CERTH
CENTRE FOR RESEARCH & TECHNOLOGY HELLAS

CPERI
Chemical Process and Energy Resources Institute

Sustainable and Novel fuel cell applications for Island Energy Systems

P. Grammelis, A. Nikolopoulos, K. Sfetsioris, K. Atsonios, K. Manou

Contact: +30 211 1069 500, *Fax :* +30 211 1069 501,
e-mails: grammelis@certh.gr, atsonios@certh.gr

Contents

1. **Motivation**
2. **Concept idea**
3. **Members of the Consortium**
4. **Project details**

- Great interest of EU in energy islands/ geographical islands

CERTH/CPERI participates in the H2020 project **SMart IsLand Energy systems – SMILE**, that investigates innovative technological solutions for smart grids development in islands (info at: http://www.h2020smile.eu/)

- Greek islands: special challenges to overcome

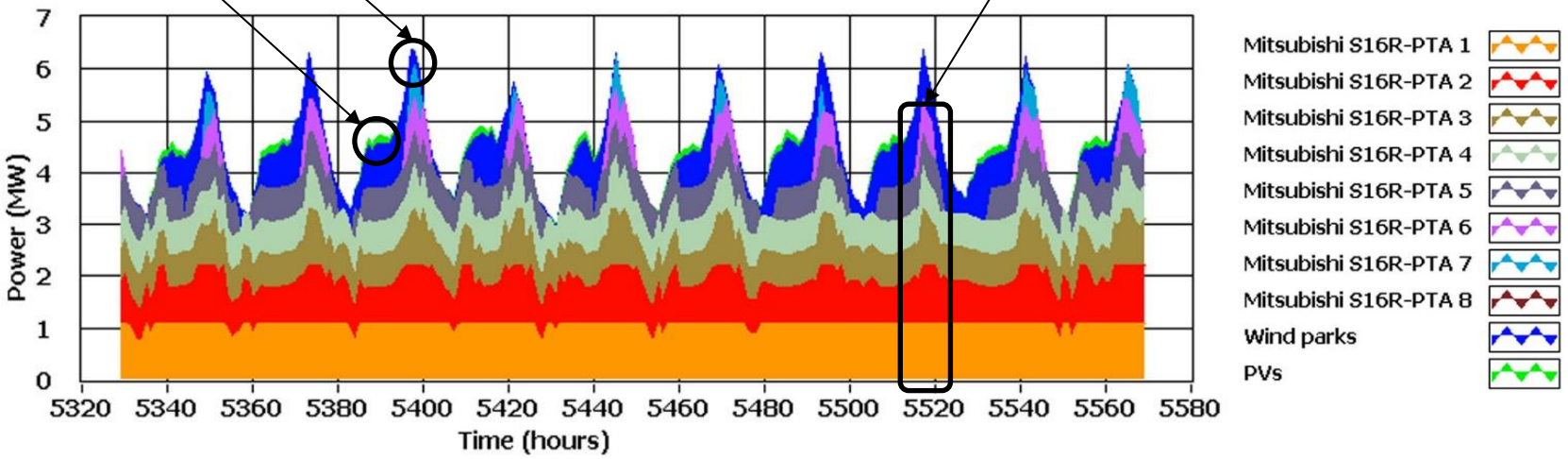
PV cannot support during the peak demand period

peak demand in the evening

energy storage is needed

Great dependence on diesel engines

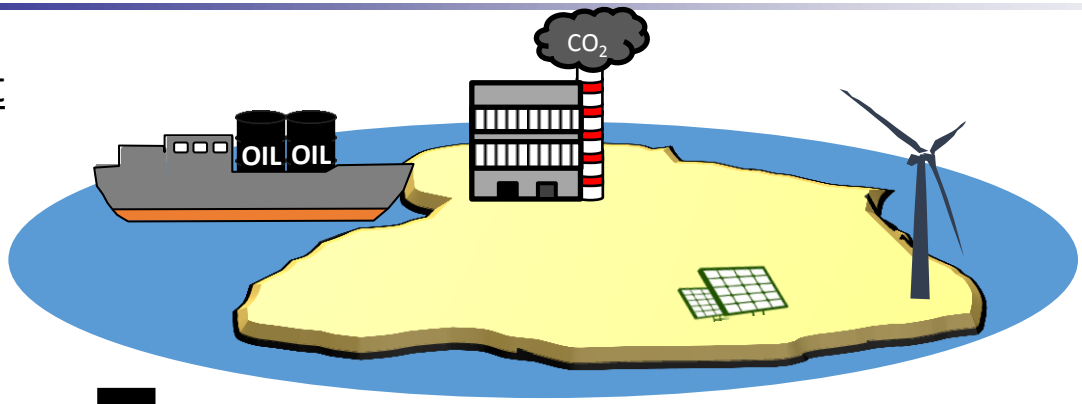
too high cost of electricity!!!



Power production synthesis during the annual peak power demand period (August) in a Greek island

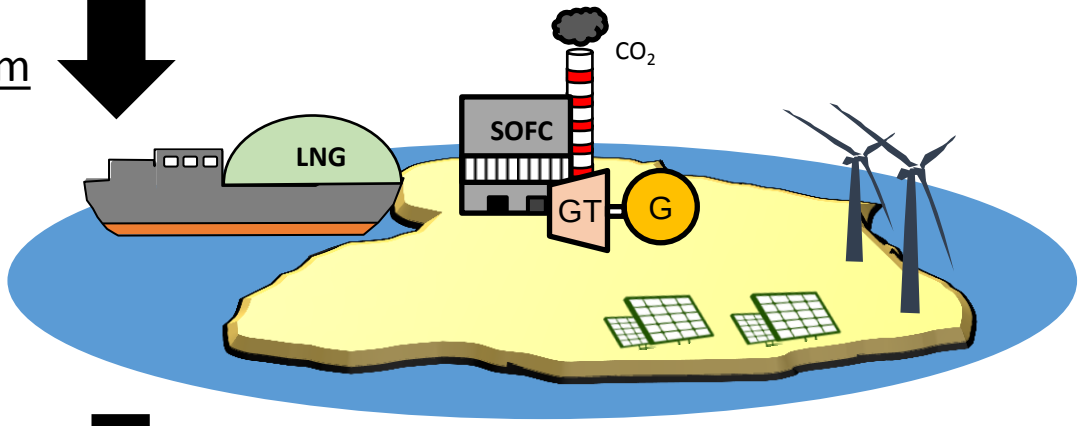
Development of LNG based technologies integrated with energy storage solutions

current



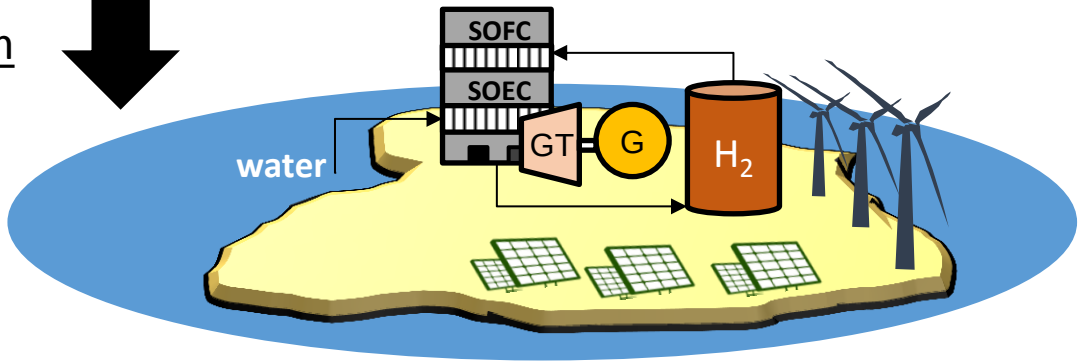
- Dependence on oil fuel
- High electricity cost
- High CO_2 emissions
- Technical difficulties for RES development

short-term



- Dependence on NG
- High efficient electricity production
- Low CO_2 emissions

mid-term



- Sustainable concept
- No fossil fuel dependence
- Zero CO_2 emissions

SOCs: Solid Oxide Cells

SOFC — Fuel Cell
Fuel → Electricity

- Electrochemical oxidization of fuel without combustion leading to **ultra-high efficiencies (up to 60%)**
- **Low emissions** due to the electrochemical reaction.
- **Variety in fuels:** NG, LNG, H_2, biogas
- Possibility to **assembly in power plants** from micro-scale (<1 kW) to large-scale (>10 MW).
- Excess heat utilization for **cogeneration purposes** (space heating, DHW, district heating, stream, desalination, etc).
- **exhaust gases utilization at a bottomed thermodynamic cycle** (e.g. Rankine, Brayton) → hybrid system

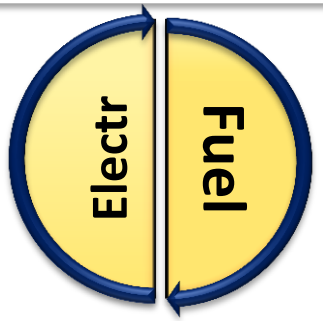
GT
- Necessary during **start-up** until the SOFC reaches operability.
- Overall hybrid cycle **efficiency** can be **>70%.**

Hybrid SOFC-GT

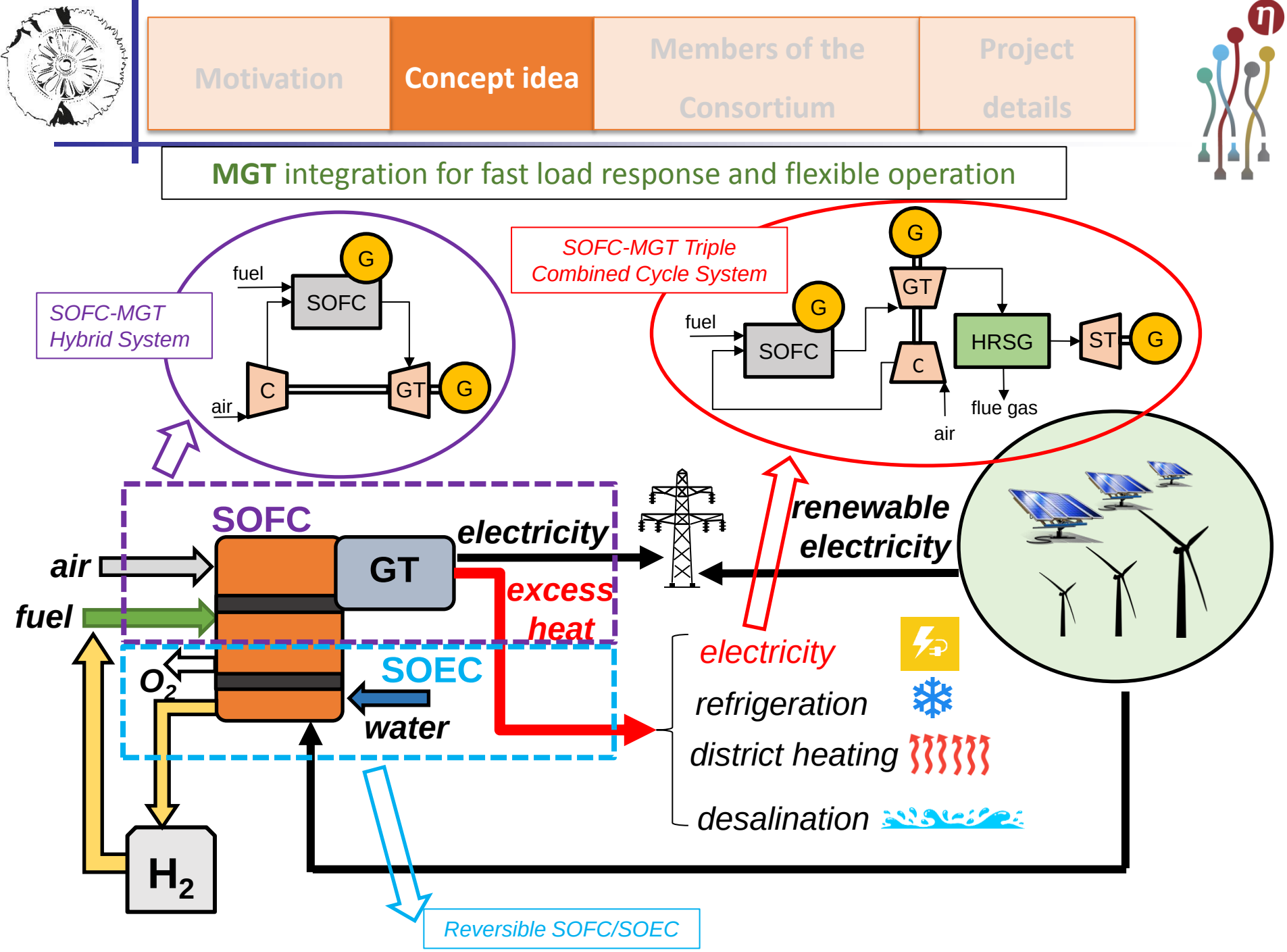
SOEC — Electrolyzer Cell
Electricity → Fuel

- Operates at higher temperatures than other electrolyzers (Alkaline & PEM) and **consume much less electricity** thank to superior energy conversion efficiency
- **Direct electrolyzing CO_2.** Syngas product from co-electrolysis of H_2O & CO_2
- **Chemical energy storage/ carrier**

Reversible operation



MGT integration for fast load response and flexible operation



Centre for Research & Technology Hellas (CERTH)

Project Coordinator

- One of the largest research centres in Greece, founded in 2000
- Legal entity governed by private law with non-profit status
- 1.000 competitive research programs (total budget over 423 M€).
- Employ more than 600 people.

Public Power Corporation (PPC)

- The major electricity utility in Greece
- Installed capacity about 12 Gwe (more than 80% of total)
- Portfolio: Lignite, Oil, Natural gas, Hydroelectric, Wind, Solar

Gas-und Warme-Institut Essen e.V.

Applied Science Institute – Gas and Heat Technology Applications

Universität Duisburg-Essen

Extensive expertise in the fields of power generation and energy recovery from waste, residues and biomass

Mitsubishi Hitachi Power Systems Europe GmbH (MHPSE)

- Leading Power Plant Manufacturer
- Long experience in EU research and innovation projects

Project Title: SUstainable and **N**ovel fuel cell applications for **I**sland **E**nergy **S**ystems (**SUNIES)**
Duration: 30 months
Budget: 894,000 €
Funded by: NSRF - Bilateral Research and Innovation Cooperation Greece-Germany

Project main objectives

- Proving the operability of a Hybrid-SOFC-System prototype (250 kWe) under specific fuel and load conditions
- Development of new SOFC concepts for island applications
  - highly flexible "base concept" composed of a SOFC +Micro-GT (MGT)
  - highest efficiency "Triple Cycle Concept" (SOFC+MGT+ST)
- Feasibility assessment of a reversible SOFC/SOEC concept on medium to large scale island applications

Project main activities

- Screening and determination of boundary conditions and selection of two Greek island cases (PPC, CERTH)
- Testing of the 250 kWe SOFC Hybrid System (GWI, MHPS)
  - performance & flexibility (electrical-, thermal output, efficiency, stability, degradation) by using different fuels (Biogas, different NG compositions, NH3 etc.) under different boundary conditions
- Steady state and dynamic modeling simulations (LUAT, CERTH)
- Business plans and Roadmap (PPC, CERTH)

Thank you for your attention!

Acknowledgements

The participation in ETN AGM & Workshop is financially supported by the European Union's Horizon 2020 research and innovation programme under grant agreement No 731249 (Smart Islands Energy Systems - SMILE)