

# High temperature PEM; part of the solution

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# Company setup

## SerEnergy A/S (DK)



- Research & Product Development
- Business Development
- Prototype and pilot series production

## Fischer Eco Solutions GmbH (DE)



- Development of production machinery and processes
- Medium and large scale manufacturing
- Design for manufacturing

# SerEnergy

## **Ser**!energy

- Located in Aalborg, Denmark
- Established 2006
- ~30 employees (~40 incl. Fischer)
- Privately owned
  - Founders
  - Fischer Group GmbH

# fischer group

- Important global supplier of tubes and components made of stainless steel
- Family enterprise since 1969
- 12 production sites worldwide
- 522 Mio € sales volume
- 1545 employees



# Business focus

- Focus on HT PEM stacks and modules
  - Air cooled
  - Liquid cooled
- Focus on Reformed Methanol Fuel Cell (RMFC) modules
  - Backup power
  - Auxillary power units
  - Electric mobility range extention

# HT PEM Technology

- **Characteristics**

- Operation at 160 °C
- Start up: 5-30 min
- Ambient +60 °C ( $\Delta T$  100 K)
- No water regeneration or humidification
- 250 W to 15 kW range

- **Status**

- 30.000 hours MEA level
- 5000 hours stack/system level - (12  $\mu V$  hour)
- Product/BOP maturing
- Reformer integration optimized design

# Comparison HT- and LT-PEM Technology

## HT-PEM

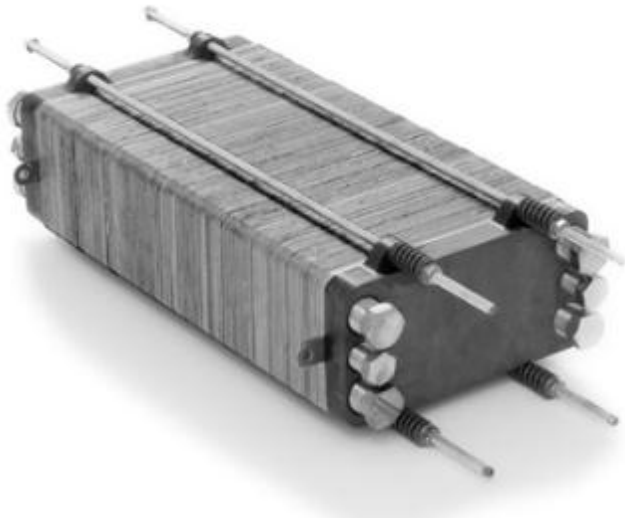
- Operating Temperature 160°C
- No gas cleaning necessary
  - Liquid fuels with reformer
- Simple fuel storage
- Heat rejection easy
  
- Power density lower of stack than LT

## LT-PEM

- Operating Temperature below 100°C
- Pure fuel gases necessary
  - Pure hydrogen fuels
- Complex fuel storage
- High cooling areas necessary
  
- Power density of stack higher than HT

# HT PEM stacks

- Air cooled - 1 kW
- Liquid cooled – 5 kW





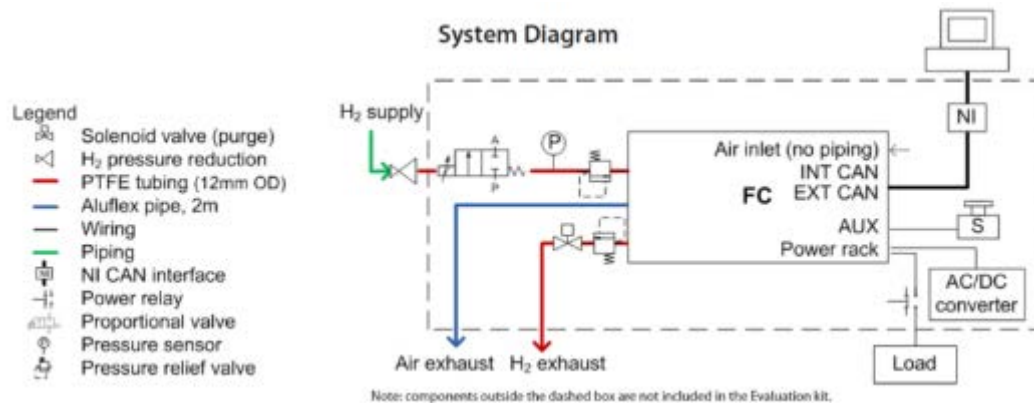
# Serenus Air modules



**Serenus Air C - module**



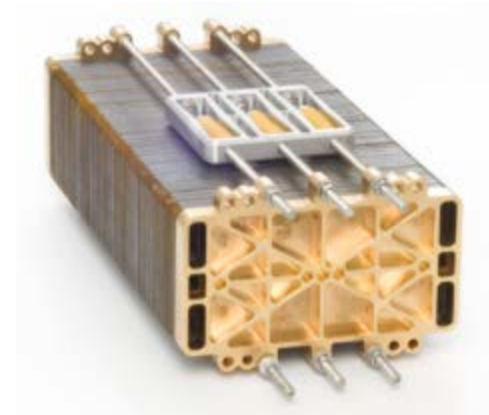
**S45 - 66 cell stack**



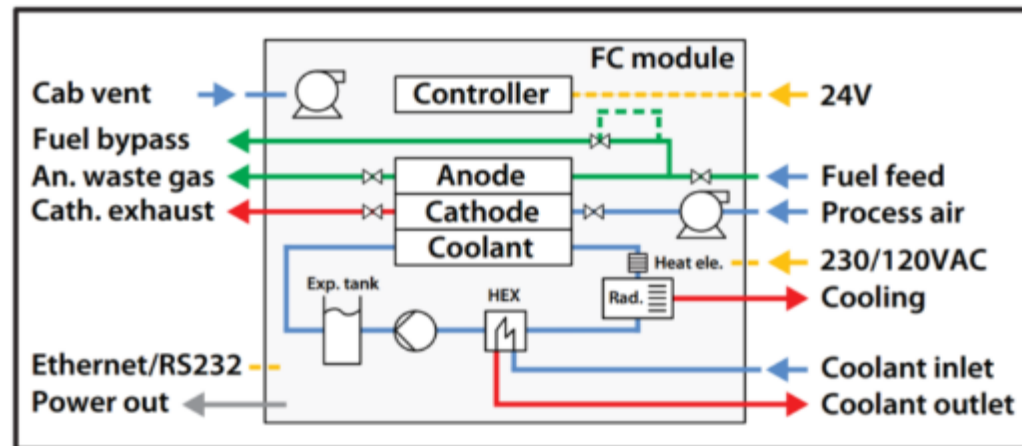
# Serenus Liquid C modules



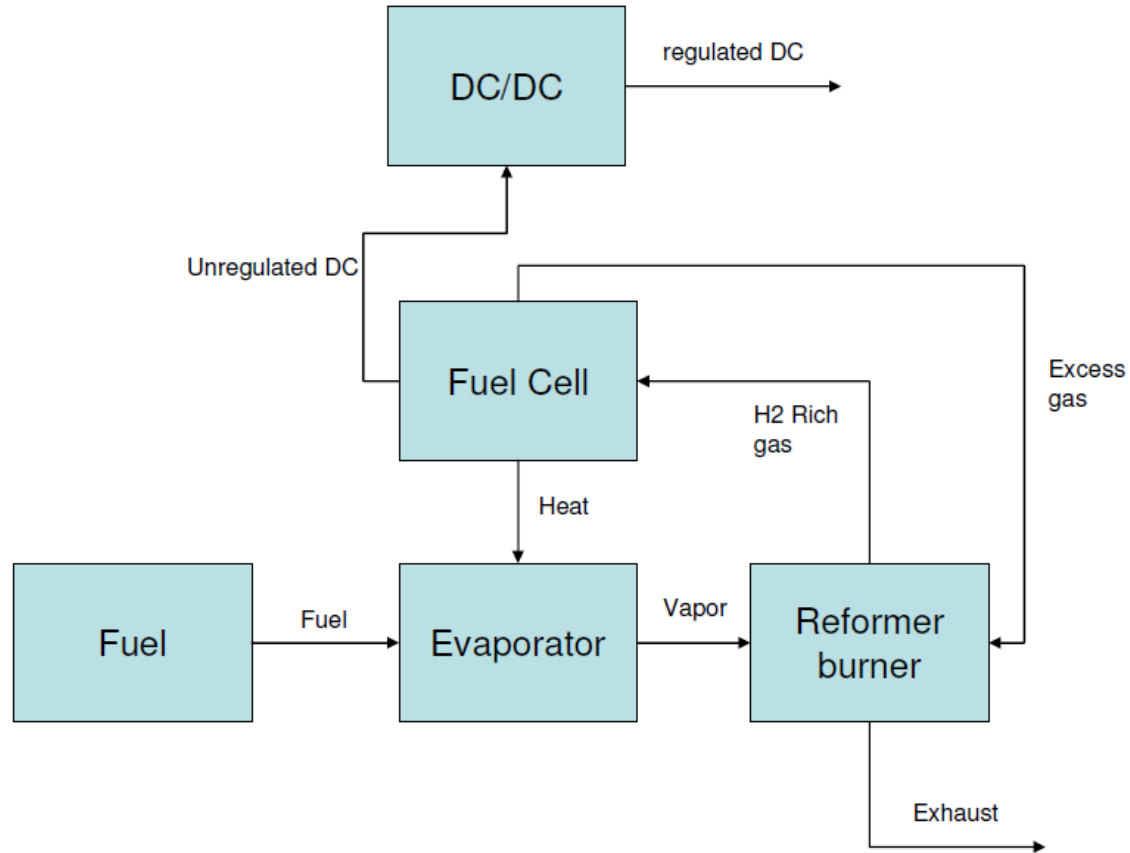
Serenus Liquid C - module



S165-120 cell stack



# Reformed Methanol Fuel Cell



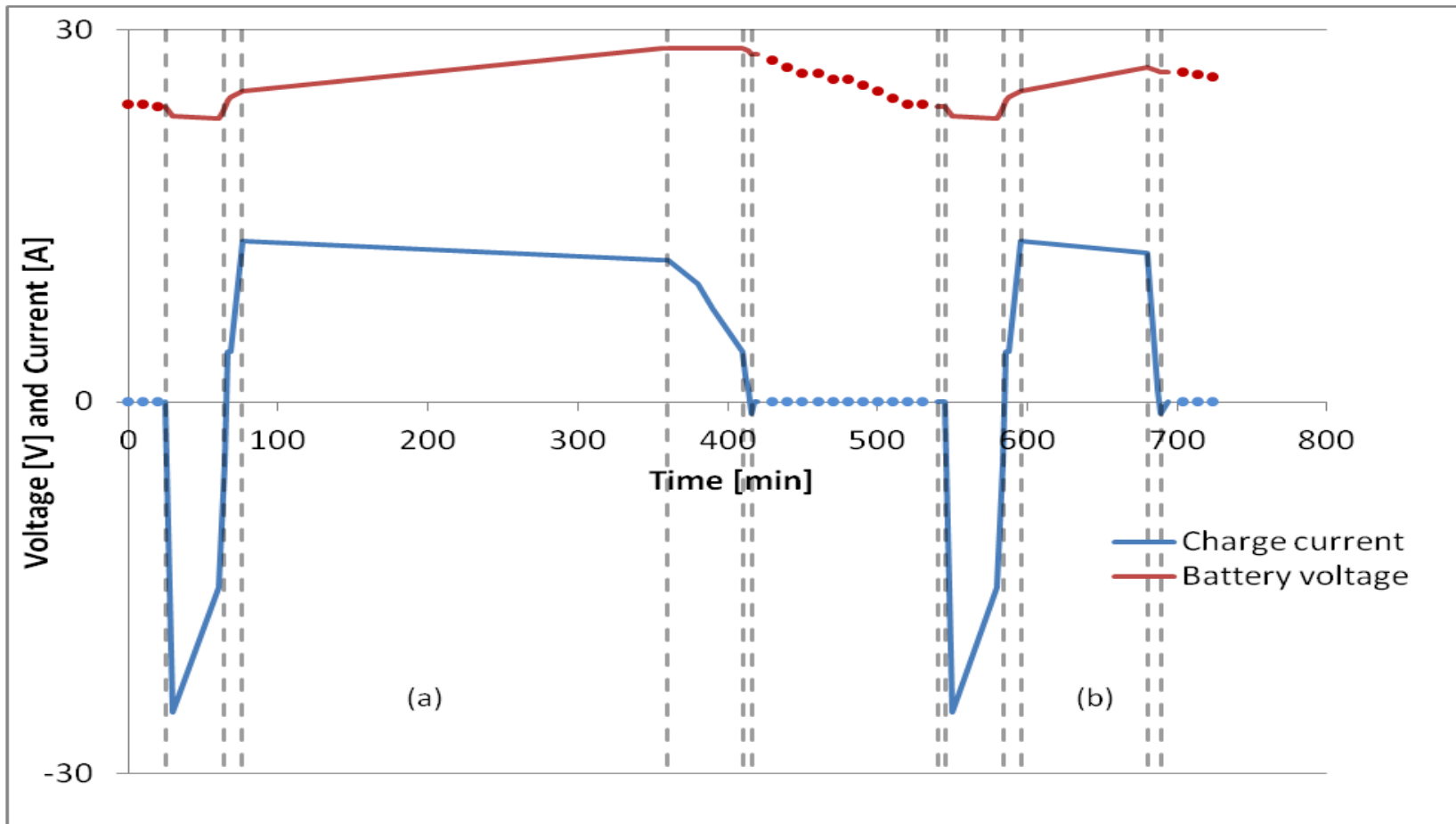
# H3 350 RMFC system

## Reformed Methnaol Fuel cell

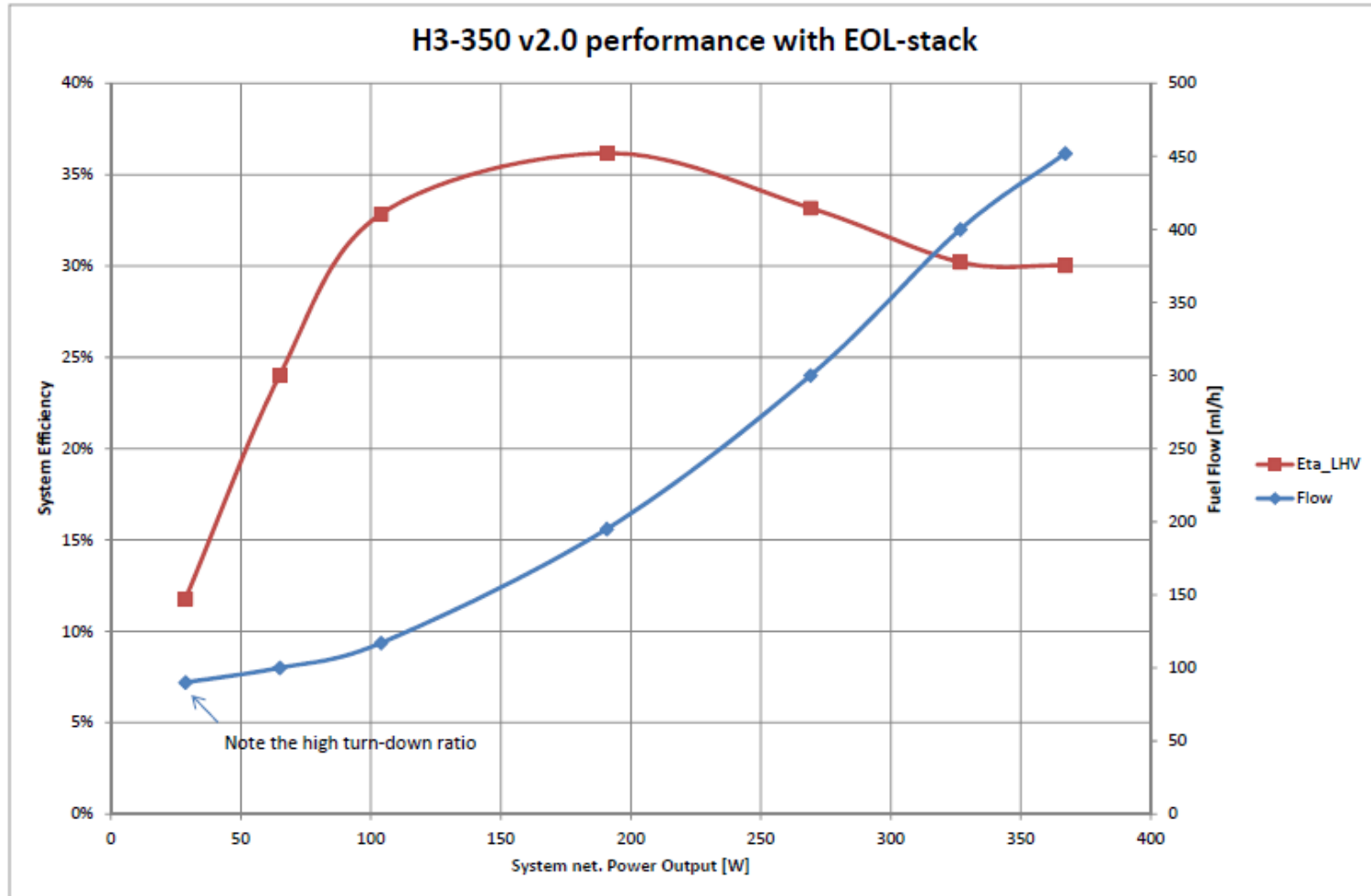
- Power output 350W
- Voltage 24 VDC
- Weight 13 kg
- Fuel consumption 0,44 L/h



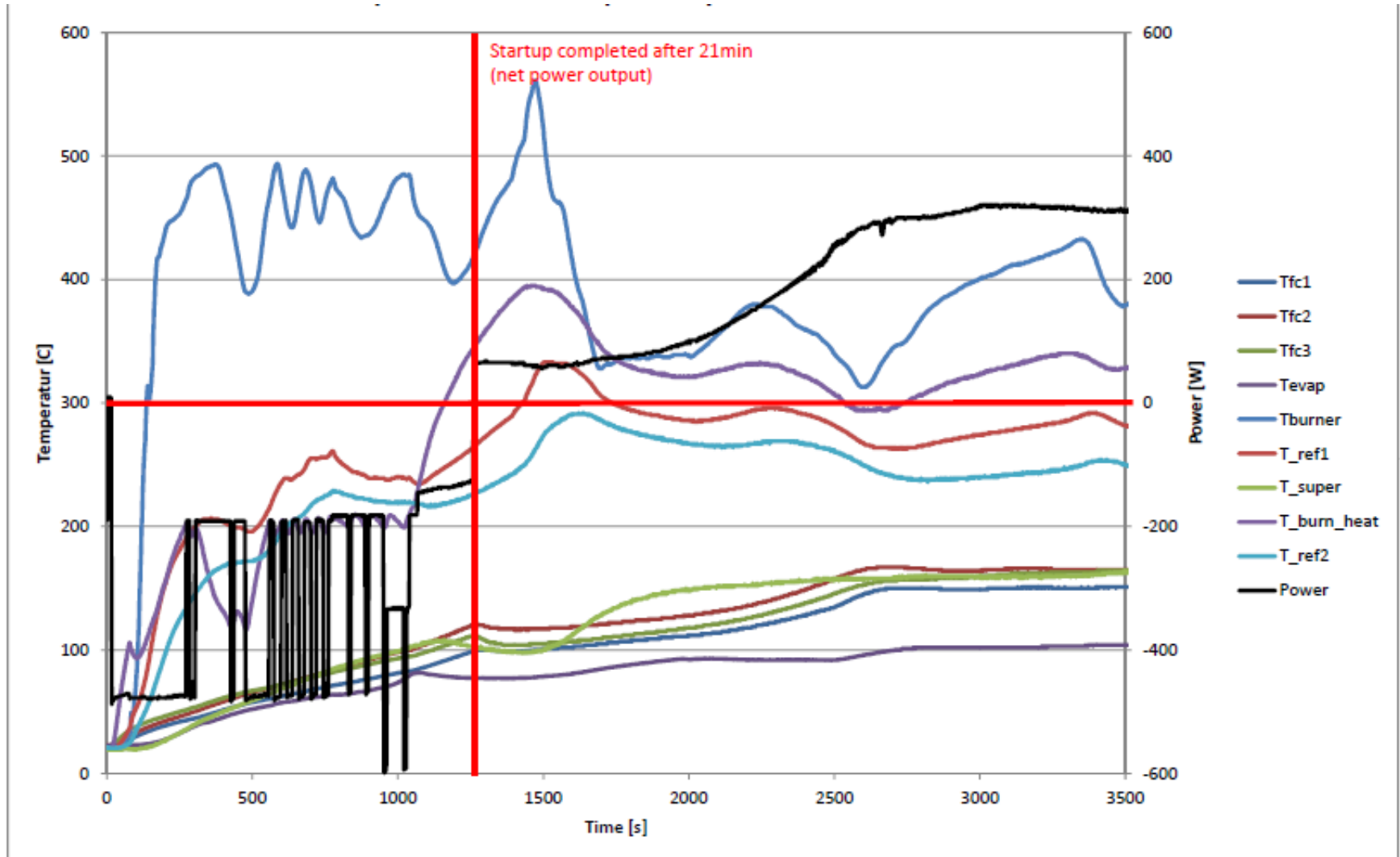
# Operation logic



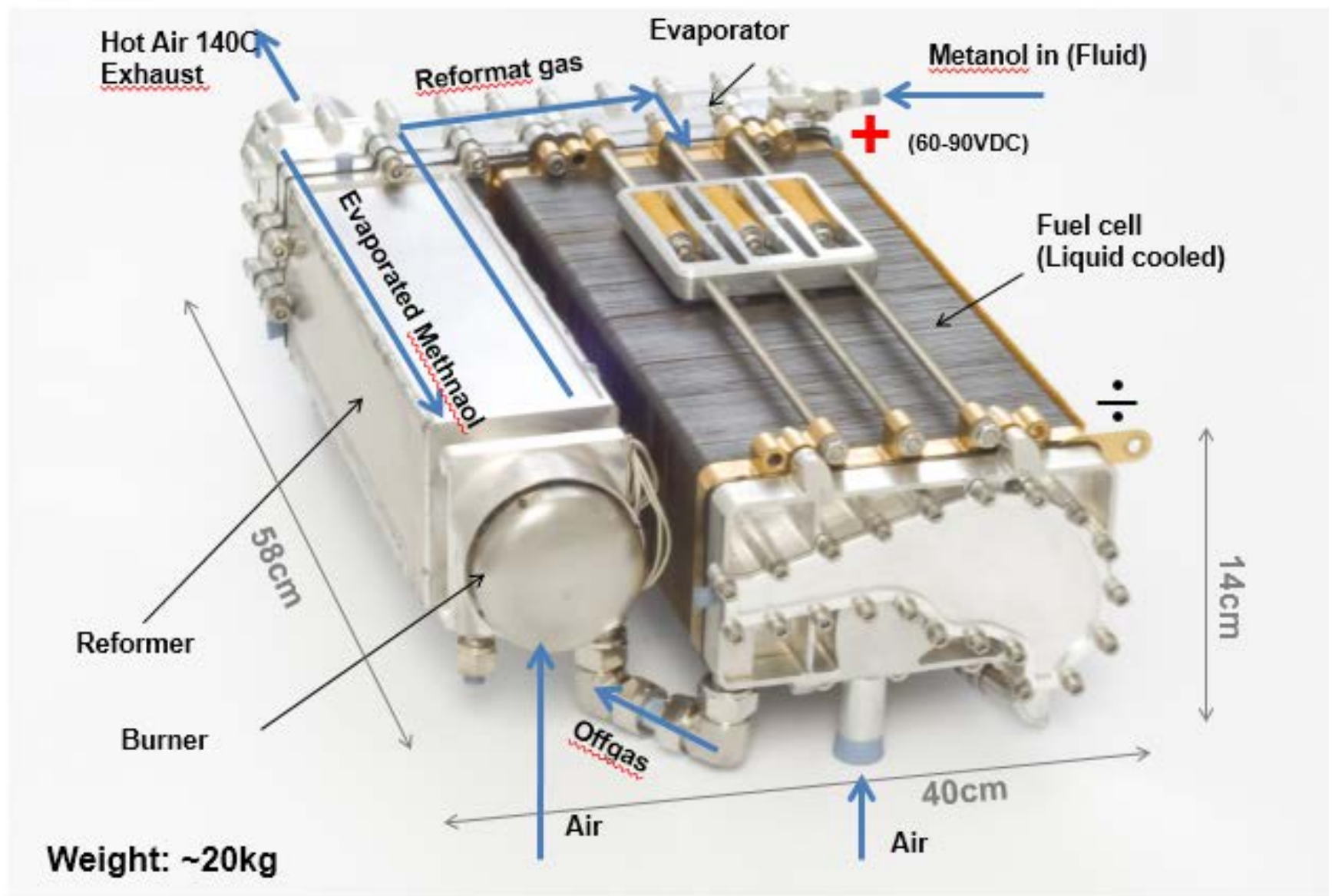
# H3 350 - EOL performance



# H3 350 start up - EOL



# Technology





# H3-5000

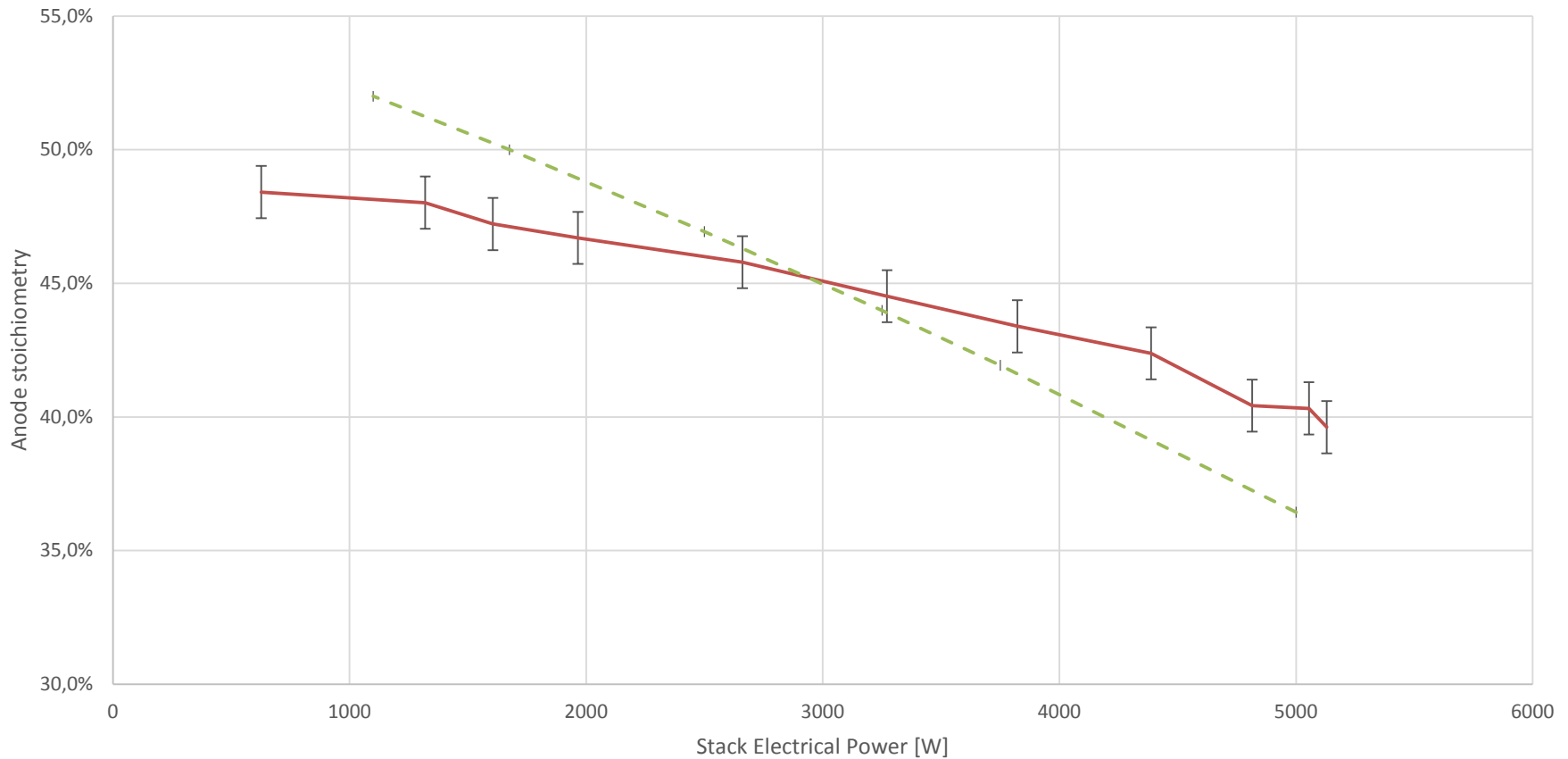
## 5kW methanol module



- Electric power: 5kW
- Thermal power: 4-5kW
- Total efficiency (LHV): >85%
- Elec. efficiency(LHV): 40-50%
- Weight: 45kg
- Dimensions:
  - Width: 19"/430mm
  - Length: 700mm
  - Height (6U/253mm)
  - Volume: 77L
- DC/DC: integrated – bat charging capability
- Output voltage: 24/48/80 or 400-600 VDC

# H3-5000 - Performance

Total Electrical Efficiency, incl BoP Power  
H3-5000 RMFC, Ver 2.2



# OEM reformer systems

Reference  
Project

- Raw stacks, Manifolds
- Complete Fuel cell Modules
- TRL 6-7 (small volume test/trial)



# Combined Heat & Power

Reference  
Project

- 20 kW grid connected
- 4 x Serenus 120 modules
- 2 x standard racks
- Reformat gas operation
- Power conversion
- Grid connected



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# Telco backup deployment

Reference  
Project

## Telco backup power deployment

- 700W @ 48 VDC
- 72 hours autonomy
- 7,5 kwA Genset replacement



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# Small Materials Handling EV

Reference  
Project

- Onboard Power supply
- Lead acid/Li-ion battery charging
- Integrated HTPEM stack, methanol reformer & power electronics
- In the field trial since 2010
- Direct replacement of diesel vehicles ; Cemetery Gartners, airports
- 2 x H3 350 units



<http://www.youtube.com/watch?v=EKLaP5ytwxw>

# Mobile Generator

Reference  
Project

## Telecom Emergency response generator

- Integrated flightcase design
- 700W power pack
- Simple to transport/carry
- Simple/safe fuel concept



# Vehicle Range Extender

Reference  
Project

- Automotive modular drivetrain (with Ecomove from Horsens)
- Battery/Reformed methanol fuel cell hybrid
- 800 km range
- 3 min refueling with existing infrastructure
- High Temperature PEM with integrated reforming
- Waste heat for both heating and cooling
- Superior WtW and energy efficiency





# REM 2030

Reference  
Project

- Regional Eco Mobility 2013
- Baden-Württemberg initiative
- AUDI, Fraunhofer, SerEnergy
- Electro mobility with range extender
- Audi A1 E-tron conversion
- Battery/Methanol fuel cell Hybrid



# Summary & outlook

- Performance
- Stability
- Price
- Product

## Outlook

- Temperature
- Pressure
- Bipolar plates

Thank you for the attention

