DENSYS

MASTER ERASMUS MUNDUS | DECENTRALISED SMART ENERGY SYSTEMS

MASTER'S THESES 2021-2023

With the support of the Erasmus+ Programme of the European Union

UNIVERSITÉ DE LORRAINE

KTH VETENSKAP OCH KONST

Politecnica di Torino

UNIVERSITAT POLITÈCNICA DE CATALUNYA BARCELONATECH

Internships and Master Theses of the cohort 2021-2023:

Fabrice Lemoine,
Chair of DENSYS

To fight this global warming, a transition towards a low carbon energy is required: renewable energy sources integration along with decarbonized energy carriers production, decarbonization of the final uses of the energy to achieve the ambitious objective of a carbon neutral world by 2050.

Decentralized smart energy systems play an increasing role in the perspective of renewable energy sources integration. This is the spirit of DENSYS. The overall goals of the DENSYS is to educate with multi-physics approaches (electrical, mechanical, chemical engineering) top skilled engineers, who will be able to design, size, optimize and operate decentralized smart energy systems while keeping a holistic vision to understand citizens' needs

DENSYS is a European Union funded program, coordinated by University of Lorraine (UL, France), jointly built with the Royal Institute of Technology (KTH in Stockholm Sweden), the Polytechnic Institute of Torino (PoliTo, Italy) and the Universitat Politècnica de Catalunya (UPC in Barcelona, Spain).

DENSYS implements the "T-shaped" education profile, the vertical bar of the T being the core competences in engineering (namely mechanical, electrical and chemical engineering) and the horizontal bar complementary competences that are required to have a holistic vision and to engage the dialog with different stakeholders.

DENSYS will provide you a solid training in engineering and also competences in economics and humanities. These last are of primary importance since the energy transition is mainly a human and societal concern, that requires to be equipped with a holistic vision and to engage the dialog with different stakeholders.

DENSYS is also an intercultural experience, which will enable us to share local contexts which are so important to develop relevant and efficient energy solution.

DENSYS aims at training responsible engineers and researchers, but also ambassadors of new energy technologies and of the energy transition and citizens of a world that must urgently shift towards a climate neutral one.

As part of their training, DENSYS students complete a long-term internship and a master thesis. The diversity of internship subjects testifies both to the open-mindedness of the students, their intellectual agility and their ability to invest in advanced technologies for heat and cold management and engineering, integration of renewables in networks, energy technology management, implementation of cross sectorial key enablers such as hydrogen sector (fuel cells, electrolysers), power to X, energy storage, including batteries and their thermal management or energy digitalisation.

Among the **23** students, internships are carried out in the following sectors:

- Hydrogen: **6**
- Integration of renewables, grids, power components: **6**
- Heat and cold: **6**
- Batteries: **5**

They are involved in large international groups, SMEs or in research laboratories, spread throughout the European Union. I let you discover our students and their master thesis topics.

DENSYS

MASTER ERASMUS MUNDUS | DECENTRALISED SMART ENERGY SYSTEMS

Cohort 2021-2023:

KM
AHSAN-UZ-ZAMAN

Jaime Andre
BURGOS

Srijan
DASGUPTA

Jana
DUNDURE

Izaz
GUL

Bismark Razak
HARUNA

Abdul Haseed
KHAN

Sthefi
KLAUS

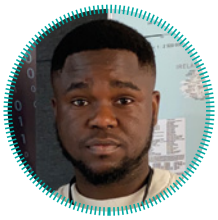
Pierfrancesco
LOSI

Yuanlu
LI

Jose Carlos
MARTINEZ ROSALES

Emmanuel Anios Fils
MOMPREMIER

Chibuoso Theo
NDAMATI



Olamilekan
OLUGBAYILA

Nikshan
PAUDEL

Kosta
PEEV

Sadia
RIAZ

Soroush
ROSTAMI

Ajmal
SHAHZAD

Lucas
SUZUKI

Sahan
TAMPOE

Md Shafwan
UL ALAM

Anjali
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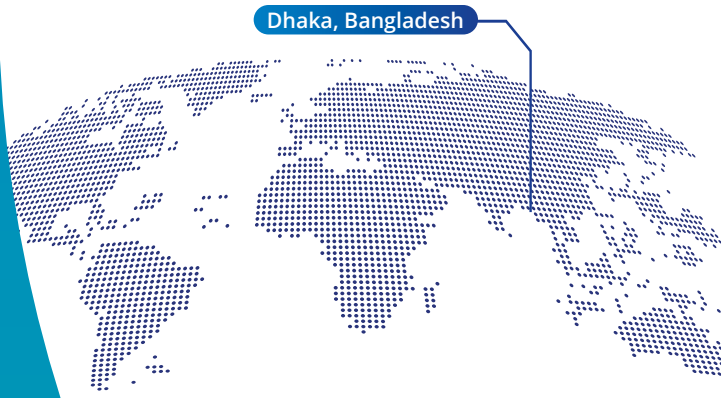
B.Sc. in Electrical & Electronic Engineering at the University of Dhaka, Bangladesh

Mobility scheme

UNIVERSITÉ DE LORRAINE

Politecnica di Torino

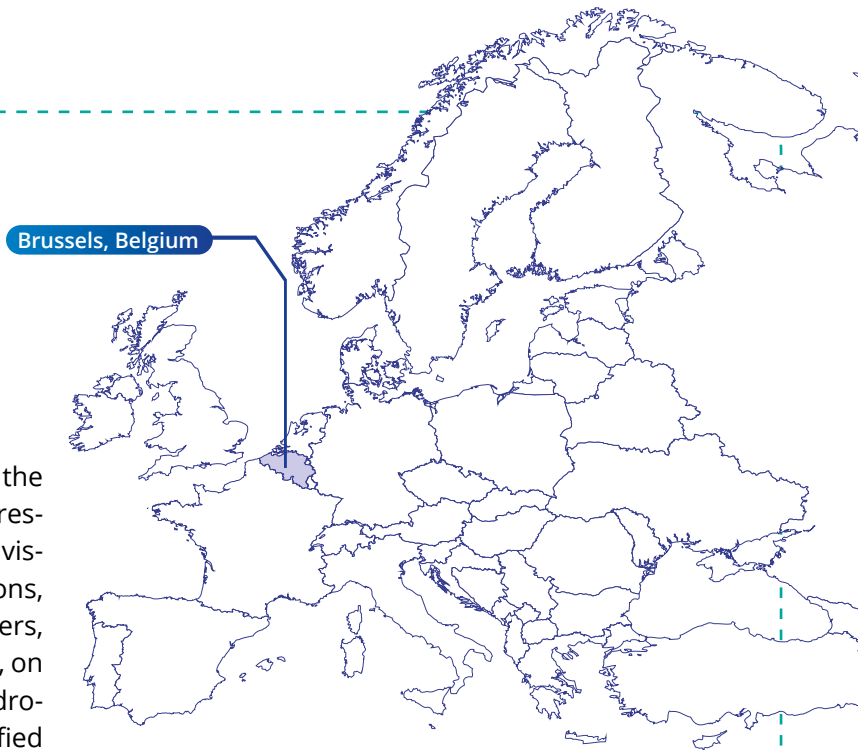


> **“Even the stars are made of Hydrogen...!”**

Company

Hinicio SA

Hinicio is a leading strategic consulting company in the hydrogen and fuel cells industry. With a global presence in Europe, Asia and the Americas, Hinicio advises a wide range of public and private organizations, including energy utilities, equipment manufacturers, chemical companies, and large energy consumers, on strategic business decisions, using profound hydrogen industry expertise combined with highly qualified managerial competencies.



Master's thesis title

Techno-environmental assessment of industrial-scale low-carbon ammonia production pathways

The use of fertilizers has facilitated the expansion of human civilization and contributes to strengthening food security across the globe. Ammonia, being one of the major intermediate products for multiple different fertilizers, along with its direct utilization, has been at the core of the fertilizer industry. The continuous supply of ammonia is expected to be an essential part of global food security in upcoming decades as well as play a crucial role in decarbonizing the economy through emerging applications as a maritime fuel, in co-firing power plants & steel-making, and as a hydrogen carrier, among others.

The industrial scale ammonia production predominantly uses the Haber-Bosch process, where hydrogen is commonly sourced from steam-methane reforming (SMR). The process is one of the significant contributors to greenhouse gas (GHG) emissions. Despite having a fleet of one of the most efficient plants, the European fertilizer industry is responsible for a substantial amount of GHG emissions. To comply with the EU's ambitious target of reducing GHG emissions by at least 55% below 1990 levels by 2030, the industry is keen to identify potential driving factors to reduce the emissions of current production processes.

This study intends to explore ammonia production pathways to identify potential low-carbon alternatives for commercial ammonia production. It will analyze the potential of utilizing low-carbon hydrogen besides the traditional SMR process to reduce the carbon footprint of the produced ammonia. One of this study's major challenges is quantifying the carbon footprint of the ammonia from the industrial ammonia production plants aligning with the EU and international standards. The study is envisioned to identify low-carbon pathways through estimating potential emission savings and CO2 mitigation to decarbonize industrial-scale ammonia production and contribute to strengthening the climate efforts of European fertilizer producers.

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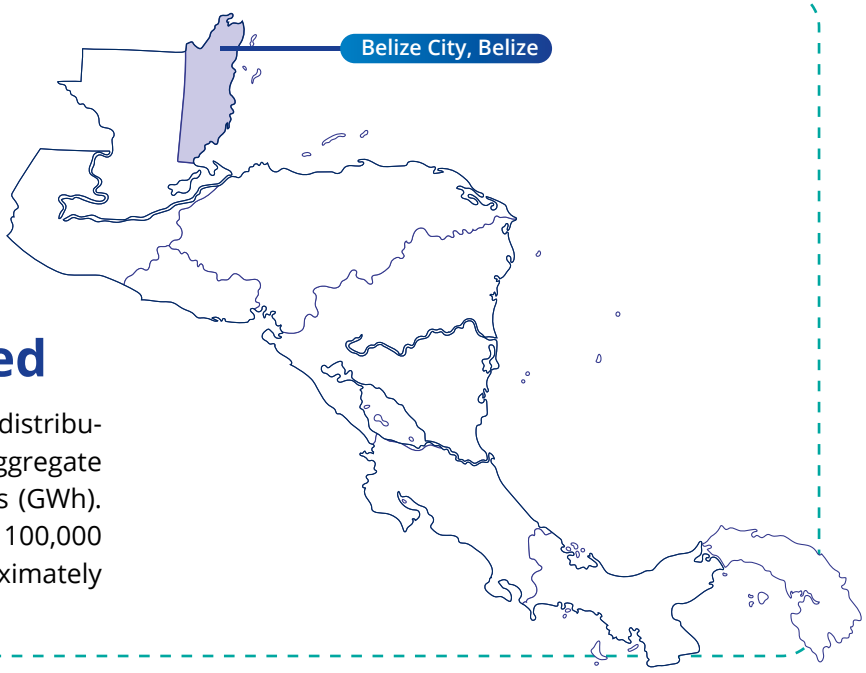
Politecnica di Torino

> **Optimization is just coding and mathematics.**

Company



Belize Electricity Limited

Belize Electricity Limited (BEL) is the primary distributor of electricity in Belize, Central America. Aggregate energy sold in 2019 was 588.4 gigawatt hours (GWh). The Company served a customer base of over 100,000 accounts with peak power demand of approximately 105.6 megawatts (MW) during the year.

Master's thesis title

Development of web app for optimal dispatch of energy from renewable sources

The adoption of variable renewable energy in an existing grid must be done in the most economical way while ensuring system stability. This is a task that is ideally automated. The system can be modeled using GIS data to produce power flow models. The addition of industrial-scale and distributed renewable energy resources can then be added systematically at variable penetration rates to determine the impact on the grid. Battery storage and online generation resources must be optimized in 15-minute intervals. The app must take weather forecast data into account to be able to produce a unit commitment output and a cost of power forecast for energy trading with Mexico.

The app will serve two purposes. One is to optimize the generation of electrical energy every 15 minutes and the next is to provide an economic analysis of different scenarios that might occur in the adoption of renewable technology. The web app will be written in C# using ASP.net framework on an IIS server. The integration of python for mathematical and scientific calculations is a possibility. It is intended to be used on the corporate intranet and might integrate with Automatic Generation Control in the future.

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Mobility scheme

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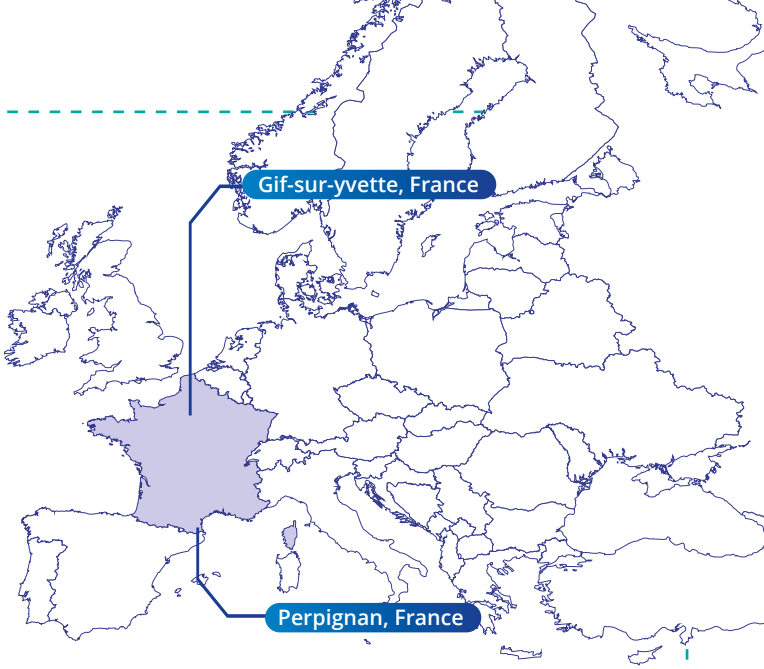
UNIVERSITAT POLITÈCNICA DE CATALUNYA BARCELONATECH

Chattogram, Bangladesh

> **Embrace the Chaos, Embrace the Sun: Riding the Waves of Turbulence to Illuminate a Solar-Powered Future**

Company



PROMES-CNRS: Procedes Materiaux et Energie Solaire (Employer)

LISN: Laboratoire interdisciplinaire des sciences du numérique (Training Site)

PROMES lab, affiliated with CNRS's INSIS (Institute of Engineering and Systems Sciences), is dedicated to advancing solar energy and high-temperature applications. LISN lab brings together researchers from various engineering disciplines to design less resource-intensive and energy efficient urban systems. Both laboratories focus on energy efficiency, sustainable transport, and cutting-edge interdisciplinary research.

Master's thesis title

Parametric study of Thermal-Large Eddy Simulation (T-LES) models in turbulent anisothermal channel flow

This internship is part of the SOLAIRE ANR project in collaboration with PROMES-CNRS and LISN lab. The project focuses on enhancing the efficiency of converting concentrated solar energy into electricity using artificial intelligence. The objective of the thesis is to evaluate sub-grid scale models on different meshes and under various physical conditions to ensure accurate assessments. Concentrated solar plants rely on solar receivers to convert solar energy into thermal energy and transferring the thermal energy to a heat carrying fluid (Pressurized air in our case). The objective this the project is to focus on optimizing thermal transfers while minimizing pressure losses.

The thesis involves using TrioCFD, an open-source computational fluid dynamics (CFD) code from CEA's Thermo-hydraulics and Fluid Mechanics department, for channel flow simulations. Different T-LES mixed models are studied and tested in turbulent flow configurations. LES simulations consider sub-grid terms through functional and structural models. One and two-layered mixed models are used to analyze numerical effects in different settings.

Parametric studies investigate discretization schemes, meshes, and model constants' impact on mass and momentum convection. Modeling errors are assessed by comparing mixed models' results with DNS results. The work contributes to the SOLAIRE project's goal of advancing concentrated solar energy conversion using AI.

Jana DUNDURE

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Mobility scheme

UNIVERSITÉ DE LORRAINE

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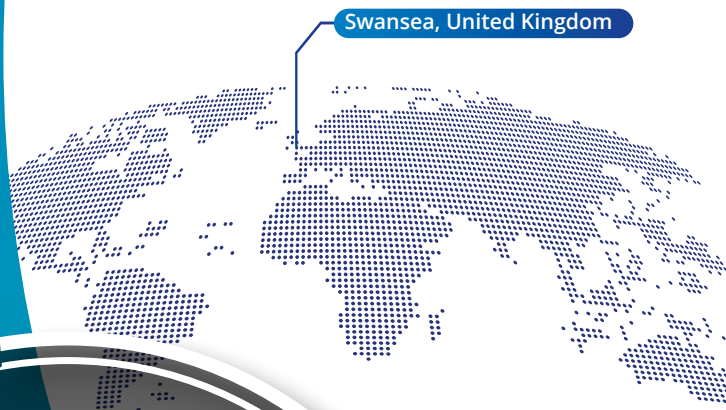
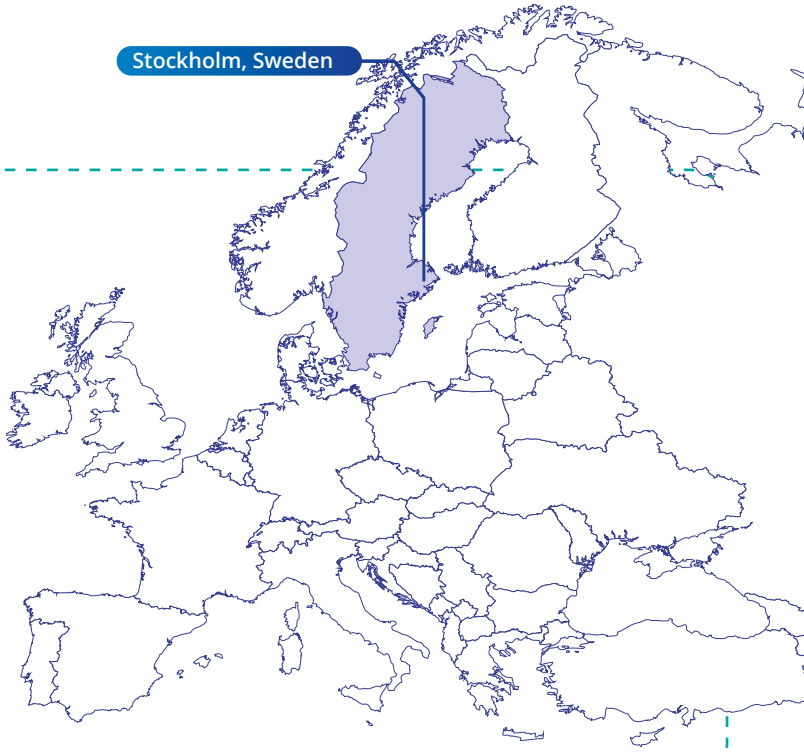


> **Energy efficiency is a key to a sustainable future, but how to know whether your system is operating efficiently? Predictive maintenance and benchmarking have your back.**



Company

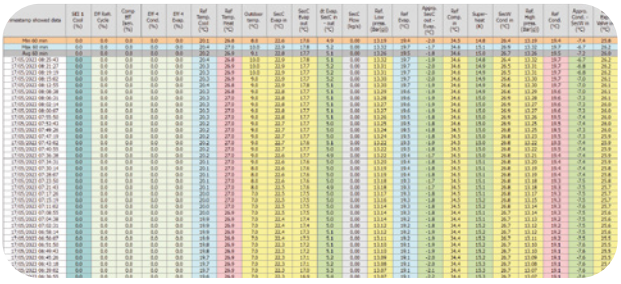
ClimaCheck

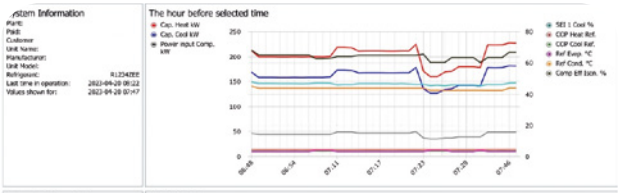
ClimaCheck Sweden AB

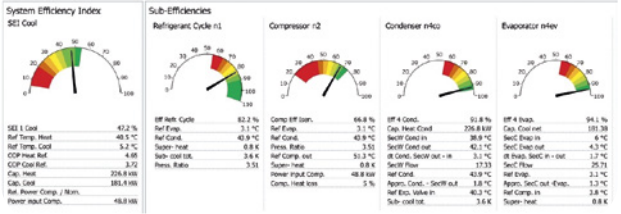
ClimaCheck provides predictive maintenance solution to track energy efficiency of the refrigeration, heat pump and air conditioning plants, which enables performance optimization and hence huge energy savings. Company's own solution implements System Efficiency Index to evaluate systems' performance and the performance of the all components inside.

Master's thesis title

Implementation of the European ecodesign standard into energy efficiency benchmarking of refrigeration systems







Climate change has had an adverse effect on human life, including the increase in utilization of refrigeration, air conditioning and heat pump systems, which account for more than 20% of total electricity consumption and increasing every year. Energy efficiency of those systems plays a pivotal role in energy savings and hence carbon emissions reduction, and predictive maintenance of systems is necessary to achieve that.

The thesis looks at the current ecodesign standard in EU, that regulates the evaluation of the performance of aforementioned systems, and implements it into the benchmarking platform currently under development by ClimaCheck. This will provide a "good performance" benchmark that would have a solid background connected to EU certification and will make it easier for systems' owners to evaluate how well their system is working and whether it is close to design performance. Additionally, the categorization of systems is provided to make the benchmarking more meaningful.

The chosen ecodesign standard is also evaluated against real working systems, as they do not typically operate at the conditions described in the standard. The performance of the system at the design stage has little to do with the real performance, which brings the need to reevaluate the existing standards to make them more realistic. The advice to the policymakers is to be provided for making energy-related standards more inclusive of field operation of systems.

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Mobility scheme

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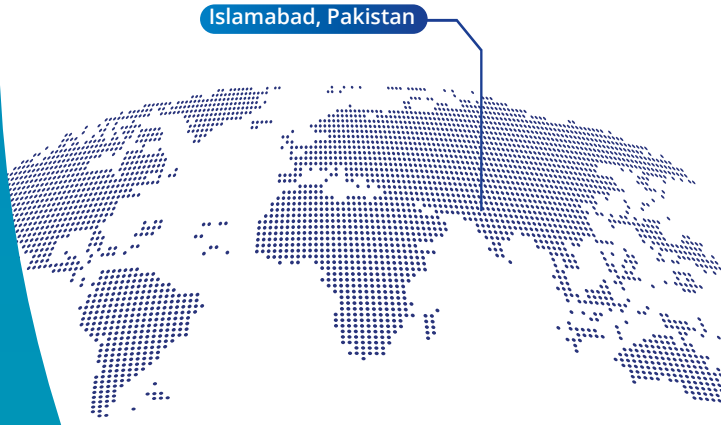
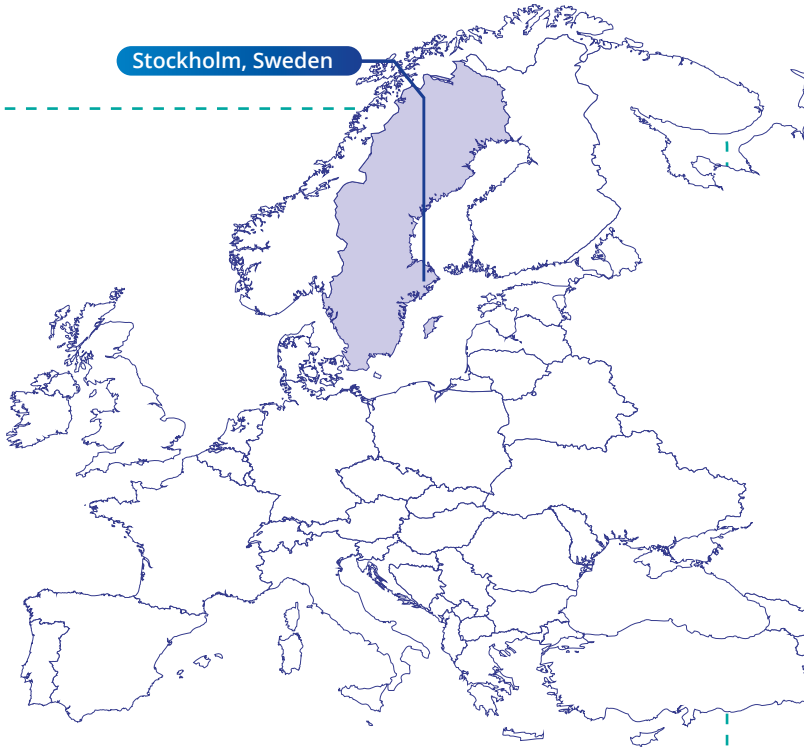
Islamabad, Pakistan



> **Cooler Batteries, hotter performance**

Company



Polestar

POLESTAR

Polestar is an electric performance car brand headquartered in Gothenburg, Sweden. It was founded in 2017 as a joint venture between Volvo Cars and its parent company, Geely. The brand's focus is on developing high-performance electric cars with advanced technology and sustainable materials, aimed at appealing to a new generation of car enthusiasts who value performance and sustainability.

Master's thesis title

Time Efficient Simulations For Advanced Battery Cooling Concepts - Enabling EV Fast Charging

The transition to electric vehicles (EVs) requires advancements in battery technology to improve range and reduce charging times. Fast charging is a key feature to enable the widespread adoption of EVs, but it presents significant thermal management challenges due to the high power and heat generated during charging. To address this issue, advanced battery cooling concepts are required, which necessitate accurate models to capture battery's thermal behavior during fast charging. This thesis presents a time-efficient simulation methodology for advanced battery cooling concepts enabling EV fast charging. The methodology utilizes a simplified model of the battery that accurately couples electrical, thermal and chemical behavior of a battery at good accuracy. The simulation is setup in Star-CCM+ using batterysim® tool. The proposed method can be used to simulate the thermal behavior of a battery module in fast charging and capture hotspots. This research provides valuable insights into the thermal management of li-ion battery modules for fast charging applications and contributes to the development of more efficient and safe EVs. The case-study simulations were carried out on a standard battery pack with cooling plates at the battery module's bottom. The results indicate that this approach leads to large temperature distribution in the cells. Hence, the design is modified by adding another cooling plate to the top. This design effectively cools the battery with minimal temperature gradients. Another studied strategy, involving placement of thin heat pipes between each cell, is proved to be even more effective approach as cells were cooled efficiently and uniformly.

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Mobility scheme

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> **“The act of being responsible can go a long way toward solving the problem!”**

Company

Karlsruhe Institute of Technology (KIT) division Institute for Technology Assessment and Systems Analysis (ITAS)

The Institute for Technology Assessement and Systems Analysis, ITAS is a research institute of the Karlsruhe Institute of Technology. As one of the leading research centres in Germany, the institute's research covers ethics, ecology, economy, society, culture and politics. It investigates technological development and possible systemic/ unintended effects.

Master's thesis title

Master thesis Social Life Cycle Assessment of Sodium-Ion Batteries

Human wellbeing is the ultimate goal of sustainable development. To avoid burden shifting and address sustainability more holistically, Social Life Cycle Assessment is used as the third pillar - Environment, Economics and Society. In the context of the ongoing green revolution, Lithium Ion batteries and Sodium Ion batteries will play a vital role in energy storage and mobile applications. These technologies are however, currently based on critical materials such as Lithium, Cobalt, Manganese, Titanium and Nickel. These materials have long been associated with environmental and social issues such as child labor and forced labor. Thus, this master thesis applies social LCA methodology to find the potential social impacts of the niche Sodium Ion battery and the result is compared to the already existing Lithium Ion technology.

The goal is to identify any social hotspots associated with the supply chain for responsible battery material sourcing and a critical review is made of the PSILCA database. Developed by Greendelta, the current version 3 of the PSILCA database is used in OpenLCA to model the system boundaries of the two technologies. Specifically, this thesis focuses on the extraction phase and prioritizes stakeholder categories; workers and local communities. While social factors and human behaviour are generally difficult to quantify, the database assigns risk levels to selected social indicators through the activity variable "worker hours". Though helpful, the database still lacks data granularity as the level of detail varies across countries and country-specific sectors which can lead to fuzzy results.

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Mobility scheme

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Islamabad, Pakistan

When downtime is not an option, machines must deliver dependable performance every time. Built to last, engineered for reliability - machines you can trust

Company

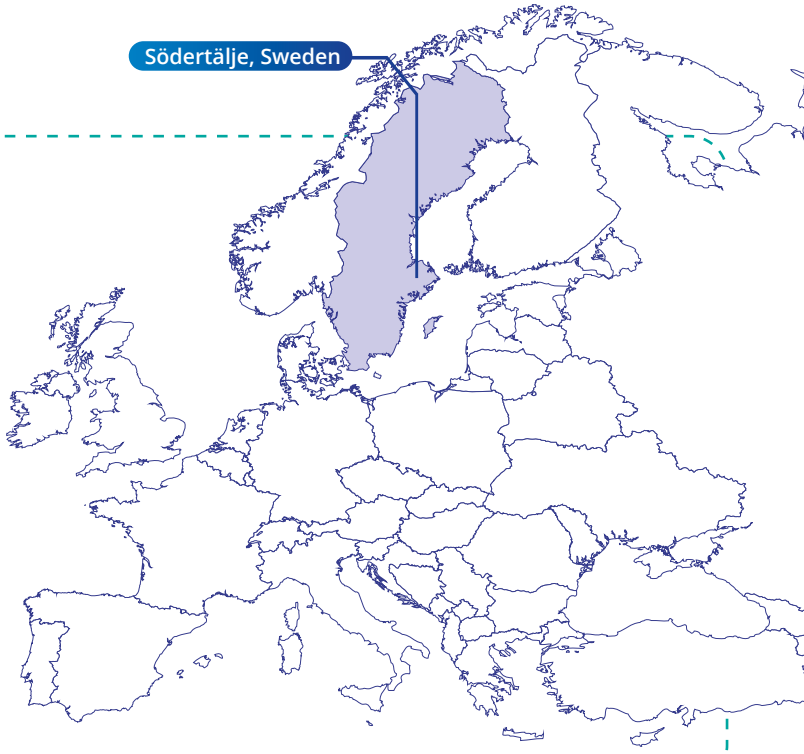
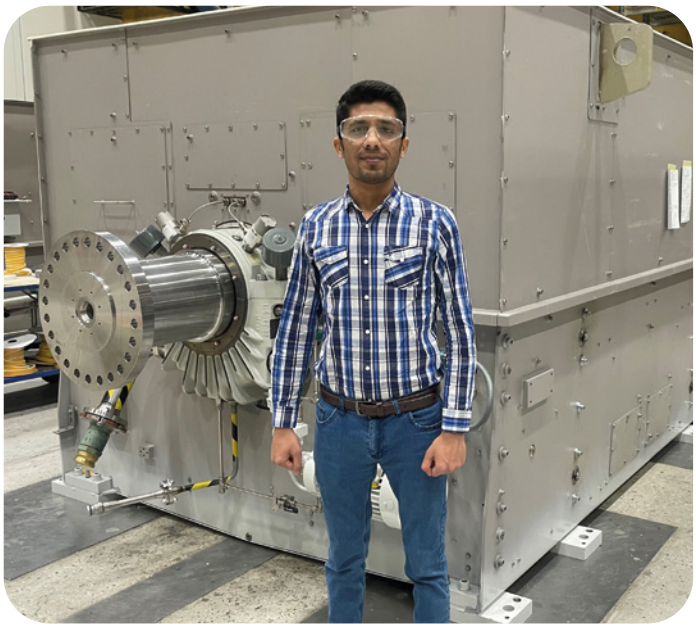


ABB Motion Services

ABB Motors and generators factory in Vasteras is a primary manufacturing facility for ABB's synchronous Industrial Motors, Generators with our 130 years of legacy and hosting the best minds in global Motion Industry. Along with manufacturing, design formulation, reliability tracking and after sales support is provided globally from the same facility.

Master's thesis title

Reliability and Availability Analysis of ABB's Large Synchronous Machines



Reliability and availability of large industrial machines including the large wind turbines is a hot topic these days since any unexpected malfunction is not only a challenge due to complex rectification processes involved there in but could also result in major financial loss.

The objective of the project is to gather data from ABB's global customers and device a standardized methodology in compliance with the IEEE and IEC rules to benchmark the reliability and availability matrix of ABB synchronous machines such MTBF, MTTR, Design availability and Operational availability along with benchmarking the effect of different maintenance routines on these figures.

In this context, the approach being selected is to use life distribution theory along power law processes to analyze the available data. An R-based tool has been developed to analyze the data and propose suitable life distribution which would eventually be implied to reach the desired figures.

Another target is to analyze the data using Markov's chain process and compare the results from the two methodologies. The one with close to reality figures would be adapted for commercial use.

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Mobility scheme

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Politecnica di Torino

> **It will take great professionals, substantial effort, and the development of multiple tools to revolutionize the energy sector. Let's get going!**

Company

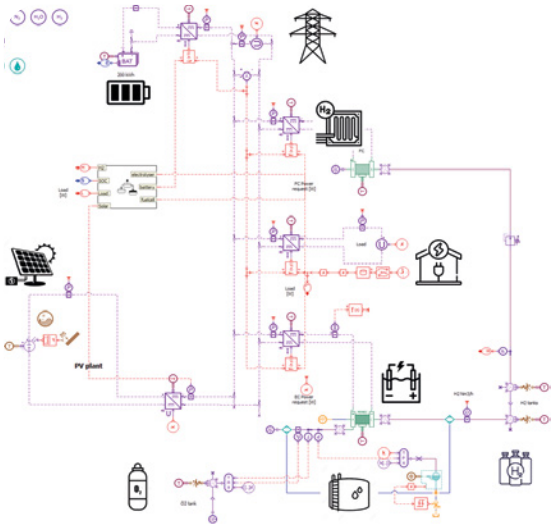
SIEMENS

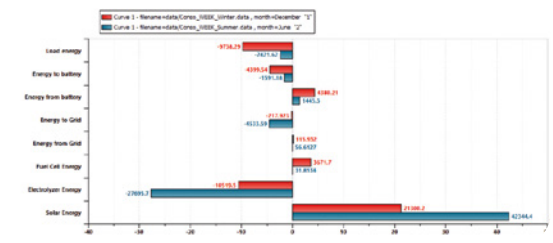
Siemens Digital Industries Software

Siemens Digital Industries Software is a leading provider of software solutions and services for the digital transformation of industrial enterprises. The company's portfolio includes product lifecycle management (PLM) software, industrial automation, and software development tools, helping companies across various industries to improve their efficiency, optimize their digital workflows and drive innovation across industries.

Master's thesis title

Modelling of a SOFC-based micro-combined heat and power (m-CHP) system for a residential application





A multi-physics process simulation software has become a fundamental instrument for managing the entire lifecycle of a product, from ideation to end-of-life. It accelerates the design and optimization of large systems, aiding in decision-making, engineering, and operation. With the recent growth of renewable energy systems and the push towards energy transition, it is necessary to develop new modules into the simulation tools to include new technologies.

Siemens is investing on that and is currently developing new modules for the inclusion of SOFC in their process simulation software Simcenter Amesim. In this context, the goal of this thesis is to develop and optimize a simulation model of a micro-combined heat and power (m-CHP) system based on the use of the Solid Oxide Fuel Cell (SOFC) for residential application.

To start, it was made a study of possible architectures of renewable energy networks that can be associated with a SOFC, the study of the limitations of the components of the Fuel Cell library and their continuous improvement. This was followed by the modelling in Amesim of the different scenarios proposed, analysis and optimization of results. This model should include the understanding and identification of the issues related to the hydrogen ecosystem in the residential context, notions of cost, control, and a sensitivity analysis.

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Mobility scheme

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> **One battery to power them all, One battery to electrify them, One battery to unite mining's quest and in renewable revolution bind them.**

Company

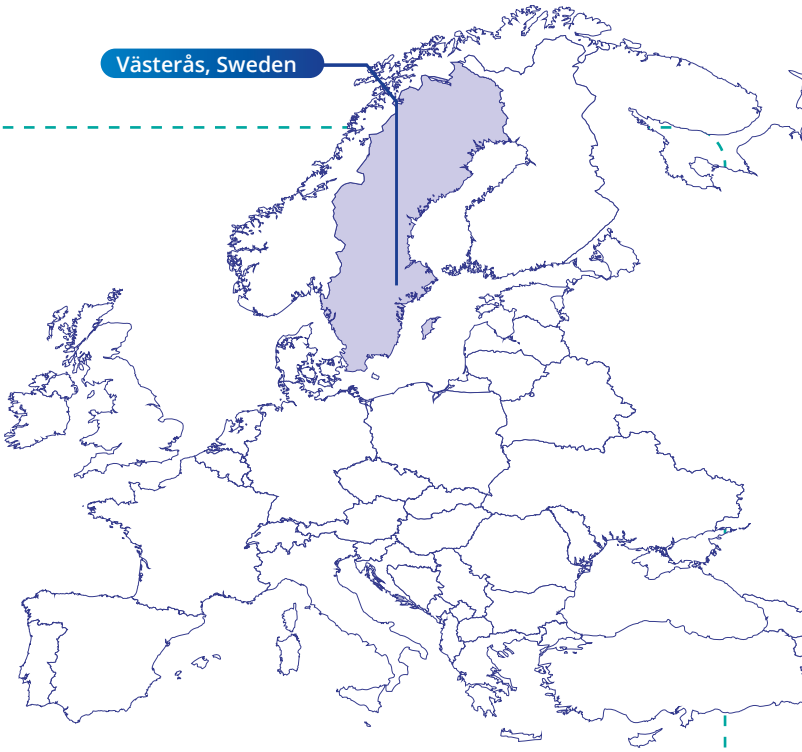

ABB Corporate Research Center (CRC)

ABB Corporate Research Center (CRC) in Västerås, Sweden, is a research and development hub for ABB group globally. The center focuses on developing innovative technologies and solutions in areas such as power electronics, robotics, and industrial automation, to meet the evolving needs of customers and drive sustainable growth.

Master's thesis title

Optimal sizing of battery energy storage for hybrid microgrid in underground mines

The mining industry is essential for society, providing resources for infrastructure and technological development while contributing to the energy transition. However, the industry's significant energy consumption, with diesel accounting for nearly half of it, together with its carbon footprint, has become a pressing global concern in combating climate change. As the world moves towards a low-carbon energy infrastructure, finding sustainable solutions for mining is crucial.

This thesis focuses on designing and sizing Battery Energy Storage Systems (BESS) within hybrid microgrids for underground mines. The goal is to reduce diesel dependence, carbon emissions, and costs. A model is developed to optimize BESS size, considering technical and safety requirements and balancing cost-effectiveness with renewable energy usage. Additionally, the thesis aims to identify key parameters for BESS sizing in the mining context. Different performance metrics, such as Levelized Cost of Storage and diesel consumption, are compared to determine the most suitable Pareto optimal solution.

To solve the optimization problem, heuristic and mathematical techniques such as Genetic Algorithms and Mixed Integer Linear Programming are utilized. The expected results will provide a framework for evaluating BESS designs in underground mines, facilitating their transition to renewable energy.

Yuanlu LI

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Mobility scheme

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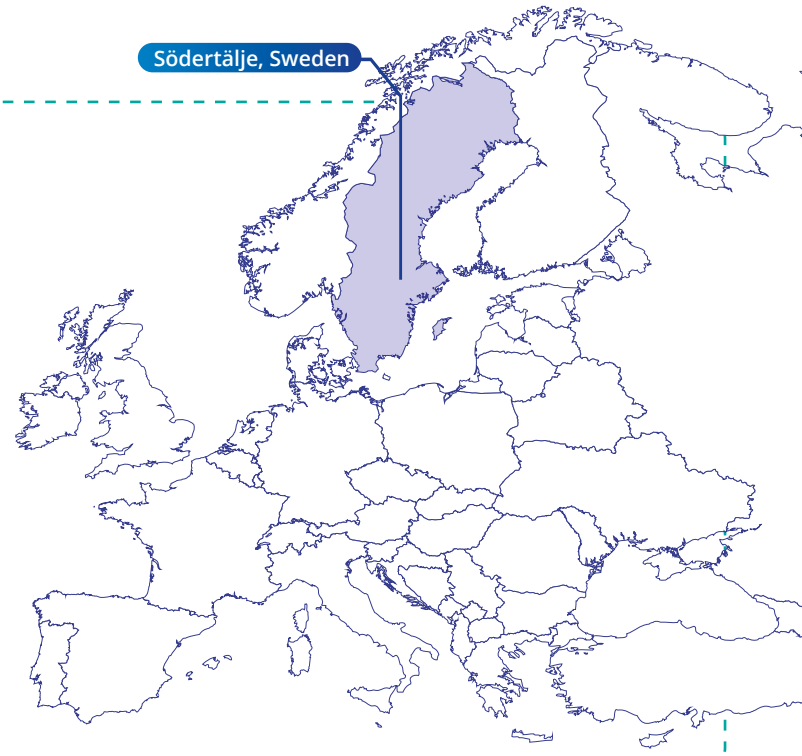
UNIVERSITAT POLITÈCNICA DE CATALUNYA BARCELONATECH

“Sustainable transport: create mobility that is better for business, society, and the environment.”

Company

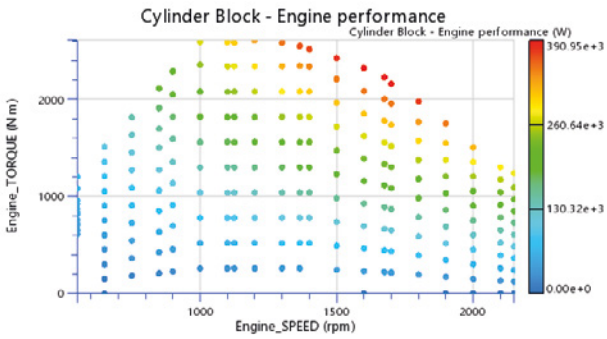


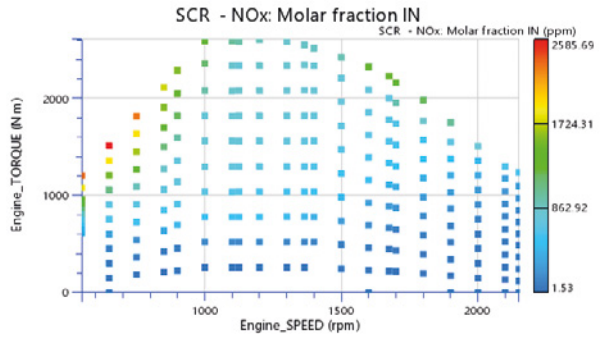
SCANIA CV AB, NXPS

Scania is a world-leading provider of transport solutions, including trucks and buses for heavy transport applications combined with an extensive product-related service offering, also a leading provider of industrial and marine engines. Scania's purpose is to drive the shift towards a sustainable transport system, creating a world of mobility that is better for business, society and the environment.

Master's thesis title

H2 Engine and Aftertreatment System 1D Modelling





This thesis aims to develop a 1-D simulation model for the exhaust after-treatment system(EATS) along with H2-ice engine using the commercial software AVL Cruise M, to extend the EATS 1-D modeling capability for SCANIA.

The first part of the project involves coupling of the EATS(Exhaust aftertreatment system) model with the AVL Cruise M H2-ICE (hydrogen internal combustion engine) model. The simulations will be performed for both steady states for different engine operation points and the transient condition WHTC(world harmonized transient cycle) to predict the emissions before and after the EATS.

The second part of the project is to develop EATS model for the H2-ICE engine model. One option is modifying the existing diesel EATS model in which the Urea-SCR(Selective Catalytic Reduction) and ASC(Ammonia Slip Catalyst) are used for the reduction of NOx. Another option is investigating H2-SCR, where hydrogen is used directly as a reductant for NOx reduction instead of AdBlue, which includes creating a new EATS model using referenced kinetic parameters.

The final part of the project involves optimizing the parameters of the H2 EATS according to the new legislative regulations proposed by EU for the emission of heavy-duty vehicles.

Overall, the EATS model can couple well and simulate together with the H2-ICE model in AVL Cruise M. However, due to the lack of experimental data in the H2 engine, the model can be validated and improved in the future, as well as the kinetic parameters of the H2 reduction model to achieve the low-cost and accurate simulation.

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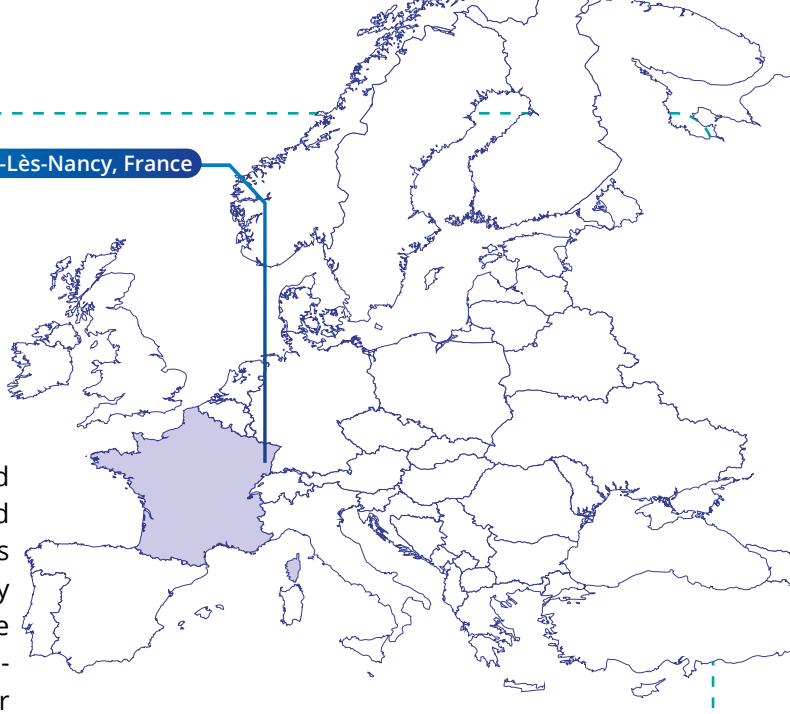
Mobility scheme

UNIVERSITÉ DE LORRAINE

Politecnica di Torino

> **Sustainability is recognizing and exercising the rights of not only our generation, but of future generations to come.**

Company

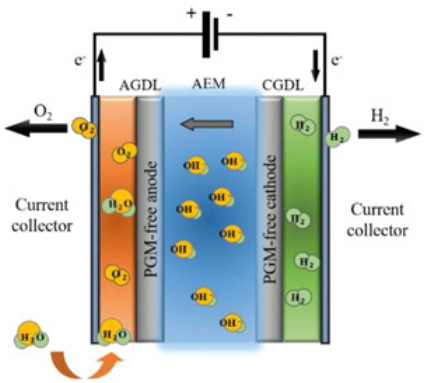


LEMTA – ENSEM

A joint research unit of the University of Lorraine and the CNRS, LEMTA focuses its research on Mechanics and Energy and is one of the five laboratories of the Jacques Villermaux Research Federation for Mechanics, Energy and Processes. Its distinct research platforms include hydrogen and electrochemical systems, fire science, solid rheology of polymers and composites, and nuclear magnetic resonance imaging and spectroscopy.

Master's thesis title

Sustainable anion exchange membrane electrolyser for large-scale green hydrogen production



Several studies anticipate a rapid increase in green hydrogen production via water electrolysis if decarbonization pledges are to be met. In this context, Proton Exchange Membrane Water Electrolysis (PEMWE) is a promising technology to produce green hydrogen. However, PEMWE requires noble metals, such as iridium, as a catalyst for the oxygen evolution reaction. Iridium is an extremely rare metal with global production rates reaching only 7 tons annually, which may hamper the future deployment of this technology.

In contrast, Alkaline Water Electrolysis (AWE) is a well-established technology. However, it suffers from the use of a corrosive liquid electrolyte and poor performance compared to PEMWE. In this context, Anion Exchange Membrane Water Electrolysis (AEMWE) allows the use of cost-efficient catalyst as AWE and can produce high-quality H2 at high current densities as PEMWE. However, “in order to be competitive, disruptive materials and technological break-throughs in electrocatalyst, membranes, ionomers and MEAs integrations and operations are needed”.

My objectives are to set up a new experimental bench to operate and characterize an Anion Exchange Membrane Water Electrolysis (AEMWE) Cell, and to benchmark the different electrodes and membranes available on the market. Modeling of the mass, heat, and charge transfer phenomena will complete the work.

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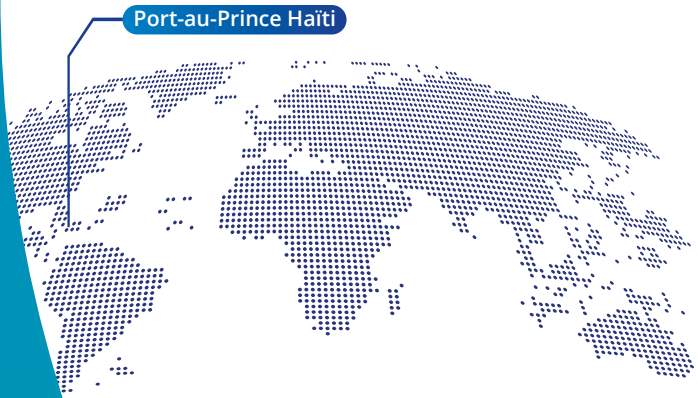
Mobility scheme

UNIVERSITÉ DE LORRAINE

KTH VETENSKAP OCH KONST

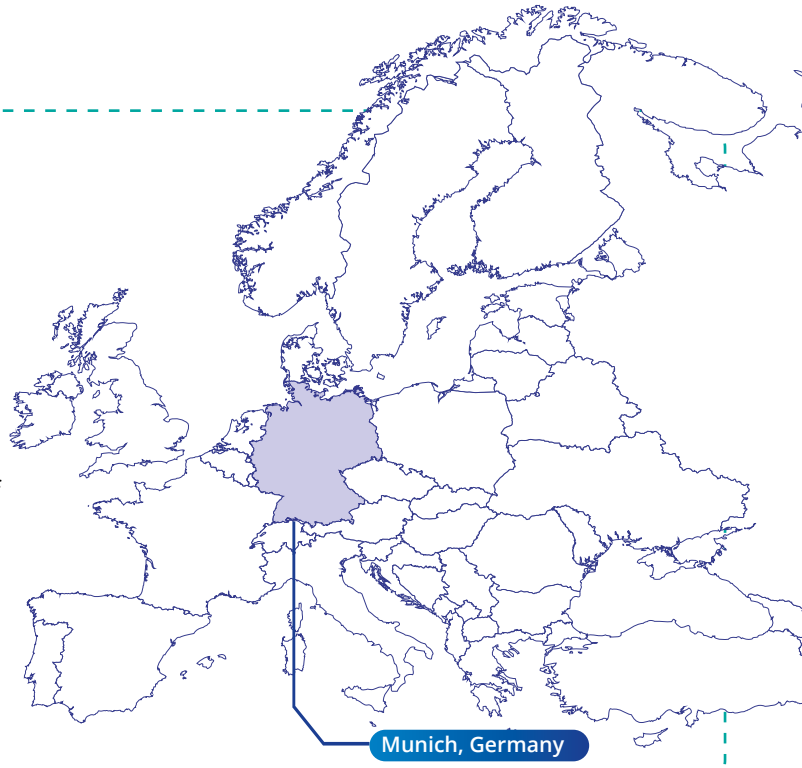


> **“The joy is electric”**

Company

BMW Group

With its BMW, MINI and Rolls-Royce brands, the BMW Group is the world's leading premium manufacturer of automobiles and motorcycles and a provider of premium financial and mobility services. At the Battery Cell Competence Center (BCCC), the BMW Group is analyzing the entire spectrum of battery cells, strengthening its battery manufacturing competence and accelerating the advancement of electric mobility.



Master's thesis title

A methodology for end-to-end digitalization of battery cell production

Due to their high energy density, long life cycle and shelf life, lithium-ion batteries (LIBs) play a decisive role in the successful electrification of vehicles. In fact, the largest automotive companies worldwide currently bet on LIBs to reach their sustainability targets within the next decades. From 2026 on, EU regulations mandate that a digital passport comprising technical information and data related to their environmental performance be attached to all EV batteries. Meeting the sustainability targets and complying with the battery passport regulation require the digital transformation of the LIB manufacturing industry. This thesis proposes a novel methodology to digitalize complex manufacturing processes from data creation to data storage and tackle limitations to successful implementation of data analytics such as lack of data acquisition, poor data quality and scarcity of usable data. The methodology for industrial machine connectivity and data acquisition (MIMCDA) accounts for the complexity, scalability, cybersecurity, data quality requirements of manufacturing processes and outlines an enabling IoT data infrastructure. MIMCDA perfectly fits the digital transformation of battery manufacturing which can benefit from data-driven solutions to address current production inefficiencies and generate relevant data to create the digital passport. The application of the methodology to the electrode manufacturing process highlights the extensive benefits of digitalization.

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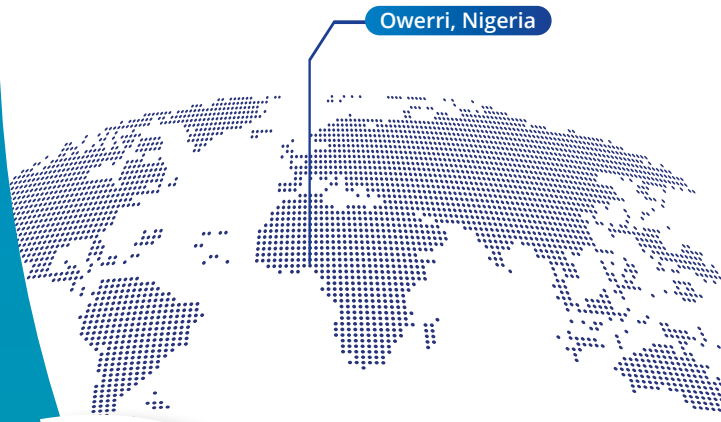
Mobility scheme

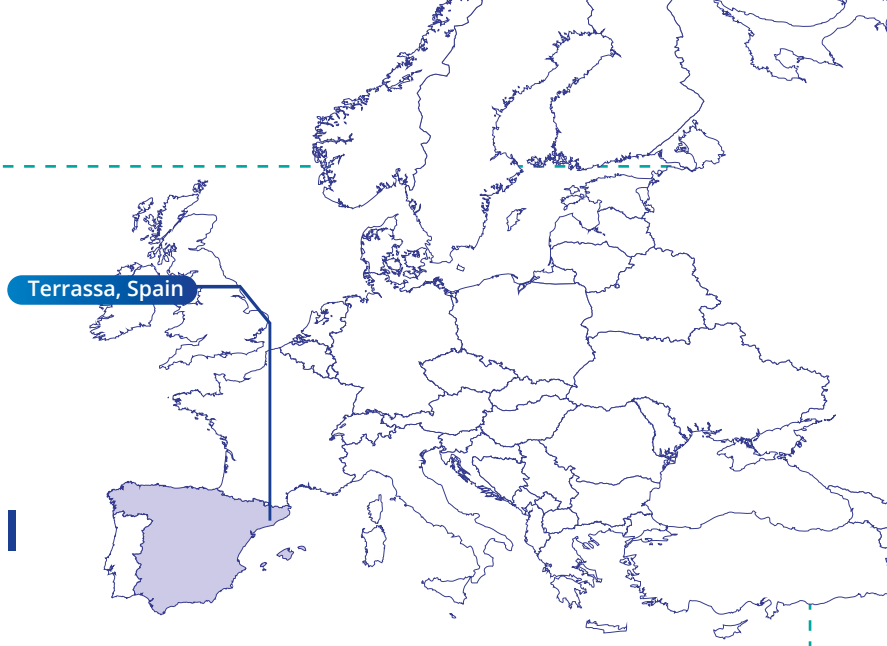
UNIVERSITÉ DE LORRAINE

UNIVERSITAT POLITÈCNICA DE CATALUNYA BARCELONATECH



“Reviving Industrial Efficiency: The Foundry Case in Spain... Don’t let your heat go to waste!”

Company



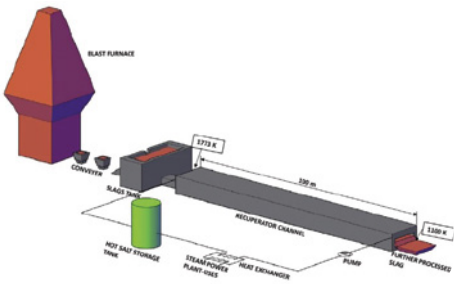
Centre Tecnològic de Transferència de Calor
Laboratori de Termotècnia i Energètica
UNIVERSITAT POLITÈCNICA DE CATALUNYA

Heat and Mass Transfer Technological Center (CTTC)

The Heat and Mass Transfer Technological Center (CTTC) is a research center of the Universitat Politècnica de Catalunya - BarcelonaTech (UPC) in Terrassa, Spain. The laboratory focuses its research activities on two main areas: the first area involves the mathematical formulation, numerical resolution, and experimental validation of fluid dynamics and heat and mass transfer phenomena, while the second area involves applying the knowledge gained from these fundamental studies to optimize thermal systems and equipment in terms of thermal and fluid dynamics.

Master's thesis title

Availability analysis of heat recovery technologies implementation in a high energy intensity industry



This research investigates the application of heat recovery technologies to capture waste heat and improve the energy efficiency of industrial processes, with a particular case in a foundry industry in Spain. Waste heat should be reused within the industrial plant rather than emitting it into the atmosphere.

The flow rates and temperatures were measured and analyzed from the waste energy streams to determine profitable heat recovery applications and processes for waste heat recovery and reuse. Amongst them, the most profound possible points for heat recovery were from the hot gases from the oven, waste heat from the slag of the molten process, hot water used after cooling the induction oven, the hot wall of the maintenance ovens, the cooling process of the hot metal pieces inside the moulders and the de-moulding process.

Considering these, the main objective was thus to take advantage of the electrical energy introduced in the melting process by recovering and pre-heating the metal pieces before melting. Various technologies have proved viable - heat pipe heat exchangers, Seebeck devices and Organic Rankine Cycle for electricity generation from low-temperature streams. Furthermore, we will consider using molten salts for thermal energy storage and implementing renewable energy sources.

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Mobility scheme

UNIVERSITÉ DE LORRAINE

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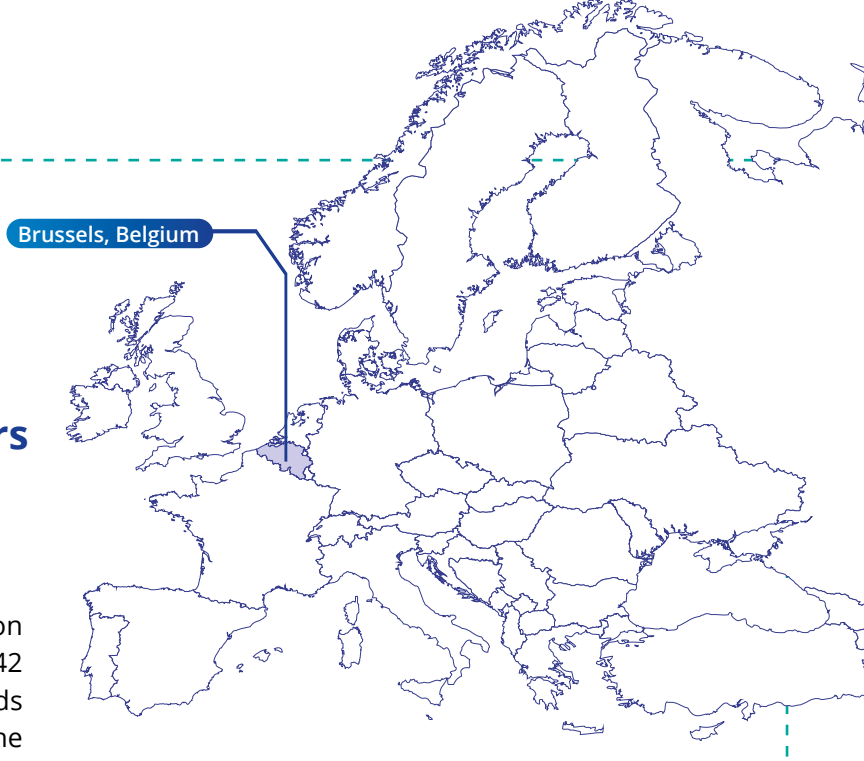
“Navigating the Watts: A High-Voltage Experience of Discovery and Growth in the Energy Space”

Company



European Network of Transmission System Operators for Electricity – (ENTSO-E) Research, Development & Innovation Section

ENTSO-E, the European Network of Transmission System Operators for Electricity, represents 42 TSOs from 35 European countries, working towards an integrated, secure, and efficient power grid. The organization plays a crucial role in achieving Europe's decarbonization goals by 2050 through cooperation in system operation, market development, and network planning.

Within ENTSO-E, the Research, Development, and Innovation (RDI) section is responsible for coordinating RDI activities to address key challenges and accelerate technological innovation. Made up of six thematic working groups and one task force under the RDI Committee to facilitate RDI work, share knowledge, support standardization and interoperability, and foster the implementation of innovative technologies across TSOs.

Master's thesis title

Analysis of Heat Pumps at the Intersection of Grid Flexibility and Thermal Comfort: Evaluating Demand Response Potential in Belgian Residential Buildings

The rapid adoption of heat pumps, spurred by EU policies like REPowerEU, offers an opportunity for their use to enhance grid flexibility, reduce energy dependence, and lower greenhouse gas emissions. With ambitious targets heat pumps expected to be installed by 2030, understanding their impact on grid flexibility becomes crucial. This thesis explores the potential of heat pumps in Belgian residential buildings to improve grid flexibility without sacrificing occupants' thermal comfort.

The objectives are to (1) develop a dynamic building model to simulate heat pump performance, (2) assess the impact of heat pump integration on grid flexibility through DR programs, (3) examine the effectiveness of managing the energy consumption while maintaining thermal comfort for occupants, and (4) evaluate case studies of heat pumps in DR programs for residential buildings to recommend best practices.

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Mobility scheme

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UNIVERSITAT POLITÈCNICA DE CATALUNYA BARCELONATECH

> **“Bringing Knowledge to Life, rethinking Energy Future with Innovative Solutions”**

Company

sener

SENER Ingeniería y Sistemas, S.A

SENER is a private engineering and technology group founded in 1956, specializing in activities related to Engineering and Construction. SENER designs and manufactures sustainable and efficient solutions to respond to the modern world, anticipating the needs of future generation.

Master's thesis title

Assessment of the role of energy storage in large scale electricity facilities

This study examines the feasibility of a Carnot battery as an alternative to Concentrated Solar Power (CSP) plants for long-duration Energy Storage (LDES) in Spain's Energy mix. Due to the failure to award contracts for CSP projects in the renewable energy economic regime(REER) auction under the Integrated National Energy and Climate Plan (INECP) 2021-2030, there is a need to explore alternative options for LDES in Spain.

The study identifies the challenges associated with CSP projects, including the discrepancy between projected and actual market conditions and evaluating the feasibility of a Carnot battery in the Spanish market. The study aims to establish the cost of energy production from a Carnot
battery by optimizing the plant's configuration.

The significant realizations achieved in this study include identifying the potential of the Carnot battery as a viable alternative for LDES in Spain's energy mix. This study's findings can aid in Spain's goal of adding 5 GW of Solar thermal electricity by 2030. Overall, this study provides a comprehensive analysis of an alternative energy storage technology that could have significant implications for renewable energy integration. The results of this study can guide policymakers in making informed decisions on the future of LDES in Spain.

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Mobility scheme

UNIVERSITÉ DE LORRAINE

Politecnica di Torino

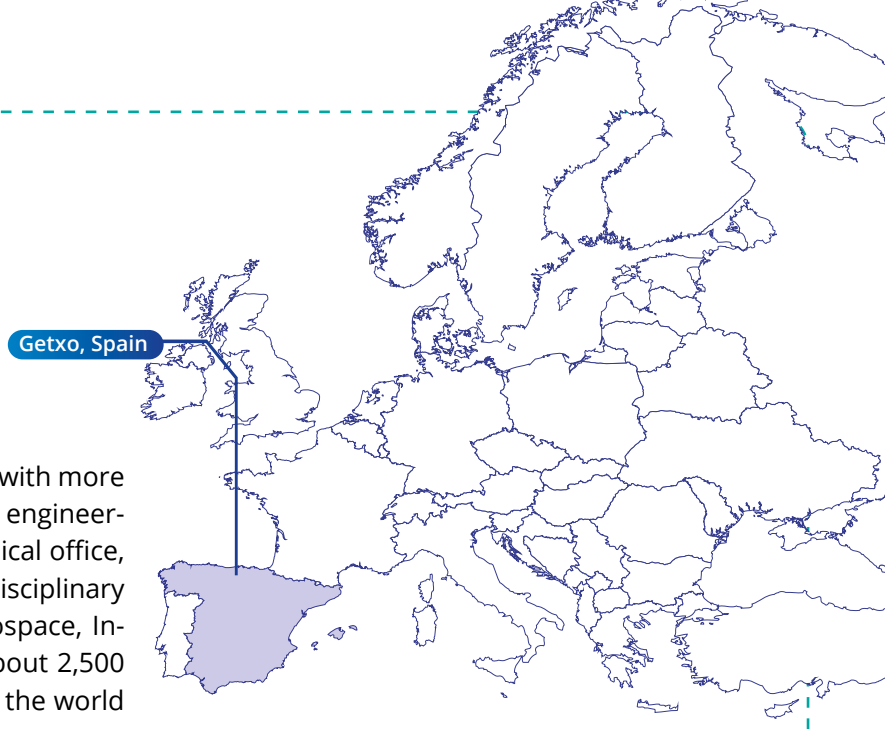
“The energy transition is the biggest challenge of our generation. Hence, I feel privileged to be a part of the renewable revolution and have the opportunity to immerse myself in the world of industry decarbonization and give my small contribution towards more sustainable societies. P.S. When in doubt – oversize!”

Company

sener

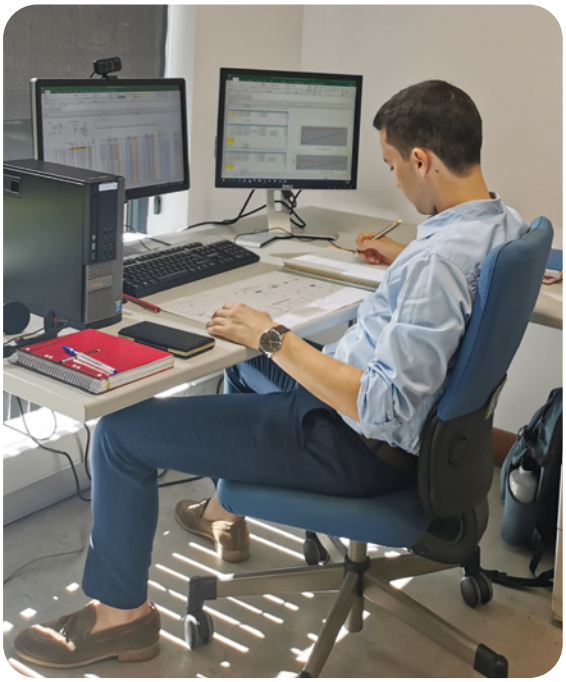
SENER Ingeniería

SENER is an engineering and technology group with more than 65 years of history. It was the first Spanish engineering company, founded in 1956 as a naval technical office, soon diversified its activity to become a multidisciplinary international group, with presence in the Aerospace, Infrastructure, Energy and Naval sectors, with about 2,500 highly qualified professionals in offices around the world and recognized for its capacity for innovation.



Master's thesis title

Utilization and integration of multiple waste heat streams from various industrial processes at an industrial site



This master's thesis focuses on the retrofitting and improvement of an industrial site's power generation system by integrating multiple waste heat streams. Given the recent "Energy transition" and volatile fossil fuel prices, previously overlooked projects have become financially attractive. Besides technical and economical benefits, these changes would also lower carbon emissions, which would result in a positive impact on the environment.

Therefore, the objective of this thesis is to analyze different system configurations and technologies, including conventional and organic Rankine cycles, different types of thermal energy storage systems, and heat recovery steam generation, in order to propose an optimal solution for the site. Having in mind that the recovered heat from the industrial processes can greatly vary (in terms of flow-rate, pressure and temperature) depending on the manufacturing needs, it is of utmost importance to choose the correct design point. However, any system has to be operational throughout the day, hence the behaviour of the system at off-design conditions has to be determined and analyzed which poses a significant challenge.

The analysis will include a complete techno-economic evaluation of each system's topology, taking into account factors such as capital costs, operating costs, and payback periods. By providing a detailed analysis, the client can make an informed decision on how to proceed with the project.

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Mobility scheme

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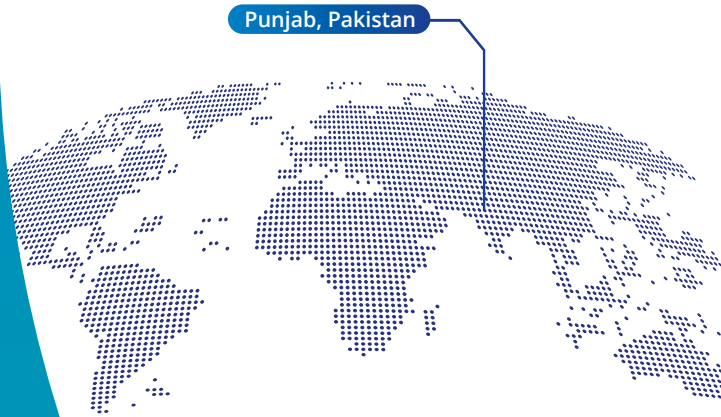
Politecnica di Torino



“Stainless steel electrolyzer components Steel The Show, enabling a greener hydrogen future!”

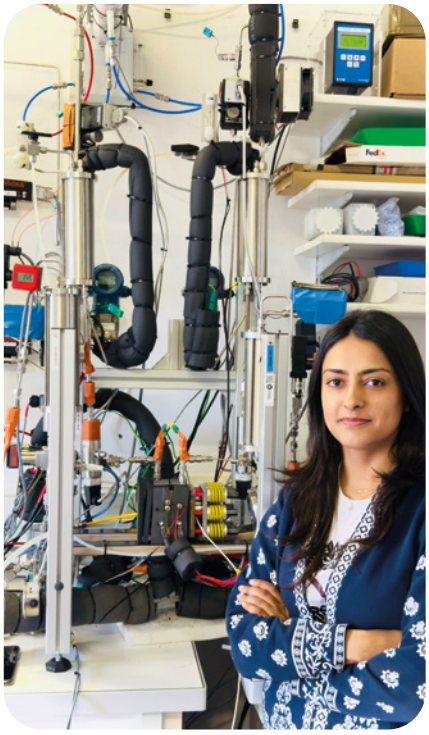
Company

LEMTA – ENSEM

A joint research unit of the University of Lorraine and the CNRS, LEMTA focuses its research on Mechanics and Energy and is one of the five laboratories of the Jacques Villermaux Research Federation for Mechanics, Energy and Processes. Its distinct research platforms include hydrogen and electrochemical systems, fire science, solid rheology of polymers and composites, and nuclear magnetic resonance imaging and spectroscopy.

Master's thesis title

Thin protective coatings for next generation bipolar plates and porous transport layers of PEM electrolysers



Titanium-based bipolar plates (BPP) and porous transport layers (PTL) currently dominate the cost of proton-exchange membrane water electrolyser (PEMWE) stacks. Replacing titanium with stainless steel for these components would significantly enhance the cost-efficiency of PEMWE. However, application of stainless-steel components in PEMWE requires functional protective coatings, to avoid dissolution of cations (i.e., iron leaching) and to avoid an increase in contact resistance in the locally acidic aqueous environment. Only a few studies are available on the requirements for and the mechanism of protective coatings on stainless steel components under immersion conditions, and even less on three-dimensional (3D) porous transport layers (PTL). The thesis is focused on studying the behavior of different coatings on stainless steel both PTL and BPP, by performing in-operando tests and interfacial contact resistance (ICR) measurements. The aim is also to model the interface between the PTL and the electrode and to study the effect of pollution caused by metal ions coming from the stainless steel. The results of the thesis will contribute to potentially lowering the cost of the components with the largest share in PEMWE system cost.

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Mobility scheme

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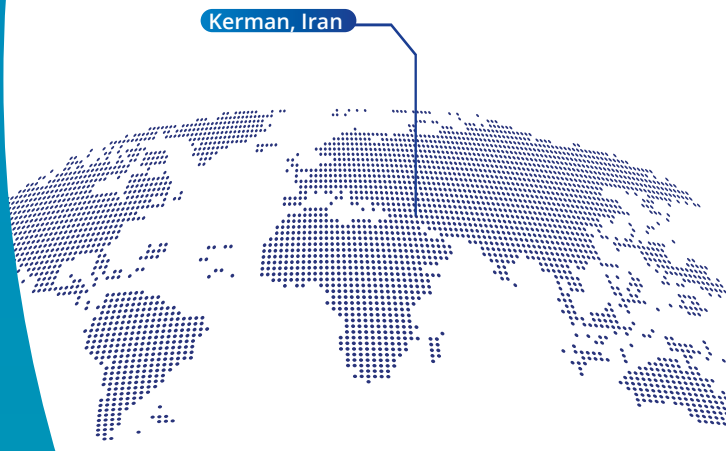
UNIVERSITAT POLITÈCNICA DE CATALUNYA BARCELONATECH



> **Be cool, even batteries work better when they are cool.**

Company

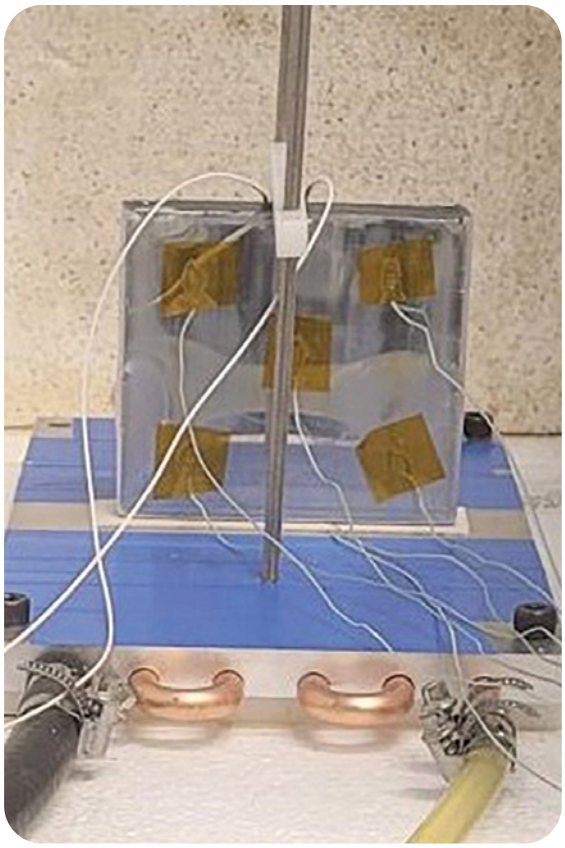
VOLVO

Volvo Group

The Volvo Group is one of the world's leading manufacturers of trucks, buses, construction equipment, and marine and industrial engines. The Group also provides complete solutions for financing and service. The Volvo Group, with its headquarters in Gothenburg, employs about 100,000 people, has production facilities in 18 countries, and sells its products in more than 190 markets.

Master's thesis title

Effects of the Thermal Interface Materials on the Cooling Systems of the Batteries



The quality of our life is significantly affected by the environment that we live in. Therefore, the great effort of mankind is directed toward the sustainability and improvement of the environment. Volvo Group is determined to contribute to driving their industry to a more sustainable future. Li-ion batteries are one of the best options to store energy for Electrical Vehicles because of their high power and Energy density. The temperature of the battery is one of the most important variables of the battery that can affect the life span of the battery. The thermal management system has the duty to manage the temperature of the battery. One of the main challenges in the thermal management systems of the battery is the empty space between the battery and the heat sink. If the air is stuck between the battery and the heat sink, thermal conductance will be decreased and therefore it affects the performance of the thermal management system. One solution is to fill the space with Thermal Interface Material to have better performance of the Thermal management system. In this project, Different Thermal Interface Materials are going to be tested with different pressure applied on and different thicknesses and the results are going to be compared with each other. A thermal simulation is going to be conducted to understand better the heat transfer between the battery and the heat sink.

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Mobility scheme

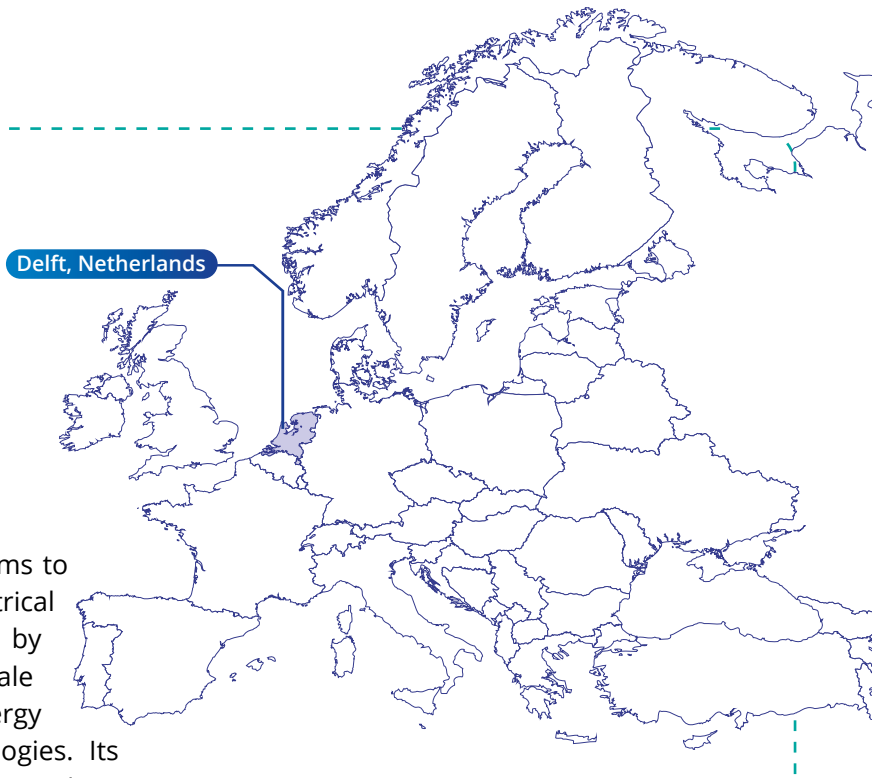
UNIVERSITÉ DE LORRAINE

UNIVERSITAT POLITÈCNICA DE CATALUNYA BARCELONATECH

Islamabad, Pakistan

“Smart grid powered by AI is a game-changer for sustainability.”

Company



Intelligent Electrical Power Grids (IEPG)

IEPG group at Delft University of Technology aims to define the technological limits of future electrical power systems in a changing world, influenced by dynamic electricity markets and the large-scale introduction of renewable & dispersed energy sources, by the application of future technologies. Its research areas are future proof power grids, integrated energy systems, flexible distribution systems, and grid security.

Master's thesis title

Coordinating and controlling Distributed Energy Resources using Deep Reinforcement Learning

Distributed energy resources (DERs) are becoming increasingly important in the green transition towards a more sustainable energy system however the coordination of DERs in the grid presents many challenges including the management of supply and demand. Optimization methods with mathematical models become computationally intractable as the number of variables and constraints increases, which happens in the case of distributed energy resources where we have a large number of variables and constraints. Also, it is not possible to model the complex system of DERs for mathematical optimization. The thesis research will provide new reinforcement learning based algorithms which can help in the coordination and control of the DERs. The developed algorithm will also be dealing with the sudden loss of the distributed energy resource in the optimal scheduling of all the resources available. The scalability of this method will be explored to make it applicable to a community level. The expected results will show the performance and resilience of the developed algorithm against mathematical optimization methods thus providing the new approach for the coordination of the DERs. The results will also show the effect of this approach on sustainability.

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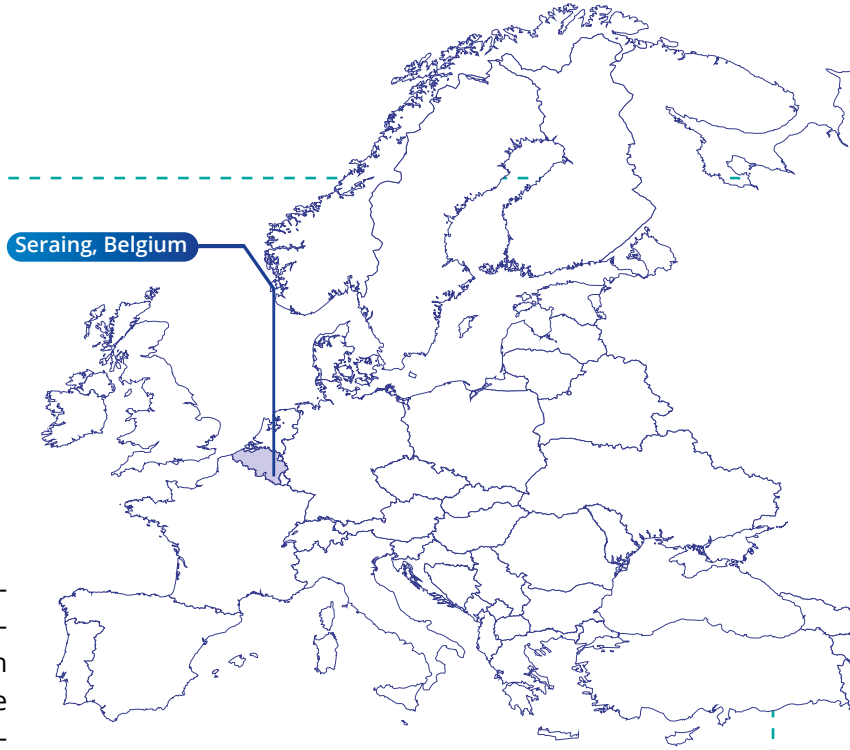
Mobility scheme

UNIVERSITÉ DE LORRAINE

UNIVERSITAT POLITÈCNICA DE CATALUNYA BARCELONATECH

“Store your energy for a brighter tomorrow.”

Company



John Cockerill Renewables S.A

John Cockerill is an engineering company with activities divided into 6 sectors (energy, hydrogen, defense, industry, environment, services) present in more than 20 countries. The Integrated Renewable Solutions (IRS) Business Unit develops turnkey solutions combining a range of technologies such as REN production (solar PV and wind), battery energy storage, e-mobility, heat recovery and others. It also operates and does research at its own microgrid.

Master's thesis title

Stationary Battery Energy Storage – Market Analysis in Selected European Countries

Energy storage has been a key technology to boost implementation of renewable energy production, increase reliability and robustness of modern power grids and accelerate the energy transition. Stationary battery systems have quickly become one of the preferred storage choices due to their performance, flexibility and technological maturity to address a wide range of use cases. While lithium-based technologies demonstrate good economic and technical parameters and are still expecting to have an increase in market share in the coming years, other technologies are also emerging as alternatives, such as sodium-based batteries.

The objective of this thesis is to conduct market research for lithium-ion and sodium-sulfur stationary batteries in France, in order to assess potential market opportunities. The methodology includes analyzing the market externally (to identify trends, select most promising applications) and internally (assess the position of the company on the targeted markets). Finally, a recommendation for market strategy is done based on techno-economic evaluation of the proposed solutions.

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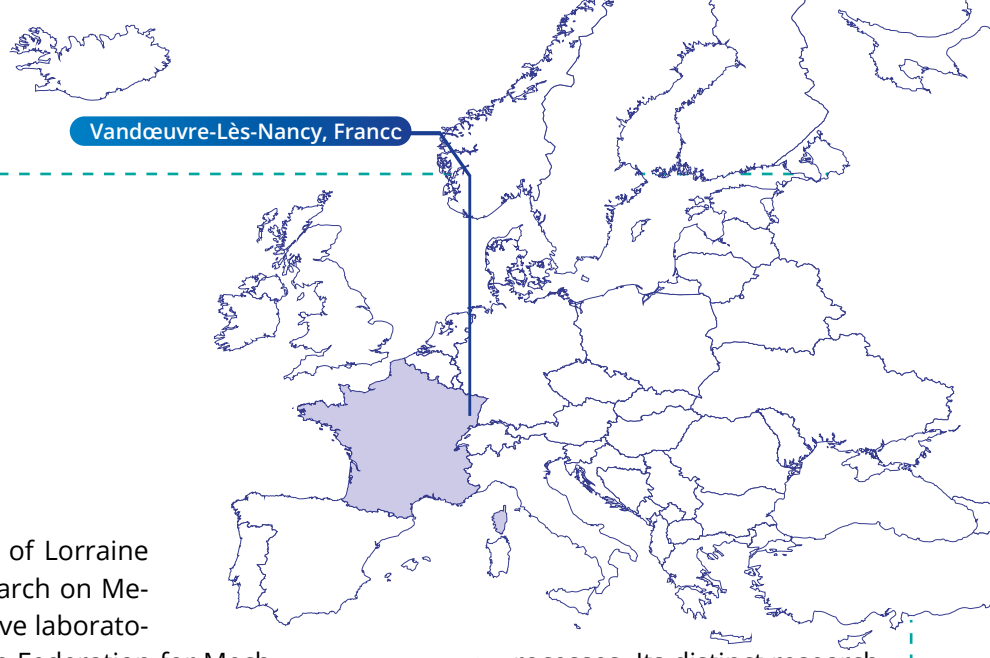
Mobility scheme

UNIVERSITÉ DE LORRAINE

Politecnica di Torino

“Maximizing Efficiency, Minimizing Iridium: The High-Pressure PEM Electrolysis Revolution!”



Company

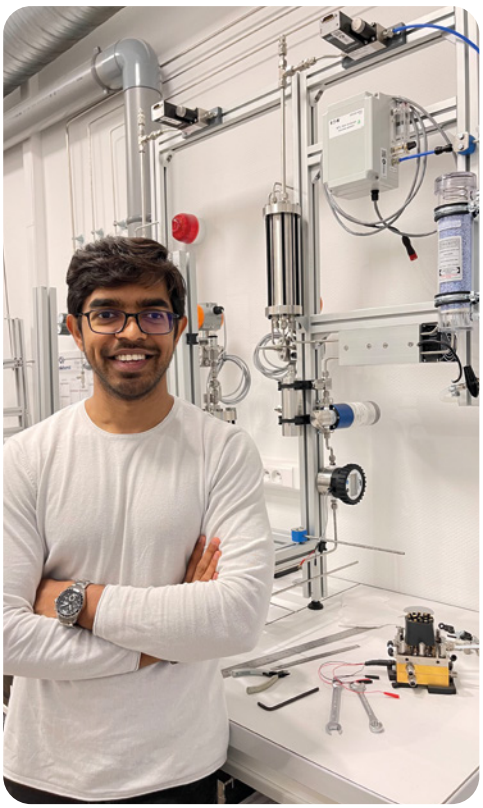
lemta 50 ans
Laboratoire Énergies & Mécanique Théorique et Appliquée
1973 - 2023

LEMTA – ENSEM

A joint research unit of the University of Lorraine and the CNRS, LEMTA focuses its research on Mechanics and Energy and is one of the five laboratories of the Jacques Villermaux Research Federation for Mechanics, Energy and Processes. Its distinct research platforms include hydrogen and electrochemical systems, fire science, solid rheology of polymers and composites, and nuclear magnetic resonance imaging and spectroscopy.

Master's thesis title

Reducing iridium loading in PEM Water Electrolysis by enhancing the operating current density



Rapid developments towards a hydrogen economy driven by renewable energy powered Polymer Electrolyte Membrane Water Electrolysis (PEMWE) are expected to increase demand for iridium, the catalyst used in the oxygen evolution reaction at the anode. As one of the scarcest elements in the world, iridium prices have increased sharply, causing its share in the capital expenditure of PEMWE to also increase as the technology is deployed with greater intensity. Consequently, the objective of this thesis is to experimentally investigate the feasibility of reducing iridium loading by increasing the operating current density of PEMWE cells. As current density is directly correlated to hydrogen production, more hydrogen could be produced with the same iridium loading, significantly improving catalyst utilisation. This can be accomplished by using thinner polymer electrolyte membranes compared to state-of-the-art materials to enable a reduction in conduction losses (or ohmic overpotential) in the cell. High pressure operation will also be studied, to save the energy needed to compress the hydrogen before storage. The anticipated challenges include the back diffusion of hydrogen from the cathode into the anode due to the presence of a reverse pressure gradient, increase in constriction resistance as a result of the thinner membrane that could inhibit the flow of electrons in the current collectors, and increase in mass transport losses at high operating current densities.

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Mobility scheme

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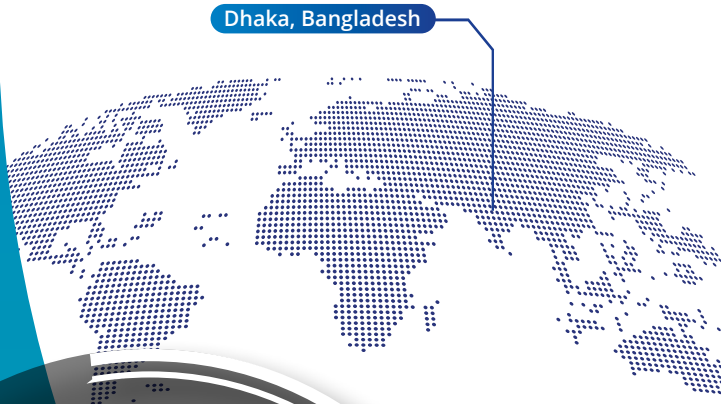

“Let’s maximize our energy potential with a high-efficiency power cycle and march towards a sustainable future.”

Company

UNIVERSITAT POLITÈCNICA DE CATALUNYA
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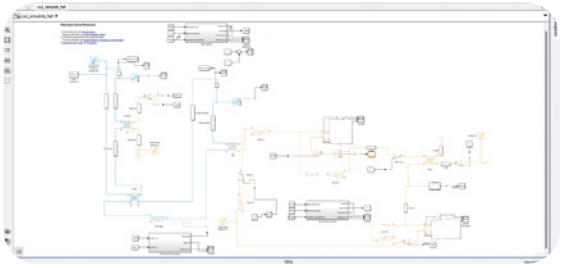
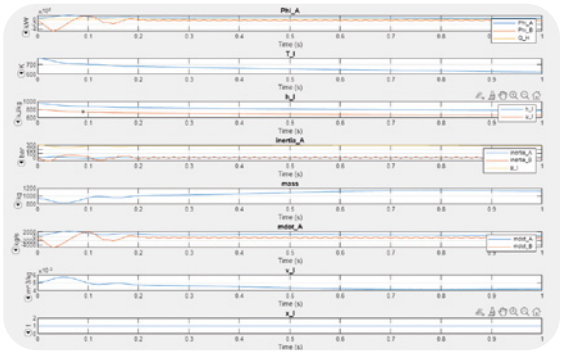
UPC Division of Nuclear Engineering (ETSEIB), Advanced Nuclear Technology (ANT) Research Group

The Advanced Nuclear Technology (ANT) Research Group conducts innovative research in thermal-hydraulics, safety, fusion technology, and nuclear data measurement with an unwavering commitment to excellence in research and technology transfer in the nuclear engineering field. The group believes that energy, specifically nuclear power, is a crucial area of expertise and that professionals should be trained to have the highest levels of proficiency and a safety culture founded on exactitude, integrity, and self-discipline. By utilizing a suite of simulation tools, the group leverages synergies between research lines, tackling interdisciplinary problems through a multi-physics approach. Ultimately, the group endeavors to educate nuclear industry professionals and support public administration in regulating the sector.

Master's thesis title

Contribution to the design of the control of a Supercritical CO^2 power cycle by means of a system model in Simulink





Supercritical CO2 power cycles have gained popularity in recent years due to the unique properties of carbon dioxide when it is maintained over its critical point, which is intermediate between those of fluids and gases. As a result, sCO2 Brayton loops outperform traditional Rankine cycles in terms of efficiency and compactness. sCO2 cycles have a wide range of potential applications, including concentrated solar power, waste-to-energy, high-temperature fuel cells, and secondary circuits of Nuclear reactors. The objective of this thesis is the optimization and improvement of a sCO2 Brayton power loop, which was designed in the MATLAB-Simulink environment.

With this thesis is expected:

- To optimize the runtime of the model
- To generate a base case for steady-state for later comparisons
- To improve the overall efficiency of the cycle
- To compare the improved results with the base case
- To test the model for one or several transient conditions

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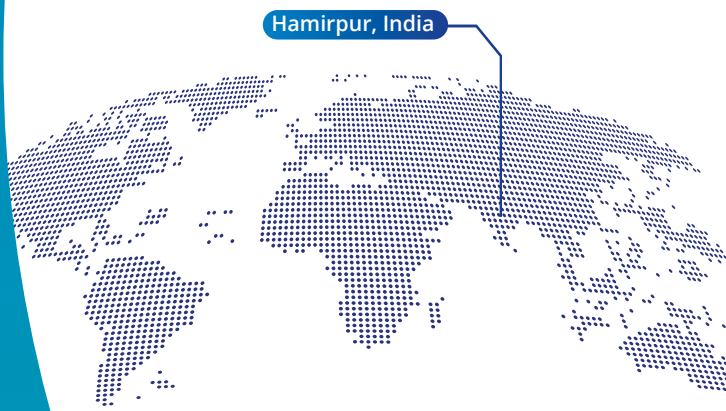
Mobility scheme

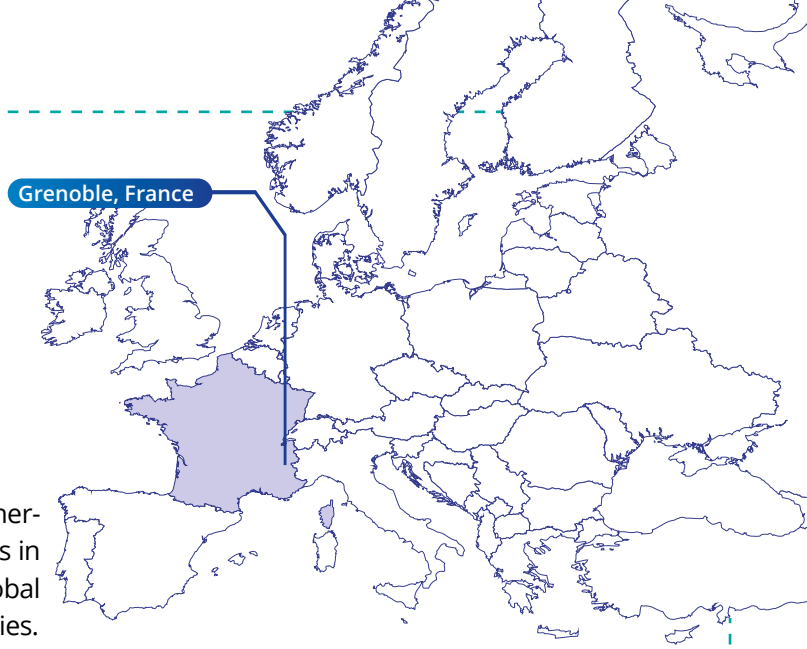
UNIVERSITÉ DE LORRAINE

Politecnica di Torino



> **"No model perfectly captures the system..but every improvement makes it closer to reality!"**

Company



CEA, Grenoble

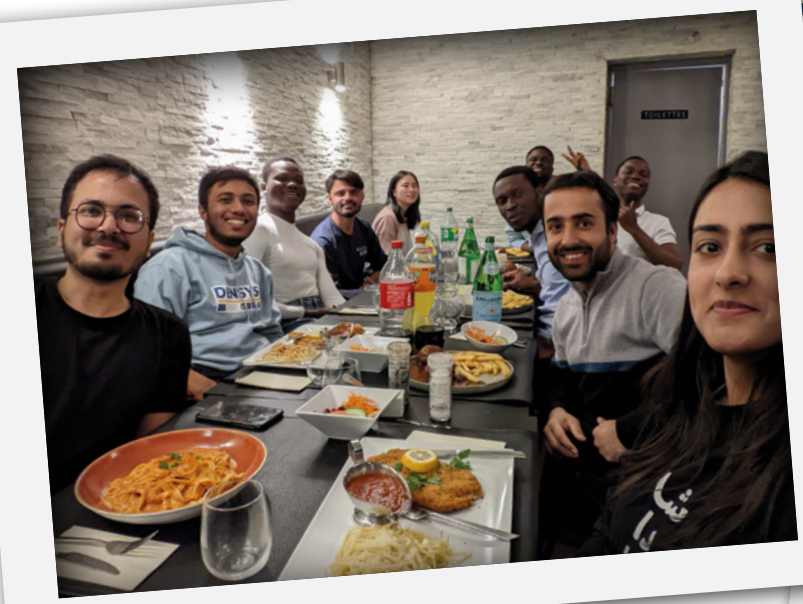
The Commissariat for Atomic Energy and Alternative Energies (CEA) is a public research organization that operates in four main areas: low-carbon energies, defense and global security, information technologies and health technologies.
Created in 1956 by Professor Louis Néel, Nobel Prize winner in physics, CEA Grenoble is the leading technological research center in Rhône-Alpes and France. It has the ranking of "Top 25 Global Innovators – Government" compiled by the Reuters agency in France, the CEA is the most innovative public body in the world.
CEA Grenoble makes a significant contribution to this ranking since it represents 70% of patent applications for the entire CEA. As part of its conversion, in 2018 the site inaugurated the first French unit for the industrial production of renewable hydrogen and is now doing extensive research in the field of renewable and alternative energy systems.

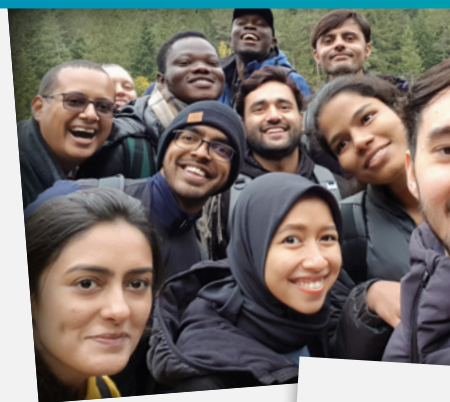
Master's thesis title

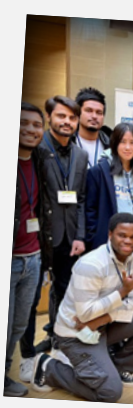
Measurement and modelling of proton and oxygen transport limitations in proton exchange membrane fuel cell electrodes

The objective of this project is to quantify the limitations to proton and oxygen transport in proton exchange membrane fuel cell (PEMFC) electrodes, by analyzing the results of electrochemical measurements by limiting current and electrochemical impedance spectroscopy (EIS) thanks to 1D and/or 2D models under COMSOL and MATLAB.
On the one hand, there is the experimental side of the project of setting up, validating, and exploiting electrochemical characterization methods that will allow dissociating and quantifying the transport limitations, mainly focusing on the protons and diffusion of oxygen. In PEMFC electrodes the study of the polarization curve, limiting current effect under oxygen and hydrogen is done. In-depth analysis of Polarization curves and Electrochemical impedance spectroscopy is necessary to understand their impact on performance. These methods are currently being developed.
On the other hand, the modeling part of the project utilizes the rigorous optimization and fitting methods in MATLAB to generate 1D and 2D models in COMSOL for the fitting and tuning of the parameters that will be adapted to the device and operating conditions. The objective is to develop and improve the models to capture real experimental data. The aim is to continuously improve and fine-tune the parameters.

COHORT 2022







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