

Decarbonisation of Winter Tourism by Hydrogen Powered Fuel Cell Snowmobiles *HySnow*



THE ULTIMATE ZERO-EMISSION POWERSPORTS-EXPERIENCE

Mission Innovation Vienna 13.06.2018

Nigel Foxhall BSc (Hons)



State of the Art

Winter tourism

- **Winter tourism** is one of the most important economic sectors in Austria (11 billion €/a which corresponds to 4,1 % of AT's GDP)
- **High energy consumption, high GHG and pollutant emissions**
- **Various different special vehicles necessary** (snowmobiles, snow groomers, tractors)
- **Internal combustion engine is state-of-the-art**



HySnow
2018



2

State of the Art

Ski resort

- Hinterstoder Wurzeralm is the **largest ski resort in Upper Austria**
- HIWU and the ski club use **10 snowmobiles** for:
 - Deliveries to the huts/gastronomy
 - Rescue operations
 - Transport of persons as well as tools
 - Tourist attractions
- **3500 l Gasoline** per season
- **High emissions and noise**

HySnow
2018

3

Motivation

The **major challenges** for **future winter tourism** and the **global special vehicle industry** are:

- ✓ Decarbonisation and reduction of the energy consumption
- ✓ Enabling utility application and individual mobility featuring the ultimate ride
- ✓ Social acceptance

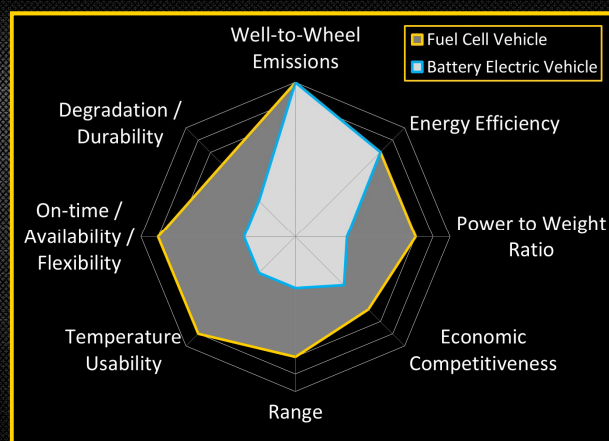
HySnow
2018

4

Zero-Emission Snowmobiles: Battery vs. Fuel Cell?

Key Requirements

- **Cost effective**
- **Frequent starts and operation at low temperatures - 40 °C**
- **High power to weight ratio**
- **High low-end torque**
- **High energy demand**
- **High flexibility**
- **Excellent efficiency**
- **Additional services APU**

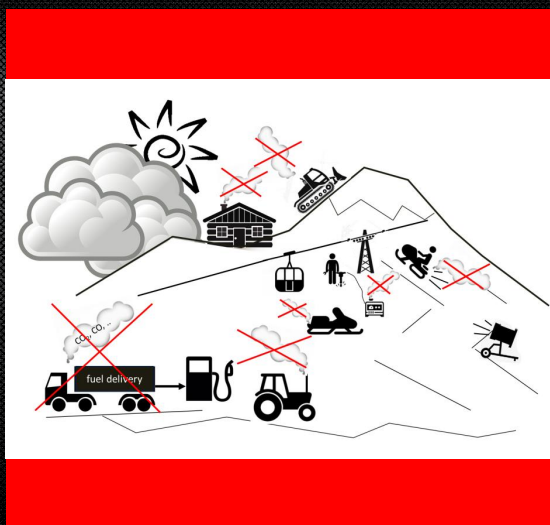
HySnow
2018

5

Vision of HySnow

Sustainable vehicles & infrastructure

- **Zero-emission special vehicles**
- Zero-emission footprint offers **new quality growth in tourism**
- **Snowmobiles** are an **excellent starting point** for transfer of special vehicles towards zero-emission
- **On-site refuelling station** required
- **New technologies and added value of Austria's industry**

HySnow
2018

6

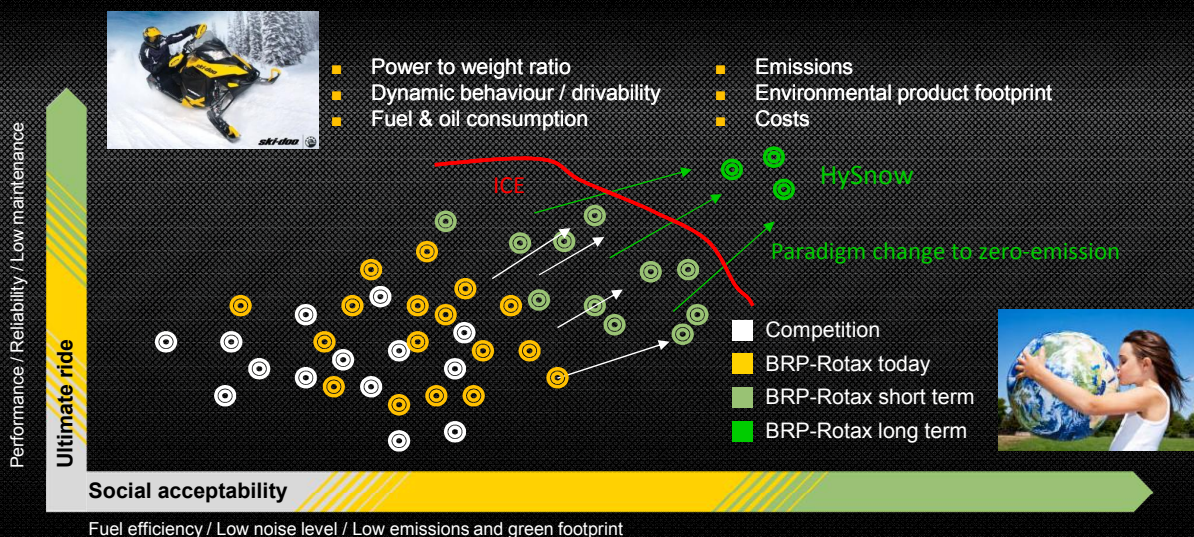
High Level Goals of HySnow

Sustainable vehicles & infrastructure

- **Research on key issues** regarding freeze start and degradation of FC
- **Development** of hydrogen-powered fuel cell snowmobile
- **Development** of sustainable on-site hydrogen refuelling station
- **Demonstration** of two vehicles over **three winter seasons**
- **Basis** for subsequent **series development** and **paradigm change** of propulsion technology



Development for a Bright Future



Project Consortium



- Deep understanding regarding needs of winter tourism
- Aspects of user acceptance
- Demonstration at Ski World Cup

HySnow
2018



Goals - Vehicle

- > 50 % life op
- > 5000
- < 5 %
- 30-40
- High lo
- Vehicle Refue
- FC sys
- Long-t
- APU fu



HySnow
2018



Goals - Infrastructure

Photovoltaics



Electricity grid

Optimized energy usage

HP-PEM electrolyzer



35 MPa without compressor

H₂ storage



Alpine conditions



H₂ dispenser



HySnow
2018



11

Goals - Infrastructure

Hydrogen production costs of < 12 €/kg

On-site 350 bar hydrogen production

Degradation of < 16 μV/h lifetime of stack: 50 000 h

System efficiency > 60 % (gross calorific Value)

Annual maintenance costs < 3 % of invest costs

Photovoltaics



Electricity grid

Optimized energy usage

HP-PEM electrolyzer



35 MPa without compressor

H₂ storage



Alpine conditions



H₂ dispenser

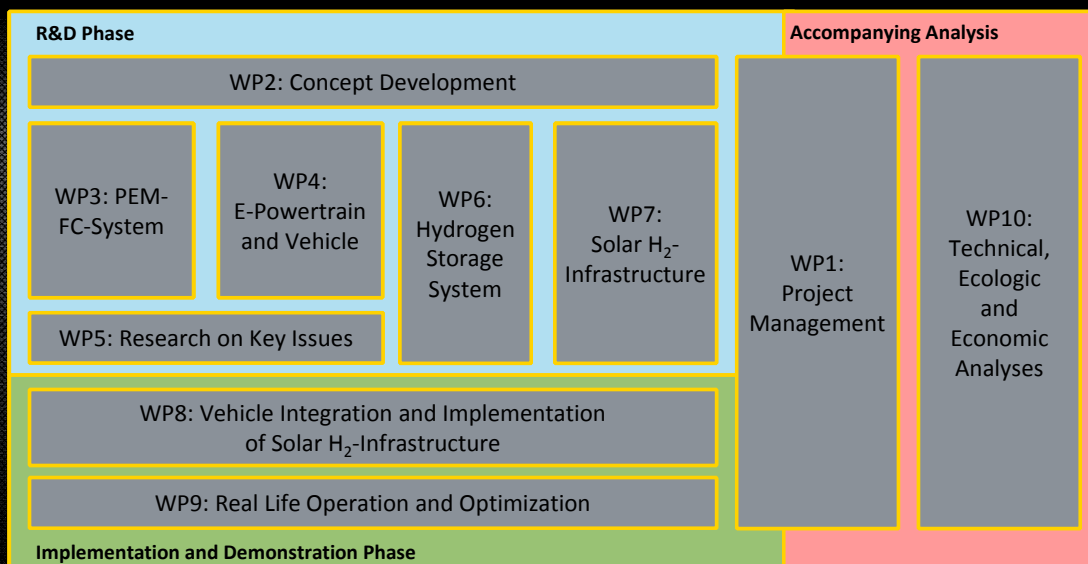


HySnow
2018

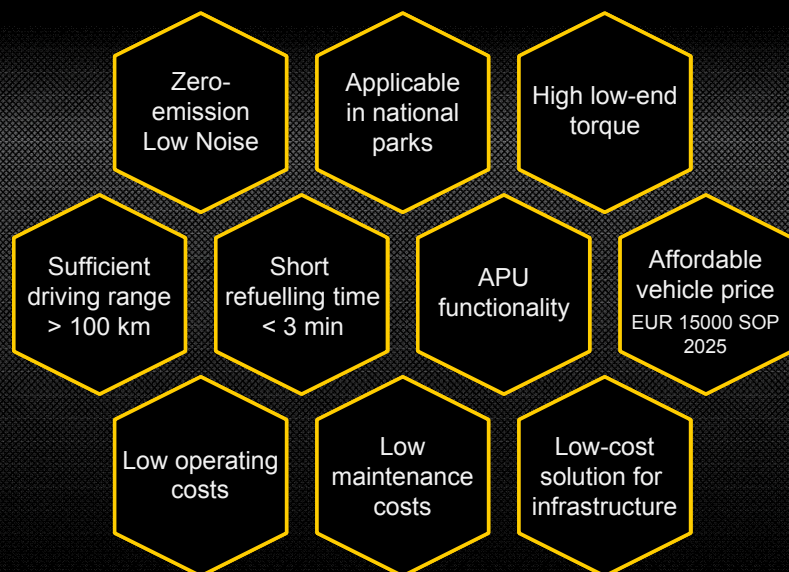


12

Structure of Work Packages



User Benefit



Relevance for Austria

Environmental aspects

- ✓ Reduction of national CO₂ emissions & elimination of pollutants (SO_x, NO_x and particles)
- ✓ Reduction of noise emissions (particularly in sensitive ecological and tourism areas)



Economic aspects

- ✓ Strengthening the competitiveness of Austrian companies and research institutes in the area of green technologies
- ✓ Support the market penetration of sustainable mobility and generation of new quality growth in tourism
- ✓ Creation of new market and leadership opportunities for the Austrian industry on the global market
- ✓ Value creation by the Austrian industry for FC and hydrogen technology
- ✓ Less dependent on imported fuels



Social aspects

- ✓ Securing the existing jobs and creation of new green jobs
- ✓ Positive impact on health
- ✓ Strengthening the green image of Austria



HySnow
2018

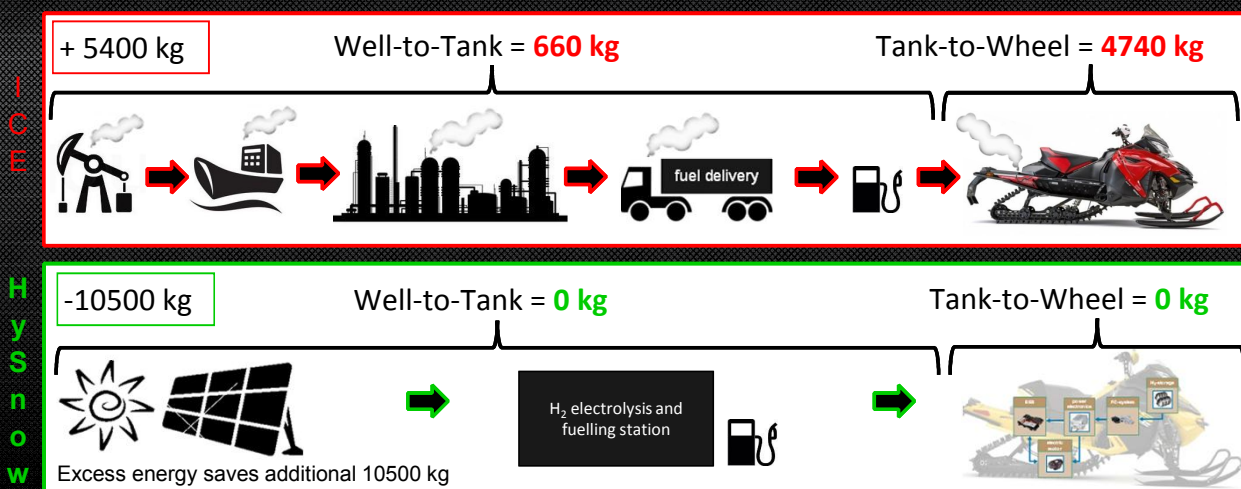


15

GHG Reduction Potential – Well-to-Wheel

15900 kg CO₂ savings of two units in three winter seasons

➡ Life cycle emissions will be calculated based on the project results



HySnow
2018



16

Time Schedule of Work Packages

HySnow																				
		2017			2018				2019				2020				2021			
WP	Lead	Cat.	TRL SO WP	TRL EO WP	Q2	Q3	Q4	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4	Q1
1	BRP	ED	n.a.	n.a.	Project Management															
2	HyCentA	ED	n.a.	n.a.	Concept Development for H ₂ -Snowmobile and Solar H ₂ -Infrastructure				MS1: Specifications defined (01.09.2017)											
3	HyCentA	ED	4	5	Development of PEM-FC-System				MS2: Stack and BoP provided for system integration (31.05.2018)											
4	BRP	ED	4	6	Development of Electric Powertrain, Packaging and Design				MS4: Design freeze vehicle (01.10.2018)											
5	HyCentA	IR	2	4	Research on Key Issues and operating Strategies of PEM-FC System				MS7: Vehicle integration (01.02.2019)											
6	HyCentA	ED	5	6	Development of 350 bar Hydrogen Storage System				MS5: H2 tank ready for integration (01.11.2019)											
7	Fronius	ED	5	6	Development of 350 bar Solar H ₂ -Infrastructure for Alpine Environment				MS3: Start of Installation H ₂ infrastructure (01.10.2018)											
8	HyCentA	ED	5	6	MS6: H ₂ station ready (31.12.2018)				Vehicle Integration and Implementation of Solar H ₂ -Infrastructure				MS8: First vehicle operation (01.03.2019)							
9	Hinterstoder	ED	6	7	MS9: Optimized vehicle (31.12.2019)				Real Life Operation and Optimization of H ₂ -Snowmobiles and Solar H ₂ -Infrastructure											
10	HyCentA	ED	n.a.	n.a.	Monitoring and Technical, ecologic and economic Analysis				MS10: Demonstration finished (01.03.2020)											

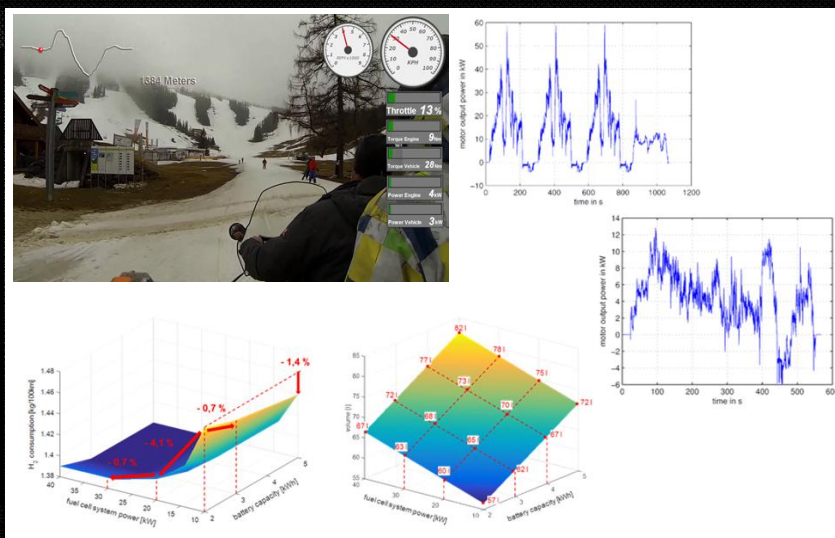
HySnow
2018



17

Status Concept Development

- Test drive measurements in Hinterstoder **FINISHED**
- Derivation of driving cycles **FINISHED**
- Performance analysis of electric drivetrain **FINISHED**



HySnow
2018



18

Status : Development of PEM Fuel Cell System

- Task 3.1: Detailed Conception of Stack Module and Short Stack Testing

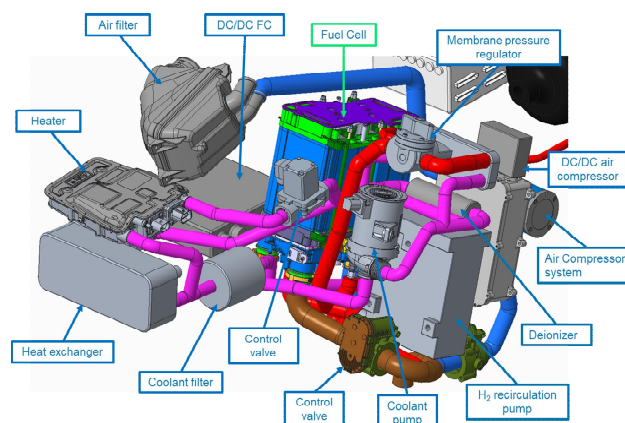
IN PROGRESS

- Task 3.2: Full-Size Stack Module Development, Manufacturing and Testing

IN PROGRESS

- Task 3.3: System Design and Selection of BoP

IN PROGRESS



HySnow
2018



19

Status : Development of Photovoltaic Infrastructure

- 34.5 kWp PV-plant has been installed
- 128 PV modules, each with 270 Wp @ 1.65 m²



HySnow
2018



20

Status : Development of Hydrogen Refueling Station

- / 1 Electrolysis container
- / 2 H2 Storage
- / 3 Refueling post



HySnow
2018



21

Thank you for your attention!

