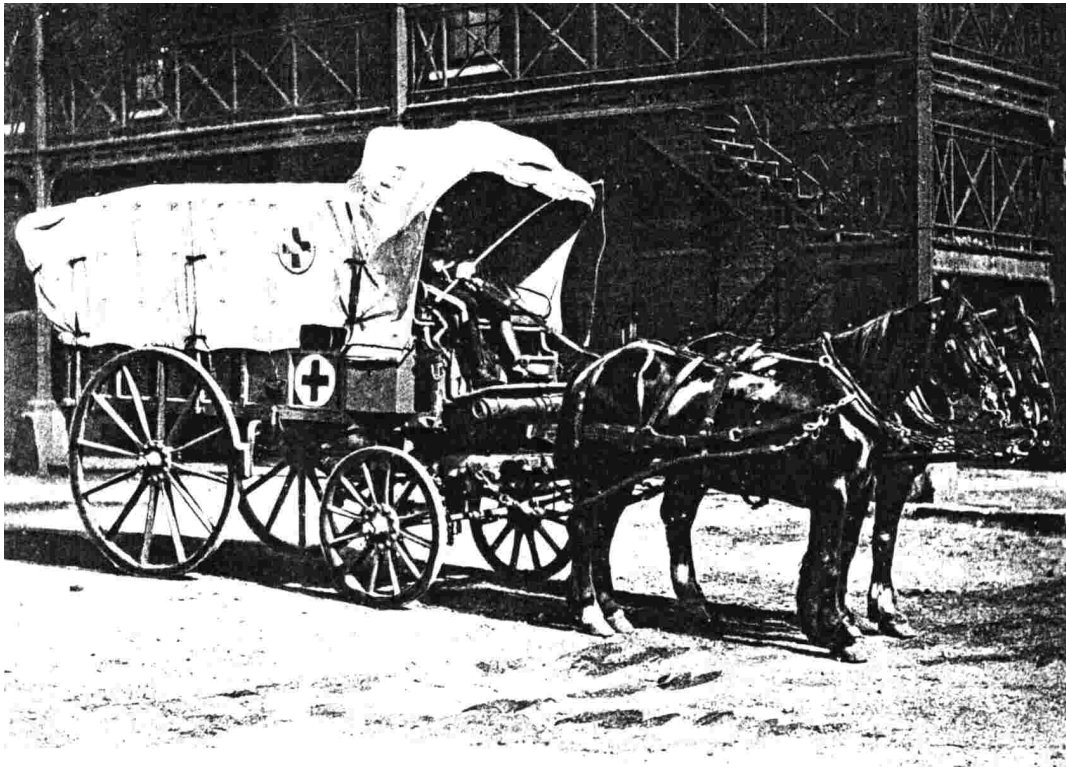




# **Catalysts for H<sub>2</sub> Iceland's first step towards the hydrogen economy?**

Jón Björn Skúlason  
General Manager  
Icelandic New Energy

# The first problem of urban transportation



# The solution

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# The new problem

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# Does this cause global warming (GHG)?

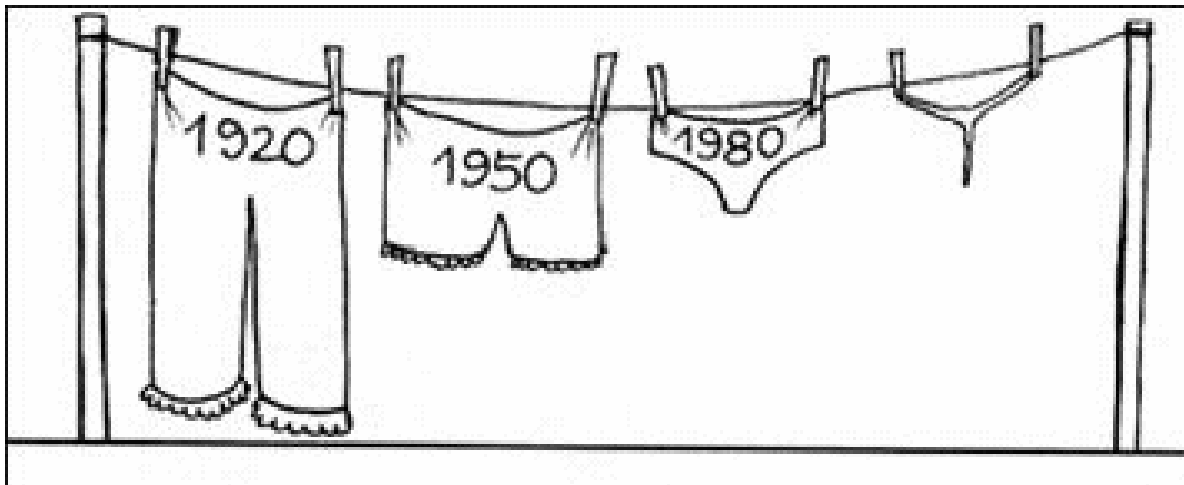
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# Does this cause global warming (GHG)?

- It is debated!

**However it is happening**



# Does this cause global warming (GHG)?

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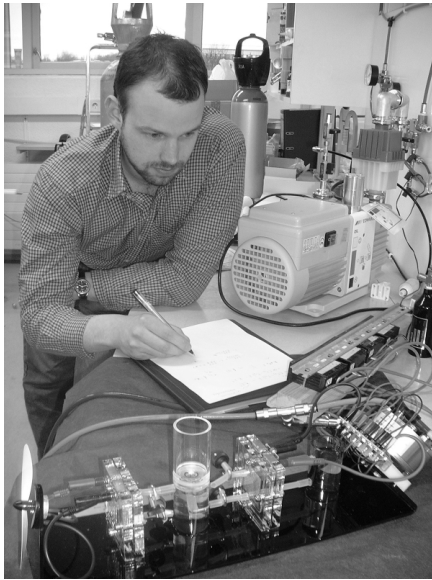
- It is debated!
- Does it matter what causes global warming
- Continued use of hydro carbon fuels will lead to:
  - Increased pollution
    - Declining quality of life
  - Depletion of resources
    - New generations should be able to use hydro carbons
  - Less energy security
  - Instable political climate



- First policy measures towards hydrogen in 1998
- Current position:
  - Iceland an international platform for hydrogen research
  - Create the worlds first hydrogen economy
- H<sub>2</sub> policy of the government:
  - Favourable framework for business and research
  - International cooperation
  - Education and training
- First major steps:
  - Taxation incentives (no taxes on hydrogen vehicles)
  - Financial and international support (IPHE)
  - Roadmapping and hydrogen policy

# Unique INE structure / objective

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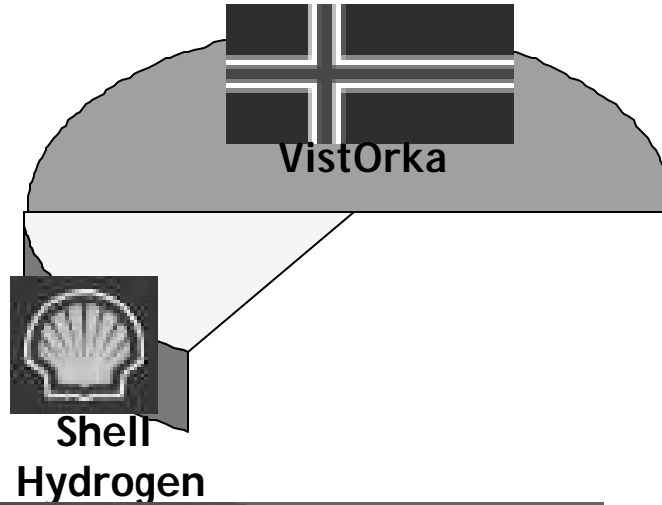


*Energy, know-how  
and an  
excellent H<sub>2</sub> research  
platform*



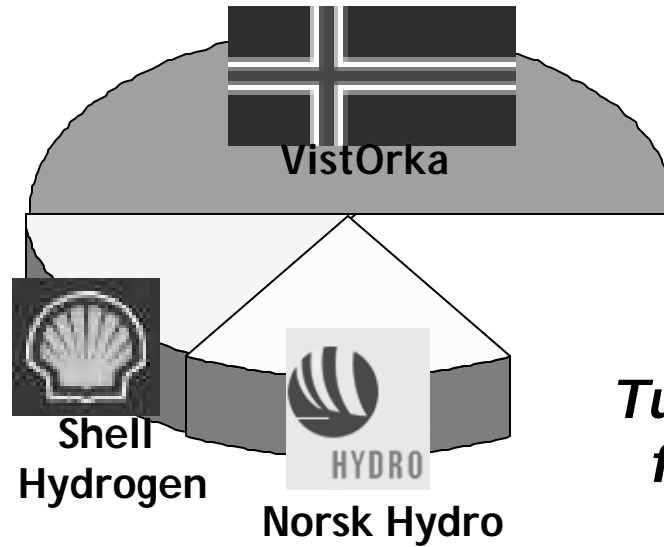
**Icel. New Business Venture Fund, Reykjavik Energy, The National Power Company, Hitaveita Sudurnesja, University of Iceland, The Technological Institute of Iceland, Fertilizer Plant, Reykjavik Resources, Government of Iceland**

# Unique INE structure / objective

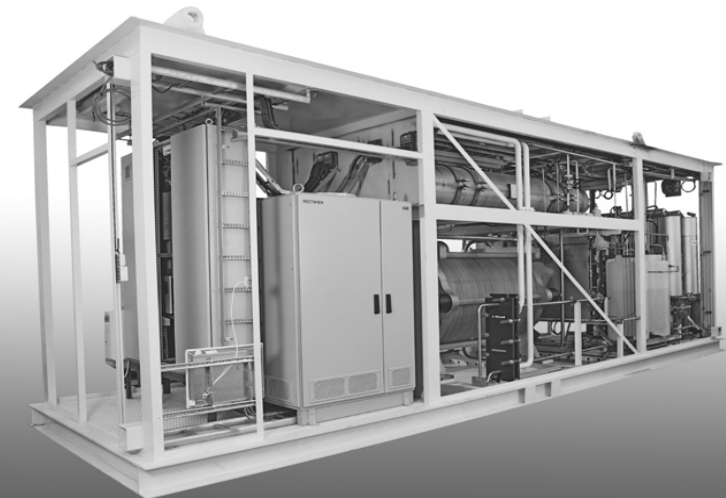


Design for the  
future H<sub>2</sub>  
infrastructure

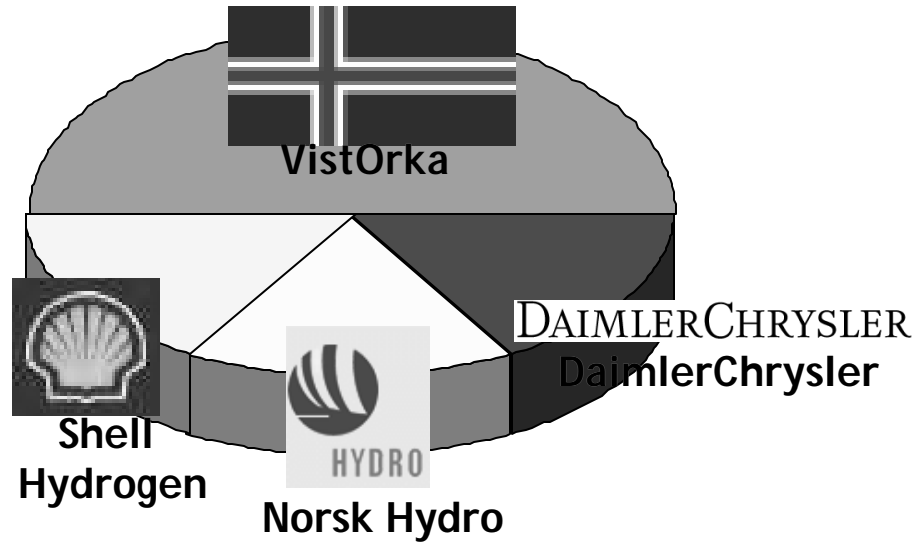
# Unique INE structure / objective



*Turn key solutions for the  
future H<sub>2</sub> infrastructure*



# Unique INE structure / objective



*H<sub>2</sub> and fuel cell  
vehicle development*



# Key Projects

## 1. Hydrogen fuel cell bus demonstration: ECTOS



Demonstration Programme

Gradual introduction into bus fleet

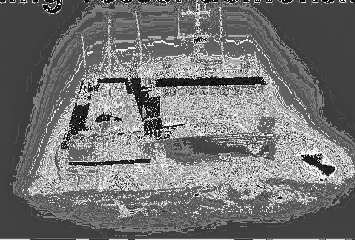
## 2. Hydrogen passenger vehicles



Demonstration Programme

Gradual introduction into passenger car fleet

## 3. Hydrogen fishing vessel demonstration



Demonstration Programme

Gradual introduction into fishing fleet

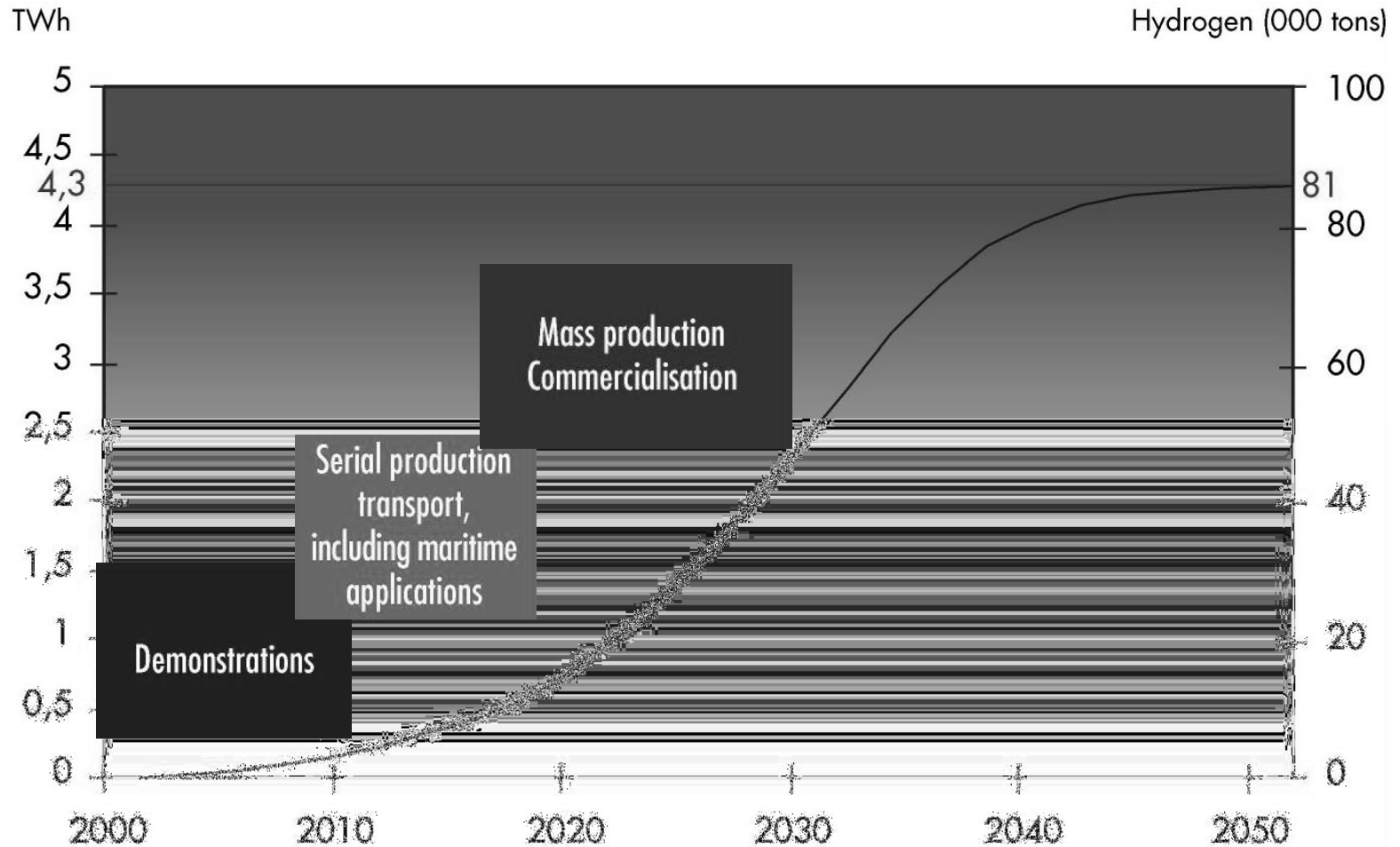
2000

2003

Time



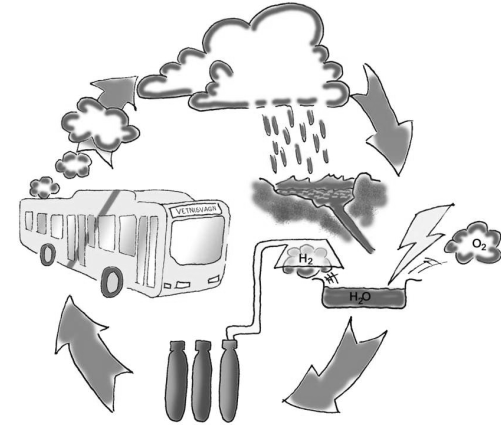
# Energy use in a hydrogen society



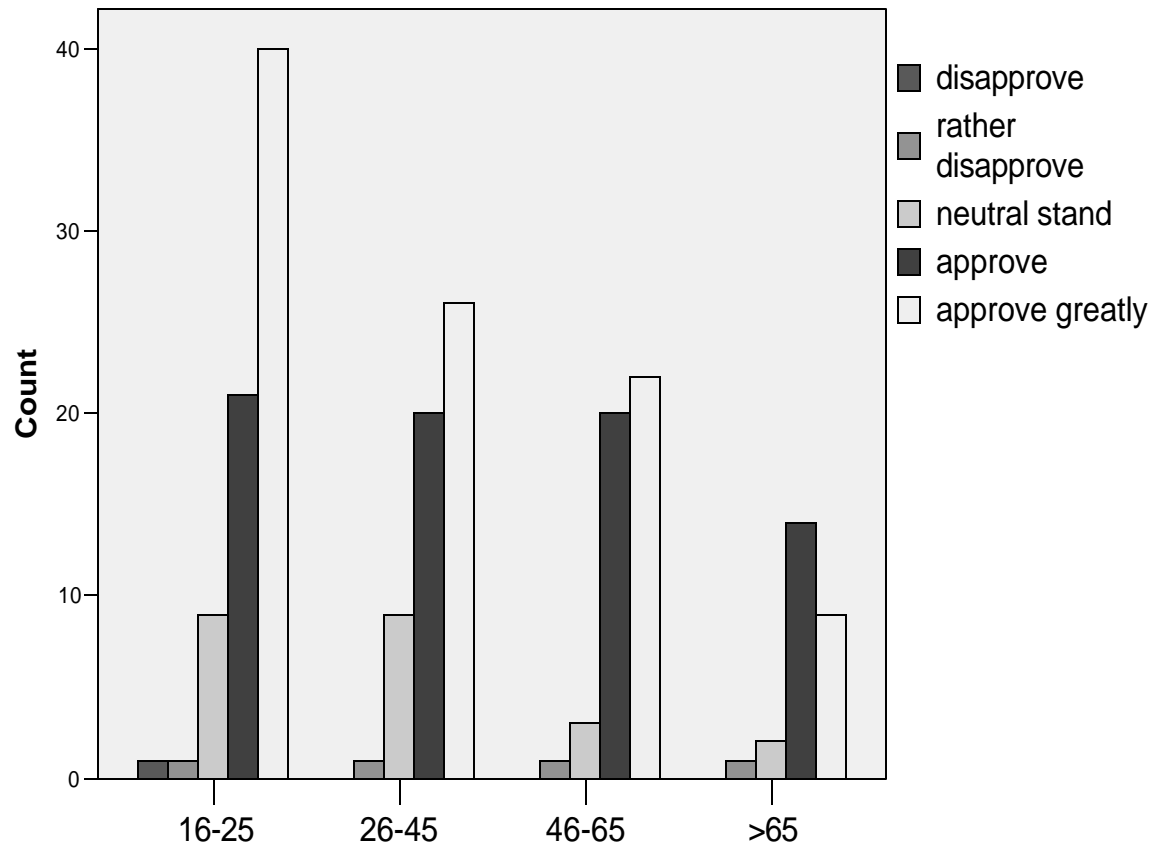
# The ECTOS project

## 2001-2005 (ended August 31<sup>st</sup>)

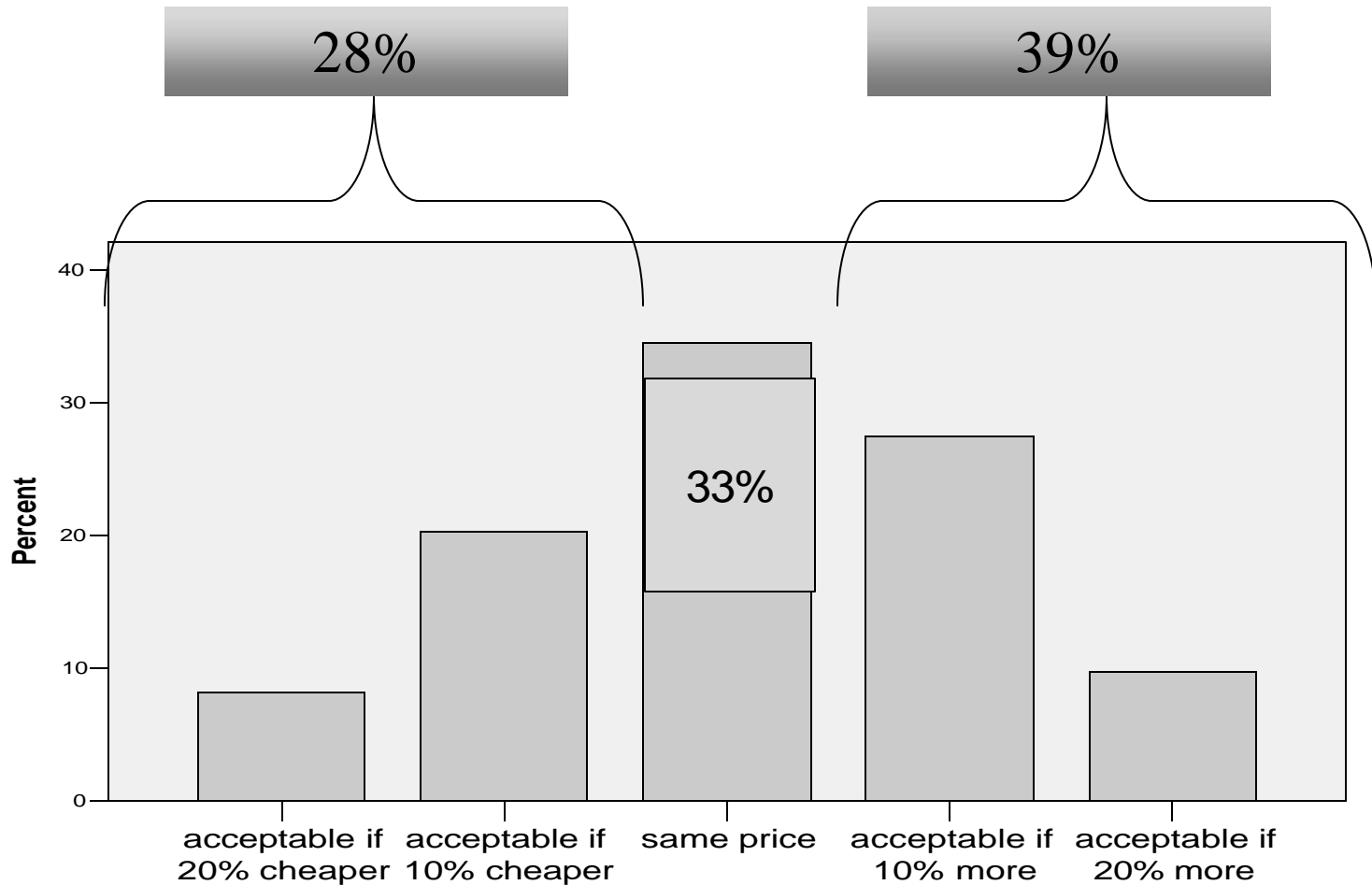
- The ECTOS-project was a 4 year project
- The project can be split into two key phases:
  - The first two years
    - Preparation, establishing infrastructure, maintenance facility, economic/social research, etc.
  - The second two years
    - The actual demonstration of infrastructure and 3 fuel cell buses
  - Has been prolonged until end of 2006; HyFleet:CUTE



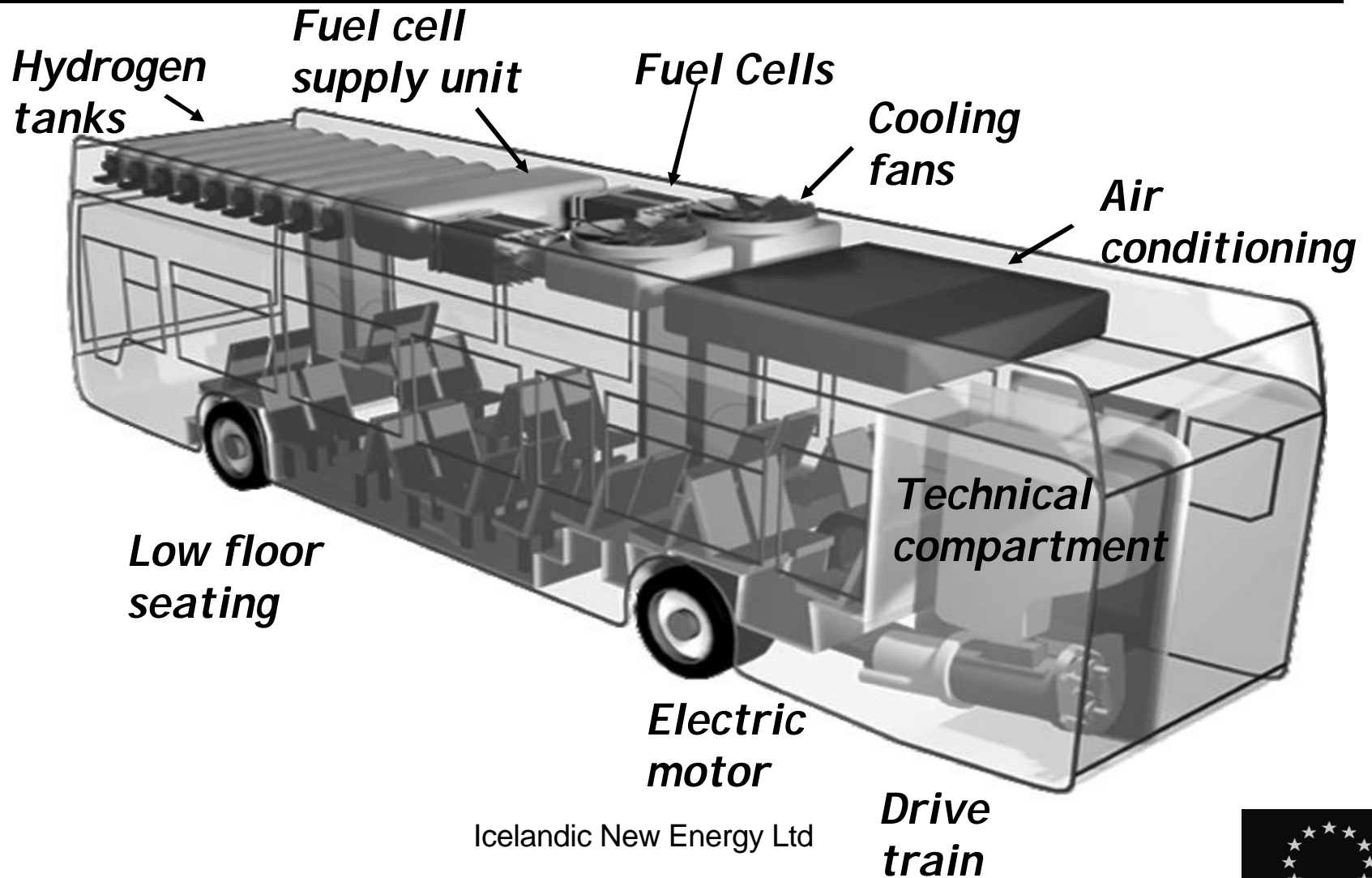
# What is your reaction to the idea that hydrogen should replace oil as the main fuel for buses, cars and vessels?



# Presumably hydrogen will be more expensive as a fuel than gasoline. Which price would you accept?



# DaimlerChrysler H<sub>2</sub> bus layout



# Global bus trial: clean and quiet urban transport

## ECTOS

- Icelandic New Energy
- EU
- Shell,
- NorskHydro
- DC/EvoBus
- and many more



Reykjavik

3 H<sub>2</sub> buses

## CUTE

- 9 Public transportation agencies
- BP, Shell, ...
- DC/EvoBus
- and many more



27 H<sub>2</sub> buses

## STEP

- Western Australian Government
- BP, BOC
- Path Transit
- DC/EvoBus
- and many more



3 H<sub>2</sub> buses

## Beijing

### FC Trial (from 9/05)

- CICETE/MOST
- UNDP
- BP
- DC/EvoBus
- and many more



3 H<sub>2</sub> buses

- Each city is operating three Mercedes-Benz Fuel Cell Citaro
- Each city is operating its own hydrogen refuelling station, some with its own hydrogen production facility



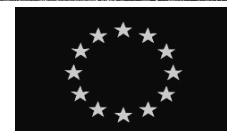
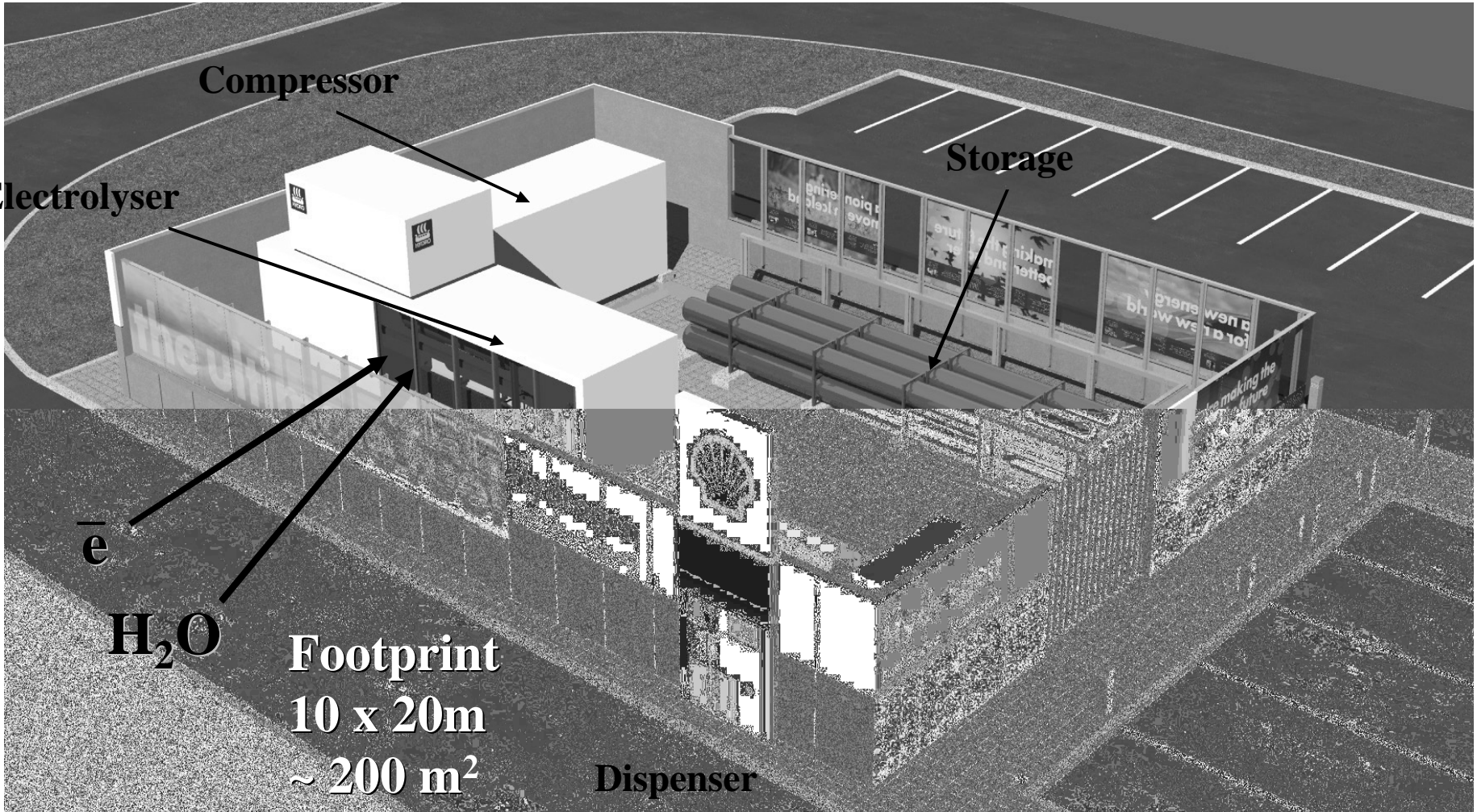
# Hydrogen station

*First station in the world operating at a  
conventional gasoline station (has full commercial license)*





# The ECTOS-hydrogen station, An example of pre-commercial filling station



# Learning

- New material development
- Underground storage has been approved
- Higher efficiency
- Smaller footprint
- Technological maturity - closer to commercialisation



# The future hydrogen infrastructure

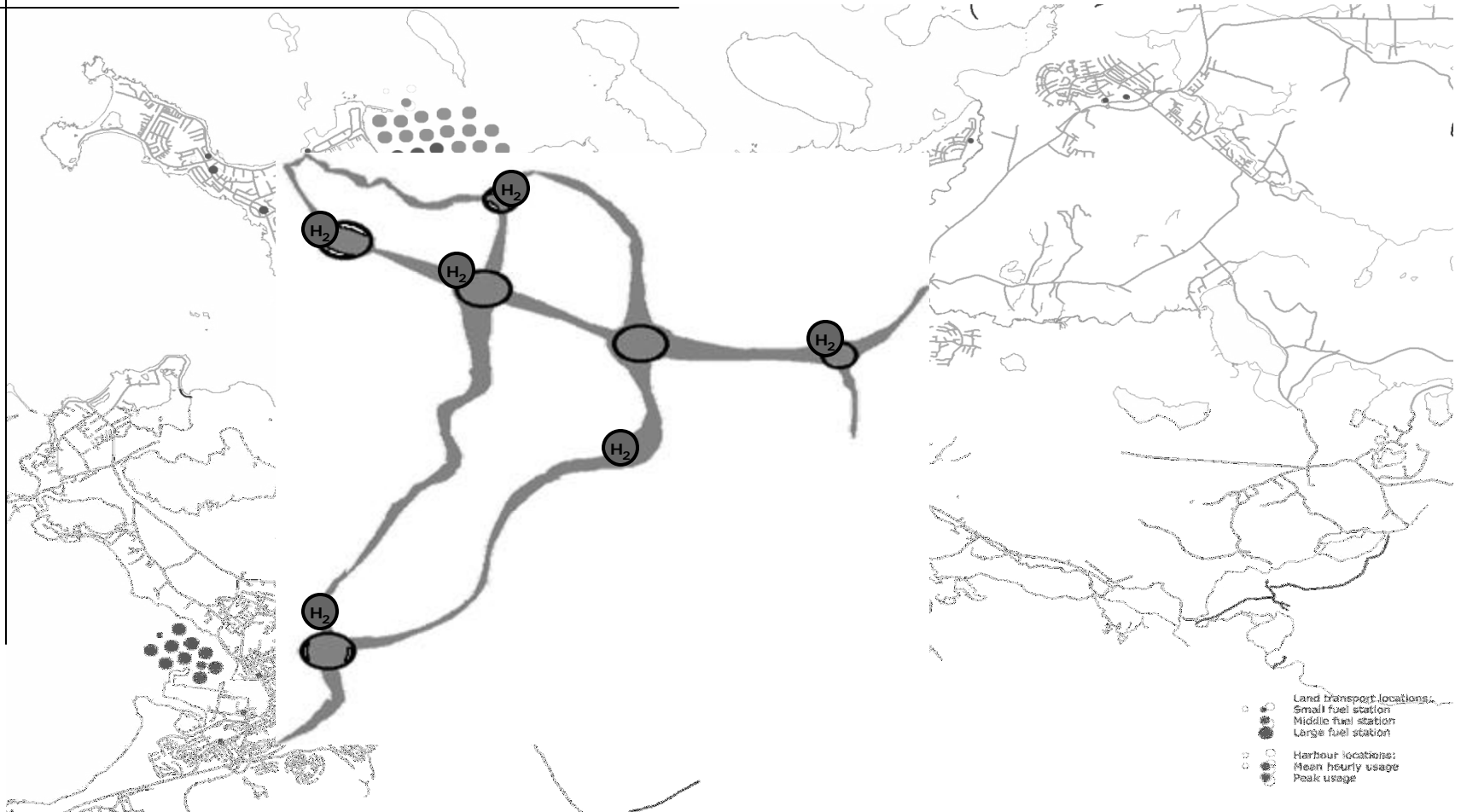
- Evaluating the future economic- and social implications of a full scale H<sub>2</sub> infrastructure
- Optimisation of H<sub>2</sub> filling stations
  - Production capacity vs. storage
  - Production capacity vs. electric prices (off peak power)
  - Regional planning (size of future infrastructure, footprint)
- National impact (cost-benefit)
  - Foreign currency savings (no imports of fuel)
  - Domestic energy
  - Independence (incentives - taxation - other)
  - Energy security



# Iceland

## First hub for infrastructure

“mini-network”



# Iceland

## First hub for infrastructure

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### “mini-network”

- Ring road is only 1400 km
- So by creating a “customer accepted infrastructure for the whole island, reaching up to 90% of the population on daily bases would require 10 more stations
  - Estimated cost of around 20-30 million € / \$



# On a H<sub>2</sub> tri-cycle around Iceland (*hydrogen puffin*)

It took a  
Japanese team  
only 2 weeks  
to go on this  
cycle around  
whole of  
Iceland



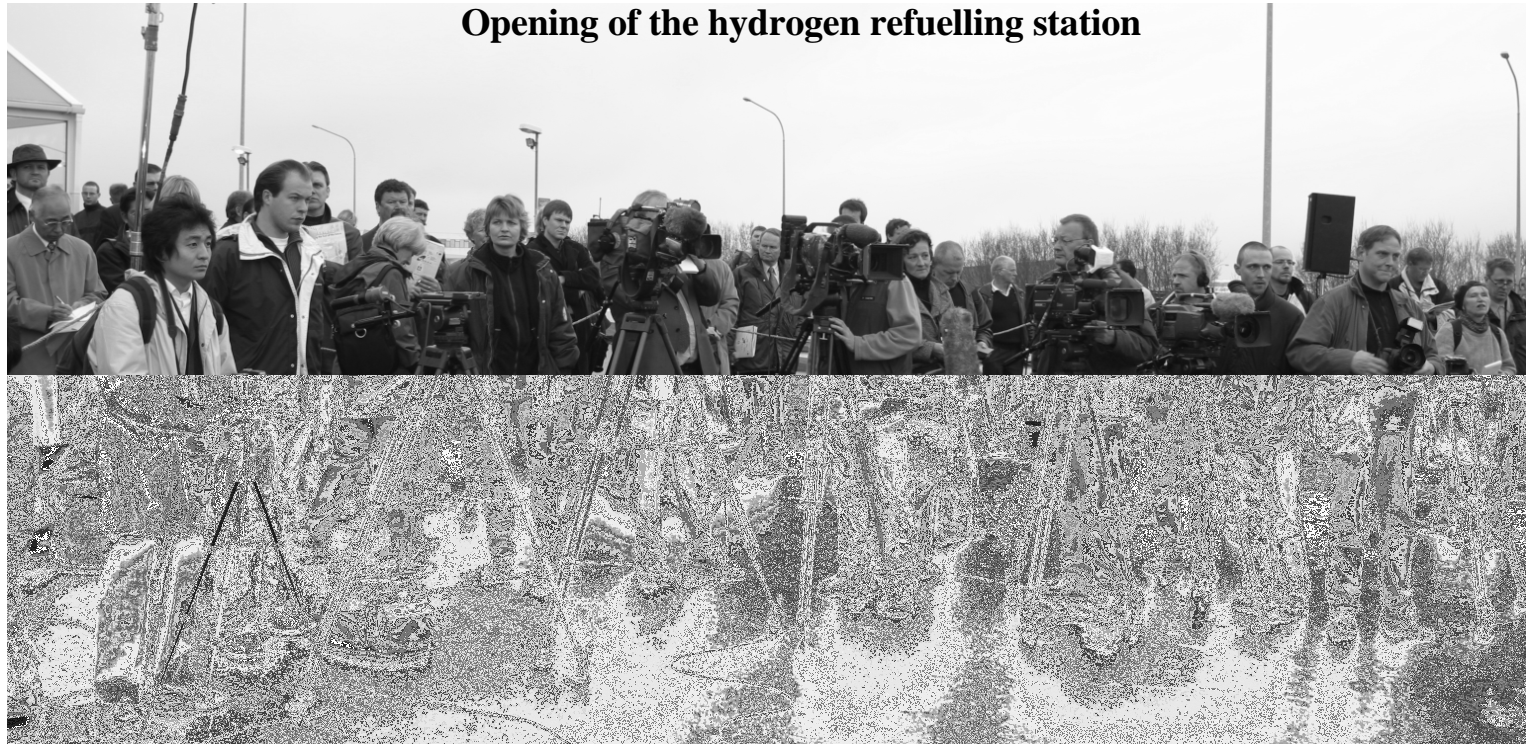
# The Icelandic accomplishment to date

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- Results are very promising
- Operation (as of February 2006)
  - >100.000 km to date
  - >6.200 operating hours
- Pumped >19.000 kg of hydrogen
- Saved over >70.000 l. of diesel / and close to 200 tons less greenhouse gas emissions
- Indication that there is over 90% of the public positive towards the new fuel



# Dissemination - Iceland



More than 400 media visits

~3000 visitors

Number of documentaries (10)

>20 study groups








# Dissemination - Iceland



**Presidents (Germany, India, Czech Republic)  
Ministers (>20), Senators & MPs (>50), Ambassadors, etc.**

# Current project (key activities)

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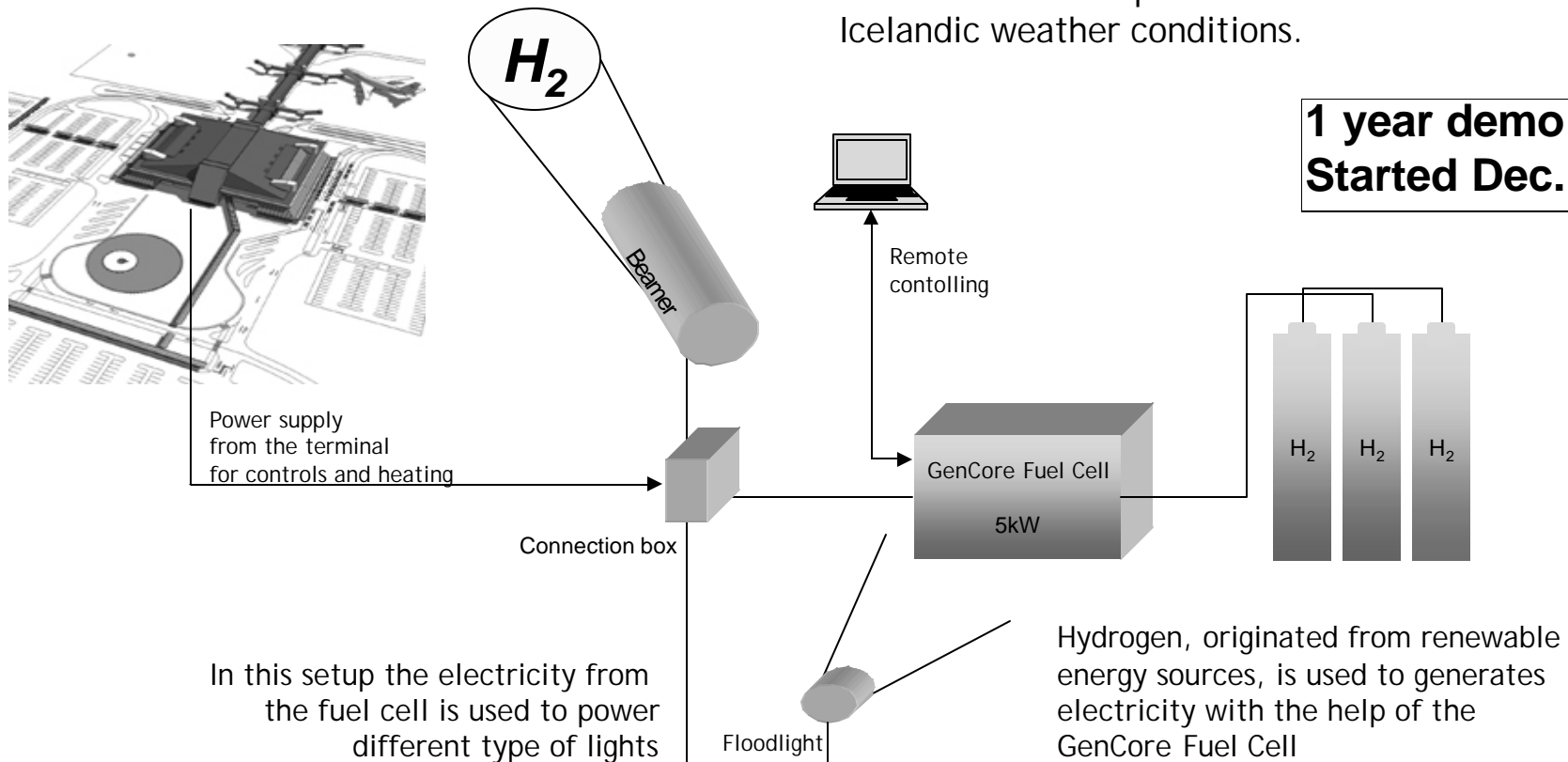
- ECTOS - bus & infrastructure demonstration 
  - Preparation underway to extend for 1 year (HyFleetCUTE)
- EURO-HYPORT - education, infrastructure and export of H<sub>2</sub> 
- Storage of H<sub>2</sub>
- Geothermal hydrogen
- Hydrogen passenger vehicles (ICEH<sub>2</sub> &/or FC)
- Market assessment of small fuel cells
  - Stationary application (trial at Keflavik airport)
- Social acceptance - Economics ((external) cost benefit, (NEEDS)) 
- Marine interest (NEW-H-SHIP) 
- Hydrogen Energy Technology Center (in preparation)
- Infrastructure, etc. (HyApproval) 
- Consultancy
- Education

**Red = finished projects**

# Keflavik airport US<sub>e</sub> H<sub>2</sub> backup

The fuel cell will operate outside in the various Icelandic weather conditions.

**1 year demo  
Started Dec. 05**



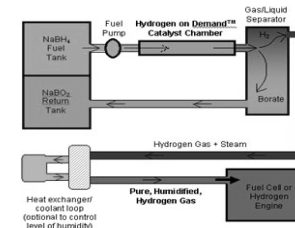
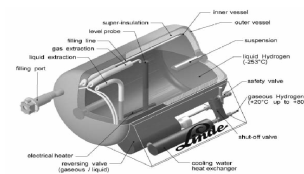
# H<sub>2</sub> vehicles

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- Vehicles are missing, (cost of vehicles)
  - No infrastructure before vehicles etc.
- Serial produced vehicles are not on the horizon until after 2010, at least if they are fuel cell
- For countries with renewable energy ICEH<sub>2</sub> vehicles could be an option
- INE has been in contact with many of the vehicle manufacturers in trying to set up a project

# Hydrogen in marine application

- A few studies have been supported
  - “New-H-Ship” coordinated by INE
- Hydrogen needs a technological validation in marine environment
  - A project like the ECTOS needs to be established, i.e. a marine version
- Studies indicate that there are no technological barriers
  - Needs stronger political support
    - Norway, Iceland, Germany - political support
- Emissions are a global issue not only an inner city problem



# Iceland today



**& also for  
future  
generations**

# *We make it happen*

## Iceland - the first hydrogen society!



Owners:

VistOrka

DaimlerChrysler AG

Norsk Hydro ASA

Shell Hydrogen



### *Replacing fossil fuels with hydrogen*