to host Symposium in June 2010 in Vancouver, Canada

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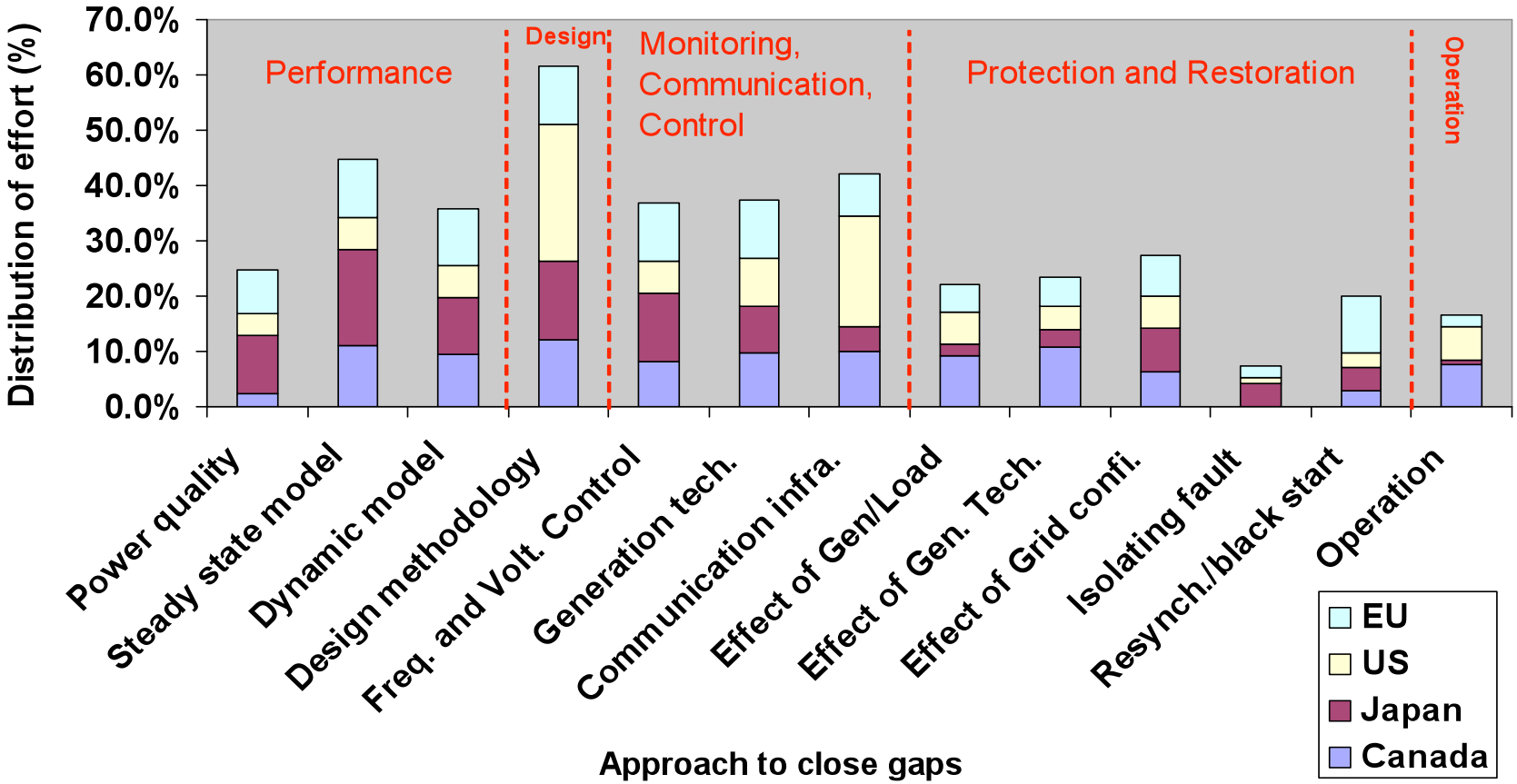
Survey Questionaire

- Based on USDOE-CEC microgrid roadmap;
- Developed in 2006 to solicit comments from Symposium participants on their research in Microgrids and their observations regarding the “gaps” in research, and barriers in the implementation of this concept;
- Part 1 identifies current R&D activities and future priority areas of the members; Part 2 questions on the difficulties associated with distribution system planning and implementation.

Approach to Close the Gap - Five Main Areas and 13 Study Topics (June 2006)



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Design Process

Planning Construction Operations

Distribution Utilities

Engineering & Planning	Asset Management	System Operations

Planned Islanding

DR Island Functionality
- Ÿ Parallel operation
- Ÿ Transition
- Ÿ Island mode - type, strategy
- Ÿ Reconnection mode

→

Design and Integration
- Ÿ Type(s) of island(s)
- Ÿ Engineering considerations
- Ÿ EPS Planning
  - Ÿ Load flows
  - Ÿ Protection planning
  - Ÿ Define operating practices
  - Ÿ DR settings

→

Operational and Management
- Ÿ Power dispatch
- Ÿ Communication and data exchange
- Ÿ Real-time operation
- Ÿ Duration of island

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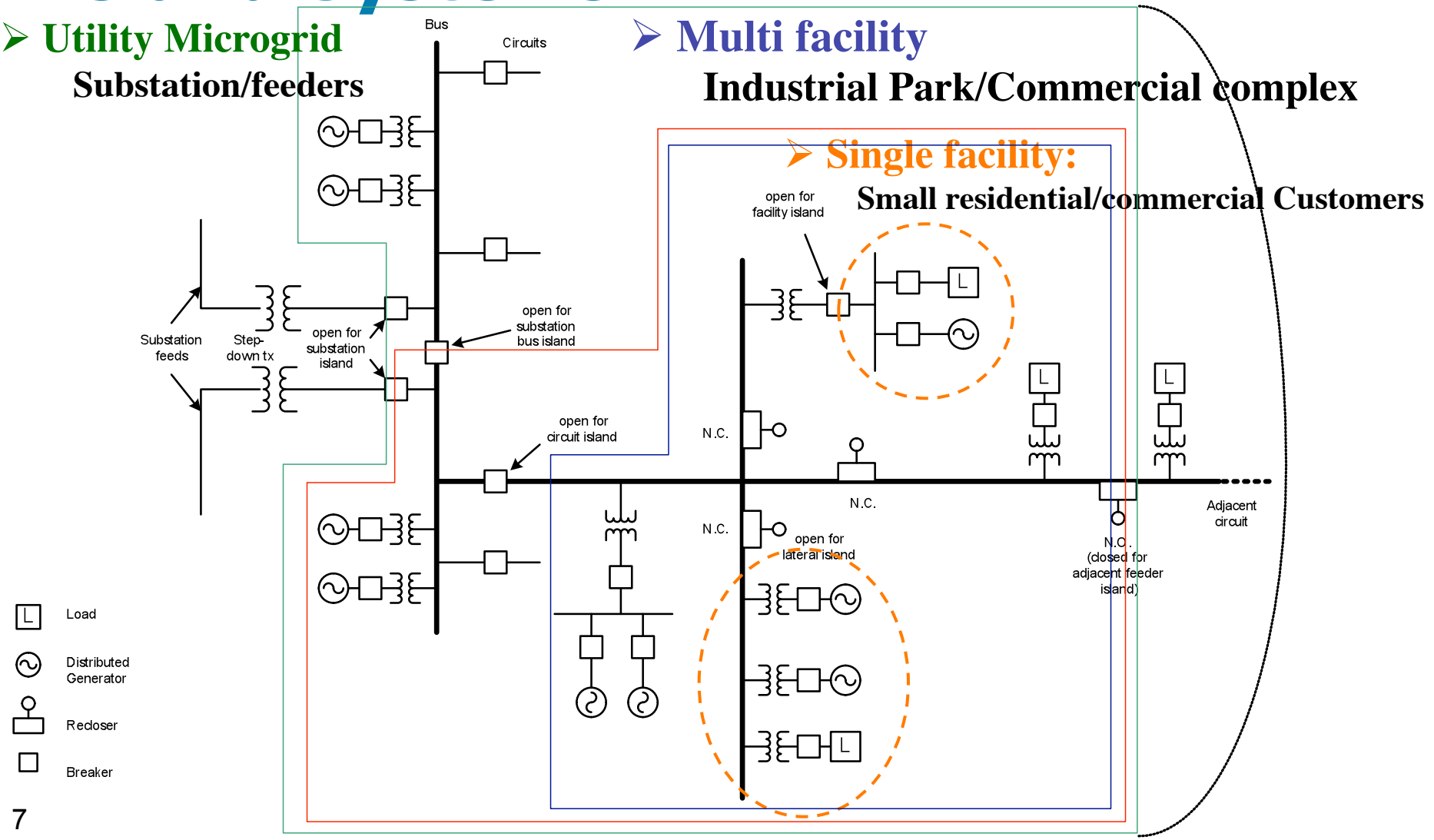
IEEE P1547.4 - Draft Guideline on Island Systems

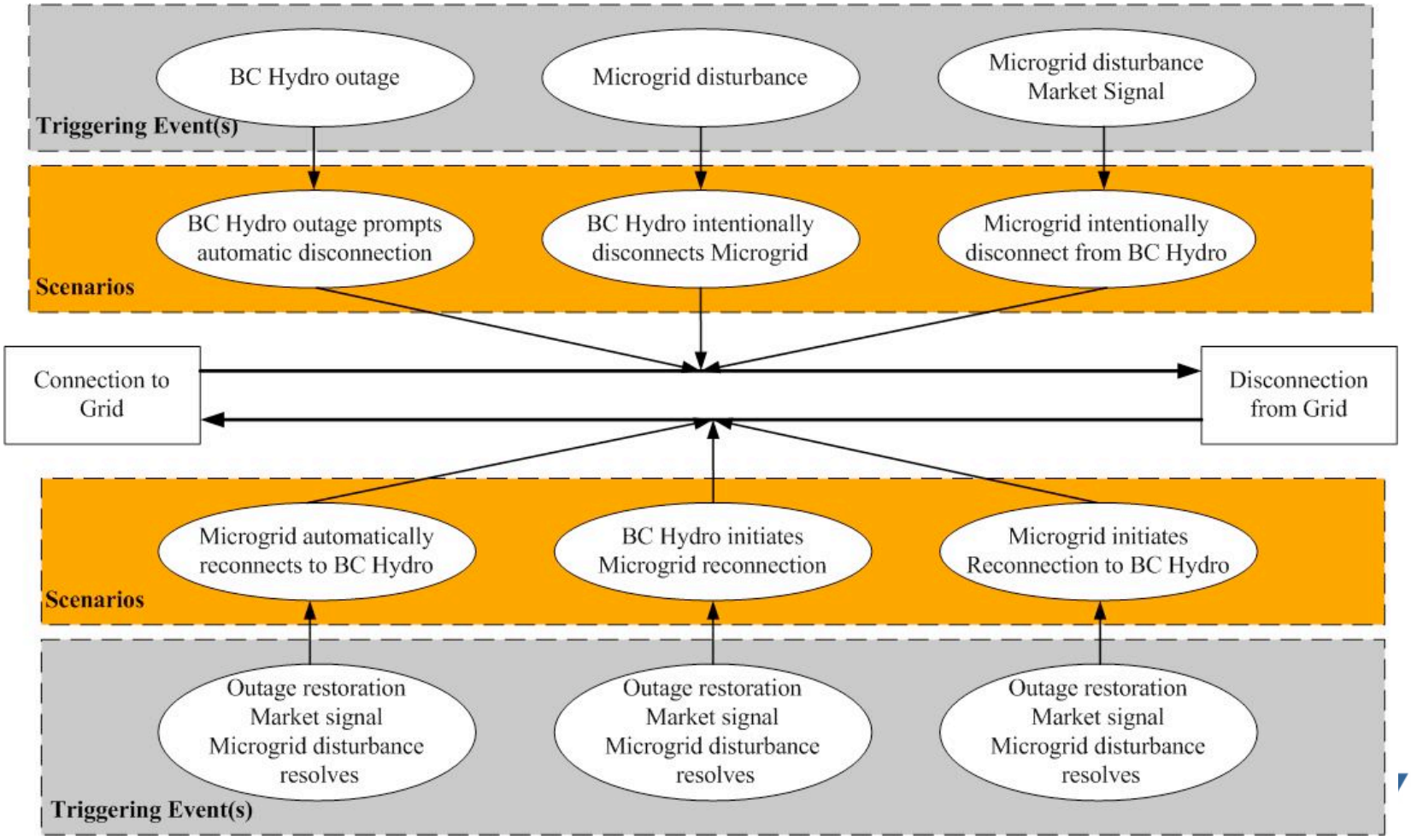
- **Utility Microgrid**
  Substation/feeders
- **Multi facility**
  Industrial Park/Commercial complex
- **Single facility:**
  Small residential/commercial Customers



Case Study Scenarios IEEE 1547.4/Draft

- Central dispatch control case studies
  - Case Study 1: Emergency backup scenario
  - Case Study 2: Load-relief scenario
  - Case Study 3: Power-quality scenario
  - Case Study 4: Multiple DR units on island and need distributed control among them
- Distributed dispatch case studies

Encourage Discussion from Project Leaders on Case Studies and Microgrid Communication "Use Cases"



BC Hydro - Distribution Power Generator Islanding Guidelines

- Published in June 2006
- PGs capable of following the load on tripping of the substation feeder CB (ride-through)
- Generators with broader VAR control (power factor ±0.8)
- Fast acting prime mover speed governor and exciters
- Inertia and controls to pick up dead-feeder load
- Black-start capability (scheduled islanding)

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Source: Jaime Peralta, Distribution Planning, BC Hydro, IEEE-PES, Calgary, Canada, July, 2009

BC Hydro – Technical requirements for Islanding

- PG with sufficient excitation current to allow fault detection and protection coordination
- Dual overcurrent protection settings (for parallel and islanded operation)
- Capability to maintain power quality (Machines with large inrush current or cyclic loads)
- Operating data/status telemetry
  - Real-time communication to the Control Centre
  - Operating data: kV, MW, MVARs, etc.
  - Generator and primary CB status

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Source: Jaime Peralta, Distribution Planning, BC Hydro, IEEE-PES, Calgary, Canada, July, 2009

BC Hydro Network System

- Required upgrades and considerations:
  - Feeder load > PG MVA rating/output ➔ Feeder sectionalization plan
  - Bi-directional line voltage regulators and fault detection elements (CB, reclosers)
  - Voltage supervision at feeder substation CB (out-of-step closing)
  - Feeder reclosers upgrade
    - Disable/delay reclosing function
    - Upgrade from 1Φ hydraulic to 3Φ electronic
  - Out-of-step relay and CB interrupting duty
    - PG plant or BCH substation CB

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Source: Jaime Peralta, Distribution Planning, BC Hydro, IEEE-PES, Calgary, Canada, July, 2009

BC Hydro Network System (Cont.)

- Line fuses upgrade (replace/relocate/remove)
- Synchronizing-check relay at substation feeder CB (Microgrids)
- PG real-time operating data/status at Control Centre and inter-operator communications
- Distribution Operating Order and PG commissioning tests for both grid-connected and islanded mode
- System impact study for islanding operation

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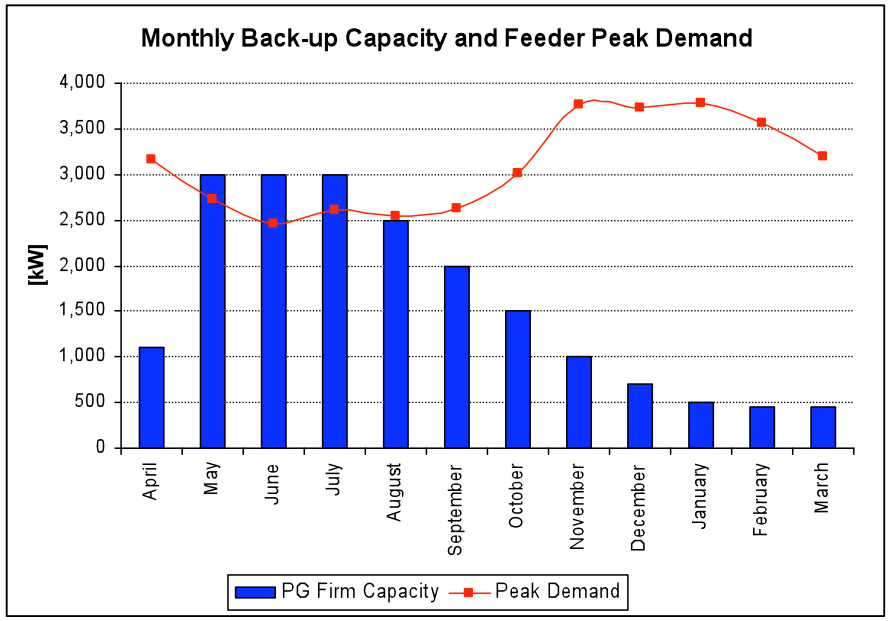
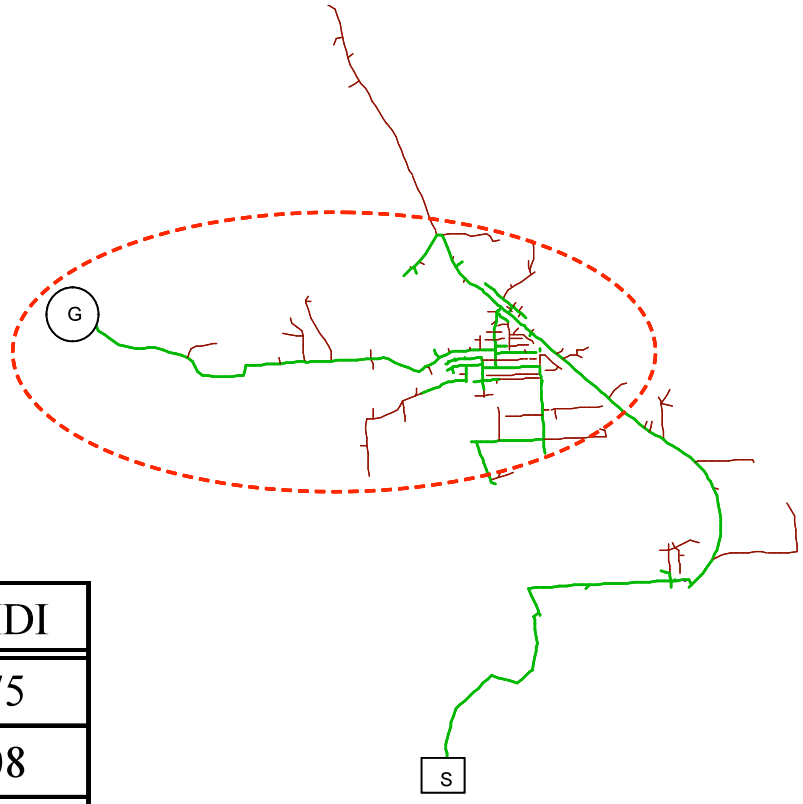
Source: Jaime Peralta, Distribution Planning, BC Hydro, IEEE-PES, Calgary, Canada, July, 2009

BC Hydro Islanding Project and reliability improvement





BC Hydro Feeder	SAIDI	SAIFI	CAIDI
2008	3.77	5.05	0.75
2007	7.20	6.65	1.08
2006	34.16	8.87	3.85
2005	4.30	4.06	1.06

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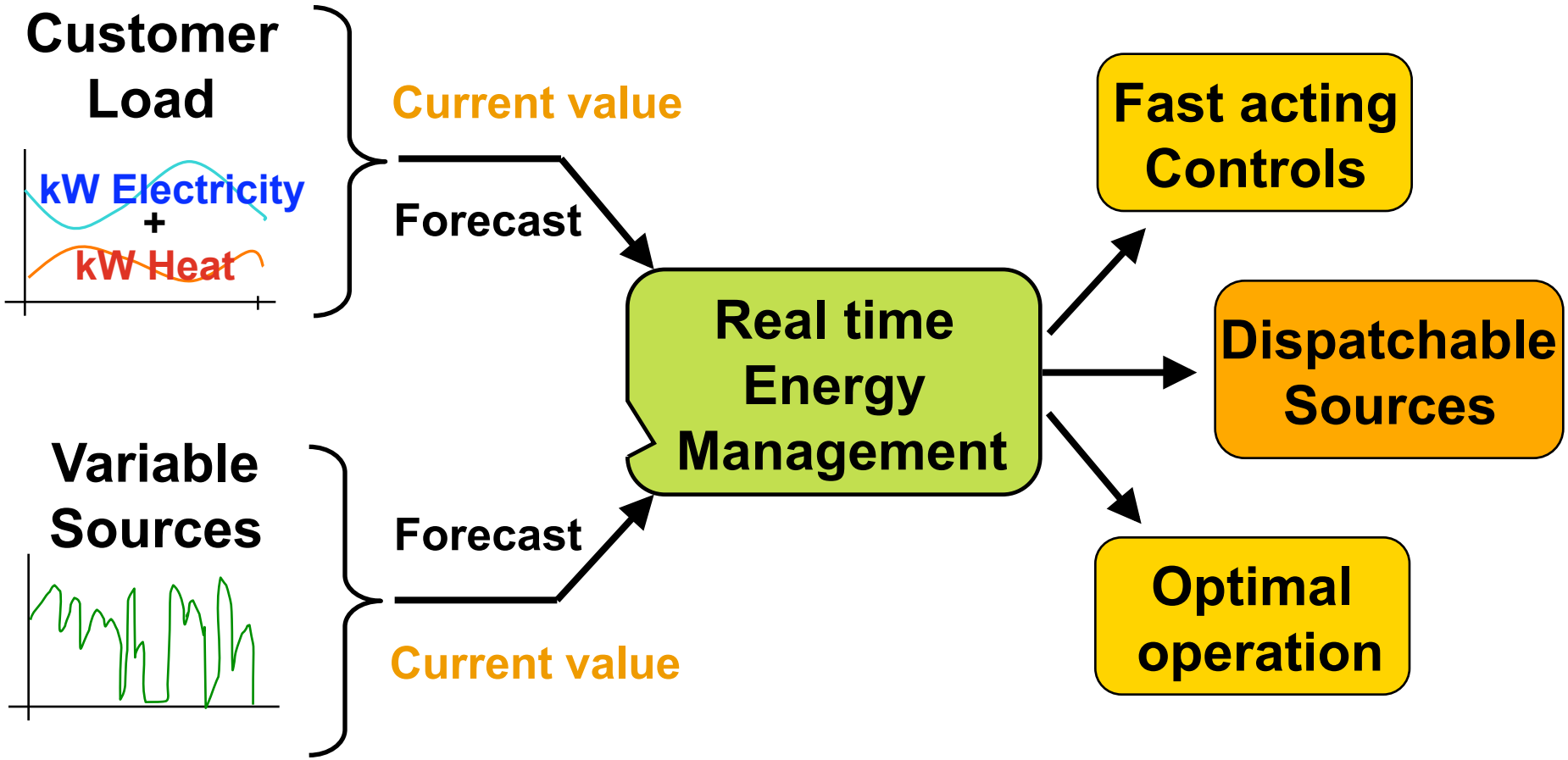
Source: Jaime Peralta, Distribution Planning, BC Hydro, IEEE-PES, Calgary, Canada, July, 2009

Smart Energy Management



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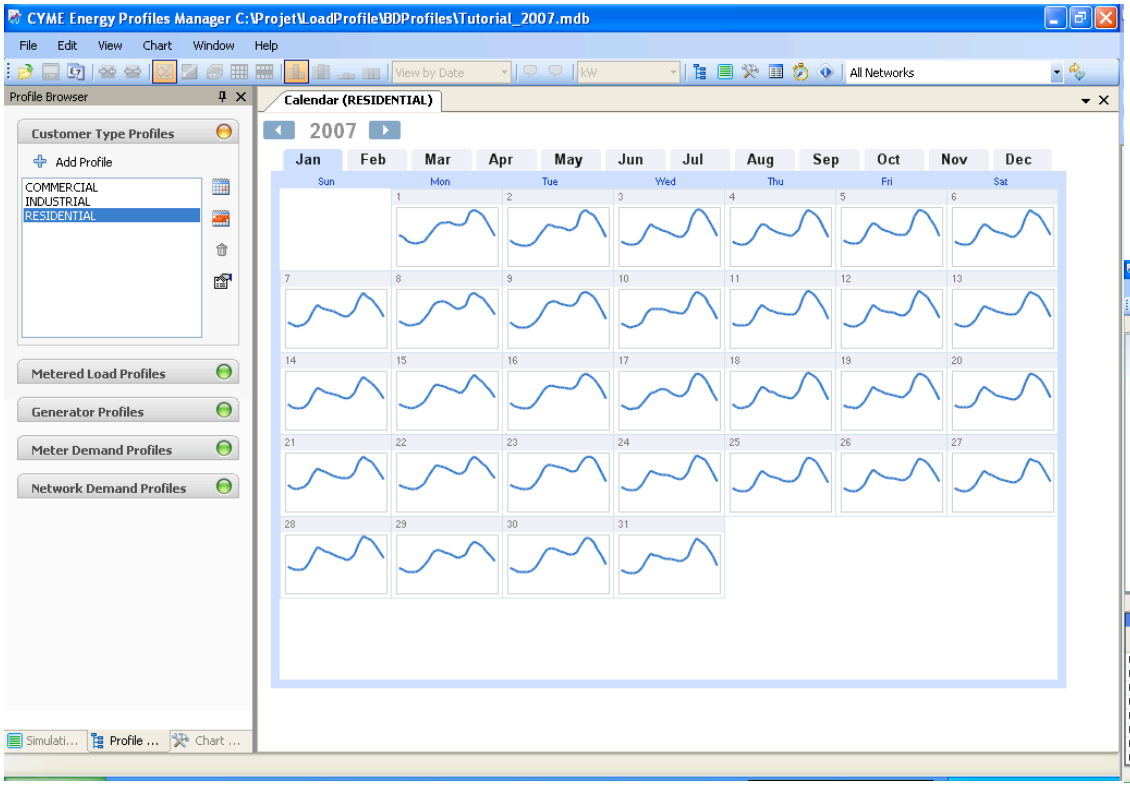
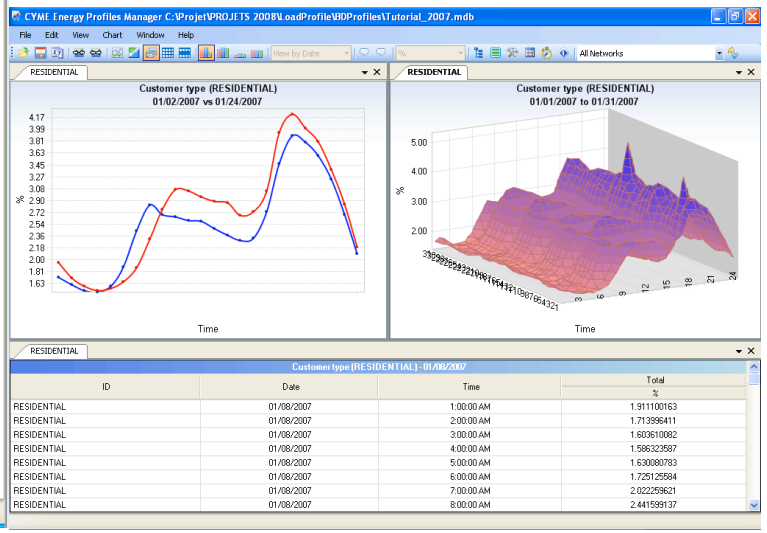
Energy Profile Manager
New planning tools





- *Metered load and generator profiles*
- *Meter demand and network demand profiles*

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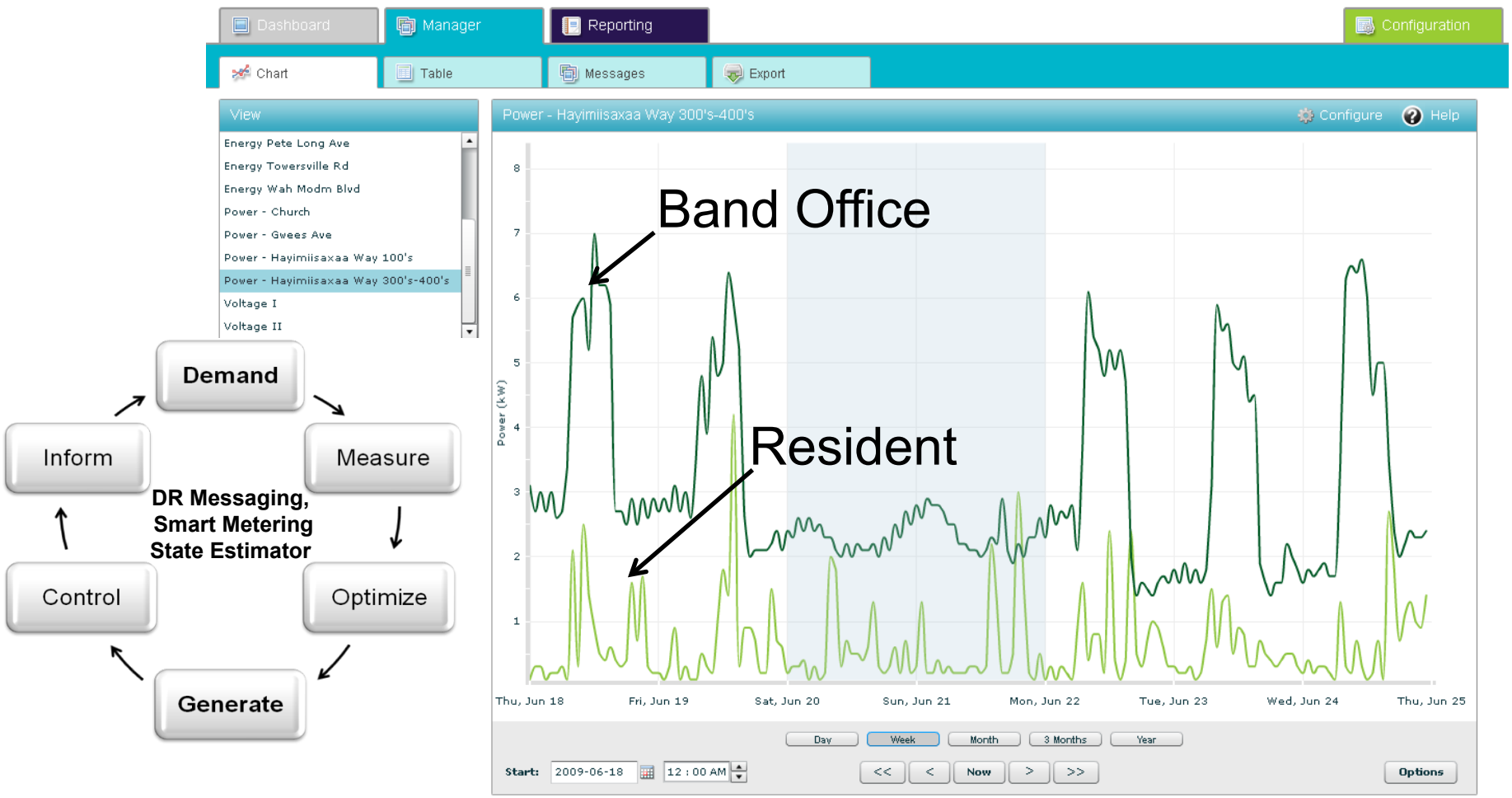
"Smart" remote Microgrid application: Hartley Bay Project

Source: M. Wrinch, B. Cullen, Pulse Energy, Vancouver, British Columbia, Canada

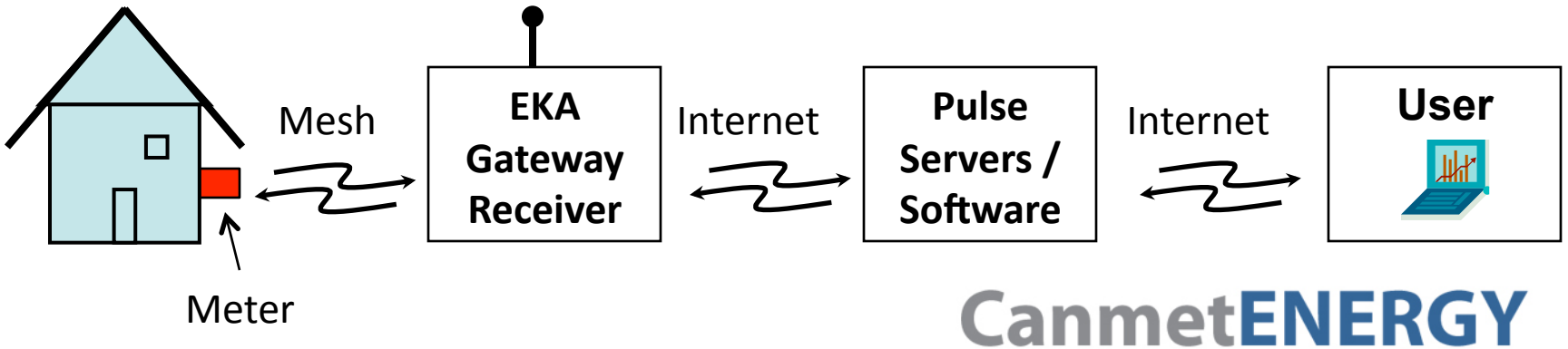
Hartley Bay – Smart Microgrid Metering Infrastructure



Source: M. Wrinch, B. Cullen, Pulse Energy, Vancouver, British Columbia, Canada

Smart Meter – Hartley Bay Project

- World Class Meter (Elster and Landis & Gyr)
- Measurements: V, A, kW, kWh
- Wireless Mesh Network: EKA Systems
- 15 minute updates
- Community Wi-Fi Installed



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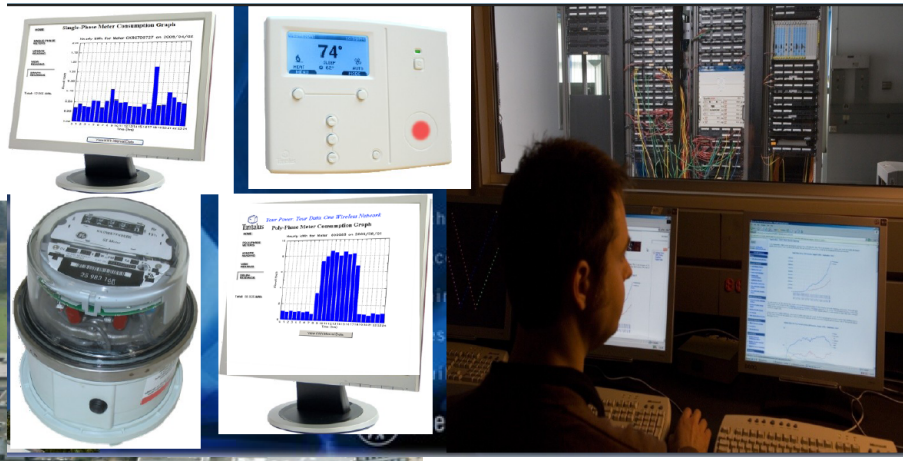
Source: M. Wrinch, B. Cullen, Pulse Energy, Vancouver, British Columbia, Canada

Intelligent Microgrid –
Canadian Microgrid Research Site

- **Smart Grid Campus R&D Site Consortium application**



BCIT's Burnaby Campus

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Source: Hassan Farhangi, British Columbia Institute of Technology, Burnaby, BC, Canada

Demand Response and Peak Load Management Application

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HVAC

Cell modem

Lighting

Heating

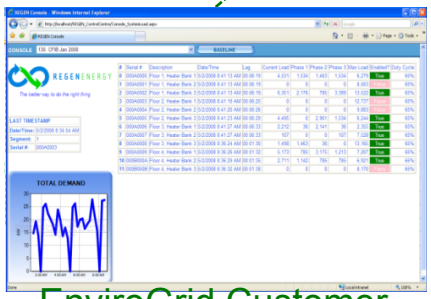
DHW

SITE INSTALLATION

Secure Internet Connection

EnviroGrid Server Cloud

EnviroGrid Web 2.0 APIs



EnviroGrid Customer Portal

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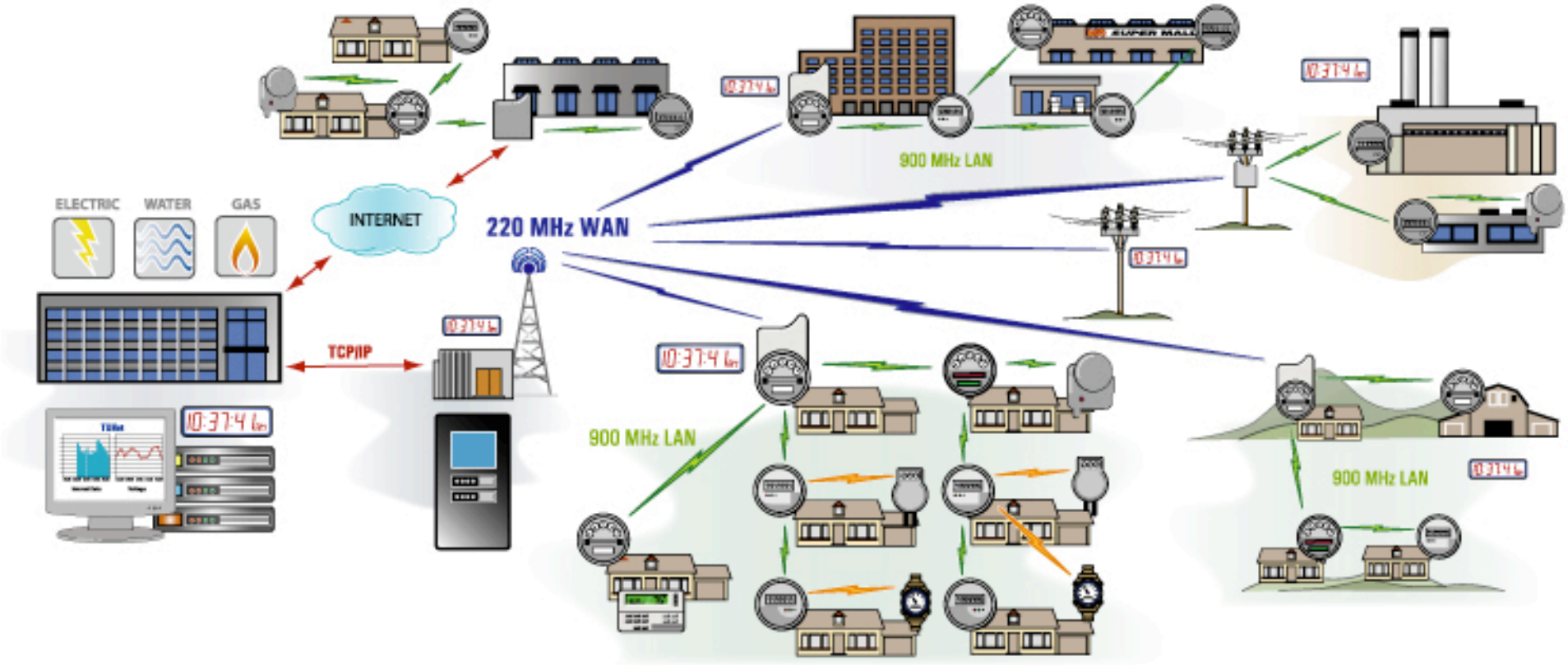
Expanding Capacity with Advanced Meter Infrastructure (AMI)



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(Source: Tantalus, British Columbia, Canada)

Conclusion

- Progress has been made on guidelines for planned islanding
- Technical research gaps have been addressed through demonstration projects.
- Need to encourage international collaboration on microgrid communication use cases
- Invitation to host the 6th International Symposium, Vancouver, BC, Canada (June 2010)

CanmetENERGY Research Centre in Varennes (Quebec)

Natural Resources Canada,

1615 Lionel-Boulet, Varennes, Quebec

http://canmetenergy.nrcan.gc.ca/eng/renewables/integration_der.html

Program objective: *To support national S&T efforts that will contribute to the modernization of the electricity grid network, enhance the benefits of renewable and clean distributed energy resources, increase diversity and reliability of supply, and facilitate recovery after disruptions.*

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