



Overview of NSF Program in Energy, Power and Adaptive Systems

Eyad H. Abed, Program Director
Energy, Power and Adaptive Systems
Division of Electrical,
Communications and Cyber Systems
(ECCS)

Feb. 4, 2014



Outline

- NSF's Role in Research and Education
- Energy, Power, and Adaptive Systems (EPAS) Program
- The Evolving Grid – Renewables and Smart Grid
- Cyber Physical Systems (CPS)
- Interagency Funding Examples
- Conclusions

NSF's Role in Research and Education

- NSF is an independent federal agency established in 1950
- Supports *fundamental* research and education in science and engineering
- NSF has a discipline-based structure with cross-disciplinary mechanisms
- Uses “rotators” or IPA’s as well as permanent program directors
- FY’14 NSF budget is \$7.17B (\$5.81B for research, of which about \$800M is in the Engineering Directorate)

Energy, Power, and Adaptive Systems (EPAS) Program

- I recently took an IPA position as a Program Director in the EPAS Program at NSF
- EPAS is the program within ECCS (Electrical, Communications and Cyber Systems Division) that supports power and energy systems and technologies as well as systems and control
- EPAS has 3 Program Directors --- 2 permanent and 1 rotator
- EPAS leverages other programs in NSF (and other agencies) whenever possible

Energy, Power, and Adaptive Systems (EPAS)



Kishan Baheti

- Control Theory & Hybrid Dynamical Systems
- Distributed & Mobile Networked Control
- Networked Sensing & Imaging Systems
- Control Aspects of Cyber-Physical Systems
- Cyber Secure Control of Power Systems
- Systems Theory in Molecular, Cellular, & Synthetic Biology
- Networked Robotics & Transportation Networks



Eyad Abed

- Energy Collection & Harvesting Devices and Systems
- Energy Storage
- Advanced Power Electronics
- Electric Grid Interfaces
- Electric & Hybrid Vehicles
- Energy/Power Sensing
- Local Distributed Power Systems



Paul Werbos

- Adaptive & Intelligent Systems
- Transmission & Distributed Systems
- Intelligent Power Grid & Economics
- Quantum Systems & Modeling
- Theory and Modeling for Systems & Devices
- Neuromorphic Engineering
- Cognitive Optimization & Prediction
- Intelligent Vehicles
- Learning & Intelligence for Robotics

Energy, Power, and Adaptive Systems (EPAS)

- Design and analysis of complex systems including sensing, imaging, control and computational technologies
- Emphasis on electric power networks including generation, transmission, distribution
- Power electronics and drives
- Energy harvesting devices and systems
- Regulatory and economic structures

Energy, Power, and Adaptive Systems (EPAS)

- Types of Proposals
 - Faculty Early Career Development (CAREER)
 - Single Investigators / Small group
 - Industry Collaborations (GOALI)
 - Exploratory Research (EAGER)
 - Workshops in emerging areas
 - International collaborations
 - REU, RET (students, teachers)
 - Other NSF solicitations (ERC, STC, IUCRC, CPS, ...)

Energy, Power, and Adaptive Systems (EPAS)

- Guidance in Preparing Proposals
 - Propose your fundamental ideas that you feel can advance the art over the medium to long term
 - NSF wants to support researchers to make fundamental advances
 - Some prior work helps to convince panels of project feasibility
 - Unsolicited proposals are all due in November of each year
 - Special programs have different deadlines (or are open)

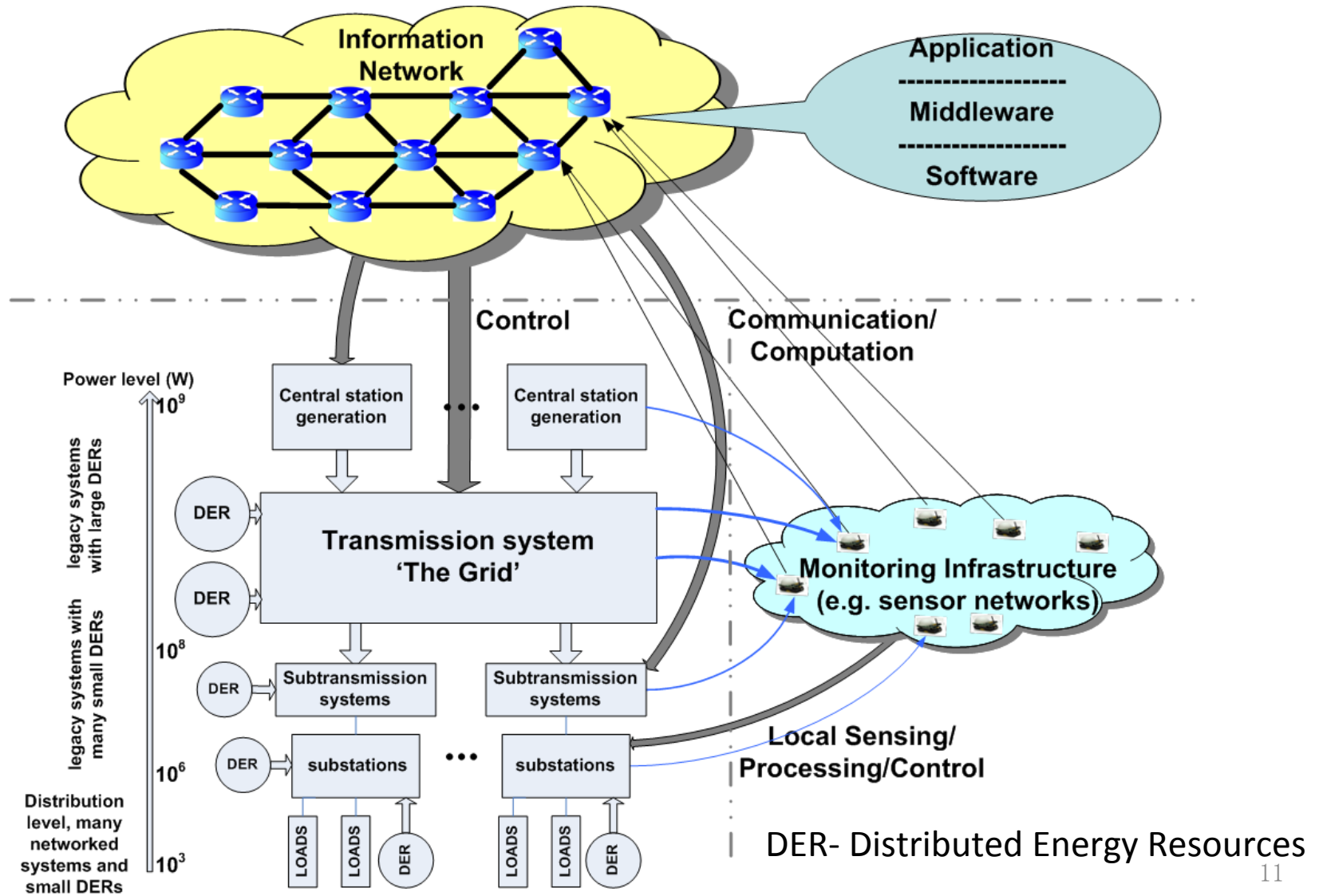
The Evolving Grid – Renewables and Smart Grid

- Producing electricity contributes 40% of world carbon dioxide emissions
- Electricity use in the U.S. is expected to double by mid-century
- The electric power industry is now undergoing significant change, some of which is motivated by environmental considerations (this is traditionally a conservative industry)
- Incorporation of renewable power sources is increasing worldwide
- Development of the Smart Grid is also occurring to obtain efficiencies and protect the environment

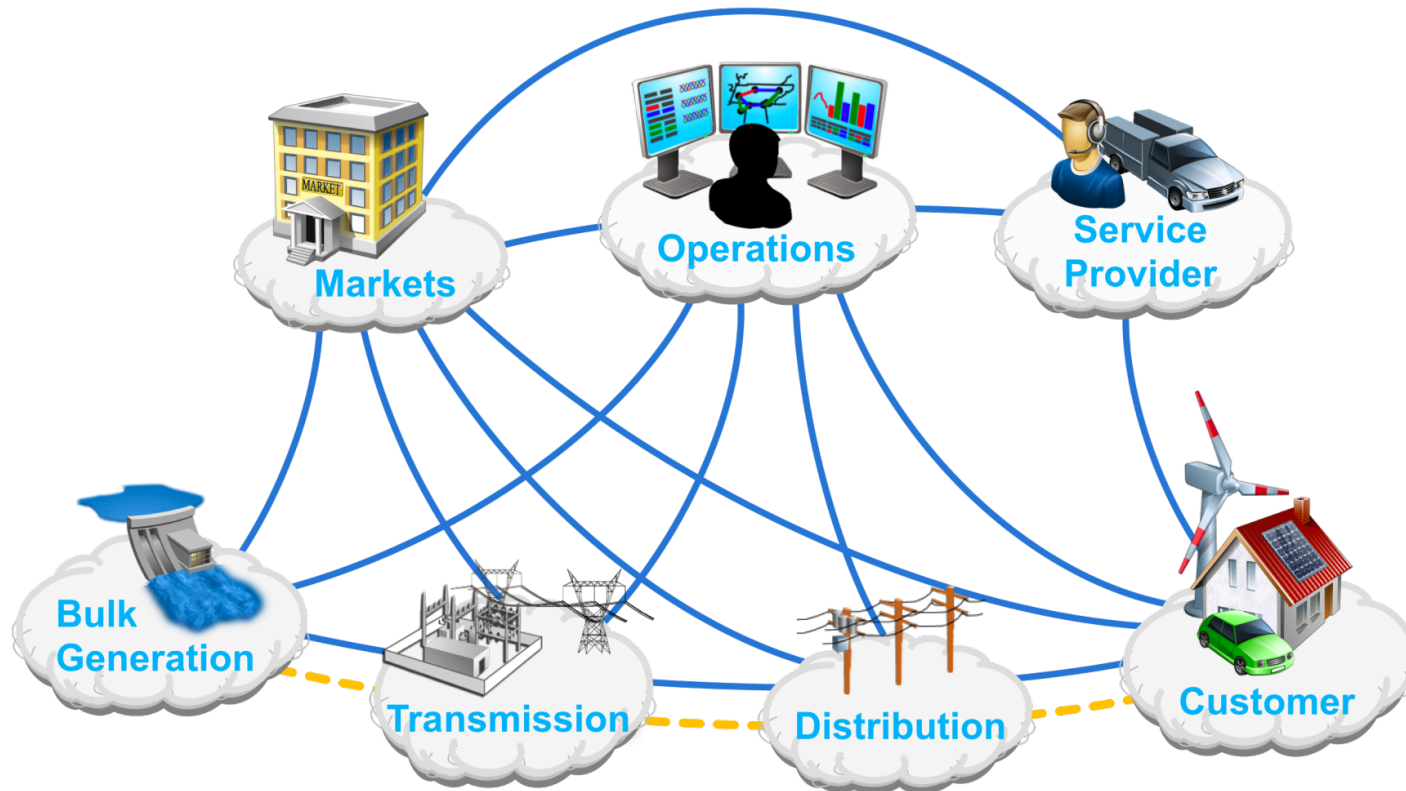
The Evolving Grid – Renewables and Smart Grid

- Many fundamental issues need to be addressed as renewable penetration increases:
 - How to build out renewables to maintain system reliability, stability, etc.
 - Advanced storage technologies
 - Effect of renewables on utilities – including economic fairness
- Smart Grid also brings up new research issues, including modeling human behavior and response to incentives; gaming; etc
- Anyway, the research community will discover and address these problems; NSF is here to help evaluate and support the research

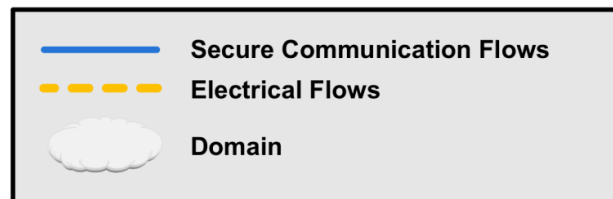
Vision of Cyber-Enabled Mega-scale Power Grid: Information Network Overlay Power System



Smart Grid Framework



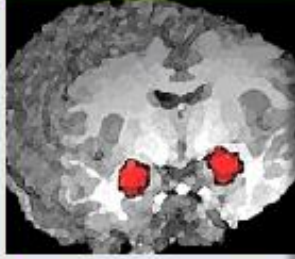
NIST Smart Grid Framework 1.0 Sept 2009





NSF AWARD SEARCH

- www.nsf.gov
 - Search awards
 - Advanced search
 - Program officer
- Many options available
 - Program Information
 - Keyword search “power Systems” “power Electronics” “Energy Harvesting” ...



Award Search

[Send Comments](#) | [Award Search Help](#)

[Awardee Information](#)

Program Information

[Search All Free-Text](#)

[Search All Fields](#)

[More Options](#)

Hint: The text field below 'Search Award For' searches

Search Award For:

Restrict to Title Only:

Program Information

NSF Organization:

Program Officer:

Baheti

Element Code:

Reference Code:

Hint: This "Program" box searches both program element and program officer. For best results, please use the program look up function.

Program:

Field of Application:

Hint: Historical data is from prior to 1976. This data is not included in the search results.

Active Awards Only:

Active and Expired Awards:

Expired Awards Only:

Historical Awards:

Search Results

[Back](#)

Results are sorted by award date, with the most recent awards at the top. Click on a column heading to re-sort the results.

The up/down arrows at the right of each column title control whether the sort is ascending or descending.

To view the abstract, click on the award number or title. Click on the data in other columns to perform a new search with that parameter.

[Refine Search](#)

141 awards found, displaying 1 to 50.

[First/Prev] 1, 2, 3 [Next/Last]

Award Number	Title	NSF Organization	Program(s)	Start Date	Principal Investigator	State	Organization	Awarded Amount to Date
1056028	CAREER: High Dimensional Statistics - Adaptive Networks, Structure and Robustness	ECCS	ENERGY,POWER,ADAPTIVE SYS	09/01/2011	Caramanis, Constantine	TX	University of Texas at Austin	\$400,000.00
1054394	CAREER: Wide-Area Control of Large Power Systems Using Distributed Synchronoscopes: Where Network Theory Meets Power System Dynamics	ECCS	ENERGY,POWER,ADAPTIVE SYS	03/01/2011	Chakraborty, Aranya	NC	North Carolina State University	\$400,000.00
1058560	CAREER: Modeling and Control of Neuronal Networks	ECCS	ENERGY,POWER,ADAPTIVE SYS	03/01/2011	Sarma, Sridevi	MD	Johns Hopkins University	\$399,999.00
1026591	CDI-Type II: Computing with Biomolecules: From Network Motifs to Complex and Adaptive Systems	ECCS	CDI TYPE II	10/01/2010	Stojanovic, Milan	NY	Columbia University	\$550,000.00
1028120	CDI-Type II: Collaborative Research: Computing with Biomolecules: From Network Motifs to Complex and Adaptive Systems	ECCS	CDI TYPE II	10/01/2010	Teuscher, Christof	OR	Portland State University	\$299,964.00
1028237	CDI-TYPE II: Collaborative Research: Cyber-Amplified Bioinspiration in Robotics	ECCS	CDI TYPE II	10/01/2010	Koditschek, Daniel	PA	University of Pennsylvania	\$1,286,200.00
1028238	CDI-Type II: Collaborative Research: Computing with Biomolecules: From Network Motifs to Complex and Adaptive Systems	ECCS	CDI TYPE II	10/01/2010	Stefanovic, Darko	NM	University of New Mexico	\$1,100,000.00
1028319	CDI-Type II: Collaborative Research: Cyber-Amplified Bioinspiration in Robotics	ECCS	CDI TYPE II	10/01/2010	Full, Robert	CA	University of California-Berkeley	\$712,113.00
1029081	Collaborative Research: Factor-Graph Approach to Monitoring and Failure Assessment in Smart-Grid Networks	ECCS	ENERGY,POWER,ADAPTIVE SYS	10/01/2010	Kavcic, Aleksandar	HI	University of Hawaii	\$75,000.00
1029178	Head Eye Coordination, Motion Detection and Feedback Control with Couplers	ECCS	ENERGY,POWER,ADAPTIVE SYS	10/01/2010	Ghosh, Bijoy	TX	Texas Tech University	\$345,560.00

Cyber-Physical Systems Program

Deeply integrating computation, communication, and control into physical systems

- Launched in 2009
- Aims to develop the core system science needed to engineer complex “smart” cyber-physical systems
- Serves key national priorities
- Coordinated across NSF and with other government agencies

114 active awards:

- \$140M+ total investment
- 43 small, average \$527K
- 66 medium, average \$1.5M
- 5 large, average \$4.7M



Transportation



Manufacturing and Industrial Automation



Energy



Healthcare and Biomedical



Critical Infrastructure



Interagency Funding Examples



Electrical Energy Systems Education with Emphasis on Sustainable Power

(ECCS- 0901635/1028326, Mohan, University of Minnesota – Twin Cities)

(Supported by NSF, NASA, ONR, DOE and EPRI)



Consortium of Universities for Sustainable Power (CUSP)™

Vision: Revitalizing Electric Energy Systems Education worldwide through proactive dissemination and the Internet using CUSP™

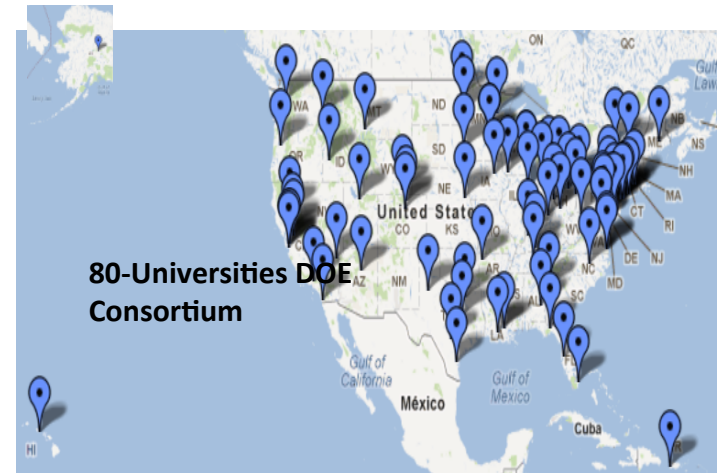
Outcomes:

- Power & Energy Curriculum
- Undergraduate & Graduate Courses
- Workshops
- Laboratories
- Student Enrollment
- Published Textbooks



Professor Ned Mohan

University of Minnesota





CURRENT (*Center for Ultra-Wide-Area Resilient Electric Energy Transmission Networks, Tomsovic, University of Tennessee, Knoxville*)
(Supported by NSF and DOE)



A nation-wide or continent-wide transmission grid that is fully monitored and dynamically controlled in real-time for high efficiency, high reliability, low cost, better accommodation of renewable energy sources, full utilization of energy storage, and accommodation of responsive load.

A new generation of electric power and energy systems engineering leaders with global perspectives and diverse backgrounds.

International Partner Universities:

National Technical University of Athens
Tsinghua University
University of Waterloo
Affiliate Universities:

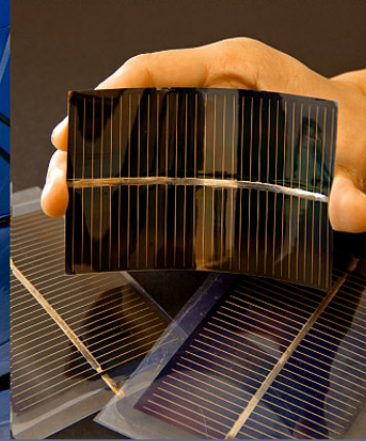
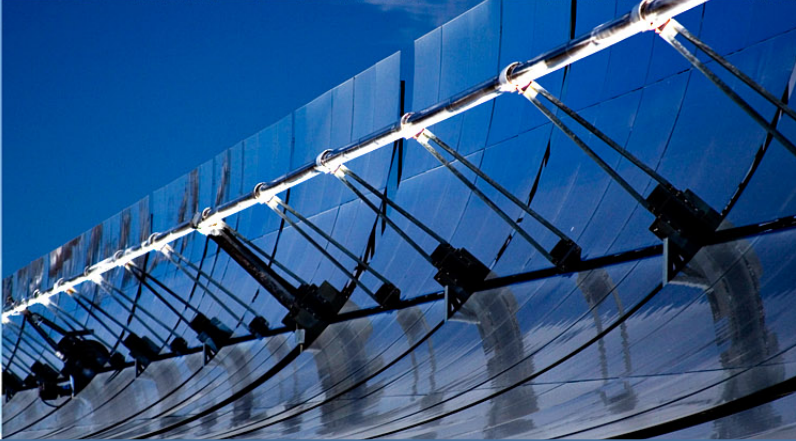
Federal University of Rio de Janeiro
Montana Tech
Supelec
Tennessee State University
Tufts University
University of California, Santa Barbara

SunShot Initiative \$145M for Advanced Solar Technologies



U.S. DEPARTMENT OF
ENERGY

Energy Efficiency &
Renewable Energy



F-PACE

(Foundational Program to
Advance PV Cell Efficiency)

- DOE/SETP & NSF/ECCS
- (18 Projects/\$38.5M)
- Awarded FY2012

Conclusions

- This is an exciting time to be involved in advancing research and education in electric energy systems
- NSF offers seed funding for fundamental research through unsolicited grants and other mechanisms
- NSF's goal is to use its resources to support development of the most promising ideas
- I am available at eabed@nsf.gov; ; feel free to contact me