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DEMOKRITOS

An integrated autonomous mobile hybrid RES / Hydrogen Power System (HYPOS)

Portable green energy production unit
energy production and hydrogen refuelling unit for small vehicles

Our Core Team:

Dr. Manos Zoulias, Partner & Technical Director (NEEST)

Dr. Thanos Stubos, Research Director (NCSRD) – National REP of Greece for H2 and FCs in the EC

Dr. Manos Stamatakis, Senior Researcher (NCSRD) Over 70 person years

of experience in this field

We focus on the following municipal issues:

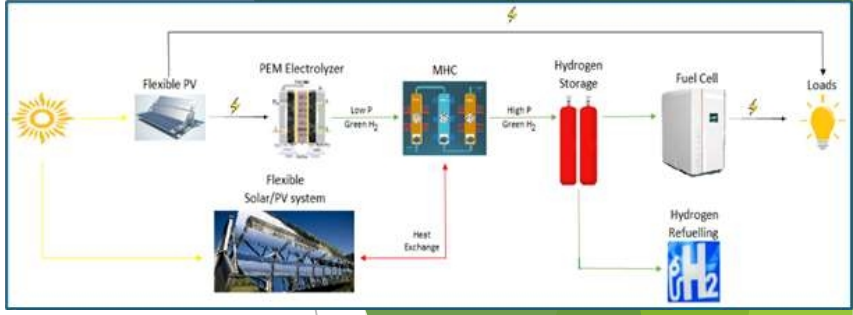
- Reducing CO_2emissions in the transport sector (responsible for 22-24% of the country's total emissions)through electrification (note that H_2vehicles are also electric, but with greater autonomy and much
  shorter charging time)

- Traffic problems: Contributes to Sustainable Urban Mobility by
  by replacing conventional vehicles with small H2 vehicles (bicycles, scooters, two-seaters, etc.)

- Lack of green and quiet energy solutions in:
  - emergency and/or humanitarian crisis situations (earthquakes, floods, fires, etc.)
  - Critical infrastructure (mobile phone networks, hospitals, etc.)
  - Areas that do not have access to Greece's central electricity grid for events, the operation of meteorological stations, fire prediction stations
    fire prediction stations, in protected areas, forests, etc.

Proposed HYPOS solution for the above problems

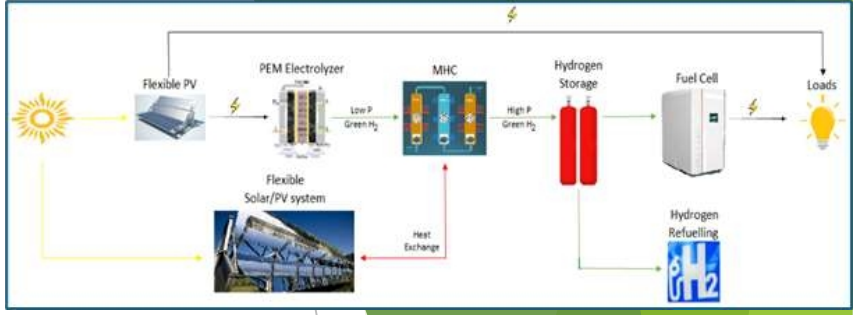
Municipalities:



- We offer a portable hybrid RES/H2 energy system that is characterised by a small footprint, high energy density, reliability, flexibility and compatibility with similar energy systems.
- The portability of the unit makes it tolerant to all climatic conditions, both for energy supply and for refuelling small $_{zero}$-emission vehicles.
- We only need the sun and water to provide green energy and "fuel" for small vehicles
- Ideal solution for municipalities aiming to:
  - Reducing CO_2emissions in the transport sector and solving traffic problems
  - Providing green energy in emergencies and in areas that do not have access to the central electricity grid

How HYPOS works:

- The portable innovative station consists of:
  - PV unit (4 kW - expandable)
  - Proton Exchange Membrane (PEM) Electrolysis Unit (3 kW)
  - Hydrogen compressor
  - Automatic control system
  - 3 kW fuel cell
- Through the use of HYPOS, municipalities gain:
  - A portable unit for refuelling small vehicles with H2, reducing CO $CO_{(2)}$ emissionsand traffic congestion in the city, contributing to Sustainable Urban Mobility
  - Portable unit for uninterrupted power supply for critical infrastructure in emergencies and when there is no access to the central electricity grid



Solution Innovation & Competitive Advantage:

- HYPOS stands out from other charging systems:
  - It is the only H2 vehicle refuelling station that uses **a silent** metal hydride compressor with no moving parts
  - At the same time, it is **also** a green energy production unit using $_{H2}$
- Innovative solution
  - The automation and control system has been developed in-house
  - It has a very small footprint, zero $_{CO_2}$emissions,and requires only water and solar energy (complete energy autonomy)
- Copyright Registration:
  - The compressor H_2has received CE mark certification, as well as EPO and WPO patents.

Technological Readiness Level (TRL):

- Current TRL 8: The actual technology is completed and qualified through tests and demonstrations
  - HYPOS has already been installed as part of the H2TRANS project at EKEFE DEMOKRITOS since 2022
  - It is fully operational, various tests are being carried out and measurements are being taken
  - The Project Team supported specific municipalities (Agia Paraskevi, Alimos Vrilissia, Kalymnos, Heraklion Crete and Ierapetra) through H2 business case development contracts within the framework of the European FCH Initiative
    European Cities and Regions Initiative
  - The Group is in discussions with municipalities in Greece and Cyprus regarding the implementing HYPOS
- Next steps: Optimisation of portability design and further reducing the footprint

Requirements for PoC:

- The PoC has already been implemented at the facilities of EKEFE DEMOKRITOS
- Total cost excluding vehicles: €400,000
- Licensing of HYPOS station in accordance with current legislation for
  H2 vehicle refuelling stations: Government Gazette 2570/B/2023, Law 5215/2025
- The development and use of HYPOS will be coordinated by the present Project Team.
  Project
- Prerequisites from Municipalities
  - Approval by the Board of Directors for the use of HYPOS
  - Cooperation with Technical Service for station location and operation

PoC implementation schedule:

- The PoC has already been implemented at the facilities of EKEFE DEMOKRITOS
- HYPOS delivery schedule:
  - Ordering of equipment parts (Month 1)
  - Receipt of equipment parts (Month 4)
  - Automation and control system (Month 5)
  - Integration of peripherals and equipment into the station (Month 7)
  - Final testing (Month 8)
  - Station delivery (Month 9)

Impact and Scaling HYPOS:

- Environmental impact of HYPOS: Directly linked to the number of small H2 vehicles introduced into each municipality's transport system:
  - Replacing a petrol or diesel vehicle means: A 79% reduction in CO_2emissions, i.e. final production of 50g CO_2 / km or **a reduction of 190 g CO_2 / km**
- Social impact: The ability to provide green electricity in emergencies, humanitarian crises and serving areas outside the central electricity grid
- Specialised jobs are created in the Municipality (operating and maintenance technicians for units and vehicles H(2) maintenance technicians for units and vehicles)
- Improvement in air quality due to reduction in pollutants
- Improvement in quality of life due to reduced traffic
- Possibility of scaling up to a large number of municipalities after successful demonstration in an operational environment
- IMPORTANT: HYPOS can be jointly acquired by neighbouring municipalities to meet common needs, while reducing the acquisition cost per municipality

HYPOS business model:

- Revenue sources: B2C (sale of H_2), B2B or B2G (sale of electricity to high price in emergencies or off-grid situations)
- The HYPOS model will become economically viable in the short term due to the mandatory reduction of greenhouse gas emissions in transport sector, resulting in the subsidisation of the cost premium H_2
- Possible models of cooperation with municipalities:
  - Sale of HYPOS (to one or more municipalities jointly)
  - Leasing HYPOS (either for vehicle refuelling or mainly for energy supply)
  - Ad Hoc in emergencies (at high cost)

NEEST Team Profile:

- NEEST E.E. was founded in 2017 and is based at TEPALEFKIPPOS
- Joint development of projects and studies with EKEFE DEMOKRITOS
- Implementation of almost all energy facilities H_2 real scale in Greece
- Implementation of energy studies for DESFA, PETROGAZ S.A., RAE, Hellenic Hydrogen S.A., Pharmaceutical Industries, Big 4 Consulting Company in the H_2sector
- Studies on energy saving and application of H_2technologies in industry

  Implementation of SDAP, SDAPC and SBAC in Municipalities
- Participation in research programmes (HORIZON & EREVNO – KAINOTOMO) in the field of H_2

Track Record NEEST:

- TRIERES (HORIZON-JTI-CLEANH2-2022-2) Project (no. 101112056) – Small-Scale Hydrogen Valley including real-scale hydrogen production and applications in many sectors, such as road transport, maritime and industry
- TETHYS (HORIZON-WIDERA-2023-ACCESS-02) TWINNING FOR EXCELLENCE IN FLOATING WIND TURBINE AND HYDROGEN SYSTEMS
- H2TRANS - Development of an autonomous hybrid system integrated RES & Hydrogen technologies for transport applications, Sep 2019 – Sep. 2022, Greek General Secretariat of Research & Technology programme, Project No. Τ1ΕΔΚ – 05294
- Private Contract with the Operator of the Greek Natural Gas Network: Study for the transformation of DESFA's Natural Gas Grid into “Hydrogen – ready”, July 2020 – Jan 2021
- Private contract with AEONORASIS S.A.: Complete energy study and techno-economic analysis for a pharmaceutical company, aiming to reduce carbon footprint through the implementation of an integrated PV and H2 technologies power system in its facilities
- Vrilissia Municipality: Support in the Implementation of the European Union City Facility (EUCF) project aiming at developing:
  - Municipal H2 refuelling stations with storage capacity
  - RES (PVs with virtual net metering) for hydrogen production
- Private Contract with Hellenic Hydrogen S.A. (Joint Venture of Motor Oil Hellas and Public Power Corporation): Pre-feasibility study for the implementation of large-scale hydrogen technology projects on the island of Crete

NEEST / EKEFA DEMOKRITOS project team:

- Project Manager: Dr. Manos Zoulias, Chemical Engineer with over 23 years of experience in the implementation of RES and Hydrogen energy facilities, including pioneering facilities for the production of H_2 from wind and solar energy, compression, storage and use in fuel cells
- Innovation and Safety Manager: Dr. Athanasios Stoumbos, Chemical Engineer, National Representative of Greece in the EU Clean Hydrogen Partnership, Coordinator of European Programmes in the field
- Technical Manager: Dr. Manos Stamatakis, Chemical Engineer, Head of Laboratory H_2 at NCSR Demokritos
- Software & Automation Engineer: George Kyriakos, Automation Engineer, Development Integrated control and automation system HYPOS
- Regulatory and Safety Expert: Grigoris Kokkonas, Chemical Engineer, Safety Studies, ATEH, ISO Standards, Installation Licensing
- Expansion Engineer: Giannis Zoulias, Naval Architect, Expansion of the HYPOS system to maritime applications (ports and vessels)

Objectives of participation in the Climate Neutral Cities Challenge:

- Presentation of HYPOS to a network of municipalities
- Achievement of specific climate agreement targets for municipalities (reduction of emissions in the transport sector, decongestion of traffic, energy supply to critical infrastructure)
- Compatibility of the solution with municipal climate plans:
  - Kalamata, Kozani, Athens, Trikala and Ioannina
  - A European funding proposal has been prepared for the HYPOS system, in collaboration with the Municipality of Kalamata and other municipalities in neighbouring countries
  - As part of the EUCF of the Municipality of Vrilissia, we collaborated on the development of business cases for H2 production from RES and vehicle refuelling, with the Decision and Management Systems Laboratory of the School of Electrical and Computer Engineering of the National Technical University of Athens (Haris Doukas Group)

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Thanks for your interest!