Hydrogen: A Safe and Clean Alternative Program

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Fuel Cells Summit VI

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Three Components of a Clean, Safe, Alternative Program

- Hydrogen infrastructure planning and deployment
  - work with key regional stakeholders to identify resources, needs, and opportunities to complement national hydrogen vision and roadmap
  - develop data and analytical tools to assess infrastructure deployment options and opportunities, particularly for the near-term
- Codes and standards
  - incorporate hydrogen safety issues into existing and proposed national and international codes and standards to facilitate market acceptance and penetration of hydrogen technologies
- Renewable hydrogen and distributed generation
  - assemble and test “renewable power packages” (RP^2)

Objectives for Infrastructure Planning and Deployment

- Develop regional approach to infrastructure planning to complement DOE national hydrogen roadmap effort
  - conduct series of infrastructure forums to gather information on regional perspectives, issues, and opportunities
  - two-pronged approach
    - institutional: link and collaborate with key stakeholders
    - analytical: develop data and tools to assess infrastructure options
      - data base on existing hydrogen infrastructure
      - geographic information system techniques employed to explore near-term hydrogen infrastructure potential
- Prepare national hydrogen infrastructure blueprint based on regional resources and opportunities

Key Assumptions

- Near-term infrastructure will grow from existing hydrogen facilities
  - merchant, by-product, and captive producers are key
- Local and regional initiatives needed to complement national vision and roadmap
- Regional hydrogen nodes will grow into national infrastructure over time
- Synchronization of investments by suppliers and users is the critical issue
  - key governmental role is to facilitate first steps

Progress on Infrastructure Planning and Deployment

- First Regional Infrastructure Forum hosted by Houston Advanced Research Center, April 18, 2002
  - invited participants from energy companies, hydrogen producers, regional and state agencies, research institutes, federal agencies
  - potential collaborative project (propane-based hydrogen fueling infrastructure) with Texas DOT, Texas State Energy Office, Fuel Cells Texas, Texas Railroad Commission
- Rocky Mountain Hy (regional collaborative) formed
  - first meeting held on December 6, 2001
  - second meeting held May 11, 2002
  - focus on R&D priorities, education, information outreach, legislative initiatives to accelerate hydrogen infrastructure

Progress on Infrastructure Planning and Deployment

- Infrastructure issues discussed at special meeting of energy, autos, and government hosted by California Energy Commission during EVAA conference
  - summary of meeting published in *Fuel Cell Catalyst*
- Preliminary data and GIS maps for near-term infrastructure analysis developed
  - data developed with Air Products, Praxair, BOC, SRI
- Work in progress with International Hydrogen Infrastructure Group
  - collaborative effort among major auto and energy companies and DOE on, *inter alia*, infrastructure risk mitigation
    - cost estimates for Hydrogen supply pathways under review

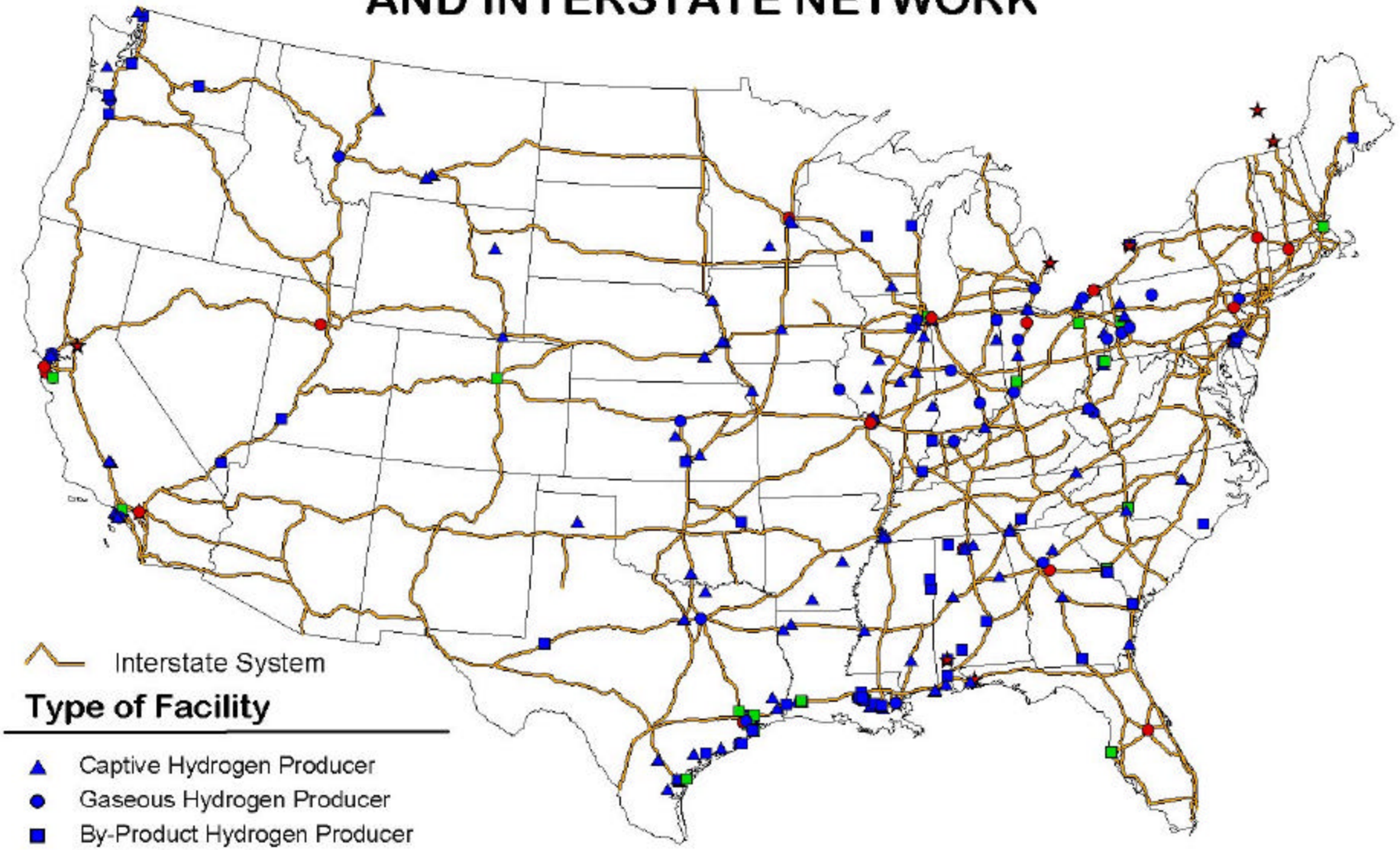
Collaboration on Infrastructure

- DOE Regional Offices and State Energy Offices
- Regional Stakeholders (examples)
  - Rocky Mountain Hy
  - Houston Advanced Research Center, TX DOT
  - CA Energy Commission, CA Fuel Cell Partnership, SCAQMD
  - Northeast Midwest Institute
  - Hydrogen Energy Center
  - Gas Technology Institute
- Industry
  - International Hydrogen Infrastructure Group
    - GM, Ford, BMW, Shell Hydrogen, BP, Exxon Mobil, etc.
  - Hydrogen producers
    - Air Products, BOC, ChevronTexaco, Praxair, Proton, Stuart

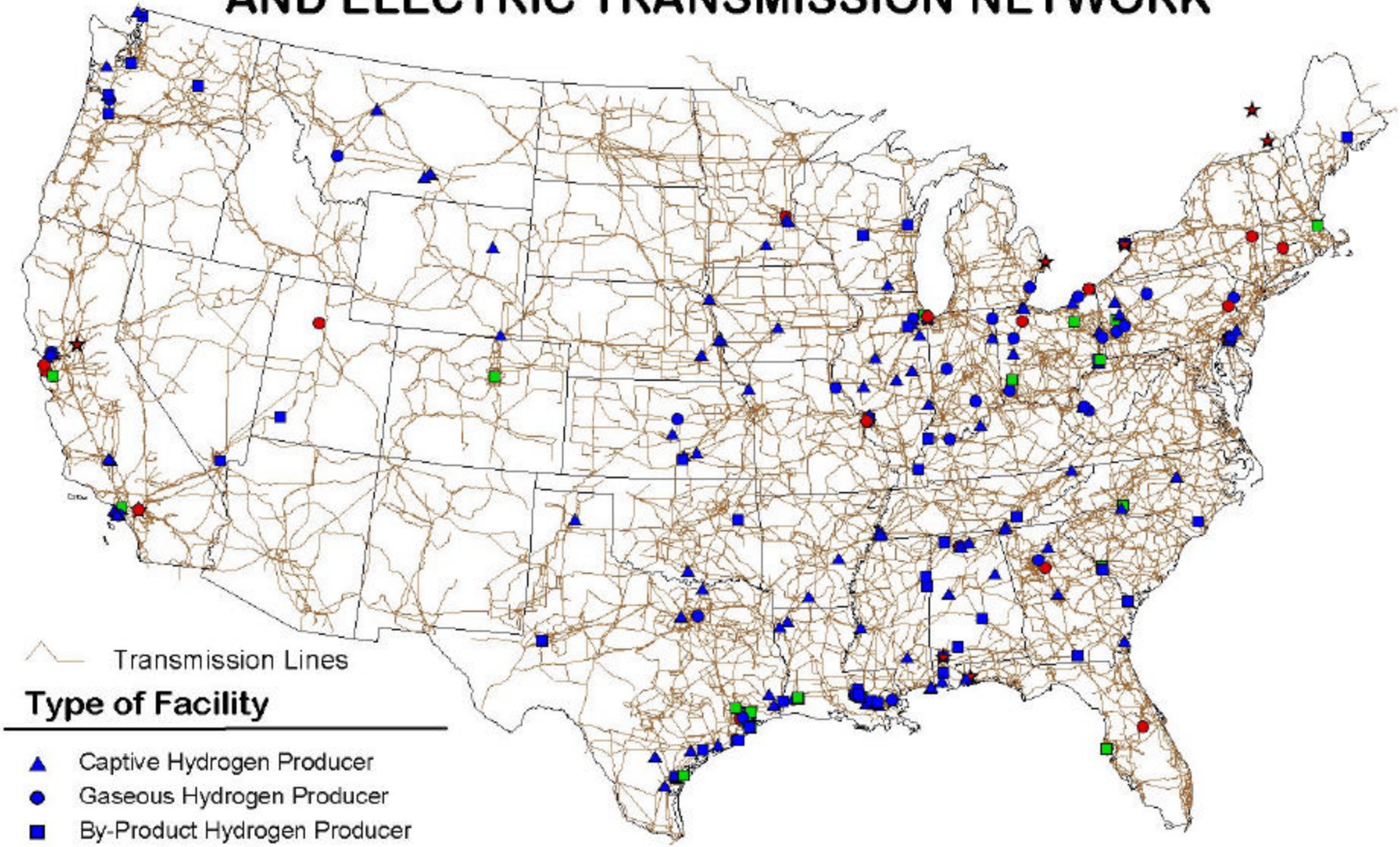
Future Work for Infrastructure Planning and Deployment

- Conduct series of regional infrastructure forums
  - Chicago (GTI) [early summer]
  - Boston (MIT) [late summer]
  - Seattle (Vulcan, Inc.) [early fall]
  - Orlando (NASA, FSEC)* [?]
  - all forums co-hosted by DOE Regional Offices
- Conduct national infrastructure forum
  - Washington, DC (late fall)
  - place regional perspectives in national context
- Develop regional infrastructure collaboratives based on national blueprint and regional opportunities and interests
- Develop detailed national data base and GIS analysis tool kit

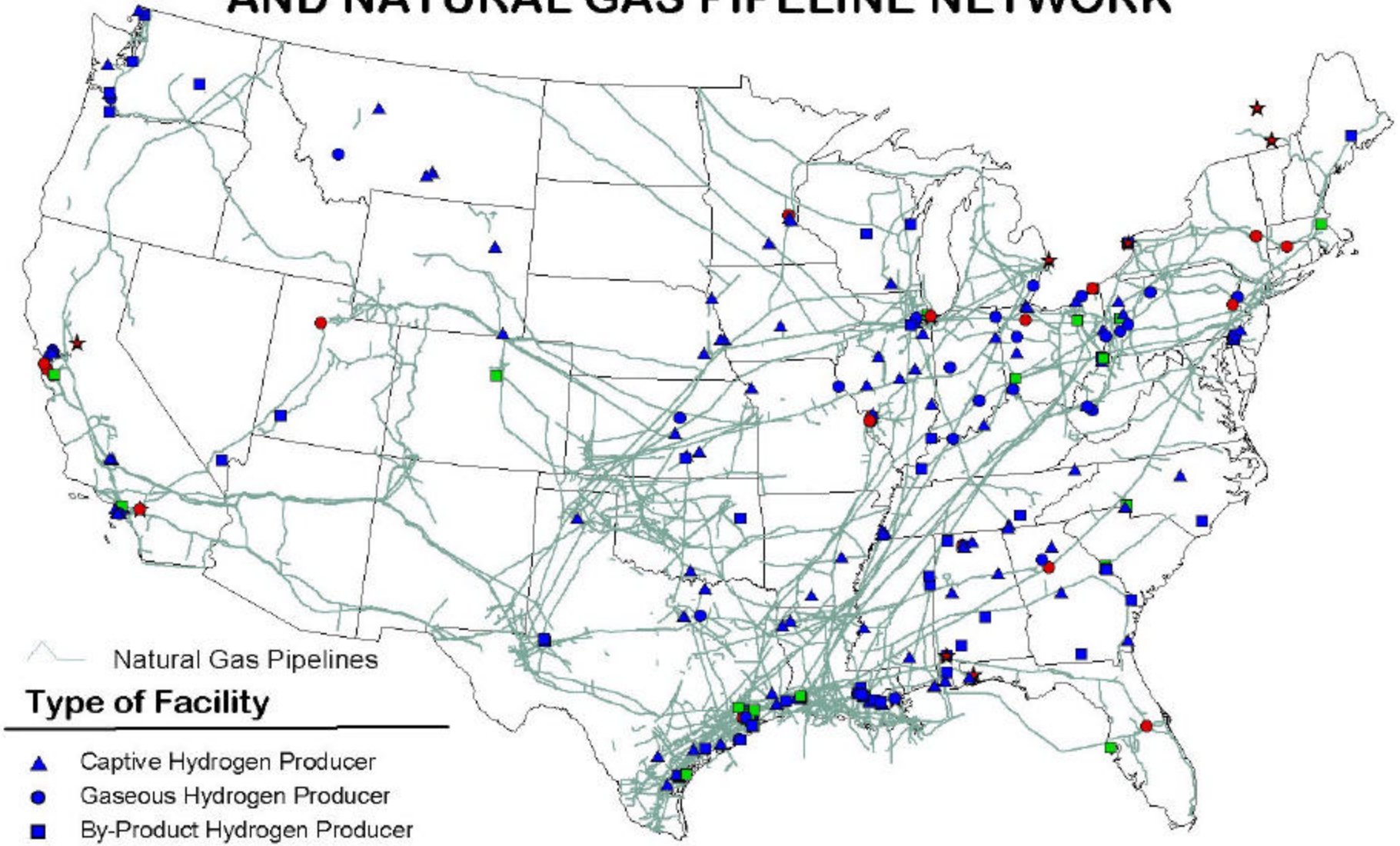
HYDROGEN FACILITIES AND INTERSTATE NETWORK



HYDROGEN FACILITIES AND ELECTRIC TRANSMISSION NETWORK

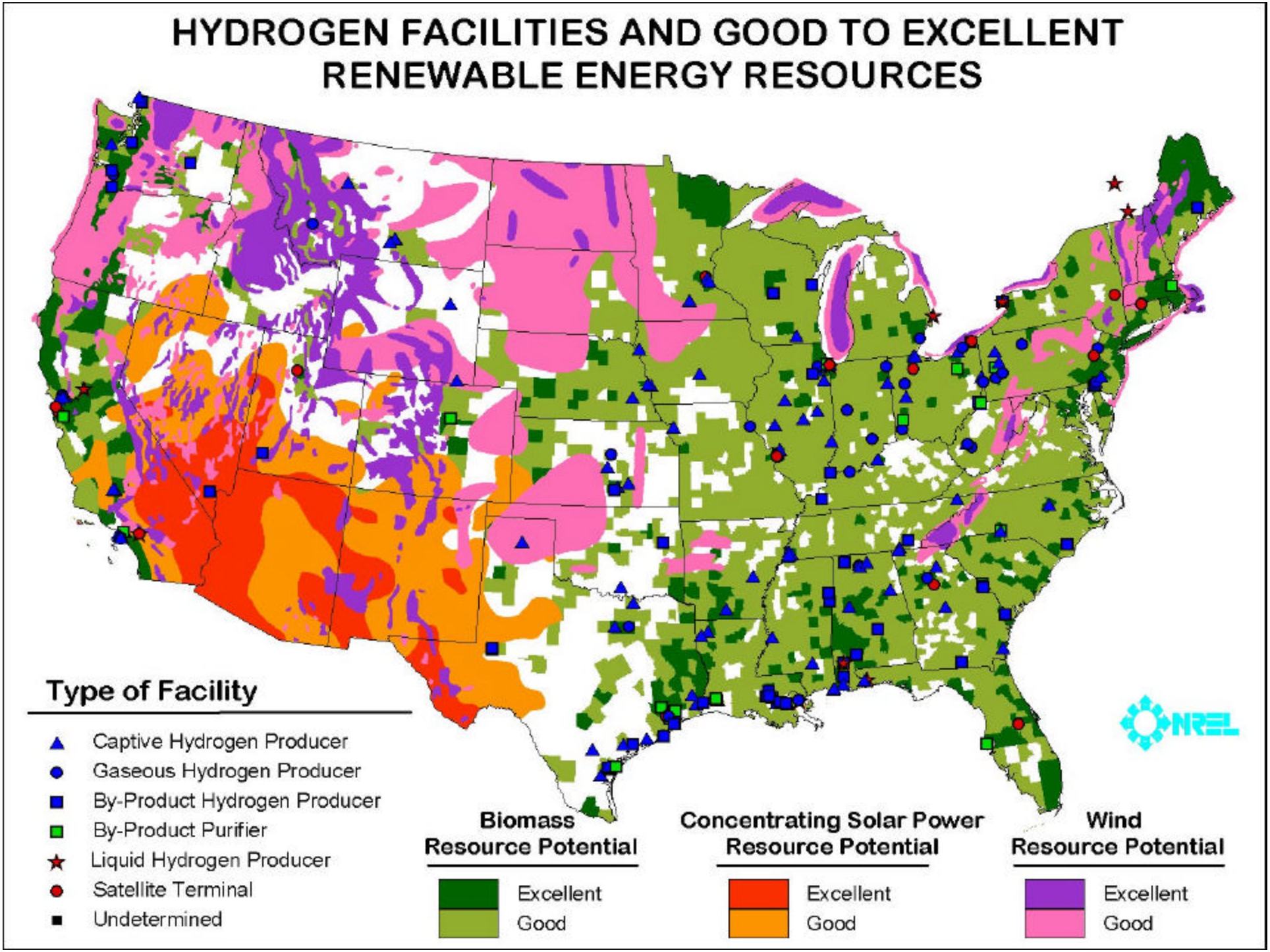


HYDROGEN FACILITIES AND NATURAL GAS PIPELINE NETWORK



NREL

HYDROGEN FACILITIES AND GOOD TO EXCELLENT RENEWABLE ENERGY RESOURCES



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Objectives for Codes and Standards

- Coordinate all codes and standards activities for the DOE Hydrogen Program
- Create an integrated, multi-year codes and standards effort with all key stakeholders
- Integrate codes and standards activities with overall infrastructure planning and deployment effort

Overall Approach for Codes and Standards

- *Sourcebook for Hydrogen Applications* (1998)
  - compilation of best industry practices, applicable standards
- HTAP Safety Committee
  - provide national forum for hydrogen safety
- NHA Codes and Standards Workshops
  - semi-annual, technical working groups
- ICC Hydrogen Ad Hoc Committee
  - incorporate standards into model codes
- International Hydrogen Infrastructure Group
  - coordinate with major auto and energy companies
- DOE H_2 Codes/Standards Coordination Committee
  - synchronize activities of all major players in US, including US TAG for ISO/TC197

Approach for Codes and Standards

- Support HTAP Safety Committee
  - develop National Hydrogen Safety Agenda
- Work with and support International Code Council(ICC) Hydrogen Ad Hoc Committee (HAHC) to incorporate hydrogen safety-related issues into ICC model codes (IRC, IFC, IMC, IFGC)
  - incorporate provisions for safe use of hydrogen
  - educate local code officials on hydrogen safety issues
  - facilitate adoption of model ICC codes by local jurisdictions in US
- Establish and manage DOE Hydrogen Codes and Standards Coordinating Committee
  - involve all key DOE/EERE sponsored efforts and major US standards and code developing organizations

Progress on Codes and Standards

- ICC public hearing, Pittsburgh, April 8-18, 2002
  - all major changes proposed by the HAHC to IRC, IMC, and IFC approved
    - changes to minimum separation distances included in IFC
  - hydrogen recognized as a “fuel gas” in IFGC and proposed changes to IFGC to address hydrogen safety approved by floor vote
- On-track to have hydrogen safety incorporated in 2003 edition of ICC model codes
  - all local chapters of major national code organizations contacted on proposed changes to model codes

Progress on Codes and Standards

- First HTAP Regional Safety Summit hosted by Houston Advanced Research Center, April 18, 2002
  - further validated safety record of industrial hydrogen producers and users in major hydrogen production/use region
  - potential collaboration with additional stakeholders
    - NASA Stennis; City of Pasadena, TX; Howe-Baker; etc.
- Work in progress with International Hydrogen Infrastructure Group (IHIG)
  - subcontract in place with Ron Sims to continue chairmanship of SAE Fuel Cell Vehicle Standards Committee, coordinate (with Brad Smith, Shell Hydrogen) codes and standards activities of IHIG

Progress on Codes and Standards

- Cooperative efforts with National Fire Protection Association (NFPA)
  - standards development (e.g., revising NFPA 853)
  - preparing reports for fire safety officials
    - *Representative Operating Hydrogen Refueling Facilities: Safety and Codes and Standards-Related Issues*
    - *How to Permit A Hydrogen Refueling Facility Guide for Code Enforcement Officials*
  - codes and standards validation
- Contract in place with Hydrogen 2000 for phase 1 of “Hydrogen: The Safe and Clean Alternative” video for general public (cost-shared with Canada, Japan)

Collaboration on Codes and Standards

- DOE H_2 Codes/Standards Coordinating Committee
  - EERE Offices: Hydrogen,Fuel Cells, and Infrastructure Technologies; Building Technologies; Distributed Energy, Electricity Infrastructure, and Reliability
  - NASA, US Navy, (EPA), (DOT)
  - NHA, SAE, ICC, IHIG, NES, NFPA, NGVC
- Industry
  - International Hydrogen Infrastructure Group
    - GM, Ford, BMW, Shell Hydrogen, BP, Exxon Mobil, etc.
  - Hydrogen producers
    - Air Products, BOC, ChevronTexaco, Praxair, Proton, Stuart
- California Fuel Cell Partnership

Planned Future Work for Codes and Standards

- Work with HAHC to gain final approval of changes to ICC model codes, Fort Worth, TX, October 1-4, 2002
- Support HTAP to prepare draft national hydrogen safety agenda
- Refine overall codes and standards coordination program
  - create centralized, publicly accessible web-based data center
    - DOE license from primary standard development organizations
    - directory of primary contacts for information and technical assistance
- Initiate project to identify and test “dossier” of potential hydrogen accident conditions and results
- Offer hydrogen safety training course for key federal officials

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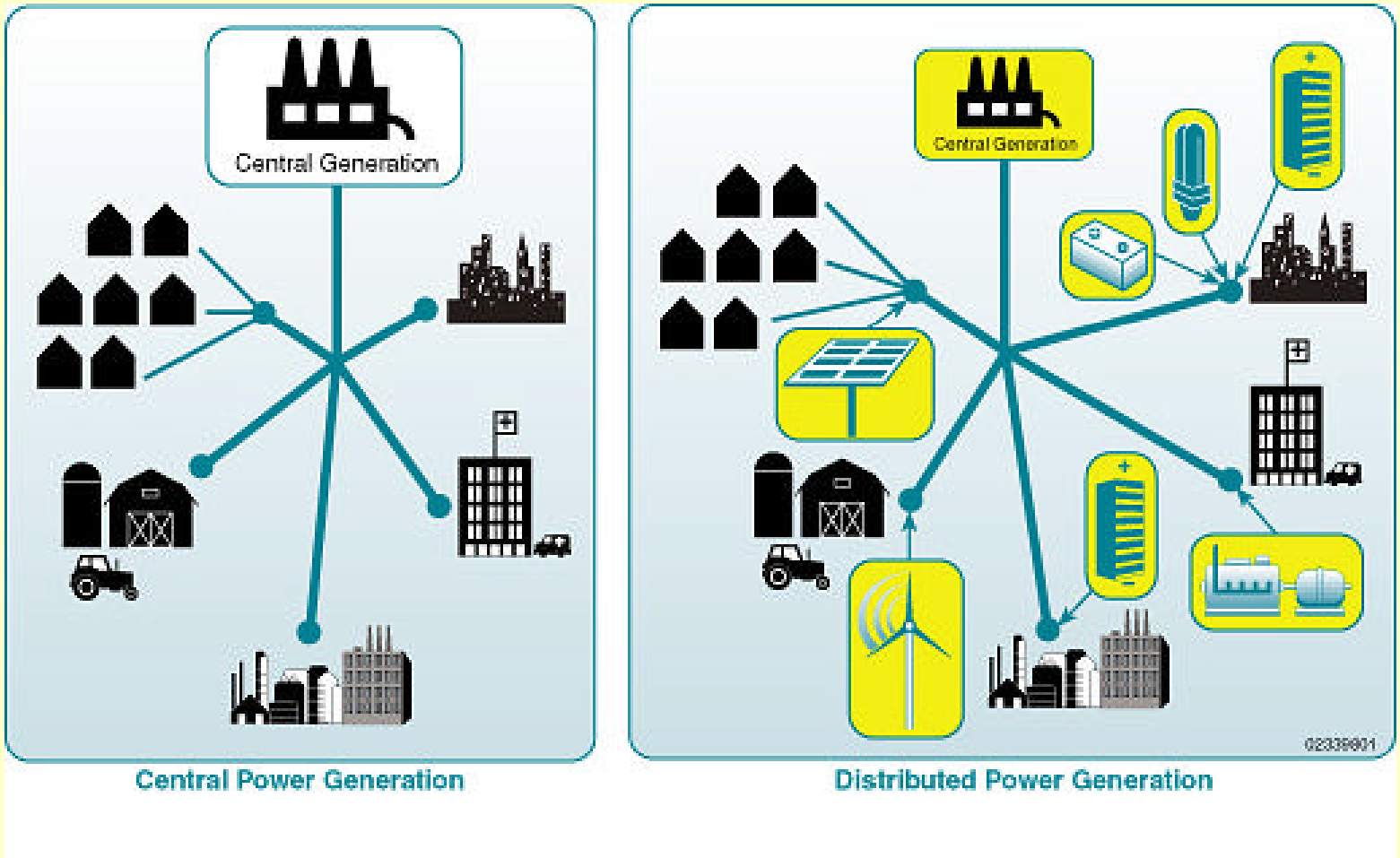
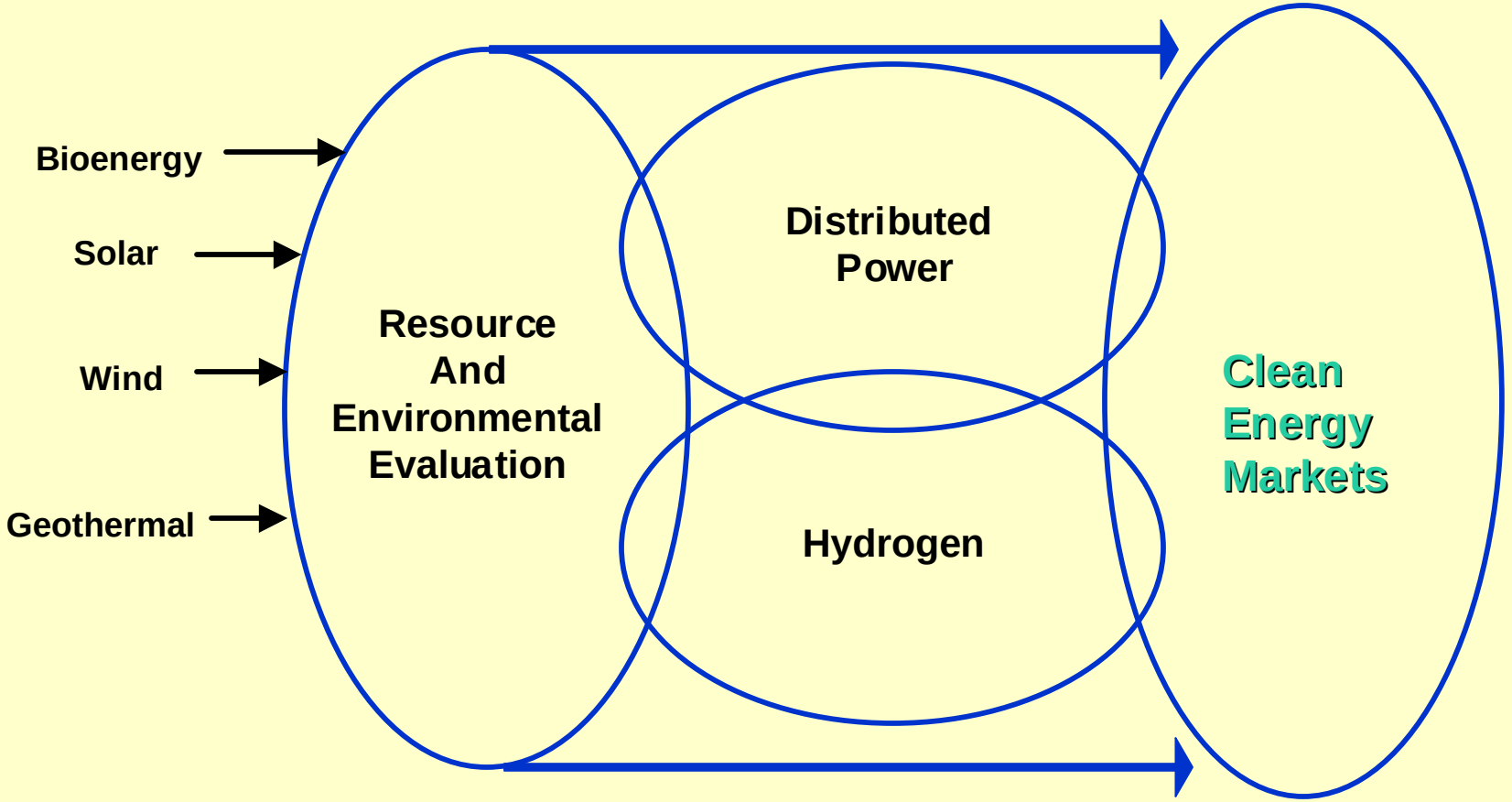
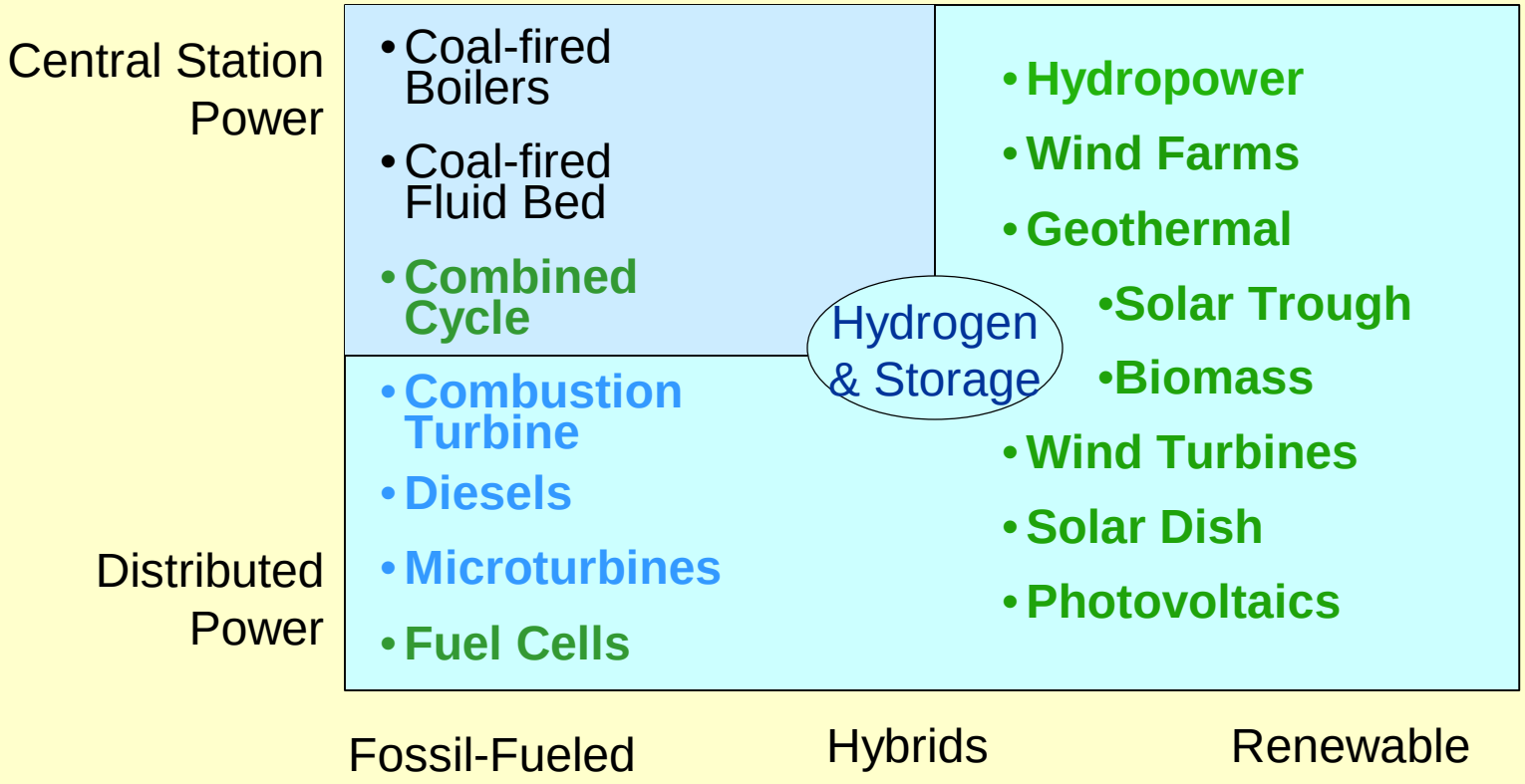
Distributed Generation: Shaping the Utility of the Future?



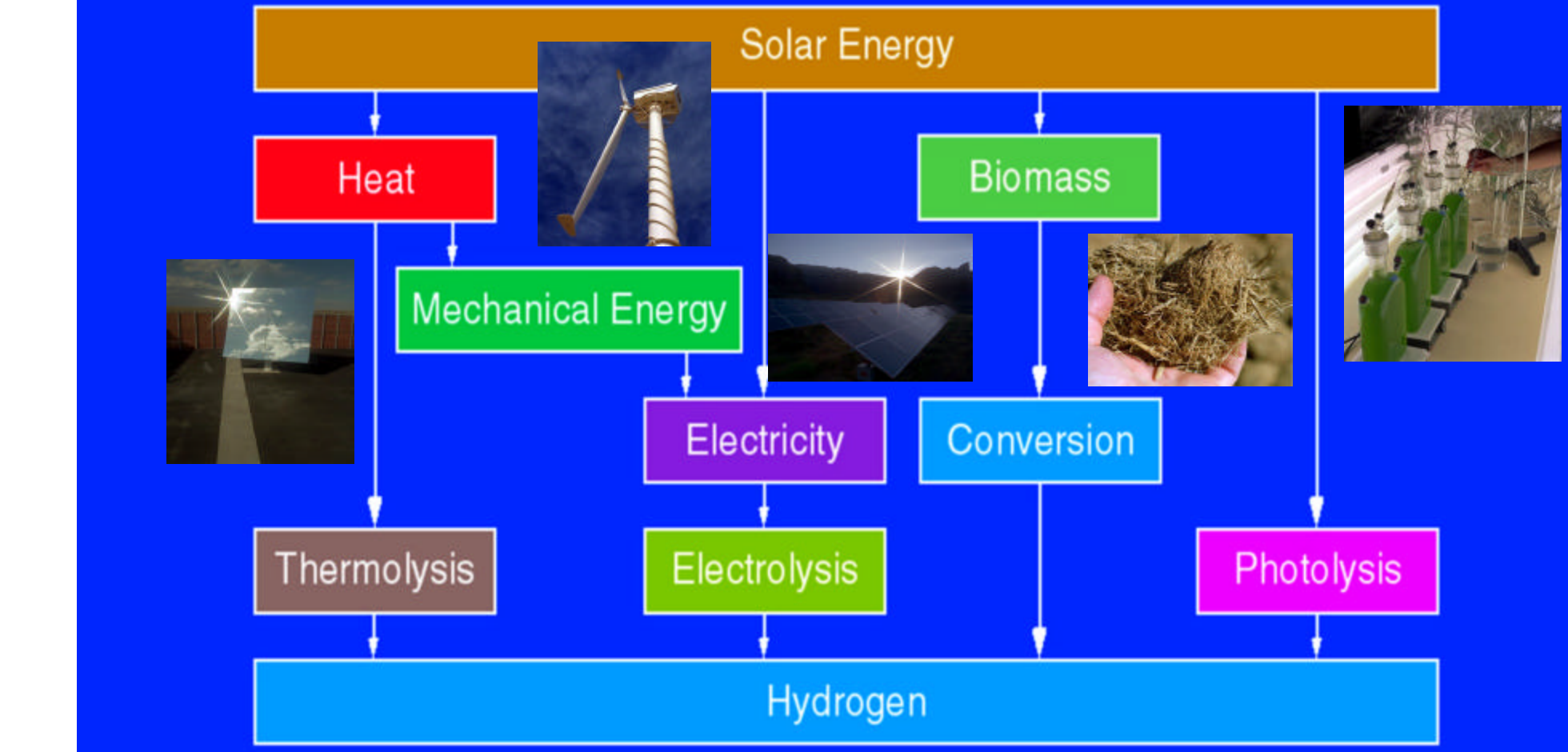
Distributed Generation Links Renewable Resources with Clean Energy Markets



Distributed and Renewable Power Sectors



Sustainable Paths to Hydrogen



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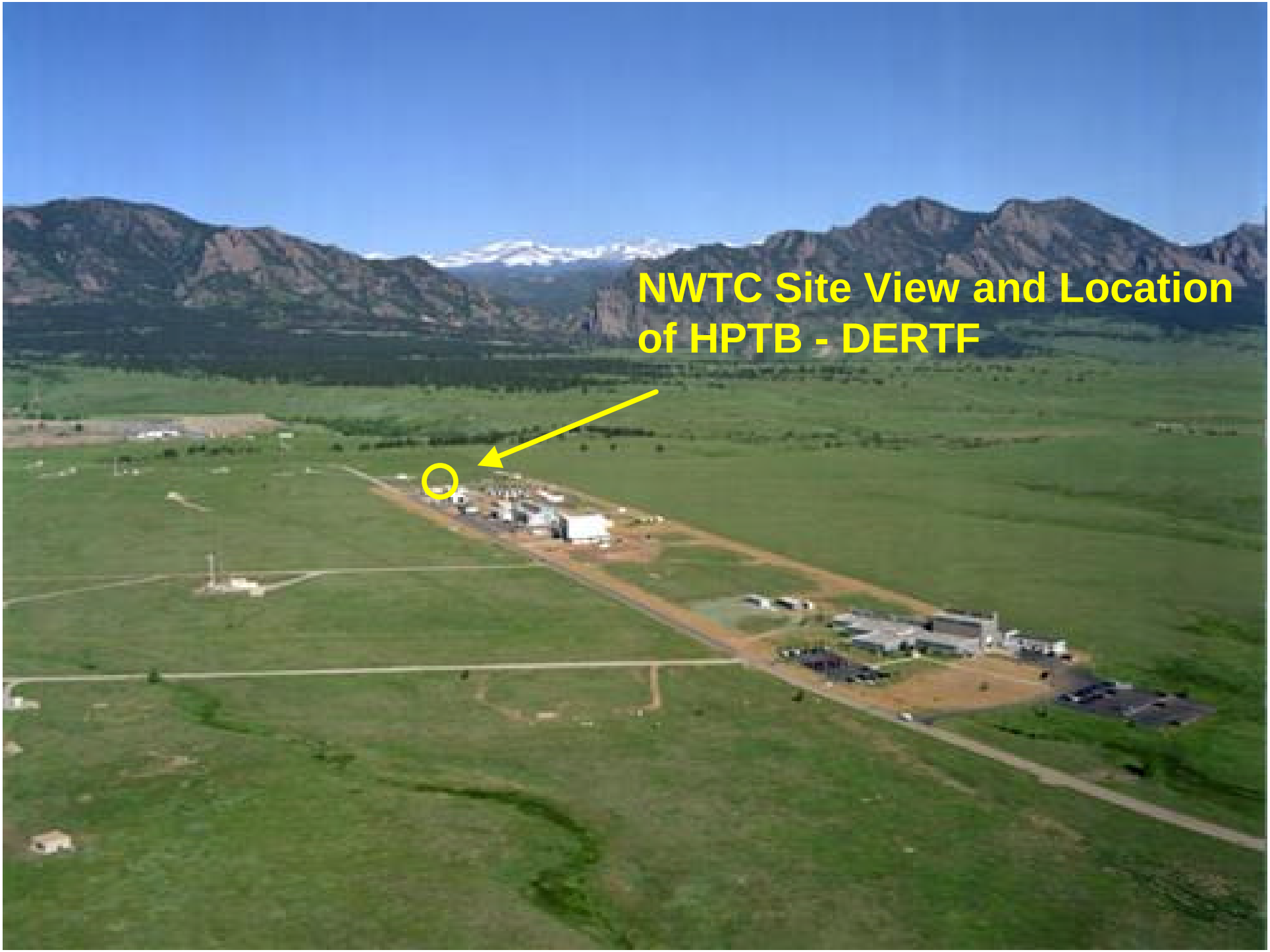
Progress in RP^2 Systems

- Testing planned for renewable hydrogen production and storage in distributed energy generation system
  - state-of-art distributed energy test facility in place
  - purchase order and collaborative testing project for PEM electrolyzer in place
  - negotiations underway to purchase/test PEM fuel cells as part of distributed energy generation system
- Conceptual planning for “renewable power packages” (RP^2) underway
  - modular renewable energy-hydrogen-fuel cell packages
    - optimized for load, resource availability, value


NWTC Site View and Location
of HPTB - DERTF

NREL DER Test Facility

Distributed Energy Resources Systems Testing at NREL

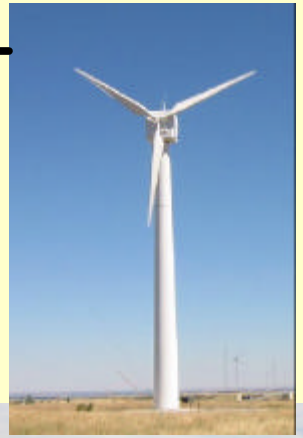
AC
Bus

Utility Grid

Building Thermal Loads

(CHP)

Wind Turbines



Inverters

DC
Bus

[Hydrogen Storage]

Hybrid Renewable Energy Fuel Cell Systems

Hydrogen fuel cells link zero emission energy conversion and renewable energy

DG, Hydrogen, and Fuel Cells: Strategic Potential

- **Renewable Energy Power Packages**
  - **Distributed generation**
    - **biomass-fired fuel cells**
    - **wind, solar electrolyzer-fuel cells**
    - **integrated building energy systems**
  - **Transportation**
    - **fuel cell electric vehicles**
    - **pure zero-emission vehicles**
- **Integrate renewable energy and fuels**

Summary

Advances in hydrogen, fuel cell, and infrastructure technologies and changes in markets and policy will shape the future of energy - a future that is likely to be more: