



Building the Hydrogen Economy: Infrastructure Strategy Prospectus

IPHE Steering Committee Meeting
Reykjavik, Iceland

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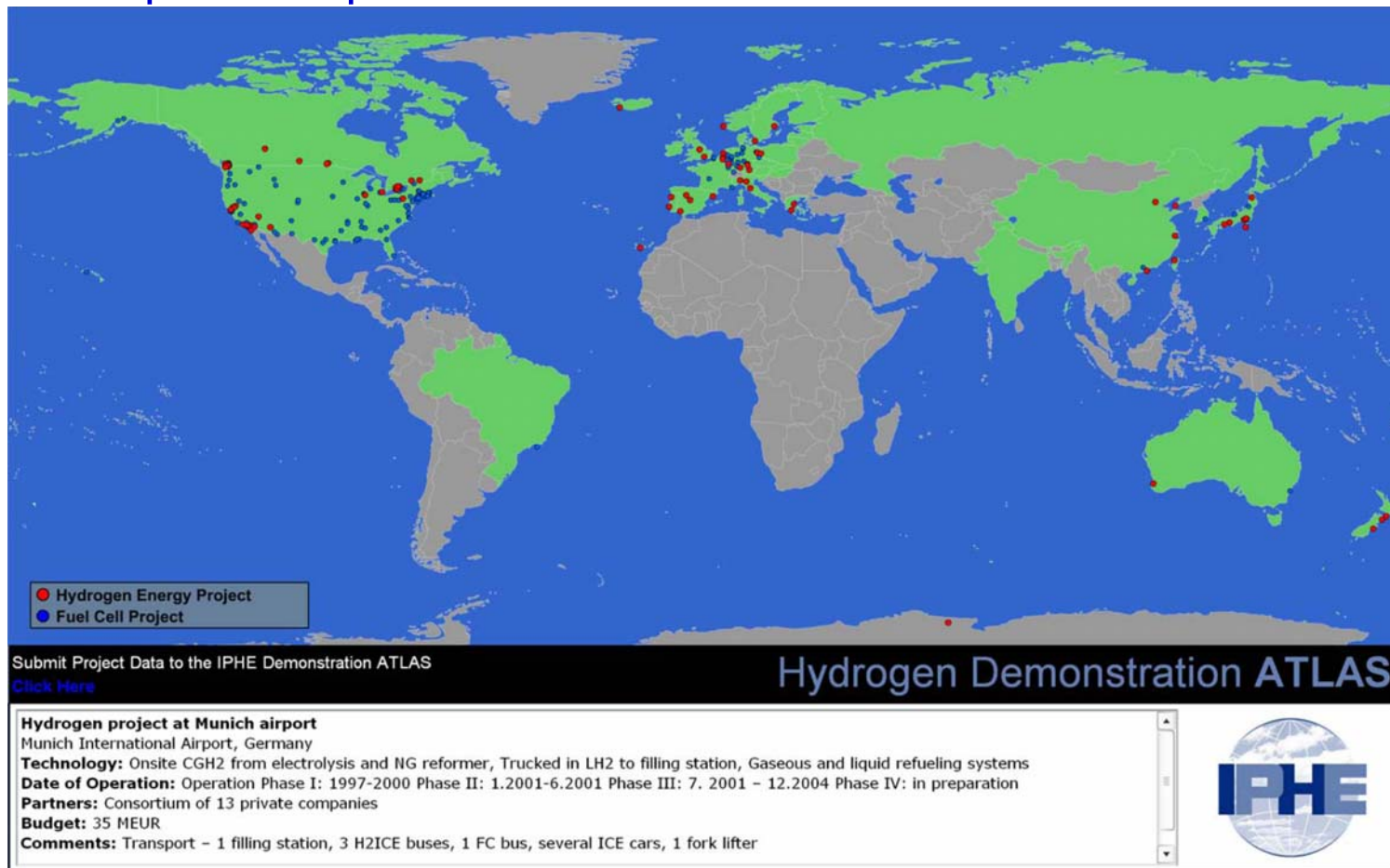
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Background

- Large-scale, long-term R,D,D+D underway
- 400+ significant H₂ + FC Demonstration Projects
- Handful of large infrastructure under consideration or beginning construction
- National R+D strategies/roadmaps have proven useful

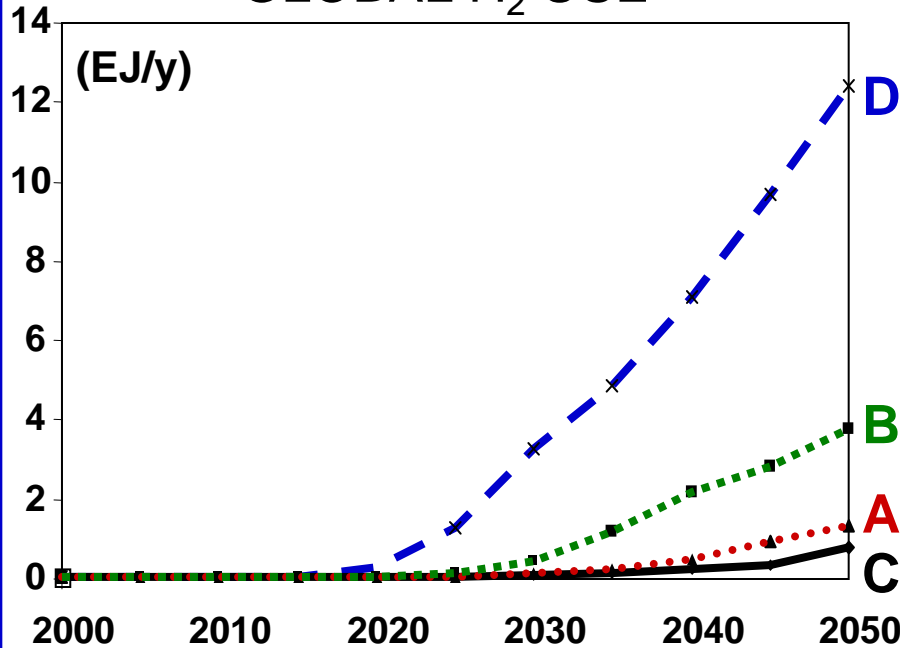
Hydrogen Demonstration Project Atlas

- name of project, partners, project dates, type of fuel, ...
- submission form for additional projects
- <http://www.iphe.net/>

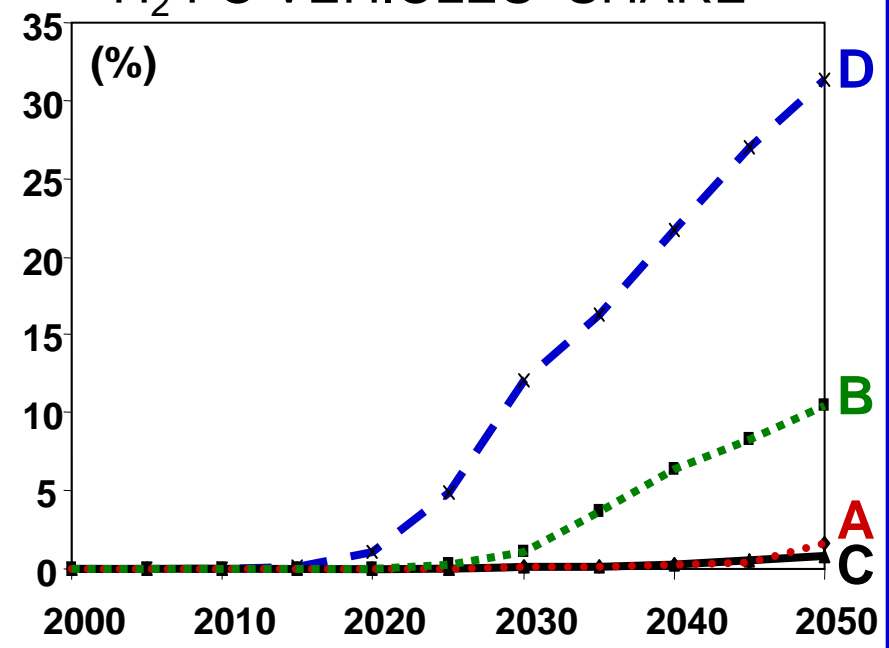


Market Scenarios

GLOBAL H₂ USE



H₂ FC VEHICLES SHARE

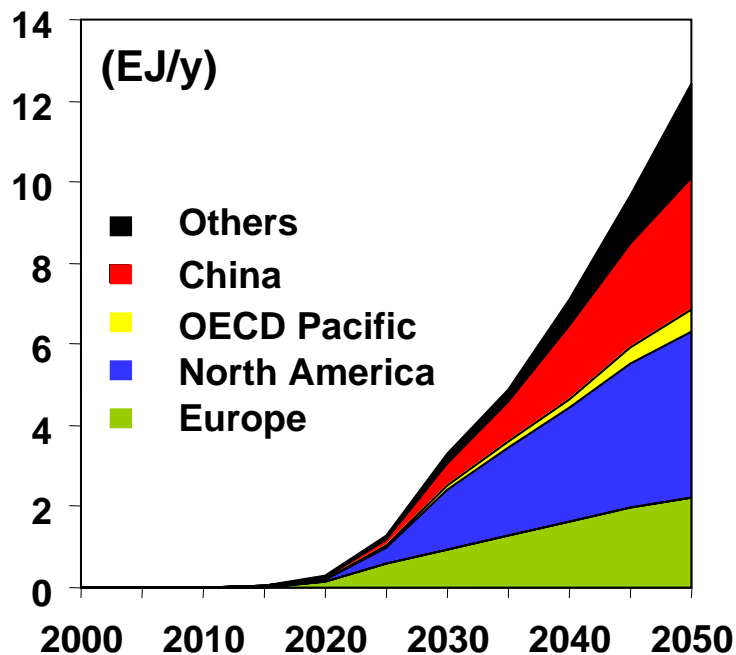


- A - Weak CO₂ policy and tech. development
- B - Strong CO₂ policy in Kyoto countries and tech. development
- C - Strong CO₂ policy in Kyoto countries and tech. lag
- D - Strong CO₂ policy world wide and tech. development

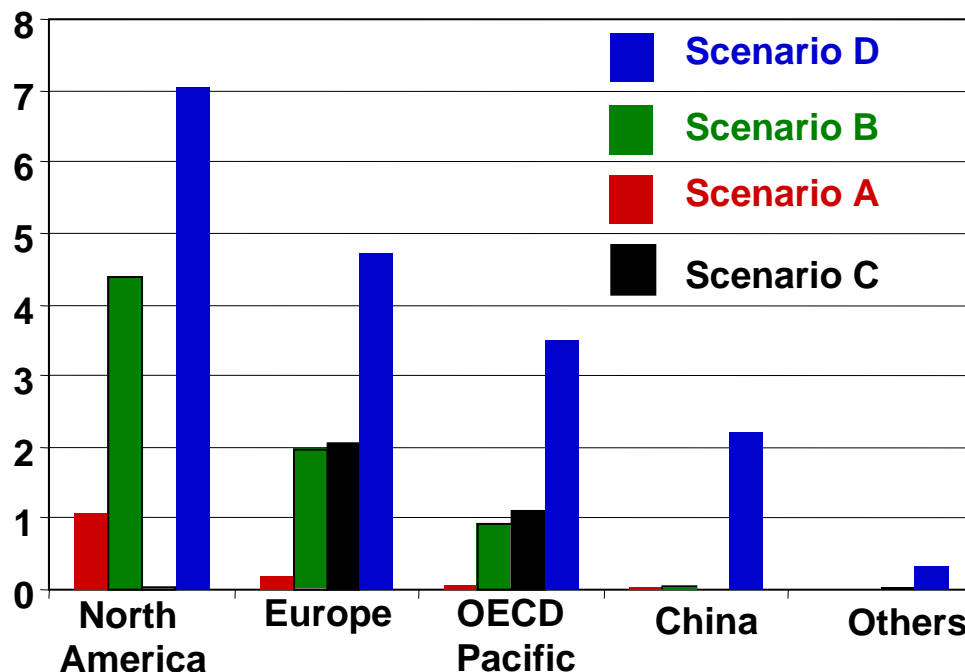
Up to 30% H₂ fuel cell vehicles by 2050

Regional Markets

H₂ Use - Scenario D



Per capita H₂ use in 2050 - (GJ H₂/pc)



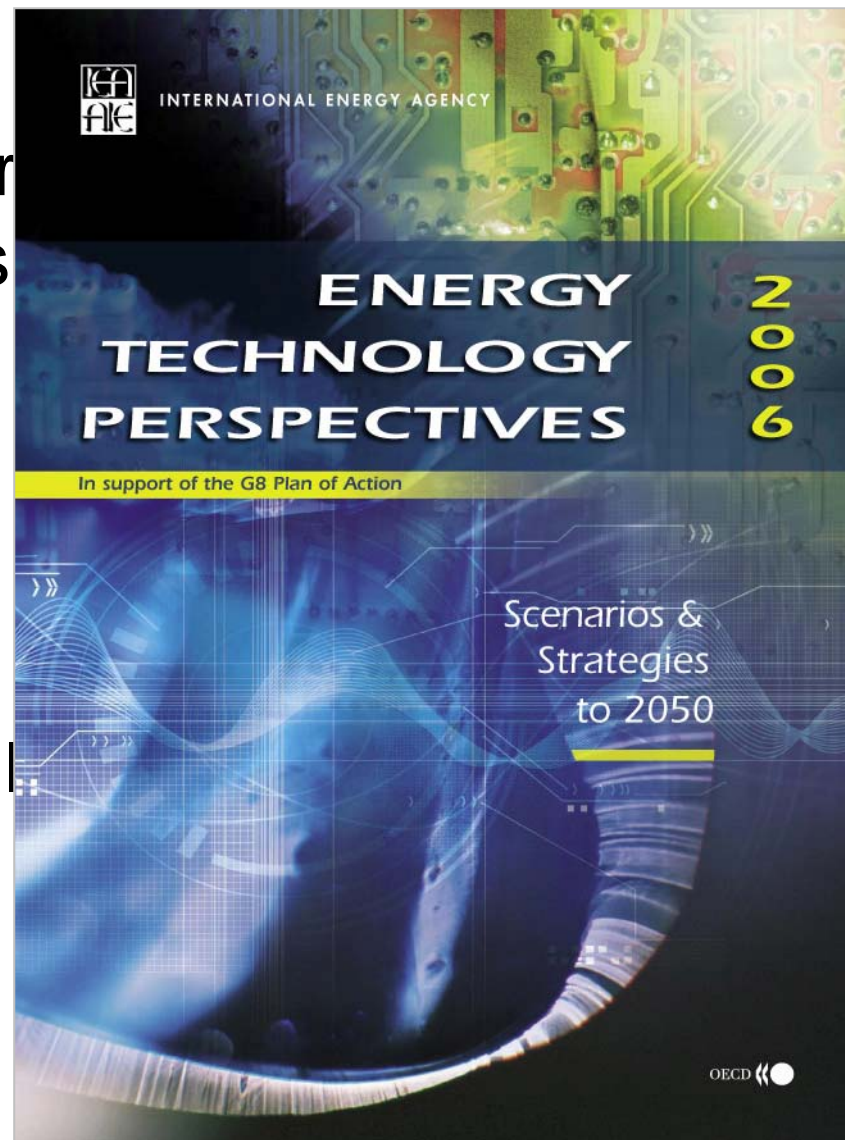
Best scenario: 60% FC vehicles in China by 2050, 42% India and US, 36-48% Europe, 35% Canada, 22% Japan, 10% Australia

Differences across regions due to discount rate, fuel taxes, infrastructure, consumers' attitude for capital-intensive investment, mobility needs, car-mileage.

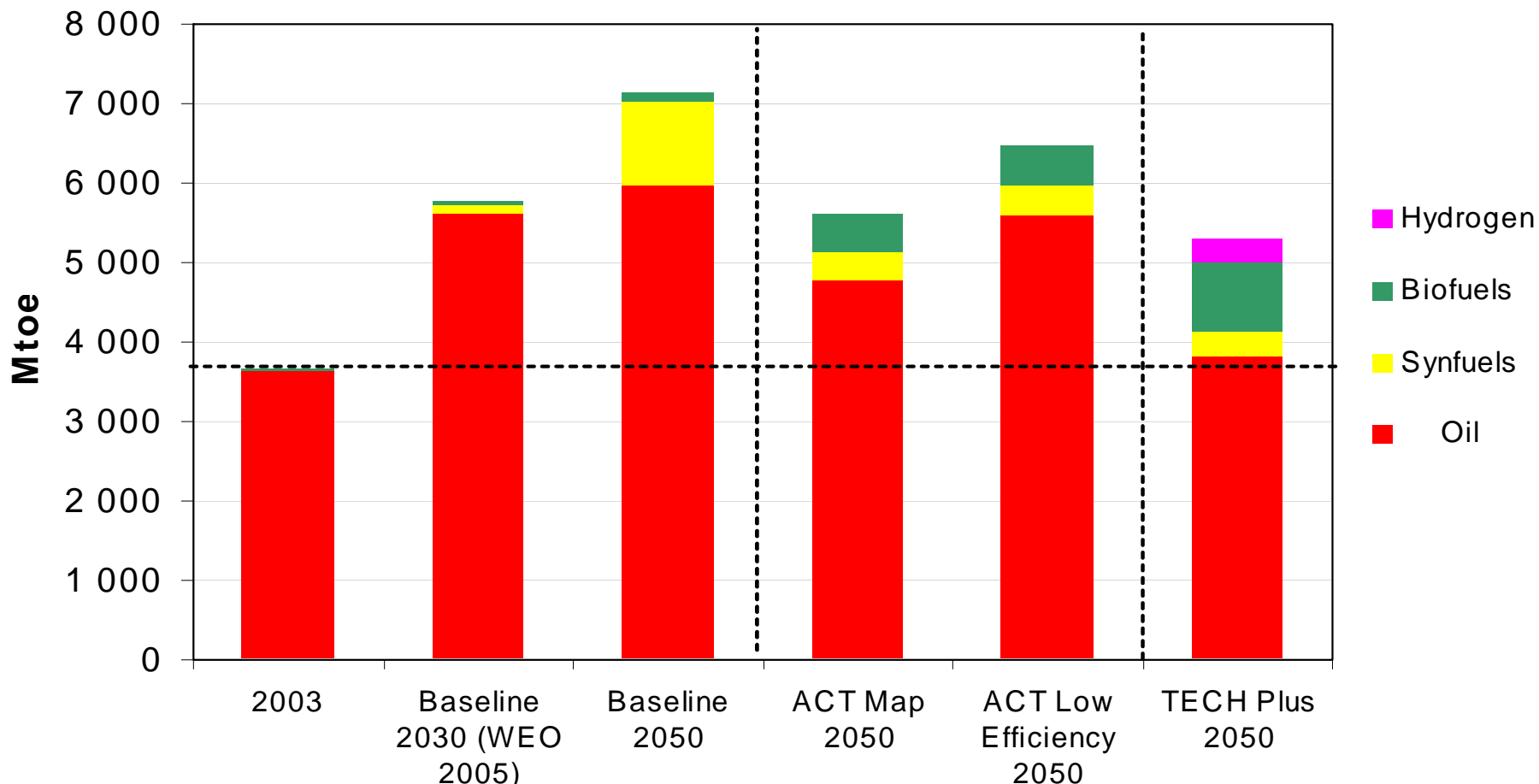
Energy Technology Perspectives 2006

ETP 2006 provides part of IEA's "advice on scenarios and strategies"

ETP 2006 presents a groundbreaking review of technologies across all sectors and assess how they together can make a difference

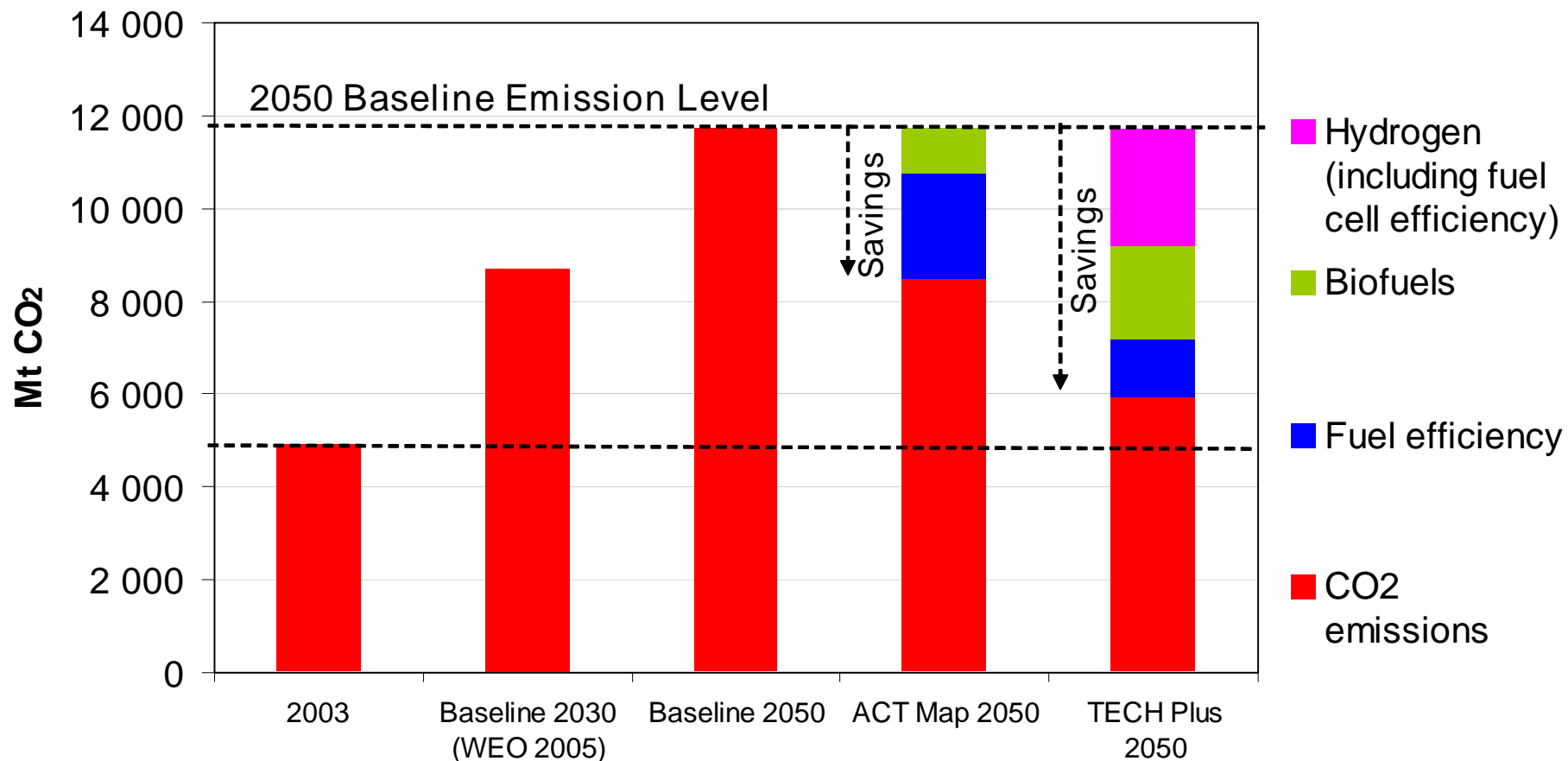


World Liquid Fuel Supply by Scenario 2003-2050



*Primary oil demand is below 2030 baseline level
and is returned to about today's level in TECH Plus.*

Transport CO₂ Emissions by Scenario



Key ETP Policy & Technology Findings

- Power Generation, via CCS, energy efficiency, renewables + NE, can largely be de-carbonized by 2050
- De-carbonizing the transport sector will take longer and we must start now
- A technology portfolio will be needed
- Collaboration between developing and developed countries essential

Now is the time to consider
infrastructure investment &
development strategies

Project Objective

Organize and convene public and private sector officials in an international strategic planning process to advance the orderly and efficient development of an infrastructure for the hydrogen economy.



Two Priority Tasks Proposed

- Convene up to three international meetings for public and private sector officials to consider and develop strategic partnerships and strategies for H₂ economy infrastructure
- Employ global energy technology optimization analysis/models, such as the IEA Energy Technology Perspectives (ETP) Model, to analyze various infrastructure investment and hydrogen economy development scenarios

Strategy Meetings

- 3 meetings: the Americas, Asia and Europe

- Participants

energy, finance and construction communities, merchant H₂ industry, transport community, distributed energy community, early investors, H₂ highway and fueling station teams, fuel cell community, community planners, codes and standards community

- Approach

facilitated small/large group discussions, back casting and forecasting exercises, critical path analysis exercise, scenarios and strategies exercise, lessons learned review, early investors perspectives, synthesis and reporting

- Scenarios & Strategies

framed by technology optimization models

- Products

build consensus & momentum, strategy document, advice to IPHE SC

Strategy Issues

- How fast can R&D and deployment programmes reduce the cost of a hydrogen infrastructure and hydrogen fuel cells vehicles?
- How much government funding would be needed in transition phase, and how can this funding be minimized and used as efficiently as possible?
- What would be the optimal balance between R&D and deployment programmes?
- How should this uncertainty in future hydrogen quality needs in terms of purity and pressure be dealt with infrastructure development?
- What are the true cost of hydrogen transmission and distribution system; can existing gas pipelines be used for hydrogen?
- Early decentralized production is either based on gas reforming or electrolysis. Electrolysis uses in fact a hydrogen fuel cell in reverse model. Could development of such electrolysis cells help to reduce cost for FCVs, and should they therefore be preferred over gas based supply systems?



Proposed Timeline

January 2007

Begin Analysis + Workshop organization

March - June 2007

Convent three workshops: Asia, Europe, North America

June - December 2007

ETP modeling and report writing

January - February 2008

Peer review and report refinement

June - August 2008

Final report & briefing at key venues*

* Interim progress reports at appropriate IPHE and IEA meetings

Proposed Budget (Euros)

Workshops 3x 50 000	150 000
Modeling / Analysis	100 000
Publication, travel, peer review	50 000
	<hr/> <hr/>
	300 000

We seek  endorsement of
the project.

The IPHE logo features the letters 'IPHE' in a bold, blue, sans-serif font, with a semi-transparent globe of the Earth behind the letters.

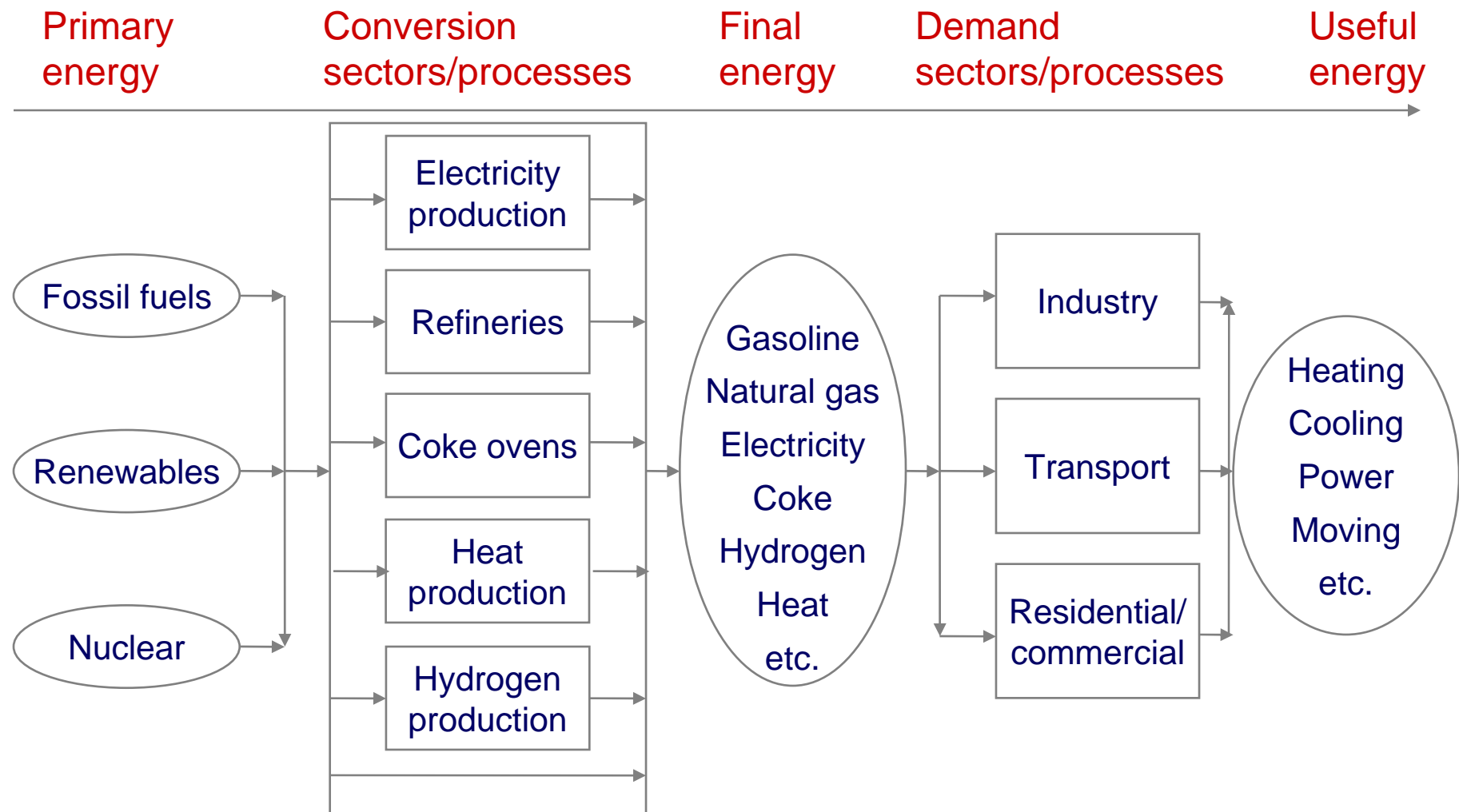
Thank you!



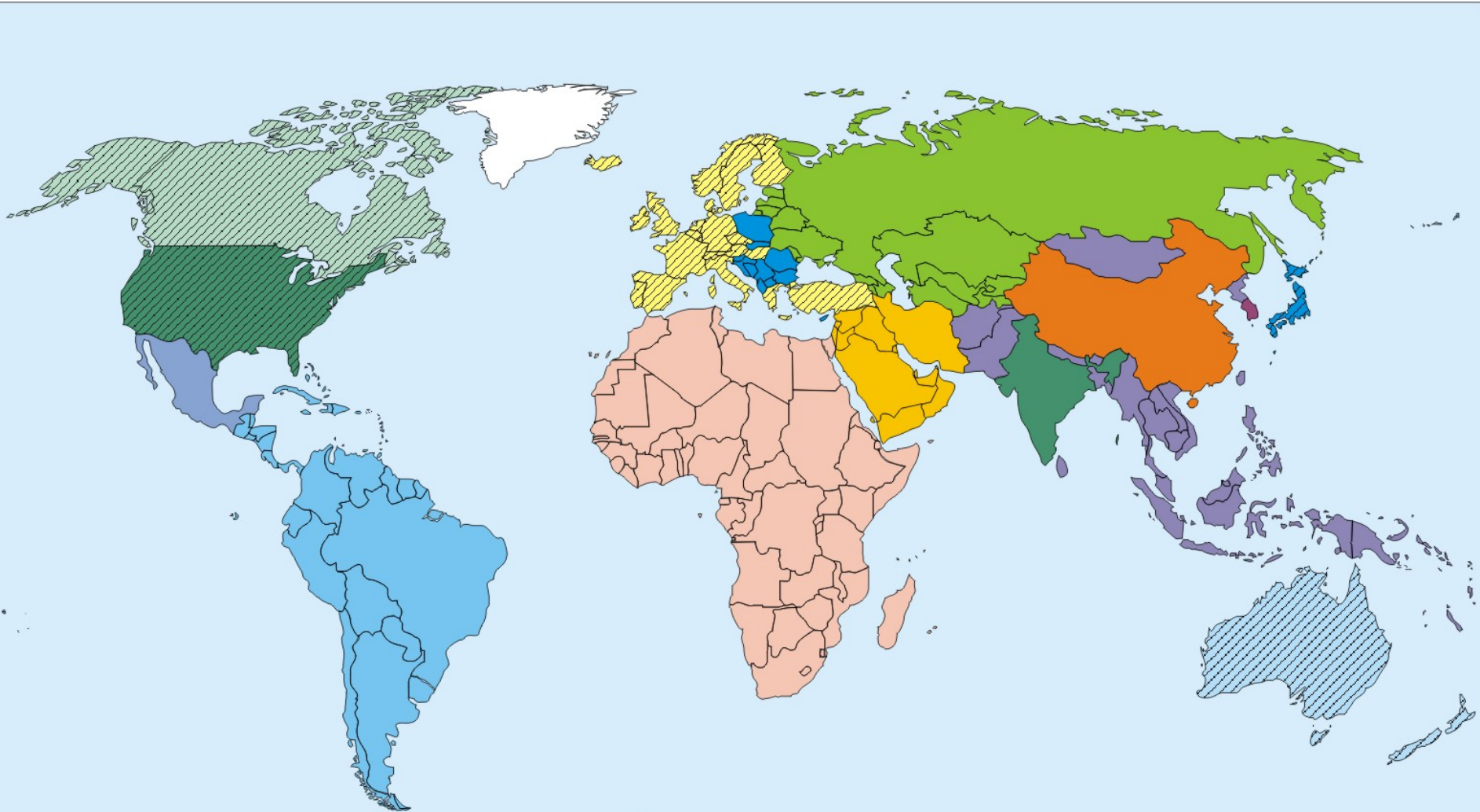
Energy Technology Perspectives Model

- MARKAL type model
- Developed and refined by the Energy Technology Systems Analysis Implementing Agreement during the past 25 years
- Long-term (2050) analysis of energy technology policy issues
- Least-cost decision making, ideal market
- Linear programming
- Full coverage of energy system (global, supply and demand side)
- Extensive technology database (1000 technologies)
- Calibrated to World Energy Outlook Reference Scenario

Reference Energy System (RES)



15 ETP model regions



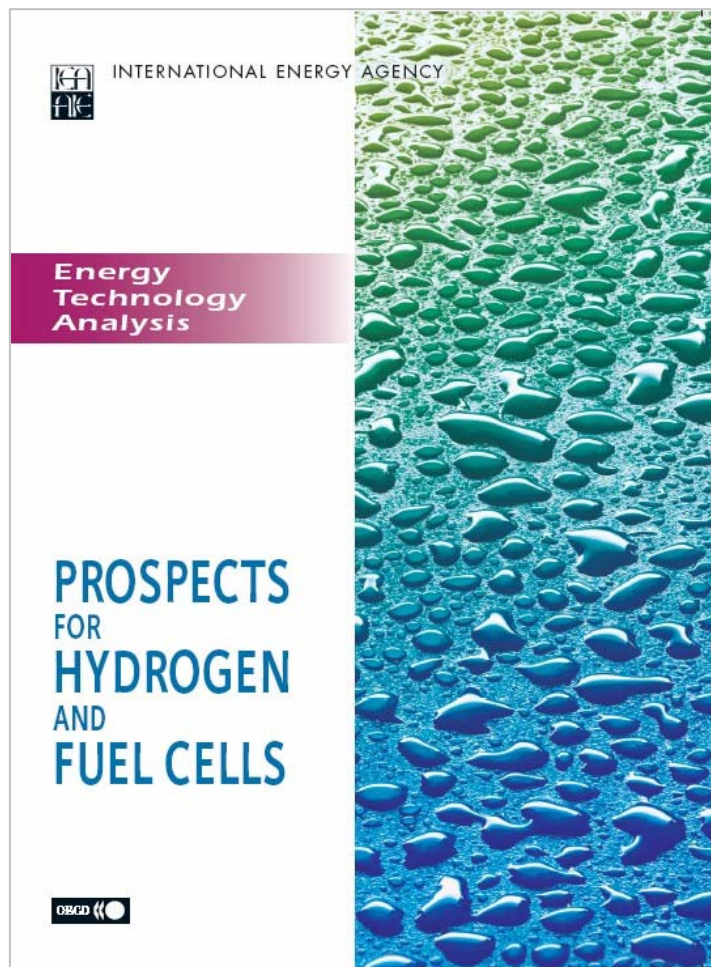
Transportation Module

- Based on SMP/MoMo
 - MoMo spreadsheet with ETP model input data
 - Demand projections
 - Efficiencies
- Many MoMo data are taken from ETP database
- 15 regions
- New technologies and fuels in ETP technology library
- Region specific multipliers
- Region specific discount rates

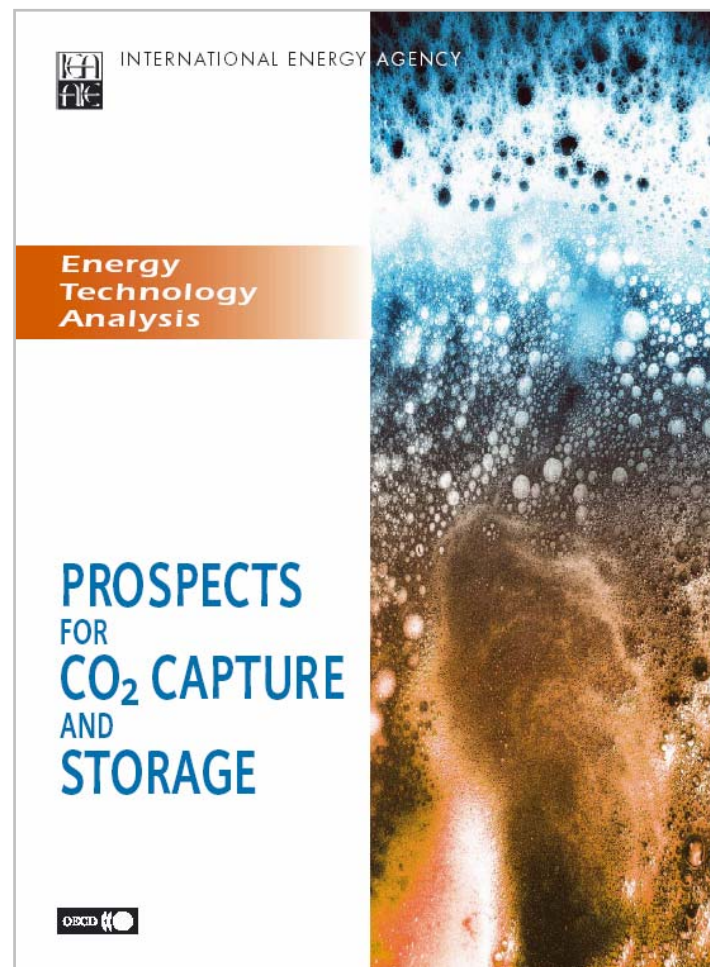
Value Added

- Proven, validated modelling framework
- Captures technological change
- Accounts for competing resource use (e.g. biomass, CO₂-free electricity)
- Accounts for competing technologies
- Endogenous fuel price response
- Carbon leakage effects
- Easy sensitivity and scenario analysis

ETP Technology Policy Modeling Studies



December 2005



December 2004

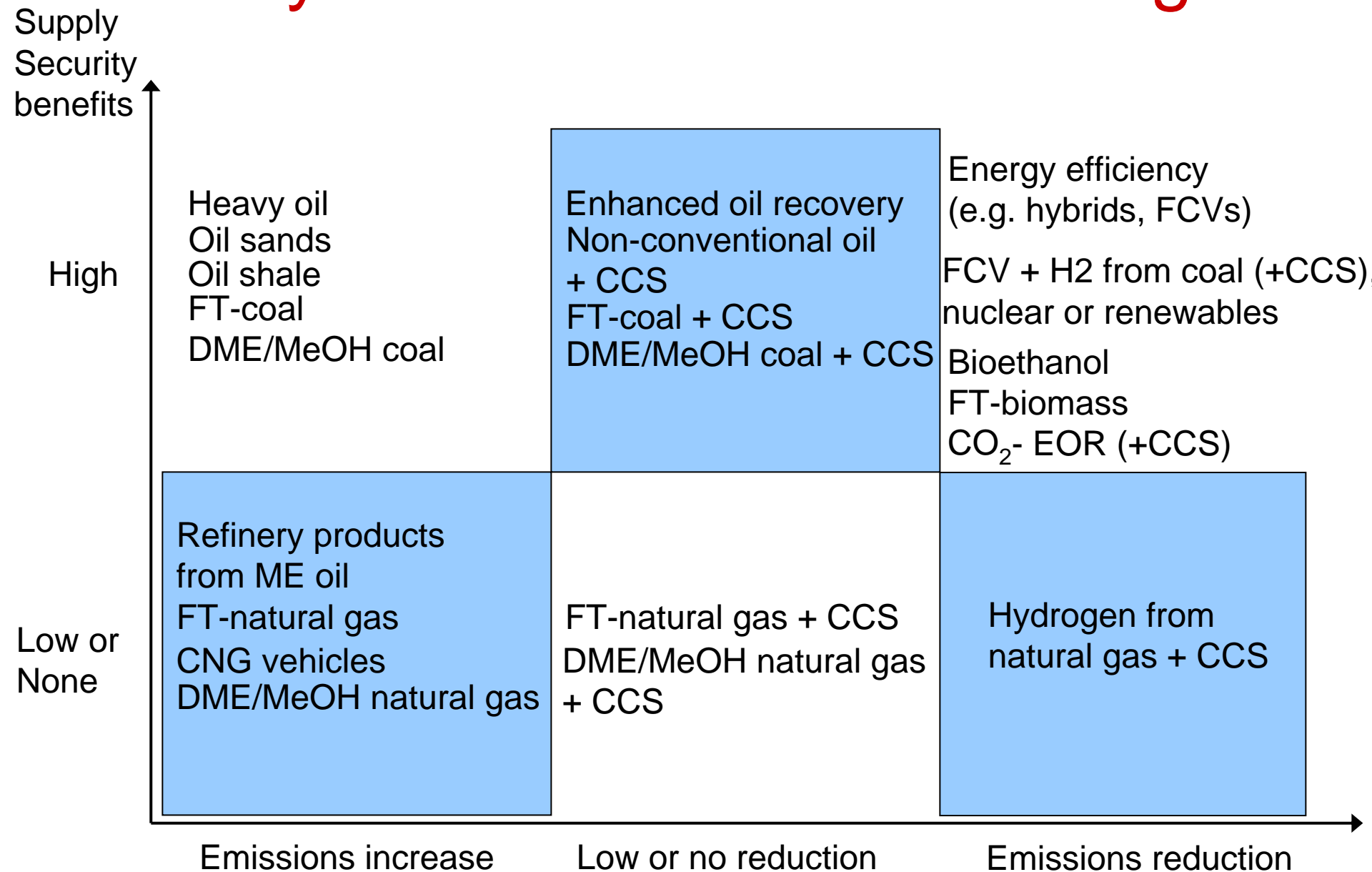
A typical MARKAL/ETP study

- 50% of resources for technology data collection and assessment
- 25% for model analysis
- 25% for reporting
- Good data are the key for all good modelling
- One accepted MoMo/ETP/WEO transportation technology database needed
- “Modelling for insights, not for numbers”
- Understanding what determines the results is a key issue
- Therefore sensitivity and scenario analysis are essential

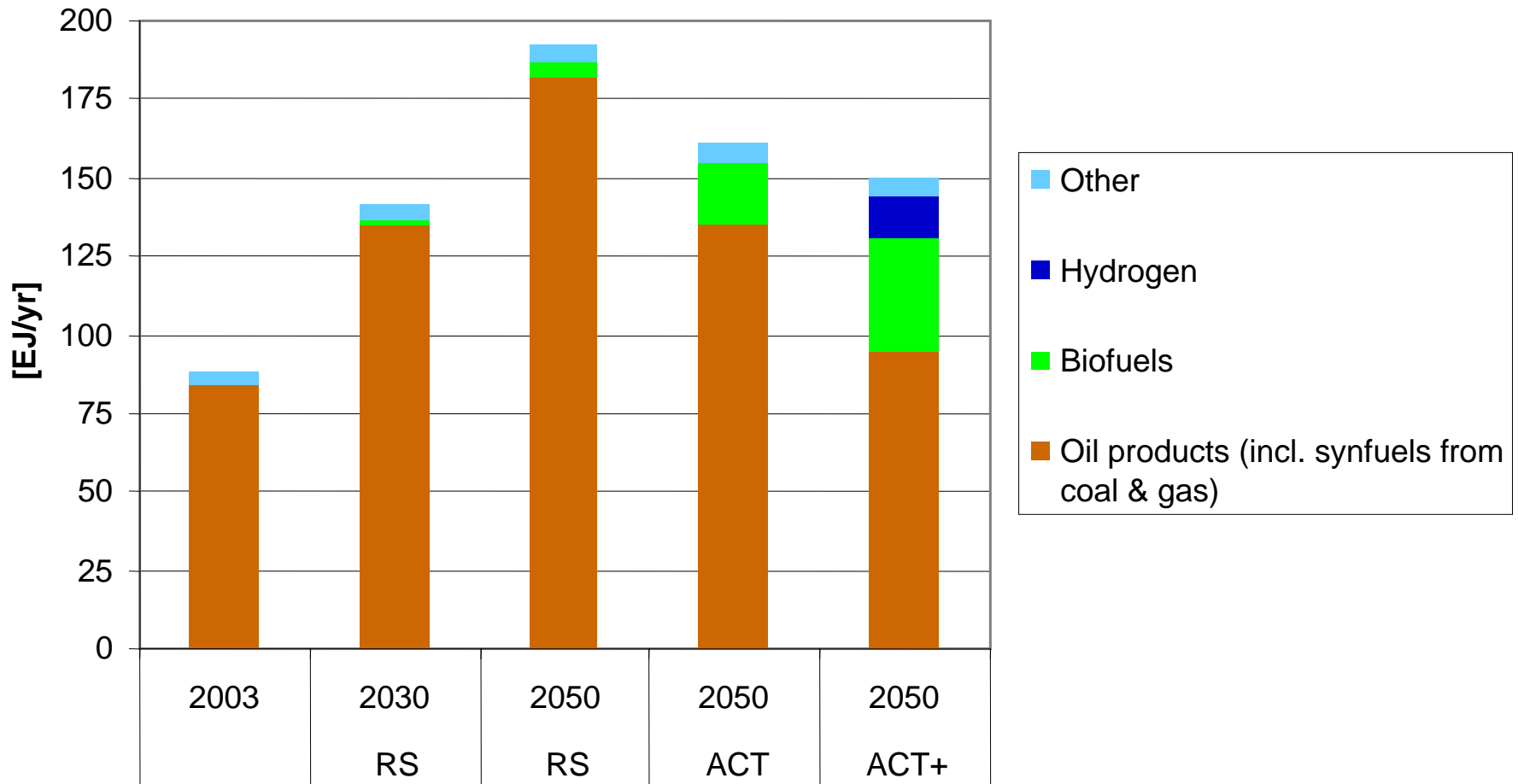
Issues

- Doubling of oil demand in BAU scenario
- Oil transportation fuel supply concerns
- CO₂ emissions
- Solutions
 - Fuel Efficiency (advanced ICEs, Hybrids, Fuel Cells)
 - Biofuels
 - Hydrogen FCVs

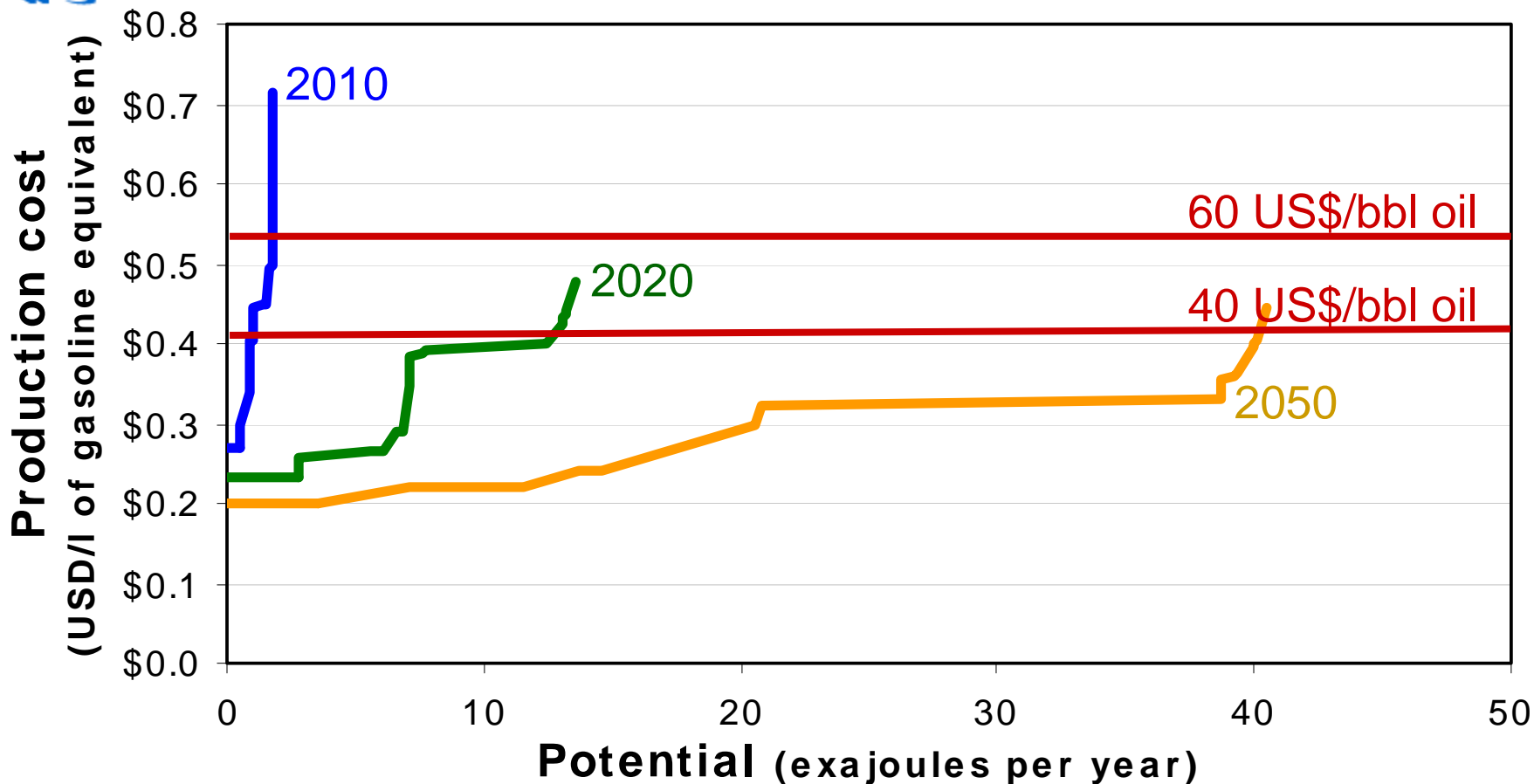
Many Solutions to the Challenge



Transportation fuel demand (model output)



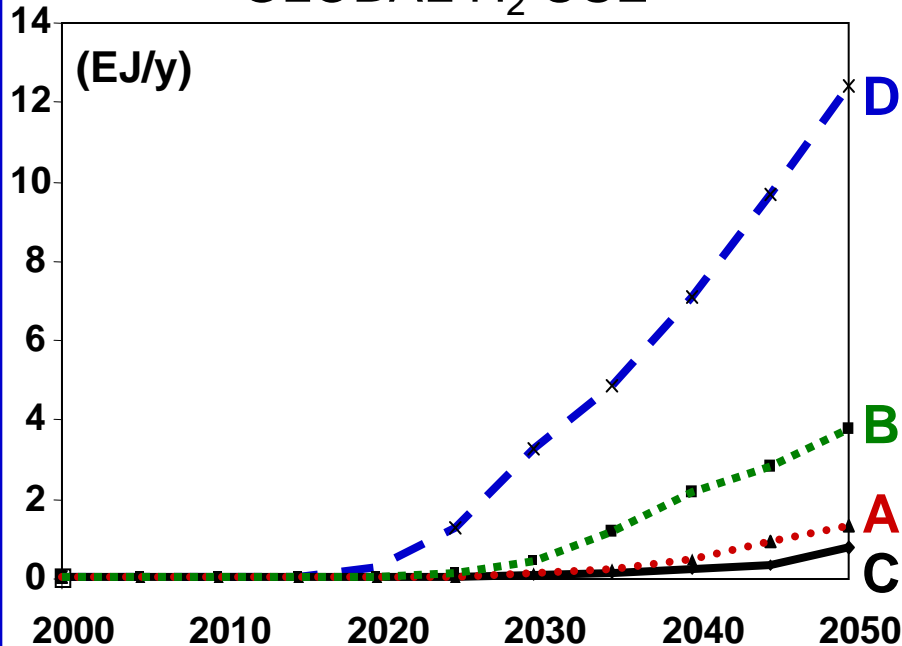
Global Bioethanol Supply Curves



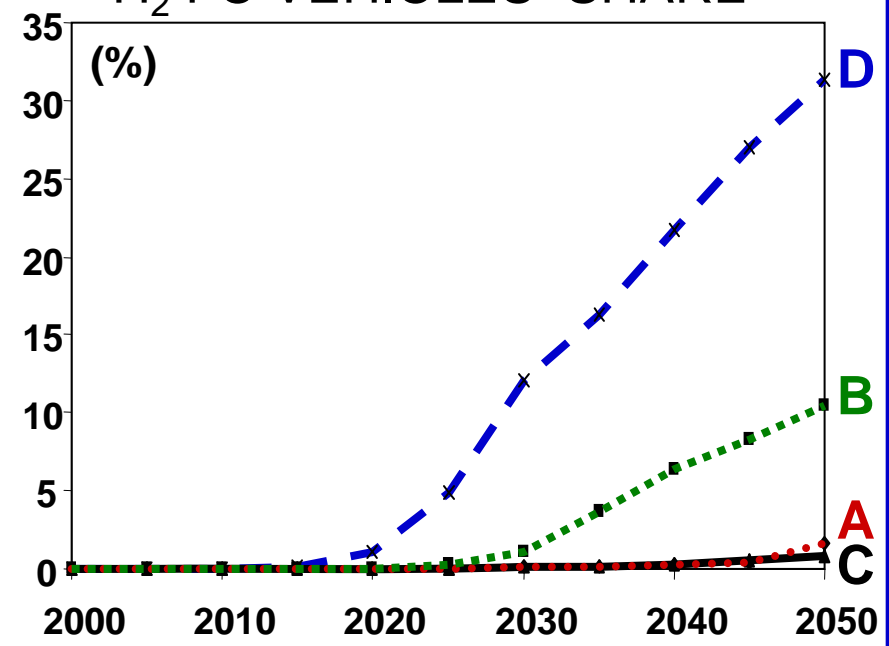
Prolongued high oil prices and new technology will result in lots of alternative fuels.

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