areNH3a

First Workshop ARENHA project: "Introduction to novel technologies related to ammonia-based energy storage"

Development of Low-Temperature Solid Oxide Electrolysis Cells

Freddy Kukk
Contact: freddy.kukk@elcogen.com

This project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement No 862482

Fuel cell technology elcogen

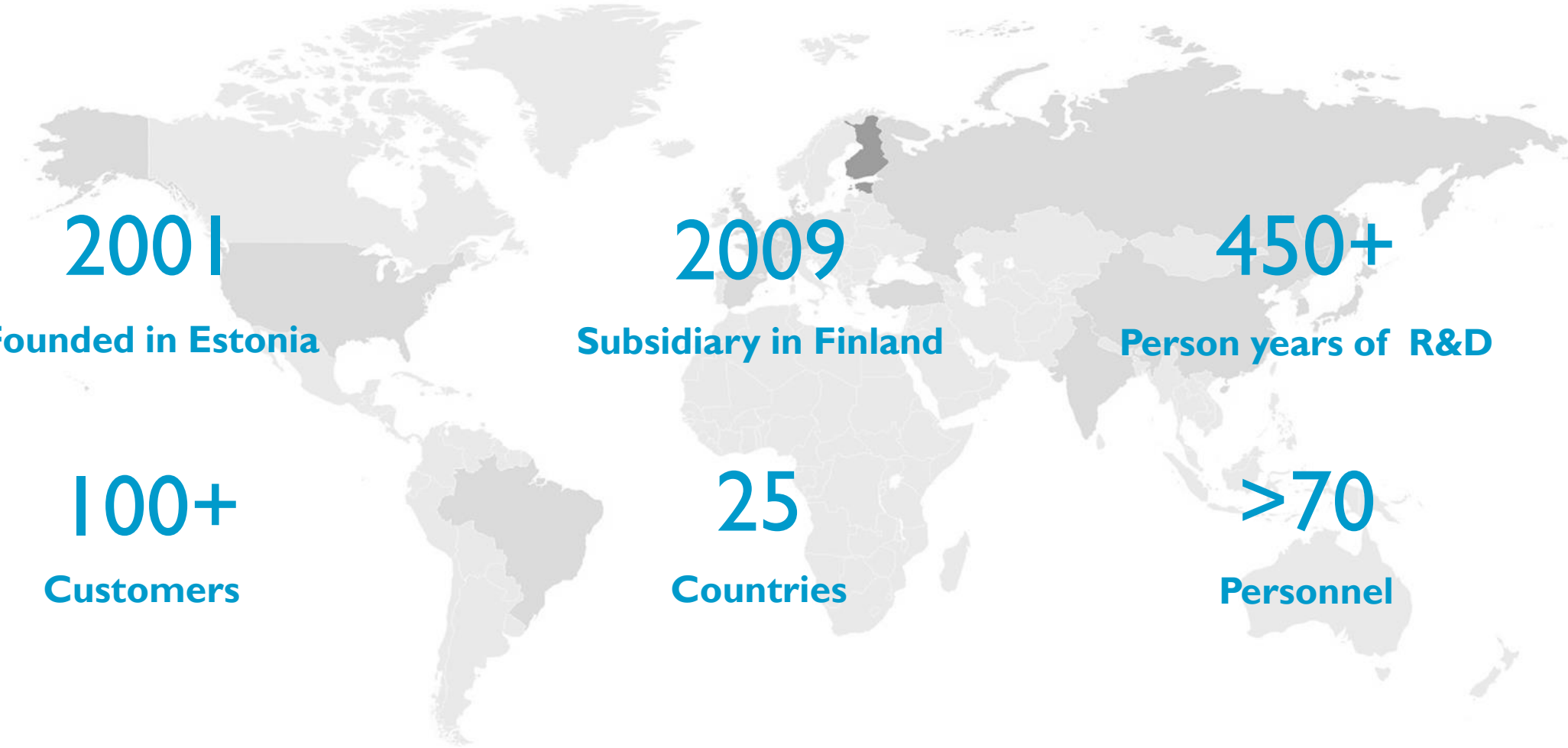
areNH3a

Index

1. Introduction – Elcogen at a glance
2. Introduction – Elcogen products
3. Elcocell® Structure and Properties
4. Elcostack® Performance – SOEC Mode
5. SOEC development approach in ARENHA
6. Results from ARENHA
7. Results from ARENHA II
8. Most promising results
9. Other development ventures

areNH3a

1. Introduction – Elcogen at a glance



2001
Founded in Estonia

2009
Subsidiary in Finland

450+
Person years of R&D

100+
Customers

25
Countries

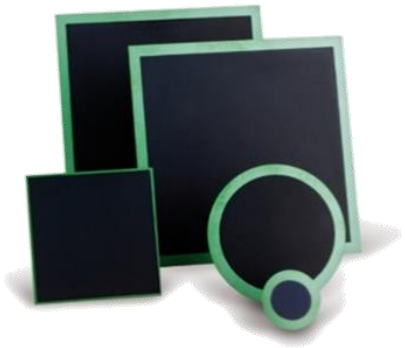
>70
Personnel

Fuel cell technology
elcogen

areNH3a

2. Introduction – Elcogen products

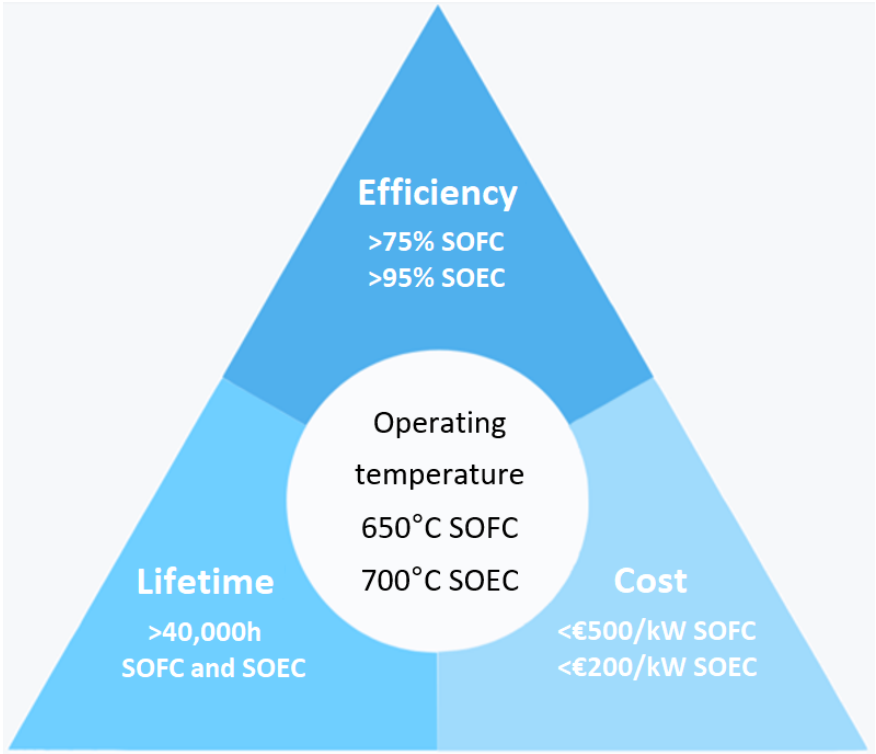
elcoCell



- Planar, ceramic, anode-supported cells operating at **600-800 °C**
- **Patented technology**
- **Flexible manufacturing**, to fit **different stack technology** requirements

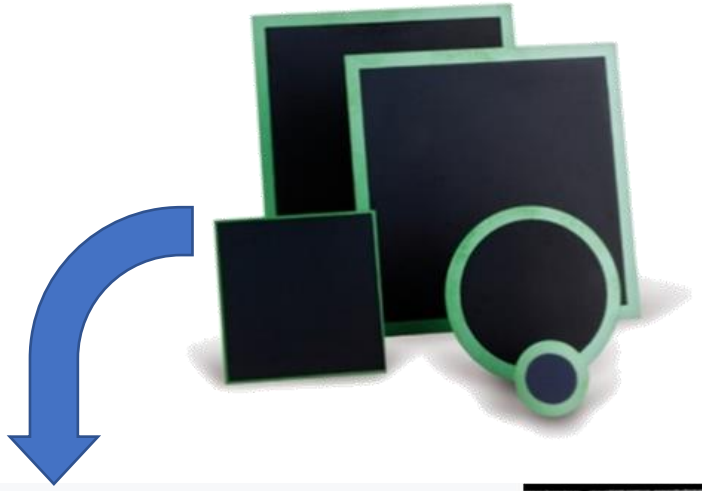
elcoStack

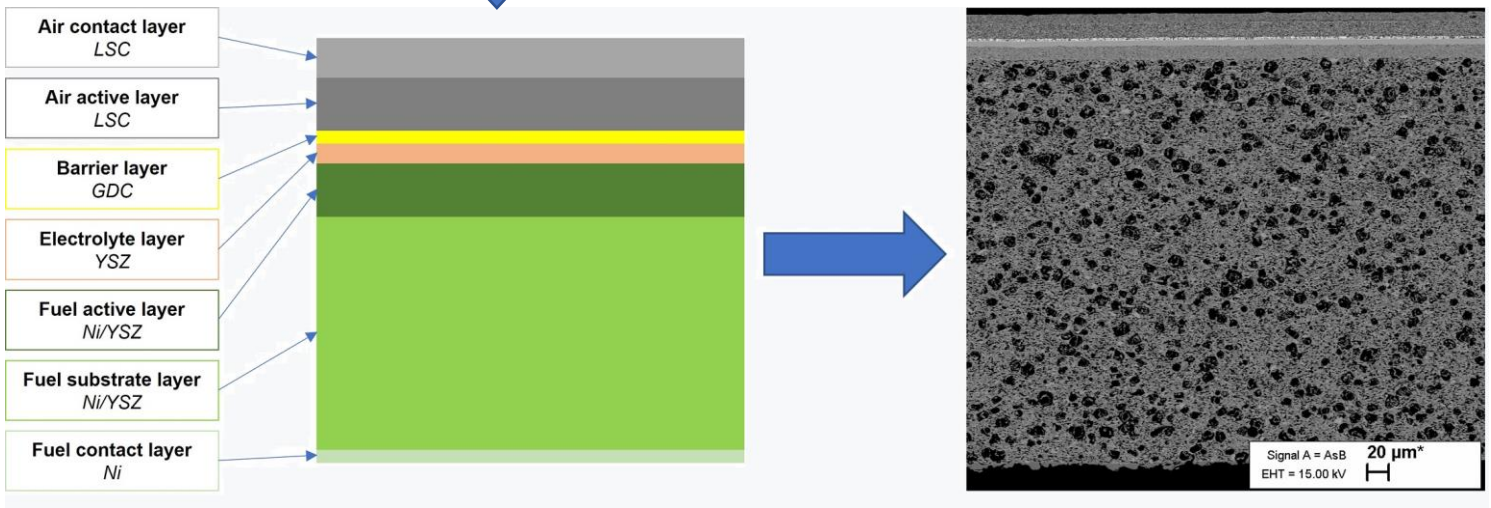
- Stacks operating at **600-700 °C**
- **1kW** and **3kW** in **SOFC**; or **3kW** and **10kW** in **SOEC**
- **Patented technology**
- **Low-cost** materials and components



Fuel cell technology
elcogen

3. Elcocell® Structure and Properties

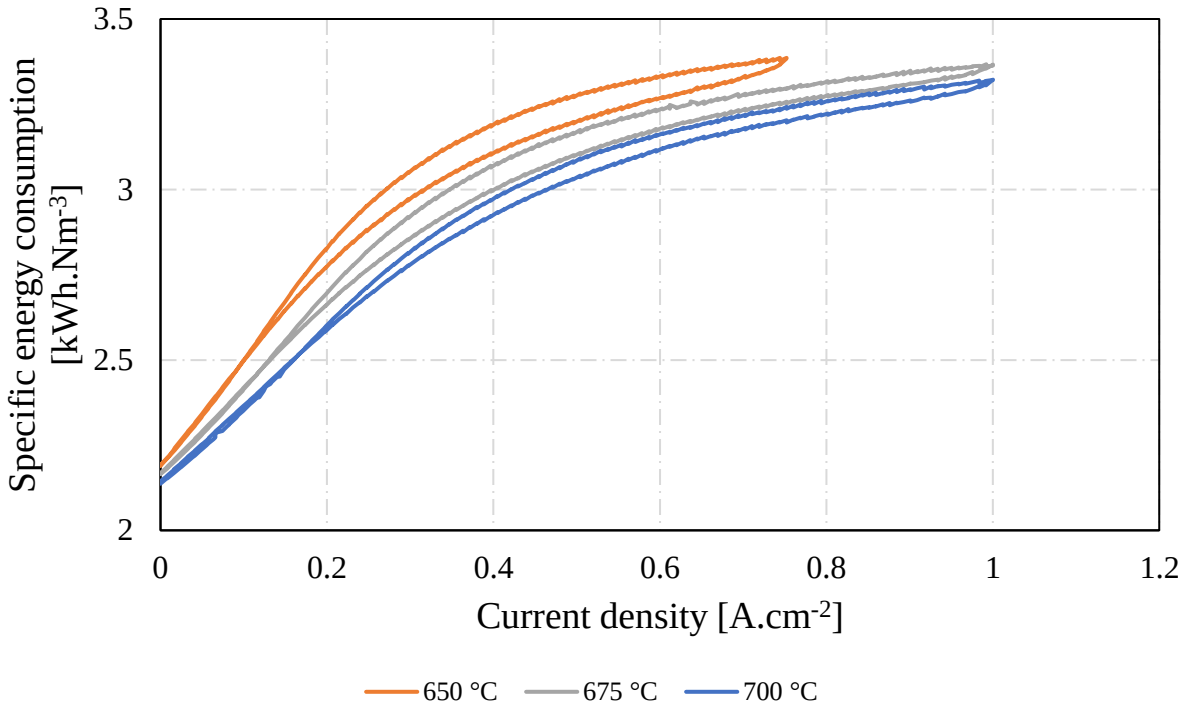




- Planar, ceramic, anode-supported cells operating at 600-800 °C
- Different shapes: from button and rectangular cells to custom-designed non-symmetrical configurations
- Different sizes available: from 1 to above 200 cm2 of active surface area per cell
- Different thickness of cells: from 300 to 530 µm
- Flexible manufacturing for customised products, to fit different stack technology requirements
- Easily scalable production of cells, only well-known mature manufacturing methods

4. Elcostack® Performance – SOEC Mode

- The same stack design enabling fuel cell operation and electrolysis operation
- Notably higher performance in electrolysis mode compared to competing technologies – alkaline and polymer
- Average specific energy consumption was 2.94 kWh·Nm^{-3}



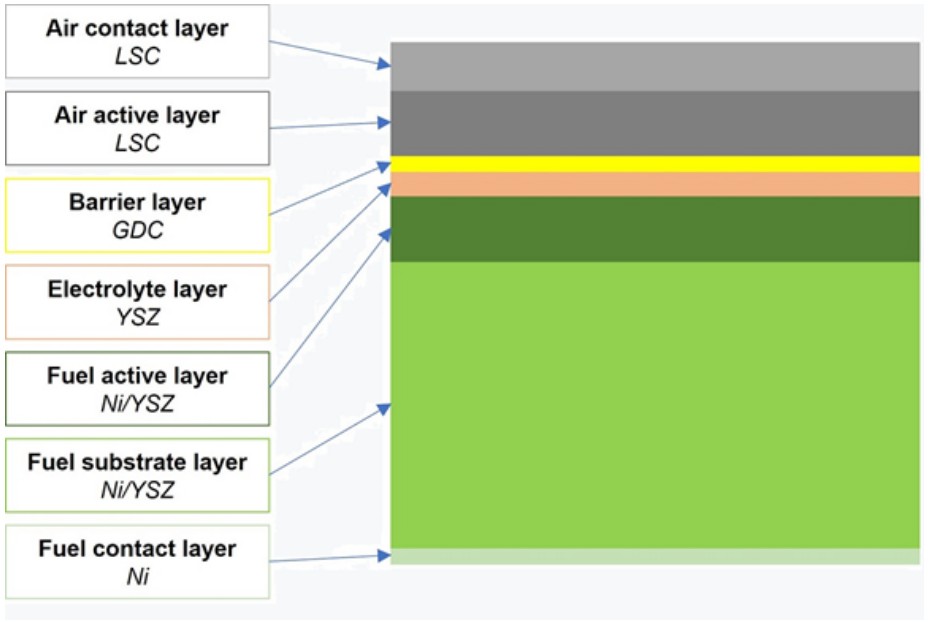
TEST CONDITIONS

Steam supply	1.42 l_N/min/cell
Hydrogen supply (mol-%)	10 %
Air supply (anode)	4.2 l_N/min/cell

5. SOEC development approach in ARENHA

A „screening“ development approach was chosen. The materials screened for suitability needed to adhere to certain conditions:

- Compatibility with Elcogen production methods
  - Screen-printable
- Chemical and physical compatibility with other layers
  - YSZ material
- Potential to increase performance in SOEC mode by increasing
  - catalytic activity towards hydrogen or oxygen reactions
  - durability by better fuel flexibility
  - redox durability
  - electric or ionic conductivity



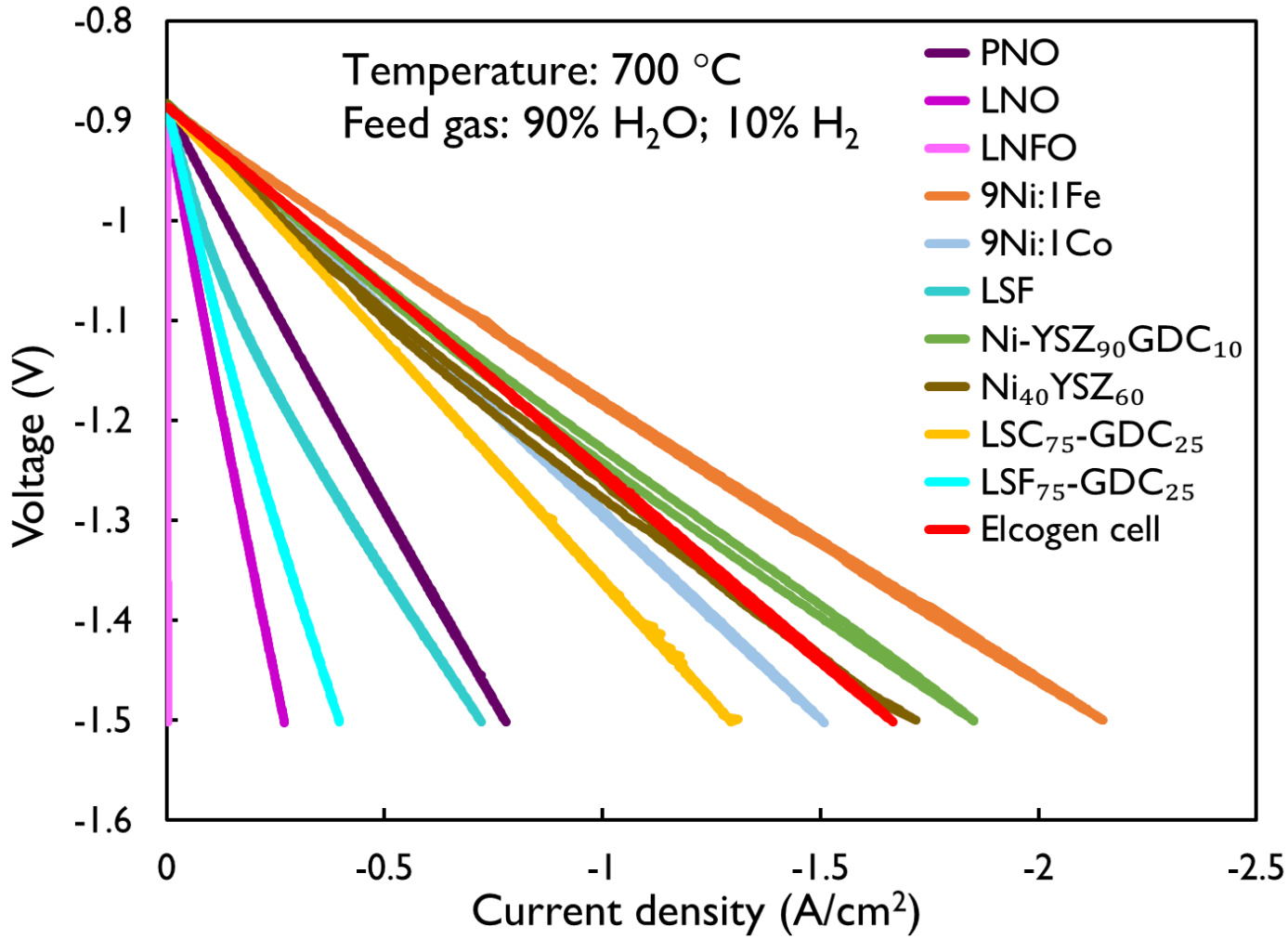
Only the active fuel and oxygen electrode layers were targeted.

The results will culminate in a new SOEC.

6. Results from ARENHA

A wide variety of materials were considered and tested in

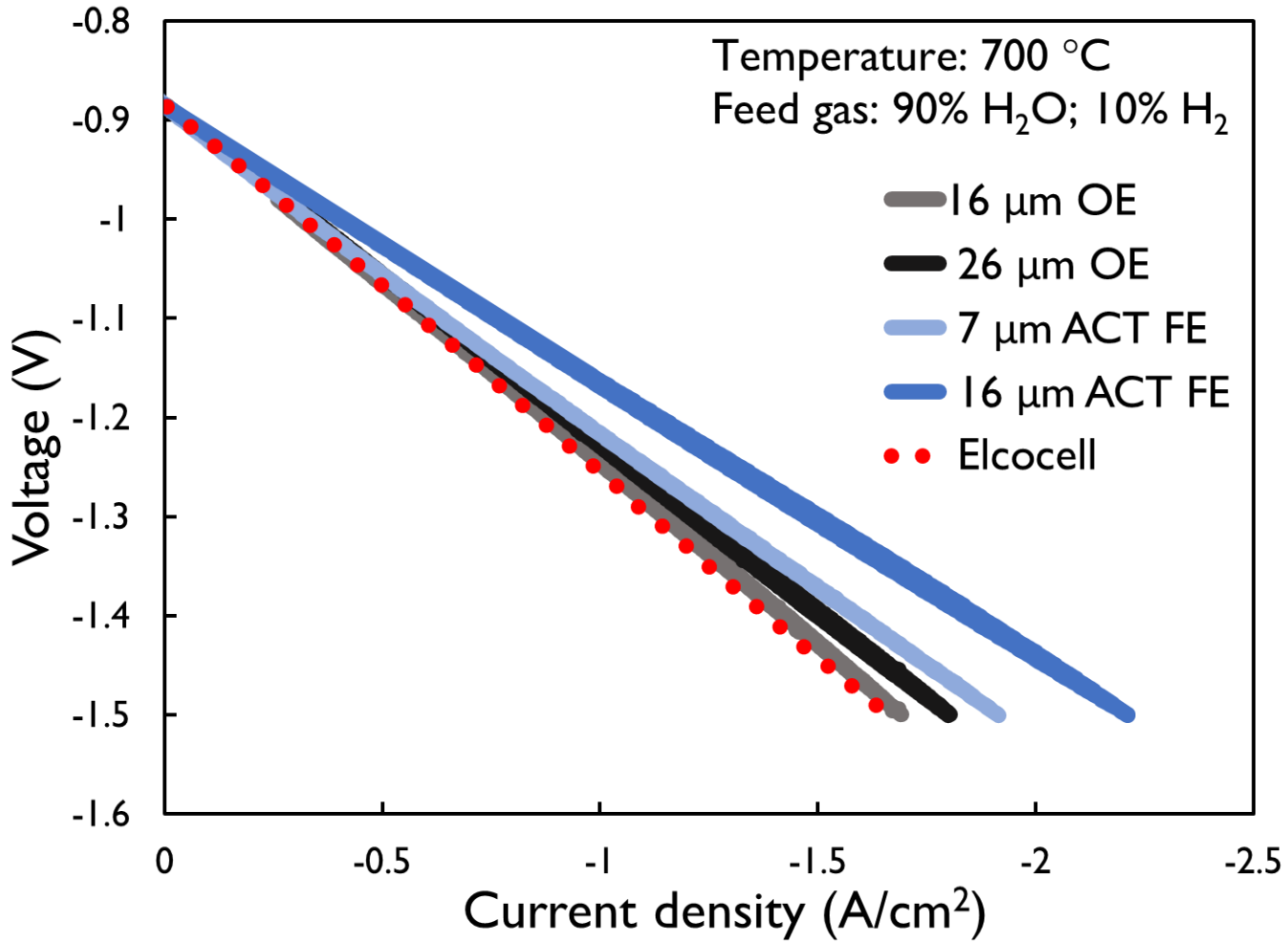
- Oxygen electrode layer
  - LSC-GDC
  - LSF
  - PNO
  - LNO
  - LNF
- Active fuel electrode
  - Ni-$(YSZ)_x(GDC)_{1-x}$
  - Ni_xFe_{1-x}-YSZ
  - Ni_xCo_{1-x}-YSZ
  - SFM
  - LaSrCaTiNiO
  - LaSrCrMnO



areNH3a

7. Results from ARENHA II

Variations in active fuel and oxygen electrode layer microstructures were also tested



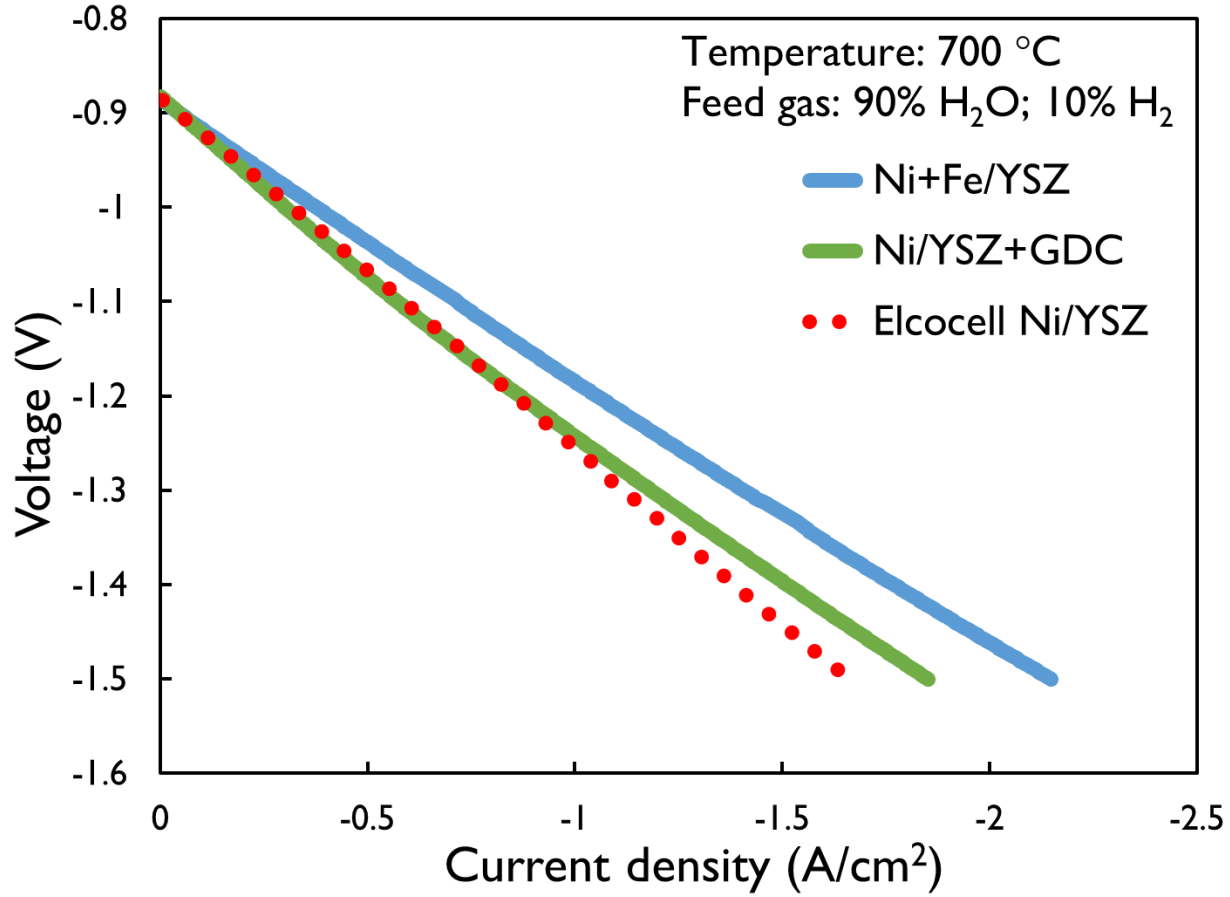
Fuel cell technology
elcogen

8. Most promising results

Interesting results were achieved with these active fuel electrode modifications

- $Ni\text{-}(YSZ)_x(GDC)_{1-x}$
- Ni_xFe_{1-x}-YSZ
- Thicker active fuel electrode

Development work for combining these modifications is ongoing.

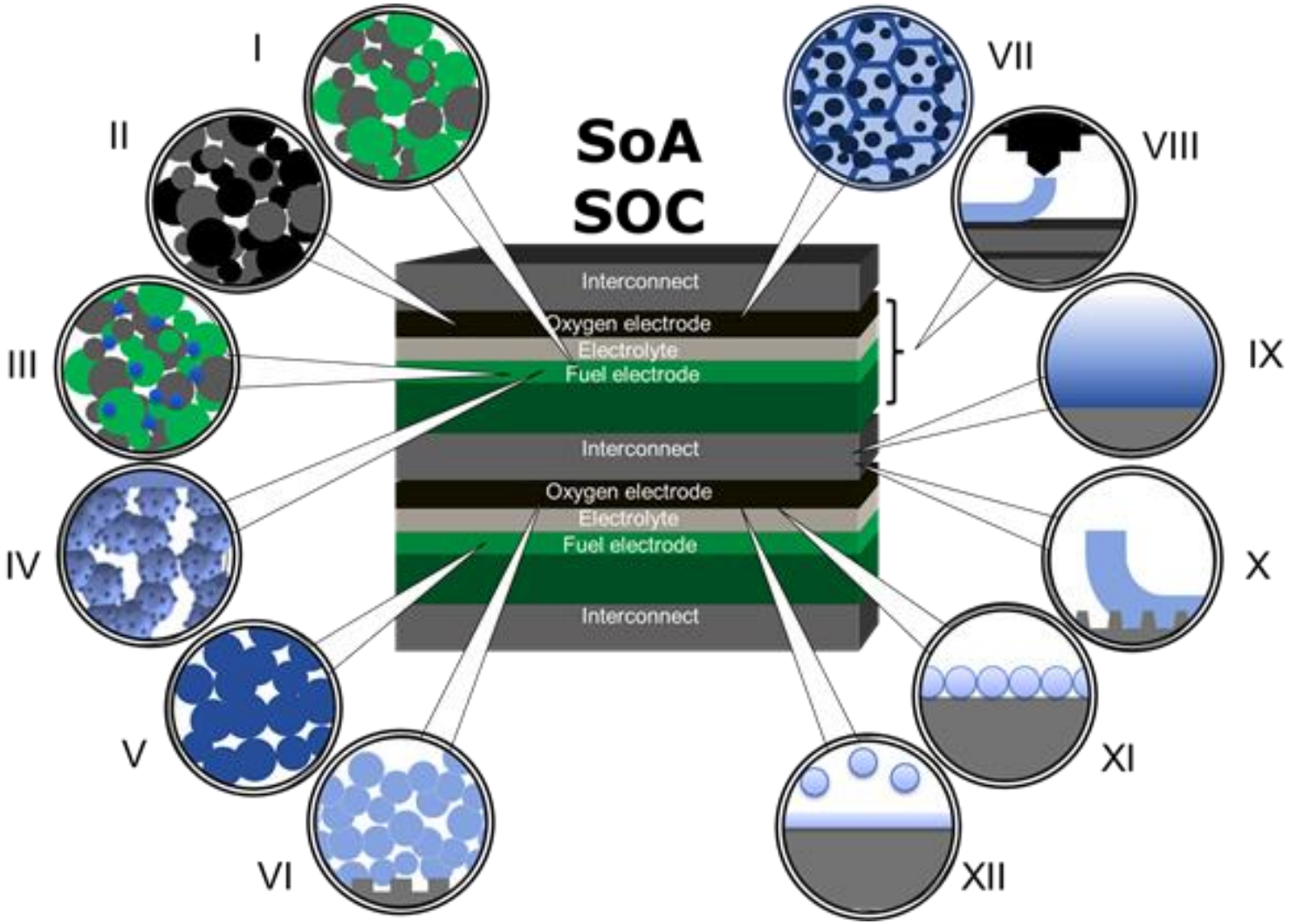


areNH3a

9. Other development ventures

Developing better manufacturing processes for thin ceramic layers and stacks

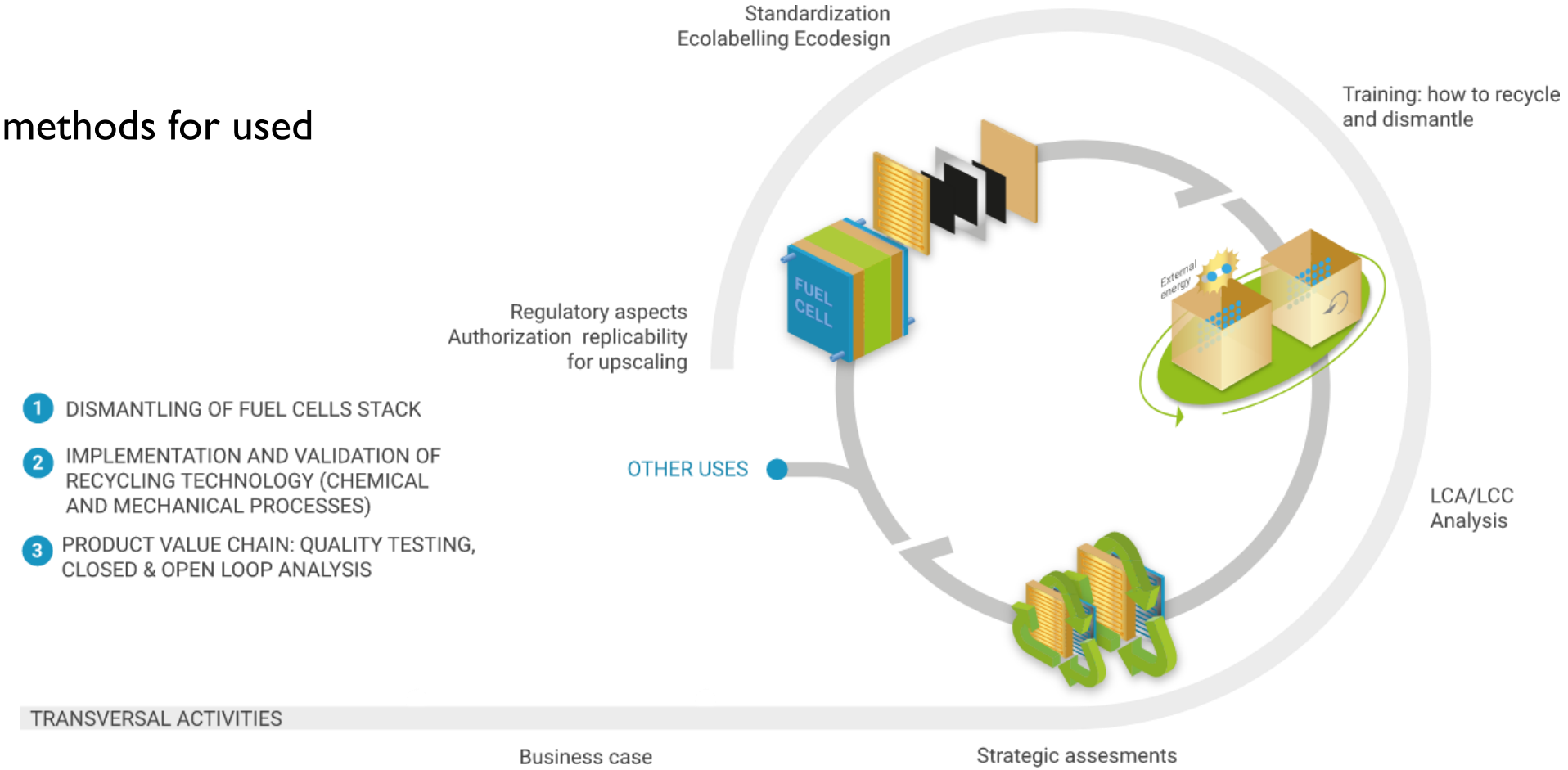
Project title: Next Generation Solid Oxide Fuel Cell and Electrolysis Technology
Call identifier: H2020-JTI-FCH-2019-1
Grant number: 874577 - NewSOC



Fuel cell technology
elcogen

10. Other development ventures II

Developing recyclying methods for used SOFC



Project title: Sustainable Solutions for Recycling of End-of-Life Hydrogen Technologies
Call identifier: H2020-JTI-FCH-2020-1
Grant number: 101007216 – BEST4HY

areNH3a

Development of Low-Temperature Solid Oxide Electrolysis Cells

First Workshop ARENHA project, ENGIE Lab CRIGEN, 07-04-2022

Thank you for your attention

Website project: https://arenha.eu/

Contact: *freddy.kukk@elcogen.com*

Fuel cell technology elcogen