International Collaboration in Hydrogen Analysis

International Energy Agency (IEA)/International Partnership for the Hydrogen Economy (IPHE)

- "Building the Hydrogen Economy: Enabling Infrastructure Development
- Investigate the global infrastructure requirements for a hydrogen economy

International Partnership for the Hydrogen Economy (IPHE)

- Joint project to compare and contrast the EU HyWays and US H2A and GREET models

IEA/IPHE Project

Objectives:

- Convene public and private sector officials in an international strategic dialogue to refine and evaluate infrastructure transition planning scenarios for building out the hydrogen economy.
- Inform policy makers of opportunities to effectively advance these transition scenarios and to plan policy instruments.
- Using a portfolio of models and proven tools, quantitatively analyze hydrogen economy scenarios and market transformation planning for the world out to 2050.

IEA/IPHE Project

Plan:

- Hold three (3) workshops throughout the world
  - North America
  - Europe/Africa
  - Asia and Pacific Rim
- Convene public and private sector officials in an international strategic dialogue
  - Organize into breakout groups to discuss and identify key technical, institutional, financial opportunities and challenges for hydrogen infrastructure development
    - Mobile application group/s
    - Stationary and distributed power generation group/s
    - Modeling and analysis of hydrogen technology and infrastructure development group
- Prepare and issue a report

IEA/IPHE Project

Progress:

- Two workshops held in Detroit (North America) and Paris (Europe/Africa)
  - Workshop themes of North America and Europe/Africa
    - Planning and Design
      - What are the likely pathways for hydrogen infrastructure development?
      - What policy and market mechanisms and opportunities will have the greatest impact?
    - Construction and Engineering
      - What are the most significant technical, financial and institutional issues and barriers to engineering and construction of hydrogen infrastructure?
      - What policy and market mechanisms and opportunities can best address engineering and construction issues and barriers?
    - Operations and Maintenance
      - What are the most significant foreseen challenges to operating and maintaining hydrogen infrastructure?
      - What are the prospective policy, market and technology solutions to operating and maintaining the infrastructure?
  - North America workshop was held in April 2007
  - Europe/Africa workshop was held July 11 and 12, 2007

- Third workshop will be held in Shanghai (Asia and Pacific Rim) on October 24 and 25, 2007

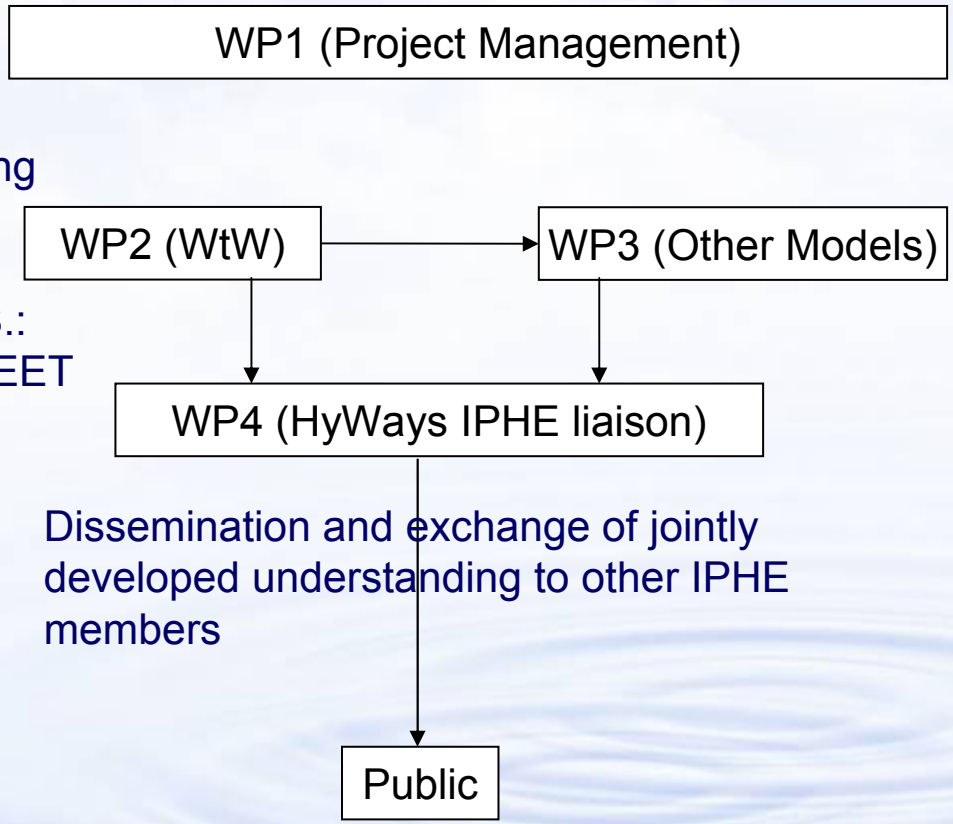
IPHE Project

IPHE HyWays/US Model Comparison Project

IPHE Project Objectives

- Compare roadmapping and system analysis activities in Europe and USA (+other IPHE partners)
- Improve understanding about the ongoing activities (common language, mutual understanding, alignment of int'l approaches)
- Compare
  - Modeling approaches
  - Pathways that are relevant in each region
  - Basic technical and economic assumptions
  - Hydrogen pathway analysis results
  - Infrastructure analysis results
- Involve stakeholder consultation
- Institutional and personal exchanges
- 24 month project (Oct 2006 – Oct 2008)

IPHE Work Plan



Compare WtW modeling methodologies and assumptions (EU: E3database / U.S.: H2A, HDSAM 1.0, GREET 1.7) by benchmarking

(Months 1-12)

Dissemination and exchange of jointly developed understanding to other IPHE members

Compare further models and approaches (infrastructure, resources, in-depth technology analysis, stakeholder consultation)

Models being Compared in WP2

- E3database (EU)
  - Models hydrogen production and delivery pathways including scenarios, costs, and WTT and WTW energy and emissions
- H2A Production (US)
  - Financial calculation model with case studies available for different hydrogen production technologies
- HDSAM 1.0 (US)
  - Delivery-scenario model that calculates capital and operating costs for scenarios based on general inputs defined by the user
- GREET 1.7 (US)
  - Greenhouse-Gas, energy, and emissions tool that calculates WTW energy and emissions

Pathways being compared in WP2

1. 2007 – onsite SMR – FS
2. 2007 – onsite grid-mix electrolysis – FS
3. 2007 – central (regional) biomass gasification – pipeline – FS
4. 2015 – central SMR – LH2 truck – FS
5. 2015 – central SMR– pipeline FS
6. 2015 – central wind electrolysis – pipeline – FS
7. 2015 – central coal gasification (CCS) – pipeline – FS
8. 2030 – central SMR (CCS) – pipeline – FS
9. 2030 – co-production of H2 and electricity (IGCC) with electricity credit – LH2 truck– FS

Comparisons have begun for pathways in red

Legend:

FS – Fueling Station

SMR – Steam Methane Reformer

LH2 – Liquid hydrogen

CCS-Carbon capture and sequestration

Important Differences

Financial Parameters

	H2A & HDSAM	E3database
Financing	100% Equity	100% Debt
Taxes	35% Federal 6% State	None
Working Capital	15%	0%
Depreciation	MACRS	Straight Line

Resulting Cost + Return is greater in H2A & HDSAM

Important Differences

Production Analyses

- Expected differences
  - Capital costs
  - Biomass price
  - Utility prices
- Notable differences
  - Biomass conversion efficiency
    - E3 Data base efficiency (65%) is higher than H2A (45%)
  - Coal conversion efficiency
    - H2A efficiency (60%) is higher than E3 Data base (44%) for the near term case

Energy and Emissions Analyses

- Well-to-Tank (WTT) and Well-to-Wheels (WTW) analyses are being compared

Delivery Analyses

- Different modeling philosophies
  - HDSAM 1.0 designs a delivery scenario
  - E3database has a single chain for analyses without specific regionality (i.e., a single station with transport distances input by the user)
- US uses a lower vehicle fuel efficiency than EU
  - US uses 57.5 miles / kg vs. = 0.365 kW h / km
  - EU uses 89 miles / kg = 0.235 kW h / km
  - Due to differences in vehicle size, driving cycles, and estimation method
- Pipeline architecture (rings in HDSAM 1.0 vs. star in E3database)
- Dispensing pressure
  - H2A is 5,000 psi
  - E3 Database/EU is 10,000 psi

Conclusions

- The project is underway to compare analysis approaches and models of the EU & US
- Developing a common understanding and language is challenging
- Financial parameters and technical parameters may need to be adapted to different world-regions

Thank You

For More Information

Systems Analysis

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