# News from the Hydrogen work In Iceland in times of economic crisis

Prof. Thorsteinn I. Sigfusson

IPHE meeting in Essen, May 2010

- Demonstrations and Public Awareness work by Icelandic New Energy

Jón Björn Skúlason
Leader of Icelandic New Energy Ltd.

# SMART-$H_2$ 2007-2010

**(Sustainable marine and road transport – $H_2$ in Iceland)**

- Goal:
  - Demonstration of a fleet of hydrogen cars 20-40 cars
    - Various engine types and from different vehicle producers
  - Demonstration of an auxiliary boat engine
  - Testing of infrastructure for different users and increasing the availability of hydrogen within Reykjavik/Iceland
  - Various research element – follow-up from the bus demo (including hydrogen FC, battery vehicles, plug-ins, etc.)
    - Social studies
    - Environmental studies
    - Economic studies

# Different vehicles

- 150.000 km
total in the project



# Different vehicles (cont.)

Hydrogen
Fuel Cell
Plug-in


Ford Edge being refuelled in Iceland

# Testing durability and social acceptance


In January 2010, 10 used Ford Focus Fuel Cell vehicles was added to our fleet.

These are rented out, measured for fuel efficency and social acceptance and their performance reported to Ford.

Their endurance is under the microscope.

# SMART-$H_2$ - Research

- Technical assessment of different vehicles and technologies
- Follow up on all the research done in the bus demo – focusing on the three pillars of sustainability
  - Social
  - Environment
  - Economics
- Continue the validation of the hydrogen infrastructure – station only 5 years in operation
  - There is a need to validate lifetime and reliability of the infrastructure

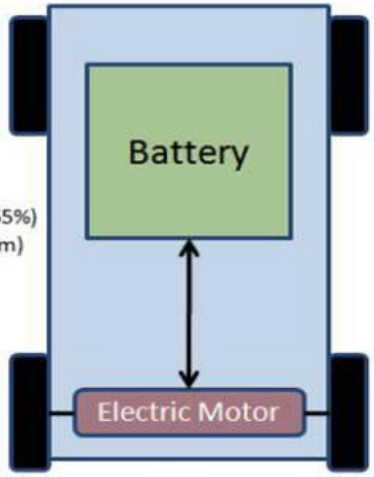
# SMART-$H_2$ - Research

- Example of technical research (done by VistOrka)
- The team has added engine heaters to the Toyota Prius retrofitted vehicle
- The first 3 months of 2008 were very cold (all three months are lower than the average)
  - Jan average -0,2˚C
  - Feb average -0,2˚C
  - March average +0,8˚C
- Without engine heater ~1,762 kg/100km
- With engine heater ~1,484 kg/100km
  - 15,8% less fuel consumption
- Other problems also reduced
  - Less water in the oil
  - Less problems with batteries, spark plugs and coils

# Comparison

Electric Vehicle

EV
Pros : High efficiency (55-65%)
Cons: Low Range (60-160km)
Price : Medium high




•Large Battery

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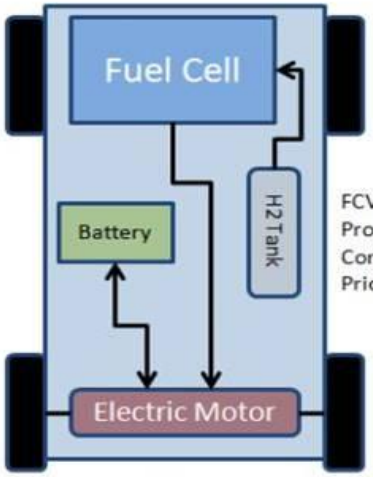


Hydrogen Fuel Cell Vehicle

FCV
Pros : Good Range (300-700km)
Cons: Medium efficiency (25-26%)
Price : High

•Small Battery
•Large Fuel Cell

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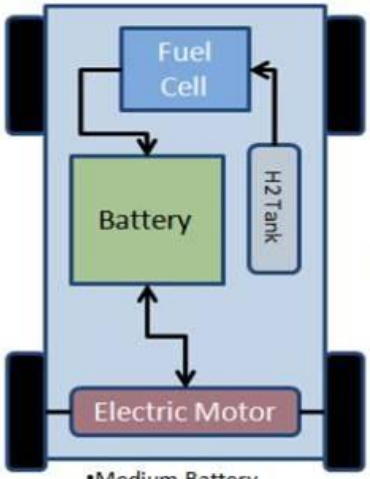


•Medium Battery
•Medium-small Fuel Cell

Hydrogen Hybrid Electric Vehicle (HHEV)

HHEV
Pros : Good Efficiency (30-40%)
Good Range
Cons: None
Price : Medium high

Example: Ford Edge Hy-Series

# Hybrid electric transport satisfy…

*…the need for long operation range & energy efficient drive*

| | Batteries | Hybrid |
|---|---|---|
| *Drive system weight/km* | 1 – 1,5 kg | <0,7 kg |
| *Weight at 400 km* | 400-600 kg | <280 kg |
| *Refuelling time* | Several hours | < 5 min. |
| *Energy efficiency* | >85% | <70% |
| *Drive system weight/km* | 1,5 – 2 kg | <0,7 kg |
| *Weight at 600 km* | 900-1200 kg | <420 kg |
| *Refuelling time* | Several hours | < 5 min. |
| *Energy efficiency* | >85% | <60% |

*Small size car*

*Full size car*

# General know-how

- The public generally understands that a new energy paradigm can be expected
  - People realise that there will be a transition phase – without stating time. When will the technology be fully mature
- There is a notion that domestic fuels can replace imported fuels
- Technical understanding is not very high but expectations are, specifically regarding performance
  - The public can not make distinctions between performances of different technologies f.ex. hydrogen, battery, plug-ins, etc.
  - The general public wants electric mobility and expects that such mobility will provide the same comfort level as the current gasoline vehicles
  - This could affect the acceptance of EV´s as people might become disappointed "range, recharging time, etc."

# The boat

- Based in Reykjavik, the **Elding**, is a 125-ton, well equipped cruiser with a capacity of 150 passengers.
  - Whale watching
- The Elding is a safe and extremely stable ship, originally built in Iceland as a rescue ship
- H2 FC hybrid system provides now all the auxiliary power max 15 kW (main engine still diesel)

# Scandinavian cooperation

- Iceland now proudly present the largest $H_2$ vehicle fleet in Europe, Norway has the 3rd largest fleet
- HyNor and INE have a MoU – information exchange
- Network projects between all Scandinavian countries
  - North Atlantic Hydrogen Association (NAHA)
  - Scandinavian Hydrogen Highway Partnership (SHHP)
- Joint approach
  - Vehicle manufacturers
  - Potential customers
- Jointly we seek more partners for our RD&D projects

# Prepare-$H_2$

- Icelandic New Energy will manage an EC –JTI project on cross-cutting non technical assessment for future lighthouse projects.
- Partners: Icelandic, German, Norwegian, Danish & Italian
- Goal is to recommend social and economic assessment frameworks for future $H_2$ lighthouse projects within EU
- Methodology in Prepar-$H_2$ is interviews with those who have experience on all levels of running a hydrogen fuel chain
- Identify pros & cons in social and economic aspects within projects that have been funded on national basis and expand on experience

ÍSLENSK NÝORKA ehf
ICELANDIC NEW ENERGY Ltd.

# SMART-$H_2$ - Dissemination

- Total 27 $H_2$ cars have been tested in Iceland (22 today in service)
- First marine operation started on a commercial boat in 2008
- The goal is to increase the no. of $H_2$ vehicles from 2009 onwards

High level US guests at INE

# SMART-$H_2$ - Dissemination

- There have been more than 5.000 visitors to the company over the last 5 years, very difficult to accompany so many visitors for a SME.
- Companies attention is very high >500 int. media visits since 2003


Opening of the hydrogen refuelling station

# Icelandic New Energy makes it happen

# Hydrogen Education

Prof.David Dvorak
University of Maine
Dean of H-FC

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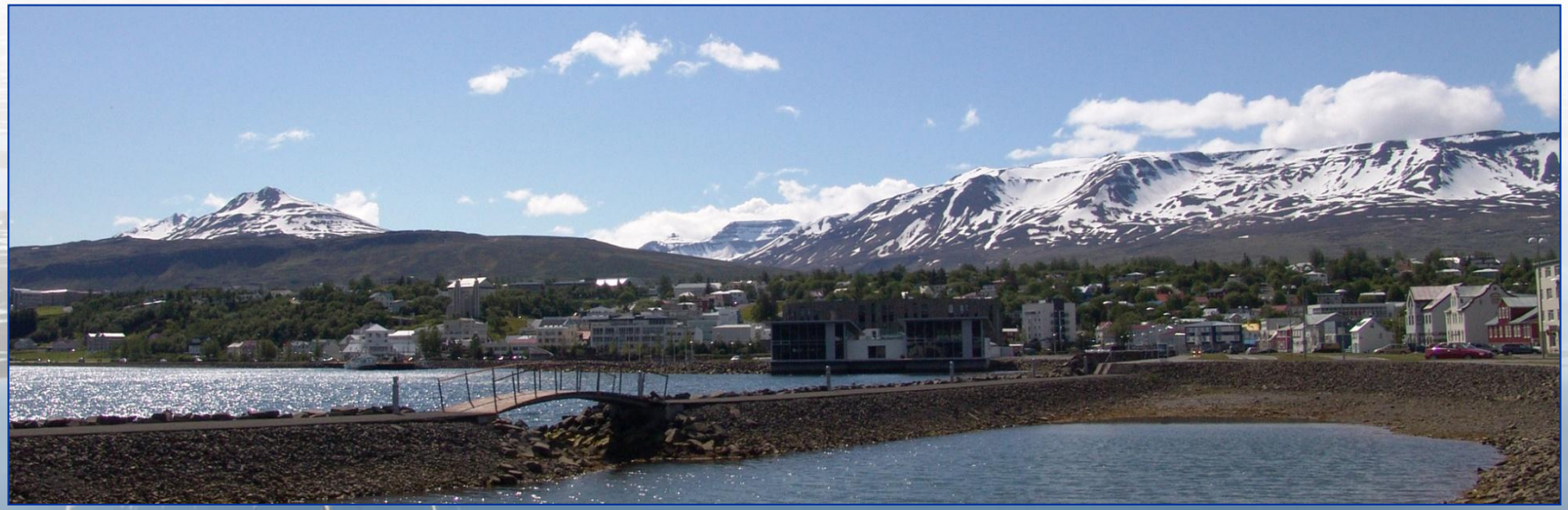
SKÓLI *á sviði* ENDURNÝJANLEGRA ORKUGJAFA



# RES Graduate Program:
# Fuel Cell Systems and Hydrogen

- FC601 Electrochemistry of Fuel Cells (3 wks)
- FC602 Fuel Cell Systems and Technologies (3 wks)
- FC603 Hydrogen Production (2 wks)
- FC604 Hydrogen Storage (2 wks)
- FC605 Fuel Cells in Transportation (2 wks)
- FC606 Stationary and Mobile Fuel Cell Systems (2 wks)
- FC607 Policies and Future R&D of FC Technology (1 wk)

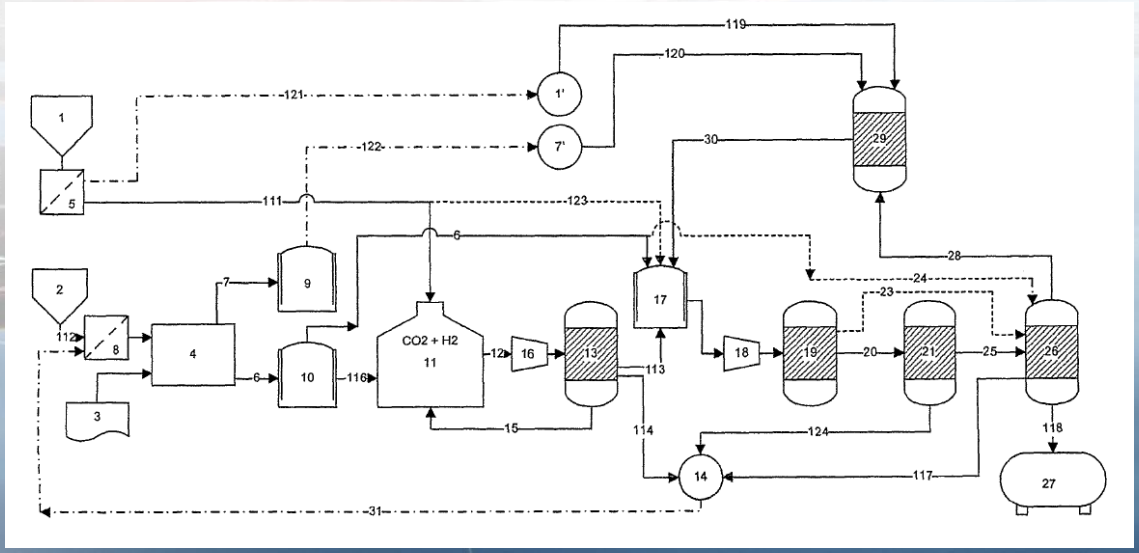
# FC602 Fuel Cell Systems and Technologies

- Dr. S. David Dvorak
  Professor at University of Maine
  School of Engineering Technology
  Orono, Maine, United States

- Dr. Denise McKay
  Assistant Professor of Engineering Science
  Smith College
  Massachusetts, United States

# Student Profile: Mateusz Kluska

- Thesis topic: Methanol production pathways and feasibility in Iceland.
- Project advisors: Thorsteinn Sigfusson, David Dvorak, Ingolfur Thorbjörnsson (Managing Director in Innovation Centre), KC Tran (CEO CRI), Kiran Kumar (Engineering Manager in CRI).



# Testing the 1200 W Ballard / Nexa Fuel Cell System, Keflavik

# Fuel Cell Students using Matlab with Dr. Denise McKay (Smith College)

# RES FCS&H2 Graduate Students, 2008: At the Icelandic Innovation Center with Dr. Thorsteinn Ingi Sigfusson

Thanks to Jón Björn Skúlason and David Dvorak for providing materials for this Exclusive IPHE presentation

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