Enterprise Architecture for the Smart Grid: A Status Update

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National Institute of Standards and Technology (NIST)

- Under the Energy Independence and Security Act (EISA) of 2007, NIST has "primary responsibility to coordinate development of a framework that includes protocols and model standards for information management to achieve interoperability of smart grid devices and systems..."
- For additional information on NIST's role and activities, see http://www.nist.gov/smartgrid/.

NIST Interagency Report, Feb draft

- Developed by members of the Smart Grid Interoperability Panel–Cyber Security Working Group (SGIP–CSWG), formerly the Cyber Security Coordination Task Group (CSCTG).
- The group is chaired by Annabelle Lee of NIST.
- "Smart Grid technologies will introduce millions of new intelligent components to the electric grid that communicate in a much more advanced ways (two-way, with open protocols) than in the past. Because of this, two areas that are critically important to get correct are Cyber Security and Privacy."

Working Groups and Committees of the SGIP

As part of the NIST three-phased plan, the Smart Grid Interoperability Panel (SGIP) was created as a public/private partnership for longer-term evolution of standards interoperability. Go to the SGIP main page (SGIP Working Groups and Committees Start Page) for more details and to follow the work of this organization.

The following links will take you directly to the working groups and committees of the SGIP:

SGIP Standing Committees

- Smart Grid Architecture Committee
- Smart Grid Testing and Certification Committee

SGIP Permanent Working Groups

- cyber security coordination task group (CyberSecurityCTG)

SGIP Working Groups

- transmission and distribution (TnD)
- home-to-grid (h2g)
- building-to-grid (b2g)
- industry-to-grid (i2g)
- vehicle-to-grid (pevtg)
- business and policy(BnP)

SGIP Governing Board Working Groups

- Communications, Marketing & Education Working Group
- Bylaws and Operating Practices Working Group

CSWG Architecture Group: Goals

- Provide conceptual, physical, and functional diagrams including a harmony between the three
  - **Single high level diagram encompassing entire smart grid**
  - **More detailed diagrams of each Smart Grid domain**
  - **Major data flows labeled in functional and physical diagrams (similar to current FERC 4+2 diagrams)**
  - **Data flow reference numbers consistent between all diagrams**
  - **Each data flow referencing the use case or source it came from**
  - Scope primarily targets technologies released in the last 5 years or will be released in the next 5 years
  - Technologies outside of the 5 year windows will be included if the group deems necessary but will need to be labeled accordingly

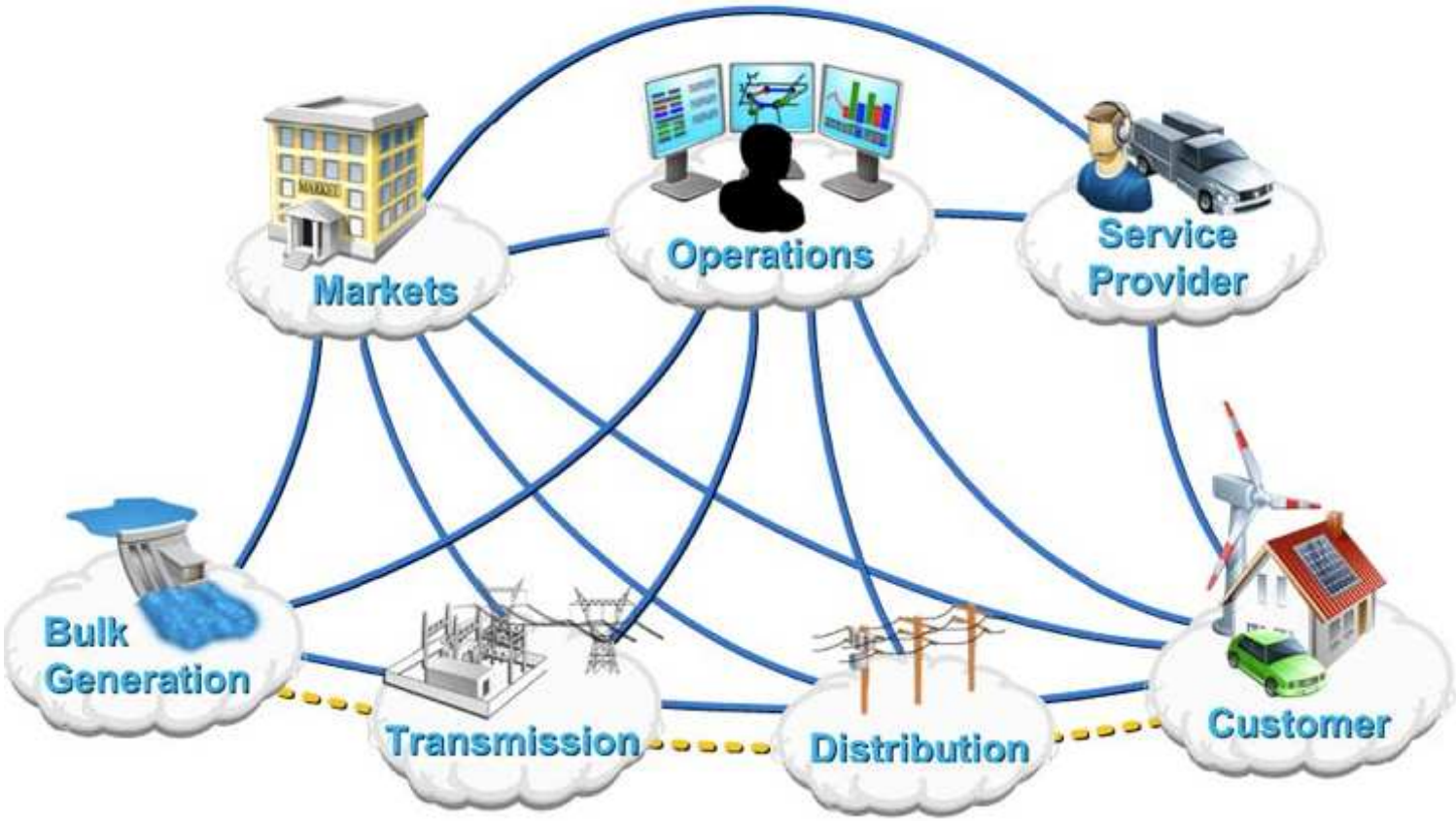
Goals, con't

- Conceptual diagrams
  - Purpose: used to give a non-technical overview of each Smart Grid domain
  - Use the current cloud diagrams
- **Functional diagrams**
  - **Start with current FERC 4+2 diagrams**
  - May move to or merge with with upcoming ASAP-SG diagrams
  - **FERC 4+2 diagrams need to be synchronized, too much overlap and nomenclature differences**

Goals, con’t

- Physical diagrams
  - Portrays major variants of physical deployments (variants are innumerable)
  - Shows logical components in each physical asset (to aid mapping to functional diagram)
  - Shows where physical assets are commonly placed (At utility, in substations, on poles, on homes, etc...)
  - Identify major standards/protocols used in existing products in each domain or product class
  - Based on existing and planned vendor products (meaning discussion and participation with vendors)

Conceptual Model



Also called a Domain Model, this one is at a *very* high level.

Unified Logical Diagram Process

- Domain experts created the FERC 4+2 diagrams
  - Advanced Metering Infrastructure
  - HAN/BAN
  - Distribution Grid Management
  - Wide-Area Situational Awareness (WASA)
  - Electric Transportation
  - Electric Storage
- SGIP Panel–Cyber Security Working Group combined them into one diagram, unifying Actors and Interfaces
- Efforts continue to combine information from multiple sources

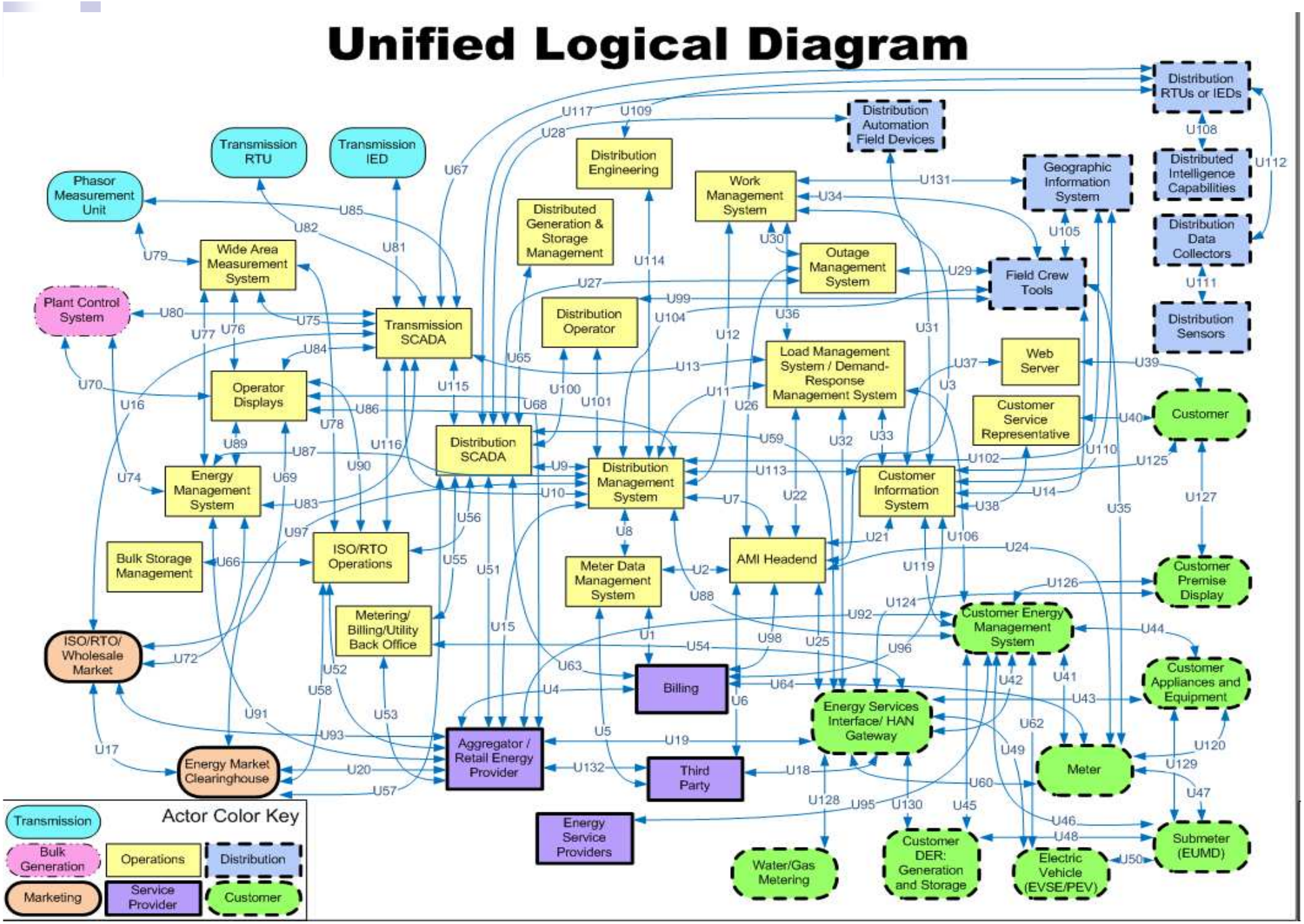


Figure 2.1 Unified Logical Architecture for the Smart Grid [10]

Chapter 2 – *Logical Architecture and Interfaces of the Smart Grid*

- includes
  - **an overall functional logical architecture of the Smart Grid – including all the major domains**.
  - This architecture focuses on a short-term view (1-3 years) of the proposed Smart Grid.
  - **The chapter also includes individual logical interface diagrams for six areas: electric transportation, electric storage, advanced metering infrastructure (AMI), wide area situational awareness (WASA), distribution grid management, and home area network/business area network (HAN/BAN)[12].**
  - These lower level logical interface diagrams provide a more granular view of the Smart Grid domains.
  - **All of the logical interfaces included in the six diagrams are included in the overall functional architecture**.

[12] This was previously named Demand Response

Table 2.1 Actor Descriptions for the Unified Logical Architecture for the Smart Grid

Actor Number	Domain	Actor	Acronym	Description
1.	Bulk Generation	Plant Control System - Distributed Control System	DCS	A local control system at a bulk generation plant. This is sometimes called a Distributed Control System (DCS).
2.	Customer	Customer		An entity that pays for electrical goods or services. A customer of a utility, including customers who provide more power than they consume.
3.	Customer	Customer Appliances and Equipment		A device or instrument designed to perform a specific function, especially an electrical device, such as a toaster, for household use. An electric appliance or machinery that may have the ability to be monitored, controlled and/or displayed.
4.	Customer	Customer Distributed Energy Resources: Generation and Storage	DER	Energy generation resources, such as solar or wind, used to generate and store energy (located on a customer site) to interface to the controller (HAN/BAN) to perform an energy related activity.
5.	Customer	Customer Energy Management System	EMS	An application service that communicates with devices in the home. The application service may have interfaces to the meter to report usage or to the operations domain to get pricing or other information to make automated or manual decisions to control energy consumption more efficiently. The EMS may be a utility subscription service, a consumer written application, or a manual control by the utility or consumer.
6.	Customer	Electric Vehicle Service Element/Plug-in Electric Vehicle	EVSE/PEV	A vehicle driven entirely by an electric motor powered by a rechargeable battery that may be recharged by plugging into the grid or by recharging from a gasoline-driven alternator
7.	Customer	Energy Services Interface/Home Area Network Gateway	HAN	An interface between the distribution, operations, and customer domains and the devices within the customer domain.

Table 2.2 AMI Logical Interfaces by Logical Interface Category

Logical Interface Category	Logical Interfaces
1a. Interface between control systems and equipment with high availability, and with compute and/or bandwidth constraints, for example: • Between transmission SCADA and substation equipment • Between distribution SCADA and high priority substation and pole-top equipment • Between SCADA and DCS within a power plant	U3, U28
1b. Interface between control systems and equipment without high availability, but with compute and/or bandwidth constraints, for example: • Between distribution SCADA and lower priority pole-top equipment • Between pole-top IEDs and other pole-top IEDs	
1c. Interface between control systems and equipment with high availability, without compute nor bandwidth constraints, for example: • Between transmission SCADA and substation automation systems	
1d. Interface between control systems and equipment without high availability, without compute nor bandwidth constraints, for example: • Between distribution SCADA and backbone network-connected collector nodes for distribution pole-top IEDs	
2a. Interface between control systems within the same organization, for example: • Multiple DMS systems belonging to the same utility • Between subsystems within DCS and ancillary control systems within a power plant	U9, U27

Additional Information in NISTIR

- Chapter 1 – *Cyber Security Strategy*: includes background information on the Smart Grid and the importance of cyber security in ensuring the reliability of the Grid and the confidentiality of specific information.
- … see previous slide for Chapter 2
- Chapter 3 – *High Level Security Requirements*: specifies the high level security requirements for the Smart Grid.
- Chapter 4– *Privacy and the Smart Grid*: includes a privacy impact assessment for the Smart Grid with a discussion of mitigating factors.

Table 3.1 Analysis Matrix of Security-Related Logical Interface Categories, Defined by Attributes (ATR)

Attributes / Logical Interface Categories	ATR-1a: Confidentiality requirements	ATR-1b: Privacy concerns	ATR-2: Integrity requirements	ATR-3: Availability requirements	ATR-4: Low bandwidth of communications channels	ATR-5: Microprocessor constraints on memory and compute capabilities	ATR-6: Wireless media	ATR-7: Immature or proprietary protocols	ATR-8: Inter-organizational interactions	ATR-9: Real-time operational requirements with low tolerance for latency problems	ATR-10: Legacy end-devices and systems	ATR-11: Legacy communication protocols	ATR-12: Insecure, untrusted locations	ATR-13: Key management for large numbers of devices	ATR-14: Patch and update management constraints for devices including scalability and communications	ATR-15: Unpredictability, variability, or diversity of interactions	ATR-16: Environmental and physical access constraints	ATR-17 Limited power source for primary power	ATR-18: Autonomous control
1a. Interface between control systems and equipment with high availability, and with compute and/or bandwidth constraints			X	X	X	X	X	X		X	X	X	X	X	X		X		X
1b. Interface between control systems and equipment without high availability, but with compute and/or bandwidth constraints			X		X	X	X	X		X	X	X	X	X	X		X	X	X
1c. Interface between control systems and equipment with high availability, without compute nor bandwidth constraints			X	X			X	X		X	X	X	X	X	X		X		X

Additional Information, con't

- Chapter 5 – *Standards Review*: includes a review of the standards that were identified in the workshops that NIST conducted and others that have been identified through the Priority Action Plan (PAP) process.
- Chapter 6 – *Research and Development (R&D)*: includes R&D themes that identify where the state of the art falls short of meeting the envisioned functional, reliability, and scalability requirements of the Smart Grid.

Appendices in NISTIR

- *Appendix A*: key power system use cases with security applicability used in the risk assessment process
- *Appendix B*: crosswalk of cyber security documents used in developing the security requirements
- *Appendix C*: vulnerability classes used in the risk assessment process
- *Appendix D*: bottom-up security analysis of the Smart Grid used in the risk assessment process
- *Appendix E*: state laws – Smart Grid and electricity delivery regulations
- *Appendix F*: acronyms and glossary
- *Appendix G*: SGIP-CSWG membership.

The requirements included in this NIST report will form the basis for the standards and guidelines developed with coordination by NIST and the SGIP.

Upcoming Minnesota Events

MINNESOTA TRADE OFFICE
Department of Employment and Economic Development

IREE
INSTITUTE ON THE ENVIRONMENT
UNIVERSITY OF MINNESOTA

The Business of SMART GRID:

Benefits for Minnesota's Companies and Workforce

IF YOU haven't heard much about the "smart grid" yet, you will. Big changes are coming to our nation's electricity grid, which is dated and under stress from growing energy demand. The envisioned solution calls for a comprehensive upgrade and transformation costing as much as $1 trillion dollars in the coming decades — smart meters, enhanced information systems, the integration of renewable sources, new hardware, new software, the list is long and growing. A more efficient, smarter and resilient electricity grid will result for consumers and commercial energy customers.

What does this mean for Minnesota's businesses and workforce? It means a world of emerging business and job creation opportunities generated by a massive initiative that touches many sectors of industry and anyone who uses electricity. Many Minnesota companies are seizing opportunities already—and are poised to grow their businesses even more as smart grid grows. Many other countries are adopting the smart grid model as well, and that spells export opportunities for U.S. companies.

The Minnesota Trade Office is pleased to partner with the University of Minnesota's Initiative for Renewable Energy and Environment to offer "The Business of Smart Grid—Benefits for Minnesota's Companies and Workforce," a daylong event featuring national experts.

Featured Presentation and Panel Topics:

- The Smart Grid Concept
- US Government Policy Priorities for Smart Grid and Clean Energy
- US Department of Energy Vision for the Smart Grid
- International and Export Business Opportunities in Smart Grid
- Venture Capital and Investment in a Smart Grid Future
- Panel Discussion: The Communications Backbone – Technology Standards Critical to Smart Grid
- Panel Discussion: Smart Grid Domestic and International Opportunities
- Panel Discussion: The Promise of Smart Grid – An Engine for Job Growth

DATE: **Wednesday, June 9, 2010**

TIME: 9 a.m. to 4 p.m. Registration and networking begin at 8:30 a.m.

LOCATION: Northstar Ballroom, St. Paul Student Center, University of Minnesota, 2017 Buford Avenue, St. Paul.

MAP: www1.umn.edu/twincities/maps/StCen/

COST: $35 includes refreshments, lunch and materials.

QUESTIONS? Contact Steve Riedel at steve.riedel@state.mn.us or 651-259-7494.

About the Speakers

We are especially pleased to welcome two senior US Government officials to this event:

Mary Saunders

Mary Saunders, Deputy Assistant Secretary for Manufacturing and Services at the U.S. Department of Commerce, will share the latest in U.S. clean energy and export policy priorities. In January 2010 the Obama Administration launched the National Export Initiative (NEI), which aims to double U.S. exports over the next five years and focuses on assisting small businesses to enter new export markets. DAS Saunders will share insight on federal clean energy and export policies, with highlights on opportunities for U.S. clean energy companies.

Eric Lightner

Eric Lightner from the U.S. Department of Energy and Director of the interagency Smart Grid Task Force will provide insight on the most recent developments of the Smart Grid Investment Grants and Smart Grid Demonstration Grants which were announced in October 2009 and November 2009, respectively. These stimulus bill programs, which are managed by the Department of Energy, will advance smart grid infrastructure throughout the United States, while putting tens of thousands of Americans to work.

Leading the list of Minnesota experts at this event is **Dr. Massoud Amin**, Director of the Technological Leadership Institute at the University of Minnesota. Dr. Amin is a respected international expert in the smart grid, and will also present and moderate panel discussions.

Registration

Registration is being handled by the University of Minnesota

Click here to register.

About the Minnesota Trade Office

The Minnesota Trade Office (MTO) is the state office that helps companies increase export sales. A division of the Department of Employment and Economic Development (DEED), the MTO is the state's official export promotion arm. Detailed information about our services is available online at

www.PositivelyMinnesota.com/trade

About the Initiative for Renewable Energy and the Environment

IREE's mission is to promote statewide economic development; sustainable, healthy and diverse ecosystems; and national energy security through development of bio based and other renewable resources and processes.

http://environment.umn.edu/iree/

Co-Sponsor

Minnesota Department of Commerce, Office of Energy Security

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