

1st International Renewable Energy Storage Conference (IRES I)
Gelsenkirchen, Oct. 30th/31st, 2006
Session IIIb ‚Electrical Storage Systems‘

The storage of wind energy: Technological and economic realisation

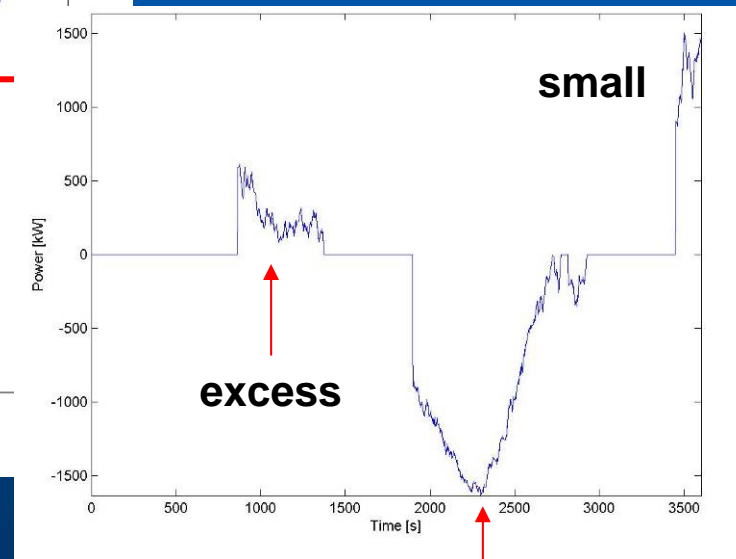
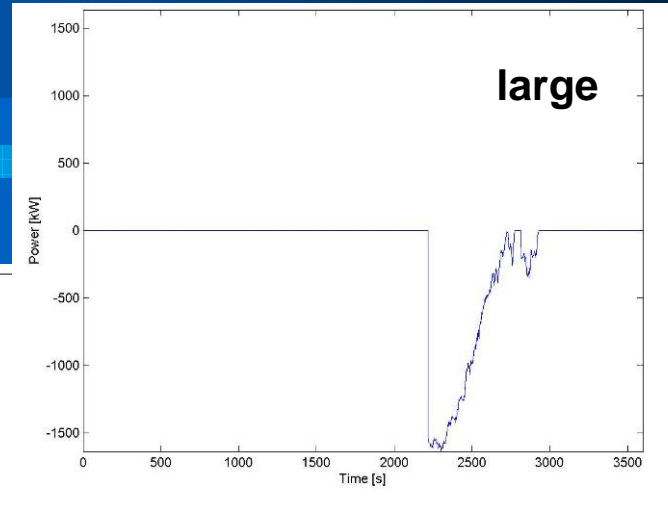
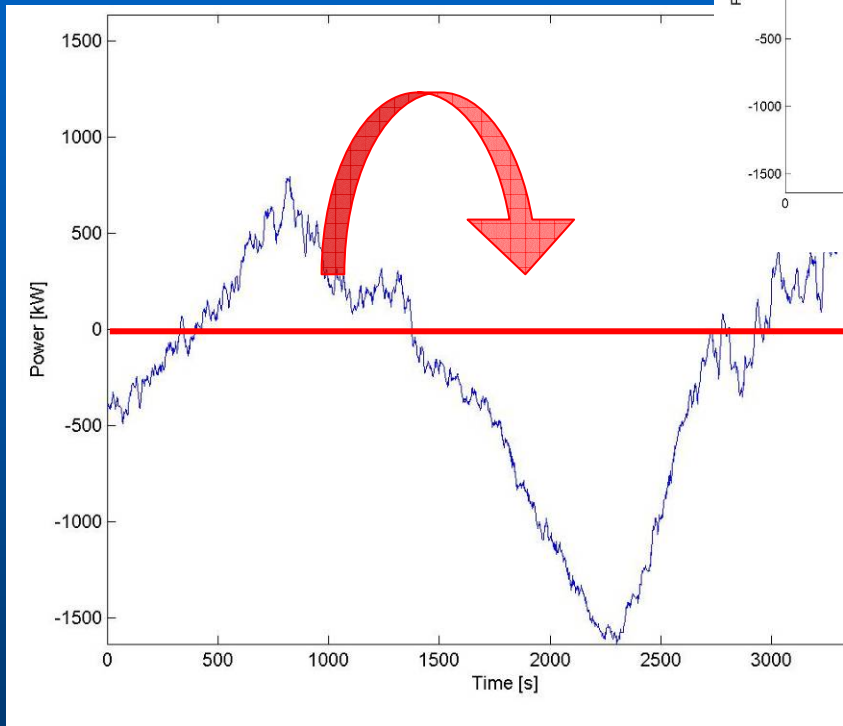


Jörg Linnemann
Dr. Robert Steinberger-Wilckens
PLANET - Planungsgruppe Energie und Technik
Oldenburg, Germany

Motivation for Renewable Energy Storage

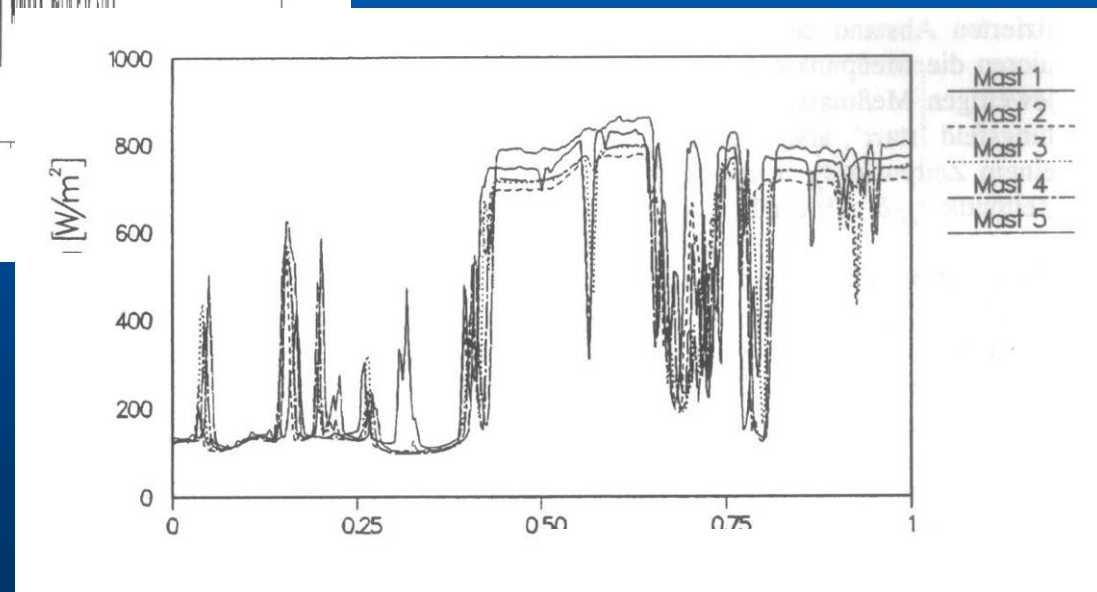
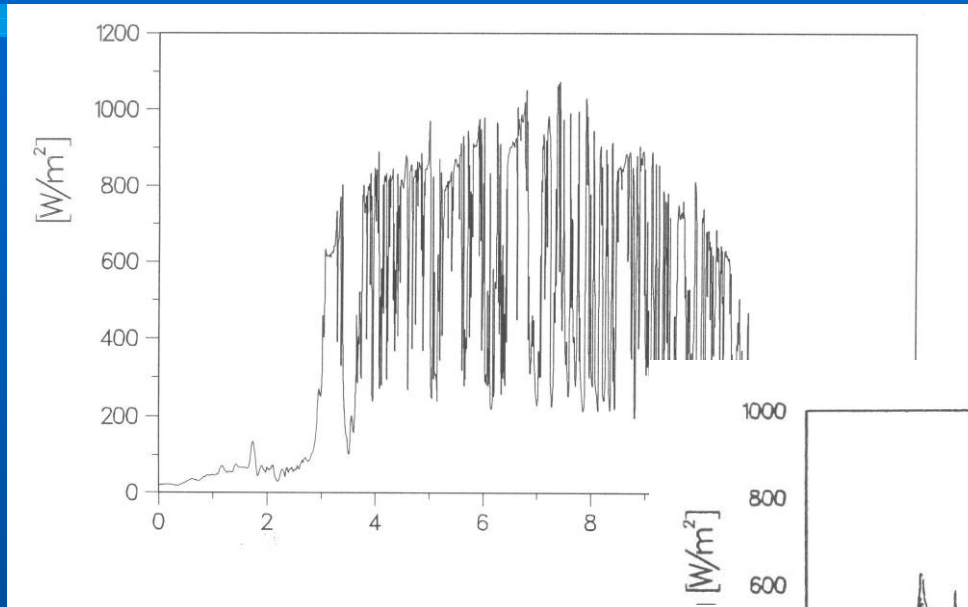
- Temporal shift of power:
 - storage for periods of low renewable production
 - storage for peak demand periods
 - Reduction of fluctuations
 - Integration of surplus/stranded production
- time-of-sale can be deliberately determined and be de-coupled from stochastic meteorological fluctuations
- 'green' power can be traded at power exchanges (e.g. EEX)

Interim Storage



loss of load

Reduction of fluctuations



solar radiation from 5 sites

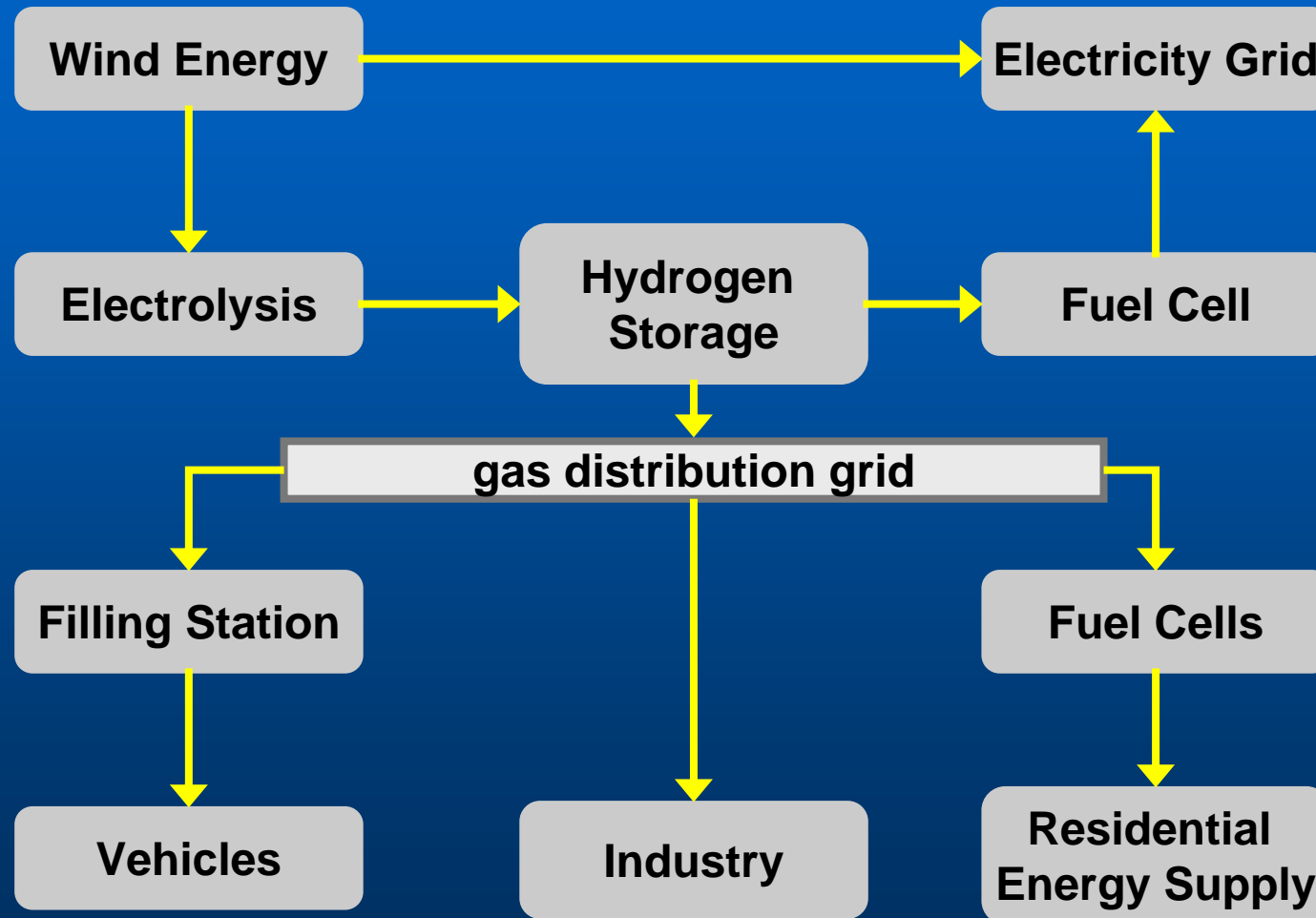
Hydrogen Advantages as Storage

- de-coupling of storage capacity from input / output power
- fast response and switch-over
- low long-term losses
- scalable to any size
- low cost of storage capacity
- alternative uses of hydrogen

disadvantages:

- high cost of total system
- low overall efficiency

Wind-Hydrogen Conversion System



Component Availability

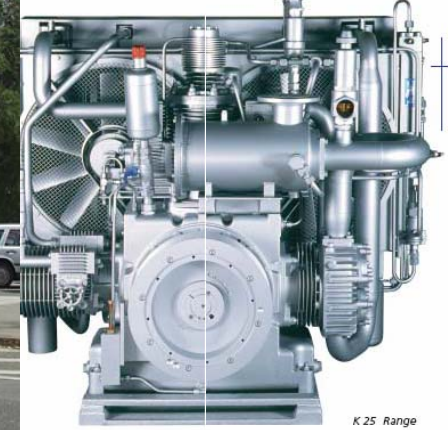


Electrolysis & hydrogen handling

- proven technology
- narrow supplier base
- improvements needed, but little market pull

Fuel cells

- suppliers & early adopters evolving
- durability issues



photographs courtesy PLANET, Bauer, NedStack, Casale

Project Example Utsira

project realised by
Norsk Hydro
and
Enercon

wind-hydrogen
power supply to
10 households



photographs courtesy Hydro

Requirements:

- well-defined base case
- cost for hydrogen & fuel cell equipment available
- energy consumption available

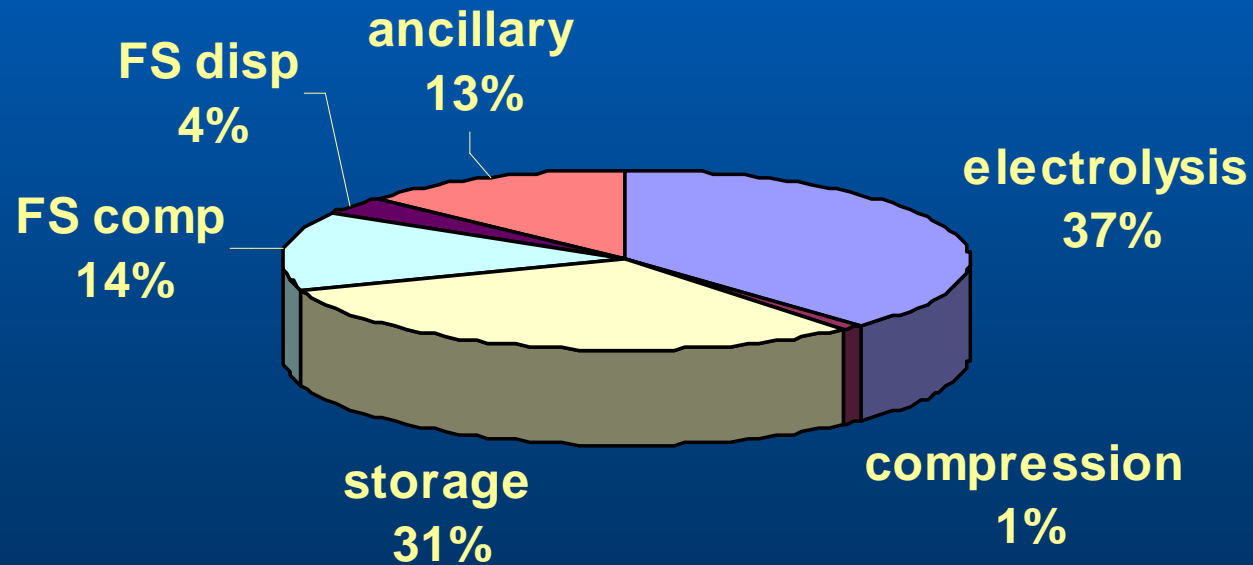
Choice:

- diesel vs. hydrogen FC vehicle (DC F-Cell)
- market and external costs available
- realistic consumption data available



Cost Breakdown Investment

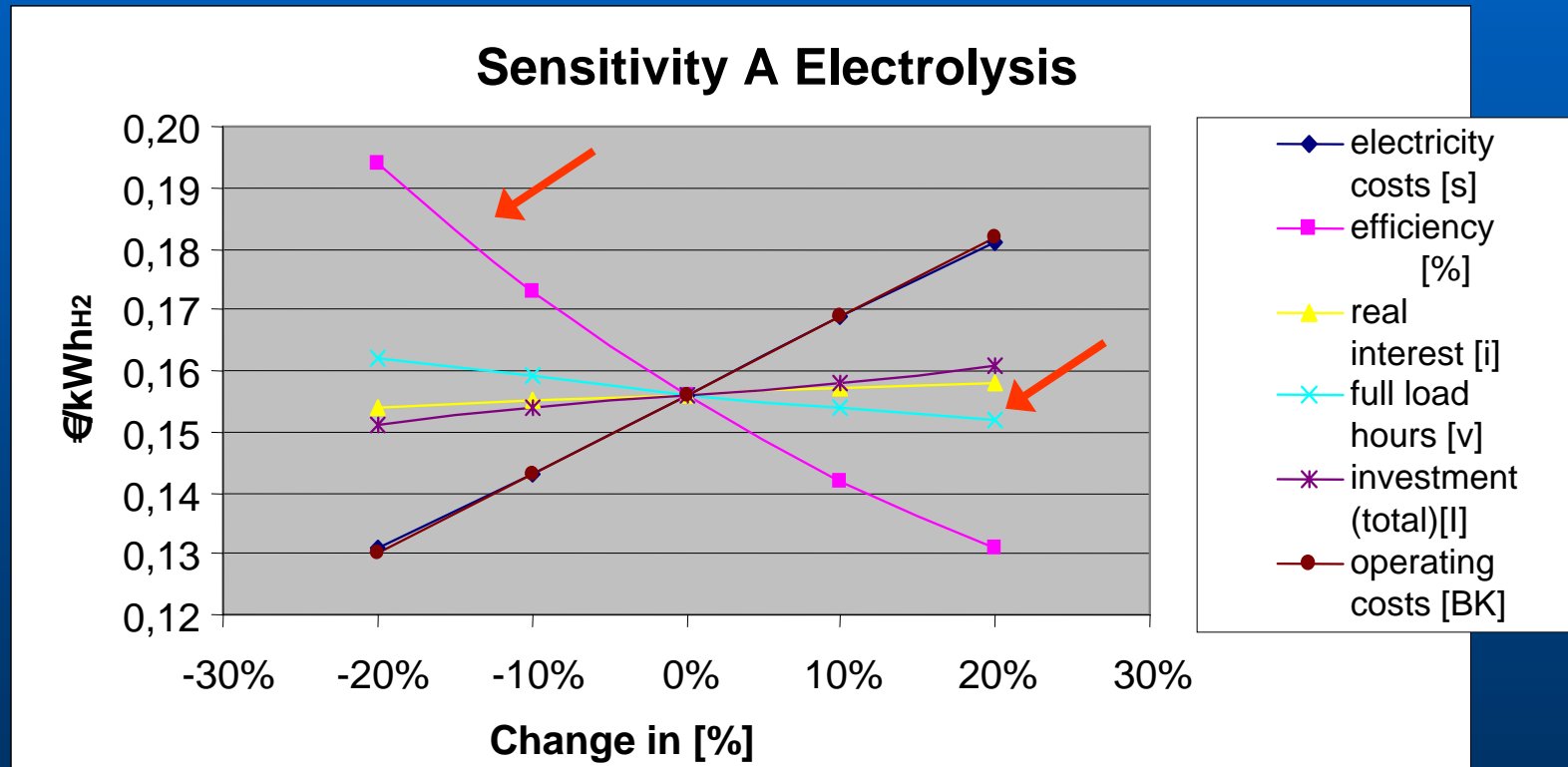
(wind-) hydrogen plant
300 MW electrolysis (60,000 Nm³/h)
520 mio.€



Cost Analysis Results

	Bulk plant 60.000 Nm ³ /h
Investment	520 Mio. €
Elektrolysis	0,156 €/kWh
Compression 150 bar	0,036 €/kWh
Pipeline 100 km	0,005 €/kWh
Compression 500 bar	0,066 €/kWh (0,107 €/kWh)
Filling station	0,027 €/kWh
Grand total	0,290 €/kWh

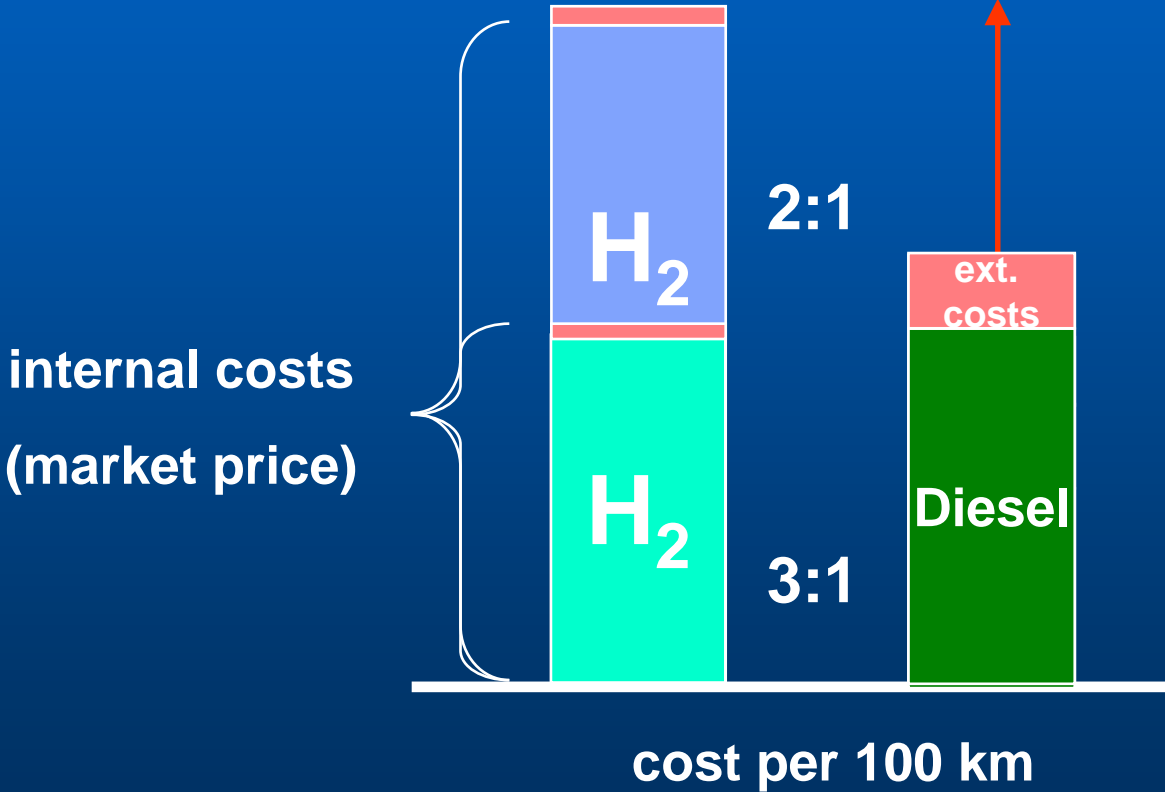
Cost Sensitivity - Bulk Production Plant



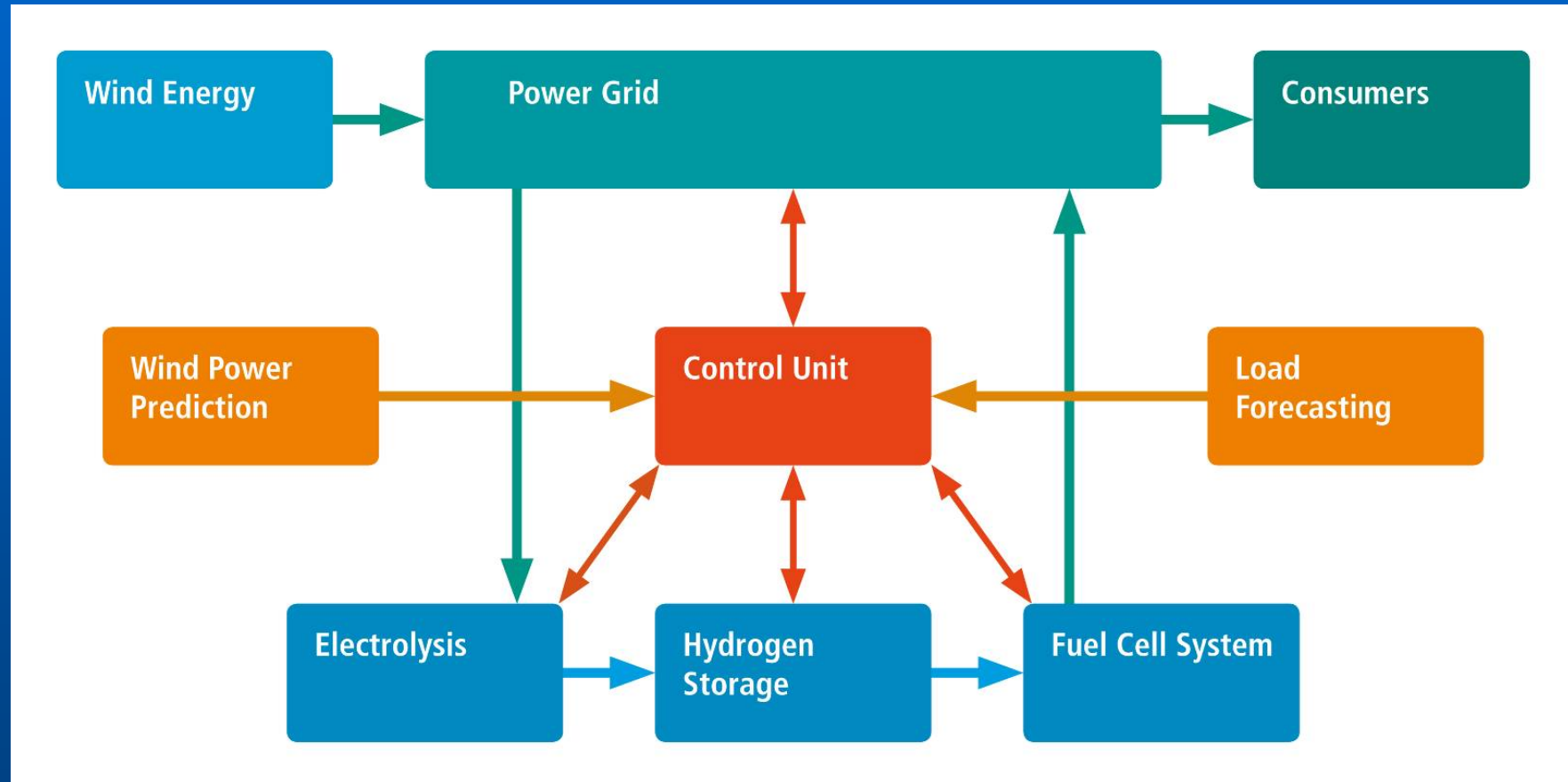
Vehicles: Internalising External Costs

	Diesel	Hydrogen
Internal costs per 100 km	4,66 € to 5,89 €	17,49 €
External costs per 100 km	3,55 €	-
Total costs	8,21 € to 9,44 €	17,49 €

Full Cost Comparison



HyWindBalance - Wind-Hydrogen Balancing Power Plant



HyWindBalance Concept



- relieve the electricity grids from the need to balance wind power fluctuations
- deliver wind electricity as a power source that can be
 - scheduled
 - predicted
- deliver balancing power to the grid at zero CO₂
- deliver peak power to the grid at zero CO₂

- hydrogen technology is available today, though fuel cells are not yet fully developed
- wind derived hydrogen is still expensive
- nevertheless, large scale wind-hydrogen production could be near to market, even at today's equipment costs
- internalising external costs will remove the inherent subsidies for mineral oil products
- ... rising oil prices will do the rest of the job
- hydrogen can be used as an intermittent storage medium in ,intelligent' concepts of coupling renewable energy to the grid
- renewable energies can then be scheduled and planned ahead

Acknowledgments



Thanks go to

you, as an interested audience

and to

the European Commission for co-financing the EUHYFIS project,

the Ministry of the Environment of the Federal State of Lower Saxony and the EWE for support of the HyWindBalance project, and

HyWindBalance partners Oldenburg University, Overspeed, Ökoveat, and energy&meteo systems

www.planet-energie.de

info@planet-energie.de

www.euhyfis.com

info@euhyfis.com