

# H<sub>2</sub> - fossilfreie Energie für den Schwerverkehr sowie die benötigte Infrastruktur

Dr. Philipp Dietrich, CTO H<sub>2</sub> Energy

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# Agenda



Was wir bis jetzt gemacht haben

Was ist die Herausforderung?

Was kann H2 beitragen, im speziellen im Transportsektor?

Schlussfolgerungen

# Ecosystem sets the stage for commercial roll-out of zero-emission-heavy-duty trucks



Hyundai H2 Energy

Hyundai Hydrogen Mobility  
Partnership with H2Energy

**H2-Truck-Fleet**

- Range 400 km
- Total weight 36-42 t
- 'Pay-per-use' Model

**Petrol Station owners – H2 Mobility Association**  
Avia, Agrola, Coop/CMA, Migrol, Shell, Socar, Tamoil

**H2 Refueling Station**  
Target 30-50 HRS by 2025



Alpiq H2 Energy Linde

**H2 production from renewable energy**

**H2 trading/Sourcing**

**H2-Logistics**  
Supply of HRS in Switzerland

**Without subventions**

# Locations in Switzerland: Filling stations serve both 700 bar for cars and uncooled 350 bar for trucks/busses



## H2 Tankstellen und Produktion in der Schweiz

350 bar & 700 bar

### H2 Tankstellen eröffnet

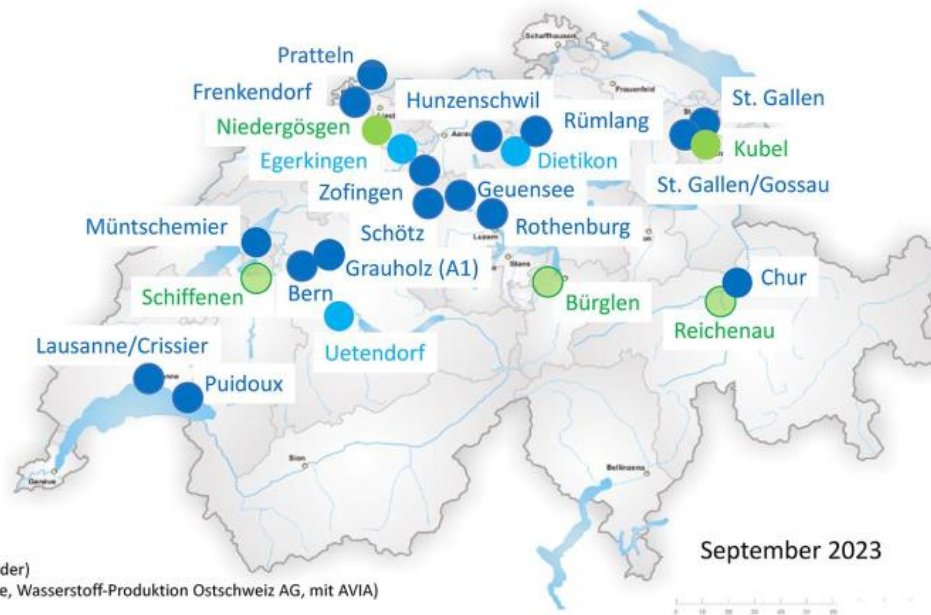
Hunzenschwil	Coop
St. Gallen	AVIA
St. Gallen/Gossau	AVIA (350 bar)
Zofingen	Agrola
Rothenburg	Agrola
Rümlang	AVIA
Lausanne/Crissier	Coop
Geuensee	AVIA
Bern	Coop
Müntschemier	Schwab-Guillod
Frenkendorf	Coop
Chur	Coop
Schötz	Agrola
Puidoux	AVIA
Grauholz	Socar
Pratteln	AVIA

### H2 Tankstellen in Realisierung

Dietikon	Coop (in Planung)
Egerkingen	Coop (in Planung)
Uetendorf	Oiltrans AG

### H2 Produktion

Niedergösgen	in Betrieb (Hydrospider)
Kubel St. Gallen	in Betrieb (Testphase, Wasserstoff-Produktion Ostschweiz AG, mit AVIA)
Schiffenen	im Bau (Groupe E)
Reichenau	im Bau (Axpo und Rhienergie AG)
Bürglen	in Vorbereitung (h2 Uri AG – EA-energieUri AG und AVIA Schätzle)



September 2023

# Status of Swiss Ecosystem substitutes with 47 HD-trucks ca. 2'500 to CO<sub>2</sub>-Emissions per year



- H<sub>2</sub> production capacity: 800 Nm<sup>3</sup>/h in operation (Hydrospider and partners)
- HRS\* in commercial operation: 16 (700 bar for cars; 350 bar uncooled for trucks/busses)
- H<sub>2</sub> Logistics by 350 bar containers: >4200 swaps (Hydrospider/ transport companies)
- Hyundai FC-trucks (HHM\*\*): 47 trucks in CH: >8.6 Mio. km (plus >70 FC trucks in Germany)



\* Hydrogen refuelling station

\*\* Hyundai Hydrogen Mobility

# BEV vs. FCEV-trucks: Total energy consumption (Wh/t\*km) within 10% if the total energy chain included

BEV HD truck



Additional tours + 21%  
compared to Diesel  
(reference pay load)

**BEV**  
51% Losses PV-power  
60% Losses CH-Consumer-Mix power

FCEV HD truck



Additional tours + 5%  
compared to Diesel  
(reference pay load)

**FCEV**  
55% Losses with heat usage  
65% Losses without heat usage

### Assumptions BEV 40to:

Range	400 km
Consumption	1'300 Wh/km
Battery-system	130 Wh/kg
Battery usage	0.8 Kapazität
Battery mass	5'000 kg
Reference pay load	29 to
Pay load	24 to

### Assumptions FCEV 40to:

Range	400 km
Consumption	0.08 kg H2/km
Battery mass	545 kg
Mass FC and tank	788 kg
Reference pay load	29 to
Pay load	27.7 to

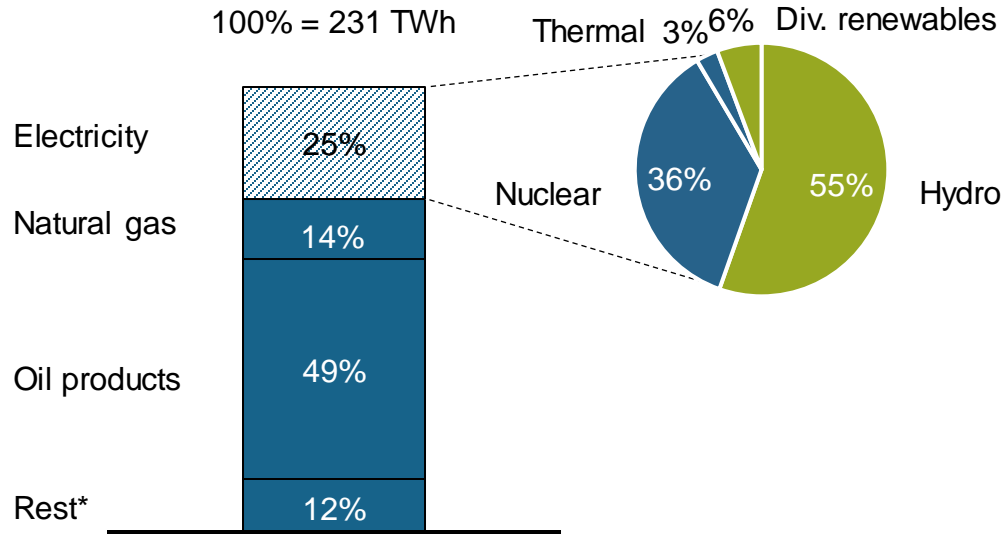
**Difference of energy loss of transport service BEV vs. FCEV is <10%**

# In Switzerland Electricity counts today for ¼ of final energy consumption



## Final energy consumption CH

Nearly 2/3 of power production is renewable



Final energy consumption CH 2018

### Conflict of targets

- Security of supply of energy for CH
- Decarbonisation of energy sector

Quelle: Gesamtenergiestatistik Schweiz 2018

\* Holz, Fernwärme, Industrieabfälle, übrige erneuerbare Energien (ca. 3%), Kohle

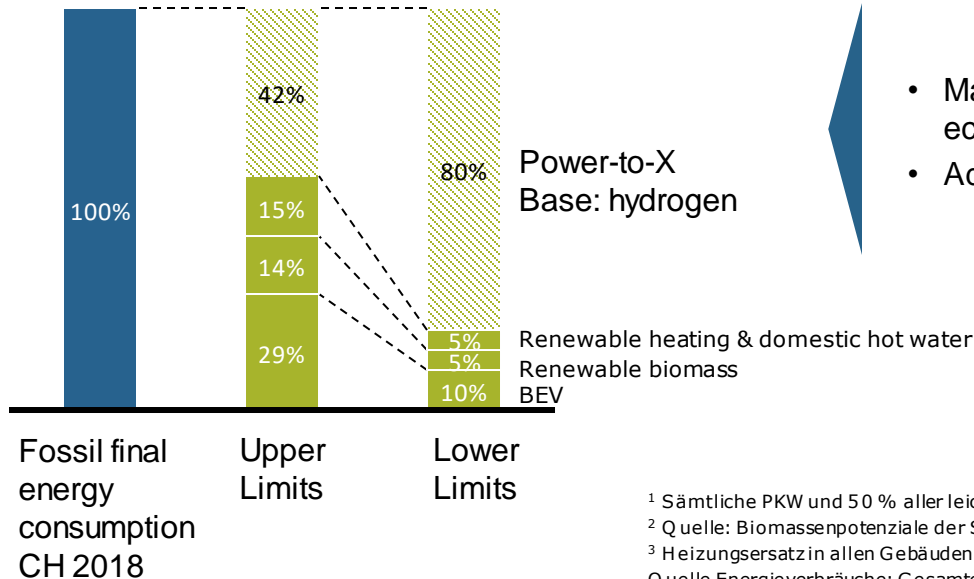


# 42-80% of fossil energy will have to be shifted towards hydrogen for decarbonization

## Conversion of today's fossil energy carriers to renewable carriers (Switzerland)

In TWh and percent

100% = 196 TWh



- Massive shift to hydrogen-based energy economy
- Adaptation of infrastructure needed

<sup>1</sup> Sämtliche PKW und 50 % aller leichten Nutzfahrzeuge in der CH verwenden BEV (Upper Limits)

<sup>2</sup> Quelle: Biomassenpotenziale der Schweiz für die energetische Nutzung 2017 (Upper Limits)

<sup>3</sup> Heizungersatz in allen Gebäuden der Schweiz abzgl. Heizung mit Biomassespeicher im Gebäude (Upper Limits)

Quelle Energieverbräuche: Gesamtenergiestatistik der Schweiz 2018



Pipeline network grow **after** local demand clusters established 

## **H2-Logistics (compressed gas)**

Start & low consumption: Bundle or trailer/container delivery 300-500 bar

Medium consumption: Container or LP-tubes from regional hubs (25-30 bar)

Large consumption: LP- or HP-pipelines; container for backup

## **Pipeline capacity**

H2-pipeline delivers 80-90% energy of naturalgas pipeline

Assumptions:            same diameter  
                                 same pressure level  
                                 same pressure loss

## **Refueling cost as function of truck tank-pressure level**

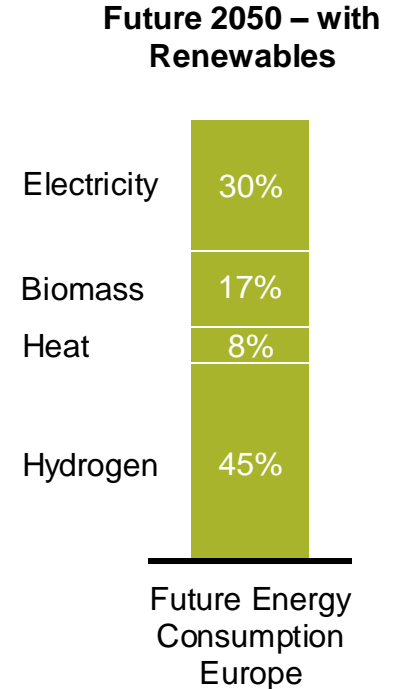
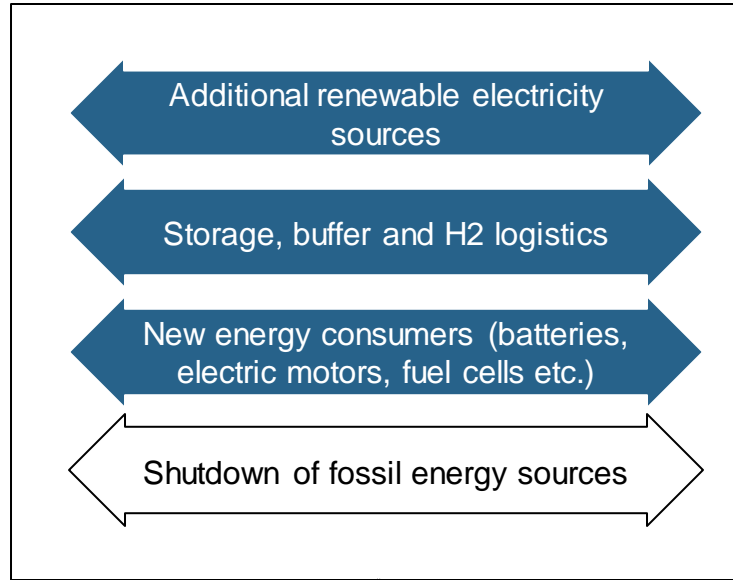
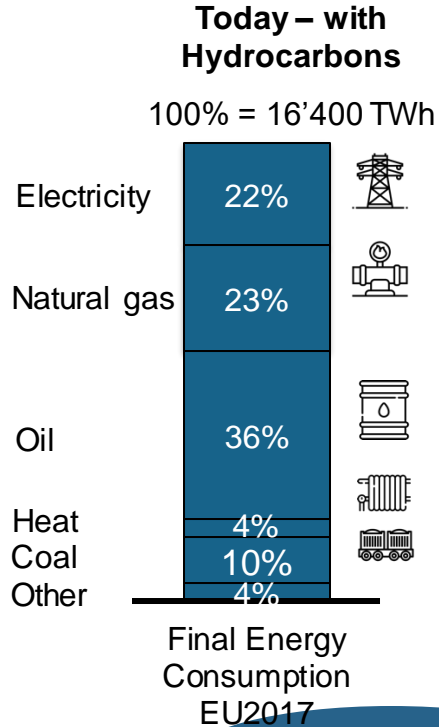
Operation for heavy duty trucks: cost at HRS [CHF/kg H2 dispensed]

350 bar uncooled	350 bar cooled	700 bar cooled
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x	x + 1	x + 2
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 **Unlikely that transport companies will pay additional cost for premium H2 (cooled)**

# How to decelerate climate change



# 1 GW PtX facility in Esbjerg for 90'000 to/y renewable H2

- Planned 1000 MW green hydrogen production facility in Esbjerg DK
- Sourcing energy from new and already operating DK wind farms
- Hydrogen used for decarbonisation of transport, industrial use and PtX-production (storage)



# Kvyreen: Off-grid BEV fast-charger with H2 supplied



- H2 Energy developed a **mobile** technology for **off-grid charging** solutions
- Applications include off-grid **fast-charging for BEV** or **electricity generation** services
- Kvyreen is **powered by green hydrogen** and hence producing renewable energy
- CE certification obtained mid 2023



# Key messages



- **Hydrogen complements direct use of electricity**
  - HRS infrastructure is cost-competitive to BEV-wall boxes (in particular for HD trucks)
- **Efficiency comparisons need the integration of all implications in the whole energy system** (including user benefits)
- **Hydrogen as storage and energy-carrier**
  - Large scale storage of renewable energy needs **molecules** -> **Hydrogen** or hydrogen based energy carriers (methanol or ammonia etc.)
  - **Energy supply** of end customers needs **power-lines & containers/pipelines** for H2 based fuels
- **Hydrogen to intensify decarbonization in several economic sectors**
  - Transportation
  - Industry
  - Services (Backup power of critical infrastructures)
- **Hydrogen applications can support investment security for renewable power generation projects**
  - H2-production plants increase investment security for large renewable power production projects ( offshore wind, hydropower etc. )



Hohlstrasse 188 | 8004 Zürich | Switzerland