ECN

Energy research Centre of the Netherlands

Early Markets and Cross-Cutting Issues for Fuel Cell Applications

M. Weeda

Presented Roads2HyCom Workshop on Regional Development and Hydrogen Projects, Brussels, 4th March 2009

ECN-L--09- 169

December 2009

Early Markets and Cross-Cutting Issues for Fuel Cell Applications

Roads2HyCom Workshop on

REGIONAL DEVELOPMENT AND HYDROGEN PROJECTS

Marcel Weeda, ECN

Brussels, Wednesday 4th March 2009

General Policy objectives related to the use of energy

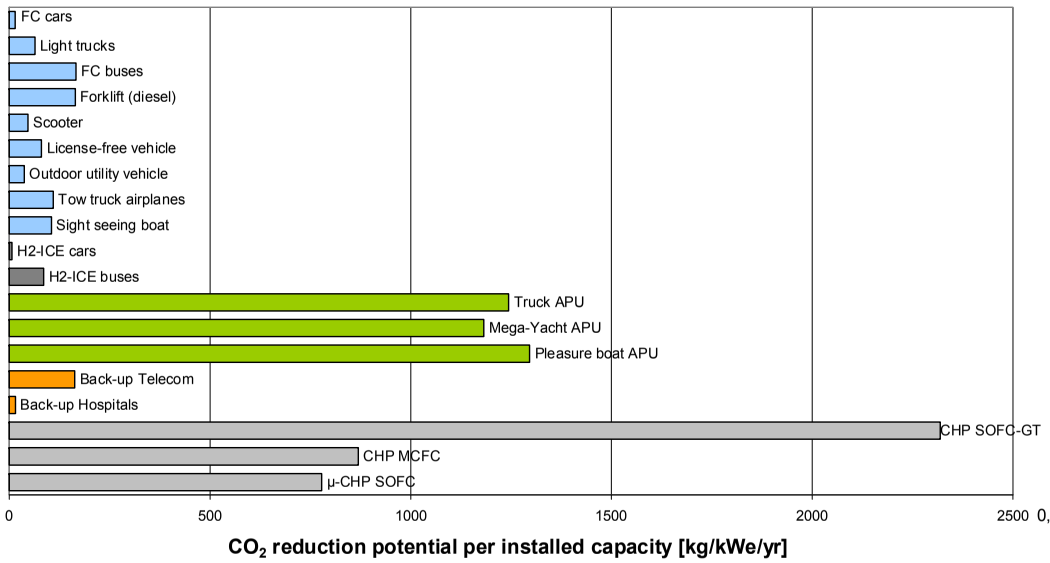
- General policy objectives:
  - Increase security of energy supply:
    - Reduce energy use
    - Increase energy efficiency
    - Diversify in use of primary energy sources
  - Reduce emission of greenhouse gases
  - Reduce air pollution – increase air quality
  - Innovation to create new economic activities

- Fuel cells and Hydrogen are not a goal at all cost, they are a means to achieve policy goals

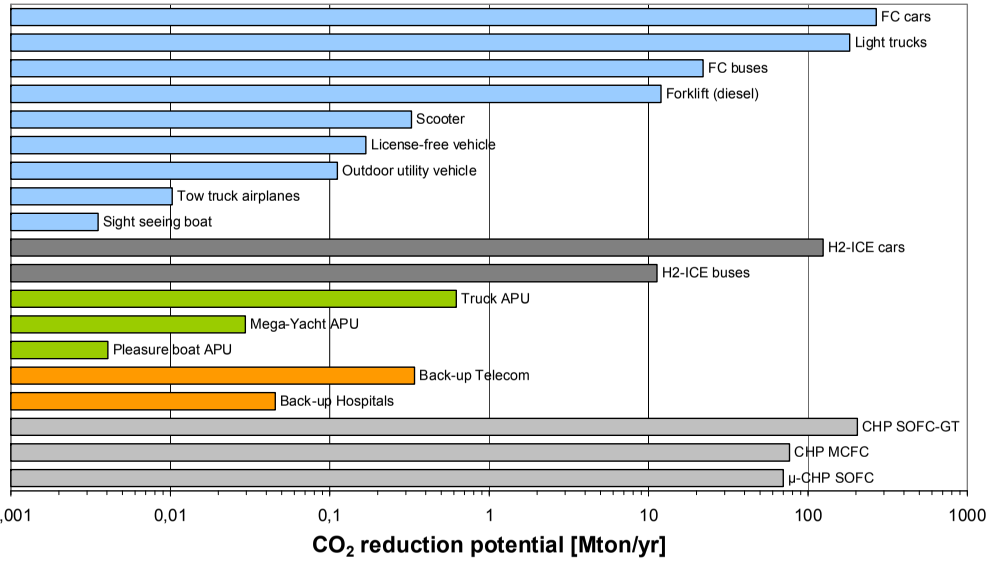
- Windows of opportunity of FC applications and their global impact on CO_2 emissions have been analysed for various potential applications

CO_2 emission reduction potential for various Fuel Cell and Hydrogen applications

Specific CO_2 emission reduction potential



Overall CO_2 emission reduction potential

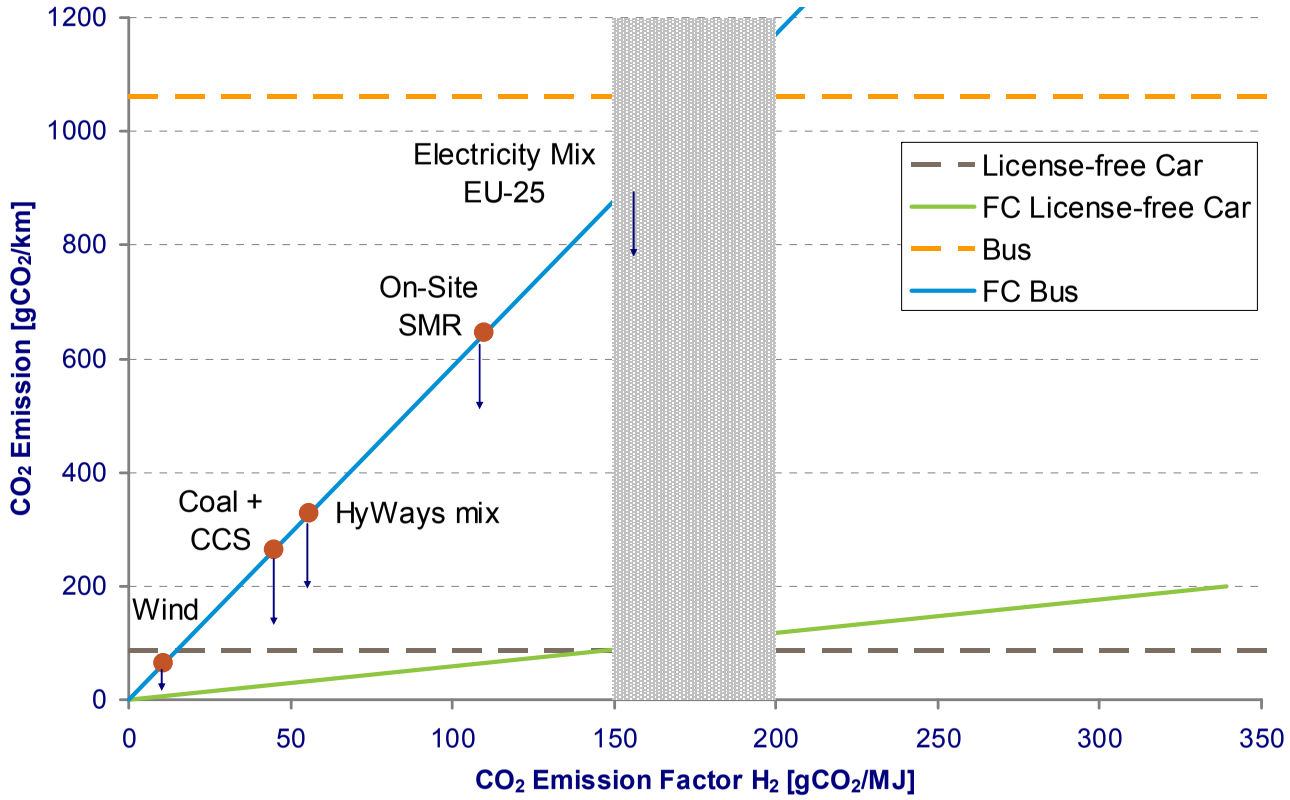


- HyWays hydrogen mix
- 100% implementation

- Stationary applications and auxiliary power units (APU) have the highest CO_2 emission reduction potential for an installed unit of power …

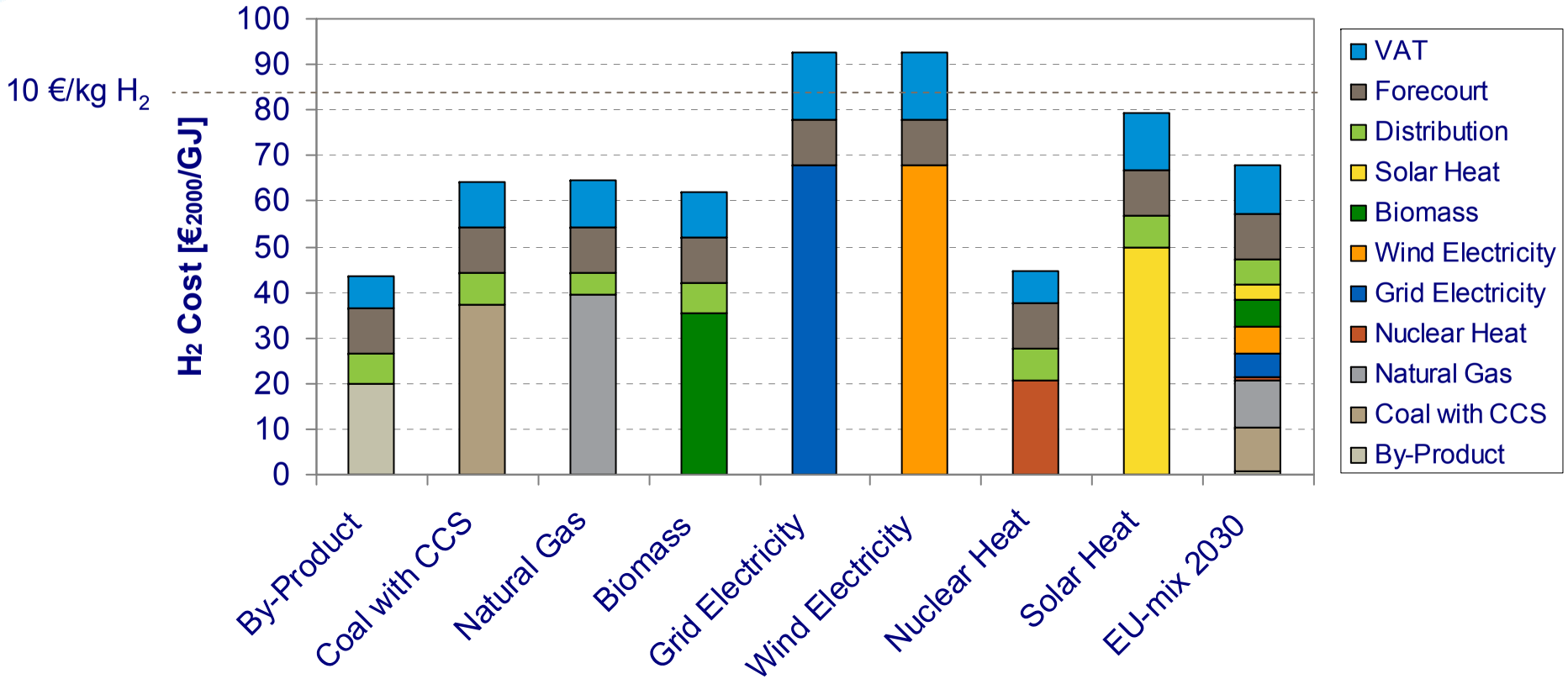
- … but mass applications like passenger cars and light duty trucks represents the largest total reduction potential of CO_2 due to the number of units involved

CO_2 emission reduction depends on H_2 emission factor, but many possibilities exist to achieve significant reduction



- Well-to-User emission factors for energy carriers based on EUCAR/CONCAWE/JRC
- CO_2 emission reduction depends on hydrogen production technology/fuel source

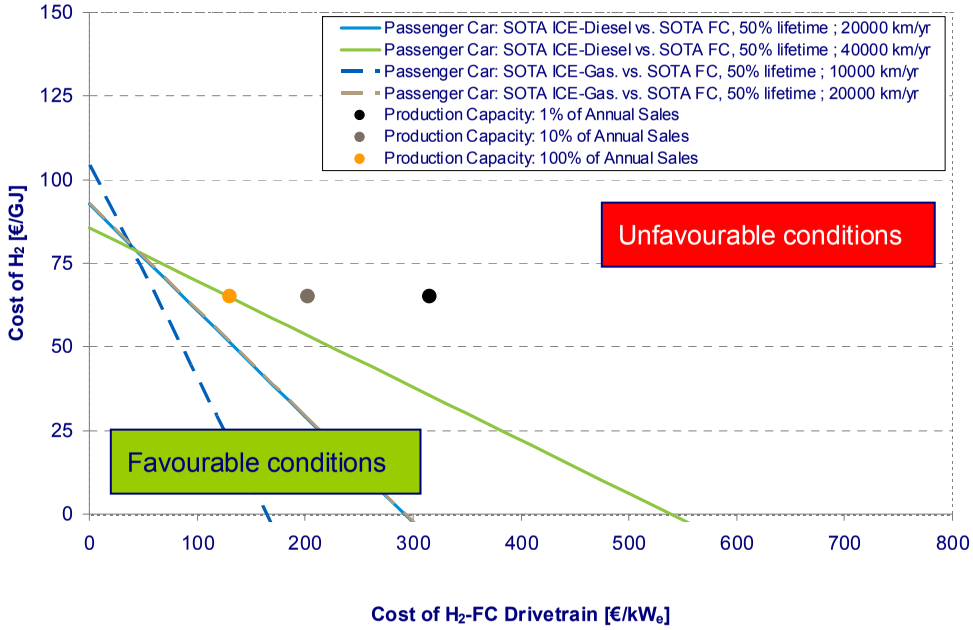
Hydrogen costs for the final user have been calculated by adding VAT, transport cost and forecourt



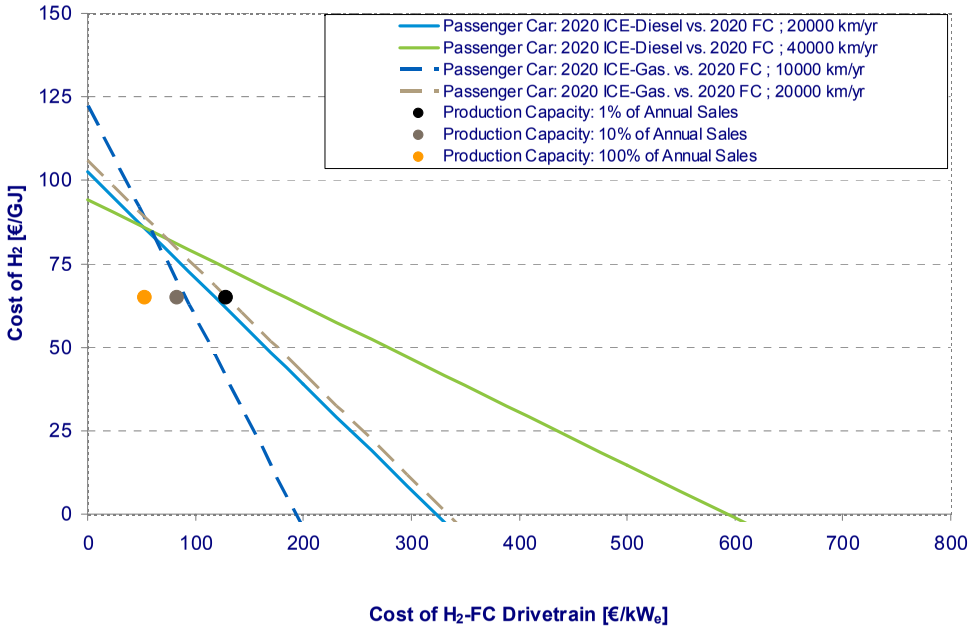
- Cost of hydrogen (€$_{2000}$/GJ) from different sources using R2H production cost analysis and HyWays production mix for 2030 from member state review
- **Production cost is only part of the cost**. Distribution and refuelling infrastructure may add significantly

Current and future window of opportunity for fuel cell passenger cars

State-of-the-art technology, including economy of scale effects



2020 technology by applying learning effects and including economy of scale effects

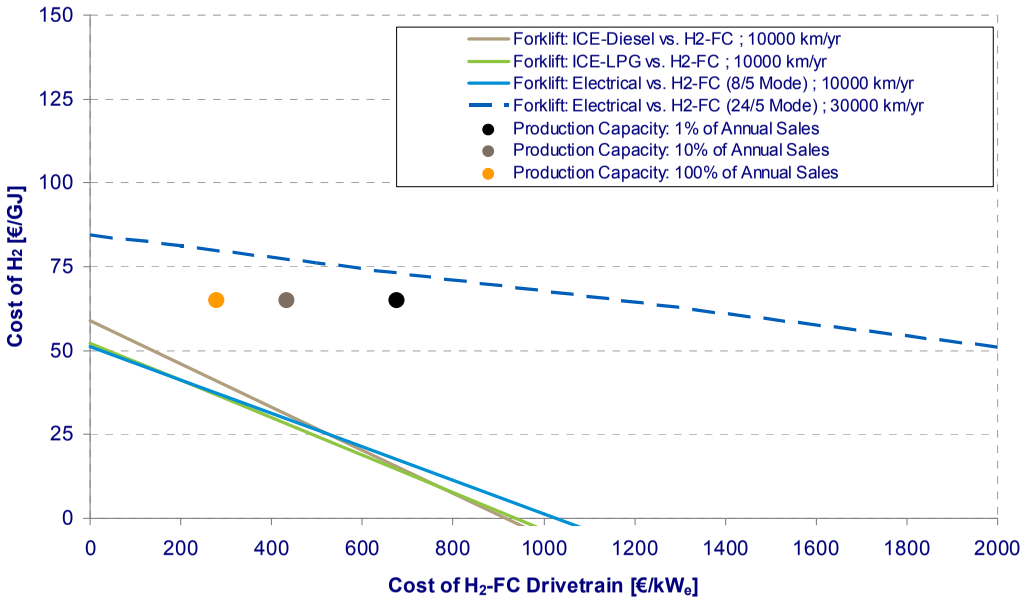


- Windows of Opportunity for passenger cars based on SOTA technologies and 2007 energy prices
- The data points reflect SOTA H2-FC specifications, assuming that the lifetime of the stack is 50% of the application's lifetime

- Windows of Opportunity for passenger cars based on 2020 FC and ICE technology and energy prices.
- The data points reflect SOTA H2-FC specifications assuming equal lifetime of the stack and application

Applications identified as near and mid-term markets

State-of-the-art technology,
including economy of scale effects



- Battery electric forklifts in 24/5 or 24/7 operation are identified as near term market due to limited energy storage capacity and recharging characteristics of batteries
- Also applications using battery back-up power systems favour H_2 fuel cell systems

- Other **applications identified as near to mid-term markets**:
  - Battery electric outdoor utility vehicles
  - Light duty trucks
  - License-free cars (city cars)
  - Passenger cars
- In general, **favourable characteristics of early markets** are:
  - High annual mileage or full load hours
  - Modest fuel consumption; with high fuel consumption cost of H_2 becomes limiting
  - Small system power; relatively low extra investment cost
  - Transport or stationary applications requiring more range, flexibility and reliability than possible with batteries

Observations and considerations

- **H_2 and FC technology can compete with reference technologies, but only if further technology improvement and economies of scale are realised:**
  - Political commitment required
  - Hydrogen requires long term investment
  - From project finance to deployment policy
- **Development of different early markets or focus on mass market application?**
  - Many early markets face similar cost barriers as passenger cars
  - To bridge the gap early markets require comparable market penetration as passenger cars
  - Market size early markets (specific applications) is relatively small …
    - Forklifts: 164,000 (share battery electric in 24/5 or 24/7 not known)
    - Outdoor utility vehicles: 20,000
    - License-free cars: 35,000
    - Light duty trucks: 2,000,000
    - Passenger cars: >15,000,000
  - … consequently the contribution of developing early markets in bridge the cost gap for mass market applications may be limited:
    - Small system power in addition to limited market size
    - Applicability of learning effects from specific markets to mass market applications

Observations and condsiderations

- **Look for synergies:**
  - Combine different applications with similar fuel cell and storage systems – efficient use of maintenance infrastructure
  - Link build-up refueling infrastructure to early markets: clustering, shared use and publicly accessible
- **Added value of early markets:**
  - Generating (local) expertise in the field of safety
    - Prevention: which regulations, codes and standards
    - Measures to limit impact: risk assessment, safety distances
    - Contingency planning: how to act in case of emergency
  - Get the public accustomed and creating acceptance
    - Communication of plans
    - Dissemination of results
- **Maximise learning:**
  - Define clear purpose, without it is hard to measure success
  - Monitoring and evaluation is essential

Summary

- **Various applications identified** as viable near and mid-term markets for fuel cells and H_2:
  - Transport applications:
    - Battery electric forklifts in 24/5 or 24/7 operation and outdoor battery electric utility vehicles
    - Light duty trucks, license-free cars and passenger cars
  - Stationary applications
    - Hydrogen fuelled back-up power systems e.g. for telecom application
    - Natural gas fuelled commercial and industrial CHP systems (high temperature fuel cells)
- **Good prospects for CO_2 emission reduction** are present even if hydrogen is not completely renewable; prospects for renewable hydrogen are similar to prospects for renewable electricity
- **Largest CO_2 emission reduction potential** for FC passenger cars, light duty trucks, and medium sized CHP systems
- Whatever the application or chosen solution, results indicates that **research to reduce cost and realisation of mass-production, is essential**.
- **Hydrogen requires short and mid-term investments for long term benefits**
  - Political commitment is essential
  - Strategic planning of deployment of applications and building the refueling infrastructure
  - Safety, education, training, public acceptance all integral part of the development
  - Maximise learning: Monitoring and evaluation