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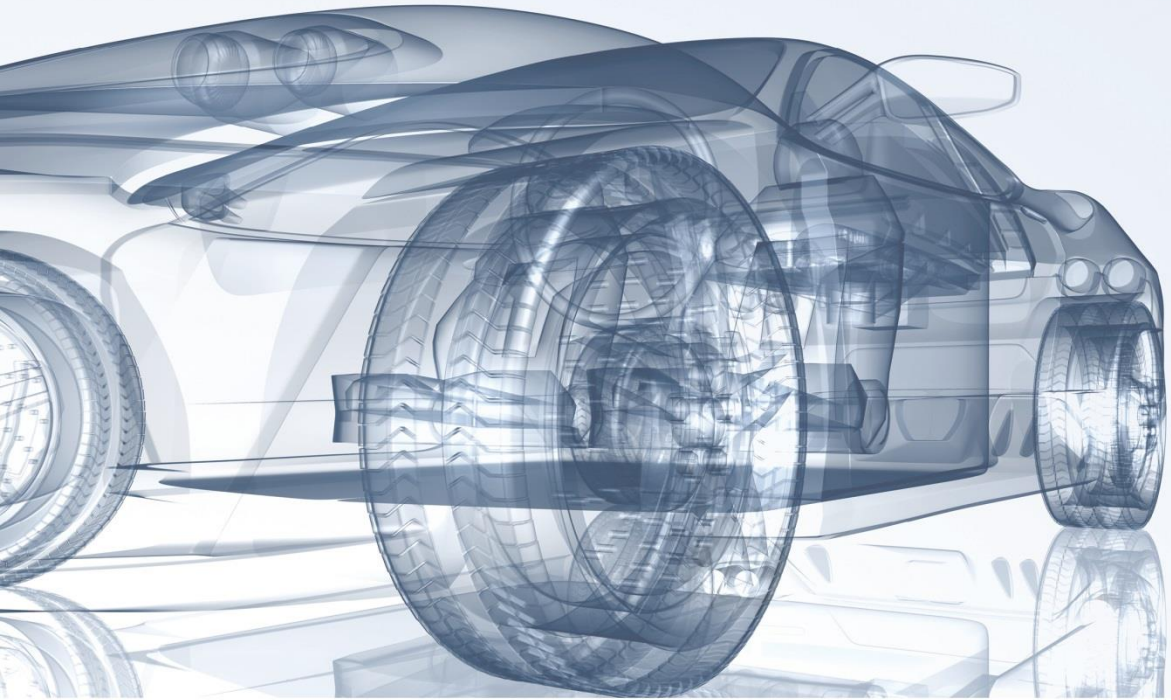

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The EnergyTube System

A Module based, Scalable Energy System, with Battery and Fuel Cell for Portable, Mobility and Stationary Applications

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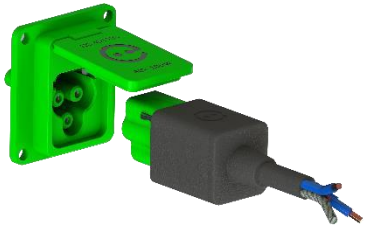
Agenda

- Company Background
- The idea of EnergyTube System
- Author Background with Fuel Cell Cycles
- Concept of
  - H2 FuelCellTube
  - H2 StorageTube
  - H2-FuellingTube
- Specifications, Energy Density and System-Effects
- Applications
- Advantages and Challenges
- Summary

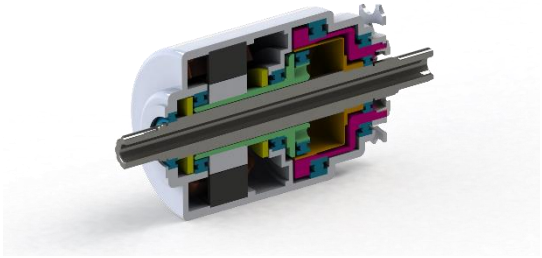
Unicorn Engineering GmbH

- Was founded in Schwäbisch Gmünd, Germany 2010.
- Development Company which works together with partners for industrialization.
- Development of new technologies based on meaningful modularity and standardization.
- Main produced developments are:

EnergyTube



EnergyLock



EnergyDrive

Video: www.energytube.de

Range of applications for the EnergyTube System

number

50.000

1.200

600

100

30

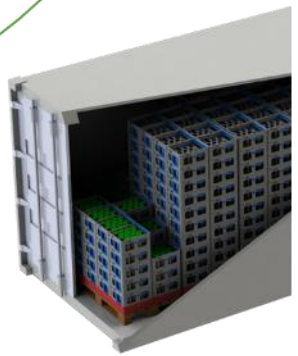
10

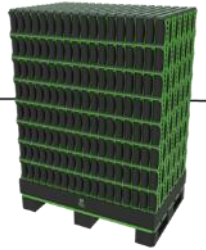
3

The specification for the worldwide standard: **IEC TS 61851-3-3 „Battery Swap System“**, will be likely published 2018. EnergyTube is the first battery system developed according to this standard and may be used in private, public and industrial applications.

EnergyTube enables **„changing instead of charging“** for e-mobility and mobile applications

EnergyTube enables **multi-usage in numerous appllications**





100Wh

600Wh

1kWh

4,8kWh

170kWh

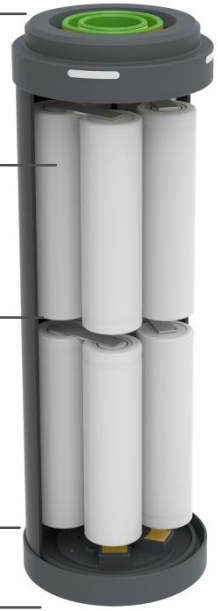
up to 6 MWh

EnergyTube Battery Module

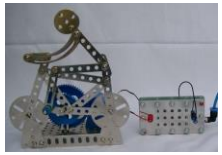
Universal, modular battery module
Plug & Play to handle by end user

Small, compact units with enough performance to serve also powerful applications

Self-finding magnet connector which is disconnected by kinking



Fuel Cell Cycles
A long term passion of the Author



2000 Eitech Fuel Cell Construction Toy

2001 H2 power scooter

2002 Pios hydrogen cycle

2003 Pios hydrogen tricycle

2008 Pios fuel cell motorcycle

2010 Shell Eco Marathon

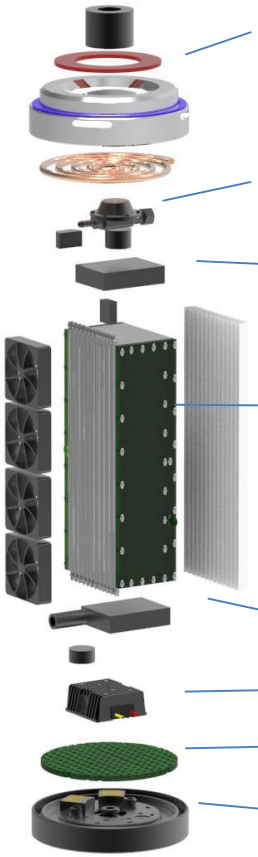
2010 Fuel Cell Cycle with Pios Power Pack

2013 Monarch Fuel Cell Cycle

2017 Fuel Cell Cycle with H2 EnergyTube System

Presenter: Dr. Joerg Dieter Weigl, Unicorn Engineering GmbH

Concept of H2 FuelCell Tube and H2 StorageTube



H_2-interface (input) contactless communication and power interface

H_2-pressure regulator

H_2-valve

PEM-fuel cell stack with air supply, cooling system, air filter

H_2-purge valve

DC/DC converter

controller

electric connector with NFC-communication

energy converter 100 W

energy storage 200 Wh

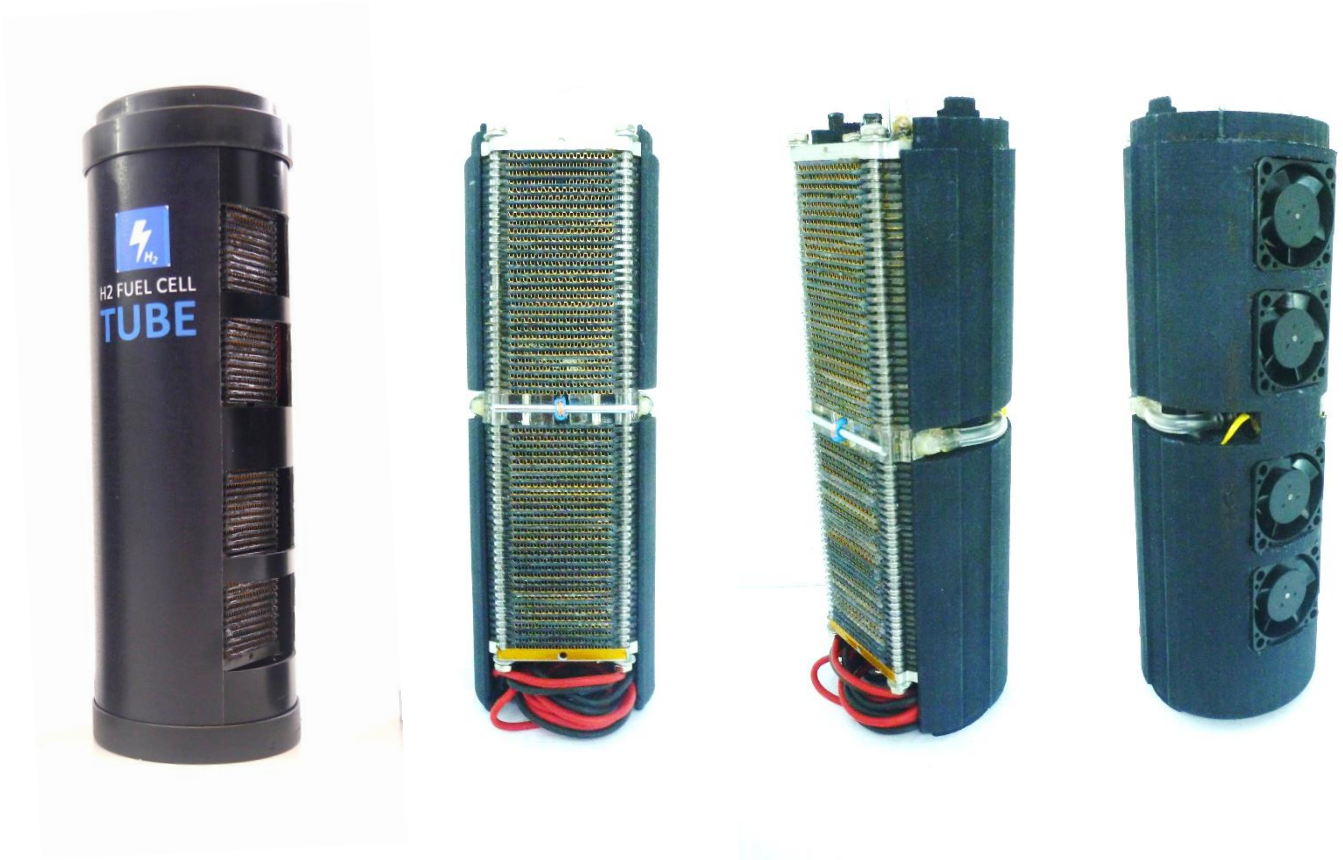
H_2-interface (input) contactless communication and power interface

H_2-pressure tube aluminium- and carbon fibre tube

H_2-fueling valve plus pressure and temperature control

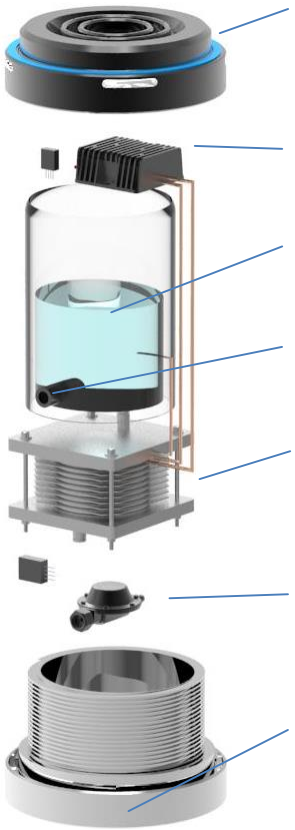
H_2-interface (output) contactless communication and power interface

H2 FuelCell Tube Prototype



Concept of the H2-FuellingTube

H2 FUELING
TUBE



electric connector with NFC-communication

DC/DC converter for power generation

H_2O tank

H_2O filling connector

electrolyser (high pressure) with cooling device

H_2 + O_2 outlet valve plus pressure and temperature control

H_2 outlet connector with contactless communication power interface

Energy Densities in Comparison

ENERGY TUBE + ENERGY TUBE + ENERGY TUBE = 300 Wh

H2 ENERGY TUBE + H2 STORAGE TUBE + H2 STORAGE TUBE = 400 Wh

H2 ENERGY TUBE + H2 STORAGE TUBE = 500 Wh

Modular Structure and Scalability

6 • ENERGY TUBE = 600 Wh

ENERGY TUBE + H2 ENERGY TUBE + 4 • H2 STORAGE TUBE = 900 Wh

ENERGY TUBE + H2 ENERGY TUBE + 4 • H2 STORAGE TUBE = 2600 Wh

Synergy-effects of Battery- and Fuel Cell Module

- Complementation of the EnergyTube by doubling the capacity and reducing the weight by half with fuel cell.
- Flexible hybridisation allow better adjustment to the load profile
- Single tubes are replaceable, without disrupting the whole system
- Consumer friendly, easy to use
- Intelligent system with remote power tracking and control.

Technical Specifications of the EnergyTube System Moduels

Description	EnergyTube (battery module)	H2 EnergyTube (fuel cell module)	H2 StorageTube (pressure tank module)	H2 FuelingTube (electrolyze module)
Diameter	59 mm			59 mm*
Hight / Length	180 mm (174 mm connected)		180 mm single tube 360 mm double tube	180 mm*
Weight	624 g	400 g*	300 g*single tube 500 g* double tube	1kg*
Power	250W	100 W	H2 flow 1 Slpm	90 W* (Consumption)
Capacity	100Wh	-	200 Wh* single tube 500 Wh* double tube	1,5 g* H_2 per hour (up to 800 bar)
System Voltage	9 – 60 V (adjustable by NFC communication)		(5 V* internal)	Input 9-60 V *
Start-up time	<4ms*	< 1 min*	Opening time < 10 s*	1 - 2 min*
Start-up voltage	auxiliary power source 12V			-
Communication	Nearfield communication (NFC)		Qi-Standard	NFC*
Costs (Sales Price)	<100 €	<500 €	200 -300 €	1000-2000 €

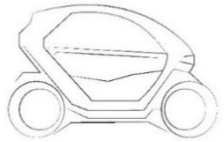
*target value

*target value

Applications with the H2 EnergyTube System

- **Emergency systems** which need a fast and reliable electrical supply – (almost no self-discharge of the hydrogen system)
- **High capacity** and **low weight applications** (motorised vehicle applications)
- Island applications and which benefit from **long-term storage** of solar and wind energy

Daily and **seasonal storage** of the solar- and wind energy



Advantages and Challenges in developing the H2 EnergyTube System

- **Challenges are:**

  H2 FuellingTube: High pressure electrolysis

  H2 StorageTube: Approval process

  H2 FuelCellTube: Reproduceable fuel cell stack performance/quality

- **Advantages are:**

  Compatible system with many applications - economy of scale and same parts

  Accepts 20-40 times higher fuel cell stack per kW costs than fuel cell passenger cars

  - as they are small systems

  Small scale of each module with low hydrogen flow rates gives advantages for new system design

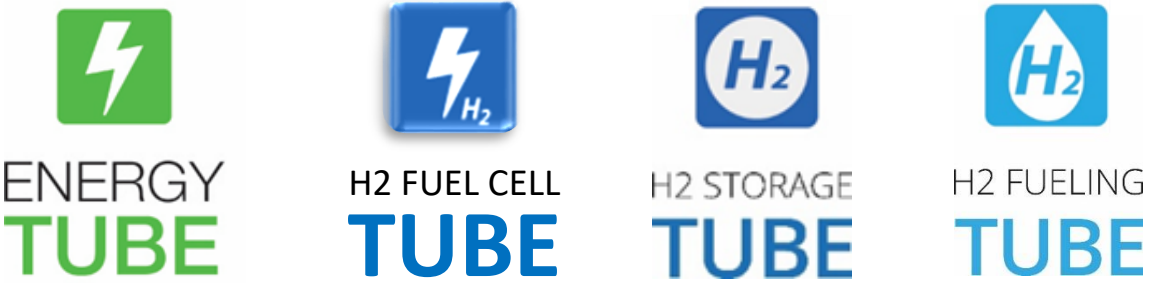
Summary

- The **EnergyTube System** with its modularity and safety has a very high market potential in various applications. (**Portable, Mobile and Stationary**)

- For the **EnergyTube battery system** the production has started aiming to produce a **30 000 units** till X-mas 2017.

- The **H2 EnergyTube** system with **Fuel Cell, Storage and Refuller** is in the prototype stage developing to production in the next two years; - partners are welcome!

- The **H2 FuelCellTube System** will compliment the EnergyTube battery systems wherever and when ever **more capacity/rang (x2), less weight (1/2)**, and additional **reliability** by a second system is required or wished for.



Thank You!

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