Hydrogen

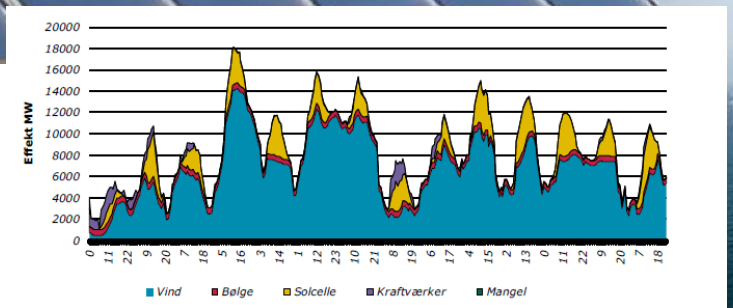
Mr. Jan Jensen (ExCo Chairman)
Dr. Marcel Weeda (Task 28 Operating Agent)
Dr. Susan Schoenung & Mr. Jochen Linssen (Task 30 Operating Agents)
Ms. Kari Espegren (Task 30 Subtask Leader)
Mr. Clemens Trudewind (Task 30 Expert)
Ms. Mary-Rose de Valladares (ExCo. Secretariat Manager)

IEA CERT workshop, Paris, 7.november 2011

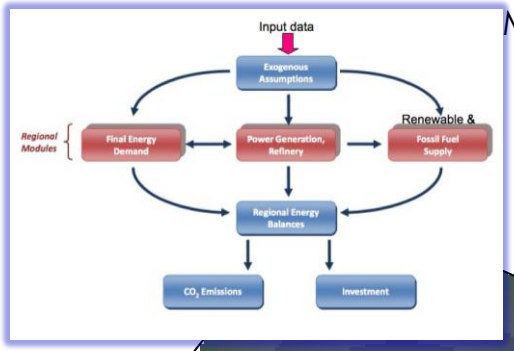
Outline of presentation

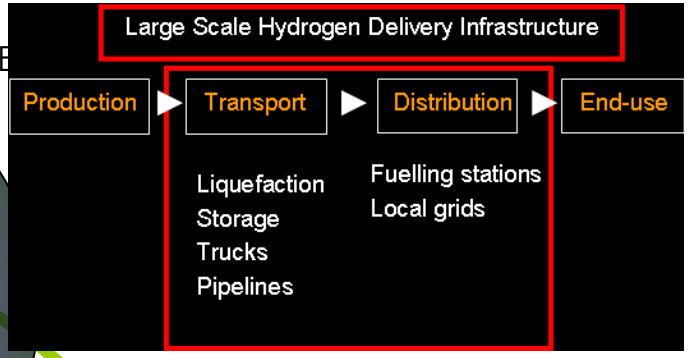
1. **Introduction**
2. Hydrogen as part of an energy system
3. Hydrogen production and infrastructure
4. Hydrogen Applications
5. Hydrogen - matching renewable energy production and energy demand

Future power supply….




Forklifts
SPECIAL/NICHE
Toys
Tools
PORTABLES
Cell phones
Laptops
PDAs
Auxiliary Power Units
Home Appliances
CHP & Micro CHP
Automotive
Back-up Power
Buses
UPS
STATIONARY APPLICATIONS
Trucks
Maritime
STORAGE
TRANSPORTATION
Refueling Stations
Trains
END USE SECTORS/ MARKETS & APPLICATIONS
(de Valladares)
KOHLER
ENEOS CELLTECH
PRAXAIR
AIR PRODUCTS





Task 28: Large Scale H2 Delivery Infrastructure

May 2010 – April 2013

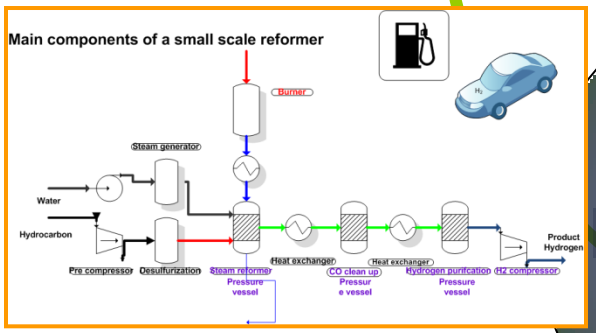
OA: Dr. Marcel Weeda

Task 30: Global Analysis of Hydrogen Systems

May 2010 - June 2013

OAs: Mr. Jochen Linssen and Dr. Susan Schoenung

H2 as part of an energy system



Task 23: Small-Scale Reformers for On-Site H2 Supply

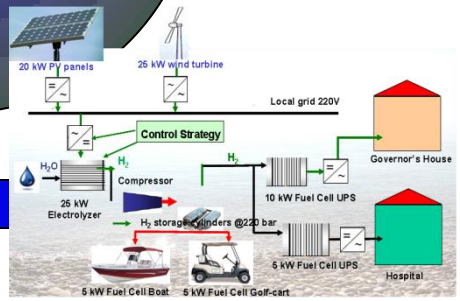
December 2006 - December 2011

OA: Dr. Ingrid Schjølberg of Sintef

Task 29: Distributed and Community Hydrogen

December 2010 - December 2013

OA: Dr. Federico Villatico



1. Introduction

2. **Hydrogen as part of an energy system**

3. Hydrogen production and infrastructure

4. Hydrogen Applications

5. Hydrogen - matching renewable energy production and energy demand

Hydrogen

- Hydrogen is both a fuel and an energy carrier that can be efficiently converted into other energy carriers
- Hydrogen can be produced from diverse resources, and it is found in carbon containing materials (fossil fuels, biomass and carbohydrates) and water.
- Zero-emission renewable and nuclear sources can be used to “electrolyze” water and produce hydrogen
- Together with electricity, hydrogen is the only non-carbon containing energy carrier.
- Hydrogen can be stored, centralized or decentralize

Big Picture Hydrogen

On- and offshore wind power

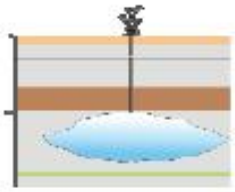
Grid

Fluctuating electricty

Electrolysis

H_2

Compression



H_2 storage in saline dome with H_2 drying

Electric re-conversion

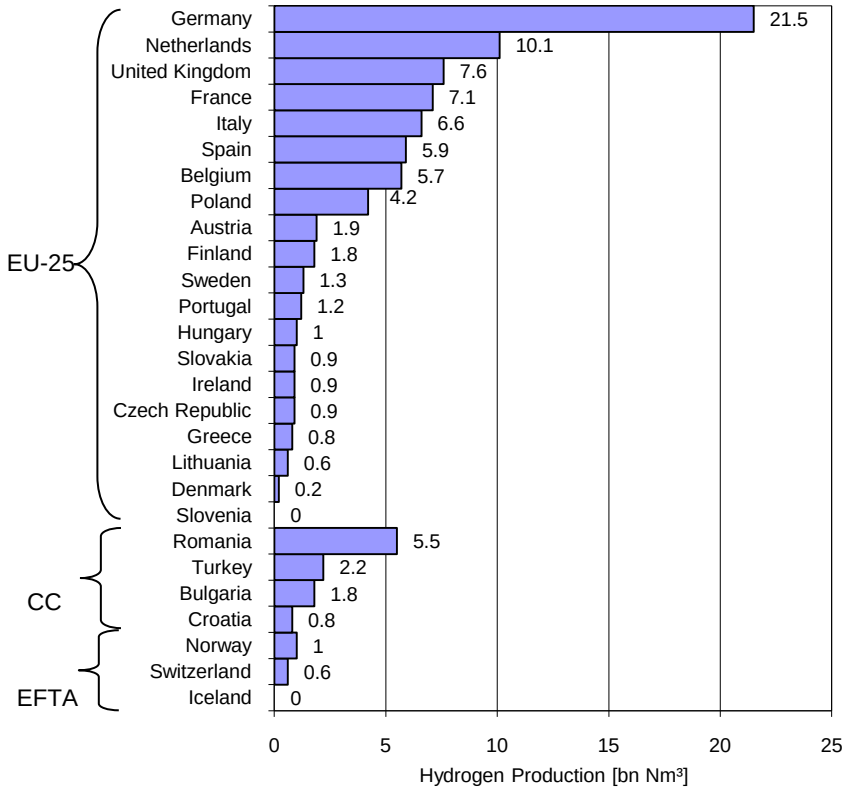
Fueling station

Industrial Usage

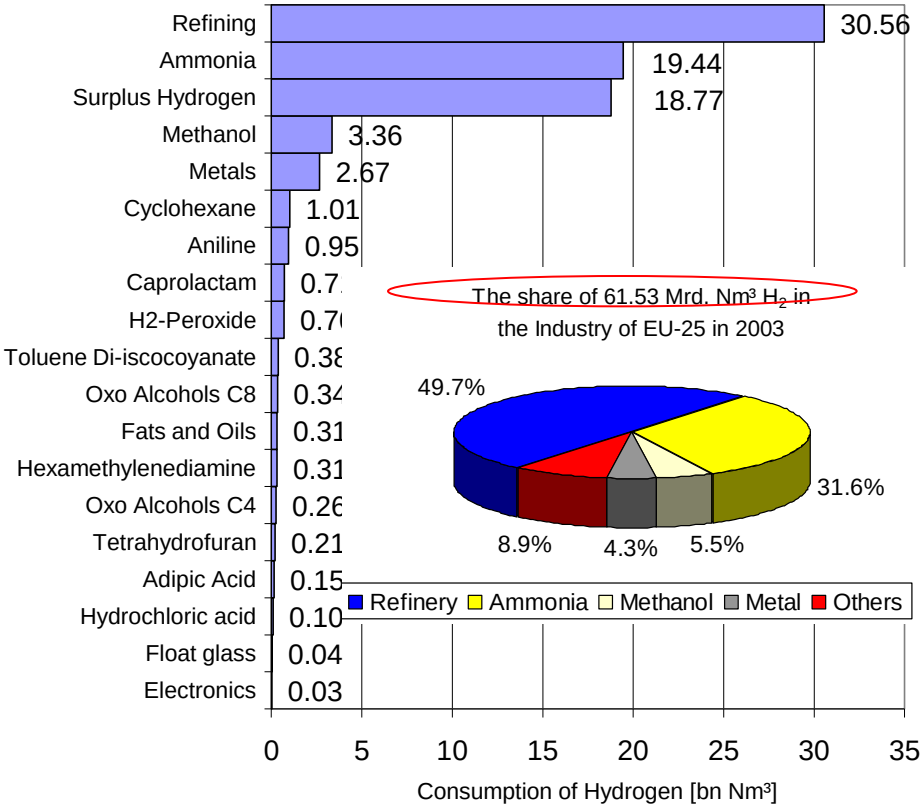
Feeding-in Natural Gas Grid

Hydrogen production and demand in Europe, 2003

In Europe Hydrogen Production amounts to 93 bn Nm³/a respectively 80.2 bn Nm³ in EU-25



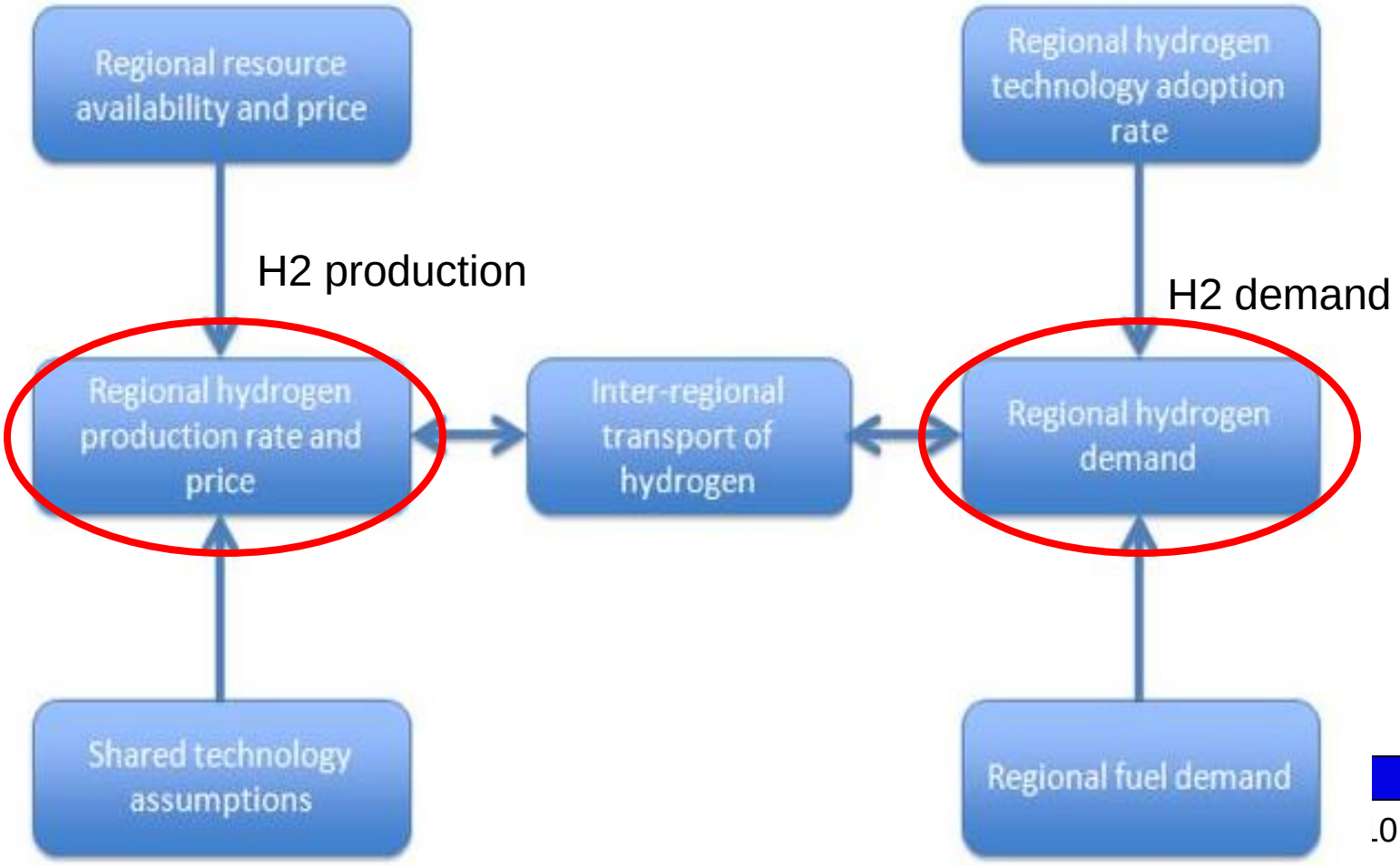
Consumption of 80.2 bn Nm³ by major production processes in 2003 in Western Europe



Source: Roads2HyCom (2007): Deliverable 2.1 and 2.1a, „European Hydrogen Infrastructure Atlas“ and „Industrial Excess Hydrogen Analysis“. Part II: Industrial surplus hydrogen and markets and production, Document No. R2H2006PU.1

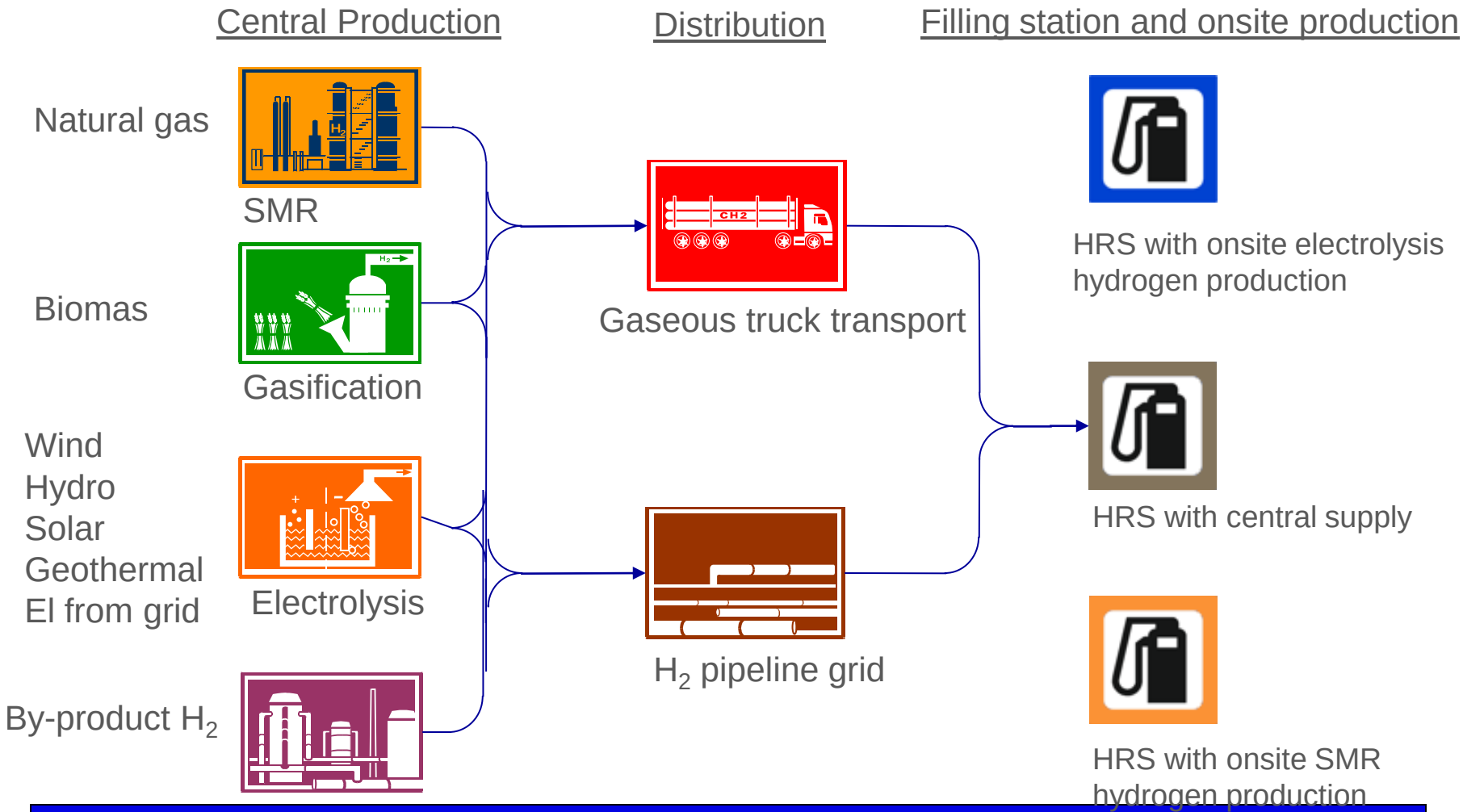
Global Resource Study, HIA Task 30 Activity

Supply and demand analysis => Hydrogen sources, including import and export



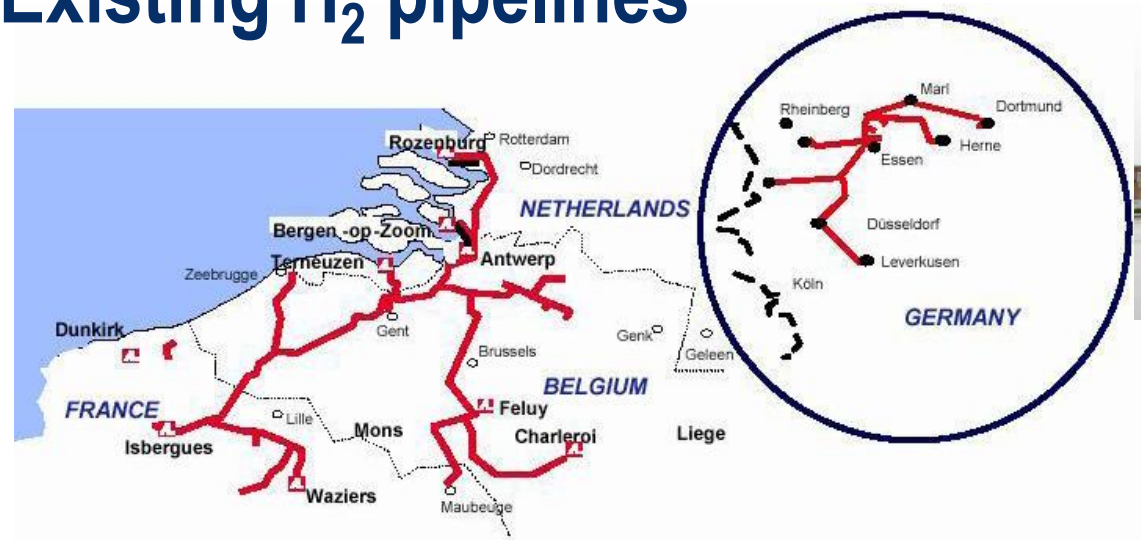
1. Introduction
2. Hydrogen as part of an energy system
3. **Hydrogen Production and Infrastructure**
4. Hydrogen Applications
5. Hydrogen - matching renewable energy production and energy demand

Production and distribution of hydrogen



Transportation and Distribution

Existing H_2 pipelines



Source: Presentation ,, Wo steht die Wasserstoff- und Brennstofftechnologie heute?‘‘, Dr. Johannes Töpler, DWV

CH_2 and LH_2 trailer

Gaseous pressure vessles
or
liquid storage tanks

North Europe Pipeline, Air Liquide

- Belgium-Frace-Netherlands
- 966 km
- 10 MPa

Rhine-Ruhr-Area

- 240 km
- 1,1 / 2,3 / 30 MPa

Fuelling station

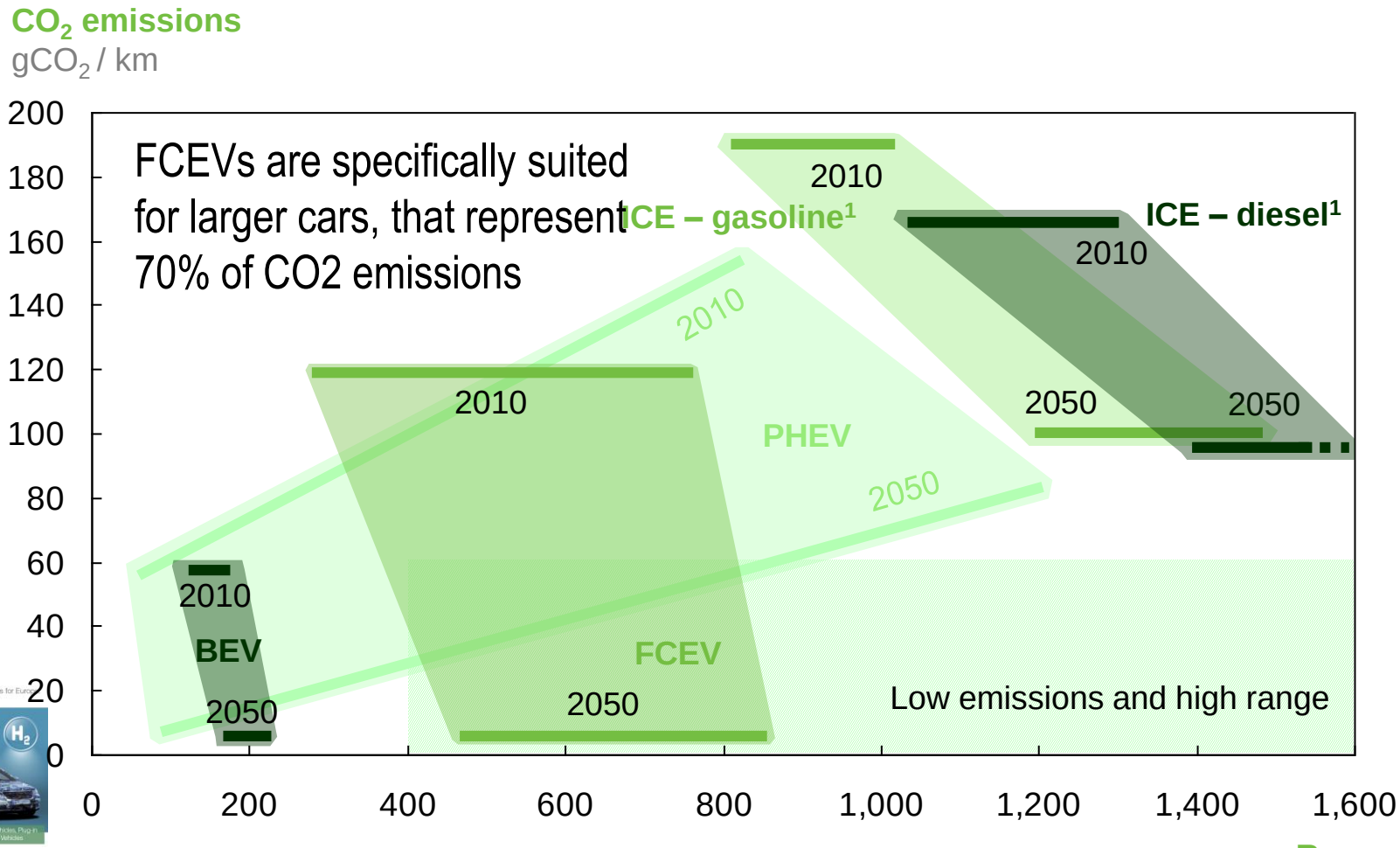
1. Introduction
2. Hydrogen as part of an energy system
3. Hydrogen production and infrastructure
4. **Hydrogen Applications**
5. Hydrogen - matching renewable energy production and energy demand

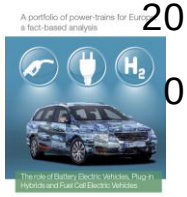
Hydrogen applications

- **Transport sector**
- Materials handling
- Energy storage
- Back-up power
- Uninterruptible power systems
- Combined heat and power in Residential / Industry Applications
- Specialty/niche markets
- Portables

Motivation for hydrogen
BEV and FCEV can achieve low emissions

C/D SEGMENT

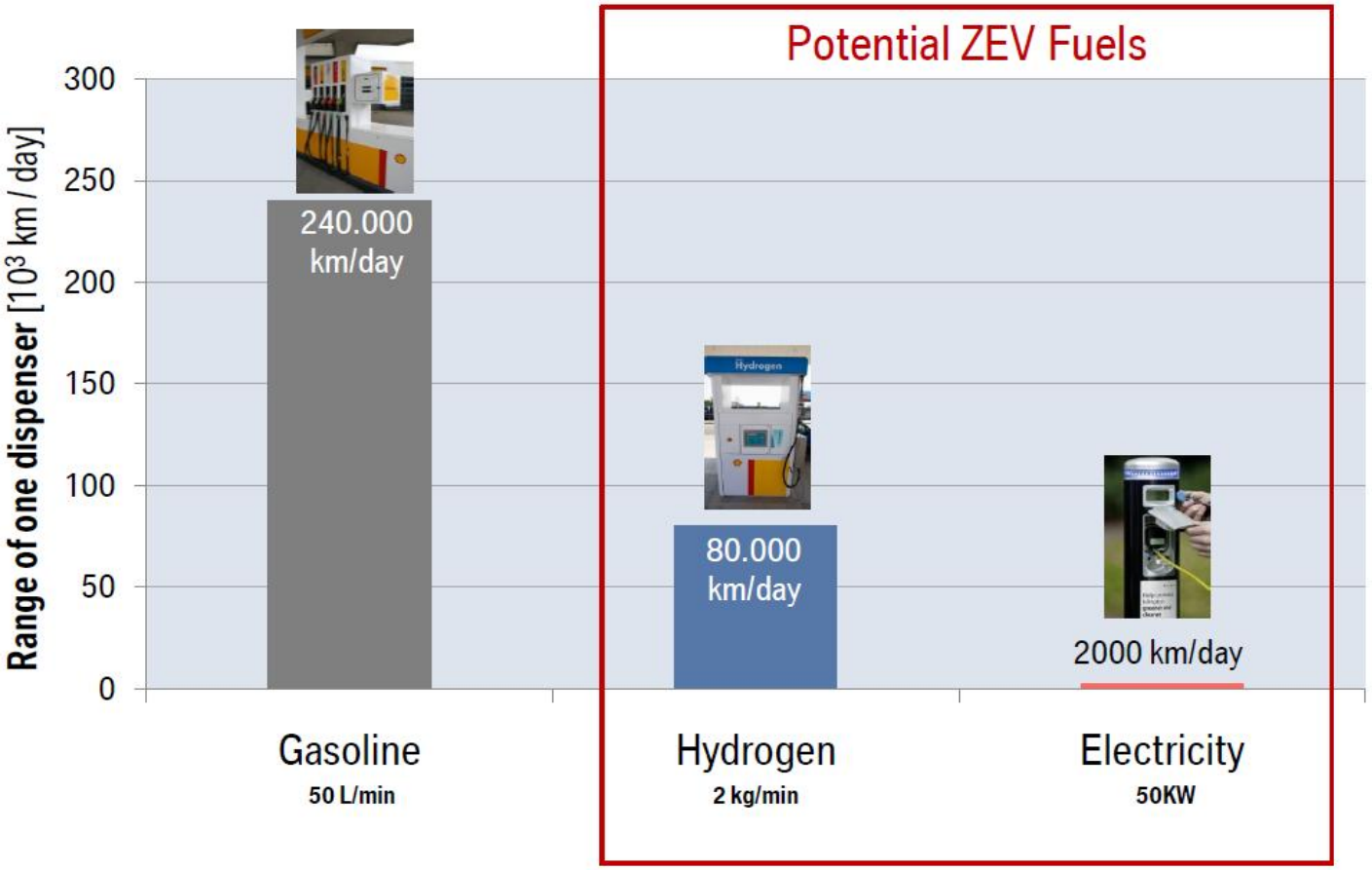




Source: Mc Kinsey et al. 2010: A portfolio of power-trains for Europe: a fact-based analysis

Motivation for hydrogen

Fuel dispensing/refueling time



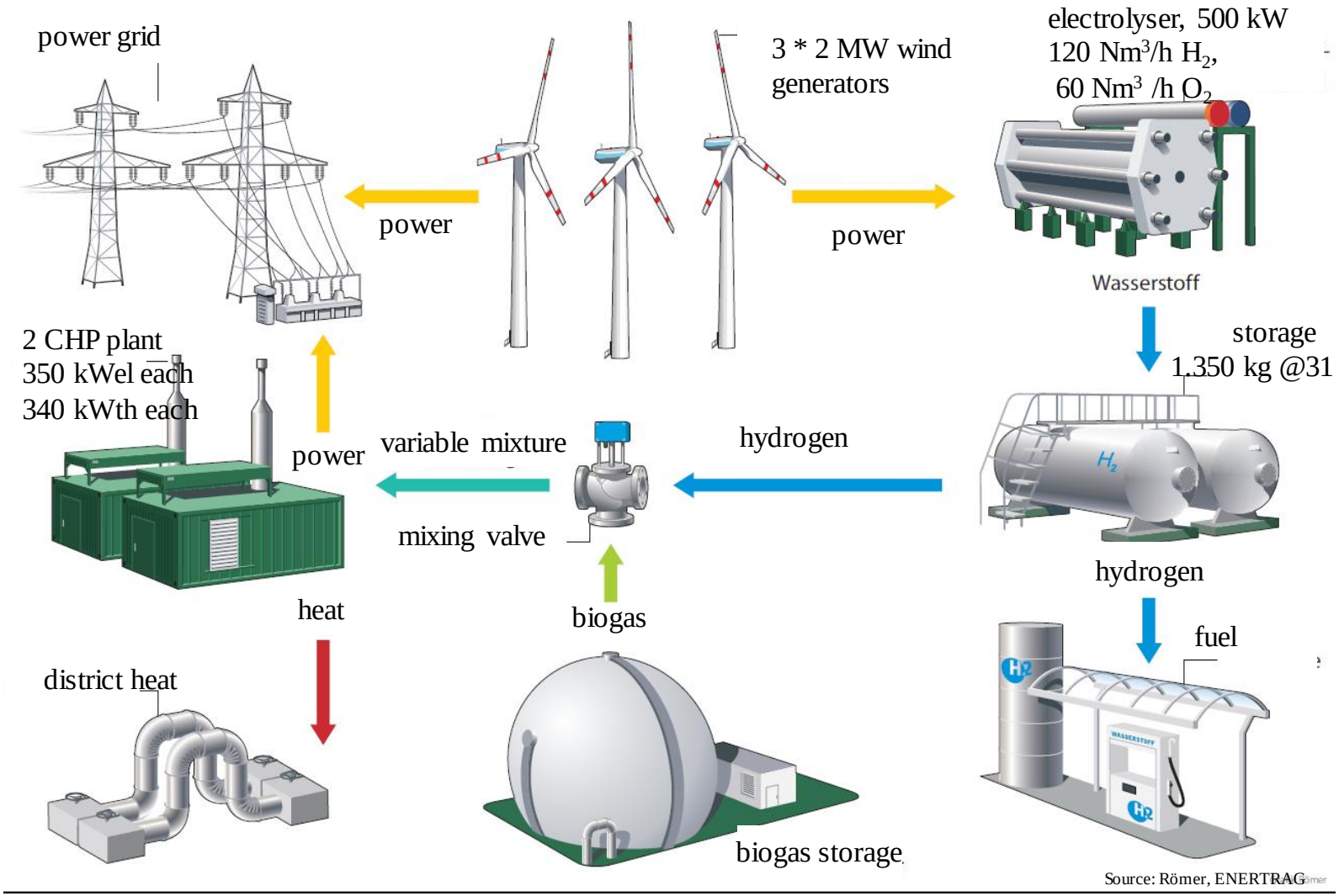
Source: Tobias Brunner, BMW

1. Introduction
2. Hydrogen as part of an energy system
3. Hydrogen production and infrastructure
4. Hydrogen Applications
5. **Hydrogen - matching renewable energy production and energy demand**

Balancing demand and production

- Hydrogen is a leading candidate for use as energy storage
  - short and long term
  - stationary and transport applications
  - on grid and off-grid
- On-grid, hydrogen can be used for peak shaving and load balancing as well as optimizing of intermittent and seasonal renewable energy
- Smoothening of mismatch between energy demand and supply, both in time (easy storage) and geographically (easy transport)

Demonstration: Hybrid Power Plant, Germany 2011



Benefits of hydrogen

- Significant emission reduction and deployment of low carbon technology is needed to tackle the climate change challenge
- Use of hydrogen is key to realizing the GHG emissions reduction necessary to achieve the targeted 50% reduction by 2050
- Hydrogen can play a valuable role in fostering both energy security and economic development, as hydrogen is a sustainable energy carrier with varied and flexible domestic energy sources

Thank you

Contact information:

Kari Aamodt Espegren

Institute for Energy Technology
Norway

kari.espegren@ife.no