Medium- to longterm Energy Perspectives: Sustainable Energy Systems and the future role of Hydrogen

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«Hydrogen- and Fuel Cell Based Energy Systems In a Future Sustainable Energy World »

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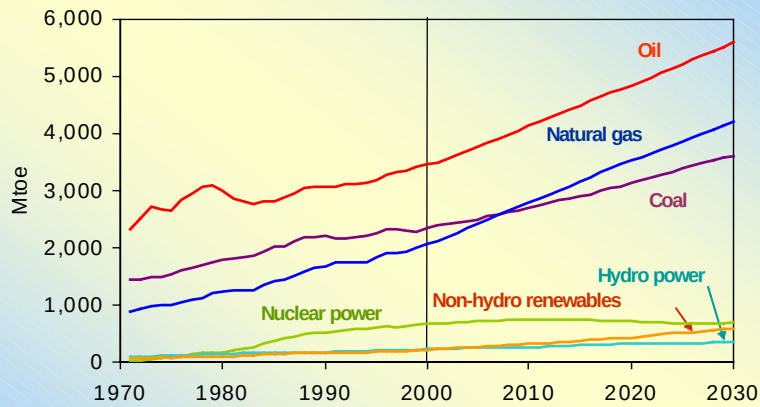
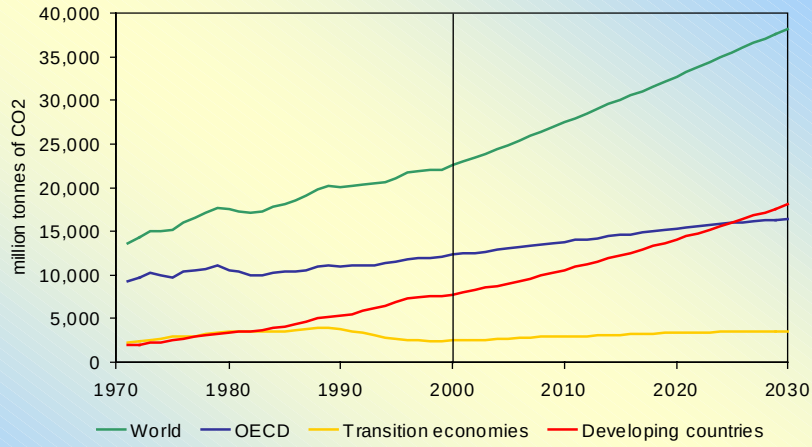
World Primary Energy Demand 1970-2030



Gas grows fastest in absolute terms & non-hydro renewables fastest in % terms, but oil remains the dominant fuel in 2030

Source: *IEA World Energy Outlook*, 2002

Energy-Related CO_2 Emissions



World emissions increase by 1.8 % per year to 38 billion tonnes in 2030 – 70% above 2000 levels

Source: *IEA World Energy Outlook*, 2002

Transition to Sustainable Energy System

- **Policies Matter**
  - Global and local
  - Cost effective, predictable, flexible
- **Technologies Matter**
  - Current technologies do not meet energy security and environmental challenges at reasonable cost
  - Need to expand technology frontier
- **Energy Security and Access Matters**
  - Affordable, stable energy prices essential for economic growth

Which Technologies …

- Efficient Energy End-Uses;
- CO_2 Capture and Storage for Fossil Fuel Power Generation;
- Renewable Energies;
- Advanced Nuclear Power;
- Hydrogen for Transport, Energy Storage and Distributed Generation; and
- Fusion Energy… in a very long term

Energy Efficiency Has A Key Role To Play, And Is Available In The Short Term

High performance buildings

Least life-cycle cost appliances

Labelling and certification

Energy efficiency offers:

- **substantial energy and greenhouse gas savings at low or negative cost**
  - **470 Mt/y CO2 in IEA region by 2020 in appliances alone**
    - **At *negative* cost: -€169/t CO2 (IEA)**
- **energy security and reliability benefits**
  - **Up to 1.5 Gt/y C by 2010; 2.7 Gt/y by 2020**
    - **Half of this at negative cost (IPCC)**
- **enhanced business competitiveness and social welfare**

Efficient information and communication technologies

Reducing standby power consumption

Compact Fluorescent Lamps

LED traffic lights

Super windows & daylighting

The Technology Challenge

Stabilising Greenhouse Gas Concentrations in the Atmosphere

Vehicles: Efficiency, Bio-fuels, Hydrogen Fuel Cells

Zero Net Emission Bldgs., Industrial Efficiency, CHP

Nuclear Power Generation IV

No single technology or policy can do it all

Different

- regions
- resources
- markets
- preferences
- scale-up requirements
- technology timing
- infrastructures

Carbon (CO_2) Sequestration

Renewable Energy Technologies

Bio-Fuels and Power

Advanced Power Grids

What Actions

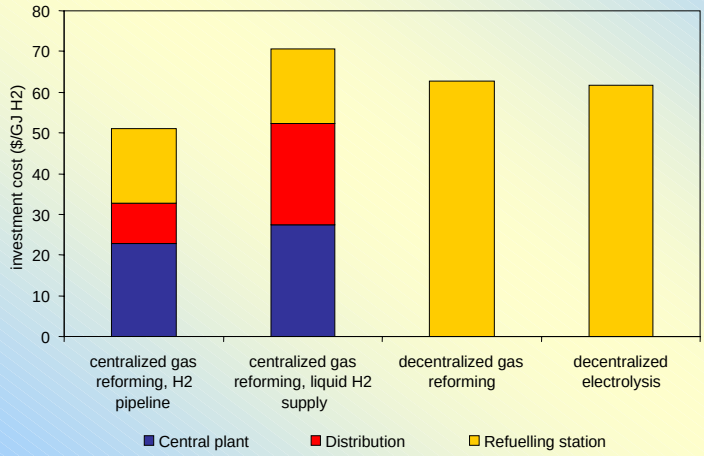
- Spur investments in clean energy technology
- Support underlying basic sciences R&D
- Harmonize energy technology policies and exploit synergy of the international co-operations

What lessons from the past …

- Reducing CO_2 emissions will not be free even with the benefits of advanced technologies;
- Learning-by-doing will require societal technology investments to reduce cost;
- Energy policies and real governmental commitment will be needed to achieve uptake of advanced technologies;
- Governments should not "pick winners" but identify and support technology priorities.

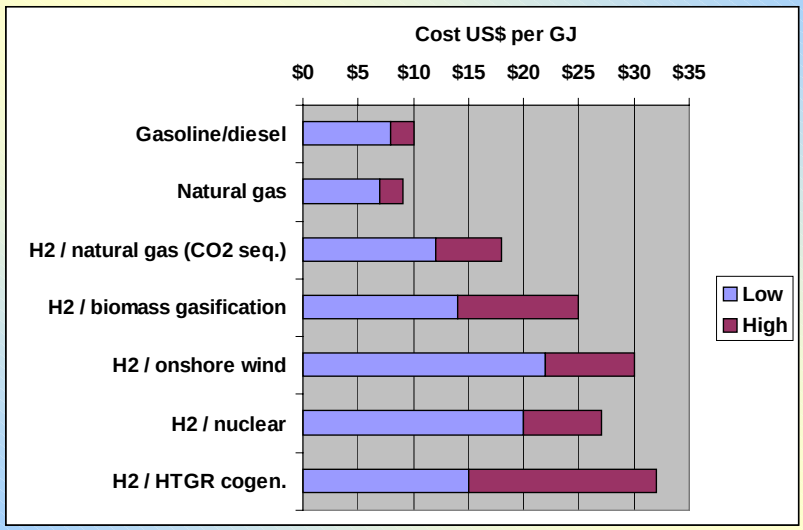
International H_2 & FC Collaboration

Long-term Investment Costs of Alternative Hydrogen Production and Supply Systems



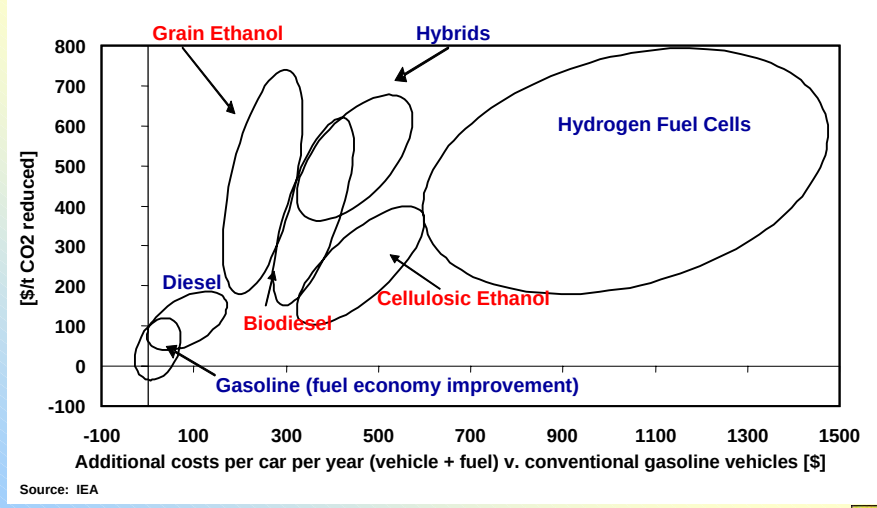
Source: *IEA World Energy Investment Outlook, 2003*

Hydrogen Supply Costs



Source: *World Energy Investment Outlook*, IEA, 2003.

CO2 Reductions and Cost: How do H2/FCs compare?



Source: IEA

The Challenge Ahead

- **Market competition with other, cost effective technology options and measures to reduce emissions and enhance security;**
- **<u>Stationary Use:</u> Cost and availability of CO_2-neutral Hydrogen (fossil fuels with CO_2 sequestration, renewables, nuclear?);**
- **<u>Mobile Use:</u> Cost and availability of H_2 Infrastructure and FCV market (chicken & egg);**
- **Fuel Cell cost and lifetime.**