Canada Overview
Microgrid Research and Applications

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Vancouver 2010 Symposium on Microgrids

July 21-22, 2010

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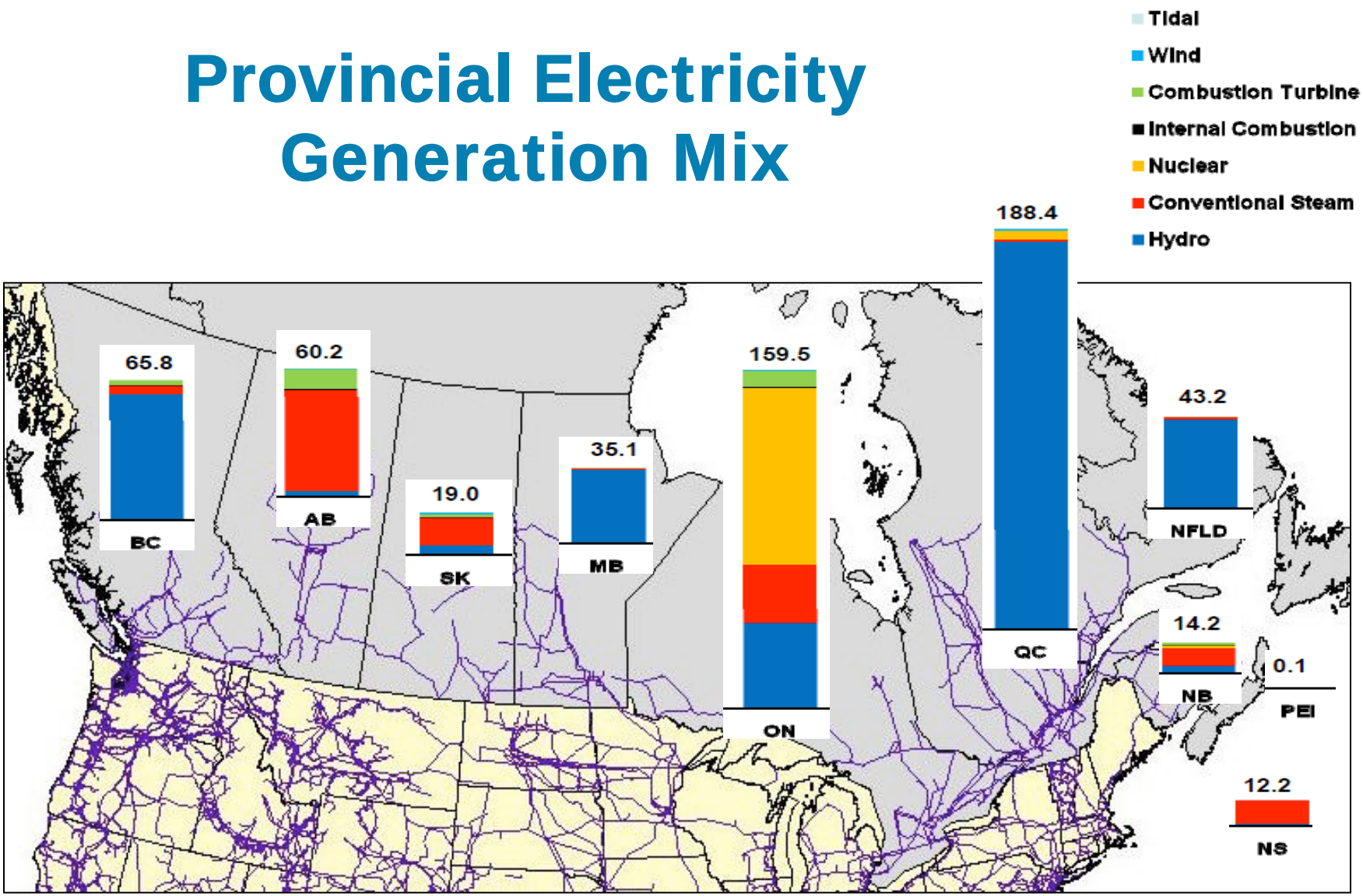
Presentation Plan

- Introduction – Canadian Context
- Project Overview
- Role of Demand Response
- Communication Issues
- Summary

Provincial Electricity Generation Mix



Statistical Source: North American Electric Reliability Council (NERC)
Map Source: Global Energy Network Institute (GENI)

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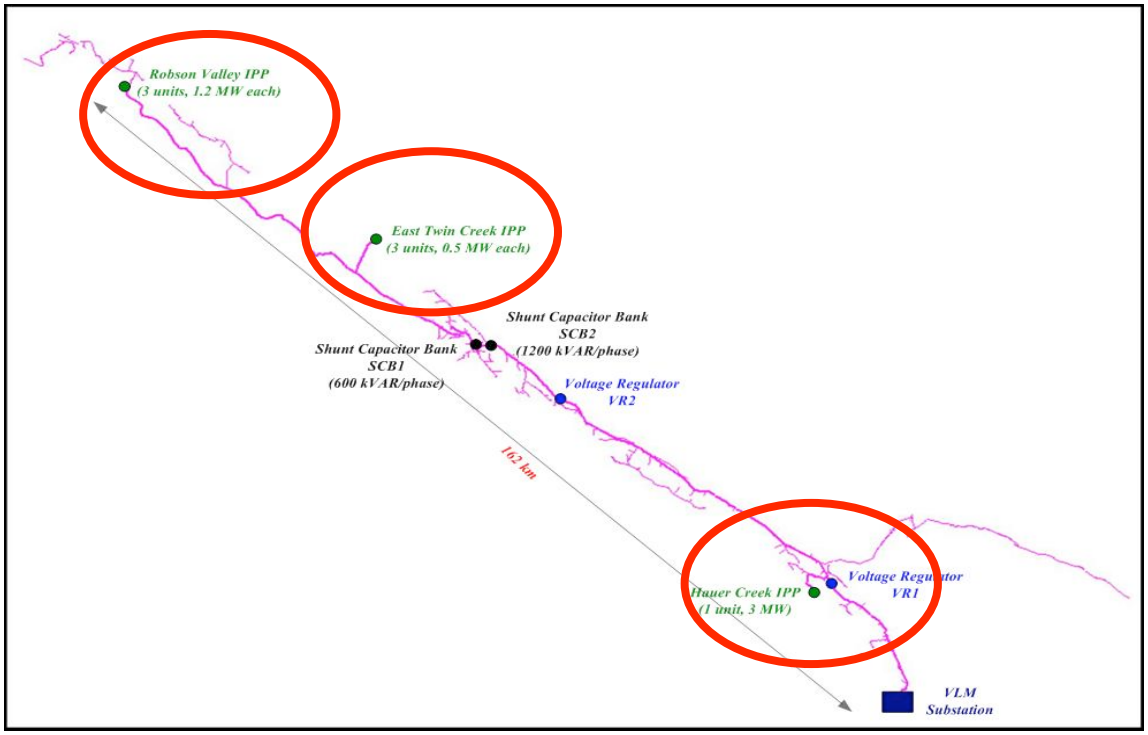
Program Objective

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.

Microgrid Research Activities

- Technology Assessment and Demonstrations
- Modeling, Simulation and Benchmark Case Studies
- Standards
- National and International Collaboration

Multiple-DG and Feeder Islanding Study BC Hydro

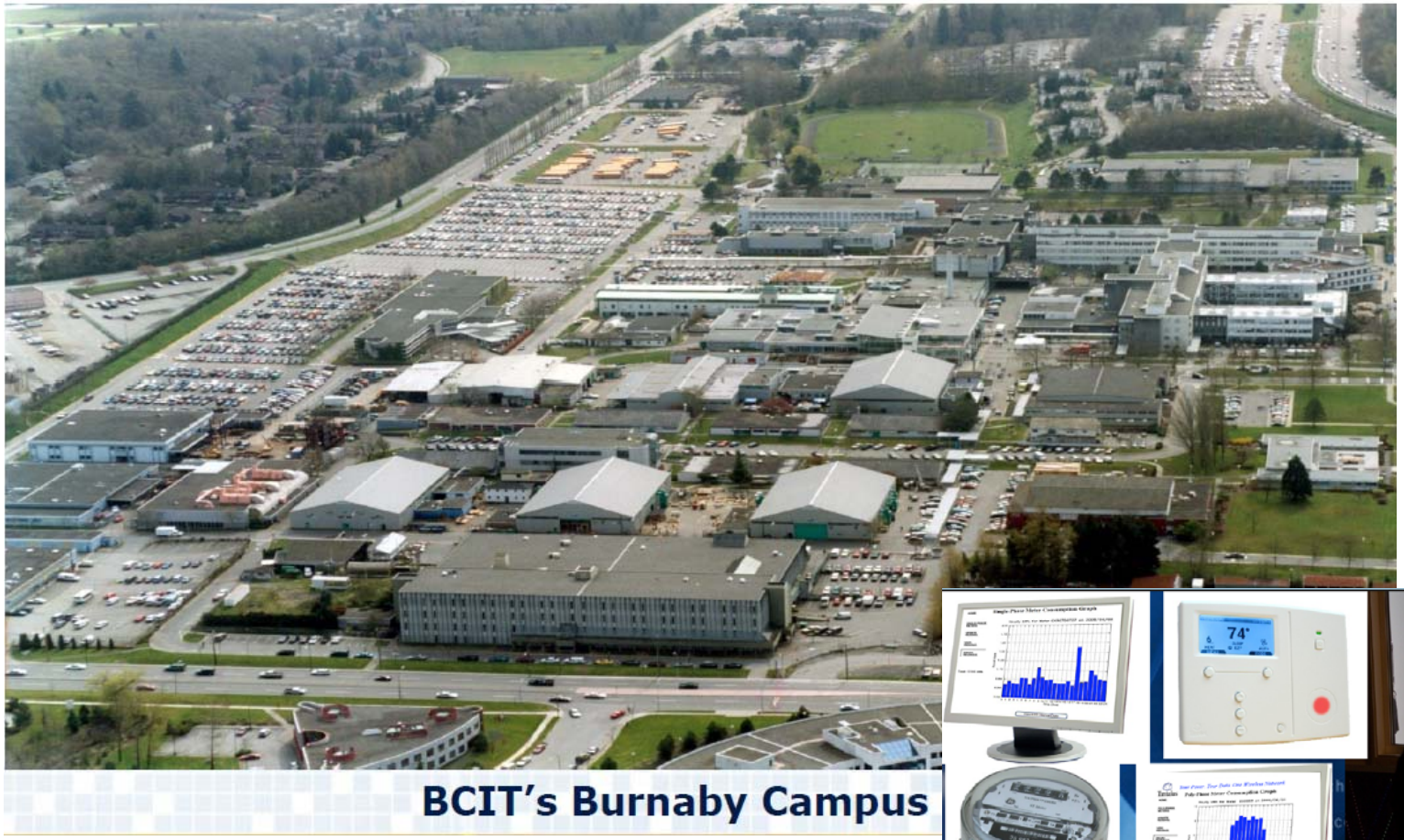


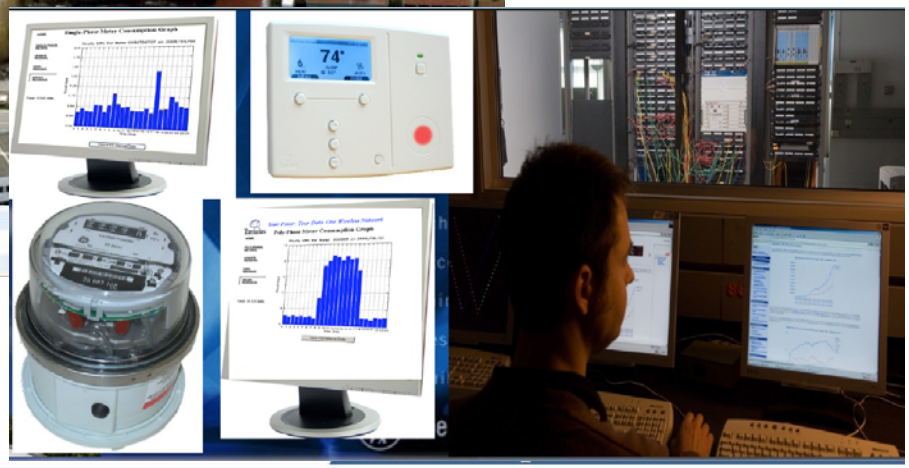
- Proven approach to improve reliability
- BC Hydro has over 10 years experience on islanded distribution feeders
- Smart grid technologies required for multiple DG implementation

R. Fulton, et al “Planned islanding of 8.6 MVA IPP for BC Hydro system reliability” First International Conference on the Integration of RE and DER, 1-3 December, 2004, Brussels, Belgium

J. Peralta, et al "BC Hydro perspective on distribution islanding for customer reliability improvement," Integration of Wide-Scale Renewable Resources Into the Power Delivery System, 2009 CIGRE/IEEE PES Joint Symposium, vol., no., pp.1-2, 29-31 July 2009

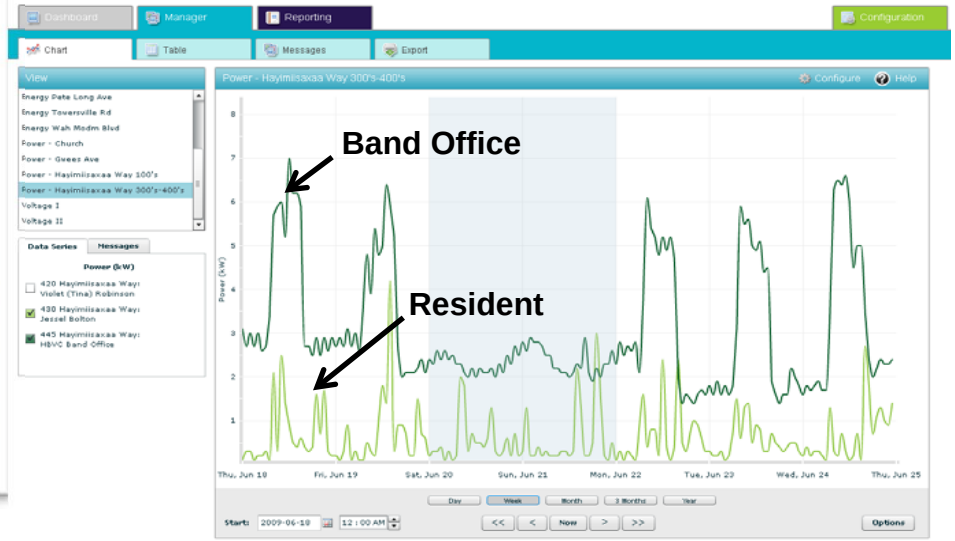
BCIT Campus Microgrid



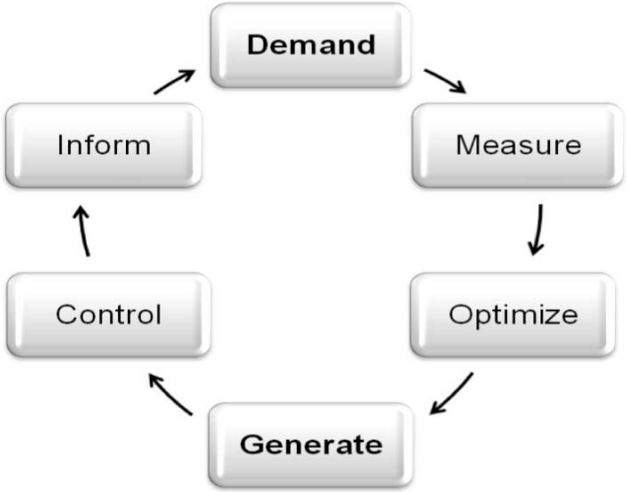


H. Farhangi "A path to smart grid", IEEE Power and Energy Magazine, Volume: 8 , Issue: 1 (2009) pp. 18-28

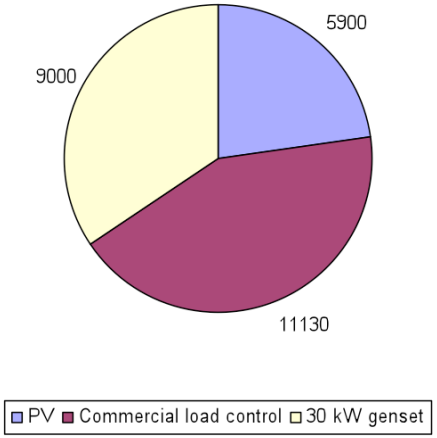
Smart Microgrid Project, Hartley Bay, BC



- July 22 presentation of remote community's experience
- Microgrid research provides valuable case study for remote and off-grid communities.
- Better understanding of cost-benefit of advanced metering infrastructure



Integrating PV in Remote Minigrid Application – www.iea-pvps.org



Fuel savings (in litres) from each of the three implemented measures.

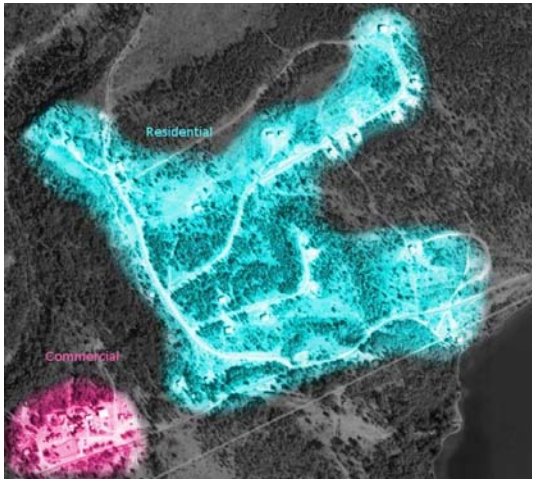
- Canada is convenor of IEA collaboration on PV-hybrid and minigrid Task 11 research

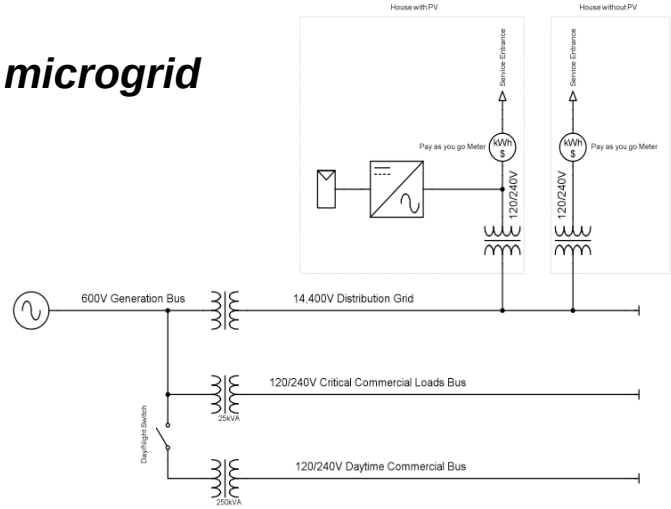
- Research and demonstration project in Nemiah, BC

Three measures were implemented in the Xeni Gwet'in mini-grid and monitored fuel savings

- Introducing distributed 27 kW Solar PV,
- Adding smaller genset to optimize system,
- Reducing commercial loads on weekday evenings and weekends by introducing a contactor to switch these off.

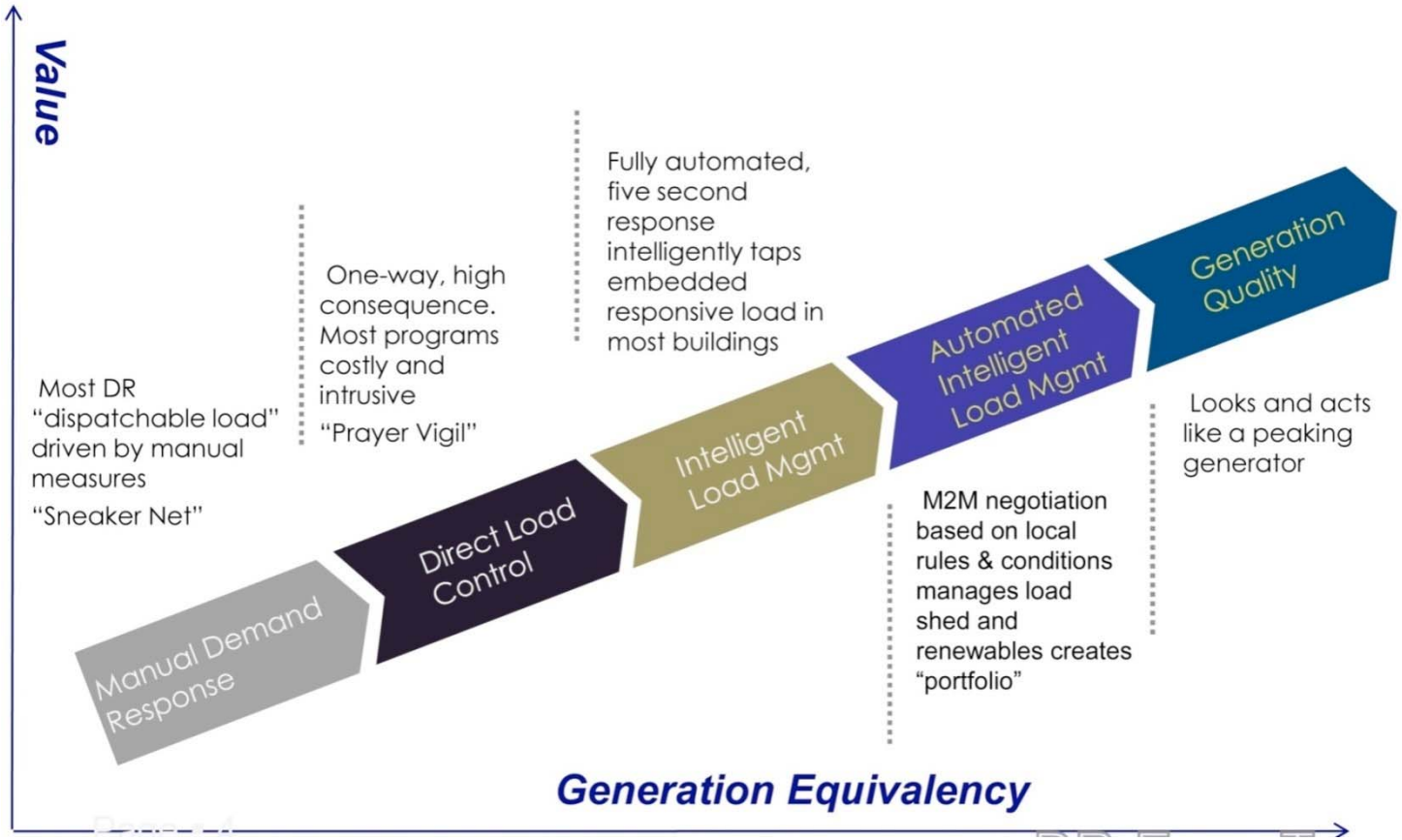
- July 22 presentation in remote microgrid session





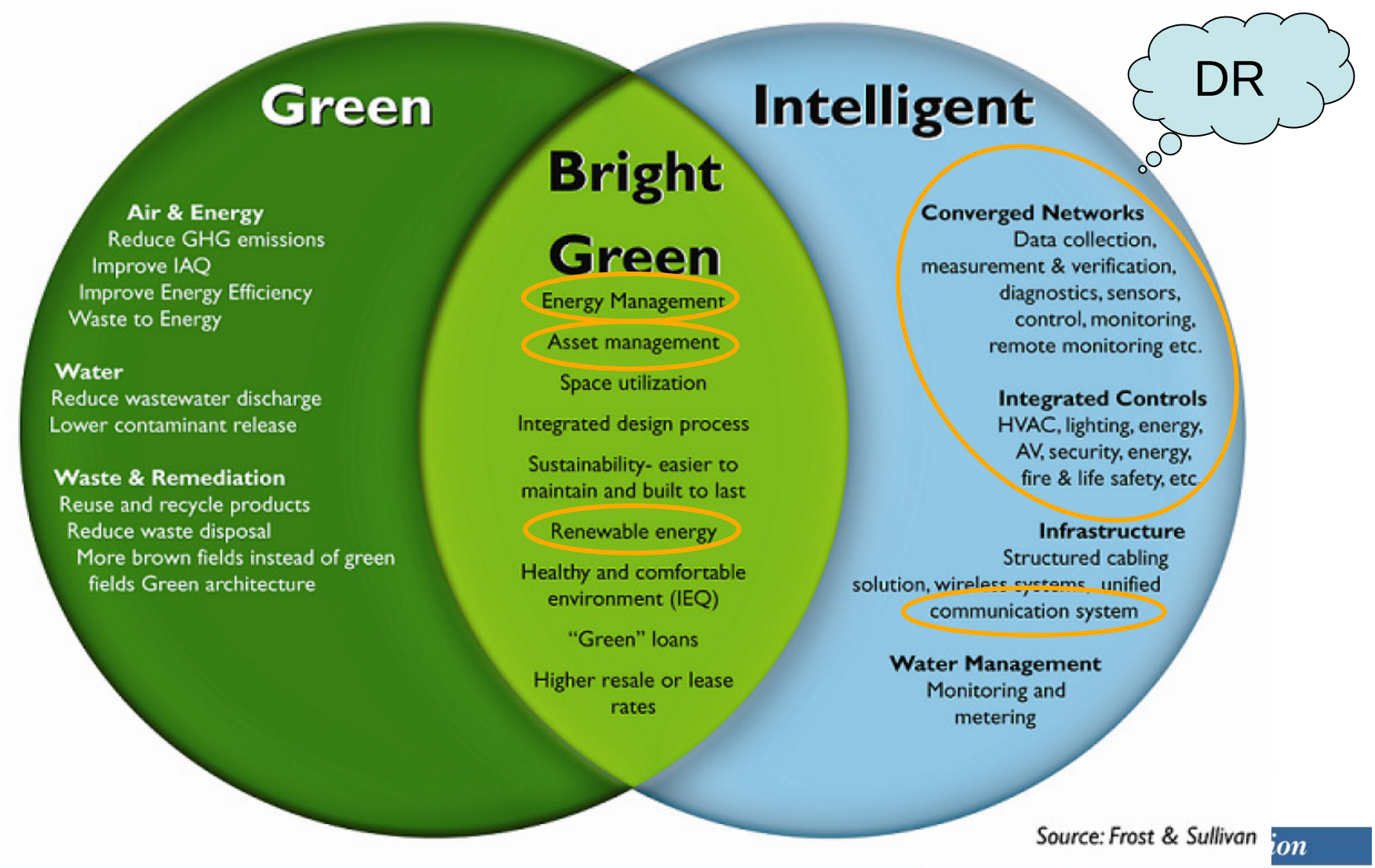
General Diagram of the mini-grid.

Demand Response



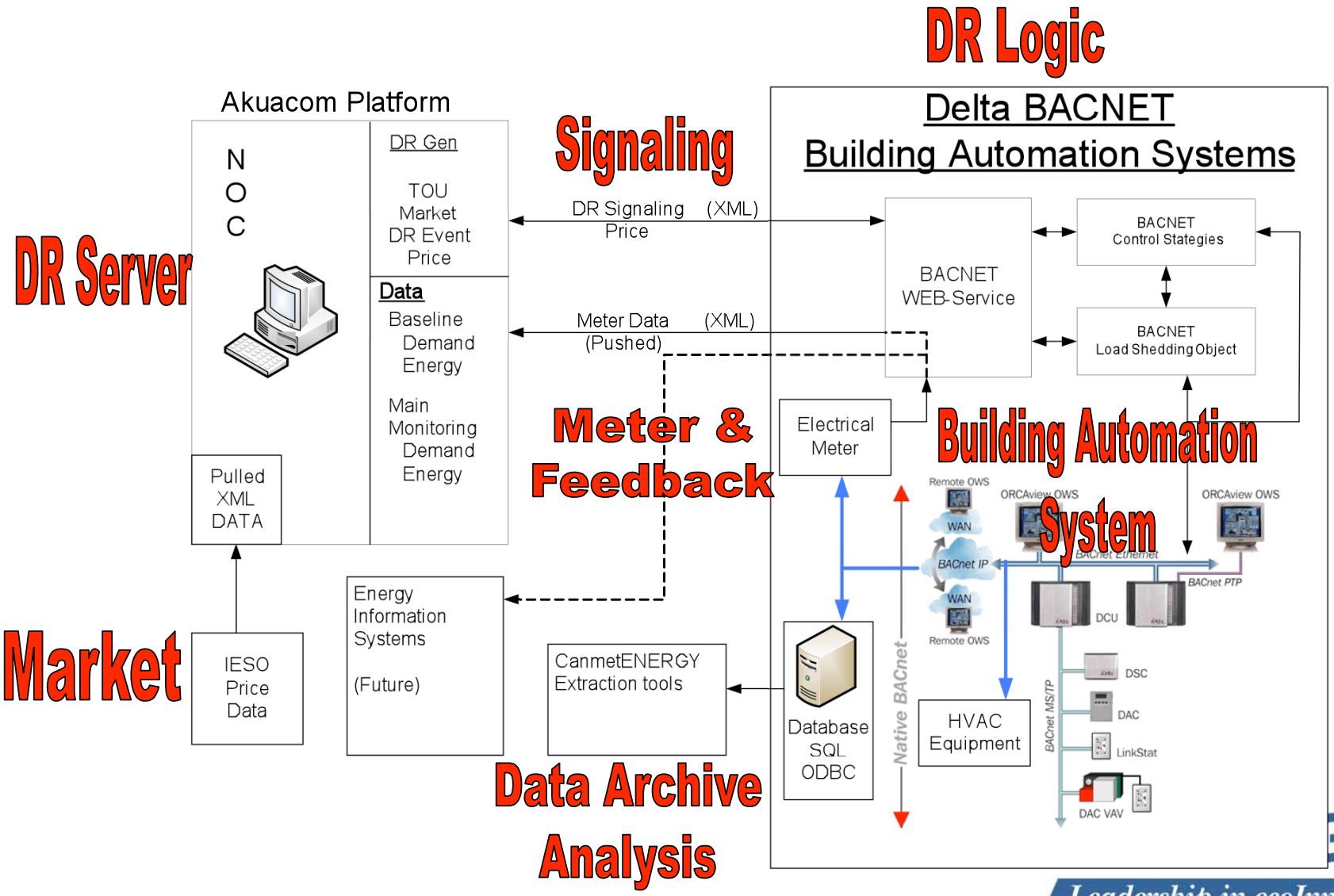
Source: http://www.pointview.com/data/2008/12/27/pdf/Mike-Frost-3638.pdf

Role of Demand Responsive (DR) Buildings



Source: Frost & Sullivan

Demand Responsive Building Architecture



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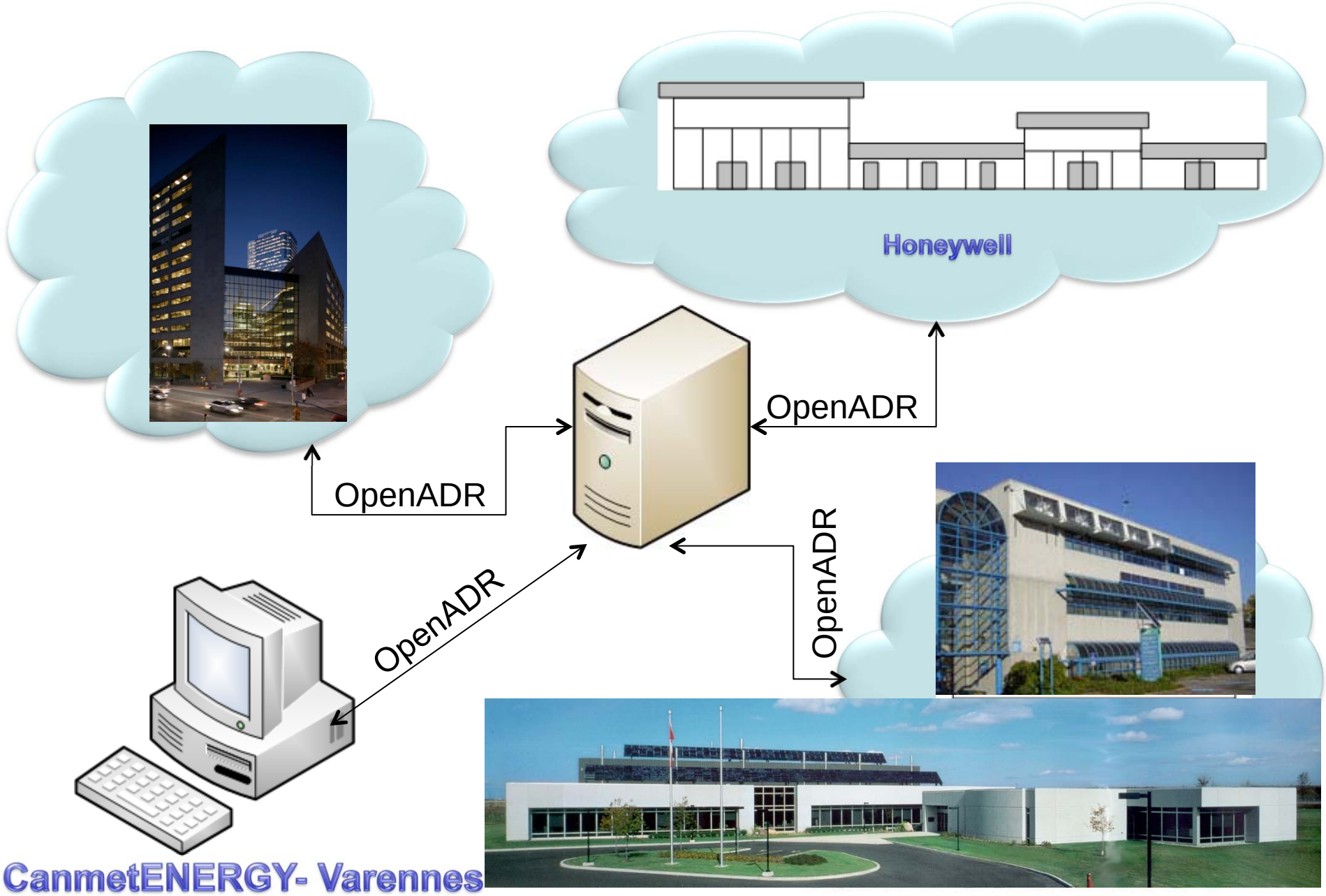
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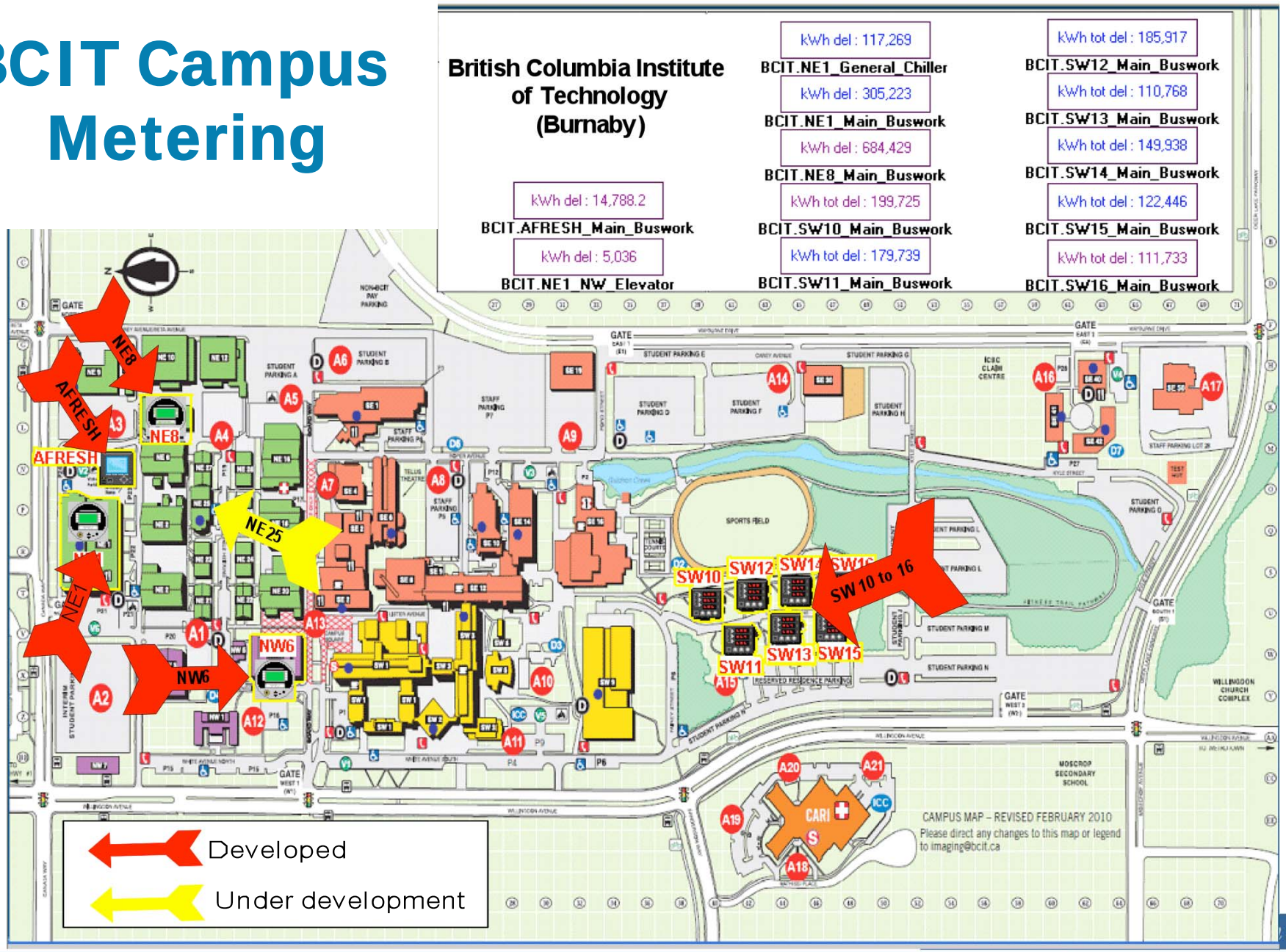
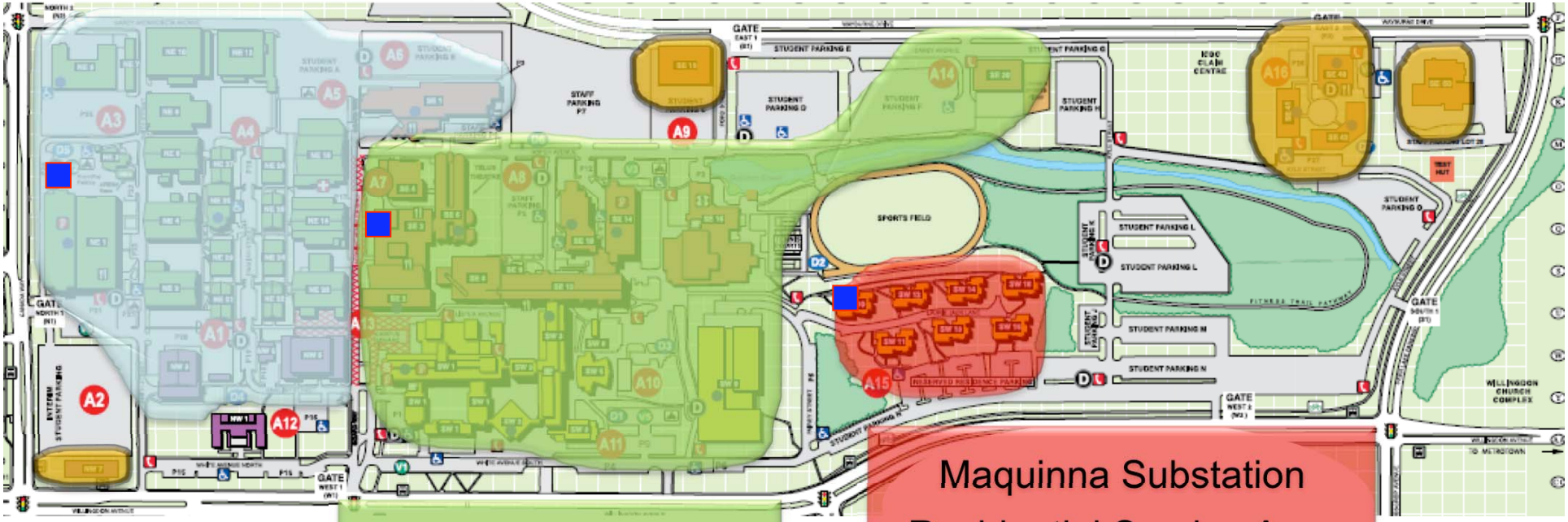


BCIT Campus – BC Hydro Interconnection

Canada Way Receiving Station Serving Area

Buildings Fed from Dedicated BC Hydro Pad/Pole Mounted Transformers



Goard Way Receiving Station Serving Area

Maquinna Substation Residential Serving Area

Receiving station/substation

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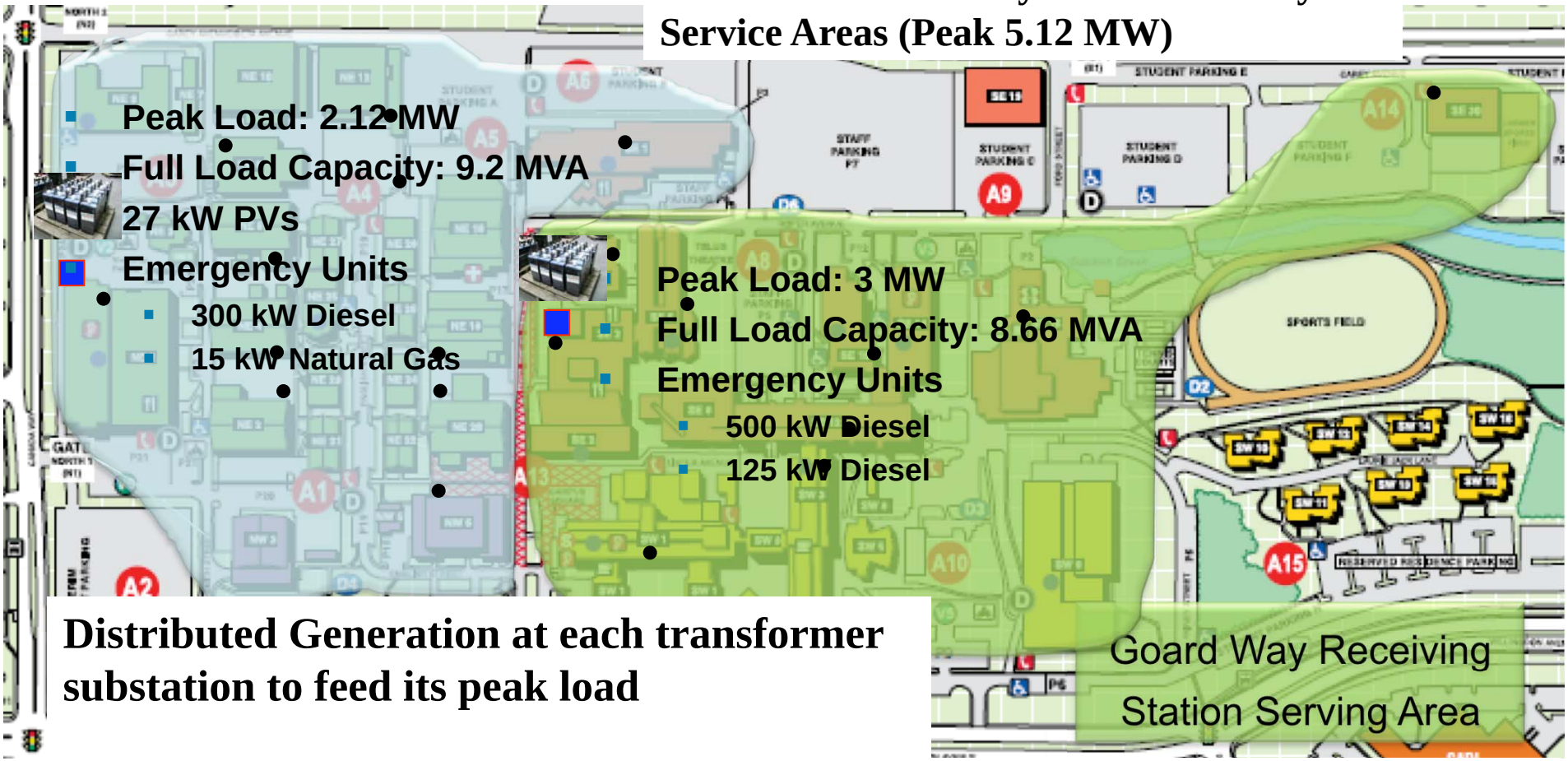
Modeling and Simulation

Canada Way Receiving Station Serving Area

Focus on Canada Way and Goard Way Service Areas (Peak 5.12 MW)

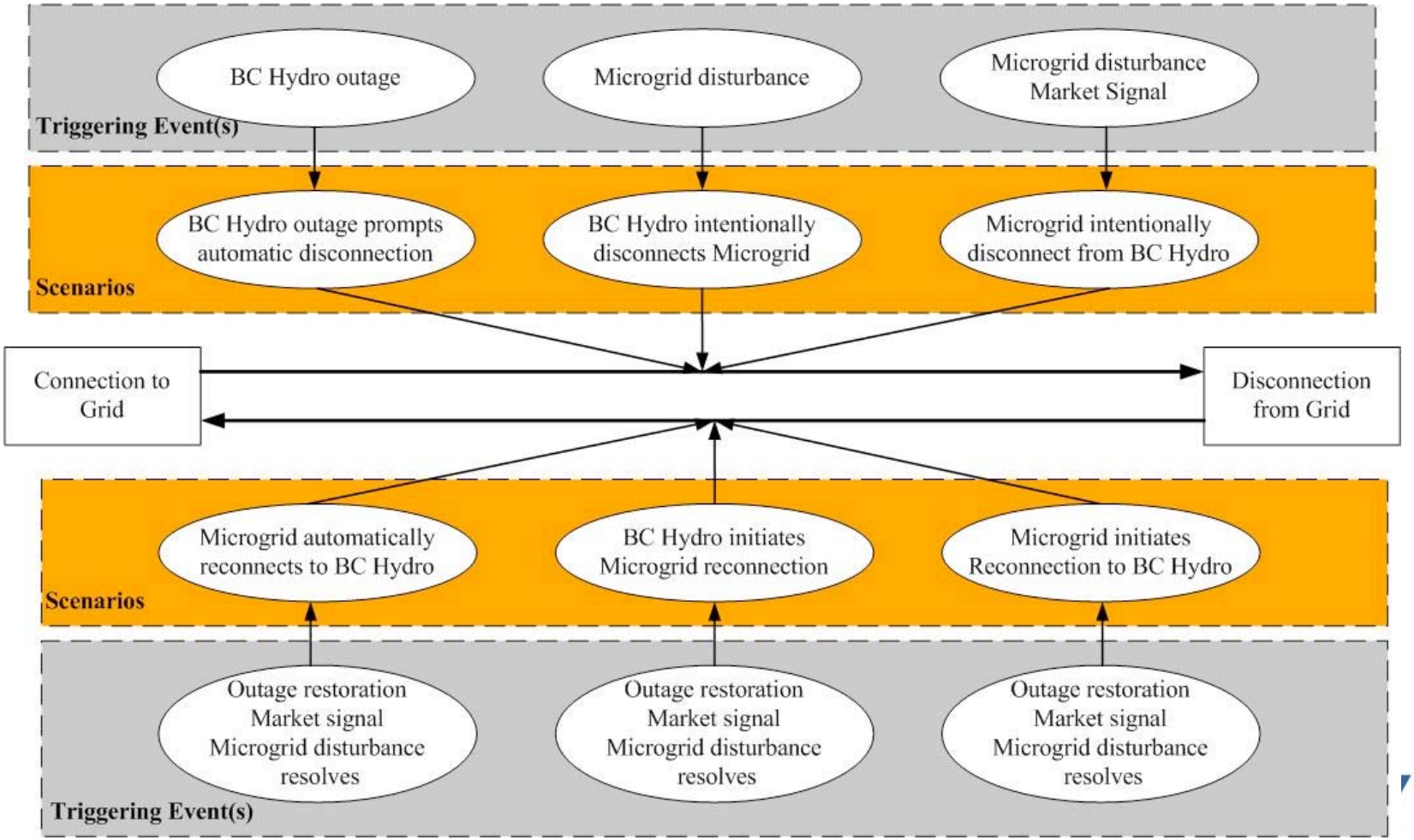


Distributed Generation at each transformer substation to feed its peak load

Storage at each receiving station for voltage regulation and power mismatch balancing during Microgrid operation

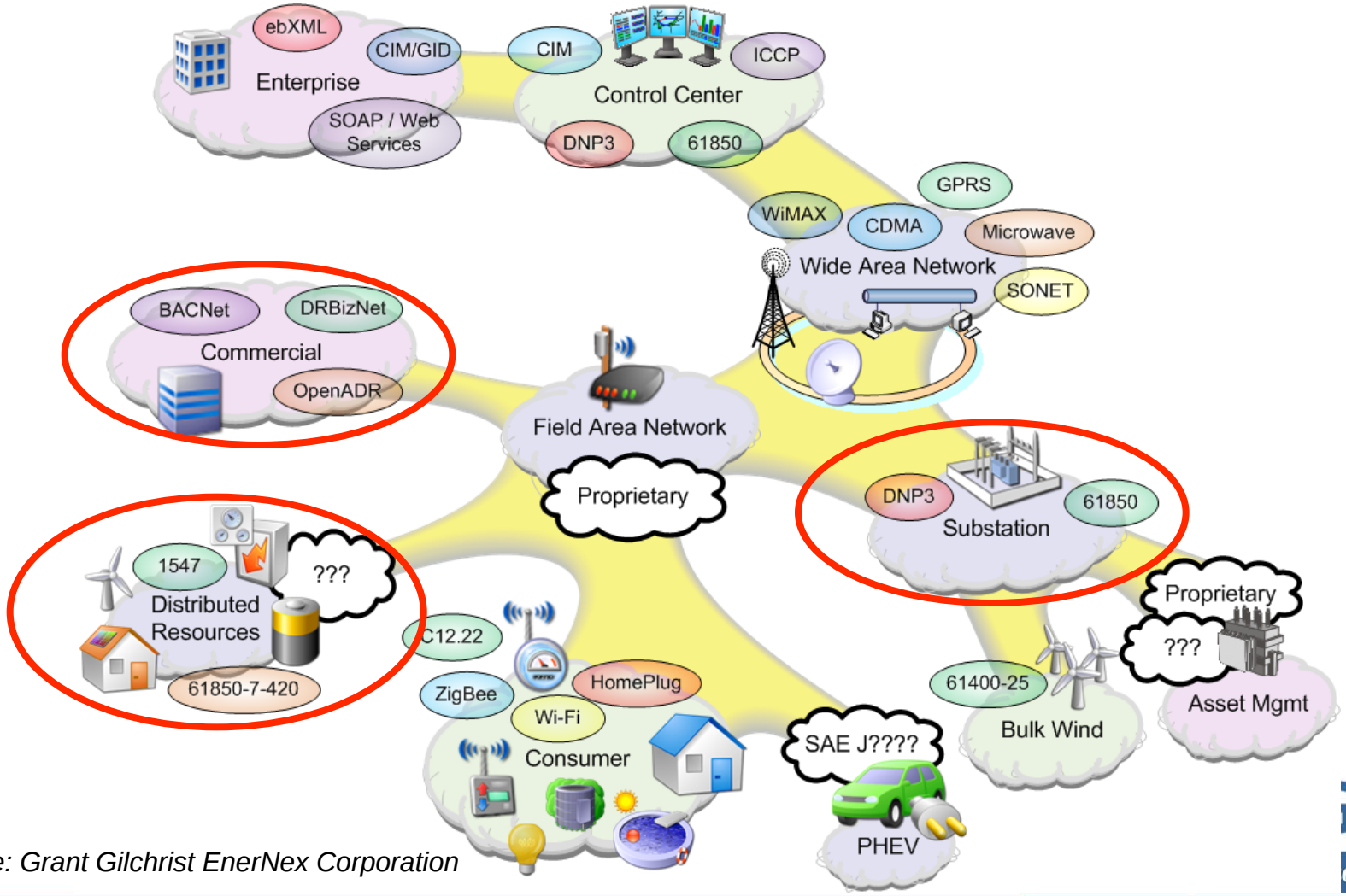
- Receiving station/substation
- Transformer + Distributed Generation

Microgrid Communication "Use Cases"



Standardization Effort Smart Grid :

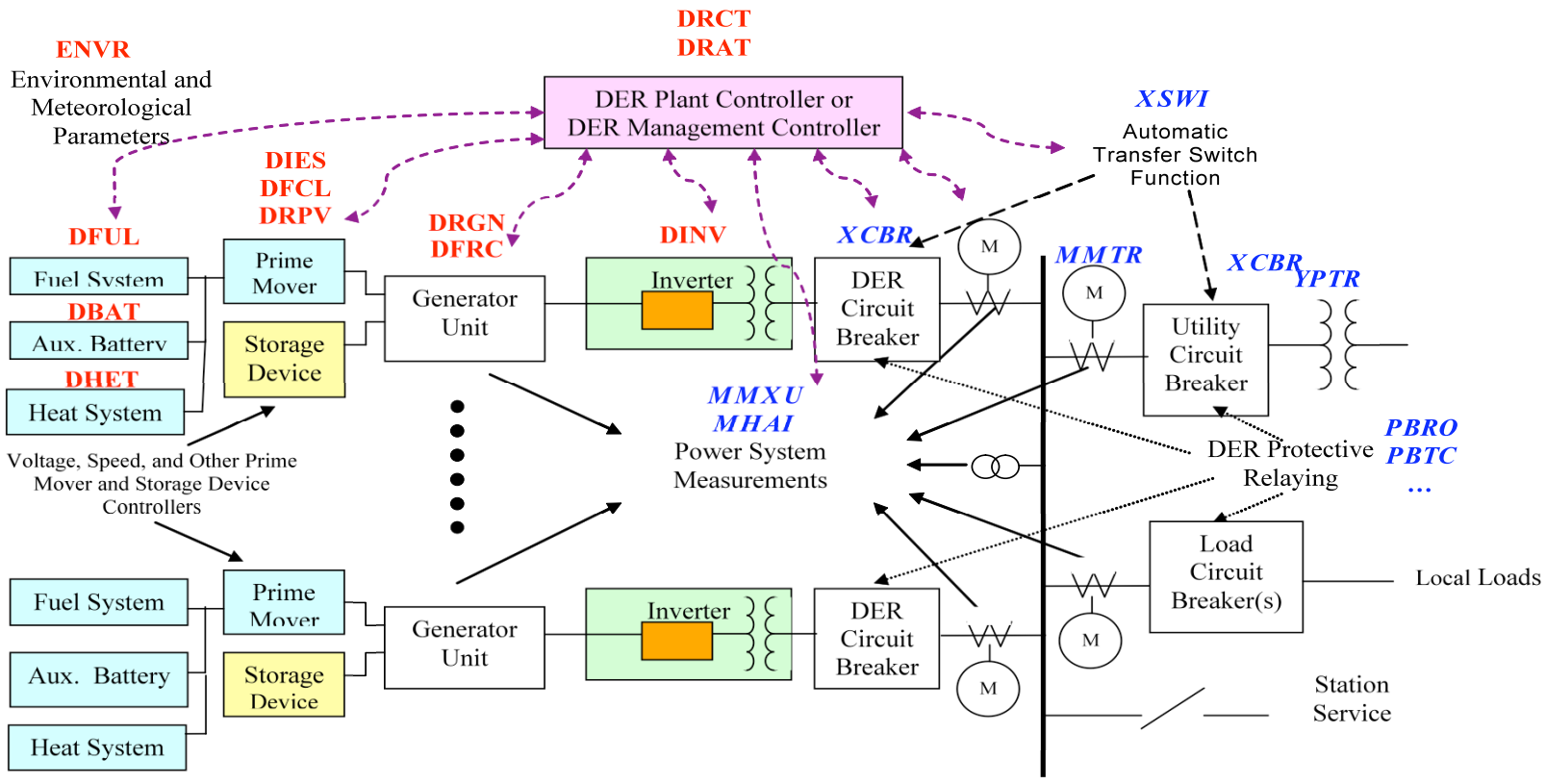
- Participation in Canadian IEC Technical Committee 57
- Communication protocols addressing inter-operability



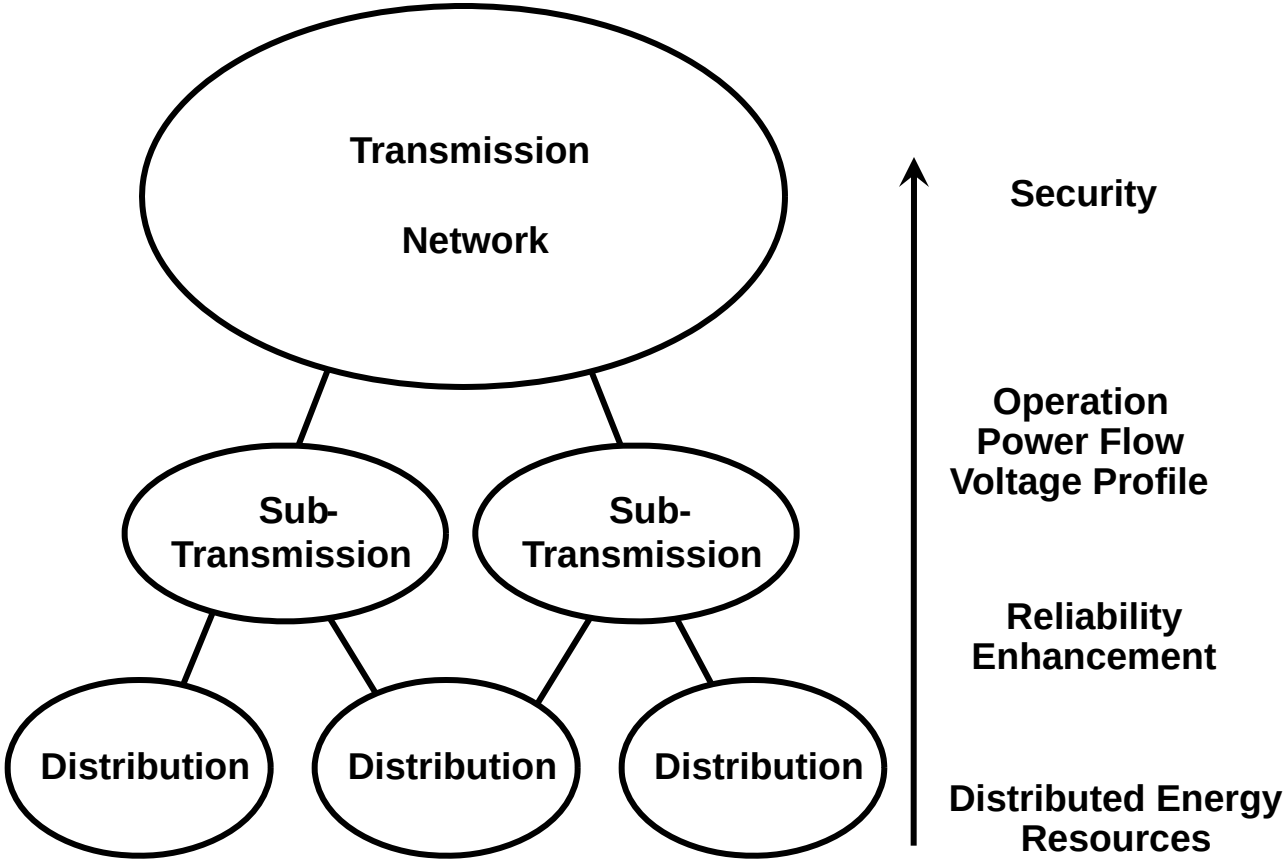
Source: Grant Gilchrist EnerNex Corporation

Communication Networks and Systems for Power Utility Automation - IEC TC 57

IEC 61850 Part 7-420 Distributed Energy Resources Logical Nodes



Advancement in Transmission and Distribution Management Systems



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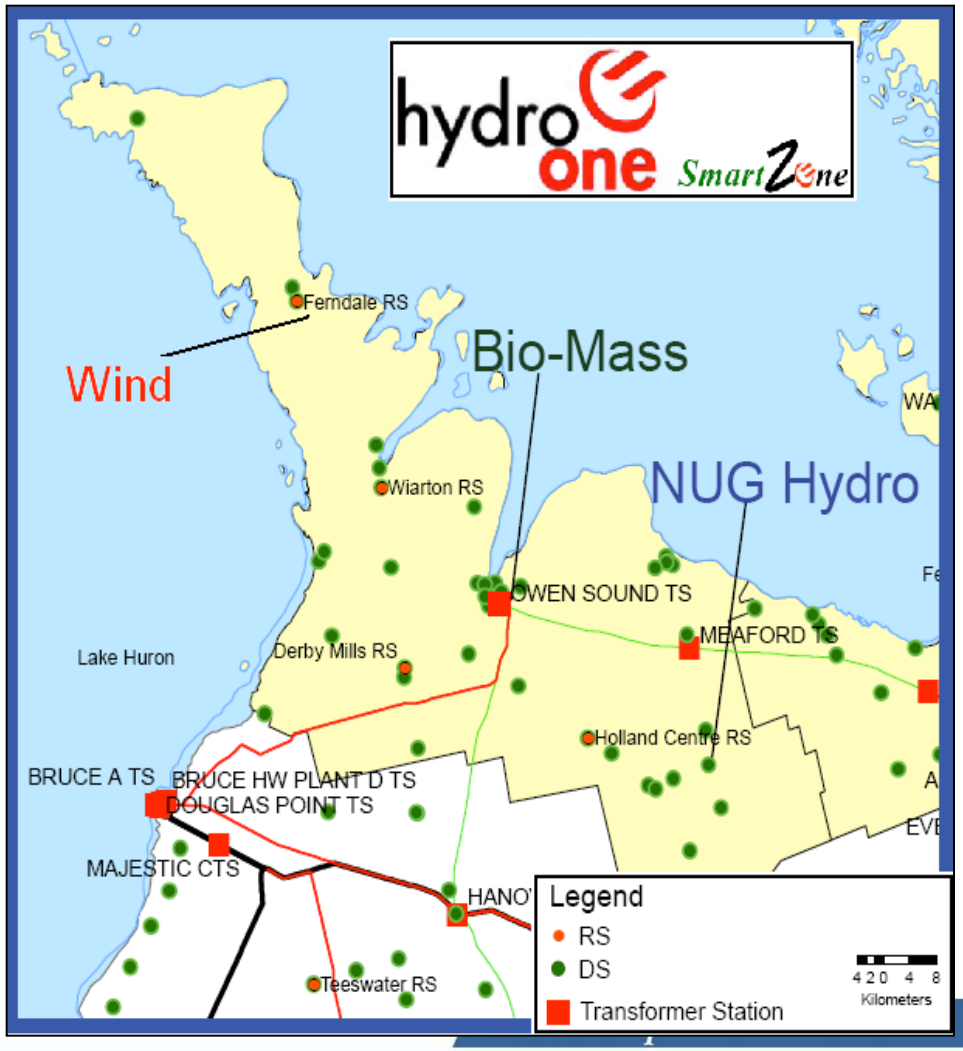
Example: Ontario Smart Zone project

- Two LDC companies and one TSO
- Serving 110,000 people
- Mix of rural and urban customers
- Mix of TS and DS stations
- Renewable resources
- Integrate protection, control and metering solution
- Fiber optic backbone
- Testing wireless WiMax 1800-1830 MHz
- IEC 61850 substations



Source: Hydro One

References to Canadian Microgrid Publications 09-10

1. Mizani, S.; Yazdani, A.; “Design and operation of a remote microgrid”, Proceedings of the 35th Annual Conference of IEEE on Industrial Electronics, 2009. IECON '09. (2009) Page(s): 4299 - 4304
2. Mizani, S.; Yazdani, A.; “Design and operation of a remote microgrid”, Proceedings of the 35th Annual Conference of IEEE on Industrial Electronics, 2009. IECON '09. (2009) Page(s): 4299 - 4304
3. Mizani, S.; Yazdani, A.; “ Optimal design and operation of a grid-connected microgrid”, Proceedings of the 2009 IEEE Electrical Power & Energy Conference (EPEC). (2009) Page(s): 1 – 6
4. Yan Li; Yun Wei Li;” Decoupled power control for an inverter based low voltage microgrid in autonomous operation”, Proceedings of the IEEE 6th Power Electronics and Motion Control Conference, 2009. IPEMC '09. (2009) Page(s): 2490 – 2496
5. Hosseinzadeh, H.; Huang, X.; Jiang, J.; “Simulation of micro-sources in a small scale microgrid” Proceedings of the IEEE Power & Energy Society General Meeting, 2009. (2009) Page(s): 1 - 8
6. Yun Wei Li; Ching-Nan Kao; “An Accurate Power Control Strategy for Power-Electronics-Interfaced Distributed Generation Units Operating in a Low-Voltage Multibus Microgrid” IEEE Transactions on Power Electronics, Volume: 24, Issue: 12 (2009) Page(s): 2977 - 2988
7. Yan Li; Yun Wei Li; “Virtual frequency-voltage frame control of inverter based low voltage microgrid” Proceedings of the 2009 IEEE Electrical Power & Energy Conference (EPEC). (2009) Page(s): 1 - 6

References to Canadian Microgrid Publications 09-10

8. Yun Wei Li; ChingNan Kao; “An accurate power control strategy for inverter based distributed generation units operating in a low voltage microgrid” Proceedings of the 2009 Energy Conversion Congress and Exposition, 2009. ECCE 2009. (2009) Page(s): 3363 - 3370
9. Aghasafari, M.A.; Lopes, L.A.C.; Williamson, S.; “Frequency regulation and enhanced power sharing in microgrids including modified droop coefficients and virtual resistances” Proceedings of the 2009 IEEE Electrical Power & Energy Conference (EPEC). (2009) Page(s): 1 - 6
10. Bhuiyan, F.A.; Yazdani, A.; “Multimode Control of a DFIG-Based Wind-Power Unit for Remote Applications” IEEE Transactions on Power Delivery, Volume: 24 , Issue: 4 (2009) Page(s): 2079 - 2089
11. Delghavi, M.B.; Yazdani, A.; “A control strategy for islanded operation of a Distributed Resource (DR) unit”, Proceedings of the IEEE Power & Energy Society General Meeting, 2009. (2009) Page(s): 1 - 8
12. Abbas, A.M.; Lehn, P.W.; “A unified power delivery solution for integrating DER into distribution networks through VSC based DC system” Proceedings of the IEEE Power & Energy Society General Meeting, 2009. (2009) Page(s): 1 - 6
13. Kamh, M. Z.; Iravani, R.;” Unbalanced Model and Power-Flow Analysis of Microgrids and Active Distribution Systems” IEEE Transaction on Power Delivery, (2010)
14. Mehrizi-Sani, A.; Iravani, R.; “ Potential-Function Based Control of a Microgrid in Islanded and Grid-Connected Modes” IEEE Transaction on Power Systems, (2010)
15. Delghavi, M. B.; Yazdani, A.; “Islanded-Mode Control of Electronically Coupled Distributed-Resource Units Under Unbalanced and Nonlinear Load Conditions” IEEE Transaction on Power Delivery, (2010)

Summary

- Technical research gaps are being addressed through demonstration projects
- Provide test results required for revision or update to standards
- Strengthen Canadian capacity through dissemination of knowledge and collaborative projects between publicly funded research centers, utilities and developers
- Share results at international conferences and workshops

Albuquerque, New Mexico, USA

4th International Conference on

Integration of Renewable and Distributed Energy Resources

December 6 - 10, 2010
Albuquerque, USA

Organizers

Conference Organizer

Electric Power Research Institute
3420 Hillview Avenue
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Conference-related questions or comments? Please contact EPRI.

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- ***Invitation to the 4th International Conference on the Integration of Renewable and Distributed Energy Resources***
  - December 6-10, 2010
  - Very successful events every 2 years contributing to the advancement of the research to address, technical, regulatory and market integration issues.

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Questions

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

Communication Specifications

1. "ISO/IEC-7498-1 Information Technology – Open System Interconnection – Basic Reference Model: The Basic Mode"l, Second Edition, 1994.
2. "EIA Standard RS-232-C Interface Between Data Terminal Equipment and Data Communication Equipment Employing Serial Data Interchange", Electronics Industries Association, August 1969.
3. "TIA/EIA-485: Electrical Characteristics of Generators and Receivers for Use in Balanced Digital Multipoint Systems", Engineering Department, Electronic Industries Association, Greenlawn NY, 1985
4. Ethernet, "IEEE 802.3: IEEE Standard for Information Technology-Telecommunications and Information Exchange Between Systems-Local and Metropolitan Area Networks-Specific Requirements Part 3: Carrier Sense Multiple Access With Collision Detection (CSMA/CD) Access Method and Physical Layer Specifications", Institute of Electrical and Electronic Engineers.
5. WiFi, "IEEE 802.11: IEEE Standard for Information Technology-Telecommunications and Information Exchange Between Systems-Local and Metropolitan Area Networks-Specific Requirements - Part 11: Wireless LAN Medium Access Control (MAC) and Physical Layer (PHY) Specifications", Institute of Electrical and Electronic Engineers.
6. "Bluetooth Core Specifications", The Bluetooth Special Interest Group (SIG), http://www.bluetooth.com/English/Technology/Building/Pages/Specification.aspx.
7. "Modbus Application Protocol Specification V 1.1b", The Modbus Organization, MA, USA, December 2006, http://modbus.com/specs.php.
8. CANbus, "ISO 11898-1: Road vehicles - Controller area network (CAN) - Part 1: Data link layer and physical signalling", International Organization for Standardization, 2003 – revised in 2006.
9. "RFC 791: Internet Protocol – DARPA Internet Program – Protocol Specification", Internet Engineering Task Force (IETF), 1981, http://tools.ietf.org/html/rfc791, follow links for various amendments.
10. "RFC 793: Transmission Control Protocol – DARPA Internet Program – Protocol Specification", Internet Engineering Task Force (IETF), 1981, http://tools.ietf.org/html/rfc793, follow links for various amendments.
11. "RFC 2616: Hypertext Transfer Protocol -- HTTP/1.1", Internet Engineering Task Force (IETF), 1999, http://tools.ietf.org/html/rfc2616, follow links for various amendments.
12. "RFC 5321: Simple Mail Transport Protocol", Internet Engineering Task Force (IETF), 2006, http://tools.ietf.org/html/rfc5321, follow links for various amendments.
13. "USB Specification", Consortium of Hewlett-Packard Company, Intel Corporation, Microsoft Corporation, NEC Corporation, ST-NXP Wireless and Texas Instruments, http://www.usb.org/developers/docs/
14. IEC 61850-7-420Ed.1: Communication networks and systems for power utility automation – Part 7-420: Basic communication structure – Distributed energy resources logical nodes, www.iec.ch, 2007