# DENSYS

MASTER ERASMUS MUNDUS | DECENTRALISED SMART ENERGY SYSTEMS




# MASTER'S THESES 2024-2026

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

UNIVERSITÉ DE LORRAINE

KTH VETENSKAP OCH KONST

Politecnico di Torino

UNIVERSITAT POLITÈCNICA DE CATALUNYA BARCELONATECH

# Internships and Master Theses of the cohort 2024-2026:



**Fabrice Lemoine,**
Chair of DENSYS

The fight against climate change calls for an urgent and profound transformation of our energy systems. Achieving carbon neutrality by 2050 requires not only the large-scale deployment of renewable energy sources and low-carbon energy carriers, but also a fundamental rethinking of how energy is produced, distributed, and consumed across all sectors of society. This transformation must be embedded within a just transition—one that is fair, inclusive, and leaves no one behind—an ambition that lies at the very heart of the European Green Deal.

At the same time, a rapidly evolving and increasingly uncertain geopolitical landscape has highlighted the need to complement sustainability objectives with broader strategic considerations. The transitions currently underway—energy, industrial, digital, and societal—must also address issues of competitiveness, strategic autonomy, resilience, and sovereignty. Europe's capacity to secure its energy future while maintaining its industrial leadership will be one of the defining challenges of the coming decades.

This is precisely the vision that underpins DENSYS. Our ambition is to educate a new generation of engineers capable of designing, operating, and managing the decentralized smart energy systems that will power a carbon-neutral and just society. DENSYS provides students with a strong multiphysics engineering education spanning electrical, mechanical, and chemical engineering, while fostering a systemic understanding of societal needs, economic realities, and environmental challenges.

Funded by the European Union and coordinated by the University of Lorraine (France), DENSYS is delivered in partnership with the Royal Institute of Technology (KTH, Sweden), the Polytechnic University of Turin (PoliTo, Italy), and the Universitat Politècnica de Catalunya (UPC, Spain). Together, these institutions offer a unique "T-shaped" educational model that combines deep technical expertise in multi-physics engineering with broad transversal competences in economics, social sciences, innovation management, and stakeholder engagement. Because the energy transition is not only a technological challenge—it is fundamentally a human, economic, and societal one.

Throughout the programme, we place strong emphasis on interdisciplinarity, systems thinking, problem-solving, international and intercultural collaboration. By studying and living in different European countries, our students experience diverse academic environments, industrial ecosystems, and societal contexts, equipping them with the perspective required to develop impactful and sustainable solutions for the challenges ahead.

Above all, DENSYS seeks to train responsible engineers and researchers who will become future leaders and ambassadors of clean energy technologies, sustainable industrial development, and climate neutrality.

As part of their final year, students undertake extensive internships and Master's thesis projects within leading universities, research centres, industrial companies, international organisations, and NGOs across Europe and beyond. These projects address a wide range of topics that are critical to the success of the energy transition, from renewable energy integration and energy storage to hydrogen systems, clean heat generation, energy efficiency, digitalisation, industrial decarbonisation, and energy policy.

This booklet showcases the achievements of the 23 students of the DENSYS 2024-2026 cohort. Through their Master's theses, they have demonstrated not only scientific excellence and technical competence, but also creativity, commitment, and a genuine determination to contribute to a more sustainable and resilient future. The remarkable diversity of topics covered reflects both the multidisciplinary nature of the programme and the breadth of opportunities offered by the energy transition.

We hope that these works will inspire future students, academic partners, industrial stakeholders, and policymakers alike, and highlight the transformative role that international and interdisciplinary programmes such as Erasmus Mundus play in preparing the next generation of leaders to tackle the complex challenges of our time.

# Cohort 2024-2026:


Ibrahim ABUZARIFA


Faraji Samiul Haque BIJOY


Paula Andrea CHACON SANTAMARIA


Lisseth Milena CRUZ RUIZ


Vanesa Ivonne DELGADO OROZCO


Sofia FARAKHUTDINOVA


Walmy Jose FERNANDEZ DOMINGUEZ


Teresa HALLSTE PÉREZ


Niayesh HOSSEINI FARAHANI


Muhammad Rafi Afif INDRAJAYA


Mayank JOSHI


Aayush KARNA


András KEÖVES


Sagar NIROULA


Morris Tambah NYANTEE

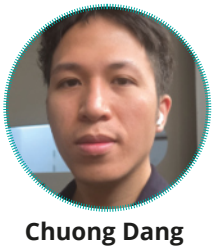

Rashida OLOMOWEWE


Silas Opoku OSAFO


Oluwajoba Elisalome OYEFUSI


Saqib REHAN


Valeria SOLÓRZANO ARAQUE


Chuong Dang TA


Ofosua Angela TWUM


Marc Alec Dominic YAU

# Ibrahim ABUZARIFA



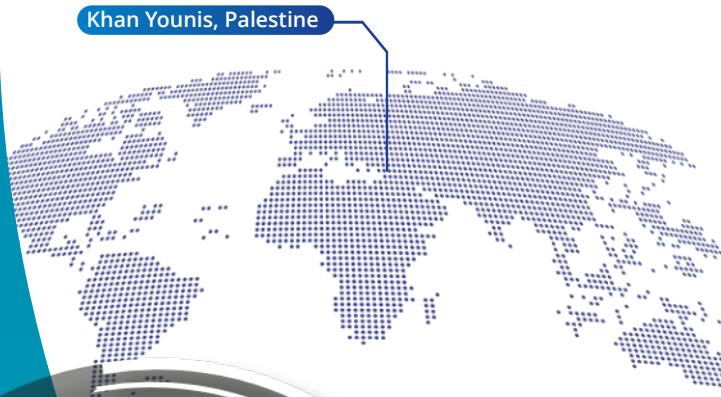
www.linkedin.com/in/ibrahim-abuzarifa

**Bach. in Renewable Energy Engineering, Al-Azhar University – Gaza, Palestine**

## Mobility scheme

UNIVERSITÉ DE LORRAINE

Politecnico di Torino




> **Reliable energy starts with resilient design**

# Company

INSTITUT JEAN LAMOUR

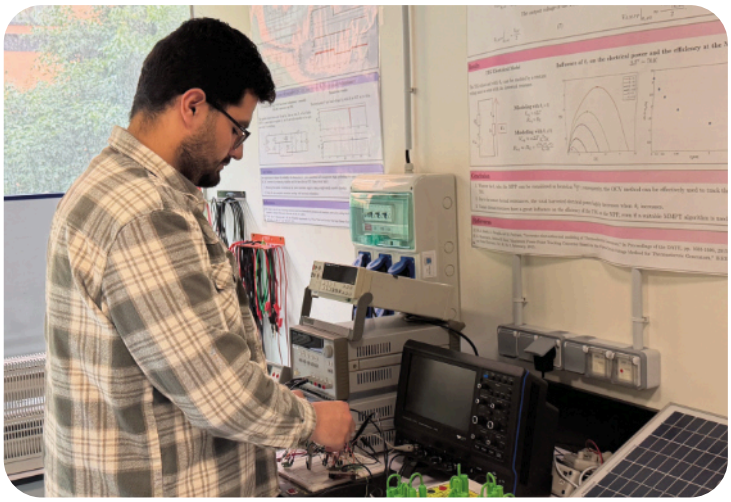
## Institut Jean Lamour (IJL)

The Institut Jean Lamour (IJL) is a fundamental and applied research laboratory. It is a joint research unit (UMR 7198) of the CNRS and Université de Lorraine. The institute is a multidisciplinary laboratory covering materials science, metallurgy, nanoscience, plasma science, surfaces, and electronics, addressing key societal challenges such as energy, environment, future industry, mobility, resource preservation, and health. Its research activities range from device design to industrial applications.




# Master's thesis title

## Fault-Tolerant Operation of Two-Stage Non-Isolated DC-DC Converters under Open-Circuit Switch Fault, Based on Redundant Synchronous Switch



This master's thesis focuses on the development of fault-tolerant two-stage non-isolated DC-DC converters for renewable energy applications. These systems, commonly used in energy harvesting such as photovoltaic applications, are particularly vulnerable to power switch failures, which significantly affect system reliability and peformances. The main objective of this work is to design and analyze a novel fault-tolerant circuit based on redundant synchronous switches, ensuring continuous operation under open-circuit switch faults. The study begins with a comprehensive review of existing DC-DC converter topologies, including Buck, Boost, Sepic, Cuk, and Buck-Boost converters, followed by the analysis of their cascaded configurations. Then, the various fault-tolerant cascaded topologies are studied by integrating equivalent synchronous switches to maintain system functionality in the presence of faults. The proposed designs are validated through simulations using MATLAB/Simulink and Simscape tools, and some selected configurations are further evaluated experimentally. The results demonstrate improved reliability and robustness of two-stage DC-DC conversion systems, contributing to the development of more resilient and efficient renewable energy solutions.

# Faraji Samiul Haque BIJOY



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Bach. in Nuclear Engineering at the Military Institute of Science and Technology, Bangladesh

**Mobility scheme**

UNIVERSITÉ DE LORRAINE

UNIVERSITAT POLITÈCNICA DE CATALUNYA BARCELONATECH

Dhaka, Bangladesh



> **The impediment to action advances action**

## Company

metroscope

### Metroscope

Metroscope develops AI solutions to improve the performance and availability of power-generation assets. Its monitoring platform combines physics-based models and data analytics for anomaly detection, diagnosis, forecasting, and transient analysis. It detects faults, quantifies losses, and supports maintenance decisions. With 700+ users, it equips 100+ plants, including EDF's entire French nuclear fleet.




## Master's thesis title

# Failure Mode Identification In CCGTs via Coupled APR and Physics-Based Models



Modern industrial assets such as Combined Cycle Gas Turbines (CCGTs) generate large volumes of sensor data, enabling machine learning–based anomaly detection to flag abnormal behavior early. In the Metroscope software, a physics-based digital twin and a diagnosis inferential engine can already detect faults and propose plausible root causes. In contrast, the Anomaly Detection tool—built on ML/statistical models rather than an explicit physical model—typically produces an alert that the data is deviant, without explaining what drives the deviation, limiting the value of alerts for engineers. This thesis aims to bridge the gap between anomaly alerts and root-cause analysis (RCA). Two complementary approaches are investigated. First, a hybrid workflow uses anomaly detection as an early-warning layer and then routes the alert to the existing diagnosis inferential engine, translating anomalous patterns into symptoms, matching them to candidate faults, and ranking root causes with evidence from the digital twin. Second, the anomaly detection pipeline is extended with its own inferential capability by training models that estimate variable contributions and learn mappings from contribution signatures to fault hypotheses. The approaches are evaluated on CCGT monitoring use cases, comparing diagnostic accuracy, interpretability, and deployment constraints. The outcome is an actionable RCA layer that shortens troubleshooting time and improves maintenance decisions while preserving the sensitivity of anomaly detection.

# Paula Andrea CHACON SANTAMARIA




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**Bach. in Mechanical & Industrial Engineering, Universidad Industrial de Santander, Colombia**

## Mobility scheme

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**"Capturing radiative heat, one particle at a time"**

# Company

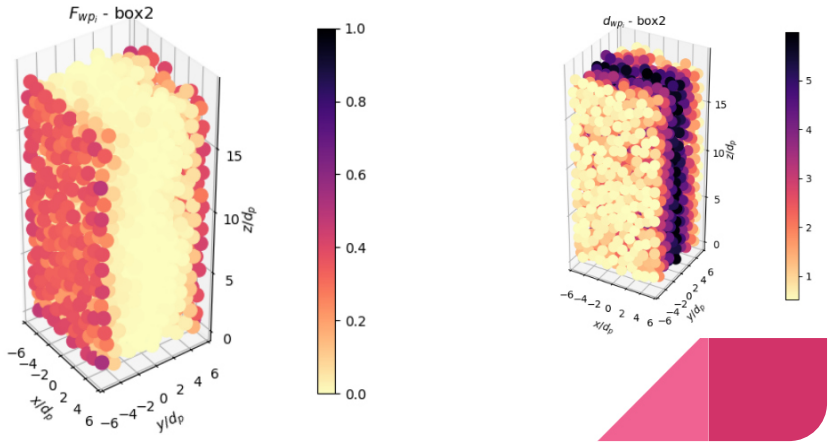



## Laboratoire PROMES
### (Procédés, Matériaux et Énergie Solaire)

PROMES Laboratory is a CNRS research unit linked to the University of Perpignan. It focuses on solar energy conversion, high-temperature processes, advanced materials, energy storage, and system integration, combining experimentation and modeling to support sustainable energy and industrial decarbonization.

# Master's thesis title

## Monte Carlo simulations of radiative heat transfer in fluidized bed solar receivers




Circulating fluidized beds (CFBs) are promising systems for high-temperature heat transfer in concentrated solar power applications due to their excellent mixing, transport, and thermal properties. However, the complex interplay among fluid-particle dynamics, wall effects, and radiative heat transfer remains a significant scientific and engineering challenge. In particular, accurately predicting particle-to-wall radiation in high-temperature fluid-solid flows requires simulations involving thousands of particles and a detailed representation of radiative interactions. In this work, a numerical framework is developed to predict particle-wall heat transfer in a CFB solar receiver using air as the fluidizing gas and olivine particles as the solid phase. The radiative model assumes that the gas phase (air) is transparent to radiation, while particles are treated as black bodies. The framework integrates Monte Carlo simulations of radiative transfer (Stardis) with fluid-particle interaction modeling (TrioCFD). Simulations are performed at different fluidization velocities to quantify their effect on particle-to-wall view factors. Additionally, the radiative modeling is enhanced through spatial discretization of receiver walls, improving the accuracy of heat flux predictions. A feasibility study of dynamic coupling between Stardis and TrioCFD is also conducted to enable fully coupled multiphysics simulations. Results show that particle-wall view factors decay exponentially with distance from the wall and increase with fluidization velocity, leading to localized enhancements in radiative heat flux. These findings provide valuable insights for the design and optimization of high-temperature solar receivers.

# Lisseth Milena CRUZ RUIZ




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Bachelor in Mechanical Engineering, Universidad Distrital Francisco José de Caldas, Bogotá – Colombia

## Mobility scheme

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KTH

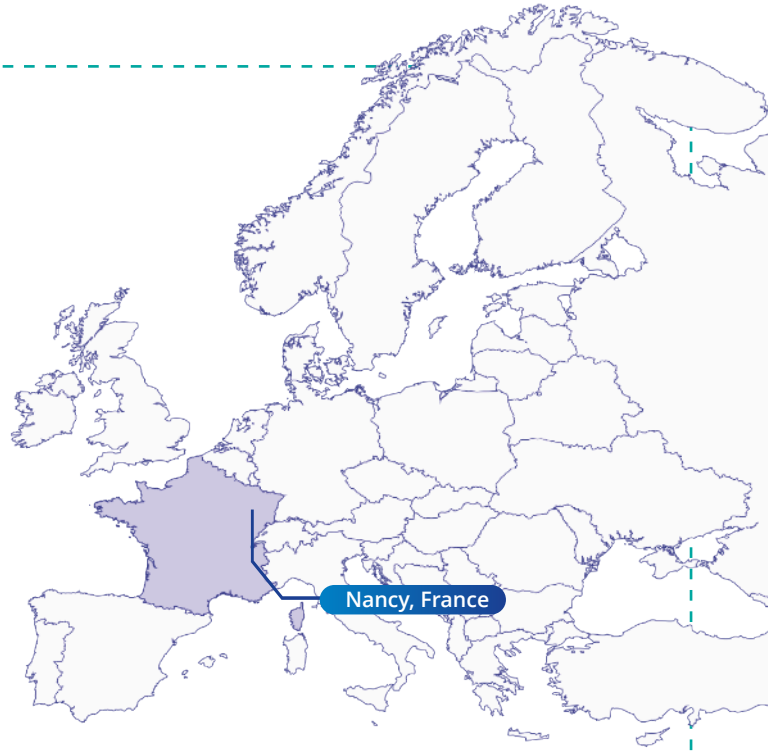



**“The Path to Join the Energy.”**

# Company

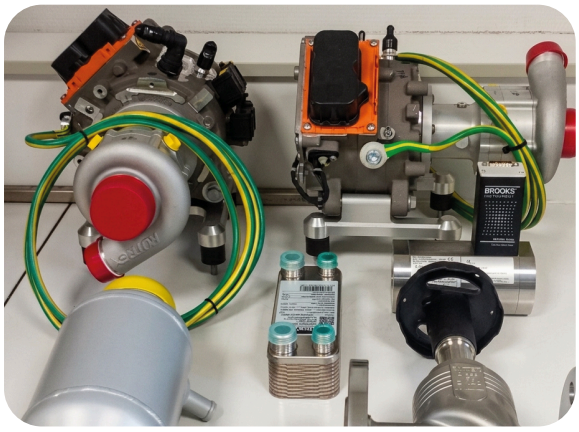
## LRGP – Laboratoire Réactions et Génie des Procèdes, Université de Lorraine

The LRGP is a joint unit of the University of Lorraine and the CNRS which concerns the study of processes taken in their entirety and their complexity. The work focuses on the development of scientific and technological knowledge necessary for the design, study, control and optimization of complex processes of physico-chemical and biological transformation of matter and energy.




# Master's thesis title

# Design of a compression test bench operating with formic acid for residential heat pumps



Heat pumps are recognised as a key technology for the decarbonisation of residential heating and cooling, which accounts for approximately 30% of global energy consumption. However, their relatively low performance is largely associated with inefficiencies in the vapour compression process, particularly due to high compression work and excessive temperature rise when using inert working fluids. In this context, the ERC-REACHER project proposes reactive working fluids undergoing reversible dimerization ($A_2 \rightleftarrows 2A$), enabling reduced compression work through endothermic effects during compression and exothermic effects enhancing heat release during condensation. Building on the findings of this European project, the ERC-CREATIVE project aims to evaluate the use of reactive working fluids, specifically carboxylic acids, in residential heat pumps. This thesis contributes to the CREATIVE project by assessing the feasibility of compressing formic acid under sub-atmospheric conditions using air as a surrogate fluid. A thermodynamic and numerical model of a multi-stage compressor train test bench is developed using commercially available compressors, with the aim of identifying suitable operating points. The model incorporates intermediate pressure control, valve behaviour, and compressor performance characteristics, and is used to perform a parametric analysis under varying operating conditions, including inlet states, rotational speed, and valve openings. In parallel, a simplified heat pump model is implemented based on the derived operating conditions to evaluate overall system performance and enable comparison with conventional inert fluids. The results support the design of an experimental test bench and demonstrate that the compression process required for formic acid-based heat pumps can be feasibly achieved using existing technologies.

# Vanesa Ivonne DELGADO OROZCO



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**Bachelor's in Mechanical-Electrical Engineering, Tecnológico de Monterrey, Mexico**

## Mobility scheme

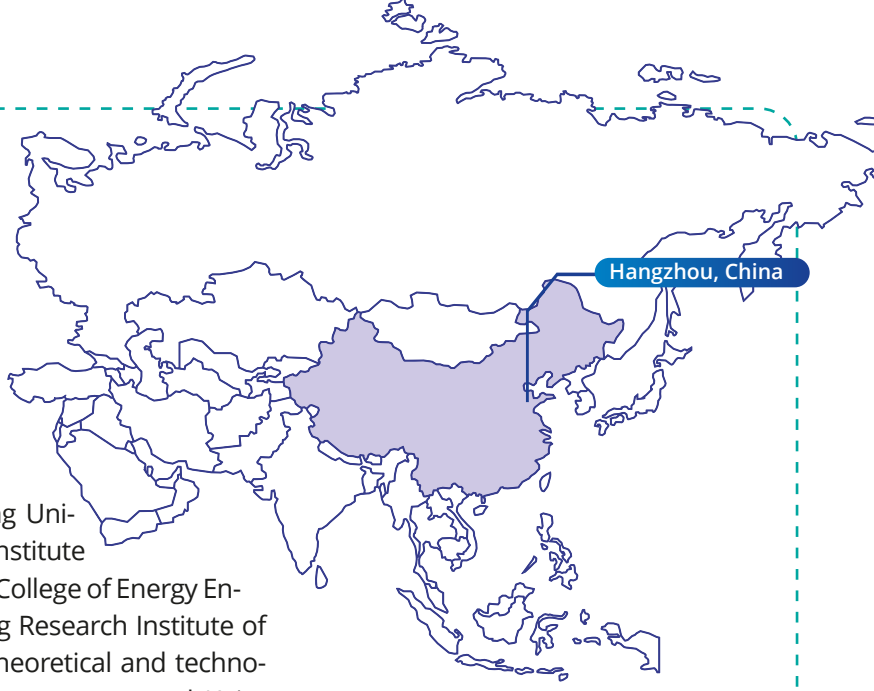
UNIVERSITÉ DE LORRAINE

KTH

Chihuahua, Mexico

> **The grid is full of surprises. We're teaching it to be a little more predictable**

# Company

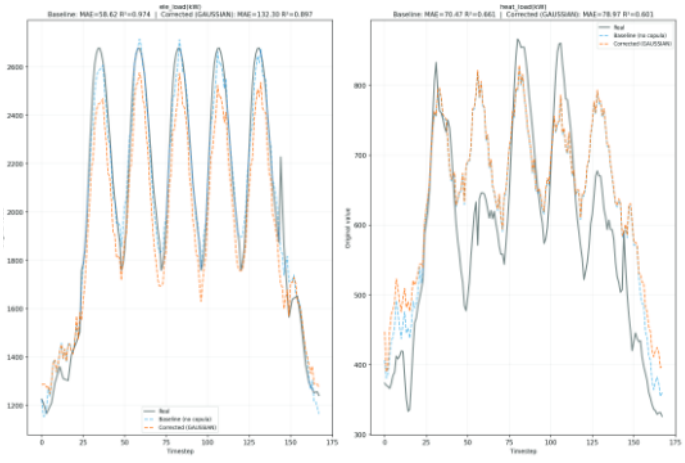



## Zhejiang University

The Smart Energy Systems Laboratory at Zhejiang University, founded in 1953, is established under the Institute of Thermal Engineering and Power Systems of the College of Energy Engineering, the Polytechnic Institute, and the Jiaxing Research Institute of Zhejiang University. It has carried out extensive theoretical and technological research in interdisciplinary fields that integrate energy and AI, including smart heating, smart energy, systems engineering, and integrated energy systems.

# Master's thesis title

## A Multi-energy Load Forecasting Method Based on Attention Mechanism



Accurate energy load forecasting is essential for the efficient and low-carbon operation of integrated energy systems. With the increasing integration of renewable energy sources and new types of loads, energy systems are becoming more complex and uncertain. Different energy loads, such as electricity, heating, and cooling, exhibit intrinsic coupling relationships, where variations in one type of demand can influence others and create opportunities for energy complementarity and substitution. Artificial intelligence is a promising approach for extracting patterns from both supply and demand data. Among these approaches, attention mechanisms have become one of the most widely studied forecasting models due to their flexibility and accuracy. However, modelling complex dependencies among multiple energy variables and features remains a significant challenge for current attention-based methods. The aim of this thesis is to improve multi-energy load forecasting accuracy by integrating copula-based multivariate distribution methods into attention mechanisms. Through data-driven learning, the proposed approach seeks to better capture nonlinear relationships among different energy loads, supporting more efficient operational scheduling and energy management in integrated energy systems.

# Sofia FARAKHUTDINOVA



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**Bachelor in Electrical Power Engineering, Saint Petersburg, Russia**

## Mobility scheme

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> **“One direction is so 2010. In music and in charging”**

# Company

VOLVO

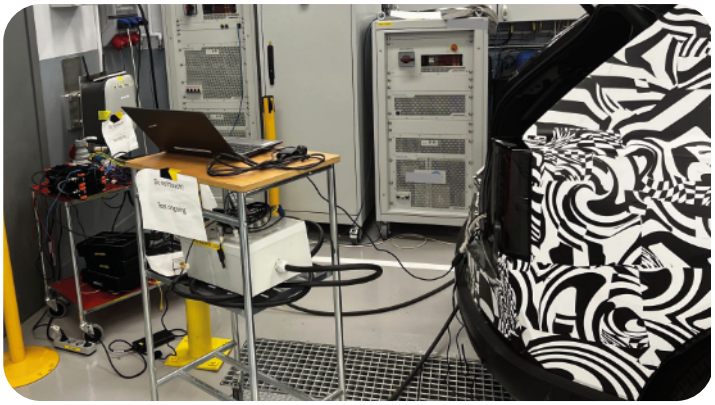
## Volvo Cars

Volvo Cars produces premium vehicles for customers worldwide, with growing emphasis on electric vehicles and sustainable innovation. Its work spans electrification, software integration, advanced safety features, and reducing the environmental impact of automotive production through more efficient and circular manufacturing practices.




# Master's thesis title

## Power Quality Impacts on EV Charging and Discharging in Diverse Grid Conditions



Bidirectional electric vehicle charging introduces vehicle-to-grid (V2G) operation into low-voltage distribution networks, but the power quality behavior of onboard chargers under realistic grid disturbances remains poorly characterized. Most studies treat the vehicle as the harmonic source, while the grid-as-disturbance-source direction has received limited experimental attention. Furthermore, harmonic assessments typically focus on low-order components, leaving supraharmonic emissions above 2 kHz largely unexplored despite their relevance to smart metering and ripple control interference. This work presents a laboratory characterization of a three-phase production onboard charger operating in both charging and V2G modes under combined voltage unbalance and over/undervoltage conditions. A programmable grid simulator with hardware impedance emulation reproduces network conditions derived from a Swedish low-voltage network model with mixed photovoltaic generation and EV loading. The charger is treated as a black-box device accessible only at its AC terminals, reflecting the information boundary faced by network operators.Additionally, the study also investigates the charger's response to injected supraharmonic disturbances in the 2 to 5 kHz range. Initial results show that the charger handles conventional disturbances well in both modes. However, combined conditions reveal asymmetric harmonic responses between charging and V2G, linked to internal DC-link dynamics. As networks host increasing numbers of power-electronic-interfaced devices, understanding these interactions becomes essential for maintaining power quality in future grid operation.

# Walmy Jose FERNANDEZ DOMINGUEZ



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Bach. in Electrical Engineering at Instituto Tecnológico de Santo Domingo, Dominican Republic

## Mobility scheme

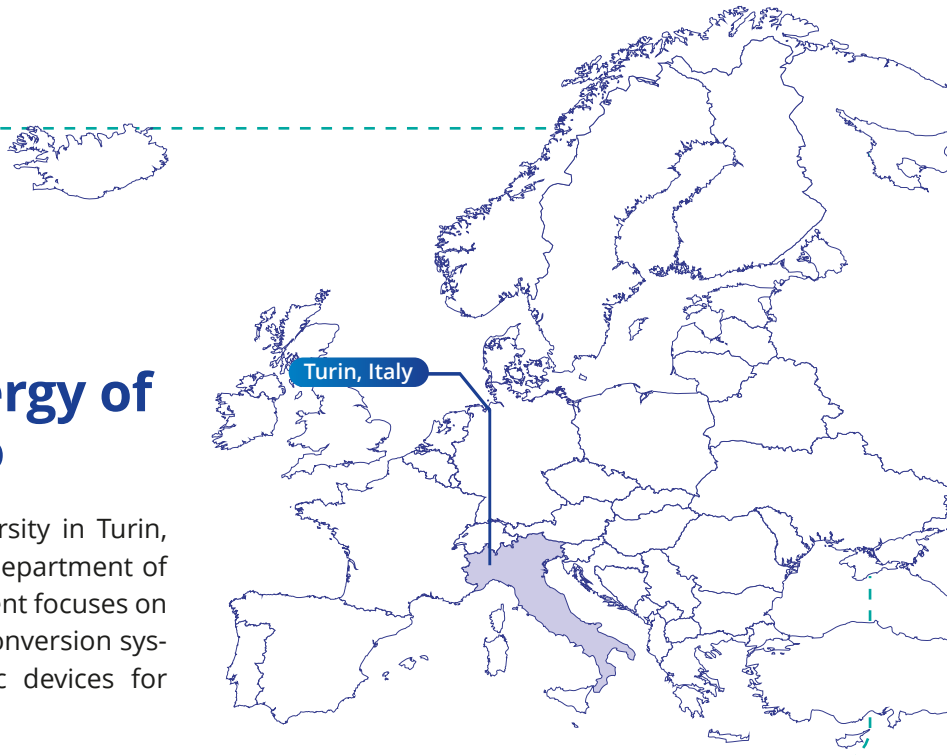
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Politecnico di Torino




**“Making MOSFETs, IGBTs, and datasheets slightly less terrifying”**

# Company

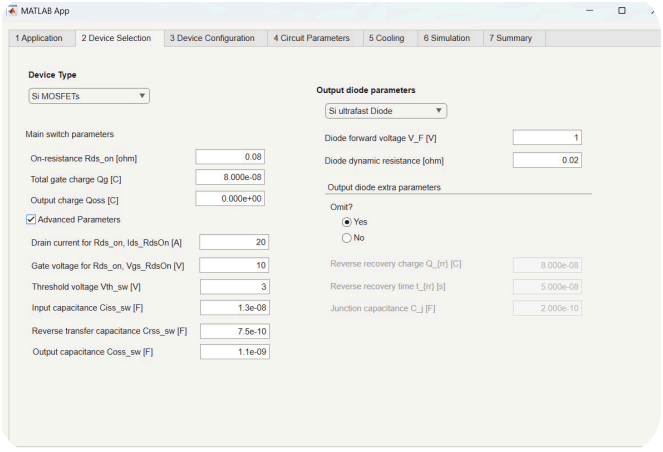



## Departament of Energy of Politecnico di Torino

Politecnico di Torino is a technical university in Turin, Italy. The thesis is developed within the Department of Energy (DENERG). The research environment focuses on energy technologies, power electronics, conversion systems and reliability of power electronic devices for efficient electrification applications.

# Master's thesis title

## MATLAB-based Platform for Accurate Loss Evaluation of Power Electronic Devices in Selected DC/DC and DC/AC Topologies




Power electronic converters are essential in renewable energy, e-mobility and electrified transport systems, where accurate estimation of semiconductor losses is necessary for efficiency assessment, thermal design and device selection. This master's thesis develops a MATLAB-based platform for accurate loss evaluation of power electronic devices in selected DC/DC and DC/AC converter topologies. The platform combines a MATLAB App Designer interface with Simulink converter models, allowing the user to select the topology, semiconductor technology and operating conditions, and then simulate the corresponding converter model in a structured workflow. The work considers Si MOSFET, SiC MOSFET, GaN MOSFET and IGBT technologies, using datasheet-oriented parameters such as on-state resistance, gate-drive conditions, switching energies, diode characteristics and optional thermal modelling inputs. Representative converter structures include buck, boost, flyback, half-bridge, full-bridge and three-phase inverter configurations. A key challenge is to keep the application simple for the user while ensuring that the required parameters are correctly mapped to the Simulink models and exported to the MATLAB workspace. The expected result is a practical comparison tool for estimating conduction and switching losses, supporting early-stage design decisions and helping evaluate the impact of different semiconductor technologies on converter performance.

# Teresa HALLSTE PÉREZ



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Degree in Environmental Technologies Engineering & Degree in Natural Environmental Engineering Polytechnic University of Madrid

## Mobility scheme

UNIVERSITÉ DE LORRAINE

KTH

Madrid, Spain



> **Collective means efficiency and justice in the energy transition**

# Company

nasuvinsa OTC Navarra | KEB Nafarroa

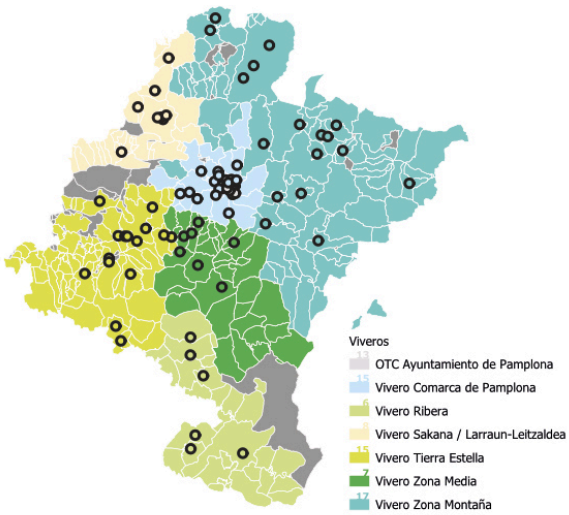
## Oficina de transformación comunitaria (otc) navarra, nasuvinsa

OTC Navarra (Communitarian Transformation Office of Navarre) within the public housing company of Nasuvinsa enlarges the number of energy communities created, incentives cooperativism and citizen grass-root initiatives, spreads the energy community concept and its benefits, transforms the energy model incorporating social economy and solidarity and promotes a fair energy transition and circular economy.




# Master's thesis title

## Collective vs individual: Energy communities in the fast and fair energy transition




This Master's thesis is built upon the idea that the energy transition must be a social transition in order to succeed. In this sense, energy communities are generators of social tissue to accelerate change. In a context of ecological crisis, geopolitical tensions and economic pressure, the energy transition arises as a must, and so it has been reflected in the European targets and regulations. This transition is approached from different angles, one of which is consumer activation. However, this activation can be individual or collective: this is exactly the difference that this work wants to examine. To perform this comparison, this thesis selects energy communities case studies and develops models simulating different individual scenarios. To identify whether collective or individual solutions are performing best in environmental, economic, social and technical dimensions, multiple indicators are used. Moreover, this work includes examination of key barriers or regulatory advantages that influence their establishment and effects from a local to european region perspective. Ultimately, this work enlightens the value and potential of Energy Communities to become tools of society transformation.

# Niayesh HOSSEINI FARAHANI



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**Bachelors degree in Mechanical Engineering, Shahid Beheshti University, Tehran, Iran**

## Mobility scheme

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**“Too hot to waste!”**

## Company

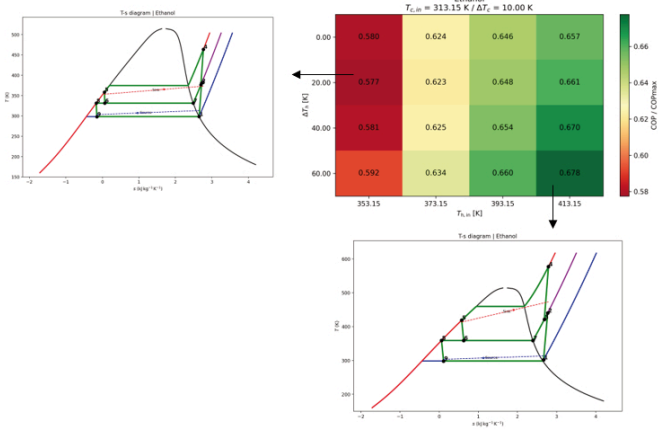



### Laboratoire Réactions et Génie des Procédés (LRGP) École nationale supérieure des industries chimiques (ENSIC)

The LRGP is a joint unit of the University of Lorraine and the CNRS which concerns the study of processes taken in their entirety and their complexity. The work focuses on the development of scientific and technological knowledge necessary for the design, study, control and optimization of complex processes of physico-chemical and biological transformation of matter and energy.

## Master's thesis title

# Modelling of High-Temperature Heat Pumps




This thesis focuses on high-temperature heat pumps as a promising technology for supporting the decarbonization of industrial heat production. Many industrial processes still depend on fossil fuels, especially for process heat, and replacing these systems requires efficient and reliable alternatives. The study aims to examine how high-temperature heat pumps can recover waste heat and upgrade it to useful heat for industrial applications. The work compares different heat pump designs and working fluids under a range of operating conditions. The objective is to understand how system performance changes with temperature requirements and to identify suitable options for industrial use. One of the main challenges is that heat pump performance depends strongly on the heat source, heat sink, refrigerant, and cycle design, so a general comparison is needed to support better design choices. The expected outcome is a clearer understanding of how high-temperature heat pumps can be applied in industry and how they can contribute to cleaner and more efficient heat supply. This study therefore provides useful guidance for early-stage selection of heat pump technologies in industrial decarbonization.

# Muhammad Rafi Afif INDRAJAYA



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BSc. in Electrical Engineering at Sophia University, Japan

**Mobility scheme**

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Politecnico di Torino




> **If you can imagine it, you can create it, it's all about the "vibe" :)**

## Company

FEV

### FEV Europe GmbH

Based in Aachen, Germany, FEV Europe GmbH functions as a prominent global engineering and digital mobility institution. Traditionally specialized in automotive powertrain systems, the organization now delivers cutting-edge software and energy management services, utilizing industrial-scale facilities to pioneer sustainable technological advancements for the modern energy landscape.




## Master's thesis title

# Optimization of Hybrid Biomass Power-to-Methanol System: MILP vs Reinforcement Learning approaches



The transition to a net-zero economy necessitates the decarbonization of hard-to-abate sectors through green fuels like methanol. This research, conducted at FEV Europe GmbH, addresses the challenge of efficient, decentralized production by integrating stable biomass gasification with intermittent Power-to-X (PtX) technologies. The study explores the synergy between classical mathematical optimization and artificial intelligence, specifically evaluating the implications of Mixed-Integer Linear Programming (MILP) and Reinforcement Learning (RL) across varying levels of modeling detail. The methodology follows a comparative benchmarking process: initially, MILP and RL frameworks are applied to linear system models to establish baseline performance. Subsequently, the optimal sizing solutions derived from the MILP framework are fed into high-fidelity non-linear models to assess their feasibility and robustness under realistic physical constraints. Finally, the RL framework is integrated directly with non-linear modeling to evaluate its real-time adaptive capabilities. System performance and sustainability are quantified through key metrics, including Levelized Cost of Methanol (LCOM), Carbon Intensity, Self-Consumption Ratio, and Grid Autonomy Ratio. By analyzing the interaction between these two optimization frameworks and the two levels of modeling fidelity, this research bridges the gap between mathematical abstraction and industrial-grade dynamics, identifying the most effective pathways for scaling sustainable industrial processes.

# Mayank JOSHI



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Bachelors in Mechanical Engineering, India

## Mobility scheme

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> **The market is like a jealous girlfriend, you never know what they want**

# Company

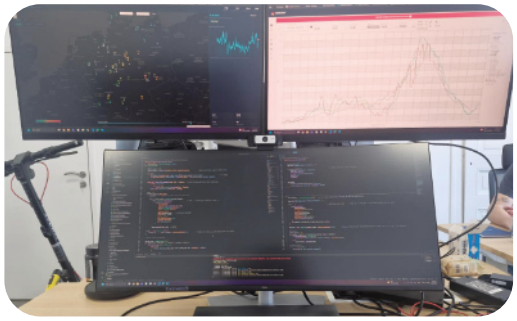
## Engelhart Commodities Trading Partners

Engelhart Commodities Trading Partners (ECTP) is a global commodity trading firm founded in 2013 by BTG Pactual. Headquartered in London, It trades across energy, metals, and agricultural commodities in both physical and financial markets, operating internationally across multiple countries with a focus on research-driven and quantitative trading strategies.




# Master's thesis title

## Geospatial Analysis of Wind and Power Forecast Deviation for Energy Trading Operations.



Renewable trading operates under continuous forecast uncertainty, positions are either over or undercommitted in the market, and corrections come too late to avoid exposure. This thesis addresses that problem by investigating whether wind forecasts carry analytical value beyond power forecast, and by building the operational infrastructure needed to monitor and act on deviation in real time across a portfolio. The first objective establishes the analytical foundation. Across a German wind portfolio, raw operational data presents challenges: assets differ significantly in turbine type, and data quality, wind measurements are absent or unusable for a large proportion of assets, and a single anomaly detection approach cannot generalise cleanly across such a heterogeneous portfolio. A systematic quality selection methodology is developed to address this, producing a validated asset subset with reliable wind-to-power relationships. Building on this, static asset metadata and historical wind measurements are processed in Python and pushed into Blizzard for backtesting, from which wind-speed forecasts are generated per validated asset. These forecasts, alongside actual wind and computed deviation, are served through a backend API and rendered as a geospatial map using JS, Leaflet with Python, with asset-level deviation visualised as dynamic map layers. By combining spatial analysis with statistical validation, the study shows that wind and power forecast deviations are mathematically equivalent, indicating that wind forecasts add no incremental analytical value beyond power forecasts alone. However, deviations exhibit coherent geographic propagation as weather systems move across the portfolio. This finding directly motivates the engineering deliverable, a real-time deviation monitoring system in Grafana. An asynchronous function parallelises ingestion across all assets in the European portfolio simultaneously, pulling MET RAW, Intra-day data from 4 forecasters, from a database with low latency at scale. AWS Lambda handles processing and stores into S3, from which Intra-day forecast deviation against live metering data is surfaced in the Grafana dashboard. The meteorological team gains a live, unified view of how Intra-day deviation evolves across the portfolio enabling proactive risk management. Ongoing work focuses on integrating NWP maps to enrich the spatial signal.

# Aayush KARNA

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B.Sc. Mechanical Engineering, New York University Abu Dhabi, Abu Dhabi, UAE

## Mobility scheme

UNIVERSITÉ DE LORRAINE

UNIVERSITAT POLITÈCNICA DE CATALUNYA BARCELONATECH






> **Hydrogen ate and left no crumbs - only water.**

## Company

ArcelorMittal

### ArcelorMittal Maizières – Global Research and Development

ArcelorMittal is the world's largest steel and mining company, producing steel for automotive, construction, packaging, and energy sectors across the globe. The Maizières-lès-Metz campus is its biggest R&D site worldwide, home to nearly 700 researchers, covering the full spectrum of group activities: process innovation, advanced steels, sustainable production, and digital manufacturing.




## Master's thesis title

# Physical modeling of the Direct Iron Reduction (DRI) process



The global steel industry faces challenges to decarbonize its production processes, with direct reduction ironmaking emerging as a key pathway toward hydrogen-based green steel. Unlike conventional blast furnace routes, direct reduced iron (DRI) technology enables the substitution of fossil reductants with hydrogen-rich gases, offering a credible route to near-zero-emission iron production. This work develops a process-level simulation model of a Midrex-type DRI plant using dedicated Process Simulation Software, covering the full gas circuit including top gas treatment, compression, and gas reforming and recirculation. The reduction zone dynamics are captured through shaft furnace modelling of gas-solid reduction kinetics and thermodynamics. With the validated plant model as a foundation, the study investigates the effect of varying hydrogen injection rates and iron ore pellet composition on key process indicators, including degree of metallization, specific energy consumption, and gas circuit stability. The parametric analysis aims to identify operating windows that maximize hydrogen utilization while maintaining acceptable product quality. Ultimately, the developed modelling framework contributes to the optimization of hydrogen-based DRI processes and supports the transition toward low-carbon steel production.

# András KEÖVES

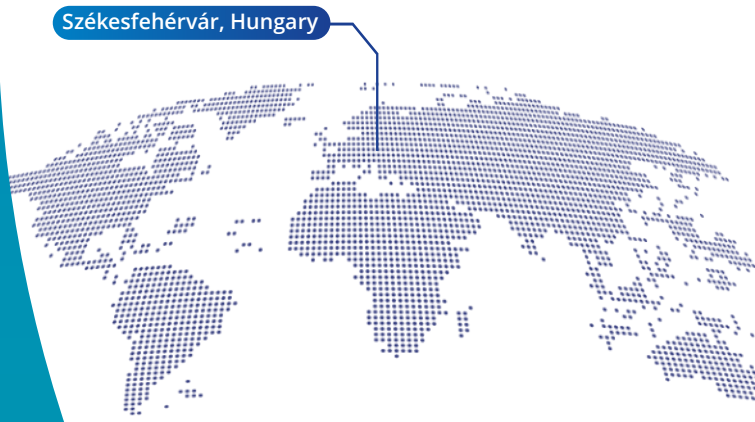
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**Budapest University of Technology and Economics**
**Bachelor's Degree in Energy Engineering**

## Mobility scheme

UNIVERSITÉ DE LORRAINE

KTH




**"Make Energy Predictable Again"**

## Company

Electron

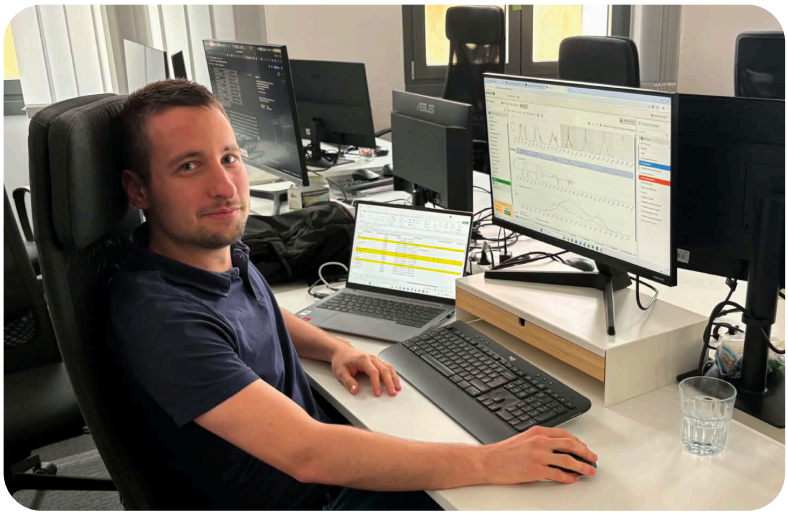
# Electron Holding Ltd.

Electron Holding Ltd. is an integrated energy company engaged in project development, design, construction, operation, energy production, trading, on-site and off-site PPA services, and system-level electricity regulation. Its strategic goal is to become one of the leading integrated energy companies in the Central and Eastern European region, meeting its partners' energy needs from renewable energy sources while maintaining security of supply.




## Master's thesis title

# Comparative Analysis of Physical PV Modelling and Machine Learning Approaches for Solar Power Forecasting



Transition toward low-carbon energy systems driven by the global warming crisis has led to a significant increase in the share of photovoltaic (PV) generation in recent years. Considering the uncertainty in power generation due to the intermittent nature of solar energy, accurate power forecasting has become crucial for this massive penetration. PV power forecasting can be achieved through physics-based models or machine-learning approaches. Physics-based models rely on mathematical equations of PV systems and meteorological data, whereas machine-learning approaches utilize historical measurements to capture nonlinear relationships between environmental conditions and power generation.

In this study, XGBoost and neural network machine-learning models are compared with a physics-based model using one year of 15-minute resolution data collected from several Hungarian PV plants. The models are evaluated in terms of normalized root-mean-square error (nRMSE) for PV power forecasting accuracy. The results demonstrate the superior performance of the machine-learning approach, particularly under varying weather conditions. In addition, the study investigates the minimum amount of training data required for the machine-learning model to outperform the physics-based approach. Finally, the study investigates the generalization capability of the physical modelling approach by transferring parameters optimized using long-term data from a PV plant with several years of data to a newly built plant without significant historical data.

# Sagar NIROULA

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Bach. in Mechanical Engineering, Nepal

## Mobility scheme

UNIVERSITÉ DE LORRAINE

Politecnico di Torino




## “Turning Volatility into Opportunity”

# Company

## Vallourec New Energies

Vallourec is a global leader in premium tubular solutions for the energy industry and the low-carbon transition. With 13,000 employees in 20 countries, it supports Oil & Gas, Geothermal, Hydrogen, and Carbon Capture & Storage (CCUS) players with innovative and sustainable solutions. Delphy is Vallourec's market-ready underground hydrogen storage solution, capable of storing up to 100 tons of hydrogen gas vertically.




# Master's thesis title

## Optimal Electrolyzer and Hydrogen Storage Sizing for Continuous E-Fuel Hydrogen Demand Using Dynamic Electricity Prices



The production of e-fuels requires a reliable and continuous supply of low-carbon hydrogen, while electricity prices in grid-connected systems can vary significantly over time. This thesis will investigate the optimal sizing of hydrogen storage and electrolyzer capacity for a grid-connected e-fuels application using high-resolution electricity price data. The main objective is to determine whether installing hydrogen storage and oversizing the electrolyzer can reduce the total cost of hydrogen supply by shifting production toward low-price electricity periods, while maintaining a constant hydrogen output for downstream fuel synthesis.

A techno-economic optimization model will be developed using Pyomo, considering 15-minute electricity price data over a representative period of six months to one year. The model will optimize electrolyzer operation, hydrogen storage charging and discharging, storage capacity, and electrolyzer installed power. The optimized system will be compared with a reference case in which hydrogen is produced continuously without storage. Key challenges include representing realistic operating constraints, accounting for capital and operational costs, and evaluating the impact of electricity price volatility on system design. The expected outcome is a quantitative assessment of the economic viability of hydrogen storage in e-fuel production and the identification of conditions under which storage and electrolyzer oversizing become beneficial.

# Morris Tambah NYANTEE



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## Mobility scheme

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Politecnico di Torino




## “The New Bottleneck of the Energy Transition: “Grid Congestion”

# Company

TNO innovation for life

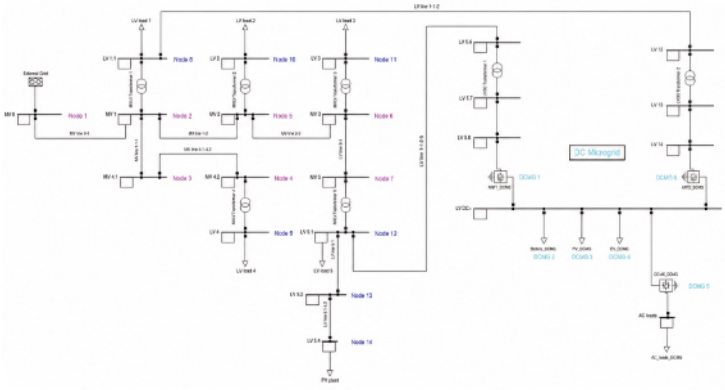
## The Netherlands Organisation for Applied Scientific Research(TNO)

The Netherlands Organization for Applied Scientific Research (TNO) is an independent Dutch institute that develops practical scientific innovations for industry, government, and society. TNO focuses on energy, digitalization, health, safety, mobility, industry, and the built environment to promote sustainable wellbeing.




# Master's thesis title

## DC Grid Integration



The Dutch electricity distribution network is experiencing increasing congestion due to a high penetration of renewable energy sources (RES) and rising electrification demand, including the adoption of electric vehicles (EVs) and heat pumps (HPs), which result in bidirectional power flows. Conventional radial distribution networks, originally designed for unidirectional flow, are unable to reroute excess power, resulting in overloaded cables, violations of voltage and thermal limits, and increased equipment stress. These challenges are slowing down the energy transition by delaying the integration of new renewable energy projects. Grid reinforcement through new infrastructure is a lengthy process and may not keep pace with growing demand, highlighting the need for more rapid alternative solutions. DC microgrids, which integrate DC-native technologies such as solar modules, batteries, and EV chargers behind a single converter interfacing with the conventional distribution grid, can alleviate stress on existing networks and enable more flexible power exchange.

This thesis developed a unified control framework for interfacing converters to support grid functionalities: bidirectional power exchange and system-level stability. It further analyses and compares congestion behavior across AC, DC, and hybrid architectures using a multi-domain approach applied to real-world scenarios. The analysis employs simulation-based methods, utilizing RMS and EMT in DIgSILENT PowerFactory. The results quantify the extent to which DC microgrids and hybrid systems can mitigate grid congestion, increase renewable hosting capacity, and assist distribution system operators (DSOs) in developing a more flexible and resilient energy system.

# Rashida OLOMOWEWE



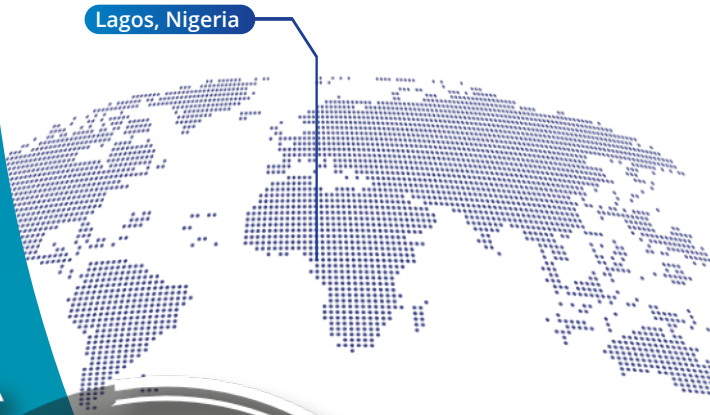

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## Mobility scheme

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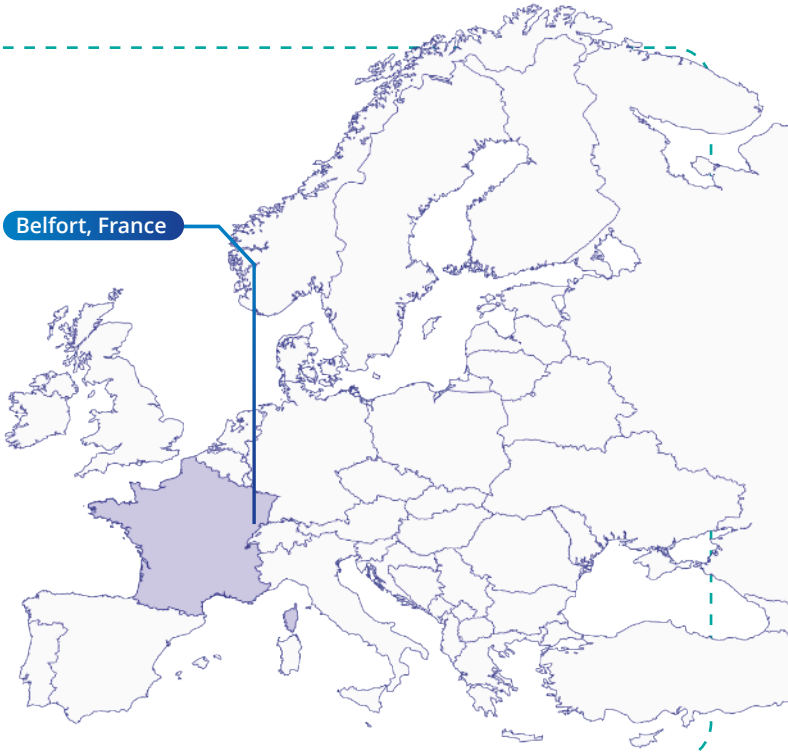



**“Discovering research, one converter and one coffee at a time”**

# Company

## FEMTO-ST

FEMTO-ST (UMR 6174 CNRS) is a joint research institute in engineering and information sciences, gathering over 700 staff across seven scientific departments, including the Energy Department, which develops research on fuel cell systems, power electronics, energy storage, and energy management for electric mobility. Affiliated with CNRS, UMLP, SUPMICROTECH and UTBM, the institute is a key contributor to research on sustainable development and the energy transition.




# Master's thesis title

## Optimal Design of DC-DC Power Converters for Heavy-Duty Fuel Cell Vehicles



Trucks, buses, and ships move the world's freight and passengers, and they remain among the heaviest polluters in the transport sector. Replacing their diesel engines with electric powertrains fed by hydrogen fuel cells is one of the few credible routes to decarbonising heavy-duty transport, but it raises a difficult electrical problem in between: the fuel cell produces a low, fluctuating voltage, while the traction system demands a stable high-voltage DC bus carrying more than 63 kilowatts. The DC-DC converter that bridges this gap dictates the volume, mass, cost, and ultimately the viability of the powertrain. Yet existing design studies of interleaved boost topologies, the preferred architecture for this role, rarely reach this power class with a fully systematic methodology.

This thesis develops a multi-objective optimal design methodology for the N-phase interleaved boost converter at high power, applied to a coupled-inductor topology. Volume, mass, and cost are minimised simultaneously under efficiency, thermal, and fuel-cell ripple constraints. Sizing laws based on statistical regressions are replaced by direct lookups in component catalogues, so that every design returned by the optimiser corresponds to purchasable inductor cores, film capacitors, and silicon-carbide devices. Pareto-optimal designs are generated through NSGA-II in MATLAB, cross-validated in Python with Pymoo, and analysed through sensitivity sweeps over switching frequency, phase count, core material, and semiconductor technology. A selected design is implemented in PLECS/Simulink with its dual-loop controller, then realised as a scaled experimental prototype controlled in real time via dSPACE, closing the loop from theoretical formulation to hardware validation.

Together, these steps establish a reproducible pathway from formal optimization to manufacturable hardware, offering both industry and research a transferable framework to accelerate the electrification of heavy-duty transport with hydrogen.

# Silas Opoku OSAFO



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**Bsc. in Electrical and Electronic Engineering (KNUST, Ghana)**

## Mobility scheme

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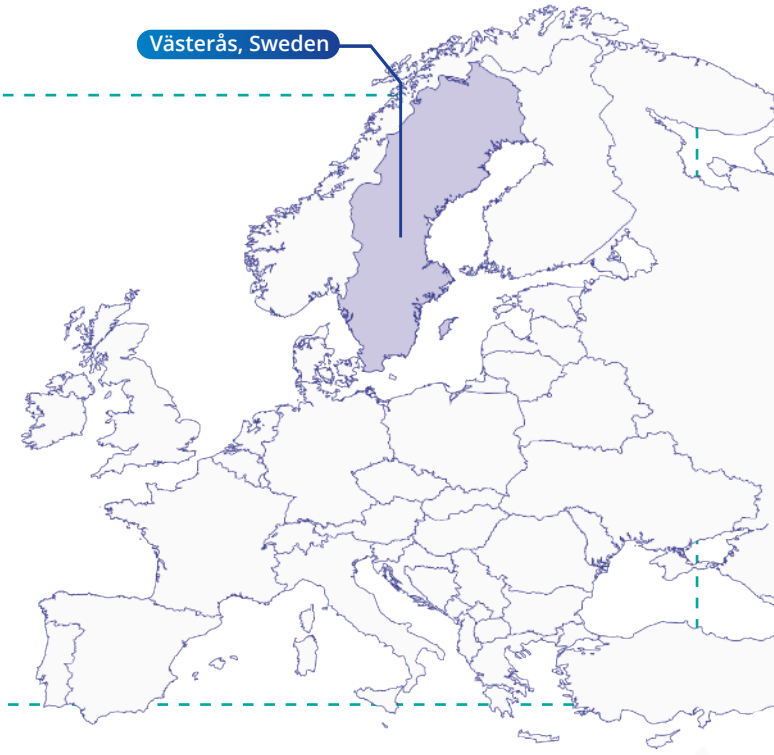

**“Redefining how smart engineering meets the energy demands of a digital future”**

## Company

HITACHI

### Hitachi Energy

Hitachi Energy is a global technology leader advancing sustainable energy systems across more than 90 countries. Its R&D in Västerås, Sweden, serves as an international hub for power electronics, FACTS devices, HVDC systems, and grid integration innovations — pioneering the technologies that enable the clean energy transition for utilities and industries worldwide.




## Master's thesis title

# Modelling, Control Design and Dynamic Performance Analysis of a Grid-Forming E-STATCOM for Data Center Loads



The rapid expansion of data centres worldwide has created new challenges for electrical power systems. These facilities demand a continuous, high-quality power supply — yet they are increasingly connected to electrically weak grid environments (low short-circuit ratios and diminished system inertia) where voltage stability is difficult to maintain. Traditional power electronic devices struggle to respond quickly and reliably enough under these conditions, leaving critical digital infrastructure vulnerable to disruption.

This thesis investigates the application of a grid-forming Enhanced STATCOM (E-STATCOM) — an advanced active and reactive power compensation device — as a robust voltage support solution for data centre applications. Operating as an intelligent voltage source rather than a passive compensator, it can autonomously regulate voltage and respond to disturbances without depending on the grid itself for reference. A control strategy inspired by the behaviour of conventional generators, known as Virtual Synchronous Generator control — was designed, implemented, and rigorously tested.

Using detailed computer simulations in MATLAB/Simulink and PSCAD, the system was evaluated across a wide range of grid conditions and load disturbances. Results demonstrate significantly improved voltage stability and faster dynamic response compared to conventional approaches — particularly under the most challenging grid conditions. This is due to both active and reactive power compensation.

Conducted at Hitachi Energy R&D in Västerås, Sweden, this work contributes directly to the development of reliable, future-proof power infrastructure for the growing digital economy.

# Oluwajoba Elisalome OYEFUSI



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**Bachelor of Engineering in Electrical/Electronics Engineering**

## Mobility scheme

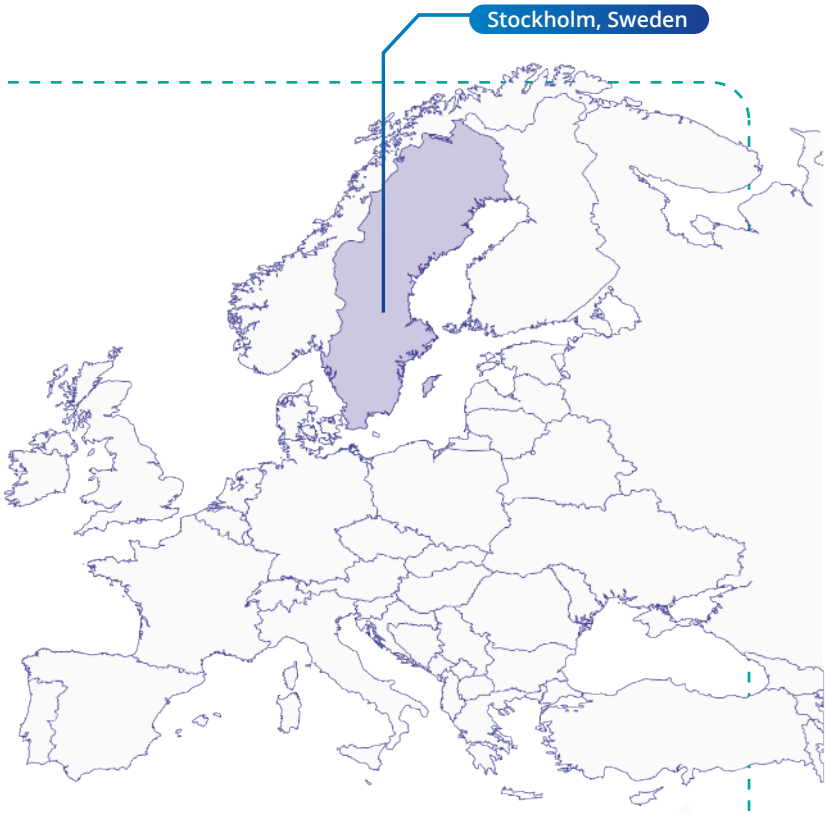
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**“Think Circular Economy”**

# Company

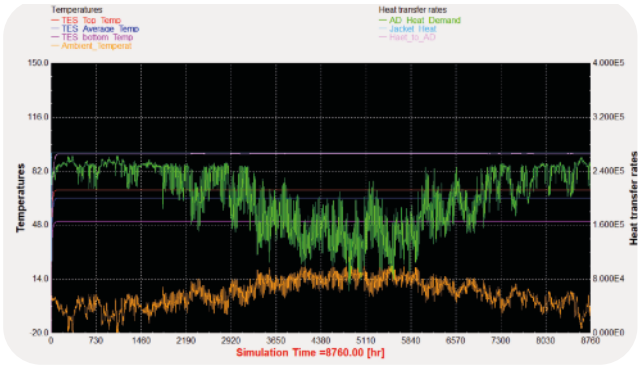



## KTH Heat & Power Technology Division

Research at the Division of Heat and Power Technology encompasses the analysis and design of critical components and systems linked to thermal and mechanical energy conversion. Strongly technical approaches are taken to harness renewable energy – solar, wind, and biomass – for providing sustainable electricity, heat, cooling, pure water, and other energy services to single households up to entire cities or regions.

# Master's thesis title

## Integrated Bioenergy Conversion and Thermal Storage for Negative-Carbon and Clean Technology Advancement (Bioenergy and TES System Integration Modelling using TRNSYS)




The global transition toward renewable energy has renewed interest in biogas as a locally producible and versatile energy carrier. Anaerobic digestion converts organic waste into biogas while simultaneously requiring careful thermal management to sustain microbial activity within the mesophilic temperature range. In cold climates such as Sweden, maintaining optimal digester conditions throughout the year presents a significant engineering challenge, as heat losses and feedstock heating demands vary considerably with seasonal ambient conditions.

This thesis develops a dynamic simulation model of a farm-scale anaerobic digestion plant integrated with thermal energy storage, built in TRNSYS and anchored to real operational data from a Swedish biogas plant. The model investigates the ability of various heat supply configurations — including a biogas boiler, a combined heat and power system, and solar thermal collectors — to maintain the digester at its optimal operating temperature throughout the annual cycle under Stockholm climate conditions. Each configuration is evaluated for its thermal performance, energy utilisation efficiency, and capacity to buffer the mismatch between heat supply and the seasonally varying digester demand. Results demonstrate that thermal energy storage is the critical enabling component across all configurations, decoupling heat supply from demand and ensuring biological activity in the digester is never compromised regardless of the season or heat source.

# Saqib REHAN

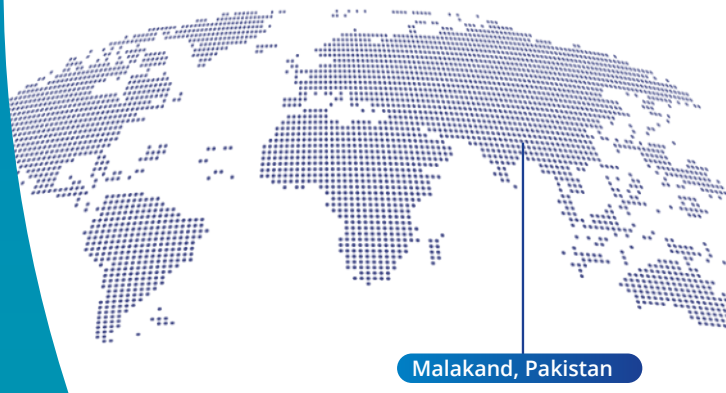
www.linkedin.com/in/saqib-rehan-b9375818b/

Bachelor in Mechanical Engineering, Pakistan

## Mobility scheme

UNIVERSITÉ DE LORRAINE

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> **“Plugging industries into a net-zero future”**

# Company

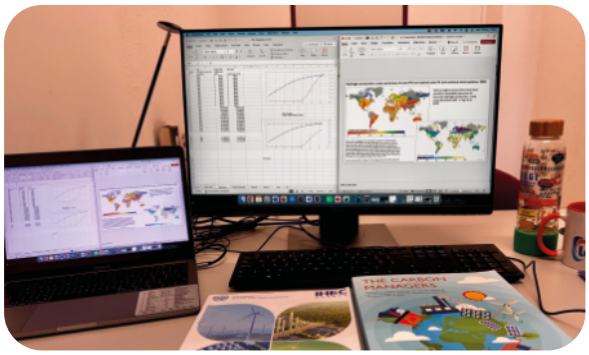
## National Centre for Scientific Research

CNRS (Centre National de la Recherche Scientifique) is France's leading public research organisation, covering all major scientific disciplines. It supports cutting-edge fundamental and applied research in partnership with universities and industry. It also plays a central role in France 2030 initiatives—notably co-leading the PEPR SPLEEN program dedicated to energy transition, low-carbon technologies, and industrial decarbonisation.




# Master's thesis title

## Electrification of the Industry as a Lever for Decarbonisation



This master's thesis is conducted within the PEPR SPLEEN Program and its Think Tank, a France 2030 initiative dedicated to industrial decarbonisation. The project focuses on electrification of the industry as a major lever to reduce greenhouse gas emissions across industrial ecosystems in France, Europe and worldwide. The main objective is to develop a multi-scale analytical framework and assessment criteria, grounded in both quantitative data and qualitative indicators, to evaluate electrification pathways, including the role of green hydrogen, across key industrial sectors. The work combines a comprehensive literature review of national and international studies with structured interviews of SPLEEN projects and Think Tank members, such as the IEA, UNIDO, IDDRI and EERA, to gather expert input for the study. The work is structured into three main components. First, a contextual analysis compares international decarbonisation scenarios, explores electricity and gas price dynamics, and assesses access to low-carbon power, while linking these factors to European and French policy frameworks relevant for industrial electrification. Second, the study identifies industrial sectors suitable for direct electrification and electrolytic hydrogen, estimates associated electricity and hydrogen needs, and applies a consistent conversion metric across multiple geographical scales. Third, an analytical framework is developed to characterise emerging electrification technologies using decarbonisation metrics and technology maturity; this framework is tested on detailed case studies, such as high-temperature industrial heat pumps and hydrogen-based iron ore reduction, with the possibility to extend to additional technologies. The results are consolidated into a scientific report and a policy-oriented brief designed to support the SPLEEN Program and decision-makers in prioritising robust, multi-scale electrification strategies for industry.

# Valeria SOLORZANO ARAQUE



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## Mobility scheme

UNIVERSITÉ DE LORRAINE

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> **“Discretizing chaos since Navier met Stokes”**

## Company

SIEMENS

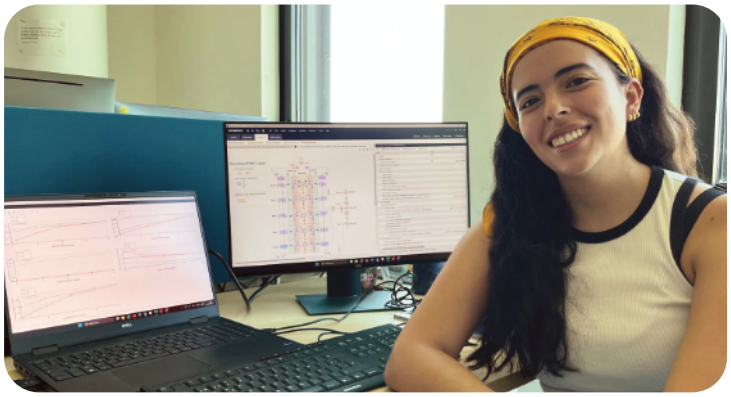
### Siemens Software

Siemens Digital Industries Software is a global leader in industrial software, providing advanced digital technologies that help companies design, simulate, and optimize complex systems. Its technologies support the development of more efficient, sustainable, and connected systems across sectors such as energy, mobility, and manufacturing, enabling innovation that accelerates decarbonization and digital transformation.




## Master's thesis title

# Physics-Based Discretization of a PEM Fuel Cell Stack in Simcenter Amesim: 1D Thermal-Electrochemical Modeling



This internship project, in collaboration with the Systems Applications team, focuses on modeling and gaining a deep understanding of the internal behavior of fuel cells. The primary objective is to create a framework to discretize and evaluate Fuel cells solving the governing equations of mass, momentum, and energy conservation in both steady and transient regimes . The importance of this approach lies in the fact that small variations in temperature, pressure, and humidity significantly impact fuel cell performance, efficiency, lifetime, and maintenance needs. Therefore, it is crucial to develop models capable of accurately capturing these phenomena without incurring high computational costs, allowing for the rapid evaluation of various configurations and operating scenarios without the need to build physical prototypes.

While many parameters can change when performing discretization studies in fuel cells, it is essential to establish a robust and automated methodology that encompasses geometric definition, electrochemical phenomena, heat and mass transfer, and discretization direction. To validate the discretized model, a reference case study is used to compare the model's results with existing experimental data and simulations. The project also involves assessing the pros and cons of different solutions for discretizing fuel cell models, including their configuration, the generation of tools , and the post-processing of simulation results. For the best identified solutions, detailed guidelines and specifications will be drafted for the development of the required submodels and user interface. This methodology will enable the development of a more user-friendly solution and an intuitive interface that allows users to easily and quickly define the discretization of the fuel cell model and configure its parameters within Simcenter Amesim .

# Chuong Dang TA



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**Mobility scheme**

UNIVERSITÉ DE LORRAINE

Politecnico di Torino

Hanoi, Vietnam

**“Who has seen the wind? Neither you nor I; But when the trees bow down their head, the wind is passing by.”**

# Company

rebase.energy

## Rebase.energy

Rebase.energy is a Python-first energy forecasting and modelling platform dedicated to accelerating the clean-energy transition. Combining deep expertise in energy markets, data engineering, and advanced algorithms, the company builds open, collaborative tools that support digitalisation, decentralisation, and decarbonisation across modern power systems.




# Master's thesis title

## Icing Power Loss forecasting for wind farms in cold climates using machine learning



Atmospheric turbine icing in cold climates causes aerodynamic degradation, structural standstills, energy losses, and operational uncertainty. This thesis forecasts wind power icing loss at 1- to 36-hour lead times using multi-year Swedish turbine SCADA and ERA5-Land data. Icing labels are established using an extended IEA Wind Task 19 Sigmoid Performance Ratio framework. Data investigation reveals inter-annual non-stationarity and wind speed - temperature overlap between icing and non-icing events. Biases between SCADA and ERA5-Land inputs are corrected using Quantile Mapping and LightGBM. From numerous candidate features across multiple physical groups, Spearman and SHAP screening remove unstable predictors. A two-stage LightGBM classifier-regressor is trained using walk-forward cross-validation over multiple winters.

Evaluation on a blind winter test set spans several scenarios: Persistence, Oracle, Realistic NWP, and SCADA-only. Persistence yields high short-term accuracy but collapses rapidly as lead time increases. Oracle (using weather observations) defines the performance ceiling. Realistic NWP tracks the Oracle classifier but suffers a regression penalty from forecast errors. SCADA-only (no weather forecasts) collapses beyond the near term. Thus, local SCADA signals dominate near-term forecasts, but meteorological forecasts are essential for longer horizons.

# Ofosua Angela TWUM



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**Mobility scheme**

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**“Bridging science and policy to strengthen BECCS integrity in climate solutions.”**

# Company

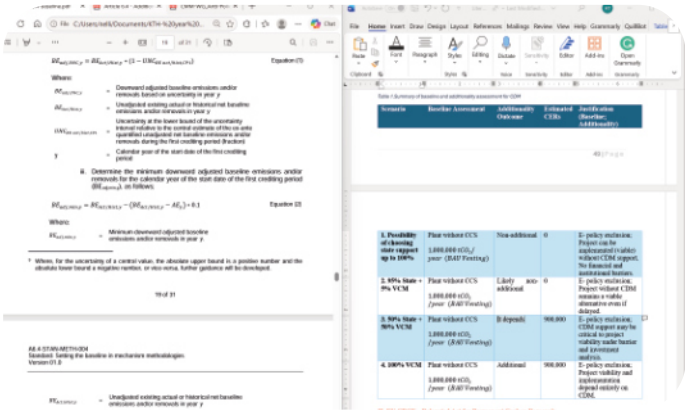



## IVL Swedish Environmental Research Institute

IVL Swedish Environmental Research Institute is an independent research institute specialising in environmental, climate, and energy systems analysis. Its work supports sustainable transitions through applied research on greenhouse gas mitigation, carbon dioxide removal technologies, circular economy solutions, and climate policy instruments. IVL collaborates with industry, governments, and academia to advance scientific and policy-relevant climate solutions.

# Master's thesis title

## Comparative assessment of BECCS carbon crediting methodologies



As countries and industries pursue net-zero targets under the Paris Agreement, Bioenergy with Carbon Capture and Storage (BECCS), is increasingly recognized as a key carbon dioxide removal pathway capable of counterbalancing residual emissions from hard-to-abate sectors and to return temperatures to 1.5°C. However, significant methodological differences across certification frameworks create uncertainty regarding the quality and environmental integrity of BECCS-generated carbon credits. This thesis investigates how different carbon crediting methodologies quantify and certify greenhouse gas removals from BECCS projects, and how these methodological differences influence environmental integrity, attribution of mitigation outcomes, and project financing.

The study conducts a comparative assessment of existing and emerging carbon crediting methodologies, including the EU Carbon Removal and Carbon Farming Certification Framework (CRCF), the Paris Agreement Crediting Mechanism (PACM), and voluntary standards such as Verra, Isometric, Puro. Earth, and Gold Standard. Particular focus is placed on how methodologies operationalize baseline setting, additionality, and double-claiming risks under different financing structures combining public support and voluntary carbon market revenues. Through scenario-based and quantitative analysis, the thesis evaluates how methodological choices affect certifiable $CO_2$ removals and financing outcomes. The study aims to identify gaps and inconsistencies in current accounting approaches and provide recommendations to strengthen transparency, comparability, and environmental integrity in BECCS certification, with relevance for the Swedish and EU climate policy development.

# Marc Alec Dominic YAU



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Bachelor of Science in Chemical Engineering, Philippines

## Mobility scheme

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> **All models are wrong, but some are useful.**

## Company

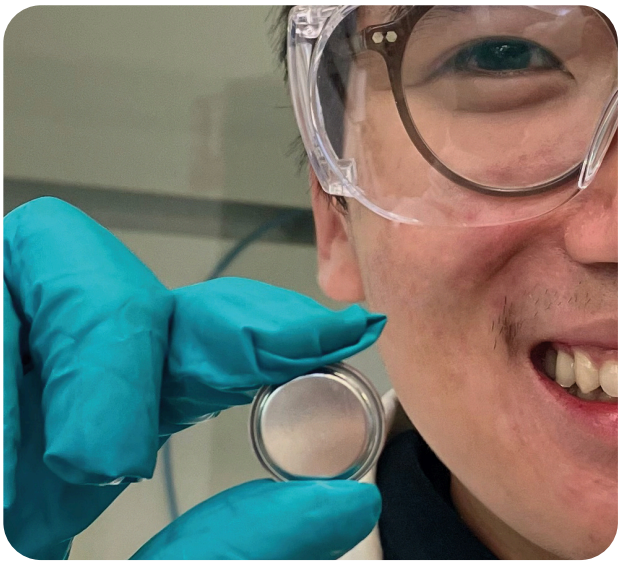
## IFP Energies Nouvelles

IFP Energies nouvelles (IFPEN) is a major research and training player in the fields of energy, transport and the environment. From research to industry, technological innovation is central to all its activities. IFPEN focuses on providing solutions to take up the challenges facing society in terms of energy and the climate.




## Master's thesis title

# Parameterization of Physics-Based Models for Lithium-ion Batteries



Among electrochemical energy storage systems, lithium-ion batteries are currently the dominant technology due to their high energy density, efficiency, and cost-effectiveness. To further improve the overall design and performance of these batteries, “physics-based models,” so called because they resolve the coupled physical processes inside the cell, serve as powerful tools for reliably predicting the behavior of batteries and reducing reliance on extensive experimentation.

This work develops and fully parameterizes a physics-based Pseudo-Two-Dimensional (P2D) model for a lithium iron phosphate (LFP) cell, a chemistry increasingly favored in mobility and stationary applications due to its thermal stability. In the P2D framework, key parameters must first be identified and calibrated during the “parametrization” step, in order to accurately solve the governing equations for ion transport, charge conservation, and electrochemical reactions. Parametrization is performed using literature data, dedicated experiments, and Python-based data analysis, while the P2D model is simulated using Simcenter Amesim. Several optimization approaches, such as direct identification, inverse optimization, and hybrid techniques, are implemented and systematically compared in terms of accuracy, robustness, complexity, and computational cost. The final validated model, particularly its capabilities and limitations, is summarized to support the design, control, and optimization of future LFP-based energy storage systems.





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