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Lighthouse Project for the Demonstration of Hydrogen Fuel Cell Vehicles and Refuelling Infrastructure in Scandinavia
Grant agreement number 245101

Dr. Ulrich Bünger
Ludwig-Bölkow-Systemtechnik GmbH

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0. Project & Partnership description

European Lighthouse Project for the Demonstration of Hydrogen Fuel Cell Vehicles and Refuelling Infrastructure in Scandinavia
01/2010 – 12/2012

Total budget	Funding
19.5 M€	**EU:** 7.5 M€ **NO:** 1.5 M€ **DK:** 0.55 M€

Coordination	Vehicles and Infrastructure	Communication	Safety	Funding
ludwig bölkow systemtechnik Ulrich Bünger Sofia Capito Jan Zerhusen	DAIMLER Ronald Grasman Teresa Fickler	Hydrogen Sweden Sven Wolf Martin Svensson Christine Apelgren Jöran Fagerlund	TÜV SÜD Tom Elliger Tim Faber	New Energy World JU fuel cells & hydrogen for sustainability
	HYUNDAI Sae Hoon Kim Hans-Ulrich Goebel Soon Gil Kweon	Hydrogen Link Flemming Wennike	SP Technical Research Institute of Sweden Thomas Berg, Peter Bremer	transnova EUDP
	H2 Logic Jacob Krogsgaard Mikael Sloth			**Local Partner**
	SINTEF Steffen Møller-Holst Magnus Kårpås Federico Zenith			Henning Larsen

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1. Achievements overview

Market preparation for Fuel Cell Electric Vehicles (FCEVs)

1. Demonstrating performance of latest fuel cell technology

- 19 FCEVs:
  17 in Oslo (Norway), 2 in Denmark
- 1 Hydrogen Refuelling Station (HRS), Oslo (Norway)
- 1 moveable HRS, EU Road Tour
- Detailed performance reporting

2. Gaining Customer Acceptance

- HRS opening, 11/2012, Oslo
- Daily operation in Oslo (Norway) and Denmark
- Public test drives in Norway:
  - 11/2011, Oslo
  - 04/2012, Trondheim
- EU Hydrogen Road Tour, 9-10/2012

3. Establishing partnership amongst stakeholders

4. Build up of hydrogen infrastructure

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1. FCEVs in daily operation since 11/2011

	Mercedes B-Class F-CELL 	Hyundai ix35 	Retrofitted TH!NK with FC range extender
Number of cars in H2mS	10	4	5
Drivetrain power [kW]	100	100	FC: 25
Driving range (NEDC) [km]	380	525	250
Hydrogen storage capacity [kg]	3.7*	5.6*	1.5
Energy efficiency [ltr_{GE}/100 km]	3.3	3.7	n.a.
Maximum speed [km/h]	170	160	100
Acceleration [sec]	0 - 100km/h: 11.4	0 - 100km/h: 14.1	0 - 80km/h: 16
Payload [passengers]	4	5	2

* about 1kg_{H2}/100 km

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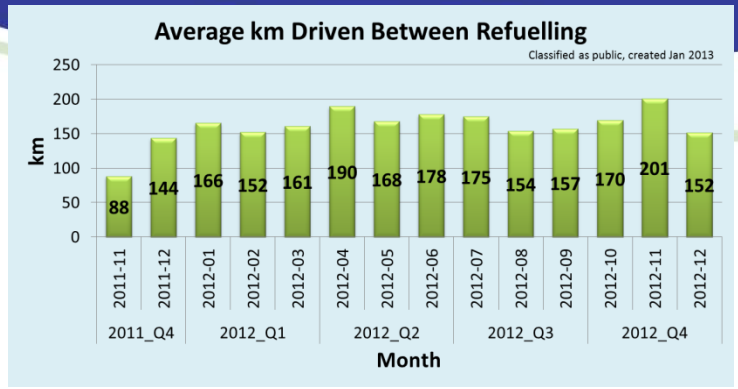
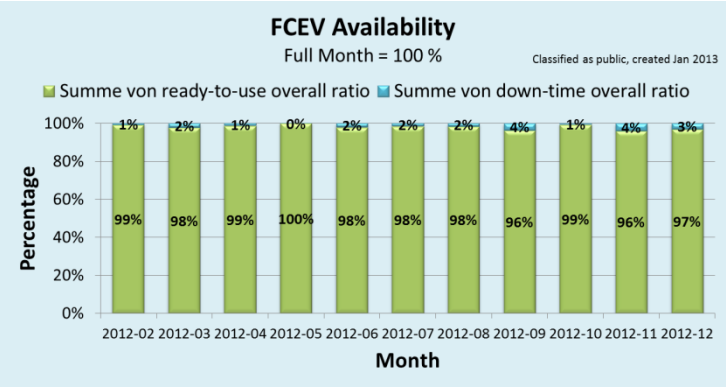
1. FCEV and HRS demonstration results

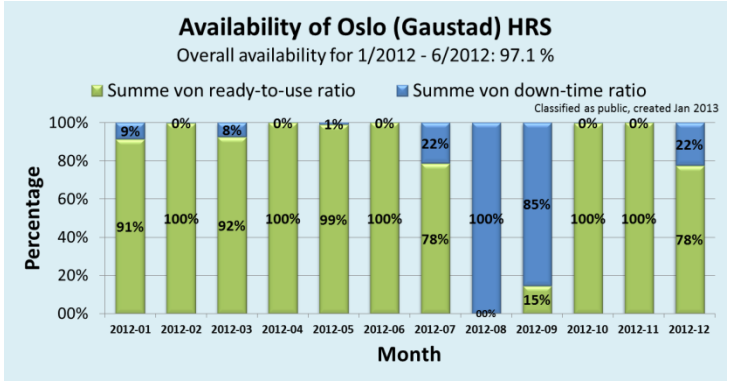
FCEVs drove around the world more than five times. Savings of about 24.5 tons CO2 equivalent.



Decreasing range anxiety:
128 km ➔ 160 - 180 km



Excellent performance: 98% overall availability.



Downtime due to compressor failure. Overall 79 % availability between 1.1.2012 – 31.12.2012.

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1. Public events to gain customer acceptance

Oslo Launch Event (21 NOV 2011)

Photo: Jöran Fagerlund, H2S

Photo: Jöran Fagerlund, H2S

- Live broadcasting on 2 largest Norwegian TV channels
- 85 press quotations worldwide

Public Test Drives: Oslo+Trondheim

Steffen Møller-Holst, SINTEF

Photo: Svein Tønseth, SINTEF

- 290 passengers
- Reach out to 15,000 people on the streets

Distance record on one refuelling in Norway (504 km with one tank)

Oslo – Monte Carlo Drive
2 cars, 2,260 km
(18-25 APR 2012)

Denmark leg of Giro d'Italia (4 MAY 2012)

"The FCEV exceeded my expectations – especially the silence and instantly available torque."

Photo: Jöran Fagerlund, H2S

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1. EU Road Tour to gain customer acceptance

- 4 weeks
- 9 cities
- 9 seminars
- 8 public test drives

Our Messages:

- Experience FCEVs yourself: fun to drive
- Technology is about to be mature for mass production
- Mitigation of emissions and noise at additional comfort
- Reliable & standardised infrastructure needs to be build up

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1. European Hydrogen Road Tour 2012

	Hamburg	Hannover	Bolzano	Paris	Cardiff	Bristol	Swindon	London	Copenhagen	Total
Workshop	X	X	X		X	X	X	X	X	8
Participants:										
VIP event	40	80	140	40	50	20	50	50	140	610
Public event	130	-	900	850	100	-	150	200	110	2440
Total	170	80	1040	890	150	20	200	250	250	3050
Panel discussion	X	X	X	X	X		X	X		7
VIP testdrive	X	X	X	X	X	X	X	X	X	9
Testdrive	X	X	X	X	X	X	X	X	X	9
Ride &Drive:										
Drivers	59	39	312	112	21	18	29	48	82	720
Riders	60	30	300	74	14	10	20	46	26	580
Total	119	69	612	186	35	28	49	92	108	1300
Refuelling*	HRS	MHRS		MHRS			HRS		MHRS	
Press event		X	X	X	X	X	X	X	X	8
H2mS presentation	X	X	X	X	X	X	X	X	X	9
Video	X	X	X	X	X	X	X	X	X	9
Other			Dolomite Rally	Invisible car					MoU	

8 workshops with 3,050 participants

7 panel discussions

9 test drives with 1,300 drivers

8 press events

9 presentations

9 videos

* HRS – stationary hydrogen refuelling station, MHRS – moveable hydrogen refuelling station (H2 Logic: Hannover, Copenhagen, Air Liquide: Paris)

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1. Alignment to MAIP/AIP

- **Targets Application Area "AA1 - Transportation and Infrastructure":**
  - **2010:** ~10 additional road vehicles (single site) plus mobile deployment to sites with existing refuelling infrastructure capable of refuelling up to 50 vehicles
  - **2015:** ~ 500 LDVs (mainly cars) at 3 additional sites with 3 new stations

- **AIP 2008 Call text:** "At least 5 vehicles shall be provided and be operational for onsite demonstration by 2010 accompanied by at least one additional fully integrated filling station capable of serving 100 vehicles (together with the existing station). "

  ➔H2mS: 17+2 FCEVs in 1(2) sites with existing hydrogen refuelling station with additional refuelling station capable of refuelling up to 50 vehicles. **Solid overperformance of H2mS!**

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1. Alignment to MAIP/AIP

- **AIP 2009 targets:**

- Total cost fuel cell system < 100 €/kW	✓	achievable in long-term
- System lifetime > 5,000 h	✓	expected this generation*
- Refuelling time < 5 min	✓	YES, <4 min achieved
- Hydrogen price at pump < 13 €/kg	✓	price: ca. 12€, cost: NO
- Demo of at least 10 vehicles at 1 demo site	✓	YES, achieved for OSL
- HRS functionality and end-user acceptance	✓	YES (WP 7)
- Certification procedures	✓	YES (WP 2)
- Regional collaboration	✓	Transnova (NO) EUDP (DK)
- Role of MSMs/SMEs	✓	through H2 Logic
- Raise public awareness (expect. mgmt.)	✓	EU Road Tour, test drives

*6,000 hrs achieved in lab under real life cycle;
demo vehicles seem to validate lab tests

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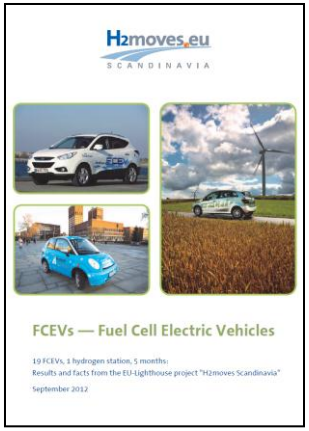
1. Gaps / bottlenecks

- Slow start, project suffered massively from difficult pioneering role (other causes were economic crises and BEV hype)
- Project negotiation too slow and bureaucratic (national processes much simpler, spec. in Scandinavia)
- Funding of service type activities unattractive (coordination/management, communication, performance reporting)

AND

- FCH JU funds were welcome and – together with national funds – helped to sustain the momentum in FC&H when losing a strategic industry partner

- Contributions to Training and Education:
  - Workshop staff from Daimler, Hyundai, and SINTEF trained
  - Pupils and students attended public seminars and events including test drives
- Contributions to RCS:
  - Assessment of state of the art of Scandinavian certification procedures for FCEVs and HRSs
- Contribution to Dissemination & public awareness:
  - European Hydrogen Road Tour 2012
  - Test drives in Oslo and Trondheim (Norway)
  - Record drive Oslo-Monaco, participation in Giro d'Italia and EcoDolomites
- Publications and presentations:
  - Zero Conference, Oslo, November 2011
  - Renewable Energy Conference RERC, Trondheim, April 2012
  - WHEC, Toronto, Juni 2012
  - 4th Austrian Hydrogen Conference, Graz, September 2012
  - Scandinavian Delegation to South Korea October 2012

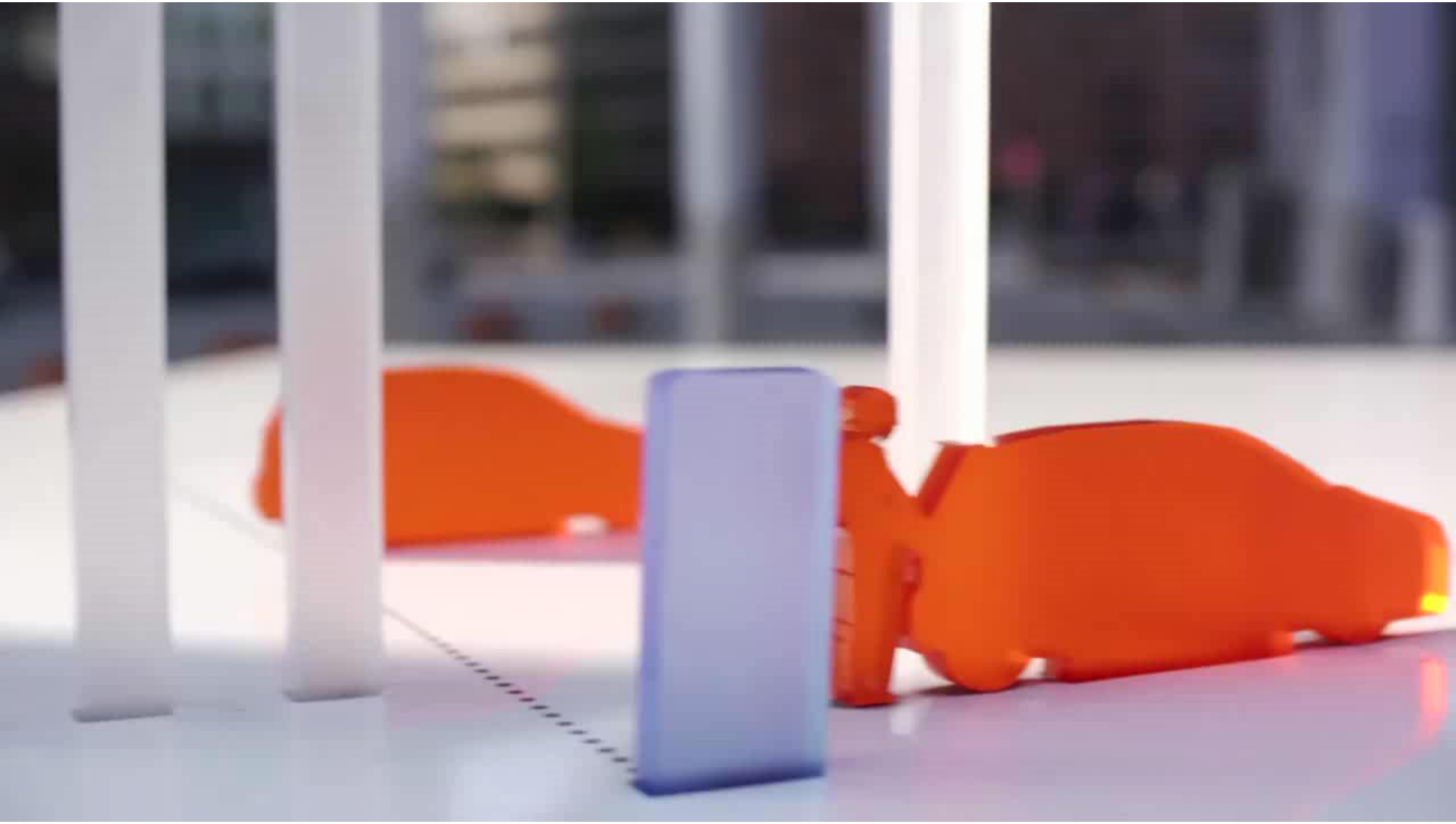


- Fuel quality assurance
  - Hydrogen quality standards for PEMFC-grade H_2 are extremely stringent
  - No laboratory in Europe can guarantee that accuracy!
  - Find easily measured "canary components" that allow inferring concentration of more difficult ones, considering information about each production method
  - **Result**: easier, cheaper and faster fuel quality assurance
- Smart hydrogen production from electrolysis
  - Electricity prices vary widely in yearly, weekly and daily cycles
  - With expansion of wind power, oscillations will grow even larger
  - **Result**: optimal strategy to produce hydrogen by electrolysis in electricity market
- Finding hydrogen stations
  - With few refuelling stations, finding them may be a problem for consumers
  - Position of mobile stations and status of fixed stations must be available
  - Most people have a mobile phone, many a smartphone with GPS
  - **Result**: smartphone apps, Web maps, and SMS service to find nearest H_2 station

- **SHHP/HyNOR:** Collaboration among Scandinavian stakeholders
- **HyTEC:** Exchange of best practice between lighthouse projects
- EU Hydrogen Road Tour
  - Joint facilitation in Hamburg (CEP) and Lower Saxony, South Tyrol (IIT), France, UK (e.g. Unni Glan, Forward Swindon, LHP), Denmark
  - Firm statements by each region visited to extend its hydrogen refuelling network
- South Korean company Hyundai is equal partner within H2moves Scandinavia
- **HyER:** Facilitation of mid-term event and public test drive in Brussels

- Vehicle demonstration phase is continuing beyond project well into 2014.
- HyOP continuing operation of Gaustad hydrogen refuelling station.
- Project has helped to keep momentum on H2&FC in Scandinavia in challenging phase (economic crisis, industry leaving, distraction by BEVs).
- Project start was bumpy for uncontrollable reasons. Yet, the project has substantially outperformed even at a reduced total budget of ≈ -25%.

- **Foster regional co-funding**
- **Simplify administrative burdens**
- **Better utilize project results :**
  - **HRS APP has been developed but finds no echo at program level**
  - **Develop instruments for better dissemination of project results after project end**
- **Network among individual demonstration projects (utilize HyLights)**



3. Useful References

- **H2moves Scandinavia** – Public Technical Performance Report http://tinyurl.com/h2mS-Report
- Official website: http://www.scandinavianhydrogen.org/h2moves
- Videos on YouTube: http://www.youtube.com/user/H2movesScandinavia
- Photos on Flickr: http://www.flickr.com/photos/h2moves_scandinavia
- Facebook: http://www.facebook.com/H2movesScandinavia