Research proposal

Topic addressed by the project:

g - Hydrogen hybrid propulsion system for special vehicles

Title:
HyPOTT - Hydrogen hybrid POwer unit for a 4x2 Terminal Tractor

- Host Institution: University of Naples Parthenope
- PI: Elio Jannelli, co-PI: Giovanni Di Ilio
- Proposal duration in months: 12
ABSTRACT

The port-logistic sector plays a crucial role in the economic development of a country. In addition, given the current growth of port commercial traffic worldwide, it has a significant impact also in terms of quality of life, mainly in the environment nearby ports and on the surrounding coastal areas. Promoting innovation on efficiency and sustainability of ports is therefore a fundamental issue. This holds especially considering the increase of foreign trade cargo volumes, which have driven maritime ports into developing their capacities from all perspectives, and the European Commission's strategic vision for achieving a climate neutral economy by 2050.

The port environment is indeed a large ecosystem, made of complex infrastructures, variegated services and advanced equipment, which require a conspicuous energy demand, today inherently related to the release of a high amount of harmful emissions, due to the intensive use of fossil fuels. Within this context, the proposed action aims at facilitating a fast decarbonisation of the port logistic industry by applying hydrogen technologies, already used in other sectors, but not yet adopted in the port sector. In particular, this project aims to develop and assess a fuel cell/battery hybrid powertrain for a yard tractor, that is a special vehicle used in terminals to move heavy trailers within different areas. This particular vehicle has been selected as it is one of the most spread machinery used in port handling operations. Thus, the successful demonstration of a fuel cell electric configuration of this vehicle may be an effective driver for the introduction of hydrogen technologies into the port sector.
RESEARCH PROPOSAL
Sections (a) and (b) should not exceed 4 pages. References do not count towards the page limits.

Section a. State-of-the-art and objectives
The maritime transport sector is responsible for a significant share of CO₂ emissions, that is around the 2.5% of the total at global scale [1]. A significant portion of these emissions originates from ships during port stays and in-port operations. In fact, the port-logistic industry has a significant impact on the urban environment nearby ports and on the surrounding coastal areas. This is due to the use of large auxiliary power systems on ships operating during port stays, as well as to the employment of a number of fossil fuel powered road vehicles required for port operations, such as yard trucks, forklifts, container movers, and rubber-tired gantry cranes. Given the demanding and energy-intensive nature of their activities, these vehicles require substantial power and on-board energy storage to maintain all-day operations, characterized by diverse operating conditions and tasks. Port machinery, typically powered by diesel engines, emits significant amounts of particulate matter, nitrogen oxides, and volatile organic compounds, which degrade air quality and contribute to noise pollution. The pathway to achieve decarbonization and mitigation of energy use in ports involves therefore the adoption of alternative and cleaner technology solutions for the propulsion systems of such port vehicles. The redesign of these vehicles with a focus on environmental sustainability presents a promising yet challenging solution to accelerate decarbonization and energy use reduction in port areas. Among the various alternatives for powering such vehicles, hydrogen fuel cells (FCs) emerge as one of the most promising options, owing to their scalability, flexibility, and high efficiency, particularly when combined with energy storage devices like Lithium batteries. In fact, hydrogen technologies are inherently clean, given that FCs operate through electrochemical reactions producing only water and heat as by-products. Additionally, fuel cells offer silent operation, a very appealing feature, especially in the context of a port environment.

Hybrid electric powertrains utilizing FCs have already been extensively explored for heavy-duty vehicle applications [2]. In particular, hydrogen fuel cells have attracted significant interest from ports worldwide, despite limited practical experience to date. Notably, the ports of San Pedro Bay (Long Beach and Los Angeles) have taken a leading role in fuel cell adoption through initiatives like the Zero Emission Cargo Transport II (ZECT II) project, which involved testing three drayage trucks using FCs, either as range extenders or primary power sources. The first hydrogen-fuelled vehicle for handling materials in ports has been recently developed within the EU project H2PORTS – “Implementing Fuel Cells and Hydrogen Technologies in Ports” [3] by ATENA scarl - High Technology for Energy and Environment District, along with its third party uniParthenope, whose members are the same of this proposal. The developed vehicle is a RoRo tractor, that is a heavy duty 4x4 vehicle used for carrying wheeled trailers from the terminal area to the inside of a cargo ship and vice-versa, according to standard Roll-on/Roll-off operations. In particular, in the H2PORTS project uniParthenope took care of the whole design process of the hybrid powertrain, while the assembling activities of the new components on-board of the vehicle was in charge of Cantieri del Mediterraneo s.p.a.

By leveraging on the experience and knowledge acquired during the H2PORTS project and other past similar projects where fuel cell power units were developed and successfully demonstrated, this project aims to design and test a hybrid fuel cell/battery powertrain for a yard tractor used in port logistics, whose average power output falls within the targeted 10-30 kW range. The research unit of uniParthenope will carry out the design process of such a powertrain, starting from a careful data acquisition campaign on an original vehicle operating in port, to the final experimental demonstration, at lab scale, of the developed system. The activities will be supported by Cantieri de Mediterraneo s.p.a. and HyTECS - Hydrogen Technologies and Energy Consulting Services, that is a new-established spin-off of uniParthenope. Some of the members of HyTECS are indeed researchers of uniParthenope who were actively involved in the activity of the H2PORTS project with specific competences in the design of control systems and telemetry systems.

In particular, the considered yard tractor is a 4x2 heavy-duty vehicle, typically employed for moving trailers within different areas of the terminal hub of the port. Despite having a similar layout, this kind of vehicle differs from the RoRo tractor already developed by the research unit, in terms of duties and, as a consequence,
of energy and power requirements. The research unit of uniParthenope will tackle all the challenges related to the new specifications, by taking advantage of the common ground between the two vehicles, namely the RoRo and the Yard Tractor.

As a fundamental requirement, the hybrid powertrain of the Yard Tractor will be designed in a way to guarantee at least the same performance, in terms of driving range and operational capabilities, of the original vehicle, currently equipped with an internal combustion engine powered by fossil fuel. As a general approach, the hydrogen fuel cell will be sized to meet the average power demand of the vehicle, hence making hydrogen the main source of energy on-board; while the battery pack will be sized so to deal with the transient operations and to satisfy higher power demands. By this means, an overall downsizing of the whole powertrain will be achieved, thus allowing for an optimization of the powertrain architecture, both in terms of layout and operation. In order to fully exploit the potential of the hybrid system, appropriate control strategies will be developed, so to make the use of the energy stored on board as efficient as possible, depending on the particular operation carried out by the vehicle. In these regards, a charge sustaining approach will be followed. By this way, short refuelling times will be achieved, given that the battery pack is charged by the fuel cell only, during vehicle operation. Moreover, the definition of the optimal control strategy will necessarily take into account the aspects related to the useful life of the components, in order to preserve their correct functioning over time, and consequently reduce the costs related to maintenance.

In the near-term, converting this vehicle into a hydrogen configuration is expected to offer a more viable and economical solution with respect to fossil fuel alternatives. Therefore, this project aims at facilitating this process and boost the adoption of hydrogen as a fuel into the port sector, by the demonstration of a new clean and efficient technology for handling equipment.

Section b. Methodology

The growing need for a sustainable worldwide mobility is leading towards a paradigm shift in the automotive industry. Therefore, it is of paramount importance to develop new advanced clean technologies and, among the many solutions, promote the hydrogen economy. In this context, the focus of this project is on the development of a hybrid fuel cell electric powertrain for a yard tractor specifically designed for terminal operations inside the port environment. In particular, the duties of this vehicle consist in the transport of various goods within the port, between different operational areas.

To achieve its ambitious goal, the project will rely on a multidisciplinary approach which involves competence in several different fields, which will be exploited through a systematic analysis involving both numerical and experimental activities, and that is grounded on a modular design approach.

The basic idea behind the new powertrain of the vehicle is to design it in such a way that the peculiarities of its main components, i.e. fuel cell and battery pack, are fully exploited. Hence, the vehicle will be equipped with a moderately-sized battery, that has to accomplish the following tasks: i) provide power to the vehicle during transient operations and protect the fuel cell from fast load dynamics; ii) recover as much as kinetic energy as possible during braking events; iii) ensure an adequate all-electric range, in case of fuel cell faults. On the other hand, the fuel cell system of the vehicle will be sized on the average estimated power demand, in order to avoid the battery state of charge depletion under continuous vehicle operation. In fact, generally speaking, the average power demand is only a fraction of the peak power request experienced by the vehicle, therefore the fuel cell rated power can be eventually selected by considering the expected mean power request. This powertrain configuration allows to reduce the overall costs by downsizing both the fuel cell stack and the battery pack. Moreover, it allows for flexible use of the vehicle and redundancy, thus improving the reliability of the powertrain.

The powertrain design process will be carried out according to an iterative approach involving technology selection, mission profile identification, simulation of power unit configurations and control strategies, and optimization based on cost objectives. Specifically, this process will be deployed into three main phases: during the first phase, an in-depth knowledge of the typical duty cycles of the vehicle will be gathered by performing a detailed data acquisition campaign and analysis; the second phase will consist in identifying the technology for the components of the power unit (fuel cell, battery, electric motor, converters, etc.), that will be chosen
based on both economic and technical considerations; in a third phase, various power unit configurations and different control strategies will be proposed and simulated. Hence, modelling of hybrid vehicle powertrains will be set up and used to support the design and validate the performance of the vehicle against realistic mission profiles.

Once the design of the vehicle powertrain and of its energy management strategy will be achieved, the system will be prototyped and tested in lab environment. This phase will involve a comprehensive testing aimed at characterizing either each single component and their integration into the whole powertrain system. Focus will be devoted on comparing the hybrid power unit’s performance against the conventional solution based on fossil fuelled internal combustion engine. Therefore, all powertrain systems and components will undergo rigorous lab testing to ensure compliance with design specifications, safety standards, and technical requirements.

The activities of this project are structured according to three main tasks. Below, a detailed description of the work is reported, task by task.

Description of work

Task 1 - Design

The design process of the new fuel cell/battery hybrid powertrain of the vehicle starts with the definition of technical and functional requirements, by considering actual mission profiles. Therefore, at the beginning of the project, a careful data acquisition campaign will be carried out by setting up a telemetry system based on CAN-bus communication and installing it on-board of an existing yard tractor, operating in the port of Genova, after the approval of port authorities. The telemetry system will be developed by uniParthenope in a synergic collaboration with HyTECS. As anticipated above, the members of HyTECS conducted a similar activity during the development of the RoRo tractor in the H2PORTS project and, for this reason, this activity will benefit from their past experience. Specifically, the telemetry system will enable real-time monitoring and data storage of all key parameters of the vehicle, such as engine speed, torque, fuel consumption, exhaust emissions, and other. These information will be instrumental to understand the powertrain requirements and develop an optimal hybrid system layout.

Data will be then used to simulate the powertrain operations into a numerical framework, and to derive some crucial insights related for instance to the kinetic energy recovery capabilities of the newly designed system. To this aim, models of vehicle longitudinal dynamics will be developed and used along with backward and forward vehicle simulators, in order to model, design and optimize the layout of a fuel cell/battery hybrid powertrain. As a main output from this analysis, each of the main components, i.e. fuel cell, battery pack, electric motor, will be sized and selected from available products in the market.

A suitable energy management strategy will be then developed during this stage. This will be designed to: i) minimize hydrogen consumption, ii) preserve the life of each powertrain components, iii) ensure the correct operation and comply with the dynamics characteristics of each powertrain component. To this aim, several rule-based energy control strategies based on a feedback control on the battery state of charge will be implemented and tested. As a result, the energy management strategy better exploiting the features of the hybrid powertrain will be retrieved, for the online implementation on-board of the vehicle.

Once the final configuration for the power unit will be fully defined, the aspects related to the thermal management of the its components will be tackled by ad-hoc analysis. Particular attention will be given to the thermal management of the battery pack, in order to avoid risks associated to thermal runaway. The integration of the various components (fuel cells and batteries) will be made through power converters and will be guaranteed by a control unit that will be able to interface with all components of the power unit. Finally, the design of electrical and mechanical auxiliary systems will be carried out, including hydrogen piping and wiring, by considering the actual space availability on-board of the real vehicle.

Task 2 – Assembling

After the design of the power unit and of its auxiliary systems, a prototyping activity will be carried out. Thus, first the procurement of components will be conducted: the choice of using commercially available
components is made in order to provide a fast and effective prototyping of the system, in line with the scope of this project. The integration and assembling of the power unit will be conducted by uniParthenope along with Cantieri del Mediterraneo s.p.a.. In fact, Cantieri del Mediterraneo s.p.a. has already gathered a unique experience and know-how during the development of the above mentioned RoRo tractor, in the context of the EU project H2PORTS and, therefore, its support would be instrumental. The system to be assembled will include also hydrogen piping and electric routing, as to demonstrate a fully operational system. The power unit will be then installed at the test bench, where testing will be conducted at both component and system level.

Task 3 – Testing
The developed fuel cell/battery hybrid power unit for the yard tractor will be extensively tested in lab environment, in order to validate it and fully characterize its performance. In particular, several preliminary tests will be conducted by using synthetic duty cycles, ad-hoc defined to investigate on the performance of individual components under a wide range of operating conditions, in order to assess their dynamic response, their integration and the effectiveness of the thermal management system. Afterwards, tests will be performed by using the real duty cycles previously acquired from the on-field campaign, in such a way to gather the most valuable information about the dynamic behaviour of the whole prototype under real operation conditions. These activities will be supported by HyTECS, in particular those related to the definition of control systems, needed to make the integration of the power unit on the test bench fully operational.

During this last stage of the project, an exhaustive assessment for the proposed energy management strategy will be performed, eventually leading to its improvement, before the future integration of the power unit on-board of the vehicle. Care will be taken also to compare both the technical performance and the economic viability of the newly developed powertrain against the original one: to this aim, several key performance indicators will be defined and evaluated, to provide a qualitative and quantitative comparison between the two solutions.

REFERENCES
Section c. Available instrumentations and resources

<table>
<thead>
<tr>
<th>Name of infrastructure</th>
<th>Short description</th>
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</table>
| **HYBRID POWER LAB**    | *Transient testing of FC hybrid electric power units up to 160 kW of power output.*  
- AVL Puma Data Acquisition System;  
- AVL Load Unit System (Dynodur);  
- AVL Blow By and oil consumption meter;  
- AVL BTE for testing and emulating battery Pack and fuel cell devices (E-STORAGE HV 160kW@1000V – max 250A) |
| **FUEL CELL LAB**       | *Testing and characterization of fuel cells.*  
- Single Cell PEM Test benches  
- Gas chromatography unit  
- 2kW PEM stack Test bench.  
- 5 kW SOFC Test Bench  
- Single Cell SOFC and SOEC Test Benches  
- Single Cell MCFC Test benches  
- MFC & MEC Testing equipment |
| **METAL HYDRIDE LAB**   | *Testing and characterization of hydrogen storage systems with metal hydrides.*  
- Glovebox  
- Electrolyser  
- Suction hoods |
| **PROTOTYPING LAB**     | *Numerical modelling and analysis, CAD environment, prototyping of components.*  
- Workstations  
- 3D Printers |
### Section d. GANTT diagram

<table>
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<th>#</th>
<th>Title</th>
<th>Month</th>
</tr>
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<tbody>
<tr>
<td>1</td>
<td>DESIGN</td>
<td></td>
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<tr>
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<td>Preliminary analysis, definition of requirements</td>
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<td></td>
<td>and control strategies</td>
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<td>ASSEMBLING</td>
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<td>Power Unit Components procurement</td>
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<td>3</td>
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<td>Power Unit Development &amp; Testing</td>
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### Section e. Milestones, Deliverables and KPI

#### MILESTONES

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<td>M6</td>
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<tr>
<td>M2</td>
<td>End of assembling</td>
<td>M9</td>
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<td>M3</td>
<td>End of testing</td>
<td>M12</td>
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#### DELIVERABLES

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<th>Title</th>
<th>Month</th>
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<tr>
<td>D1</td>
<td>Report on power unit design</td>
<td>M6</td>
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<tr>
<td>D2</td>
<td>Final report</td>
<td>M12</td>
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</table>

#### KPIs

- System nominal efficiency [%]
- Fuel/energy consumption per working shift [kWh]
- Hot-idle ramp time [s]
- Cold-start ramp time [s]
- Power unit capital cost [€/kW]

#### Annexes: Curriculum vitae research team
Appendice dell’Allegato B

Curriculum vitae PI

PERSONAL INFORMATION
Family name, First name: JANNELLI ELIO
Researcher unique identifier(s): https://orcid.org/0000-0002-8605-9905
Date of birth:
Nationality:
URL for web site: https://www.uniparthenope.it/Portale-Ateneo/organigramma/1910

• EDUCATION

1987       PhD in Fluid Machinery and Power Plants
            University of L’Aquila, Italy
1982       Master in Energy Management
            University of Naples Federico II, Italy
1981       MSc in Mechanical Engineering
            University of Naples Federico II, Italy

• CURRENT POSITION(S)

2001 – today   Full Professor – Energy Systems
                Dept. of Engineering, University of Naples “Parthenope”, Italy
2016 – today   CEO
                ATENA scarl – Distretto Alta Tecnologia Energia e Ambiente, Italy

• PREVIOUS POSITIONS/WORK EXPERIENCE

2019 – 2022  Member of National Committee of Guarantors for Research
                Italian Ministry of Research
2022 – 2022  Member of the Technical board for the elaboration of the Italian Strategy of Hydrogen
                Research - SIRI
                Italian Ministry of Research
2019 – 2021  Member of the Technical board for the elaboration of the National Research Program - PNR
                2021/2027
                Italian Ministry of Research
2008 – today  Director of the Energy Systems Lab
                University of Naples “Parthenope”
2008 – today  Coordinator of the Advanced Energy Systems Group
                University of Naples “Parthenope”
2014 – 2016  President of Scientific Committee
                ATENA scarl – Distretto Alta Tecnologia Energia e Ambiente
1996 – 2008  Coordinator of the Fuel Cell Research Team
                University of Cassino
1996 – 2008  Director of the Fluid Machinery and Energy Laboratory
University of Cassino

- **Fellowships and Awards**

  1999  **Best Paper Award** in the Track on Simulation, Virtual Reality and Automotive supercomputing for scientific paper "Numerical Simulation of Four Cylinder, 16 Valve, Spark-Ignition Engine"

  1999  **ATI/ESSO Award** for Master Degree Thesis “Performance analysis of Intercooled and Reheat High Pressure Gas Turbine cycles” – Candidate: M. Minutillo

  1999  **ATI/ESSO Award** for Master Degree Thesis “Analisi, simulazione ed ottimizzazione di un impianto di produzione di energia elettrica da fonti rinnovabili” – Candidate: M. Cusano


- **Supervision of Graduate Students and Postdoctoral Fellows**

  2008 – today  30 Postdocs/ 25 PhD/ 30 Master Students

  University of Naples “Parthenope”, Italy

  1988 – 2008  5 Postdocs/ 5 PhD/ 50 Master Students

  University of Cassino, Italy

- **Organisation of Scientific Meetings**

  2017 – today  Member of the Scientific and Organizing Committee of the European Fuel Cell and Hydrogen Piero Lunghi Conference

- **Institutional Responsibilities**

  2017 – 2020  **Rector’s Delegate for Research**

  University of Naples “Parthenope”

  2014 – 2017  **President of the Joint Evaluation of Teaching at Engineering Department**

  University of Naples “Parthenope”

  2013 – 2011  **Director of the PhD course in Energy Science and Engineering (ESE)**

  University of Naples “Parthenope”

  2011 – 2014  **Director of the PhD course in Industrial Engineering**

  University of Naples “Parthenope”

  2008 – 2014  **President of the Education Committee in Management Engineering (Master Degree Courses)**

  University of Naples “Parthenope”

  2003 – 2004  **President of the Selection Committee of the qualifying evaluation for the profession of engineer**

  University of Cassino

  2002 – 2008  **Member of the Joint Evaluation of Teaching at Faculty of Engineering**

  University of Cassino

  2001 – 2002  **Member of the Education Committee of the Master and Degree in Mechanical Engineering**
University of Cassino
2000 – 2006  Member of the Ph.D. Committee in Civil and Industrial Engineering
University of Cassino
1998 – 1999  Responsible for Design, testing and commissioning of the experimental facilities at the Research Laboratory "Energy Systems"
University of Cassino
1988 – 1993  Member of Academic Committee for the management of the Department of Mechanical Engineering
University of Cassino

• REVIEWING ACTIVITIES

Reviewer, Journal: Energy – ELSEVIER
Reviewer, Journal: Energy Procedia – ELSEVIER
Reviewer, Proceeding of the European Fuel Cell and Hydrogen Piero Lunghi Conference

• MAJOR COLLABORATIONS/COMPLETED R&I PROJECTS

2024  Visiting Professor
University of California, Irvine, US
2022 – 2023  H2RESTORE Sviluppo di un modulo integrato di accumulo di energia elettrica da fonte rinnovabile con tecnologie Innovative a idrogeno
funded by GRADED & Regione Campania
2022 – 2023  MHYMOST – Metal Hydrides-based hYdrogen storage for MOBILE and STATIONary applications
funded by Cantieri del Mediterraneo & Regione Campania
2022 – 2023  BEST Shelter modulari per la realizzazione di sistemi di stoccaggio e accumulo lithium-based
funded by MECOSER Sistemi & Regione Campania
funded by Regione Campania
2018 – 2019  “ATENA FUTURE TECHNOLOGY”
funded by Regione Campania
2016 – 2018  Innovative technologies for fast ships performance detection and control
funded by Italian Ministry of Economic Development
2015 – 2016  ET-NET - Emerging energy Technologies for International NETworks
funded by Regione Campania
2013 – 2015  MITO - Multimedia Information for Territorial Objects”
funded by Italian Ministry of Education, University and Research
2011 – 2017  "Smart Generation"
funded by Italian Ministry of Education, University and Research
2011 – 2016  "Fuel Cell Lab"
      funded by Italian Ministry of Education, University and Research
2011 – 2012  "Preliminary study for Fuel Cell APU application on MALE - UAV"
funded by CIRA - Italian Aerospace Research Centre
2011 – 2012  "Preliminary study for the selection and sizing of a hybrid propulsion system for UAS"
funded by CIRA - Italian Aerospace Research Centre
2007 – 2008  "Development of a regenerative energy system for HALE-UAV"
2007 – 2008  "Technical and economic evaluation of a waste treatment plant integrated with a CHP plant" funded by Italian Ministry of Agriculture and Forestry


2006 – 2007  "Development of an innovative prototype for dispersed generation of electricity and heat with high efficiency and low environmental impact, based on fuel cells powered by hydrogen produced from natural gas” funded by Coelmo spa and Italian Ministry of Economic Development

2004 – 2005  “Development of mobile microgenerators powered by PEM fuel cell for low power application” funded by Coelmo spa and Regione Campania

2001 – 2002  “Environmental Impact of 800 MW combined cycle power plant – site of Paduli” funded by Ansaldo Energia and General Construction

2001 – 2002  “Assets estimation of 12Mwe cogeneration plant – Anagni site” funded by Videocolor (Thomson Group) and Cogetherm (EDF Group)

1996 – 1998  "Reversible energy storage systems" funded by University of Cassino

1997 – 2000  “Fuel saving and emissions reduction by use of non-conventional fuels in internal combustion engines” funded by Regione Lazio

## Appendix: All current grants and on-going and submitted grant applications of the PI (Funding ID)

*Mandatory information (does not count towards page limits)*

### Current grants (Please indicate "No funding" when applicable):

<table>
<thead>
<tr>
<th>Project Title</th>
<th>Funding source</th>
<th>Amount (Euros)</th>
<th>Period</th>
<th>Role of the PI</th>
<th>Relation to current proposal</th>
</tr>
</thead>
<tbody>
<tr>
<td>ALRIGHT2T – Airport Level DemonstRation of Ground refuelling of liquid Hydrogen for AviaTion</td>
<td>European Commission (Horizon-CL5-2023-D5-01)</td>
<td>355.000 (Parthenope 55.000)</td>
<td>2024-2027</td>
<td>Task leader &amp; Atena Research unit coordinator</td>
<td>Power unit testing for Airport Ground Vehicles</td>
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<td>PROTOSTACK - Tubular proton conducting ceramic stacks for pressurized hydrogen production</td>
<td>European Clean Hydrogen Partnership</td>
<td>150,000 (Parthenope 37,500)</td>
<td>2023-2025</td>
<td>Task Leader &amp; Atena Research unit coordinator</td>
<td>Hydrogen Use in Maritime sector</td>
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<tr>
<td>FuelSOME – Multifuel SOFC system with Maritime Energy vectors</td>
<td>European Climate, Infrastructure And Environment Executive Agency (Cinea)</td>
<td>150,000 (Parthenope 21,250)</td>
<td>2022-2025</td>
<td>Task Leader &amp; Atena Research unit coordinator</td>
<td>Hydrogen Use in Maritime sector</td>
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<tr>
<td>e-SHyIPS - Ecosystemic knowledge in Standards for Hydrogen Implementation on Passenger Ship</td>
<td>European Clean Hydrogen Partnership</td>
<td>130,625 (Parthenope 35,000)</td>
<td>2021-2024</td>
<td>Task Leader &amp; Atena Research unit coordinator</td>
<td>Hydrogen Use in Maritime sector &amp; Modeling of power unit for ships</td>
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<tr>
<td>H2PORTS - Implementing Fuel Cells and Hydrogen Technologies in Ports</td>
<td>European Clean Hydrogen Partnership</td>
<td>676,900 (Parthenope 75,000)</td>
<td>2019-2024</td>
<td>WP – Leader &amp; Atena Research unit coordinator</td>
<td>First Hydrogen RoRo Tractor in the world</td>
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<td>Accordo di Programma Ricerca di Sistema – Progetto integrato idrogeno</td>
<td>ENEA – RSE su fondi MASE</td>
<td>220,000</td>
<td>2022-2024</td>
<td>Principal Investigator</td>
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<td>HyReFi – Modeling and Optimization of sustainable Hydrogen Refuelling Infrastructure</td>
<td>MUR – Ministero Università e Ricerca – Bando PRIN 2022 PNRR</td>
<td>165,544</td>
<td>2023-2025</td>
<td>Principal Investigator</td>
<td>Modeling &amp; Optimization of Innovative HRS</td>
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Curriculum vitae CO-PI

PERSONAL INFORMATION
Family name, First name: DI ILIO GIOVANNI
Researcher unique identifier(s): https://orcid.org/0000-0001-8056-8736
Date of birth: 
Nationality: 
URL for web site: https://www.uniparthenope.it/Portale-Ateneo/organigramma/1428

- EDUCATION
2017  PhD – Energy Science and Engineering  
University of Naples “Parthenope”, Italy  
Supervisor: Prof. Gino Bella
2014  MSc in Mechanical Engineering  
University of Rome “Tor Vergata”, Italy
2013  MSc in Mechanical Engineering  
Polytechnic Institute of New York University, US
2010  BSc in Mechanical Engineering  
University of L’Aquila, Italy

- CURRENT POSITION
2023 – today  Researcher (art. 24 c.3-b L.240/10)  
Dept. of Engineering, University of Naples “Parthenope”, Italy

- PREVIOUS POSITIONS
2020 – 2023  Researcher (art. 24 c.3-a L.240/10)  
Dept. of Engineering, University of Naples “Parthenope”, Italy
2017 – 2020  Post-Doc  
Dept. of Engineering, University of Rome “Niccolò Cusano”, Italy

- FELLOWSHIPS AND AWARDS
2023  Best Researcher of the Year  
Young Scientist Award competition, by Hydrogen Europe Research
2012  Graduate Innovation Fellowship  
Merit-based scholarship awarded based on academic achievements, offered by Polytechnic Institute of New York University
• ORGANISATION OF SCIENTIFIC MEETINGS

2024  Member of the Scientific Committe and Session Organizer
       4th Conference on Sustainable Mobility (CSM2024), Italy
2022  Member of the Scientific Committe and Session Organizer
       3rd Conference on Sustainable Mobility (CSM2022), Italy
2021  Member of the Organizing Committee
       9th European Fuel Cells and Hydrogen Piero Lunghi Conference (EFC201), (online)
2020  Member of the Organizing Committee
       29th International Conference on Discrete Simulation of Fluid Dynamics DSFD2020, (online)

• INSTITUTIONAL RESPONSIBILITIES

2021 – today  Member of the Scientific Board, PhD program “Energy Science and Engineering”
              Dept. of Engineering, University of Naples “Parthenope”
2020 – today  Member of the Committee for Internationalization
              Dept. of Engineering, University of Naples “Parthenope”

• REVIEWING ACTIVITIES

2022 – today  Scientific Advisory Board
              Conference on Sustainable Mobility (CSM)
2021 – today  Editorial Board Member
              Journal of Computational Science – ELSEVIER
2020 – today  Guest Editor for International Journals:
              - Sustainable Energy Technologies and Assessments – ELSEVIER
              - Processes – MDPI
              - Sustainability – MDPI
              - Journal of Computational Science – ELSEVIER
              - Philosophical Transaction of the Royal Society – The Royal Society
              - Applied Sciences – MDPI
2016 – today  Reviewer of more than 30 International Journals, among which:
              - Applied Energy
              - International Journal of Hydrogen Energy
              - Cleaner Energy Systems
              - Journal of Cleaner Production
              - Energy Conversion and Management
              - Energies
              - International Journal of Engine Research
2021  Scientific Evaluator
       For the Best Master Degree Thesis award, by Society of Automotive Engineers - Naples Section (SAENA)

• MAJOR COLLABORATIONS/COMPETED PROJECTS

2022 – 2023  H2RESTORE Sviluppo di un modulo integrato di accumulo di energia elettrica da fonte
              rinnovabile con tecnologie Innovative a idrogeno
HYMOST – Metal Hydrides-based Hydrogen storage for Mobile and Stationary applications
funded by GRADED & Regione Campania
2022 – 2023

BEST Shelter modulare per la realizzazione di sistemi di stoccaggio e accumulo lithium-based
funded by Cantieri del Mediterraneo & Regione Campania
2022 – 2023

HyLIVE - Hydrogen Light Innovative Vehicles
funded by Regione Campania
2020 – 2020

PAINT-IT – A new environment-friendly manufacturing approach for marine antifouling coating
funded by EU LIFE Program
2018 – 2019

NEMESIS – Combined numerical and experimental methodology for fluid structure interaction in free surface flows under impulsive loading
funded by Italian Ministry of University and Research, PRIN 2015
2017 – 2018

ATRE – Eco-sustainable thermal energy storage system for residential applications
funded by Italian Ministry of Economic Development, co-financed by the EU
2017

Academic Guest
Swiss Federal Institute of Technology (ETH), Aerothermochemistry and Combustion Systems Laboratory, Zurich, Swiss
2017

Academic Guest
Silesian University of Technology, Institute of Thermal Technology, Gliwice, Poland
2018

Hi-Quad: development of an innovative four-wheeled hybrid vehicle for urban mobility
funded by Italian Ministry of Economic Development
2014 – 2014
Appendix: All current grants and on-going and submitted grant applications of the Co-PI (Funding ID)

Mandatory information (does not count towards page limits)

Current grants (Please indicate "No funding" when applicable):

<table>
<thead>
<tr>
<th>Project Title</th>
<th>Funding source</th>
<th>Amount (Euros)</th>
<th>Period</th>
<th>Role of the CoPI</th>
<th>Relation to current proposal</th>
</tr>
</thead>
<tbody>
<tr>
<td>ALRIGH2T – Airport Level DemonstRation of Ground refuelling of liquid Hydrogen for AviaTion</td>
<td>European Commission (Horizon-C15-2023-DS-01)</td>
<td>355.000 (Parthenope 55.000)</td>
<td>2024-2027</td>
<td>Member of the Research Unit of Atena</td>
<td>Power unit testing for Airport Ground Vehicles</td>
</tr>
<tr>
<td>H2EXCELLENCE – Fuels Cells and Green Hydrogen Centers of Vocational Excellence towards affordable, secure and sustainable energy for Europe</td>
<td>European Commission Erasmus-Edu-2022</td>
<td>227.589</td>
<td>2023-2027</td>
<td>Member of the Research Unit of Atena</td>
<td>Hydrogen &amp; Fuel Cells education &amp; dissemination</td>
</tr>
<tr>
<td>PROTOSTACK - Tubular proton conducting ceramic stacks for pressurized hydrogen production</td>
<td>European Clean Hydrogen Partnership</td>
<td>150.000 (Parthenope 37.500)</td>
<td>2023-2025</td>
<td>uniParthenope Research Unit coordinator</td>
<td>High Efficiency green hydrogen generation</td>
</tr>
<tr>
<td>FuelSOME – Multifuel SOFC system with Maritime Energy vectors</td>
<td>European Climate, Infrastructure And Environment Executive Agency (Cinea)</td>
<td>150.000 (Parthenope 21.250)</td>
<td>2022-2025</td>
<td>Member of the Research Unit of uniParthenope</td>
<td>Hydrogen Use in maritime sector</td>
</tr>
<tr>
<td>e-SHyIPS - Ecosystemic knowledge in Standards for Hydrogen Implementation on Passenger Ship</td>
<td>European Clean Hydrogen Partnership</td>
<td>130.625 (Parthenope 35.000)</td>
<td>2021-2024</td>
<td>uniParthenope Research Unit coordinator</td>
<td>Hydrogen Use in maritime sector &amp; modeling of power unit for ships</td>
</tr>
<tr>
<td>H2PORTS - Implementing Fuel Cells and Hydrogen Technologies in Ports</td>
<td>European Clean Hydrogen Partnership</td>
<td>676.900 (Parthenope 75.000)</td>
<td>2019-2024</td>
<td>uniParthenope Research unit coordinator</td>
<td>First Hydrogen RoRo Tractor in the world</td>
</tr>
<tr>
<td>Accordo di Programma Ricerca di Sistema – Progetto integrato idrogeno</td>
<td>ENEA – RSE su fondi MASE</td>
<td>220.000</td>
<td>2022-2024</td>
<td>Member of the Research Unit of uniParthenope</td>
<td>Hydrogen Energy storage Systems</td>
</tr>
<tr>
<td>HyReFi – Modeling and Optimization of sustainable Hydrogen Refuelling Infrastructure</td>
<td>MUR – Ministero Università e Ricerca – Bando PRIN 2022 PNRR</td>
<td>165.544</td>
<td>2023-2025</td>
<td>Member of the Research Unit of uniParthenope</td>
<td>Modeling &amp; optimization of Innovative HRS</td>
</tr>
</tbody>
</table>