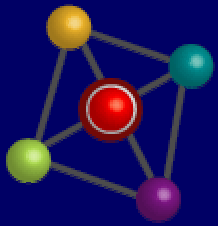


*Stimulating Economic Growth
through Electric Energy R&D*

Texas Consortium for Electric Energy- TxCEE

ERCOT TAC Meeting
April 7, 2005





TxCEE

University members

Texas A&M University

M. Kezunovic

The University of Texas at Austin

R. Hebner, M. Grady

Texas A&M University - Kingsville

S. Lee

The University of Texas - Arlington

W. Lee

The University of Texas - El Paso

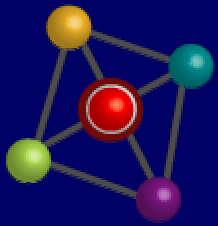
B. Dong (moved)

Texas Tech University

M. Giesselmann

University of Houston

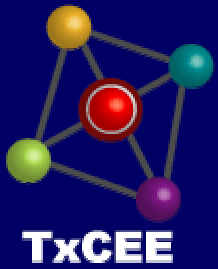
C. Ovidiu, P. Chu



TxCEE

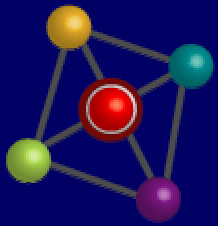
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- Q/A



Governor's Initiative

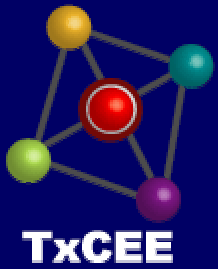
- Texas Emerging Technology Fund
- The Texas Technology Initiative (TTI)
 - State Strategy on Advanced Technology (SSAT)
 - Industry Cluster Initiative (ICI)
- Center for Advanced Energy Applications



TxCEE

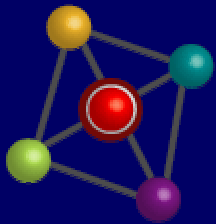
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Consortium Timeline

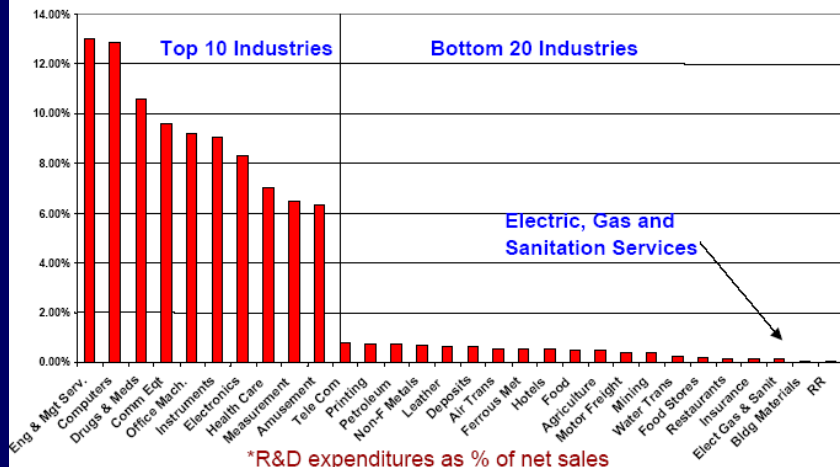
Fall 2003	Initial university contacts
Nov. 2004	First Texas Electric Energy Forum
Nov. 2004	Formal University Consortium Initiative
Jan. 2005	Confirmation of the present organization
Feb. 2005	First meeting with stakeholders



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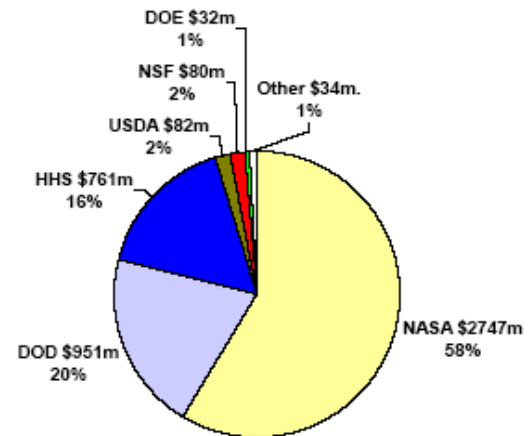
Investment and Return

R&D Expenditures*



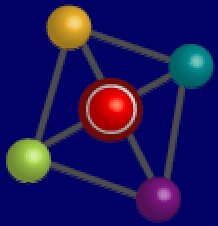
EPRI

Federal R&D to Texas by Agency FY 2000 (obligations in millions of dollars) Total: \$4.7 billion



Source: National Science Foundation, Federal Funds for Research and Development, Fiscal Years 2000, 2001, and 2002. 2002. R&D = conduct of R&D and R&D plant. JUNE '02 © 2002 AAAS

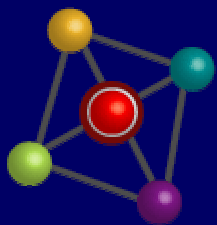
AMERICAN ASSOCIATION FOR THE
ADVANCEMENT OF SCIENCE



TxCEE

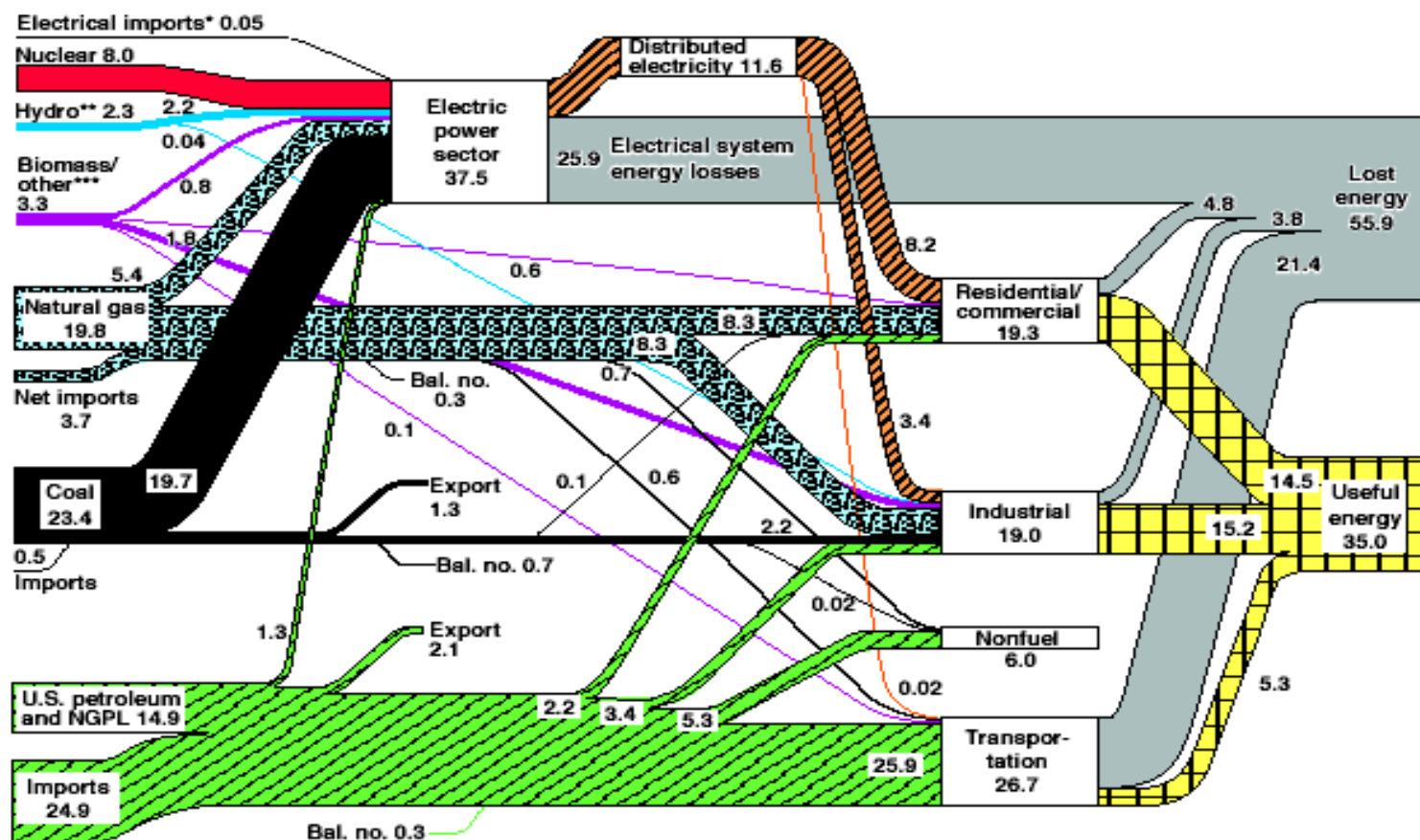
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TxCEE

US Energy Flow Trends - 2001



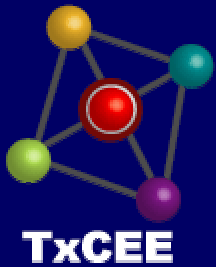
Source: Production and end-use data from Energy Information Administration, *Annual Energy Review 2001*

*Net fossil-fuel electrical imports

**Includes 0.2 quads of imported hydro

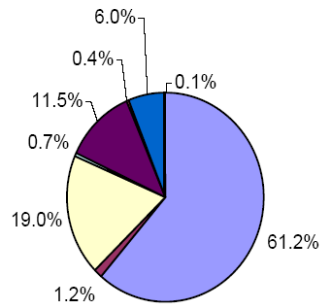
***Biomass/other includes wood, waste, alcohol, geothermal, solar, and wind.

August 2003
Lawrence Livermore
National Laboratory
<http://eed.llnl.gov/flow>



Texas Energy (electricity) portfolio

Summer 2003 Fuel Types - ERCOT



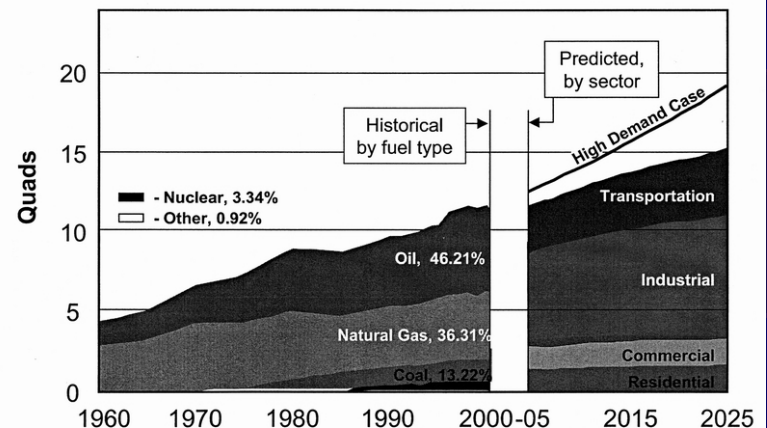
■ Natural Gas
 ■ Wind
 ■ Coal
 ■ Water
 ■ Dual Fuel
 ■ Other
 ■ Nuclear
 ■ Diesel

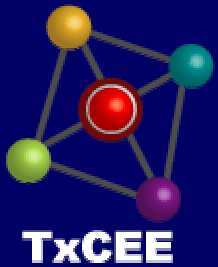
Technology	Existing MW (as of 9/1/99)	New MW (since 9/1/99)	Total MWh 2003 generation
Biomass	0	0	0
Hydro	105	10.2	239,683.7
Landfill gas	6.3	36.1	193,701.4
Solar	0	0.2	219.9
Wind	115.8	1139.7	2,515,482.2

Texas Electr. Demand by Sector in Trillion BTUs

Sector	2001	2025	% Change
Residential	613.95	824.98	34.37%
Commerc.l	564.15	789.98	40.03%
Industrial	5349.50	7137.23	33.42%

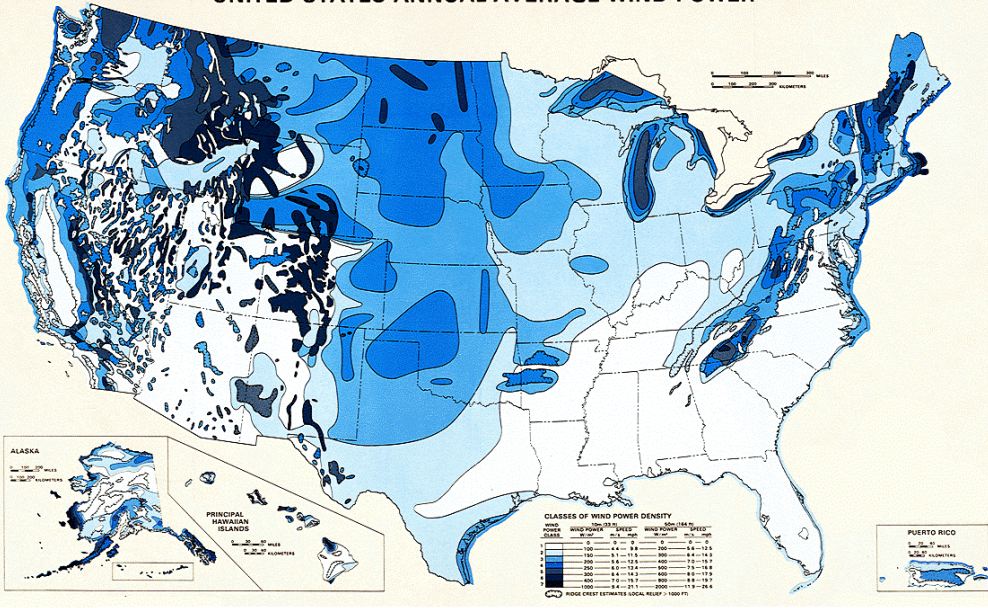
Texas Energy Consumption



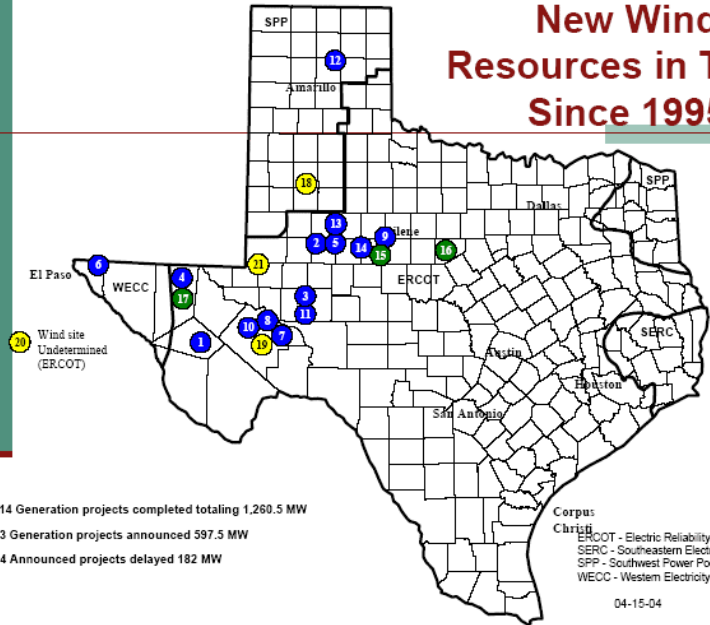


Wind

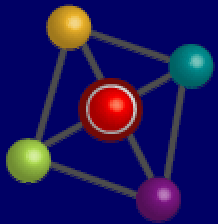
UNITED STATES ANNUAL AVERAGE WIND POWER



New Wind Resources in Texas Since 1995

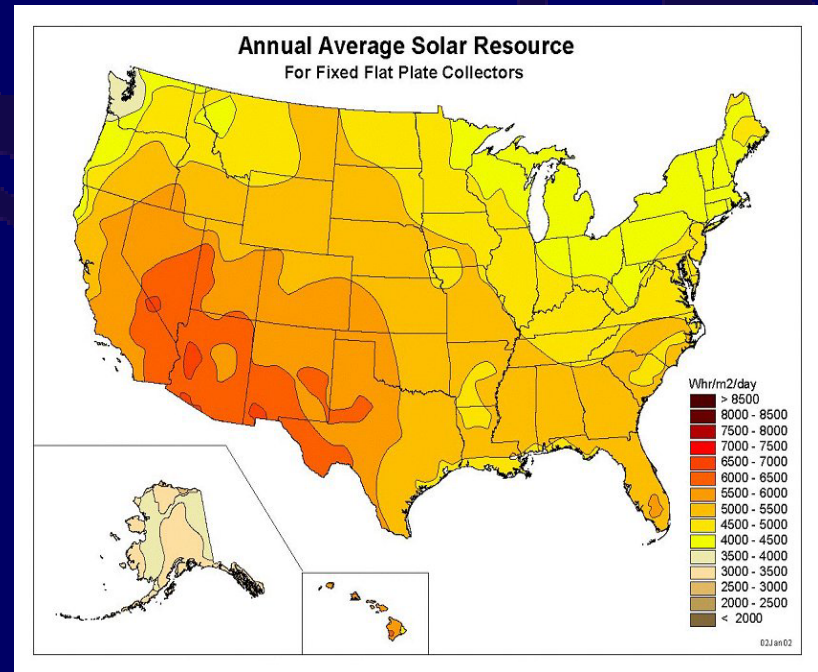
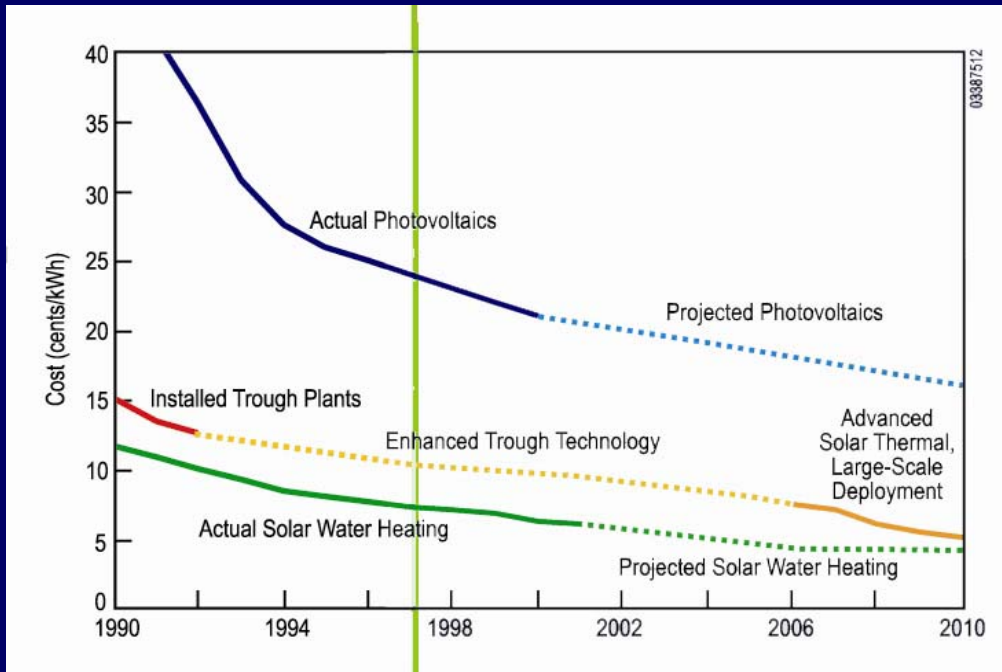


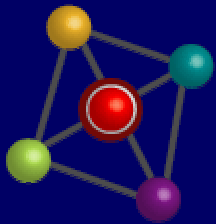
ERCOT - Electric Reliability Council of Texas
SERC - Southeastern Electric Reliability Council
SPP - Southwest Power Pool
WECC - Western Electricity Coordinating Council



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Solar

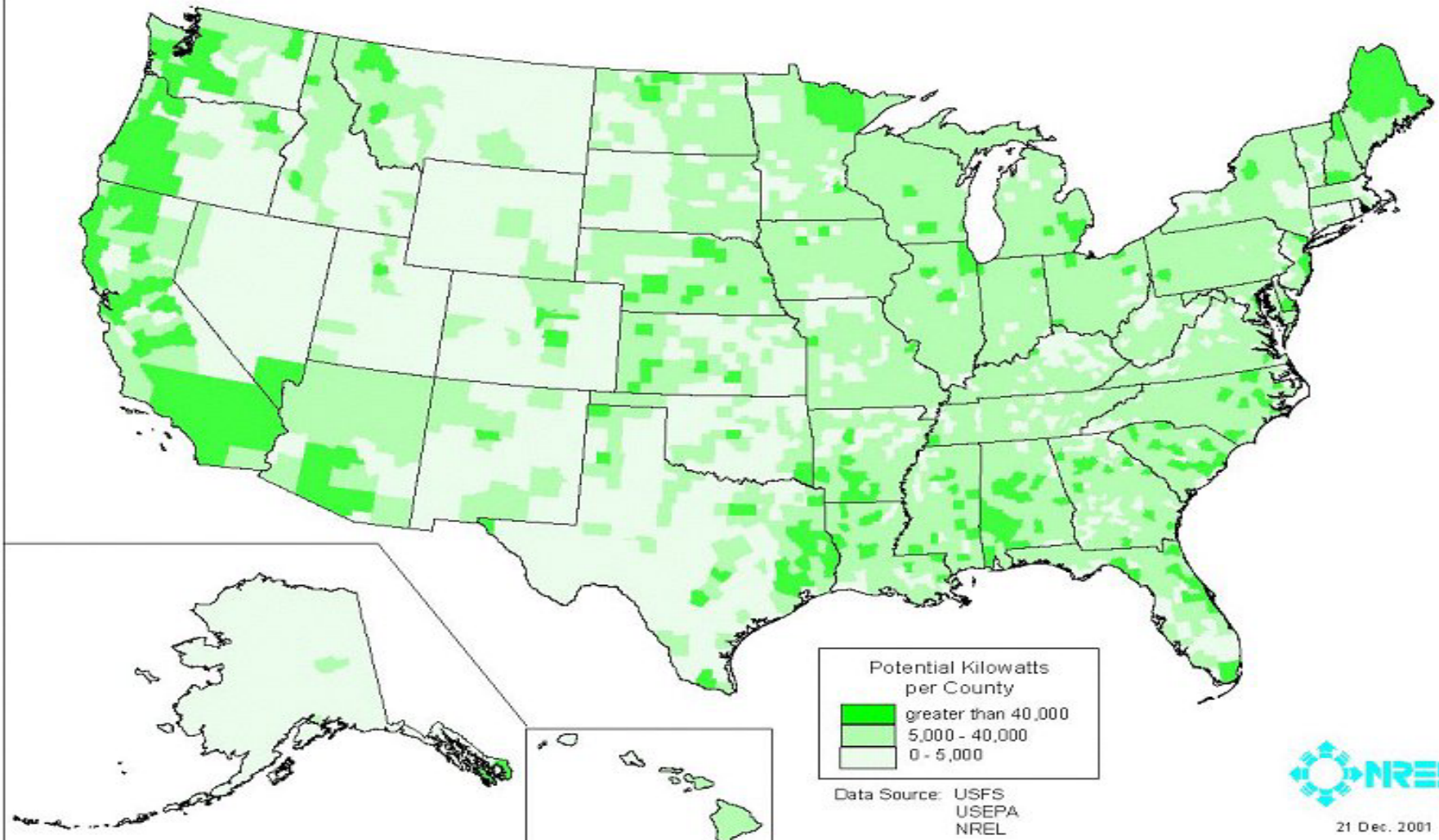




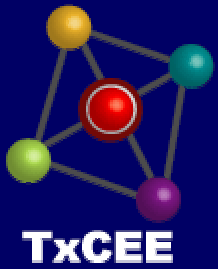
TxCEE

Biomass

United States - Biomass Resources from Residues

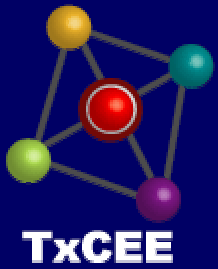


21 Dec. 2001



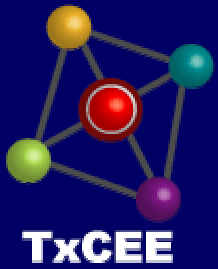
Savings and improvements (Rand Corporation Study)

- Four examples of 20 year benefits from:
 - Reduced peak demand (\$16-80 Billion)
 - Active Load management (\$16 Billion)
 - Improved system reliability (\$ 50 Billion)
 - End-User Efficiency (\$20 Billion)
- Other cost-benefit areas:
 - integration of distributed energy resources
 - reduced emission and other environmental cost
 - increased energy security
 - greater public confidence
 - Productivity gains from high quality, reliable power



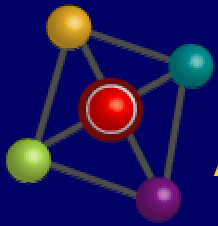
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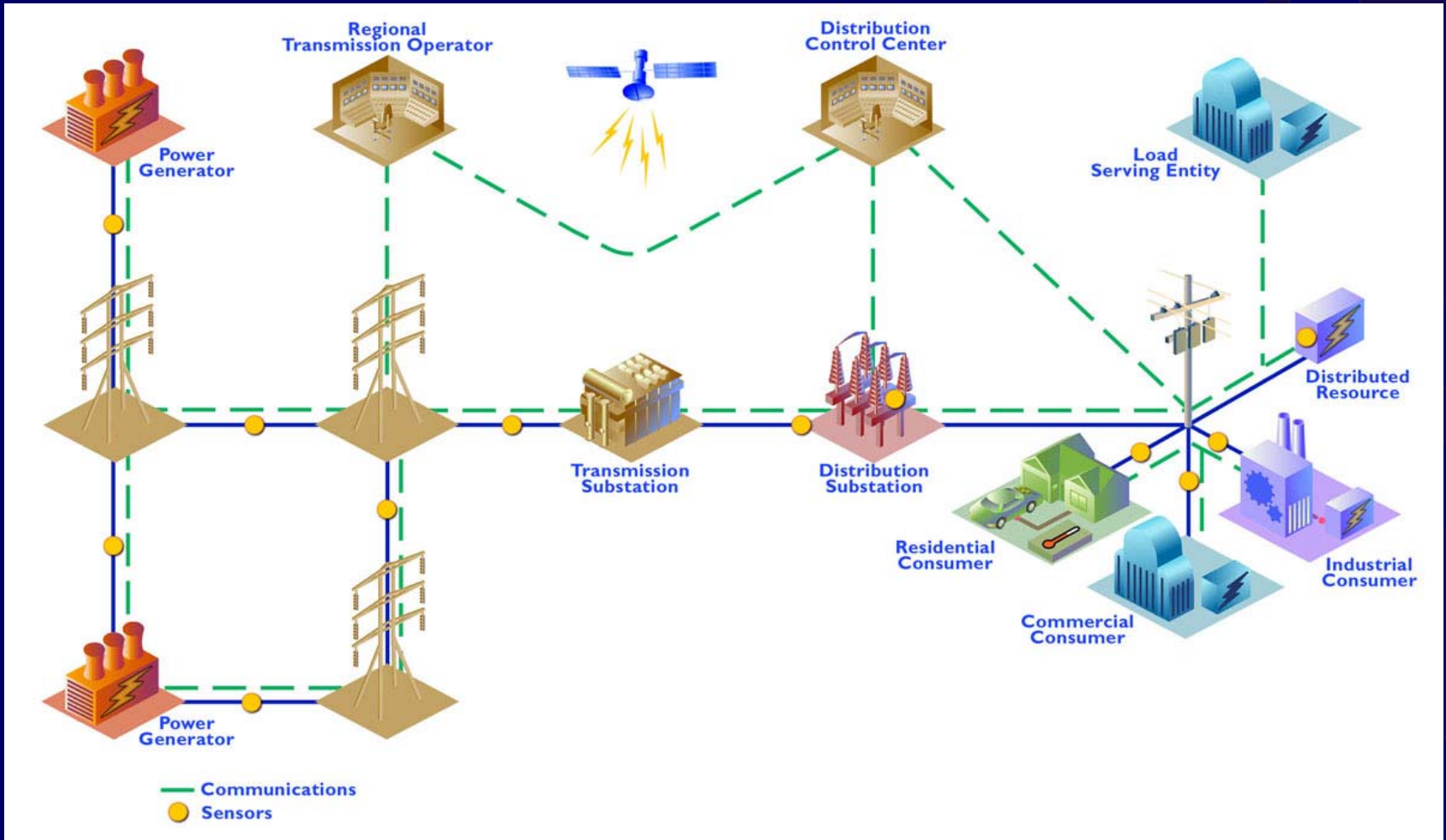
Proposed Research Topics

- Advanced Power Grid Operation for Increased Reliability
- Intelligent Demand Side Load Management for Improved Efficiency
- Renewable Energy Resources for Sustainable Electricity Generation
- Distributed Electricity Generation for Increased Security



TxCEE

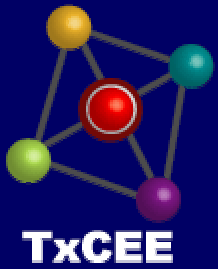
Advanced Power Grid Operation





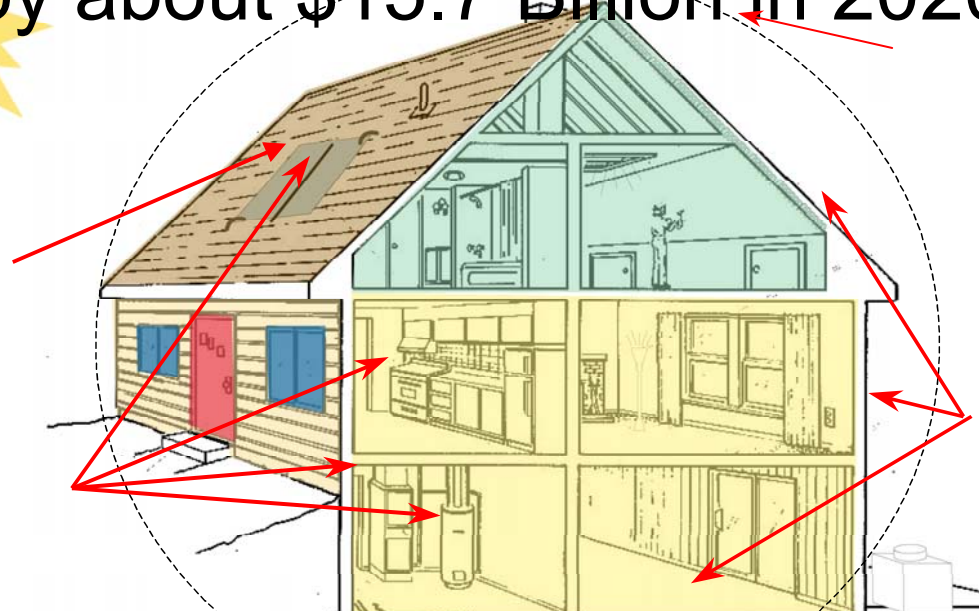
Advanced Power Grid Operation

- Sensors and information systems
- Superconductive technologies
- Energy conversion
- Means for reactive power support
- Robotics for safer power grid
- Solid State Switching
- New IEDs for System Monitoring (PMUs and State Estimation)



Intelligent Demand-side Load Management

Buildings –
Reduce U.S. Energy Expenditures
by about \$15.7 Billion in 2020.

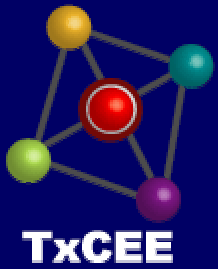


Building
Systems
(“Smart
Building
Systems”)
Integration

Building
Envelope
(Windows,
Doors, Floors)

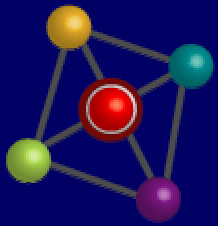
Buildings consist of a complex system of interacting components facing variable input conditions

Materials Intensity



Intelligent Demand-Side Load Management

- Control of Peak Power Consumption
 - Could help “shave” the peak
 - Could re-distribute the peak
- Building Energy management
 - Could beat current codes by 30%
 - Could cut energy use another 20%
- Emergency Power Control
 - Could create emergency power from alternative sources
 - Could allow aggregation of emergency generation for commercial uses



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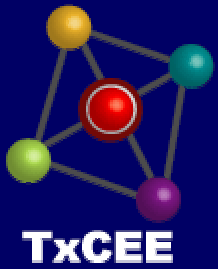
Renewable Energy Resources

● 2004: National RES Study

- Texas has the capacity to produce eight times its own electricity needs from clean renewable energy sources
- Texas consumers would save more than \$9 billion on energy bills through 2020



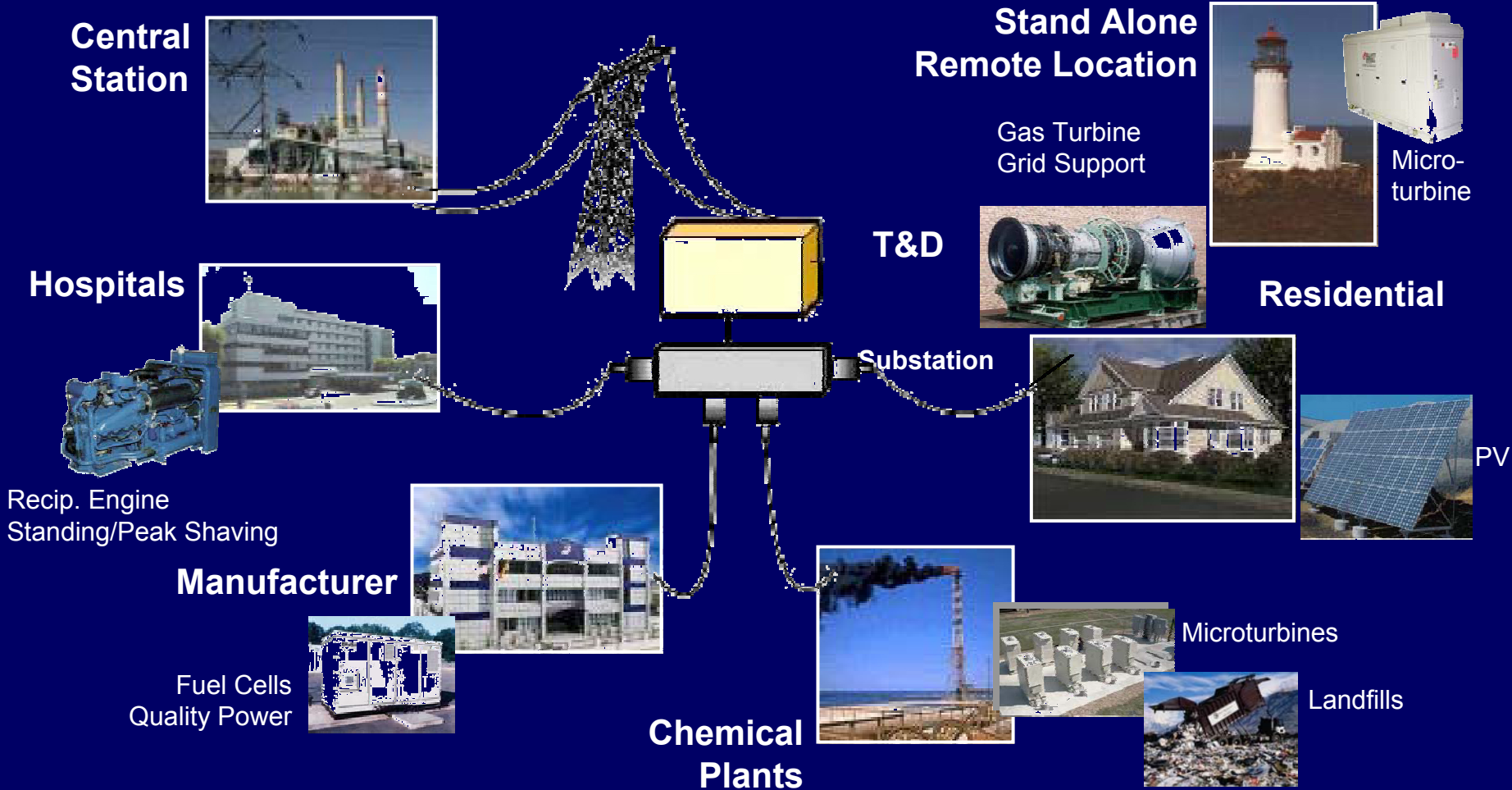
Source: Union of Concerned Scientists 2004 Study

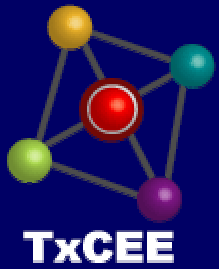


Renewable Energy Resources

- Wind Electricity Generation
- Solar Electricity Generation
- Geothermal Electricity Generation
- Biomass Electricity Generation

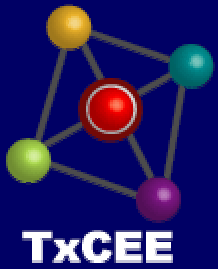
Distributed Electricity Generation





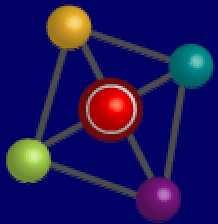
Distributed Electricity Generation

- Individual components: fuel cells, microturbines, Batteries/converters, etc
- AC and DC microgrids
- Embedded microgrids into existing grid
- Monitoring, control and protection of distributed generation grids
- Optimal mix of fuels/conversion techniques for on-site power generation



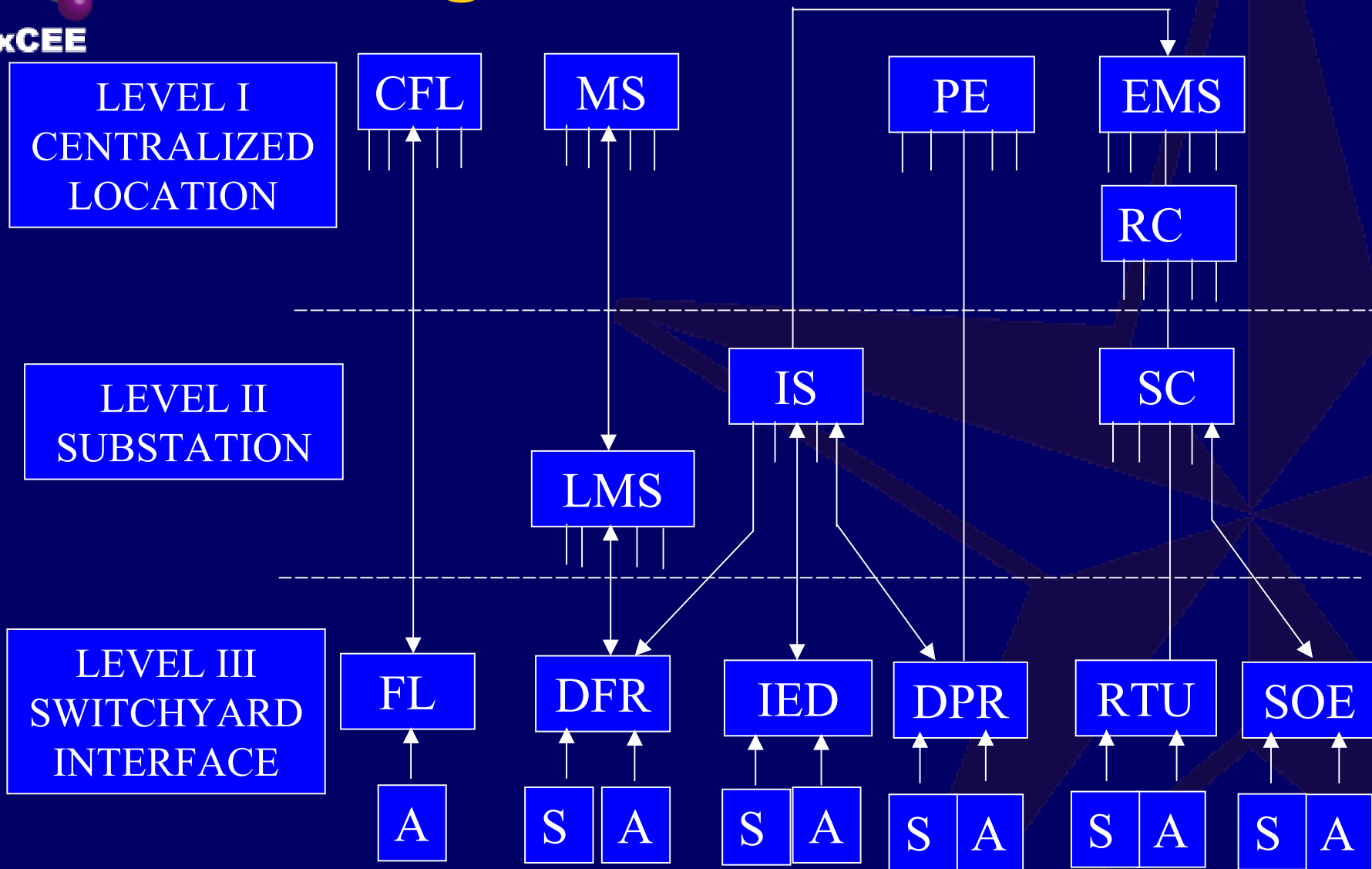
Outline

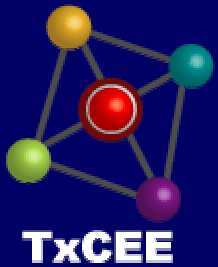
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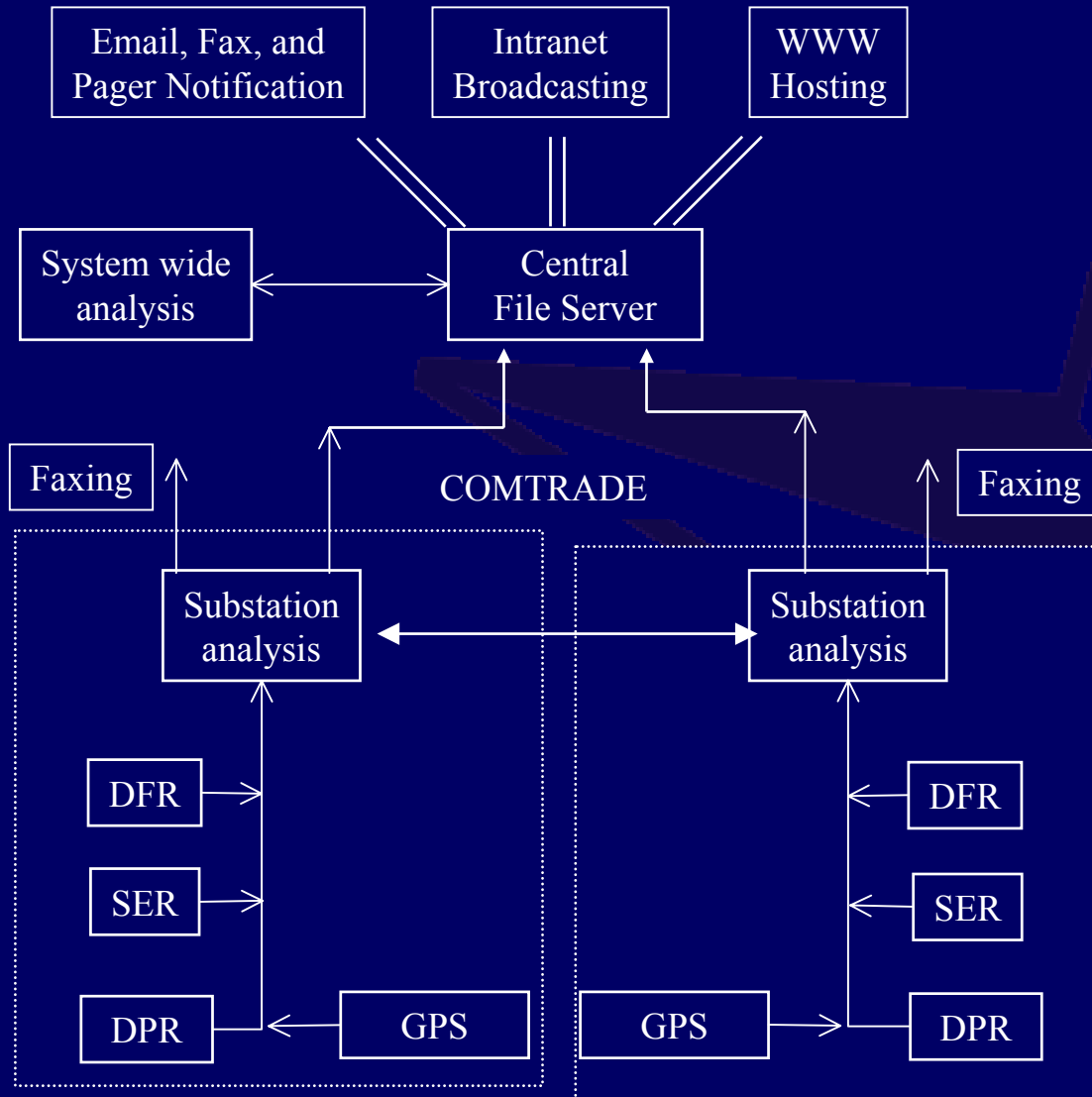
TxCEE

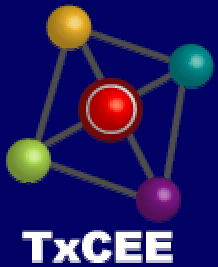
Existing Control Infrastructure



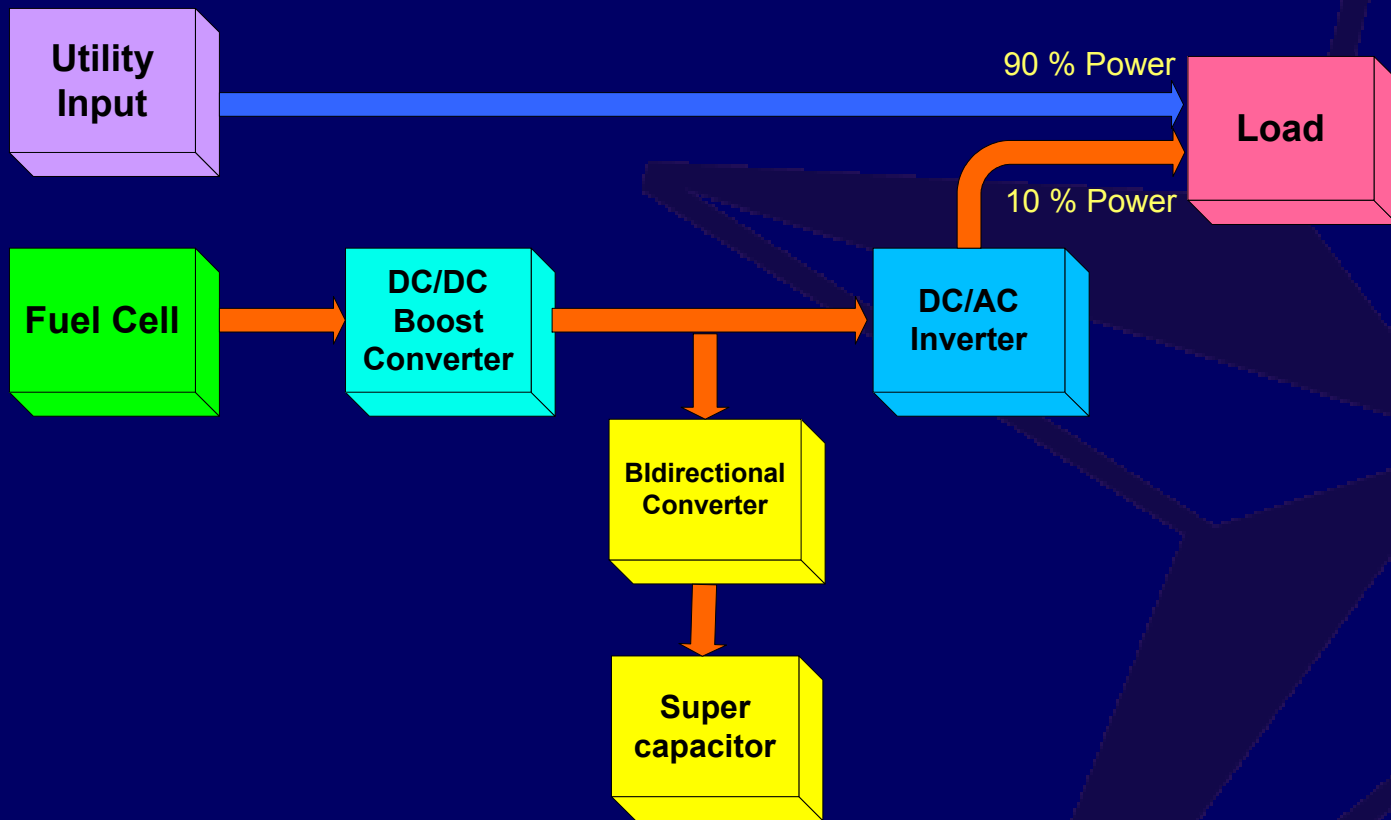


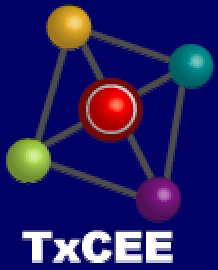
Future Control Infrastructure



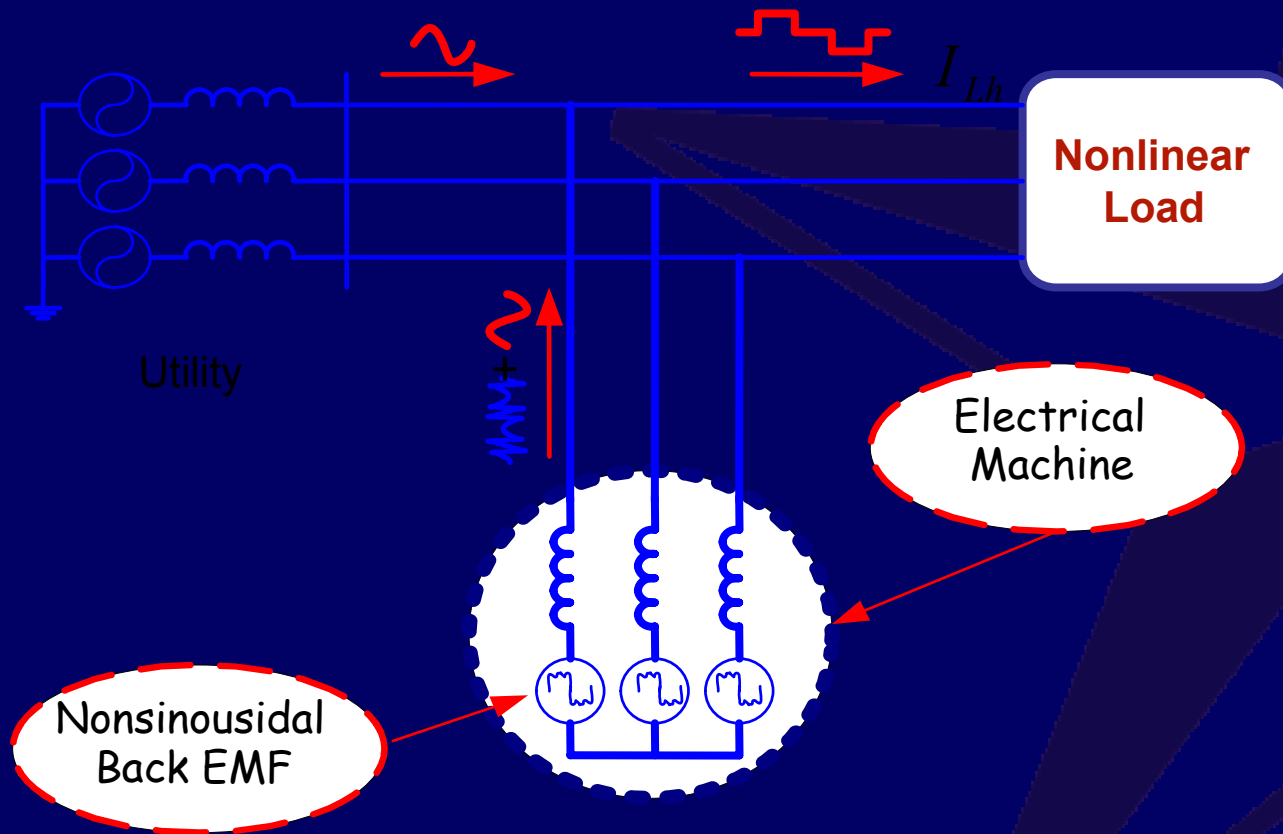


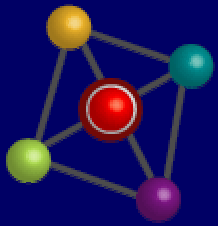
Fuel Cell Powered Line-Interactive UPS System





Compensate Harmonics using Electric Machines

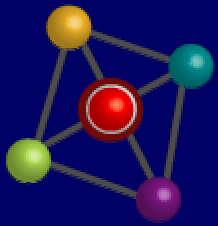




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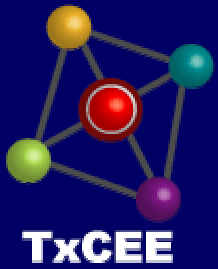
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Consortium Expertise

- **Texas A&M University:** System studies; monitoring control and protection; power electronics and drives, advance machine designs, utility interfaces, reliability, building efficiency, renewable energy, IT technologies, intelligent systems, simulation and modeling,
- **UT Austin:** System studies, Power quality, electromechanical conversion, energy markets, renewable energy, public policy, simulation and modelling, intelligent systems, IT technologies
- **TAMU at Kingsville:** Wind power, control systems, intelligent system applications, drives



Consortium Expertise

- **UT Arlington:** System studies, electricity markets, protection and monitoring, power quality, renewable energy, load forecasting
- **University of Houston:** supeconductivity, system studies, transfer capability, load modeling, non-linear control, IT technology
- **Texas Tech:** Renewable energy, power electronics, utility interface, photovoltaics

A sunset over a body of water with a dark treeline in the background. The sky is filled with soft, colorful clouds in shades of orange, red, and purple, transitioning into a darker blue at the top. The water in the foreground is calm, reflecting the colors of the sky. A dark silhouette of trees and land is visible on the horizon.

***Together -
building a prosperous future***

***where energy is
clean, abundant, reliable and affordable***