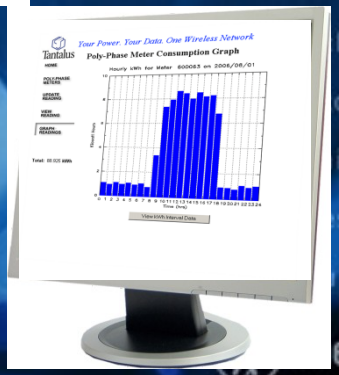
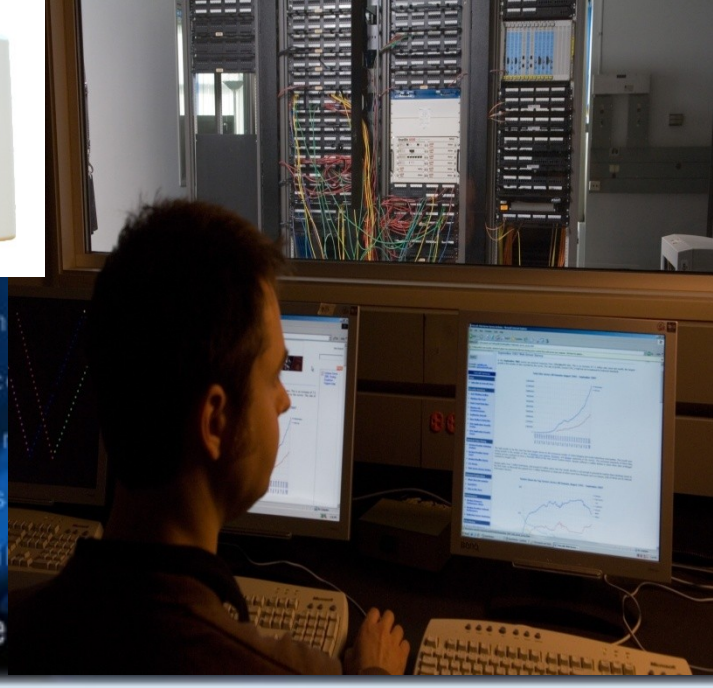




Smart Microgrid Initiative at BCIT

May 28, 2009

Dr. Hassan Farhangi (PhD, PEng, SM-IEEE) Director GAIT, TC, BCIT

Agenda

1. Problem Definition
2. The Need
3. Drivers
4. Barriers
5. Microgrid Topology
6. Value Proposition
7. Smart Microgrid
8. Applied Research Objectives
9. Applied Research topics
10. Roll-Out Plan

Problem Definition

THE VANCOUVER SUN

BC Hydro eyes 25% rate hike by 2011

That's just a start. The annual cost for an average homeowner may jump as much as $500

Scott Simpson, Vancouver Sun
Published: Saturday, January 26, 2008

The average cost to heat and light a home could increase $500 a year by 2011, driven by a projected 25-per-cent hike in electricity rates and aggressive conservation measures, according to BC Hydro documents.

A typical residential customer who heats with gas now pays about $715 a year.

A recent Hydro report says rates must rise 25 per cent between 2009 and 2011 because of expected costs to maintain and upgrade British Columbia's aging electricity grid, as well as expenses arising from higher finance costs and "an anticipated increase in government levies."

Problem Definition

Problems facing the Power Industry today:

1. Rising cost of energy
2. Aging infrastructure
3. Mass Electrification
4. Climate Change

Solutions pursued by Utility companies:

1. Optimize use of expensive assets
2. Manage end-user demand
3. Facilitate Co-Generation
4. Use alternative/renewable sources of energy

However, such solutions can not be implemented within the constraints of the existing old electromechanical Electricity Grid!

The Need

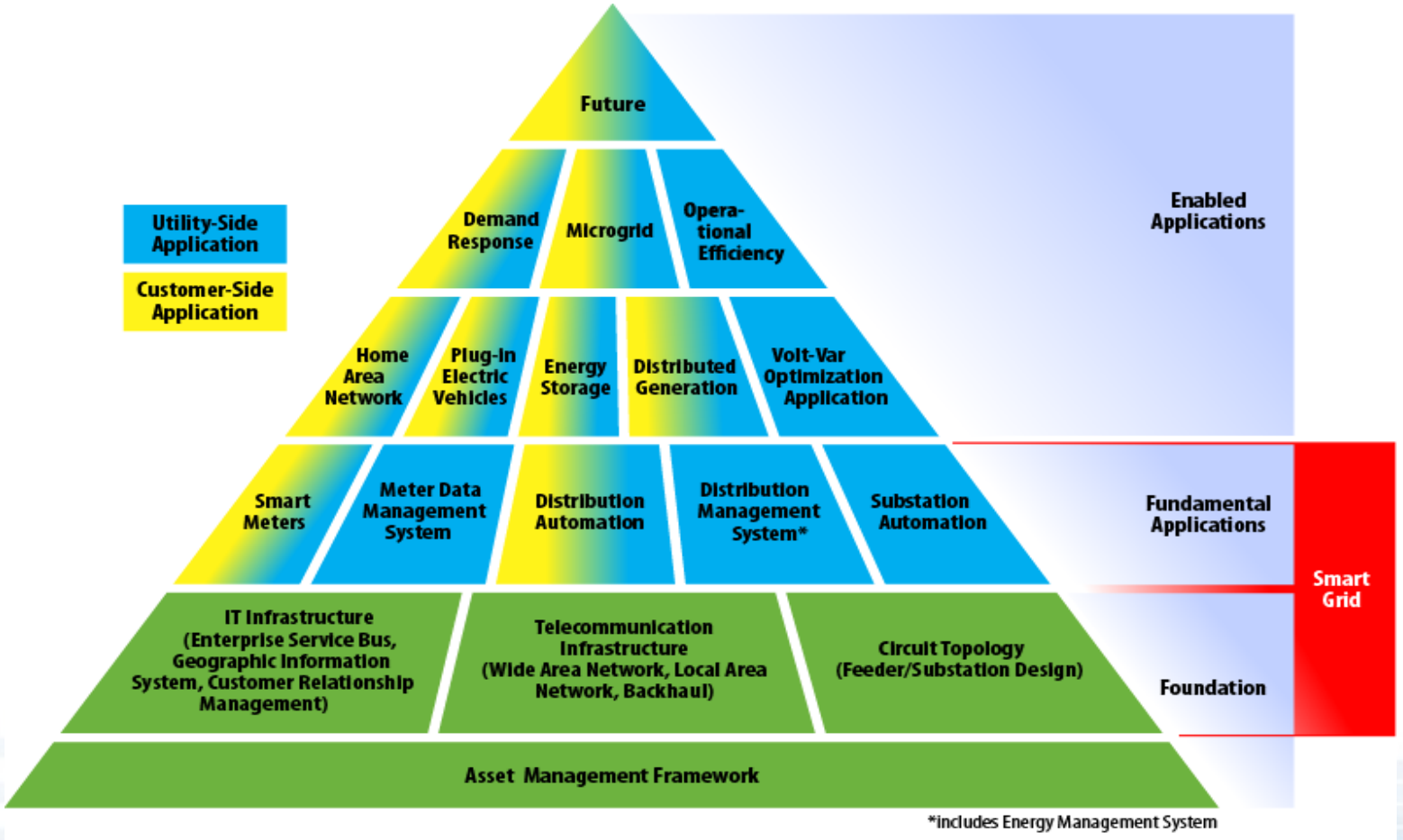
Existing Grid	Required Grid
Electromechanical	Digital
One-Way communication	Two-Way communication
Centralized Generation	Distributed Generation
Hierarchical	Network
Few Sensors	Sensors throughout
Blind	Self-monitoring
Manual Restoration	Self-Healing
Failures & Blackouts	Adaptive & Islanding
Manual Check/Test	Remote Check/Test
Limited Control	Pervasive Control
Few customer choices	Many customer choices

Source : The Emerging Smart Grid GEF/CFSE October 2005

Drivers

1. **Aging Infrastructure** (70% of assets are over 25 yrs old)
2. **Reliability & Security** (Blackouts, prone to attacks)
3. **Market Dynamics** (Choice & Competition)
4. **Rates & Pricing** (Multi-Tariffs, Time of Use, Smart Metering)
5. **Distributed Generation** (Co-Gen, New Sources of Energy)
6. **Efficiency & Optimization** (Demand Response, Peak Control)
7. **Affordable Technologies** (IT, Telecom, Computing)
8. **Rising cost of Energy** (Rising Oil Prices, Security of Supply)
9. **Need for Conservation** (Limited Energy Sources)
10. **Mass Electrification** (Electricity as the main driver)
11. **Renewable Energy** (Unpredictability, Unavailability)
12. **Green Energy** (Reduced emissions from the power sector)

Drivers



BC Hydro Smart Grid Framework

Barriers

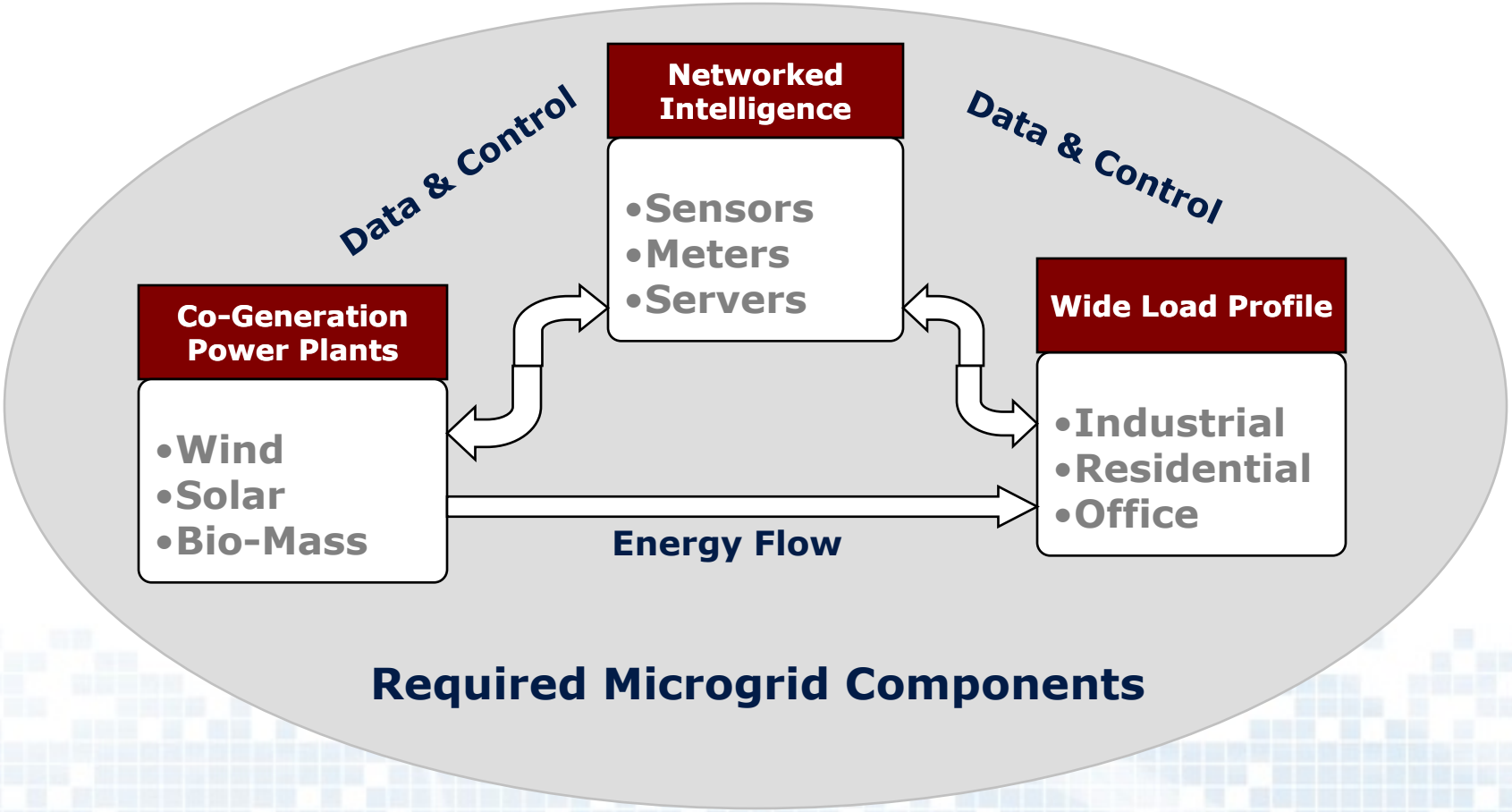
Business Barriers:

- Regulatory & Economics
- Capital & Funding Constraints
- Absence of Industry Standards

Technical Barriers:

- Unproven Technologies
- Absence of near-real Test Beds

Microgrid Topology



Value Proposition

BCIT's Smart Microgrid addresses the technical barriers that hampers the roll out of Intelligent Grid initiatives through:

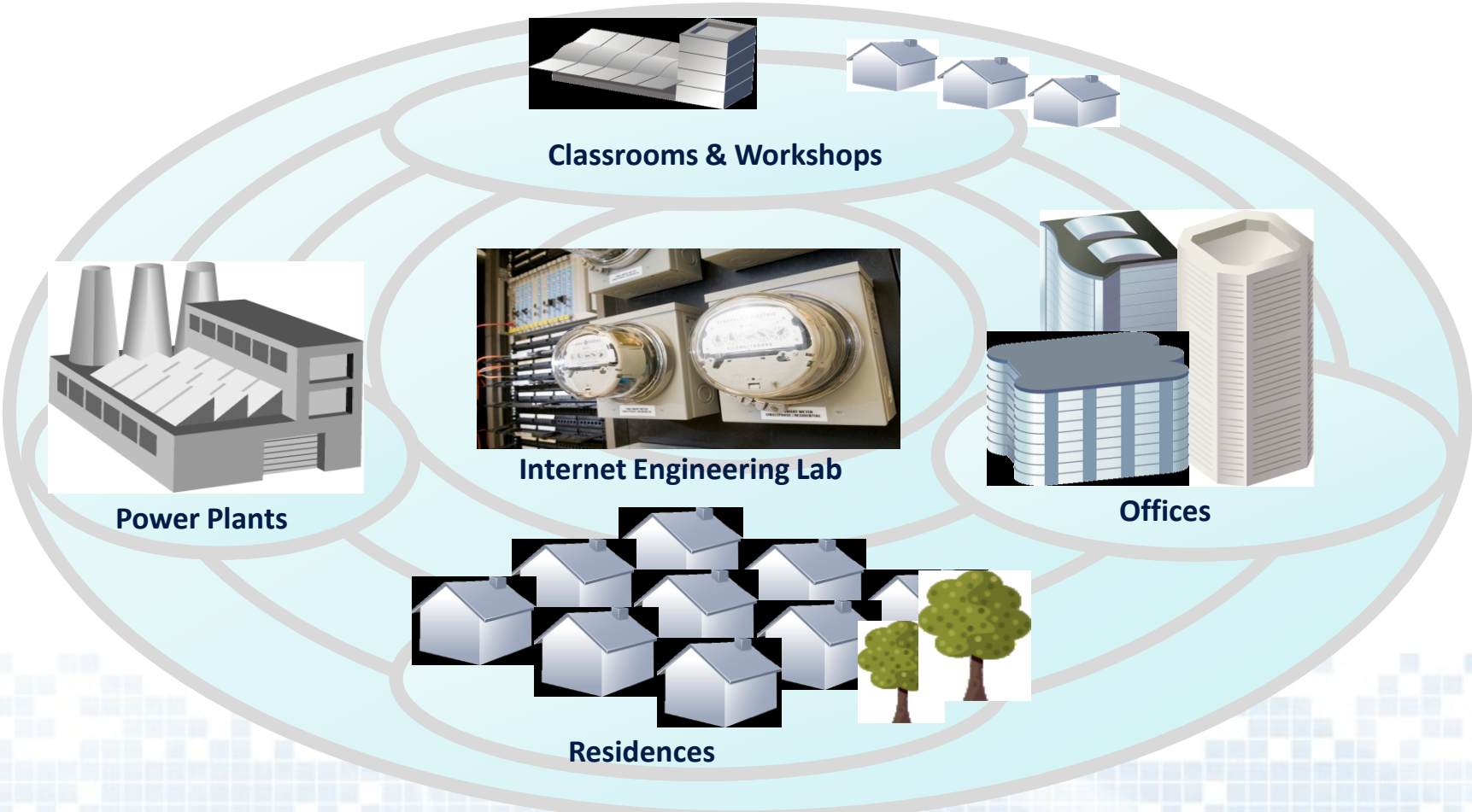
1. **Integrating the required components of a Grid under an open architecture, allowing technology providers to demonstrate their solutions & prove their technologies to their end customers and partners**

2. **Providing a programmable topology of a real power system, thus enabling Utilities to test & Verify new architectures & components (e.g. Alternatives, Renewable, etc) in real settings & applications.**

BCIT's Smart Microgrid

BCIT's Burnaby Campus

BCIT's Smart Microgrid



BCIT's Microgrid Components

BCIT's Smart Microgrid

BCIT's Photovoltaic Tower

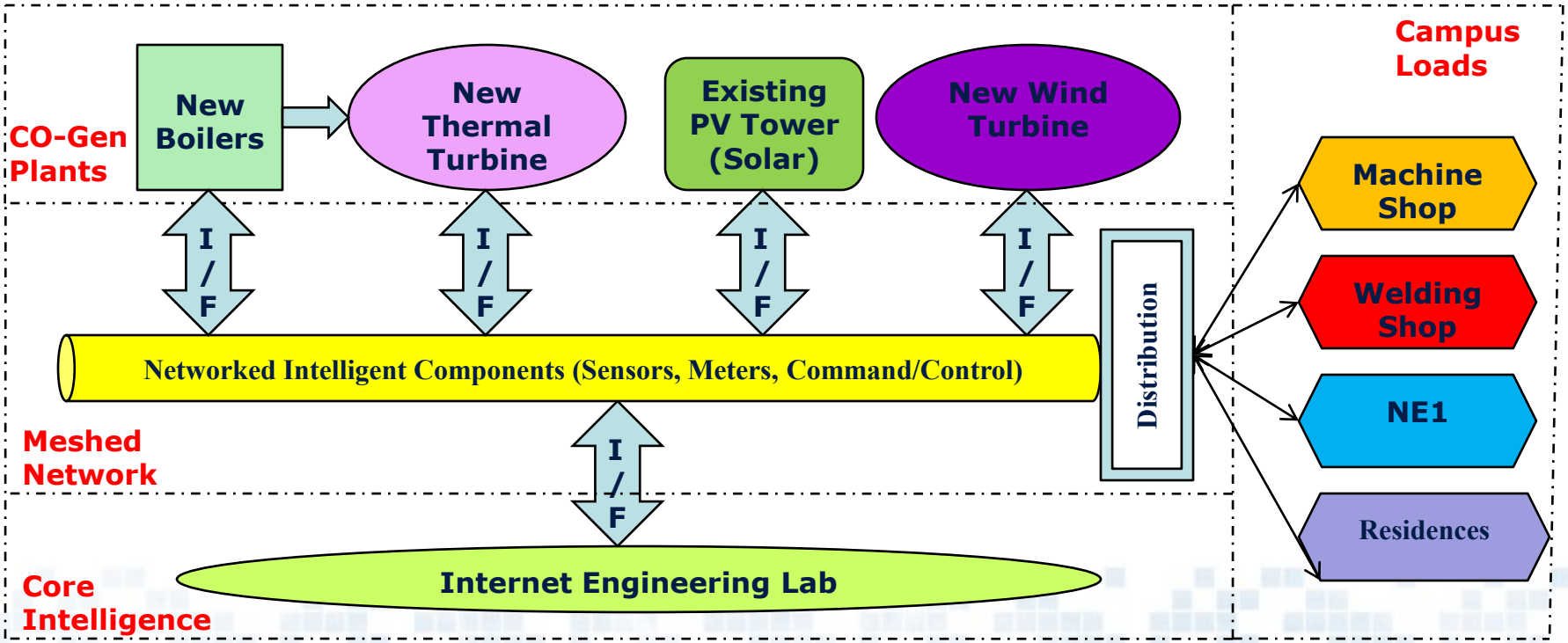
BCIT's Smart Microgrid

BCIT's Network Engineering Lab

BCIT's Smart Microgrid

Typical Metering Farm

BCIT's Smart Microgrid



Microgrid Components

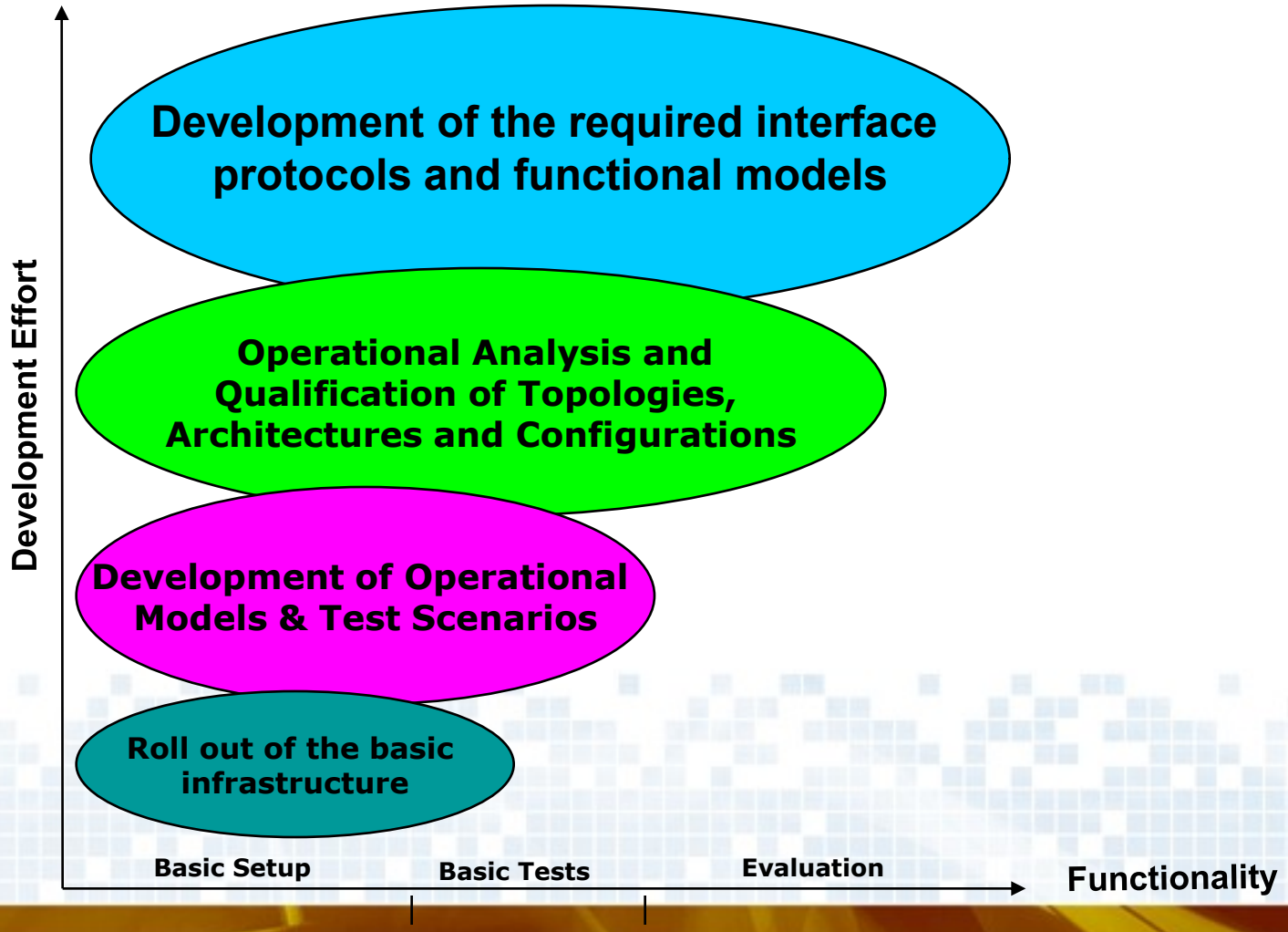
BCIT's Applied Research objectives

- **Construction of a Smart Grid Test Bed to develop:**
  - Provisioning Methods for Smart Termination Points (Meters, Data Aggregators, Appliances, Sensors, Controls, etc)
  - Integration Solutions for Alternative Sources of Energy (Co-Generation thru Wind, Solar, Thermal, Bio-Mass, etc)
  - Innovative Network Architecture and Topology for Smart Grid
- **Operational Analysis and Qualification of Grid's:**
  - Resilience, Reliability, Security and Scalability
  - Data Collection, Command & Control algorithms
  - Forward/backward compatibility with up & coming technologies
- **Development of Interface Protocols & Models to ensure:**
  - Interface with Utility Back-office tools (Billing, Load Management, Service Provisioning, Outage Restoration, etc)
  - Seamless end-to-end deployment, operation & maintenance
  - Easy & Intuitive human interface for operators & customers

BCIT's Applied Research topics

- Visualization and integrity of time-sensitive data collected from across the termination points
- Predictive Modeling of events and real-time responses
- Distributed control to prevent cascading failures or for the graceful degradation of user service based on service priorities
- Real-time wide-area control to manage power generation and prevent over-provisioning
- Context-dependent models and control of components to achieve robustness, fault-tolerance, or graceful performance degradation
- Software Development for large-scale distributed real-time embedded systems
- Support for integration and control of alternative energy generation systems and co-generation

BCIT's Smart Microgrid Roll Out Plan



Q&A

Thank You

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