The first industrial PtG plant – Audi e-gas as driver for the energy turnaround

CEDEC Gas Day 2014, Verona , 27th of May 2014

Reinhard Otten | Sustainable Product Development | AUDI AG

Observations…

- **Natural gas is a big business, but not yet in the transport sector (most important exception in Europe: Italy!)**
- **Big run on new exploration technologies rather than on really sustainable, renewable solutions**
- **Focus still strongly on fossil sources and on traditional consumers (power generation, industry, homes – no passenger cars)**
- **There a doubts about new investments into gas infrastructure**

The good news to remember…

- **Audi (and the Volkswagen Group) have identified mobility based on methane as an important pillar of GHG reduction**
- **Audi has built the world‘s first industrial Power-to-Gas plant (6 MW), enabling the storage of renewable electric power in the natural gas grid**
- **The green (excess) energy converted into synthetic methane (also called synthetic natural gas, SNG) is made available to owners of Audi CNG passenger cars by means of a fueling card**

Prof. Dr. Martin Winterkorn, CEO Volkswagen Group

- **Vienna 2013, 34th Powertrain Symposium:**
- "Natural gas engines are friendly to the environment, affordable, and practical. The technology has proven its reliability, and the cars are available in the market."
- "We have to increase the public awareness of the advantages of natural gas vehicles. All stakeholders are expected to help: Car industry, politics, and fuel companies."

CNG vehicles in the Volkswagen Group (Europe) + Scania

Passat

Passat Var.

Touran

Citigo

Octavia

Octavia SW

Skoda

up!

Golf

Golf Variant

Mii

Leon

Leon ST

SEAT

Nutzfahrzeuge

Caddy

Caddy Maxi

Lion´s City

MAN

Audi
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A3 g-tron

Ecolution

SCANIA

Audi future lab: mobility

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The new Audi A3 Sportback g-tron

- Production since December 2013
- Available in EU markets
- 1,4 litre TFSI (DI Turbo)
- 110 hp
- 200 Nm / 1400 rpm
- 123 mph
- 25.900 € (Germany)

Audi A3 Sportback g-tron

- **First CNG Audi**
  (based on the MQB modular concept)

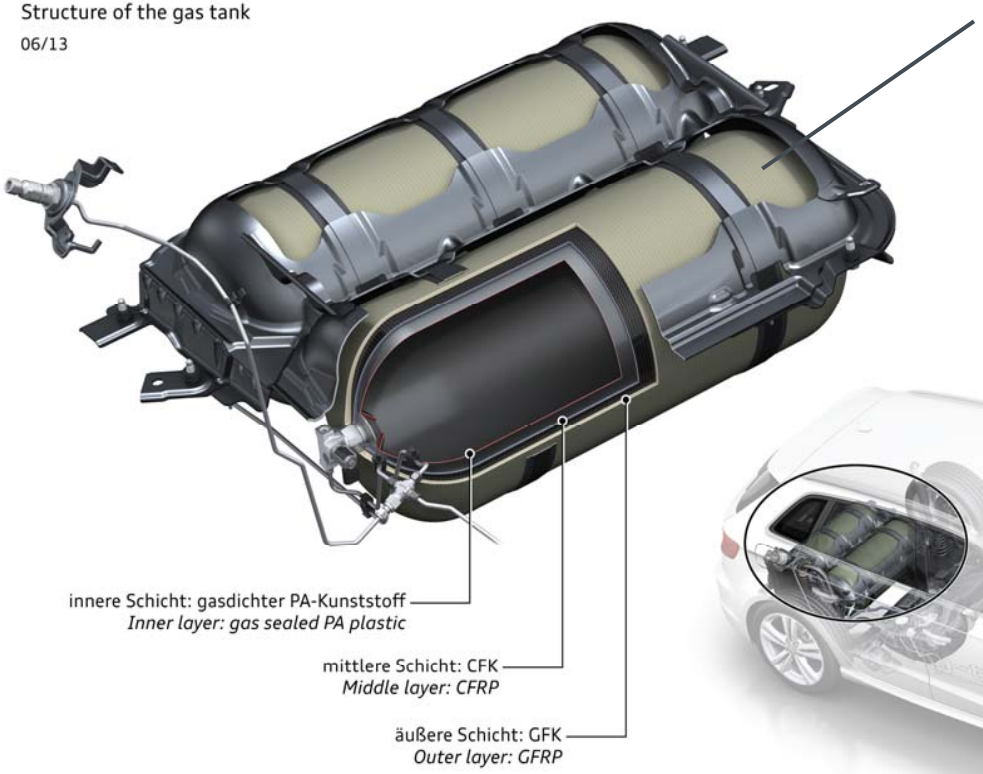
- High efficiency:
  3,2 – 3,3 kg / 100 km,
  88 – 92 g/km (natural gas mode)
  ➔ same GHG effect as 60 mpg gasoline car

- Bifuel concept:
  Range on natural gas > 400 km
  Range on gasoline: 1000 km

Dedicated CNG platform: Engine, „Omega“ rear axle, package

Audi A3 Sportback g-tron

Aufbau des Gastanks
Structure of the gas tank
06/13



Composite pressure tanks:
Saving 54 kg by making use of new lightweight concepts

Total weight:

< 1.300 kg

Total range:

> 1.400 km
> 880 miles

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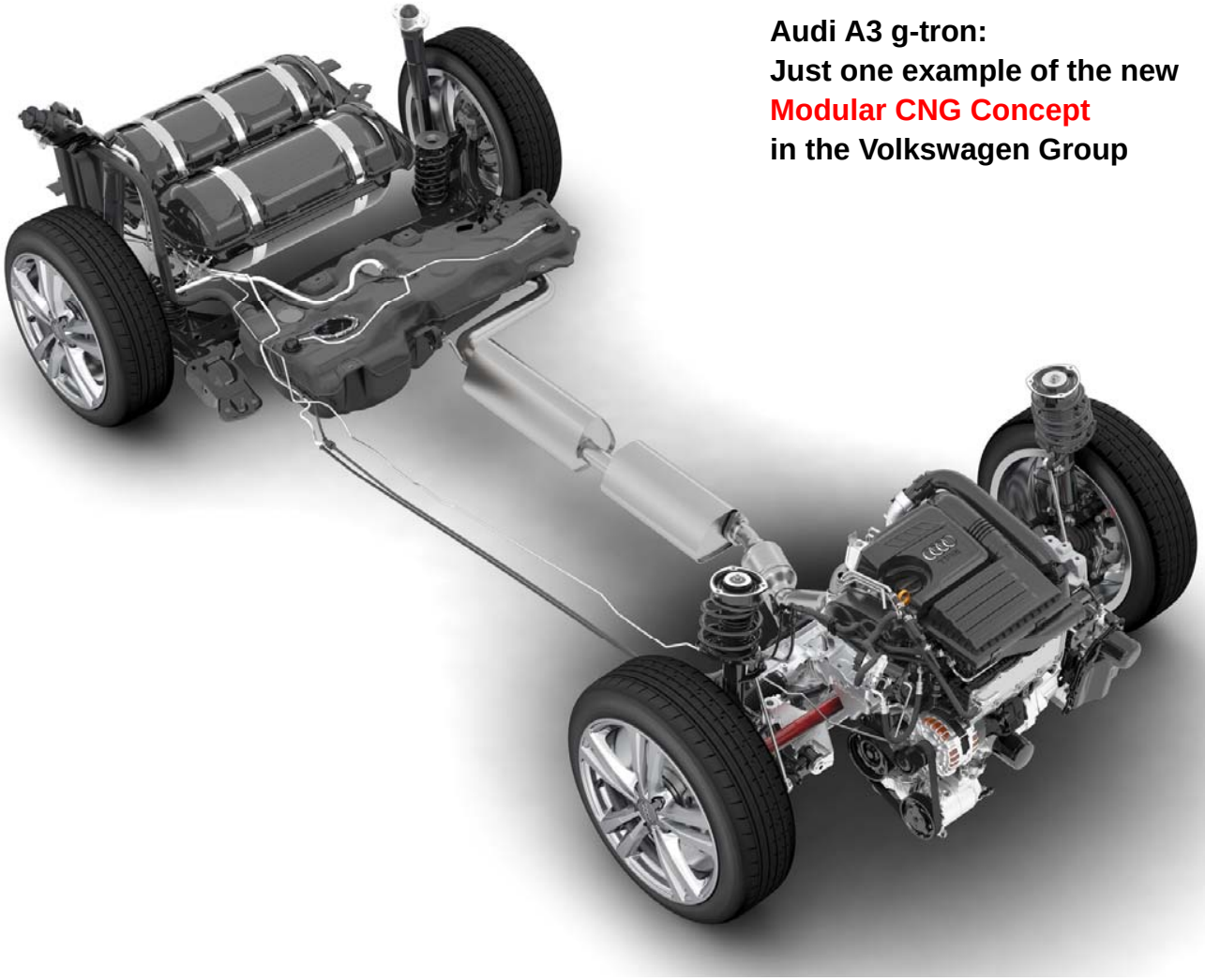

Audi A3 g-tron:
Just one example of the new
Modular CNG Concept
in the Volkswagen Group

MQB:

Modular Concept for
- Subcompact
- Compact
- Midsize
passenger cars
of the
Volkswagen Group

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Fossil fuels

Biofuels

?

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Audi A3 Sportback e-tron (PHEV)

Top speed in electric mode	**75 mph**
Range in electric mode	**~32 miles**
Total range	**~580 miles**

- **BEVs and PHEVs are part of the solution – but green electricity is crucial for low GHG balance**

Audi *e-tron* models

Audi MediaServices

Audi Vorsprung durch Technik

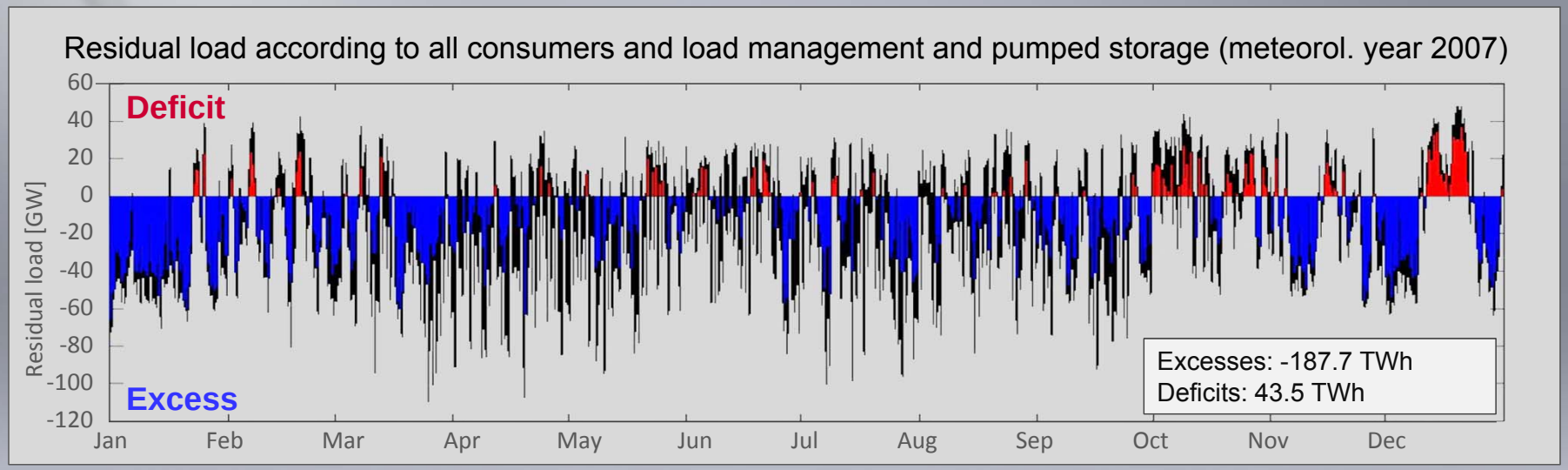
"When we speak about sustainable mobility, we have to look at the **entire energy balance**", says Rupert Stadler, Chairman of the Board of Management of AUDI AG. According to him, Audi's task is not only to build cars but to ensure their sustainable use by the customer.

"**Electric cars** from Audi must be powered by **electricity from a sustainable source**. This is why we are promoting solar and wind power installations."

- The Volkswagen Group will invest about 600 million € into renewable energy production until 2016

» **What happens to the electrical energy that is not needed directly?**

Simulation of German electricity grid with a renewable energy proportion of 78 %



Source: Fraunhofer IWES simulation, 2010

» **The expansion of wind and solar energy will lead to an electric power surplus at many times in Germany - this is already occurring locally**

Partners Audi e-gas project

ETOGAS
smart energy conversion

Fraunhofer
IWES

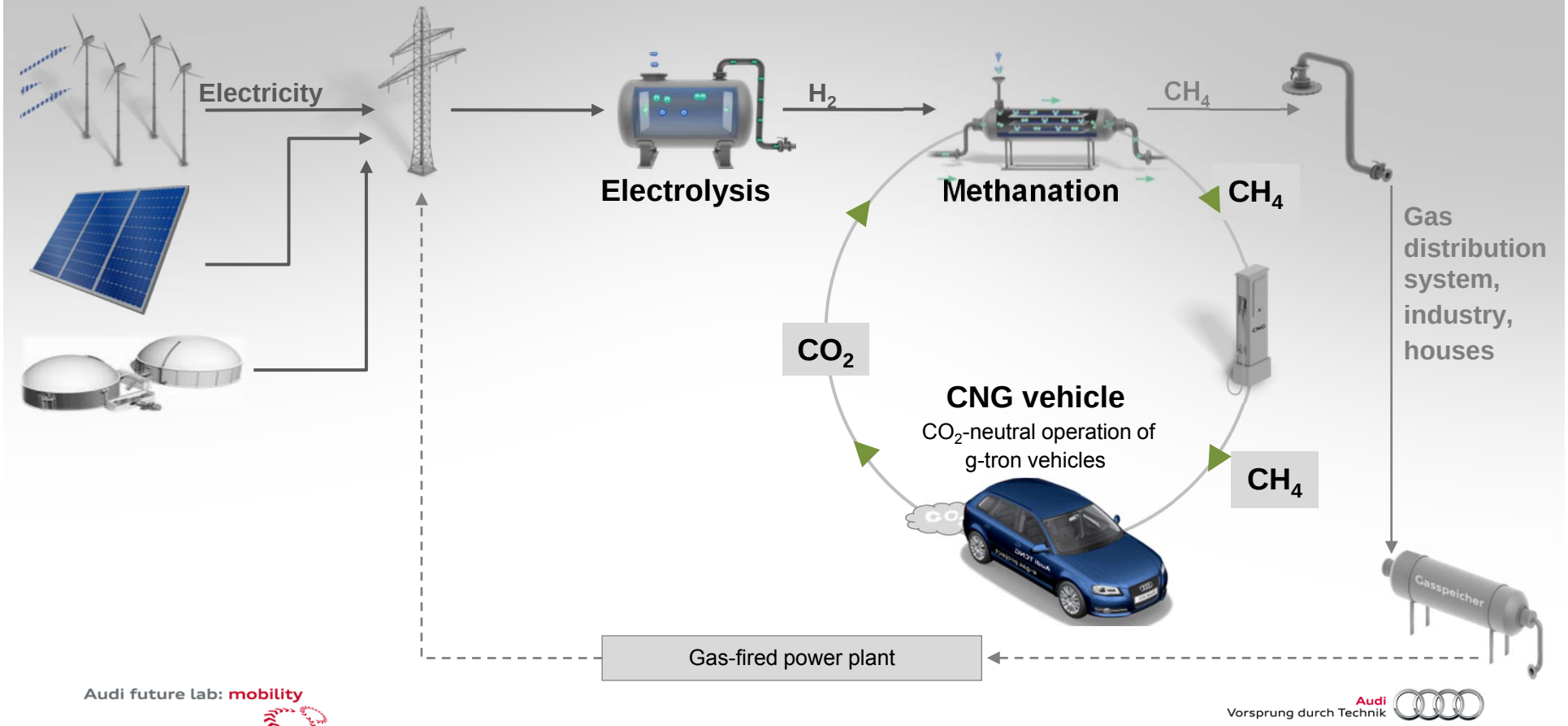
ZSW

EWE

MT | BioMethan®
Gasaufbereitungs-Technologie

The world‘s first industrial Power-to-Gas application:

The functional principle of e-gas



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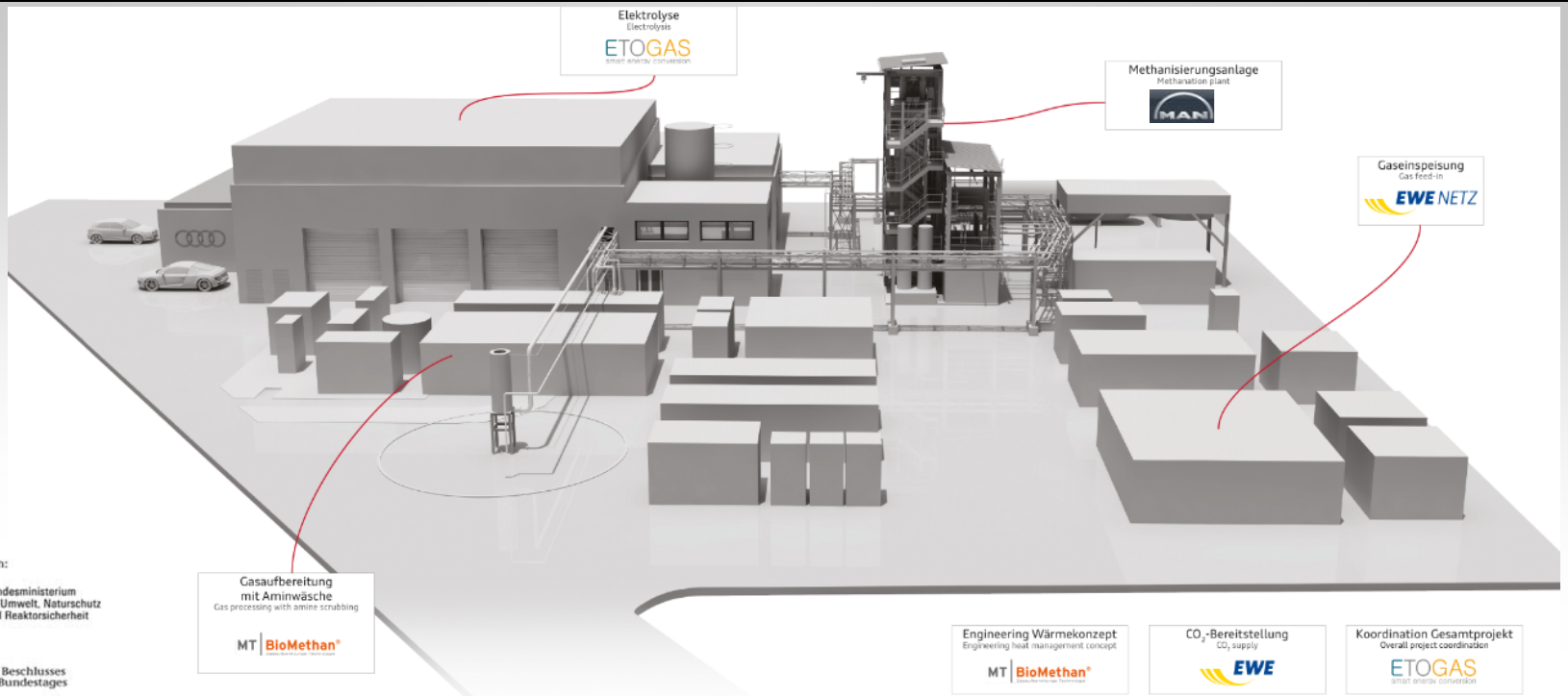
Overview Audi e-gas plant



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aufgrund eines Beschlusses des Deutschen Bundestages

Details of the Audi e-gas plant in Werlte (Northern Germany)

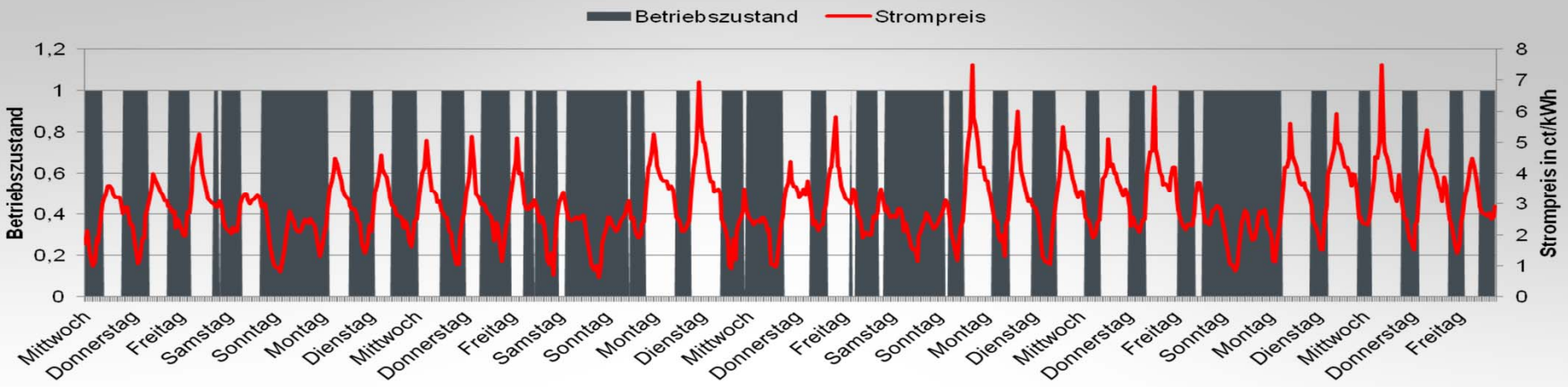
Electrolyzers (3 x 2 MW)

Methanation Unit

Key Performance Indicators Audi e-gas plant (Werlte)

Energy content e-gas (average)	13,85 kWh/kg
Electricity input (prognosis)	26 – 29 GWh/a
Power input electrolyzers	3 x 2 MW
Efficiency „power to gas“ (without using heat)	54 %
Max. H_2 output	1300 Nm³/h
Max. H_2 storage time	60 min
Max. e-gas output	325 Nm³/h
Operation time (prognosis)	4.000 h/a
e-gas output (prognosis)	1000 t/a

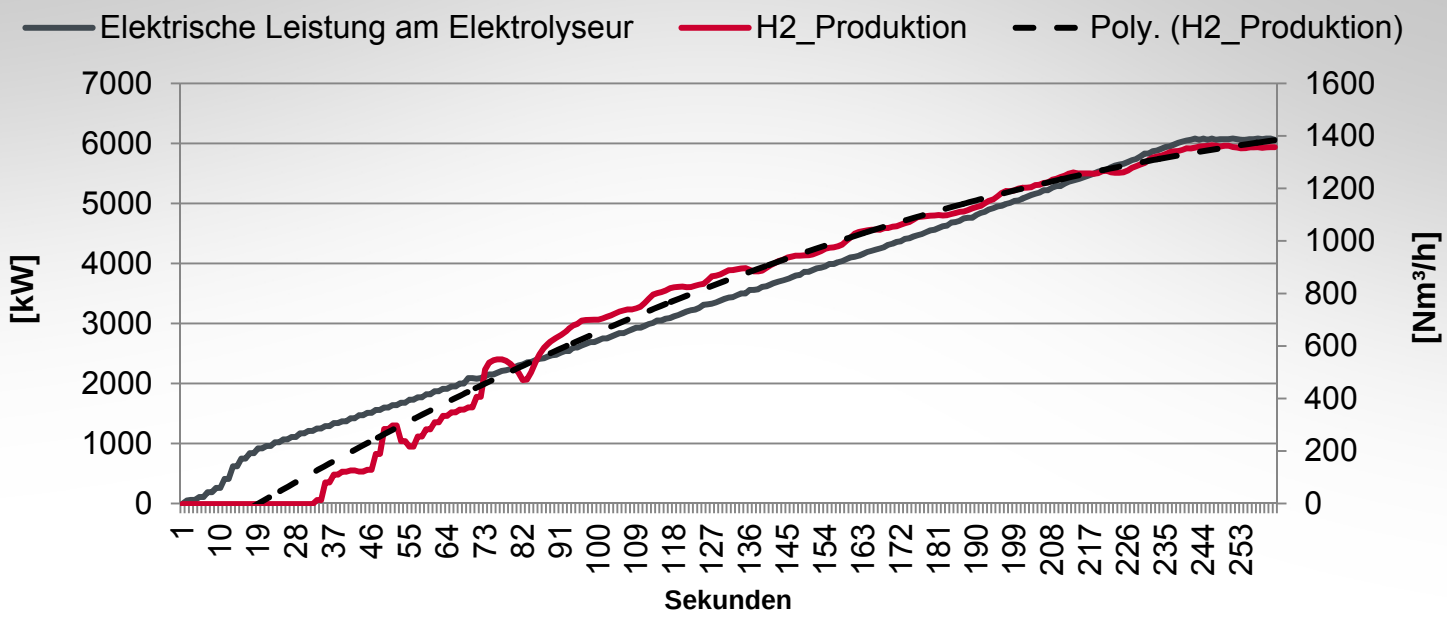
Simulation: How would a PtG plant run in function of prices at the electric power spot market?



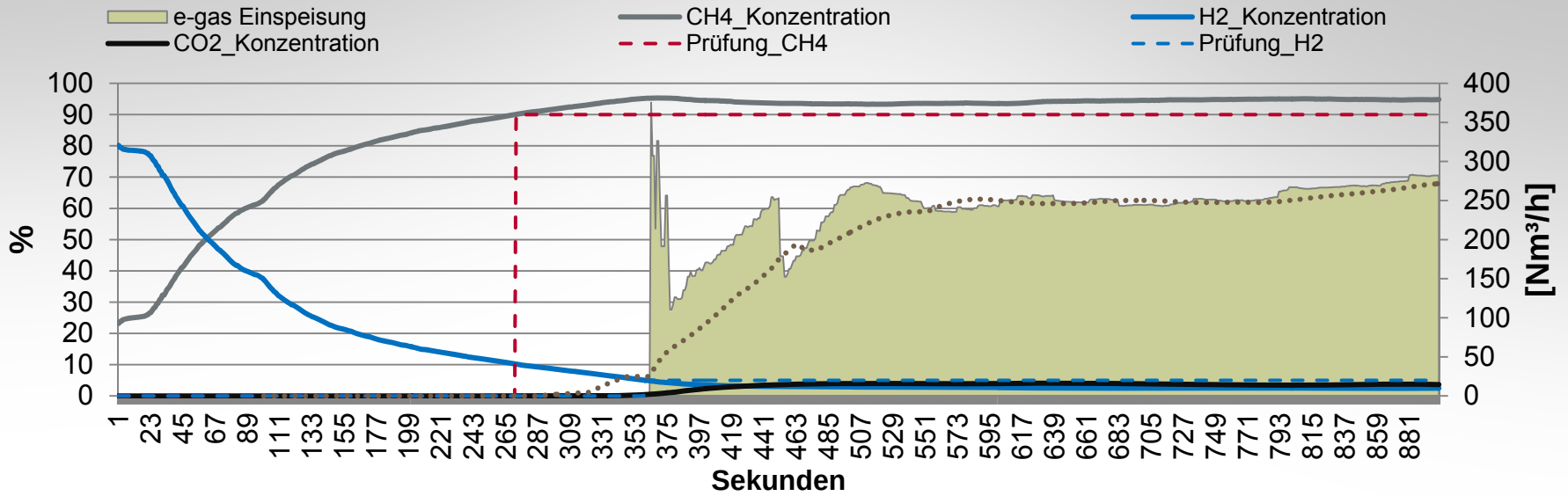
- Running especially at night and during the weekends
- Making use of times of low demand and ongoing renewable energy production
- Turning on/off 33 times in one month

Starting process of electrolyzer (Audi e-gas plant Werlte):

< 30 sec. until response to control power demand, 240 sec. until max. power



Starting process of methanation: ~ 5 min. until feed-in quality



Power-to-Gas: Audi e-gas plant in Werlte (Northern Germany)

Quelle: EWE Netz

Ideal supplement: CO_2-neutral mobility for short and long distances

e-power
(e-tron)

e-hydrogen
(HFC)

e-gas
(g-tron)

Audi e-gas Project:

- **CO_2-neutral mobility for three drive concepts**
- **Fuels from renewable energy sources, CO_2 and water**
- **Impulses for expanding renewable energy sources**

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Why synthetic methane – and not just hydrogen?

- **Existing infrastructure, feed-in without any restrictions at any time**
  Pipelines, network, facilities, storage in caverns, natural gas power stations, …
- **3,5 times higher storage capacity**
  Hydrogen needs much more space (or pressure…) for the same amount of energy
- **Handling much easier**
  Hydrogen is the smallest existing molecule….
- **Existing and affordable consumer applications – CH_4 is already an universal energy carrier**
  CNG cars and busses, CNG/LNG trucks, ships, industry (methane is also a raw material!)
- **Methanation heat losses (~ 170° C) are not necessarily lost**
  Aud e-gas plant makes use of methanation heat in the purification process of the CO_2-delivering biomethane plant
- **Flexibility – and methane opens the door for hydrogen!**
  Depending on the market situation and the infrastructure, energy can be transferred between different energy carriers.
  And: If you have a Power-to-Gas plant, there is always an electrolyzer…

How does the e-gas come to the Audi customer? (1/3)

- **Consulting at point of sales**
- **Audi Partner offers e-gas option to CNG customer**
- **Customer signs prepaid contract to get Audi e-gas**

How does the e-gas come to the Audi customer? (2/3)

Driving to gas station…

…filling the gas tank…

… paying with Audi e-gas fuel card

- **Paying and communication of the gas amount to the Audi server in one step**
- **Balancing of the gas quantities taken out of the grid (fueling station) and those fed in by Audi (Audi e-gas plant)**

How does the e-gas come to the Audi customer? (3/3)

- **Regular reporting of the used Audi e-gas quantity**
- **Reporting of CO_2 reduction (interesting for fleets with GHG policy)**

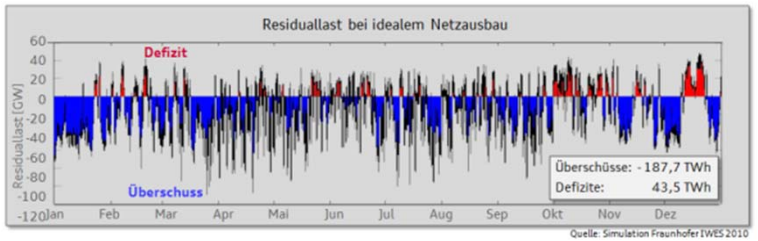
The Audi e-gas project helps to tackle important challenges of the future in the mobility and the energy sector

Today

CO_2-neutral energy for extra-urban mobility

Tomorrow and today

„Energy turnaround“ (Storage of renewable energy, control of power grid)



Conclusions

- CNG vehicles are a big issue for Audi and the Volkswagen Group
- Methane is an universal energy carrier with different climate neutral options
- The natural gas infrastructure is a crucial element for the introduction of renewable energies into the electric power grid (back up power, flexibility, storage, …)
- Power-to-Gas is the only available technology of high capacity for long term storage
- Mobility is the strongest driver for a positive PtG business case
- CNG infrastructure should be improved in order to make more renewable energy possible in the mobility sector

Thank you!

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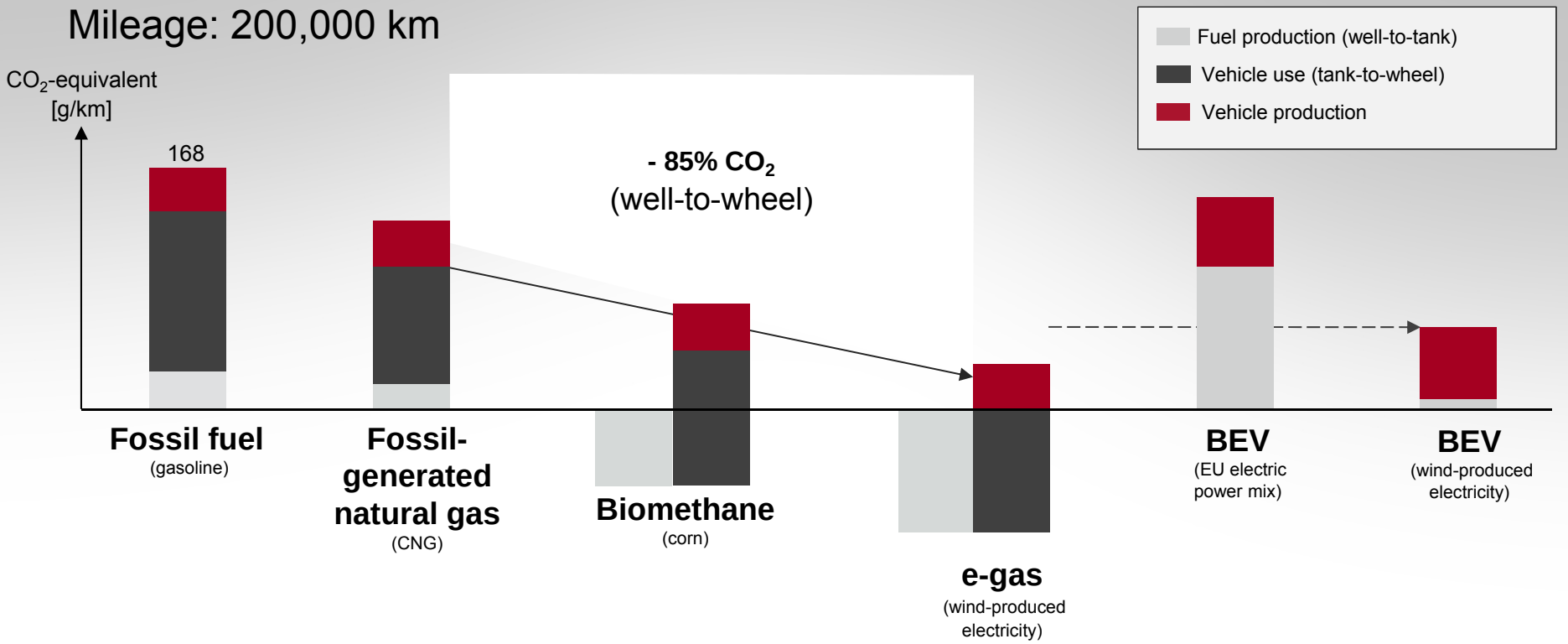
Greenhouse gas footprint in the case of the compact class

Mileage: 200,000 km



Global trends and general constraints

Climate change

Political framework

Urbanization

Challenges for the automotive industry

Scarcity of resources

Markets in upheaval

Shifting values

New technologies

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