AUDI h-tron - sustainability in future drive concepts
Drivetrain Forum (DTF) 2018
2018-05-17 | AUDI AG | J. Jablonski, Dr. S. Rank
# Agenda

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MEGATRENDS
a society in flux

Demographic change
Climate Change
Digitalization
Sustainability
Urbanization
Change of the working world

society has a claim to sustainability
companies have a commitment to sustainability

Impact on Mobility
Audi Strategy

Vorsprung is our promise

Digitalization
We are digitalizing our processes and creating a platform for integrated, connected premium mobility and digital services.

Vorsprung is our promise.
We inspire through individual, sustainable premium mobility. Our premium vehicles are the foundation.

Sustainability
We stand for sustainability in our vehicles and services throughout the entire value chain.

Urbanization
By working together with cities worldwide we ensure access to individual, city-friendly premium mobility.
Sustainability in the mobility of tomorrow

Our Vision: ZERO EMISSION

The drive of the future holds challenges – but also opportunities

Sustainability
We stand for sustainability in our vehicles and services throughout the entire value chain.
Conventional, hybrid and plug-in hybrids alone will not be able to meet the regulatory requirements as a reference.

Regulatory requirements

\[ \text{CO}_2 \text{ fleet emission} \]

- Regulatory requirements (fleet)
- Reduction of CO\textsubscript{2} fleet emissions through optimized, conventional vehicle concepts

+ Intensification of the ZEV regulation

Schema
Traffic restrictions
status and planning worldwide

in operation
in planning
expired projects / not implemented
**Life-cycle assessment**

Emissions are not just in operation

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**FCEV with decent values**

The full advantage of alternative powertrains only comes with the use of renewable energy.

**Source:** Hydrogen Scaling up – A sustainable pathway for the global energy transition | Hydrogen Council
Our Vision: ZERO EMISSION
Our Vision: ZERO EMISSION
Coarsening of the conventional portfolio

2025 Scenarios for Drivetrain-Strategy

Vision ZERO Emission

ZERO* 100 %

Source: Audi Drive Strategy

* BEV, FCEV, ggf. regenerative Kraftstoffe
Our Vision: ZERO EMISSION
Overview of the driving portfolio
Comparison of properties BEV - FCEV

Strategic positioning

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<th>Daily Range Demand</th>
<th>BEV</th>
<th>h-tron</th>
<th>FCEV</th>
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<tr>
<td>Small / Compact</td>
<td></td>
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<td></td>
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<tr>
<td>Midsize / Fullsize</td>
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<tr>
<td>SUV</td>
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<tr>
<td>Commercial Vehicles</td>
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Cost comparison
FCEV vs. BEV

At a certain level of energy capacity
FCEV offers cost advantages in a 2030 scenario

Above a range of approximately 350 km (assumption of 15 kWh / 100km) FCEV technology averages out BEV technology in terms of cost in passenger cars

Source: Hydrogen Scaling up – A sustainable pathway for the global energy transition | Hydrogen Council
Hydrogen – more than just a gas
The Hydrogen Society
Fuel cell technology as part of the energy transition
Hydrogen initiatives
Building up the infrastructure

Audi is involved in various initiatives to promote hydrogen technology

As long as there is no H₂-Infrastructure with a tight net of H₂-Fueling stations, fuel cell vehicles will not be bought by customers on a large scale.

As long as fuel cell vehicles are not sold, investments in the H₂-infrastructure will be severally hampered.
Hydrogen – more than just a gas
World wide leading regions with a significant H₂-Infrastructure development

Number of hydrogen refueling stations (HRS)¹

**USA**

- 60 stations in 2016
- 130 stations in 2020
- 600³ stations in 2025

**Europe**

- 100 stations in 2016
- 520 stations in 2020
- up to 2,000³ stations in 2025

**Asia**

- 103 stations in 2016
- 340 stations in 2020
- 830³ stations in 2025

1. Public HRS in countries with a significant H₂-Infrastrucure development
2. Countries or states with no major outlook for an H₂-Infrastructure development
3. Depending on the number of registered FCEV

Sources: H₂ Mobility, US DOE, Hydrogen Europe
Hydrogen – more than just a gas
Energy storage for the future

› Rise in regenerative electricity will lead to cyclic overproduction of electrical power
› Hydrogen makes a perfect energy carrier for (intermediate) storage
Energy storage
Hydrogen as a storage medium enables the energy transition

Means of balancing

Curtailment of extreme peaks

Hydrogen is used for:

- Long-term storage as compensation for weeks and months
- Transfer of renewable energies to other sectors (sector coupling)
- Transfer to other regions where renewable energies can not be generated adequately or not to cover costs

Batteries and balancing energy

Short-term storage to compensate for a few hours / days

For the year 2050 (80% renewable energies in Germany), a surplus of 187 TWh is forecast. This energy enables the operation of approx. 30 million fuel cell cars with an annual mileage of 15,000 km

Source: Fraunhofer Institut, EG-X
Audi h-tron program
**Audi h-tron program**

Milestones of AUDIs fuel cell activities

- **2004**
  - Audi A2 H2
  - 1st Generation

- **2009**
  - Audi Q5 HFC
  - 2nd Generation

- **2011**
  - Audi Q5 HFC
  - 3rd Generation

- **2014**
  - Audi A7 h-tron
  - 4th Generation

- **2014**
  - Audi h-tron quattro concept
  - 5th Generation

- **Audi fuel cell serial production**
  - 6th Generation
Audi h-tron program
Roadmap to serial production

Phase 1
Communication and visibility

Phase 2
Visibility and experience

Phase 3
Rollout and market penetration
Fuel Cell Technology
Key factors for a successful market entry
Technical improvements & industrialization

- Increase of power density / system efficiency
- Reduction of material cost
- Reduction of the number of system components / modularization
- Market capitalization for FCEV components

FCEV strategy
suitable for series production

- Design-to-fabricate
- Fuel tank optimization
- Automated stack production
Conclusion

› Sustainability in drive concepts is determined by far more factors than just pure emission values

› Depending on the use case, fuel cell vehicles being an important and essential field for future mobility concepts.

› Change to renewable energies will require hydrogen as energy storage.

› Development of a fuel cell system for the VW Group at Audi Neckarsulm

› Technical improvements & industrialization of fuel cell technology will lead to a consumer-friendly sustainable drive concept
Thank you!