

Overview of Smart Grid Research at BCIT

Hassan Farhangi, PhD, PEng, SM-IEEE
Director, GAIT, British Columbia Institute of Technology

June 2010



Background

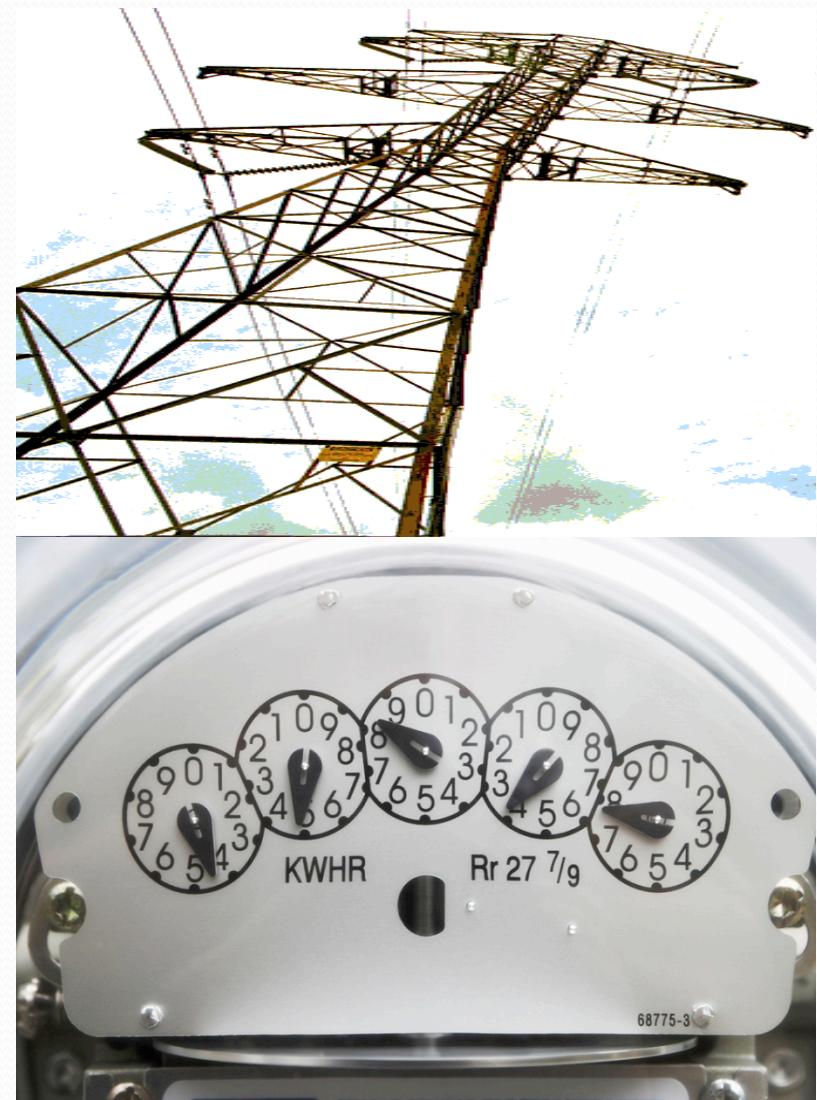
- Much of the world uses ‘dirty’ means to generate electricity (coal, nuclear, etc.)
- Existing grid infrastructure antiquated
- Tremendous pressure to meet demand
- Centralized Grid where only 1/3 of fuel energy is converted to electricity
- Waste heat is not recovered
- 8% is lost along transmission lines
- 20% gen capacity exists to meet peak demand only (i.e. 5% of time)
- Domino effect failures
- Vulnerable infrastructure



Smart Grid

Features:

- Secure
- Self-healing
- Self-monitoring
- Allows DR & Co-Gen
- Reduces GHG emissions



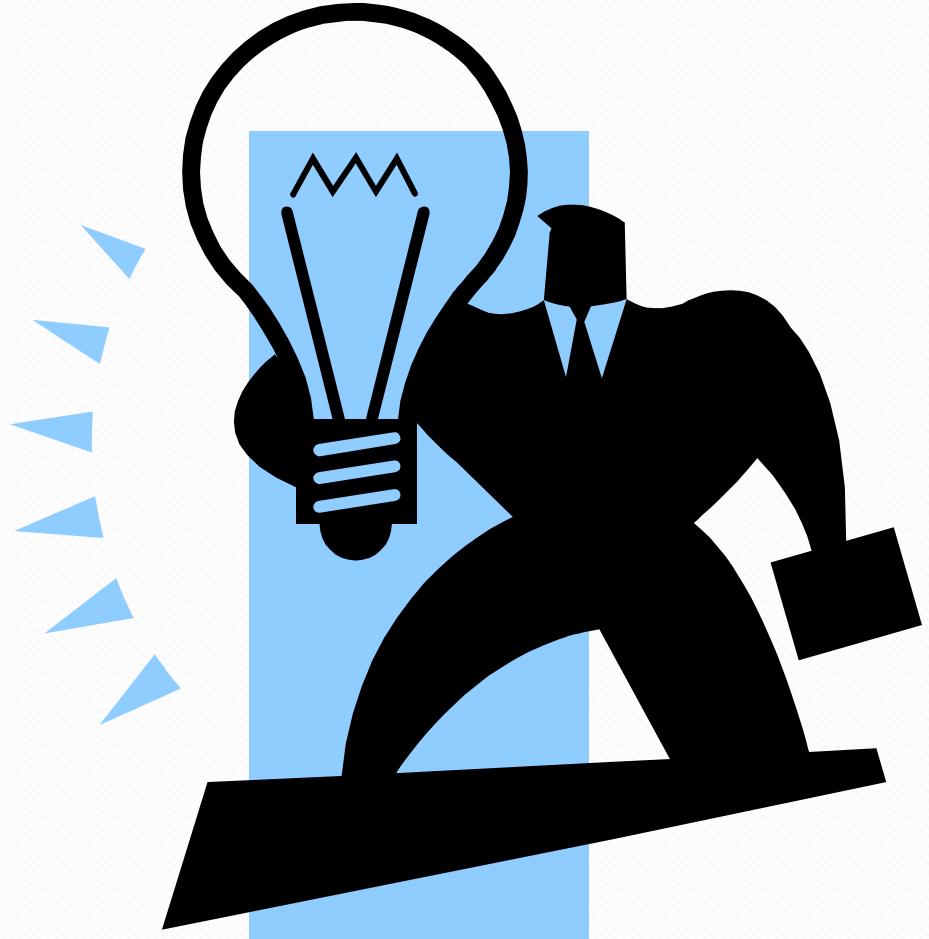
The Challenge

- Critical services
- New technology
- Proprietary solutions
- Interoperability standards
- Field unproven



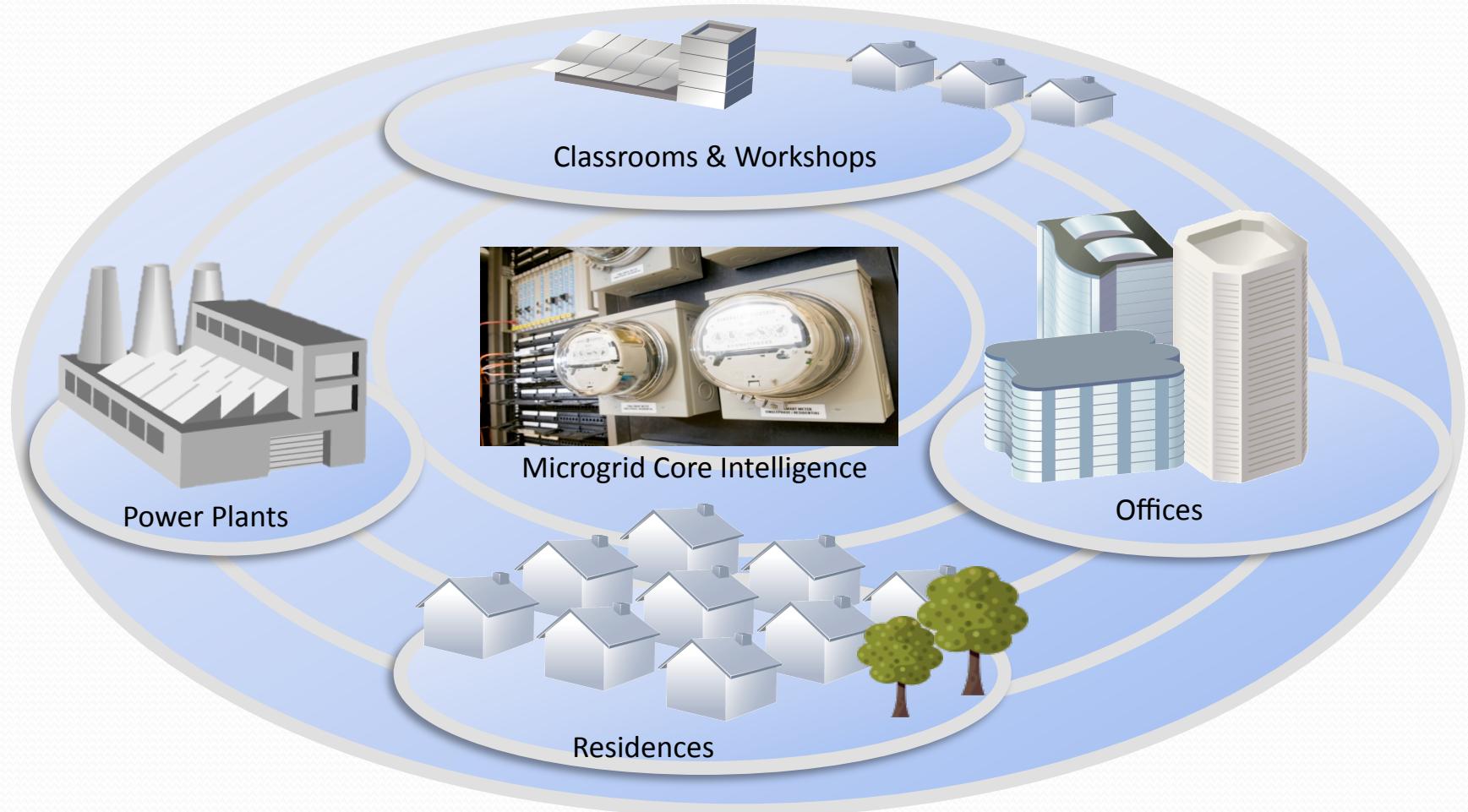
The Solution

- Near-real test bed
- Controlled
- Qualify Solutions
- Validate Standards



These require a Smart Microgrid !

Smart Microgrid



The Project

Canada's first campus based Smart Microgrid at BCIT's Burnaby Campus



Core Intelligence : BCIT's SGCS



Project Phases

Phase 1: Construction of Microgrid (2008-2010)

- Completion of Smart Metering on designated loads
- Development of Load Control Devices for Afresh/Dorms
- Integration of Comm Network (Zigbee, WiMax and Fiber backhaul)
- Integration of Co-Gen, Solar Modules and Wind Turbine
- Completion of protection/islanding of BCIT Campus
- Retrofitting and Integration of AFRESH with Microgrid
- Dev of BCIT EMS system (target 10% annual saving)

Phase 2: Research and Development (2010-2015)

- Research thru NSERC Strategic Network (UoNB, McGill, UoT, UoWO, UoA, UBC, SFU, UVIC and BCIT)

Phase 3: Microgrid Commercialization (2015-2017)

- Setup of Industry Canada's NCE (Network of Centers of Excellence) in pan-Canadian Smart Grid technology

Current Sub-Project Details

- Energy Management System
- Maquinna Residence AMI
- North Campus AMI
- AFRESH HAN
- Solar Power Tower
- Thermal Turbine
- Smart Grid Control Center



EMS - Energy Mgmt System

- Build various loads consumption profile
- Integrate power generation
- Sensors Network
- Respond to pricing signals (demand response)
- Schedule electrical consumption
- Smart Appliances



Residence Smart Meters

- Allow real-time meter readings
- Communication-enabled
- Gear donated by vendors,
installed by BCIT TC staff
- Utilities keenly interested in
HAN/LAN/WAN Performance



EMS Residence Portal

- Increase awareness of electrical consumption
- Reduce consumption by modifying consumer behavior
- Social science research strongly influences portal design
- Consumers sensitive to how they're doing vs their neighbours
- People like competitions...



EMS Residence Portal

BCIT :: applied research :: microgrid residence portal - Mozilla Firefox

File Edit View History Bookmarks Tools Help

bcit BCIT :: applied research :: micr... +

BRITISH COLUMBIA INSTITUTE OF TECHNOLOGY

applied research at bcit

home

microgrid consumer portals

Residence Portal

overview

consumption

> all houses

- » SW10 - Nootka
- » SW11 - Salish
- » SW12 - Chilcotin
- » SW13 - Carrier
- » SW14 - Kootenay
- » SW15 - Nisga'a
- » SW16 - Haida

resources

competition

contact us

Related Links

applied research at BCIT

GAIT

BCIT Sustainability Initiative

energy consumption: SW14 - Kootenay

kWh \$\$\$

Time	kWh
12am	22
3am	22
6am	40
9am	38
12pm	32
3pm	32
6pm	62
9pm	38
12am	38

Carbon Dioxide Emissions CO₂e for BC Hydro

kg

Time	kg
12am	0.6
3am	0.6
6am	1.0
9am	0.8
12pm	0.8
3pm	0.8
6pm	1.5
9pm	1.2
12am	1.2

Outdoor Temperature Degrees Celsius

Average

Time	Degrees Celsius
12am	10
3am	10
6am	10
9am	10
12pm	10
3pm	10
6pm	10
9pm	10
12am	10

Monday Jan. 11, 2010

< Day Week Month >

Kootenay Footprint

Total Per Person Per m²

kWh 848.0 kWh

\$ \$\$ \$ 110.88

CO₂ 22.0 kg

House Comparison

kWh \$\$\$ CO₂

House	kWh	\$\$	CO ₂
Nootka	848.0	110.88	22.0
Salish	848.0	110.88	22.0
Chilcotin	848.0	110.88	22.0
Carrier	848.0	110.88	22.0
Kootenay	848.0	110.88	22.0
Nisga'a	848.0	110.88	22.0
Haida	848.0	110.88	22.0

Residence Future

- “Load Control” prototype
- Enables scheduling for heat, hot water, lighting, etc.
- Communicates with load control boxes made by Technology Centre staff

The screenshot shows a Mozilla Firefox browser window titled "BCIT Intelligent Microgrid - Customer Portal - Mozilla Firefox". The URL is <http://emsv1.ielbcit.ca/index.php?page=demo>. The page displays a monthly calendar for January 2010. The calendar grid shows days from Monday to Sunday. Some days are colored yellow (Economy), red (Normal), or green (Vacation). Below the calendar, there are buttons for "Economy", "Normal", "Vacation", and "Remove". At the bottom, there is a "Manual load control" section with a dropdown menu labeled "Select load" containing options: "heater", "heater", "cooling", "lighting", and "hot water".

Mon	Tues	Wed	Thur	Fri	Sat	Sun
				01 Economy	02 Economy	03
04 Normal	05 Normal	06	07 Normal	08	09 Economy	10 Vacation
11 Normal	12	13	14	15	16 Vacation	17 Vacation
18 Normal	19	20 Normal	21	22 Vacation	23	24 Vacation
25	26	27	28	29	30	31

EMS – North Campus

BCIT :: applied research :: microgrid residence portal - Mozilla Firefox

File Edit View History Bookmarks Tools Help

bcit BCIT :: applied research :: micr...

BRITISH COLUMBIA INSTITUTE OF TECHNOLOGY

applied research at bcit

microgrid consumer portals

Residence Portal

overview

consumption

- > all houses
- > campus facilities
 - » NE8 - MainBus
 - » NE1 - MainBus
 - » NE1 - Elevator
 - » NE1 - Chiller
 - » NW6 - CNC159
 - » NW6 - CNC218
 - » NE3 - AFRESH
- > load control calendar (old ui)

resources

competition

contact us

Related Links

applied research at BCIT

GAIT

BCIT Sustainability Initiative

energy consumption: NE1 - MainBus

kwh \$\$\$

Time	Consumption (kWh)
11pm	220
12am	220
1am	220
2am	220
3am	250
4am	380
5am	500
6am	520
7am	520
8am	500
9am	480
10am	480
11am	500
12pm	480
1pm	450
2pm	450
3pm	420
4pm	400
5pm	400
6pm	380
7pm	300
8pm	280

Sunday Nov. 1, 2009

MainBus Footprint

Total Per Person Per m²

kwh 9003.0 kWh

\$\$\$ \$

CO₂ kg

House Comparison

Carbon Dioxide Emissions CO₂e for BC Hydro

kg

Time	Emissions (kg)
11pm	6
12am	6
1am	6
2am	6
3am	7
4am	10
5am	13
6am	14
7am	14
8am	14
9am	13
10am	13
11am	13
12pm	12
1pm	11
2pm	11
3pm	10
4pm	10
5pm	9
6pm	8
7pm	7
8pm	6

Outdoor Temperature Degrees Celsius

Average

Time	Temperature (°C)
12am	5
1am	5
2am	5
3am	5
4am	5
5am	5
6am	5
7am	6
8am	7
9am	8
10am	9
11am	10
12pm	11
1pm	12
2pm	13
3pm	13
4pm	12
5pm	11
6pm	10
7pm	9
8pm	8

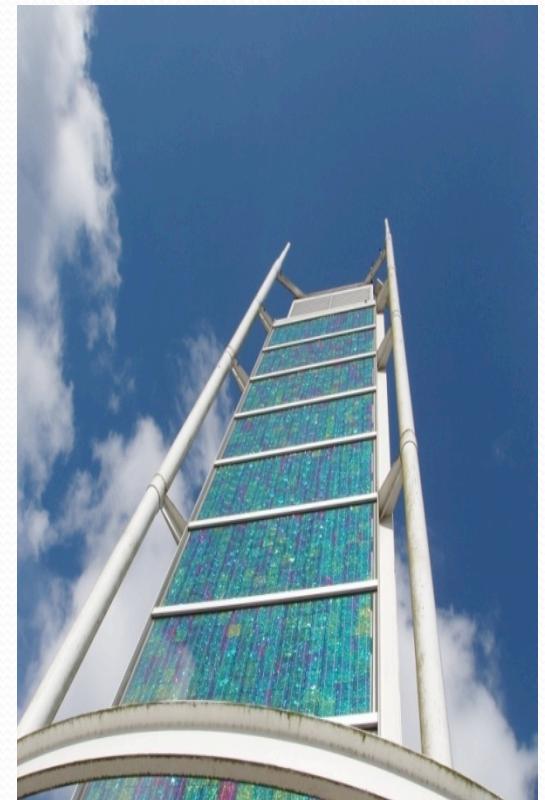
AFRESH Home

- Different Smart Metering Schemes
- Solar panels
- Fuel cell
- EV charging station
- Residential EMS
- Beyond Net-Zero home
- Grid integration issues



Solar Power Tower

- First generation design at BCIT
- Separate metering of tower sides
- Integrated into EMS
- Correlating output to data from Environment Canada
- Will develop models where power output can be estimated based on weather forecasts and time of year



Conclusions

BCIT's Smart Microgrid Initiative is about:

- Providing new and unique educational/training services for students, faculty and industry
- Reducing the carbon footprint and energy costs
- Helping utilities modernize their services & assets
- Mitigating critical infrastructure risks, security, reliability and vulnerability
- Creating a 'sandbox' where new technologies and solutions can be developed, tested and qualified

Questions?

Come see us – we love to demo!

- Hassan Farhangi, PhD
- BCIT Technology Centre
- Wing B, CARI Building
- Hassan_Farhangi@bcit.ca
- Tel: 604-456-8074
- <http://www.bcit.ca/microgrid>

