Bringing the Electric System into the Information Age: GridWise Interoperability Principles

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Lynne Kiesling

Northwestern University

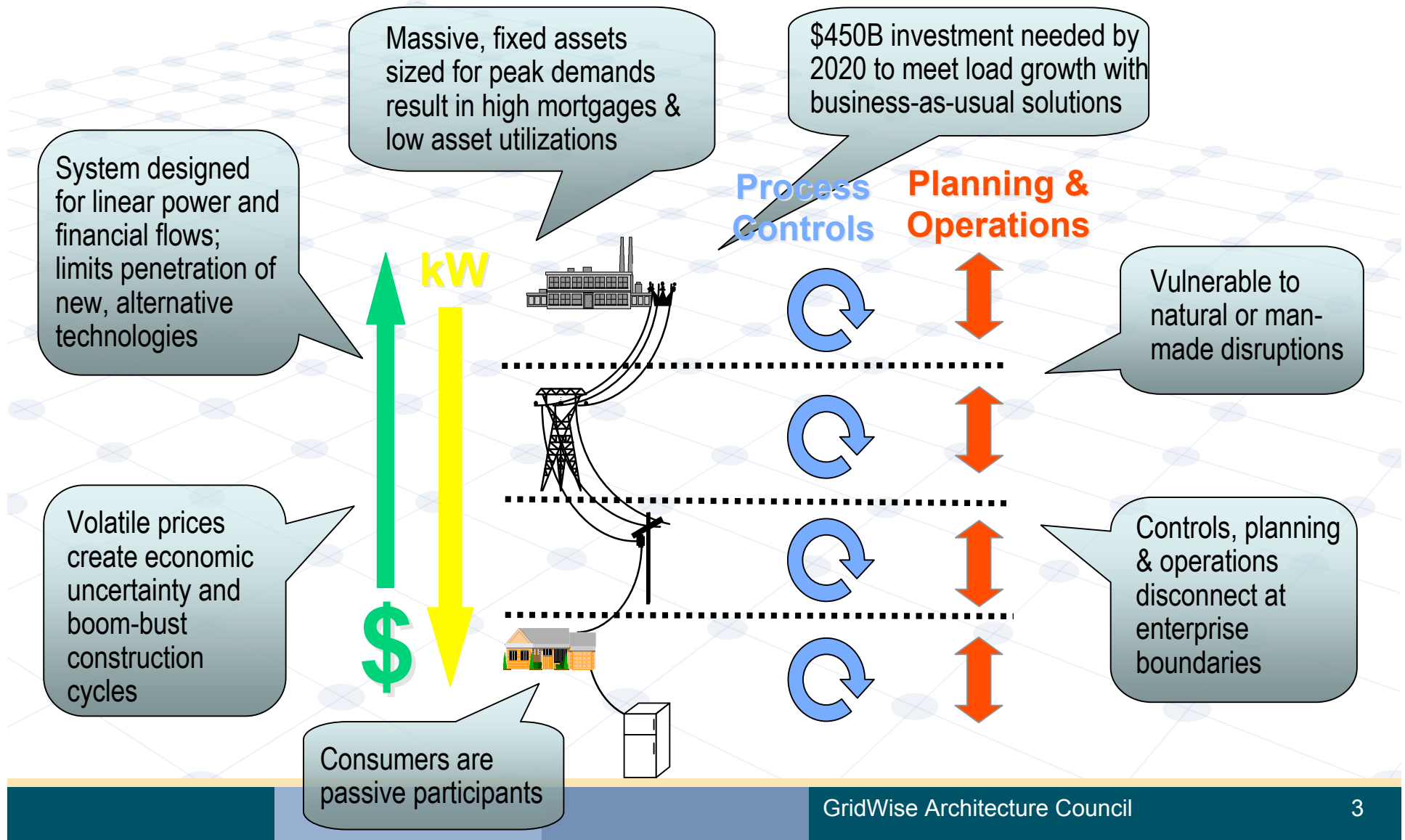NORTHWESTERN UNIVERSITY

GRIDWISE™

High level optimization

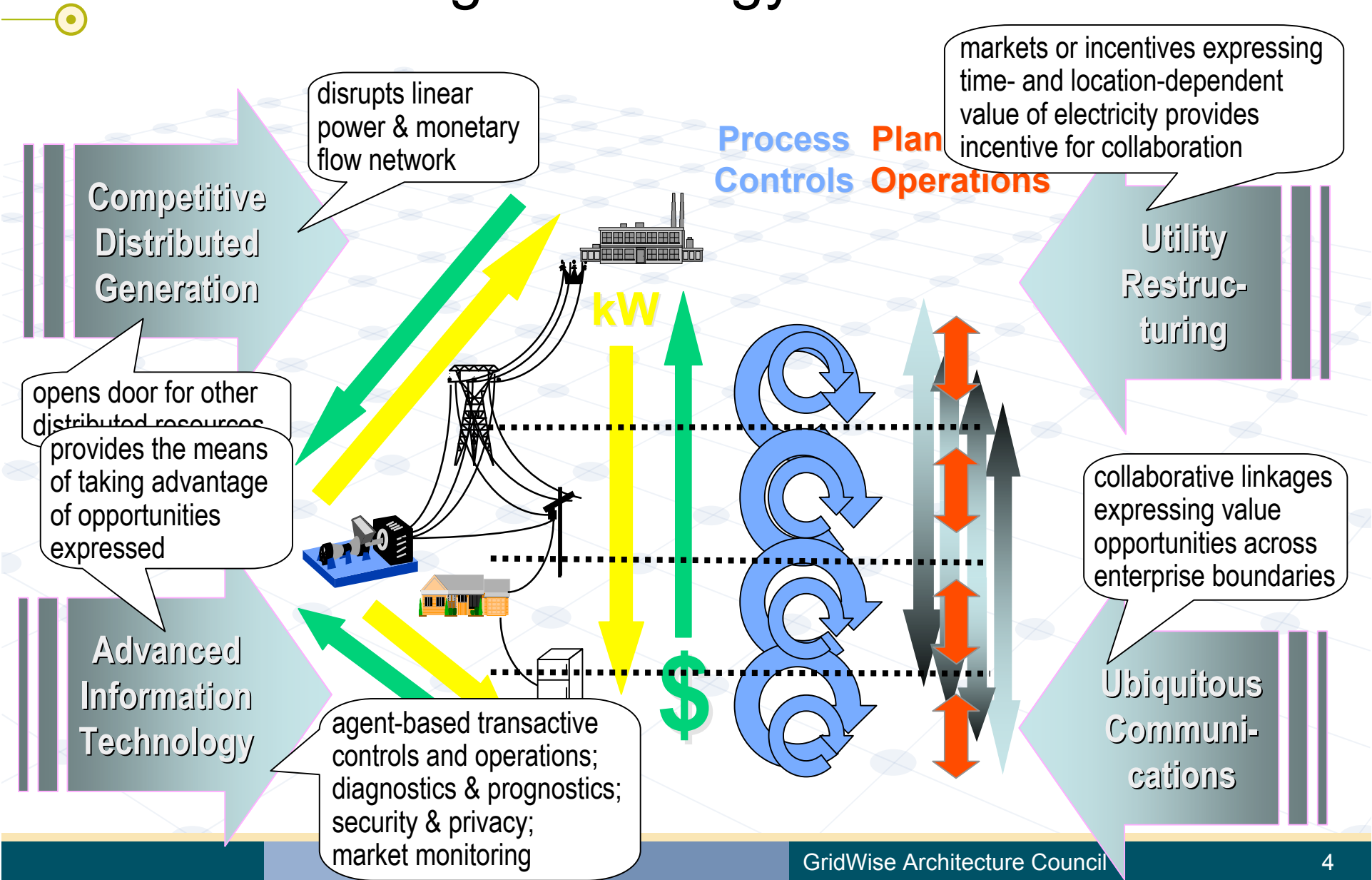The grid involves and supports three kinds of flows:

- Electricity
- Money
- Information

- We have poor operational and commercial *interoperability* across the grid -- between entities, between machines, between companies and operators, between models….

- This means that the information flows and action options needed for effective reliability and transactions are not as good as they should and could be.
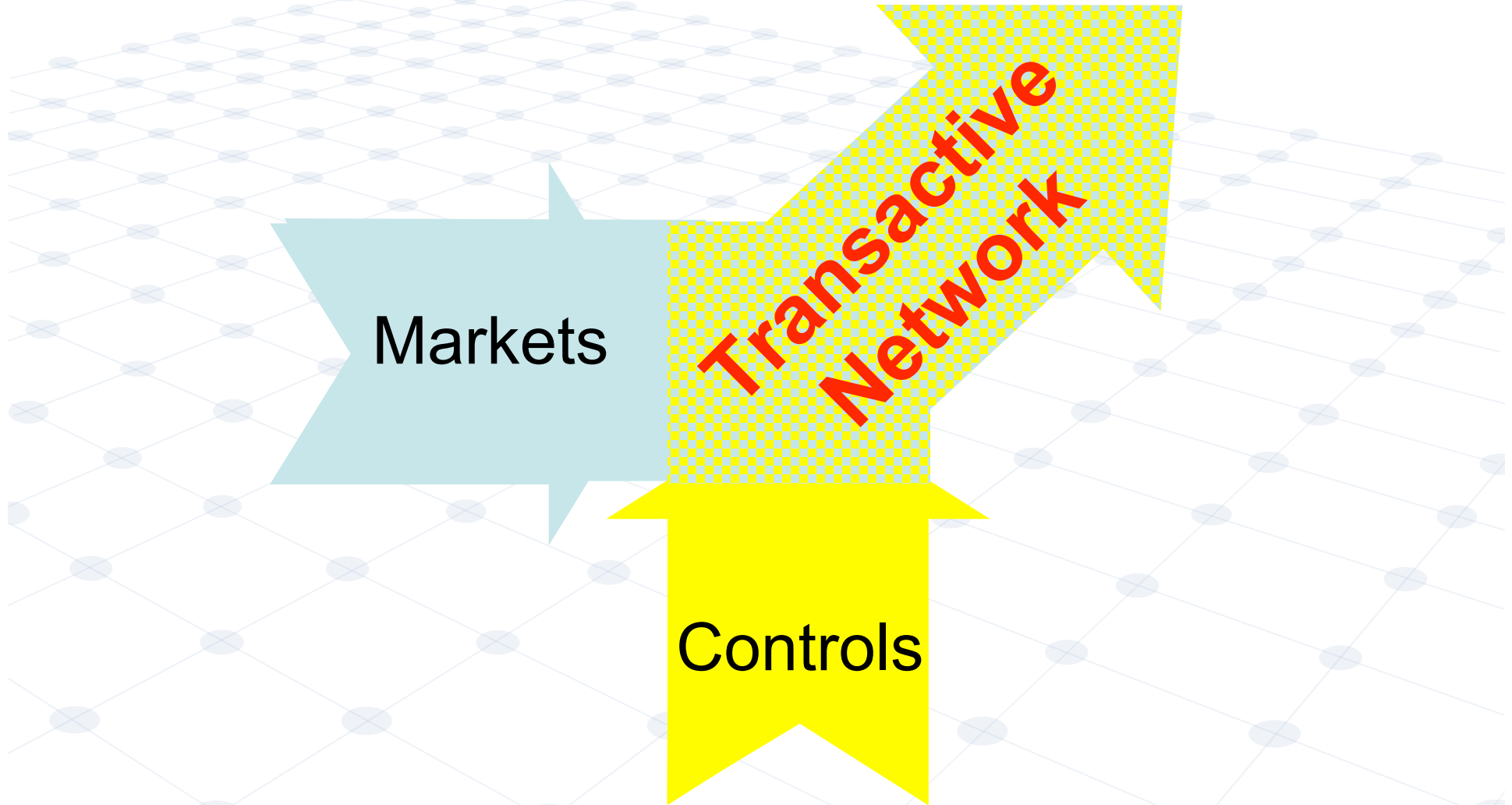
Issues & Uncertainties Surround Today's Energy Infrastructure

Massive, fixed assets sized for peak demands result in high mortgages & low asset utilizations

$450B investment needed by 2020 to meet load growth with business-as-usual solutions

System designed for linear power and financial flows; limits penetration of new, alternative technologies

Process Controls

Planning & Operations

kW

Vulnerable to natural or man-made disruptions

Volatile prices create economic uncertainty and boom-bust construction cycles

$

Controls, planning & operations disconnect at enterprise boundaries

Consumers are passive participants

Transforming the Energy Infrastructure

Markets and Controls
Merge to Form a Transactive Network

What is interoperability?

The ability of two or more networks, systems, devices, applications or components to exchange information and to use that information effectively for action -- with little or no human intervention.

- Interoperability requires interconnectivity and common protocols between hardware and software to enable effective communications, coordination and control.

- Interoperability is achieved when users' *expectations* to exchange and use information among various devices and software applications from multiple vendors or service providers are met or exceeded.

Source: EICTA INTEROPERABILITY WHITE PAPER - 21 June 2004

Interoperability and grid reliability

If we create a network of intelligent, inter-connected, communicating power plants, T&D equipment and customers linked by high-speed, ubiquitous information flows, we'll get better reliability and higher throughput at lower long-term costs.

- Better situational awareness
- Easier grid operation with better communications, better information and more points of control
- More resources available to operate the grid in real-time
- More resources -- including demand-side -- to leverage supply and T&D assets

Demand response and interop

DR is essential for better grid asset use, and requires more interop (esp. meters and measurement) and better standards to succeed.

- Manage loads better, smarter
  - Controllably thru contracts (air conditioning direct control, DG dispatch, dialing back commercial loads, emergency DR)
  - Implicitly (through customer response to pricing and rates)
  - Customer choices to sell into markets
- Price moderation and limiting supplier market power
- Precise T&D support and management

The impact of interoperability

Look at telecom, internet, banking and finance -- competition and value come from innovative content, functionality, quality, and easy interfaces

- New value for users from innovative applications, built on a platform of interoperability and interconnectivity
- Technology convergence enabled by planned interoperability and open (non-proprietary) standards, and continued investment
- Continued investment in infrastructure
- Customer access to information about options and costs and ability to act on those choices

What new apps could evolve on the grid if we let them?

Lower costs long-term

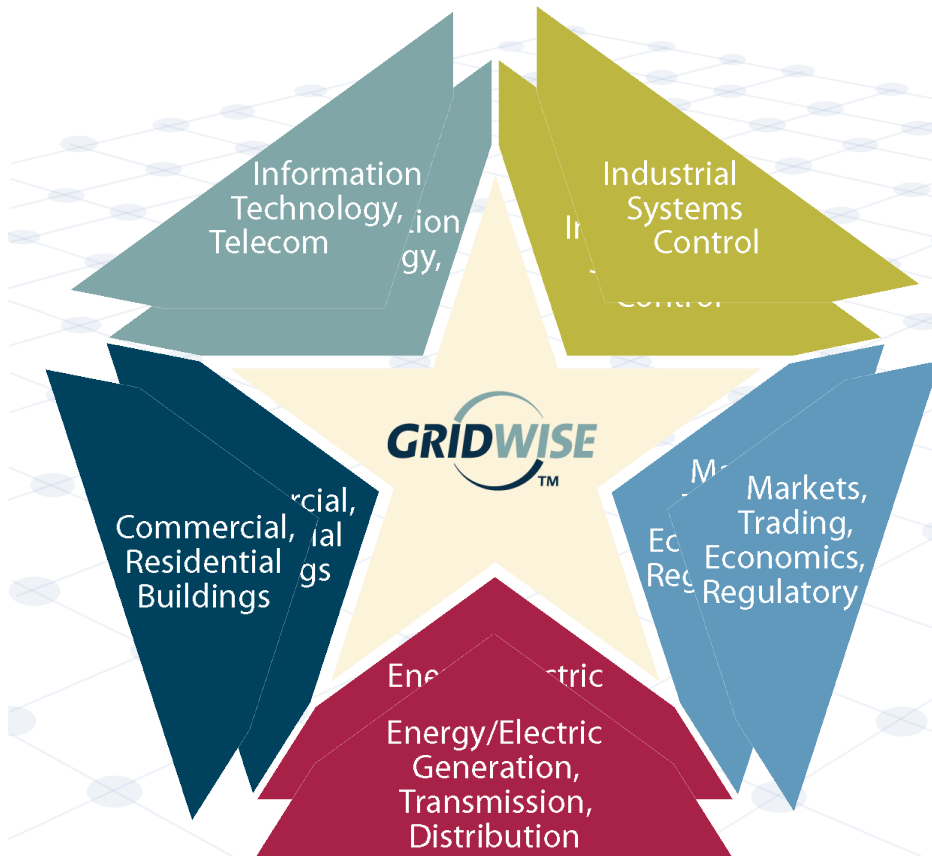Proven benefits of interoperable, standards-based systems:

- Easier integration of hardware and software (new and legacy)

- Encourage and expedite innovation for new capabilities, value creation and product development upon a trusted technology base

- Easy, clean data exchange and use

- Lower costs for system and component upgrades and expansion

- Less vendor lock-in, more competition between vendors

- Better security (protection) and privacy management

What do we need for a smart grid?

A commitment to:

- Intelligent, interconnected devices, from customer energy uses and meters to relays, transformers, distributed generation and power plants

- High-speed, high quality computation and analysis

- High-speed, high quality grid condition information

- Interoperability and open standards

- Continued investment in enabling technologies and infrastructure

GridWise Architecture Council

The Electricity Community
→ The future is in the linkage of sectors across the electricity chain.

- Who
  - Respected experts
  - Volunteers
  - Cross-sector organizations

- What
  - Principles of interaction
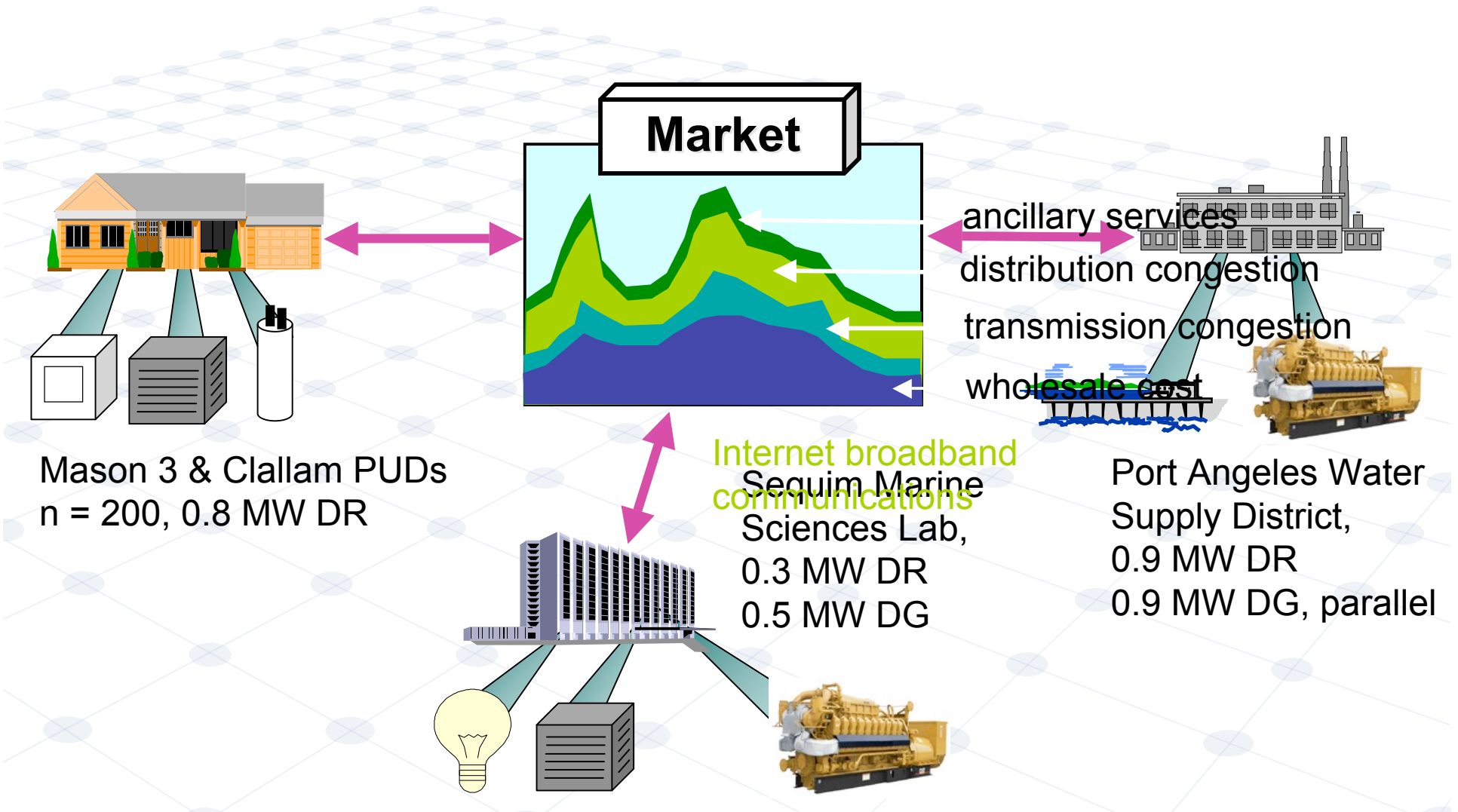 - Interoperability

  Developing
  Communicating
  Guiding

Some key GridWise principles

- Identification -- unambiguous reference to system entities
- Information models -- shared meaning and relationships of entities/concepts
- Time and date -- synchronization, sequence, time tagging…
- Discovery and configurability between components
- Security and privacy
- E-transaction life-cycle -- scheduling, operations, settlement, etc.
- Focus on boundary interactions and respect actors' privacy, independence, options

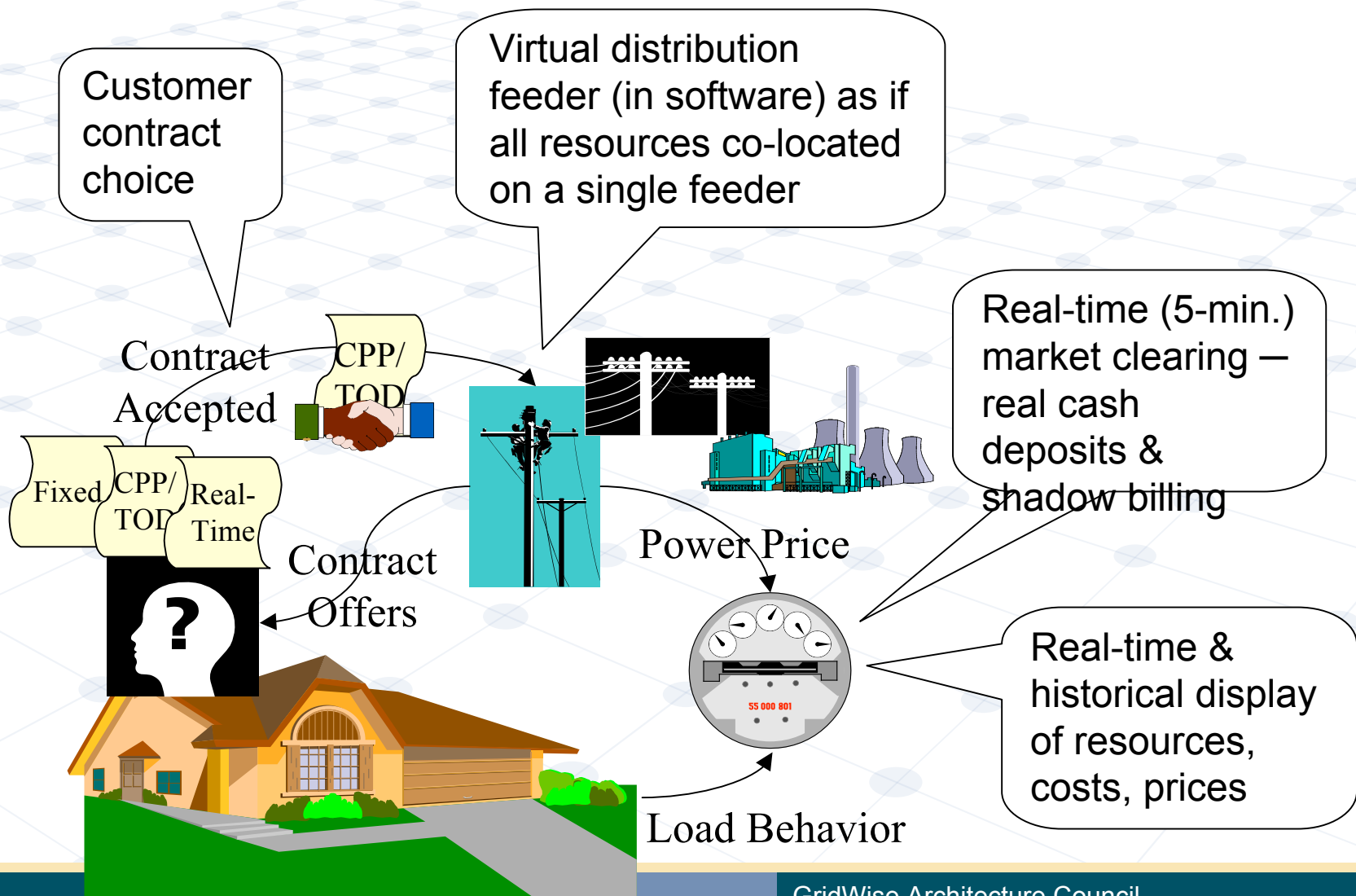# **More key GWAC principles**

- Support changes w/o system disruption
- Go to system-safe corners in event of communication or systems failure
- Adopt broadly applicable (cross-sector) best practices
- Support heterogeneous IT standards and technologies
- Consider needs of the full range of stakeholders
- Be practical
- Support verification and audits
- Communicate concepts across stakeholder base

Olympic Peninsula GridWise Demonstration

Market

ancillary services

distribution congestion

transmission congestion

wholesale cost

Internet broadband communications

Mason 3 & Clallam PUDs
n = 200, 0.8 MW DR

Sequim Marine
Sciences Lab,
0.3 MW DR
0.5 MW DG

Port Angeles Water
Supply District,
0.9 MW DR
0.9 MW DG, parallel

Testing Market-based Customer Incentives

Customer contract choice

Virtual distribution feeder (in software) as if all resources co-located on a single feeder

Real-time (5-min.) market clearing — real cash deposits & shadow billing

Real-time & historical display of resources, costs, prices

Contract Accepted

CPP/ TOD

Fixed   CPP/ TOD   Real-Time

Contract Offers

Power Price

Load Behavior

Take Away Points

- Interoperability is reducing costs in other industries
- GWAC is forming and maintaining a common vision on interoperability
  - Across community segments
  - Electric community will own and fund
  - 30 years
- Plan of Attack
  - Develop a common agenda and frame the debate on interoperability
    - Reference framework, levels for interoperability agreement
  - Involve industry sectors and policy makers for buy-in/ownership
  - Identify and address priorities for advancement
    - Standards, regulatory issues, message communication, community forums
- Research opportunities abound!

Upcoming activities & events

- Regulatory white paper & checklist
- GridWeek April 2007
- GridWise Interoperability Framework Workshop April 2007
- GridWise Expo May 2007

Information: The Virtual Electric Infrastructure

FACT:

In the next 20 years, the U.S. will spend $450B on electric infrastructure, just to meet load growth.

CHOICE:

Perpetuate a 20th Century solution

OR

Invest in a 21st Century system saving ratepayers $80B while increasing reliability and flexibility.

GRIDWISE : Revealing Values + Communications + Advanced Controls ≡ Electric infrastructure

The choice is easy because…

$ bits << $ iron

Contact Information

Lynne Kiesling
Department of Economics, Northwestern University
lynne@knowledgeproblem.com

http://www.knowledgeproblem.com

http://faculty.econ.northwestern.edu/faculty/kiesling

For more GridWise information please see,

GridWise Architecture Council: http://www.gridwiseac.org

DOE OEDER: http://www.electricdistribution.ctc.com

GridWise Alliance: http://www.gridwise.org

GridWise at PNNL: http://gridwise.pnl.gov