On Smart Cities Dialogues:

Challenge the Limits of Energy

Embrace Change - Power Progress

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National Association of State Utility Consumer Advocates (NASUCA)

June 26, 2018 – 11:15-12:00 noon - A Smart City Dialogue

TECHNOLOGICAL LEADERSHIP INSTITUTE

UNIVERSITY OF MINNESOTA

Driven to Discover℠

The Land and The People

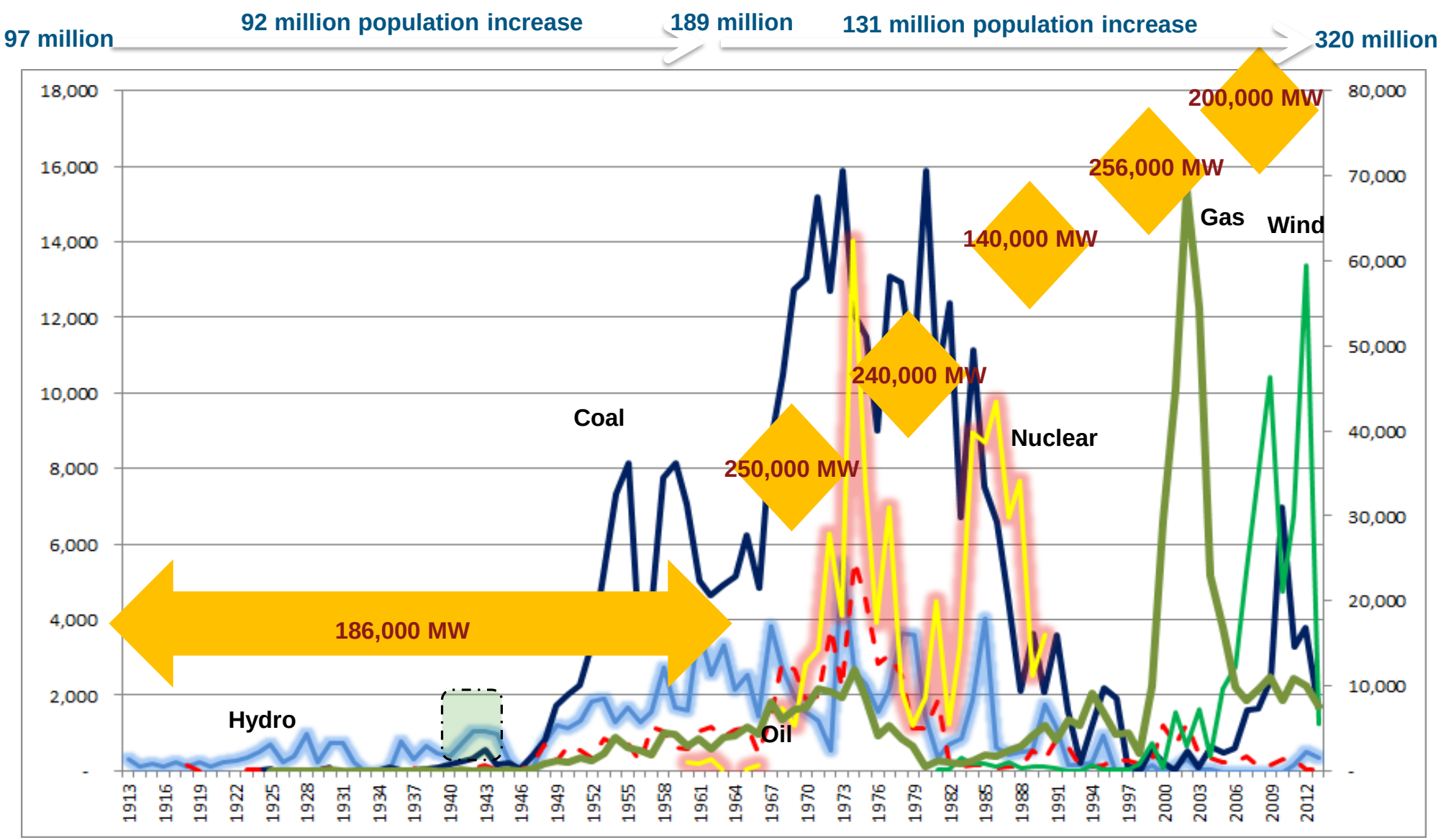
- First animal life: 500 Million years ago in the fossil record (MN was under water)
- First humans: Ancestors of today's American Indians arrived about 12,000-15,000 years ago at the end of the last ice age
- Dakota language: *Mni Sota Makoce* "land where the waters are so clear they reflect the clouds"

… Transforming how utilities and technologists create value and new

Customer Experiences

- Smart Appliances
- Electric Vehicles
- Energy Efficiency
- Demand Response
- Distributed Energy Resources

100 Years of Power Generation Development



IEEE SMARTGRID

Source: Adopted from Siemens

IEEE Advancing Technology for Humanity

The Smart Grid: 20 Years in the Making

- Self-Healing Grid (May 1998- Dec. 2002)
  - 1998-2002: EPRI/DOD Complex Interactive Networks/Systems Initiative (CIN/SI):
  - 108 professors and over 240 graduate students in 28 U.S. universities funded, including Carnegie Mellon, Minnesota, Illinois, Arizona St., Iowa St., Purdue, Harvard, MIT, Cornell, UC-Berkeley, Wisconsin, RPI, UTAM, Cal Tech, UCLA, and Stanford.
  - 52 utilities and ISO (including TVA, ComEd/Exelon, CA-ISO, ISO-NE, etc..) provided feedback; 24 resultant technologies extracted.
- Intelligrid (2001-present): EPRI trademarked
- Smart Grid: Final name adopted at EPRI and DOE

Definition: Smart Self-Healing Grid

Source: Massoud Amin, "Toward a Secure and Smart Self-Healing Grid," presentation to the Strategic Science & Technology EPRI Research Advisory Committee (RAC), Tuesday, January 27, 1998 page 5 at http://massoud-amin.umn.edu/presentations/CINSI_01-27-1998_RAC.pdf

- What is a Smart Self-healing grid?

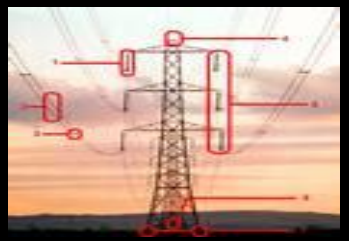
  The term "smart grid" refers to the use of computer, communication, sensing and control technology which operates in parallel with an electric power grid for the purpose of enhancing the reliability of electric power delivery, minimizing the cost of electric energy to consumers, and facilitating the interconnection of new generating sources to the grid.

- What are the power grid's emerging issues? They include

  1) integration and management of DER, renewable resources, and "microgrids";
  2) use and management of the integrated infrastructure with an overlaid sensor network, secure communications and intelligent software agents;
  3) active-control of high-voltage devices;
  4) developing new business strategies for a deregulated energy market; and
  5) ensuring system stability, reliability, robustness, security and efficiency in a competitive marketplace and carbon constrained world.

Interface of Smart Grid and Microgrids

- Fossil Fuel
- Long Distance Central Station
- An Aging Infrastructure
- Out of Capacity



- Renewable Power
- On-site
- Zero Energy Building
- Smart Grid

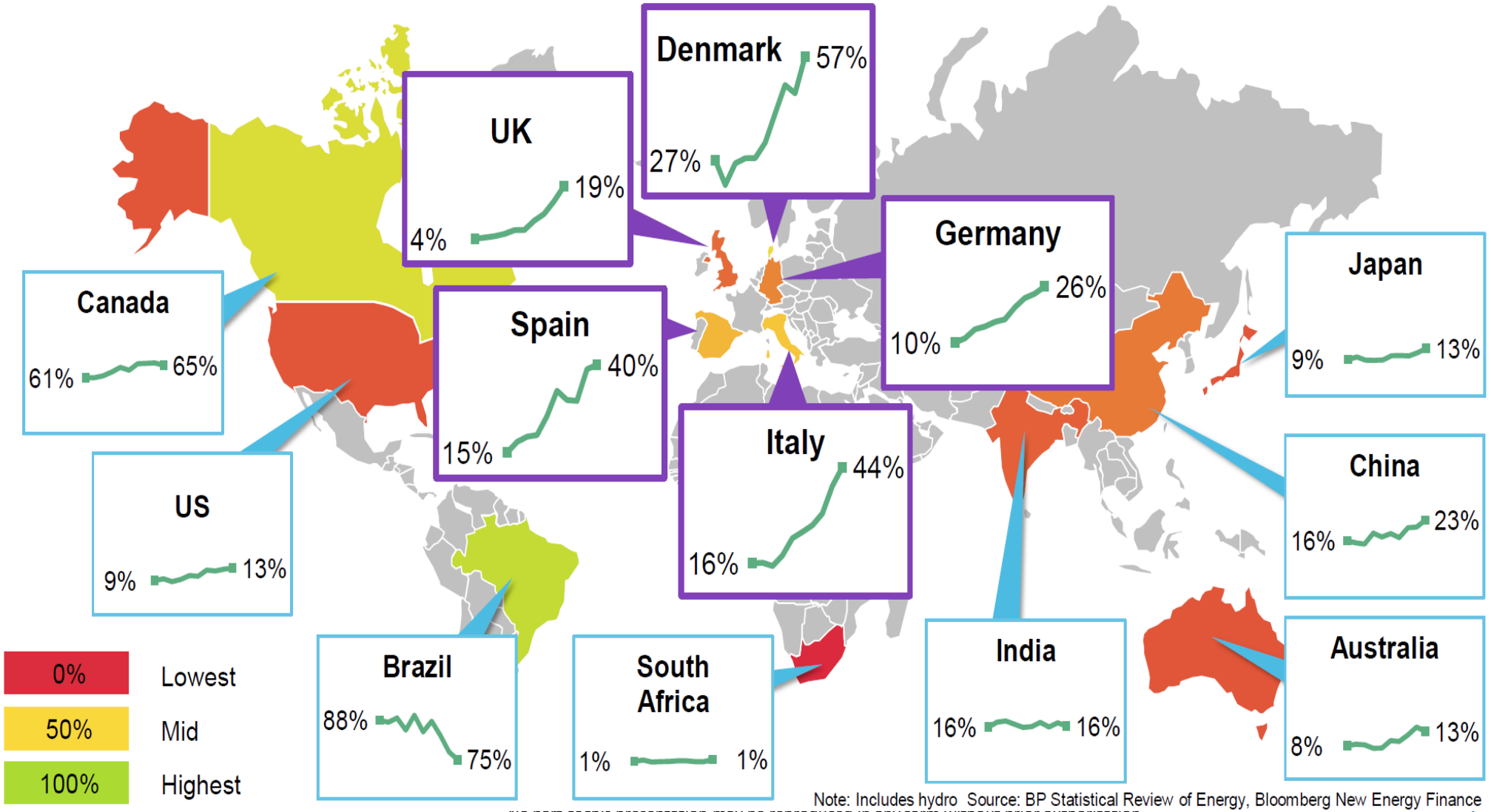
Energy Independence and Security Act

- Passed by U.S. Congress in 2007.

- "It is the policy of the United States to support the modernization of the Nation's electricity transmission and distribution system … that can meet future demand growth and to achieve each of the following, which together characterize a Smart Grid:
  1. Increased use of **digital information and controls technology to improve reliability, security, and efficiency of the electric grid**.

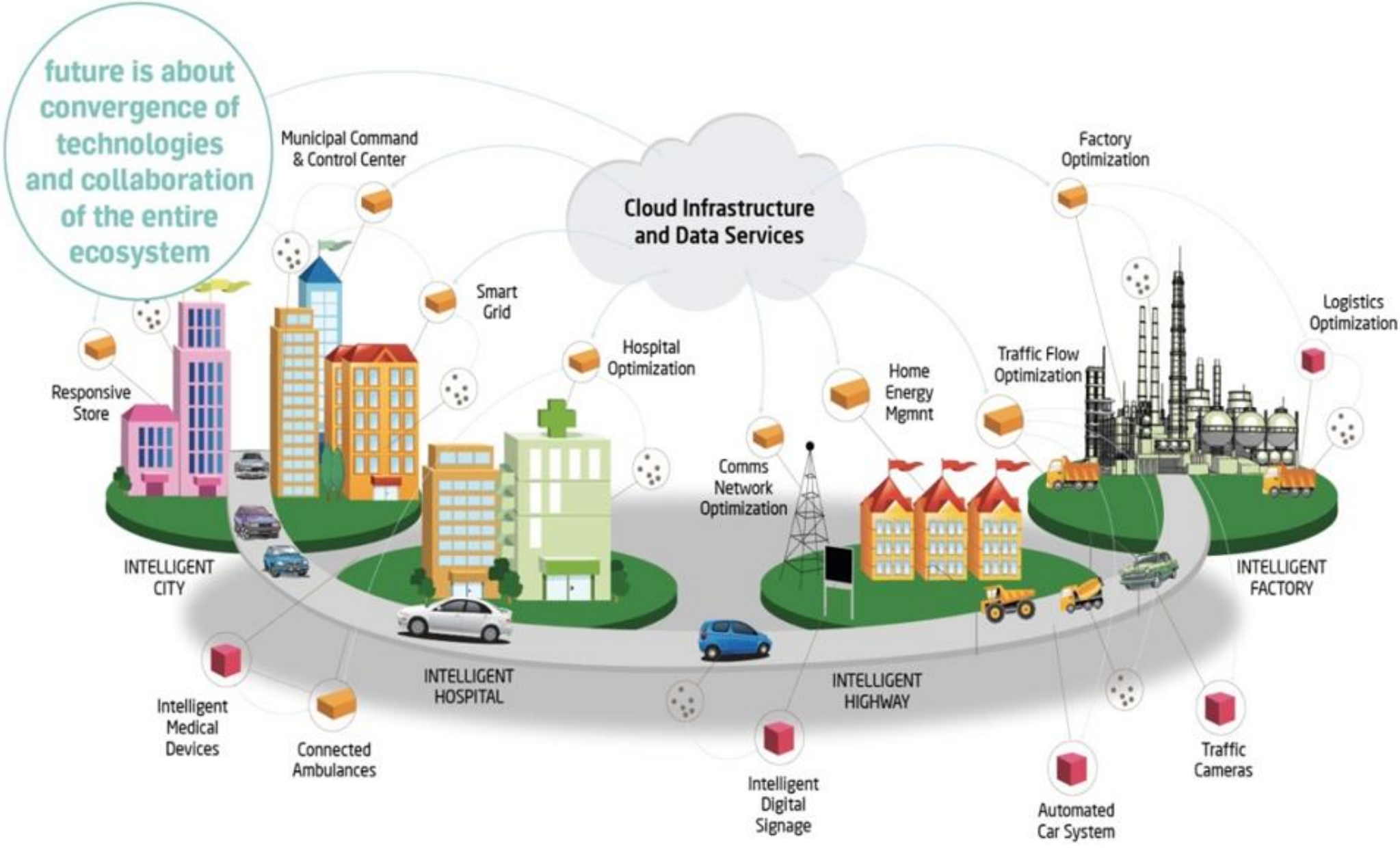
  2. **Dynamic optimization of grid operations and resources, with full cyber-security**…"

RENEWABLE ENERGY PROPORTION OF POWER GENERATION, 10 YEARS TO 2014 (%)



Note: Includes hydro Source: BP Statistical Review of Energy, Bloomberg New Energy Finance

A Roadmap to Secure Smart Cities



Smart Cities Vision

Source: IEEE Smart Grid Conference, Intelect, January 2015

Smarter about education, safety, energy, water, food, transp., e-gov… Innovative Cities:

- **Smarter transportation**
  Stockholm, Dublin, Singapore and Brisbane are working with IBM to develop smart systems ranging from predictive tools to smart cards to congestion charging in order to reduce traffic and pollution.
- **Smarter policing and emergency response**
  New York, Syracuse, Santa Barbara and St. Louis are using data analytics, wireless and video surveillance capabilities to strengthen crime fighting and the coordination of emergency response units.
- **Smarter power and water management**
  Local government agencies, farmers and ranchers in the Paraguay-Paraná River basin to understand the factors that can help to safeguard the quality and availability of the water system. Malta is building a smart grid that links the power and water systems, and will detect leakages, allow for variable pricing and provide more control to consumers. Ultimately, it will enable this island country to replace fossil fuels with sustainable energy sources.
- **Smarter governance**
  Albuquerque is using a business intelligence solution to automate data sharing among its 7,000 employees in more than 20 departments, so every employee gets a single version of the truth. It has realized cost savings of almost 2,000%.

"Cities are perfect for promoting change and renewable energies. Cities can serve as innovation platforms, creating clusters of business around green energy."

Top 10 cities

Rank	Country	City	Rating
1	Canada	**Vancouver**	98.0
2	Austria	**Vienna**	97.9
3	Australia	**Melbourne**	97.5
4	Canada	**Toronto**	97.2
5	Canada	**Calgary**	96.6
6	Finland	**Helsinki**	96.2
7	Australia	**Sydney**	96.1
8=	Australia	**Perth**	95.9
8=	Australia	**Adelaide**	95.9
10	New Zealand	**Auckland**	95.7

I-35W bridge

Just after 6:00 p.m. on Aug. 1, Prof. Massoud Amin was at work in his office on the University of Minnesota's West Bank, where he heard and watched the unthinkable happen—the collapse of the I-35W bridge about 100 yards away.

"As an individual, it was shocking and very painful to witness it from our offices here in Minneapolis," says Amin, director of the Center for the Development of Technological Leadership (CDTL) and the H.W. Sweatt Chair in Technological Leadership. Amin also viewed the tragedy from a broader perspective as a result of his ongoing work to advance the security and health of the nation's infrastructure.

In the days and weeks that followed, he responded to media inquiries from the BBC, Reuthers, and the CBC, keeping his comments focused on the critical nature of the infrastructure. He referred reporters with questions about bridge design, conditions, and inspections to several professional colleagues, including Professors Roberto Ballarini, Ted Galambos, Vaughan Voller, and John Gulliver in the Department of Civil Engineering and the National Academy of Engineering Board on Infrastructure and Constructed Environment.

For Amin, Voller, and many others, the bridge collapse puts into focus the importance of two key issues—the tremendous value of infrastructure and infrastructure systems that help make possible indispensable activities such as transportation, waste disposal, water, telecommunications, and electricity and power, among many others, and the search for positive and innovative ways to strengthen the infrastructure.

To improve the future and avoid a repetition of the past:

Sensors built in to the I-35W bridge at less than 0.5% total cost by TLI alumni

Terry Ward

Heidi Hamilton

Val Svensson

Joe Nietfeld

Technological Leadership Institute

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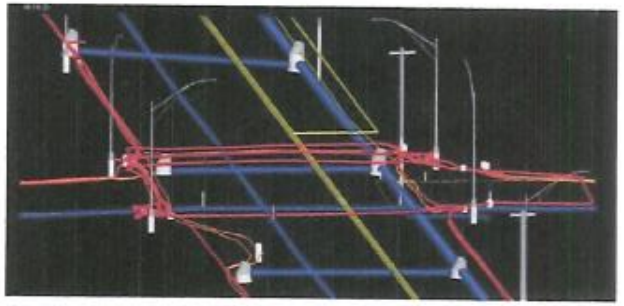
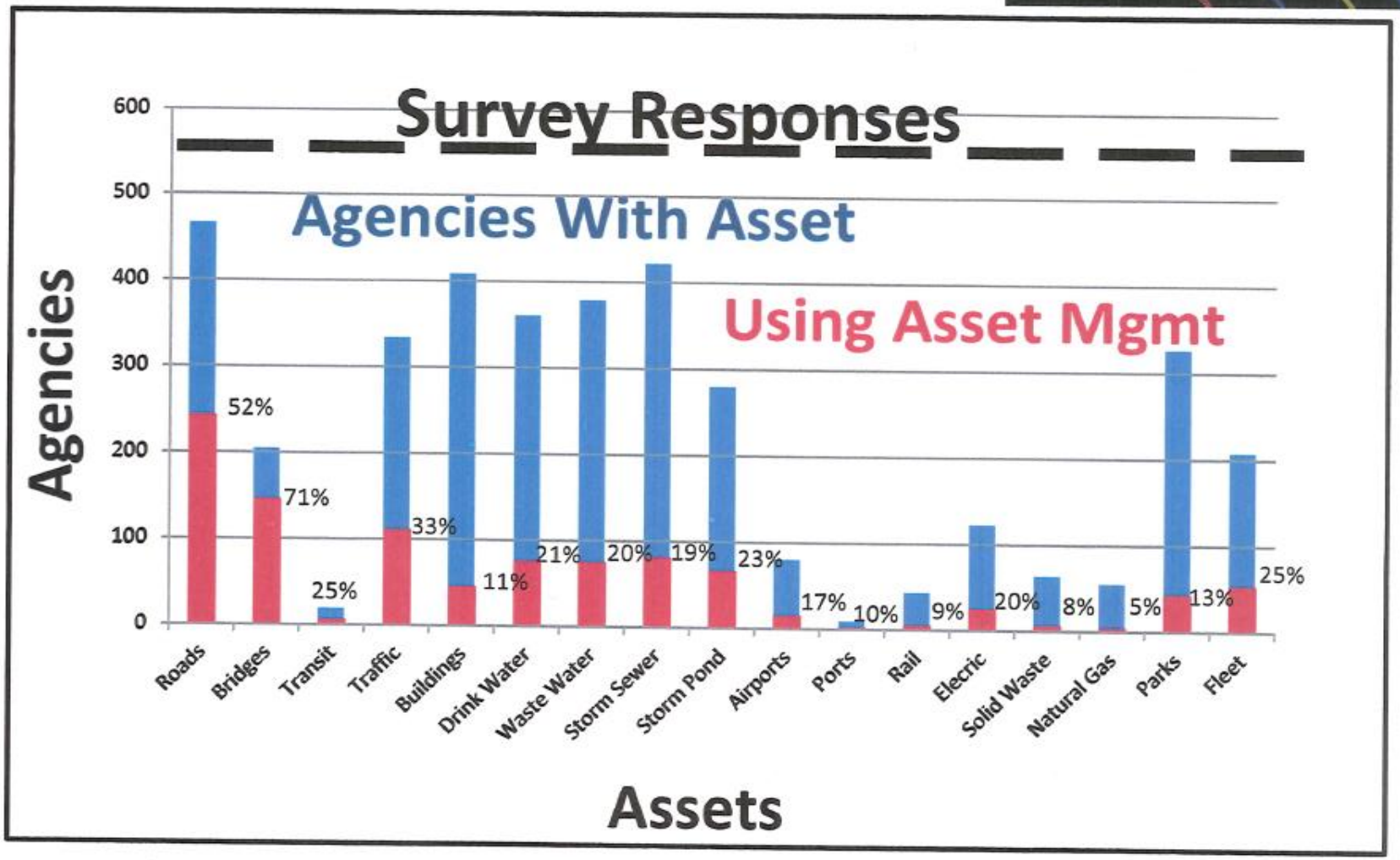
Not Just Utilities … Our Role in Minnesota:
2015 MN2050 Survey

2015 Values

	Small City	Large City	County	State	Total
Roads	$4,174,022,424	$10,517,476,430	$27,647,815,260	$29,338,312,840	$71,677,626,954
Bridges	$1,151,894,172	$807,350,570	$1,456,009,206	$6,592,940,562	$10,008,194,510
Transit	$0	$0	$0	$0	$0
Traffic	$14,168,440	$138,820,460	$59,985,398	$0	$212,974,298
Buildings	$7,583,657,510	$13,724,959,690	$4,869,723,674	$501,696,056	$26,680,036,930
Water	$1,499,020,952	$6,279,799,230	$0	$0	$7,778,820,182
Waste Water	$1,704,463,332	$4,244,983,540	$0	$6,494,782,638	$12,444,229,510
Storm sewer	$0	$2,085,960,070	$0	$0	$2,085,960,070
Storm ponds	$150,185,464	$65,757,060	$5,453,218	$0	$221,395,742
Airports	$1,240,446,922	$1,344,366,560	$0	$0	$2,584,813,482
Ports	$0	$0	$0	$0	$0
Rail	$0	$0	$3,173,772,876	$0	$3,173,772,876
Electrical	$0	$10,564,967,640	$0	$0	$10,564,967,640
Solid Waste	$0	$94,982,420	$796,169,828	$0	$891,152,248
Natural Gas	$2,056,549,066	$2,747,183,840	$0	$0	$4,803,732,906
Total	**$19.5B**	**$52.6B**	**$38.0B**	**$42.9B**	**$153B**

Minnesota Asset Management Usage

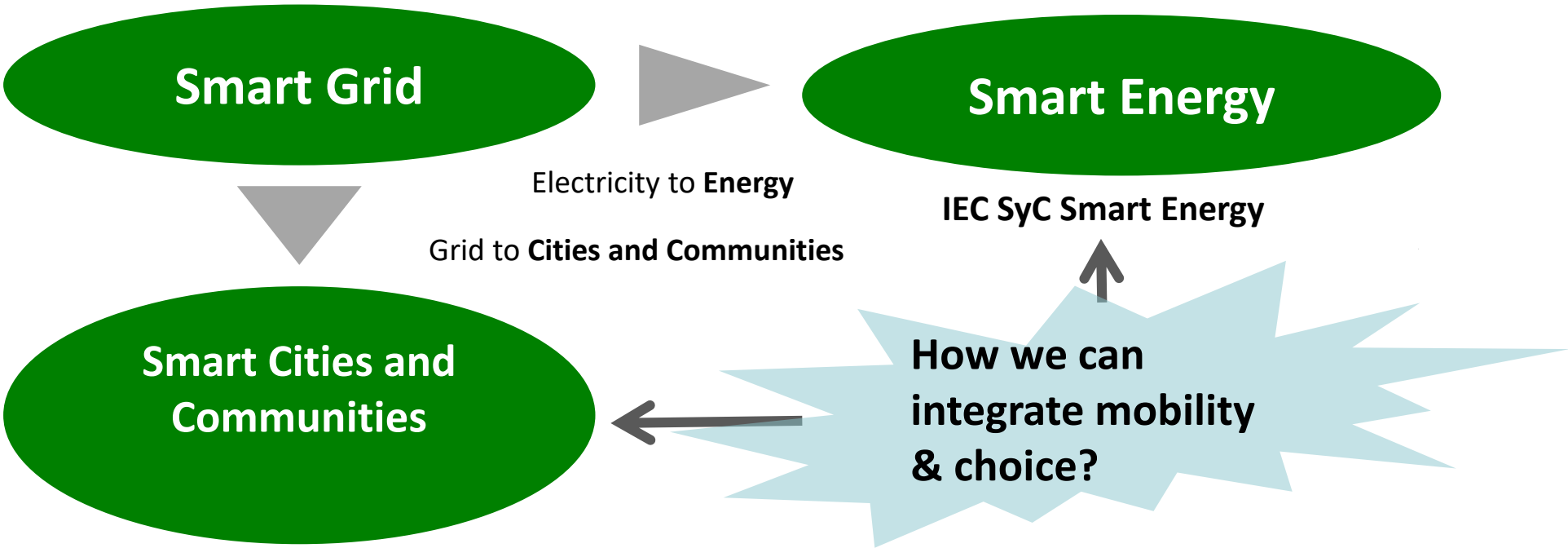




Next Steps

Two dimensions of expanding smart grid concept in standardization

1) **Smart Energy**
2) **Smart Cities and communities**



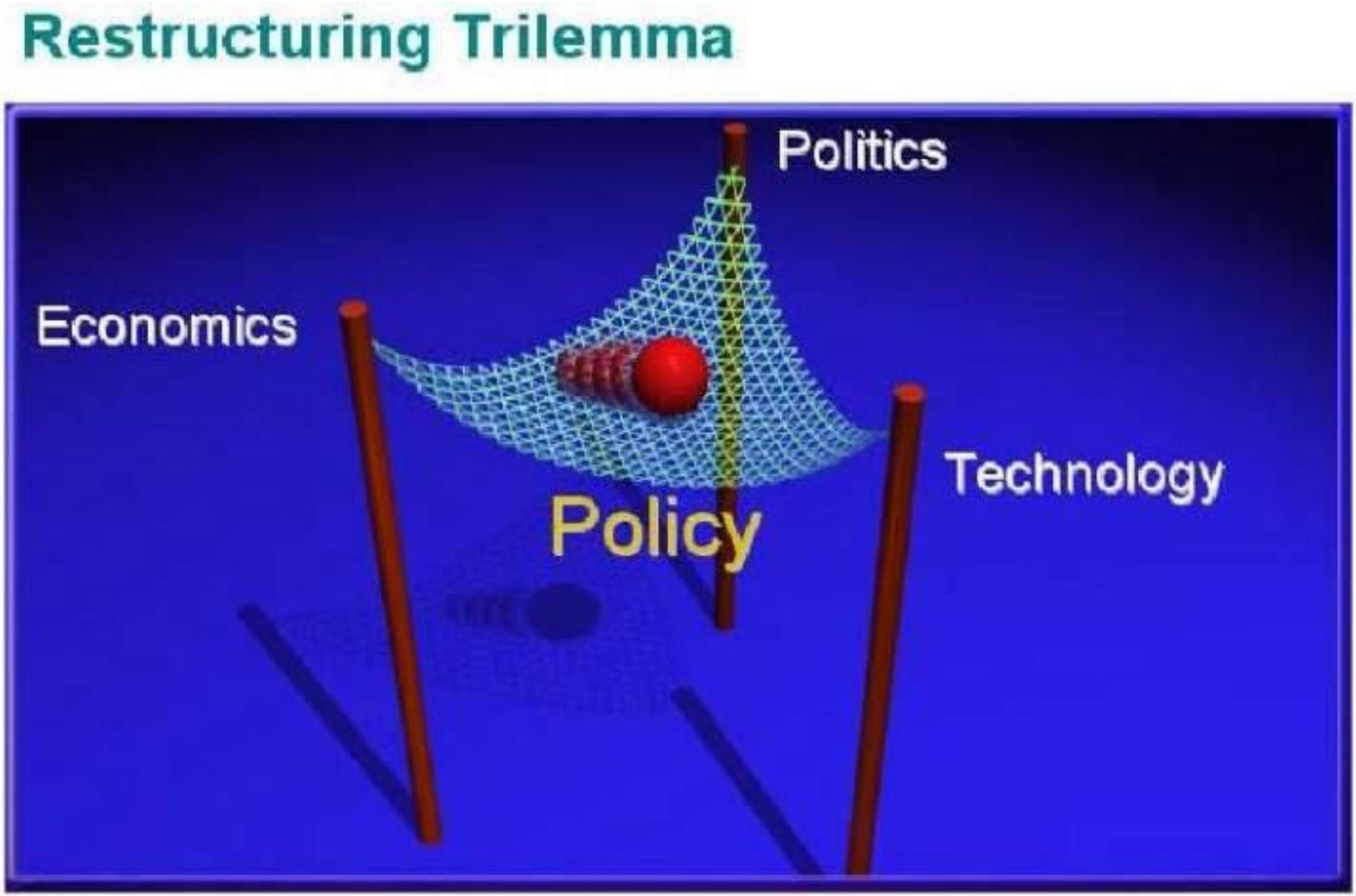
ISO TC268/SC1 Sustainable community Infrastructure
IEC SyC Smart Cities

SMART GRID POLICY IMPLICATIONS

- Focus on Consumer-Societal Benefits
  - Seamless Supply/Demand Interconnect
  - Consumer Empowerment
  - Reliability Transformation

- Help Utilities Deal with the Inevitable
  - Universal Real Time Pricing
  - Distributed Generation Microgrids
  - Retail Service Competition

Unresolved Issues Cloud Planning for the Future




THANK YOU
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