

Khaled Sayed Gad

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1 Personal Information	
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2 Educational Activities	
June 2023 - May 2026	PhD Candidate in Science, Technology and Policy for Sustainable Change Department of Energy, Politecnico di Milano, Italy Thesis Title: <i>A Protocol for transport decarbonisation: the Italian railway case</i> Supervisor: Prof. Emanuela Colombo Main Activities: <i>Developing integrated computational approaches combining energy system optimization modelling, stochastic bottom-up demand simulation, and decision-making under deep uncertainty to assess decarbonisation pathways. Key contributions: (1) novel bottom-up energy demand modelling for the transport sector; (2) disaggregating Railway Infrastructure in Energy System Optimisation; (3) robustness assessment of decarbonization strategies across uncertain futures; (4) multi-objective optimization and post-optimal analysis for policy-relevant insights.</i>
Sep 2020 - May 2023	Master of Science in Energy Engineering — Energy for Development Politecnico di Milano, Italy Thesis Title: <i>Long-term energy planning with highly detailed demand modelling for Egypt: an IOA-MAED-OSeMOSYS soft-linking approach</i> Supervisors: Prof. Emanuela Colombo Main Activities: <i>Development of an integrated modelling framework for long-term energy planning, combining input-output analysis (IOA), energy demand modelling (MAED), and optimisation (OSeMOSYS), applied to Egypt.</i>
Sep 2014 - July 2019	Bachelor of Science in Mechanical Engineering — Power Generation Ain Shams University, Cairo, Egypt Thesis Title: <i>Comprehensive Design and Thermodynamic Analysis of a 6000-Ton Multi-Purpose Cold Storage Complex: From Load Calculations and Insulation Optimization to Equipment Selection and Feasibility Study</i>

3 Teaching Activities

3.1 University Course Tutoring

a.y. 2025–2027	Teaching Tutor — Sustainable Management of Resources (1st Level Specialising Master) Department of Energy, Politecnico di Milano, Italy 23 CFU Director: Prof. Fabio Inzoli Co-Director: Dr. Diana Shendrikova Website: www.masterafrica.polimi.it Main Activities: <i>Supported instruction in the Module on Sustainable and Just Energy Transition (10 CFU) and contributed to the Final Project module (13 CFU); assisted African university researchers and lecturers in applying energy transition concepts to their institutional contexts; supported students in developing research proposals and programme designs aligned with AU–EU cooperation frameworks.</i>
a.y. 2025–2026	Teaching Tutor — Thermoeconomics and Energy Modelling (056956) MSc Energy Engineering, Politecnico di Milano, Italy 8 CFU Lecturer: Prof. Emanuela Colombo Main Activities: <i>Supported instruction in exergy-based methods and energy system optimisation modules; facilitated blended learning and flipped classroom sessions; assisted students in project work on country-level energy scenario analysis using linear programming models; introduced students to uncertainty characterisation in energy modelling outputs.</i>
a.y. 2024–2025	Teaching Tutor — Thermoeconomics and Energy Modelling (056956) MSc Energy Engineering, Politecnico di Milano, Italy 8 CFU Lecturer: Prof. Emanuela Colombo Main Activities: <i>Supported instruction in exergy-based methods and energy system optimisation modules; facilitated blended learning and flipped classroom sessions; assisted students in project work on country-level energy scenario analysis using linear programming models; introduced students to uncertainty characterisation in energy modelling outputs.</i>
a.y. 2024–2025	Lecturer & Course Developer — Modelling the Energy Transition: the role of Railway Sector energy demand POK – Polimi Open Knowledge (Online MOOC), Politecnico di Milano, Italy MOOCs for Researchers (EQF Level 7) Funded by EU NextGenerationEU / MOST – National Center for Sustainable Mobility MOOC link: Course: Modelling the Energy Transition: the role of Railway Sector energy demand POK Main Activities: <i>Developed course content and recorded video lectures covering the energy–transport nexus, bottom-up energy demand modelling, and decarbonisation scenario analysis applied to the Italian railway sector; designed and delivered hands-on sessions using the RAMP open-source tool; contributed to quiz-based assessment design.</i>

3.2 Other Educational contribution

Apr 2026	Lecturer — Energy Engineering Week (Certified Intensive Elective Course) El Sewedy University of Technology (SUT) — Cairo, Egypt ECU–Politecnico di Milano International Collaboration Agreement “Tertiary Education in Energy Efficiency” Programme <i>One-week intensive certified elective course on energy engineering foundations with focus on energy efficiency, energy system optimisation, and sustainability. Delivery includes lectures, practical sessions, and project-based work.</i>
Apr 2025	Lecturer — Energy Engineering Week (Certified Intensive Elective Course) El Sewedy University of Technology (SUT) — Cairo, Egypt ECU–Politecnico di Milano International Collaboration Agreement “Tertiary Education in Energy Efficiency” Programme <i>One-week intensive certified elective course on energy engineering foundations (Apr 2025). Delivery includes lectures, practical sessions, and project-based work.</i>
Nov 2025	Trainer — Train-the-Trainer Programme: Energy System Modelling El Sewedy University of Technology (SUT) — Cairo, Egypt ECU–Politecnico di Milano International Collaboration Agreement <i>Sessions covered innovative teaching methodologies (Blended Learning, Flipped Classroom), energy system modelling tools and curricula, and alignment with European academic standards.</i>
Nov 2024	Trainer — Train-the-Trainer Programme: Energy System Modelling El Sewedy University of Technology (SUT) — Cairo, Egypt ECU–Politecnico di Milano International Collaboration Agreement <i>Capacity building for SUT teaching staff supporting the new Energy Engineering Technology programme (Diploma + BTech tracks, Industrial and Environmental specialisations).</i>
Feb 2025	Invited Trainer — IMPRESSION Workshop: Mini-grids Modelling Software Training Politecnico di Milano — Bovisa Campus, Milan, Italy IMPRESSION Project Capacity Building Workshop <i>Delivered a hands-on training seminar on MicroGridsPy, an open-source optimisation tool (Pyomo-based) for modelling energy sizing and dispatch in off-grid and remote micro-grid systems.</i>
Oct 2024	Invited Lecture: “Applications of Energy Demand Modeling in the Railway Sector” Sapienza Università di Roma — PhD in Energy and Environment Course: Sustainable Mobility Invited by Prof. Paolo Venturini Lecture topic: <i>applications of energy demand modelling to the railway sector, covering bottom-up simulation approaches and their use in decarbonisation scenario analysis.</i>
Dec 2024	Invited Lecture: “Modelling Bottom-Up Energy Demand — RAMP” Sapienza Università di Roma — MSc Mechanical Engineering Course: Sistemi per l'Energia e l'Ambiente Invited by Prof. Domenico Borello <i>Introduction to the open-source RAMP tool for stochastic bottom-up modelling of energy demand profiles, with applications to transport and off-grid systems.</i>

3.3 MSc Student Mentoring & Co-Supervision

2026	Ibrahim Goda – PoliMi – Supervisor: Emanuela Colombo Thesis title: <i>Techno-Economic Optimization of Italian Railway Stations as Energy Community Nodes, A Post-Optimal Saturation Analysis</i>
2025	Lorenzo Caravetta & Riccardo Sordi – PoliMi - Supervisor: Emanuela Colombo Thesis title: <i>Development of a railway sector module for integration into energy system optimization models: decarbonization and modal shift in Italy</i>
2025	Marco Romio – PoliMi - Supervisor: Nicolo Stevanato Thesis title: <i>An analysis of Tanzania's energy system: impact of residential electricity demand scenarios on the future power supply mix</i>
2025	Nicola Ventura – PoliMi - Supervisor: Nicolo Stevanato Thesis title: <i>Modelling the integration of green hydrogen into Kenya's power system for fertilizer production</i>
2025	Eleonora Gentili – PoliMi - Supervisor: Nicolo Stevanato Thesis title: <i>Dynamic charging in long-term energy modelling: contributions to flexibility and implications for battery development</i>
2025	Mohamed Khedr - PoliMi Thesis title: <i>Modelling Green Hydrogen Development in Egypt: A Techno-Economic and Energy System Analysis</i>
2025	Raphael Markmann — PoliMi (in collaboration with RWTH Aachen) - Supervisor: Emanuela Colombo Thesis title: <i>Tanzania's domestic electricity power sector: Energy System Analysis and Potentials of Green Hydrogen Production</i>
2024	Tommaso Zacconi – PoliMi - Supervisor: Emanuela Colombo Thesis title: <i>Evaluating the nuclear role in the italian power sector: scenario analysis by means of energy system modelling</i>
2024	Arianna Loppi — PoliMi (in collaboration with Sapienza University of Rome) - Supervisor: Domenico Borello Thesis title: <i>Decarbonization of the Railway Sector: Taxonomy and Energy Demand Prediction of the Railway Infrastructure for Innovative Scenarios</i>
2024	Nicholas Della Valle – PoliMi - Supervisor: Emanuela Colombo Thesis title: <i>Bottom-up Modelling of the Italian Railway System: Energy Demand Simulation of Stations and Trains for Decarbonization Scenarios</i>
2024	Camilla Lo Giudice – PoliMi - Supervisor: Emanuela Colombo Thesis title: <i>Investigating the regional contributions to the Italian decarbonization: an energy modelling multi-regional approach</i>

4 Visiting Researcher Positions	
Jan – Apr 2026	Universiteit Utrecht (Utrecht University) Utrecht, Netherlands Contact: Prof. David F. Gold (d.f.gold@uu.nl) Main Activities: <i>Conducting research on DMDU applied to ESOMs; adapting a multi-sector energy system model (power, heat, transport) for Exploratory Modelling and Analysis; characterizing deep uncertainties in demand, technology costs, and system performance; assessing the robustness of national decarbonization strategies across plausible future scenarios.</i>
2023 – 2025 (periodic stays)	Sapienza University of Rome — Rome, Italy Contact: Prof. Domenico Borello (domenico.borello@uniroma1.it) Main Activities: <i>Developing bottom-up dynamic simulation models for traction energy demand prediction across Italian railway routes and rolling stock types. Applying stochastic modelling to assess energy consumption under uncertainty in load profiles and operational conditions.</i>
Jan – Apr 2018	ExxonMobil — Ain Shams University, Cairo, Egypt Industry simulation programme: Faculty of Engineering, Ain Shams University Main Activities: <i>Participated in a structured industry simulation programme. Contributed to analysis of energy poverty and proposed an enterprise business model for zero-energy homes in Egypt as a decarbonisation strategy for the residential sector.</i>

5 Professional Industrial Experience	
Dec 2019 – Sep 2020	Distributor Lube Engineer — ExxonMobil, Cairo, Egypt Embedded field technical role delivering lubrication engineering services and solutions to industrial clients across Egypt, as part of ExxonMobil's Lubricants division distributor network. Main Activities: <i>Led energy-saving initiatives across multiple factory clients, achieving 15% reduction in energy consumption and over USD 500,000 in annual cost savings recognised by clients; conducted plant surveys, troubleshooting visits, storage and handling assessments, and condition monitoring evaluations; produced formal benefit reports documenting performance outcomes; delivered technical training sessions to customer plant personnel; submitted weekly pipeline plans and quarterly market reports to Technical Managers.</i>

6 Research Activities

6.1 Research Field Description

Khaled Sayed Gad is a Research Associate and PhD Candidate at the SESAM (Sustainable Energy System Analysis and Modelling) Research Group, Politecnico di Milano. His research focuses on the development and application of energy system optimisation models (ESOMs) for long-term decarbonisation planning, with particular emphasis on the transport sector. His work integrates bottom-up energy demand modelling, stochastic simulation, multi-objective optimisation, and decision-making under deep uncertainty (DMDU) to assess robust decarbonisation pathways across uncertain futures.

Research Activity #1. Energy System Optimisation Modelling

Development and application of bottom-up energy demand models for the Italian transport sector, integrating stochastic simulation with system-level optimisation. Multi-sector scenario analyses (power, transport, industry) evaluating decarbonisation pathways and their sensitivity to key uncertainties in technology costs, fuel prices, and policy assumptions. Active contribution to the Hypatia energy modelling framework [C6] (github.com/SESAM-Polimi/Hypatia-polimi). Industry-funded research for Eni S.p.A. (2022–2025): development of the Italian Reference Energy System incorporating CCS technologies, multi-objective optimisation, and parametric scenario analysis for decarbonisation [J1]. This framework has been applied to address the energy trilemma in developing contexts, establishing integrated modelling approaches for long-term sustainable energy planning in Egypt and the Nile East Basin [J1].

Research Activity #2. Railway Sector Decarbonisation

Novel bottom-up energy demand and supply modelling for Italian railway infrastructure, disaggregating railway traction and station energy demands within energy system optimisation models and power sector analysis [J2, J3, J4] and [R1, R2]. Techno-economic and environmental assessments of decarbonisation strategies, in collaboration with Rete Ferroviaria Italiana (RFI), Sapienza University of Rome, University of Firenze, University of Naples Federico II, Bank of Intesa Sanpaolo and as part of the MOST (National Center for Sustainable Mobility) project (EU NextGeneration, MUR, 2023–2026). Development of stochastic bottom-up models to assess energy consumption of typical railway routes under uncertainty [C2], and evaluation of decarbonisation levers for urban railway stations through demand modelling and mini-grid optimisation [J4]. Post-optimal analysis of solar and battery storage systems at Italian railway stations under transitioning tariff regimes [C4]. Integration of railway infrastructure disaggregation into national energy system optimisation models to support Italy's coupled energy-transport decarbonisation to 2050 [J5].

Research Activity #3. Decision Making under Deep Uncertainty.

Application of DMDU methods (Exploratory Modelling and Analysis, robustness metrics, multi-objective optimisation) to energy system models, in collaboration with Utrecht University [C5]. Assessing the robustness of national decarbonisation strategies across wide ranges of plausible futures using the Energy Trilemma framework. Development of integrated modelling frameworks that characterise deep uncertainties in technology costs, demand evolution, and policy scenarios to identify strategies robust across uncertain futures [C5], and [R1].

6.2 National/International Research Collaborations

Jun 2023 – Ongoing	Research Associate - SESAM Research Group, Department of Energy, Politecnico di Milano, Italy Research contribution: development and application of energy system optimisation models for long-term decarbonisation planning, with emphasis on the Italian transport and railway sector.
Jun 2023 – Feb 2026	Technical Leading Research Analyst (Task 2.4) — MOST (National Center for Sustainable Mobility), WP2, Task 2.4 EU NextGeneration programme, Funder: Ministry of University and Research (MUR), 2023–2026. Developing integrated energy models for sustainable transport systems; assessing decarbonisation and energy efficiency of the Italian railway sector.
Jun 2023 – Sep 2025	Research Assistant and Project Coordinator — Modelling Suite for Technological Scenarios (Eni S.p.A.) Industry-funded project (Eni S.p.A., 2022–2025). Developed the Italian Reference Energy System incorporating hydrogen production technologies for transport and industry, Carbon Capture and Storage technologies for cement, steel, hydrogen and power sector; through multi-objective optimisation and parametric scenario

7 Publications

7.1 Publications in International Journals

- [J1] Gad, K. S., Crevani, G., and Colombo, E. (2025). An integrated modelling framework to address the energy trilemma in Egypt and Nile East Basin. *Energy Strategy Reviews*, vol. 58, p. 101689. doi: 10.1016/j.esr.2025.101689
- [J2] Gad, K. S., Tonini, F., Agati, G., Borello, D., and Colombo, E. (2025). Energy demand prediction and scenario analysis for vehicle traction: A bottom-up approach applied to the Italian railway system. *Energy Reports*, vol. 13, pp. 4196–4208. doi: 10.1016/j.egyr.2025.03.061
- [J3] K. S. Gad, L. Caravetta, R. Sordi, and E. Colombo, “Beyond black-box rail transport: how aggregated energy system optimisation models can hide infeasible planning pathways and underestimate decarbonisation costs — evidence from Italy to 2050,” *Appl. Energy*, vol. 422, p. 128293, Nov. 2026, doi: 10.1016/j.apenergy.2026.128293.
- [J4] Gad, K. S., Tonini, F., Agati, G., Agostino, M., Borello, D., and Colombo, E. — Decarbonisation Levers for Urban Railway Stations through Stochastic Demand Modelling and Mini-grid Optimisation. *Under review, Results in Engineering*
- [J5] Agati, G., Gad, K. S., Tonini, F., Colombo, E., and Borello, D. — Stochastic Bottom-Up Modelling of Energy Demand in Railway Station Infrastructure: A Fleet-Scale Archetype Analysis of the Italian Network. *Under review, Applied Energy Journal*

7.2 Contributions in National/International Conferences

- [C1] Gad, K. S., Crevani, G., and Colombo, E. (2025). Estimating Urban and Rural Residential Energy Demand Amidst Economic Challenges. In 2025 IEEE PES/IAS PowerAfrica, pp. 1–6. doi: 10.1109/PowerAfrica65840.2025.11289174
- [C2] Tonini, F., Agati, G., Gad, K. S., Borello, D., and Colombo, E. (2024). Bottom-Up Stochastic Model to Assess Energy Consumption of Typical Railway Routes in Italy. In 2024 IEEE IEEEIC / I&CPS Europe, pp. 1–6. doi: 10.1109/IEEEIC/ICPSEurope61470.2024.10751460
- [C3] Gad, K. S., Ghezzi, D., Baiocco, V., Tonini, F., Rocco, M. V., and Colombo, E. — Leveraging Italy's Railways for Low-Carbon Transport: Strategies, Impacts, and Policy Insights. Accepted, 21st SDEWES Conference, 2026
- [C4] Gad, K. S., Goda, I. M., and Colombo, E. — Optimal Solutions, Unwise Decisions: Post-Optimal Investment Analysis of PV and BESS at Italian Railway Stations Under Transitioning Tariff Regimes. Accepted, 21st SDEWES Conference, 2026
- [C5] Gad, K. S. (2025). An integrated modelling framework to address the energy trilemma in developing countries. Open Energy Modelling Initiative Workshop, March 2025, Stockholm, Sweden (lightning talk)
- [C6] Gad, K. S. (2024). Hypatia: A Comprehensive energy system modelling framework. Open Energy Modelling Initiative Workshop, March 2024, Grenoble, France (poster)

7.3 Code Repository

- [R1] SESAM-Polimi. Hypatia — A Python-based energy system optimisation modelling framework. Available at: github.com/SESAM-Polimi/Hypatia-polimi
Contribution: development and application of the framework for energy system optimisation, scenario analysis, and multi-objective optimisation applied to Italy and developing countries.
- [R2] RAMP model is publicly available at RAMP-project/RAMP: Repository of the open-source RAMP model for generating multi-energy loads profiles. The Stations Module developed is available at <https://zenodo.org/records/18984781>.

8 Conference & Session Roles	
2025	Session Convener Convener, Energy system analysis — 20th SDEWES Conference, Dubrovnik, Croatia (2025)
2024	Session Convener Convener, Energy system analysis — 19th SDEWES Conference, Rome, Italy (2024)
9 Review Activity	
Ongoing	Peer reviewer for: IEEE Transactions on Transportation Electrification, Nature Communications, IEEE/IAS Power Africa
10 Technical Skills & Languages	
Programming & Modelling	Python (Proficient): NumPy, Pandas, Matplotlib, Pyomo GAMS (Advanced) R (Basic) Energy System Models: OSeMOSYS, TIMES/VEDA-TIMES, Hypatia, MARIO, PyPSA, MicroGridsPy Demand Modelling Tools: RAMP, MAED (IAEA)
Languages	Arabic (native) English (C1/C2) Italian (C1) German (A2)