Pierre Haessig, www.pierreh.eu

CentraleSupélec
Avenue de la Boulaie — CS 47601
35576 Cesson-Sévigné Cedex, France

pierre.haessig@centralesupelec.fr
office phone: +33 2 99 84 45 76
cell phone: +33 6 81 17 12 06

Assistant professor in Electrical Engineering & Control

Research Experience

2014–present

Assistant professor of Electrical Engineering & Control at *CentraleSupélec*, Rennes campus, in the Automatic Control group of *IETR*.

Core research topics: analysis, sizing and optimal control of energy systems under uncertainty (e.g. solar and wind power production).

Methods: Stochastic Dynamic Programming, Model Predictive Control.

Software tools: Python (pandas), Julia (JuMP), and sometimes Matlab. Convex optimization solvers.

- Co-supervising 2 PhD students. Former co-supervised PhD students: Jesse James Prince Agbodjan, Joy El Feghali
- Supervised 7 Master students in the "Smart grids" Double Degree program with Xi'an Jiaotong University (XJTU)
- Co-supervised 8 5-month research contracts with student groups working on projects ordered by industry partners
- Launched in 2017 the Efficient Tools seminar series to share useful research tips between colleagues (Yalmip, Git, Julia, HOMER).

2011–2014

PhD research at the SATIE CNRS laboratory, *ENS Rennes*, France

"Sizing and optimal control of an energy storage associated with wind power generation"

supervised by Bernard Multon and Hamid Ben Ahmed on the academic side, and Stéphane Lascaud at EDF R&D on the industrial side

thesis prize: colaureate of the 2015 Paul Caseau Prize, awarded by Académie des Technologies & Fondation EDF.

- realistic modeling of energy storage systems (with losses and aging)
- modeling the temporal structure of errors of wind power forecasts
- optimization of the energy management of a storage taking into account forecast uncertainty (with Dynamic Programming)
- creation of an open source Stochastic Dynamic Programming solver stodynprog

2011, 4 months

Master thesis at L2S, *Supélec*, Gif-sur-Yvette, France

"Characterizing the uncertainty of wind power generation"

supervised by Pascal Bondon

- modeling the uncertainty in the relation between wind speed and wind power production
- modeling forecast errors with a conditionally heteroscedastic model

2010, 2 months

Research internship at ISN, *MIT*, Cambridge, USA

"Platform for the real-time simulation of power electronics systems"

supervised by Ivan Čelanović and in collaboration with Félix Hartmann, Michel Kinsy and Jason Poon

- interfacing the PC-based modeling software and the FPGA-based simulation platform with an Ethernet link
- creation of a graphical user interface (GUI) for power systems (with Python and the Qt widget toolkit)
- setting up a demonstration of the simulation platform and comparison with a real system

2009, 7 months

Research internship at ISN, *MIT*, Cambridge, USA

"Real-time simulation of power electronics circuits"

supervised by Ivan Čelanović

This project turned into a successful company, Typhoon HIL, Inc., a leader for Hardware-in-the-Loop (HIL) real-time emulators for power electronics. I continued collaboration with Typhoon until 2011.

- selection of model structures adapted to the constraints of real-time simulation (1 µs time step)
- creation of a Matlab code for the automatic modeling of power electronics circuits in state space (piecewise linear dynamical models, also called hybrid systems)

Teaching

Teaching topics

- **Electrical engineering:** Power systems, Power electronics, Renewables
- **Control theory & System modeling**: Simulink, Modelica, Optimization

Teaching mindset

I'm interested in understanding human learning and how to best organize courses to maximize students' learning. To that end, as time permits, I'm gradually reading books on the matter ("How learning works", "Teaching what you don't know", "Small teaching"). I try to find *small practical actions* which promote active learning in the classroom (or since 2020, in online settings...), but I don't claim I'm successful at applying these tools extensively. I'm less interested in "bigbang" pedagogical innovations, although I'm not opposed to them and I'm kindly skeptical at the optimistic promotion of digital technologies which claim to revolutionize teaching, although I'm fond of computing.

Teaching experience

2014–present

Assistant professor of Electrical Engineering & Control at *CentraleSupélec*, Rennes campus. 200–250 hours/year.

2016–present: 1st year electrical energy course (AC power, magnetic circuits, transforms, DC machines).

2016–present: creating and teaching a course on the Modelica multiphysics modeling language, with a focus on model structuring and collaborative engineering (version control with Git), and a short introduction to bond graphs (33 hours). Online assignment: http://éole.net/courses/modelica/ (with OpenModelica getting started videos 📹).

2019–present: 2nd year "engineering challenge term" on Microgrids and Renewable Energies, which includes an optimization project (with Nabil Sadou).

2020–present: Introduction to Power Systems course (AC load flow (Matpower), voltage regulation, integration of Renewables, 15 hours).

2021–present: Optimization under Uncertainty course (9 hours), followed by 15-hour practice sessions on optimal sizing and energy management of a Microgrid (with Nabil Sadou).

2022–present: Power electronics modeling and control lab course (with Simulink/Simscape).

2015–2018: creation of two 20 hours lab courses for our "Smart grids" Master program:

- "Grid Connected Inverter Lab" (online assignment http://éole.net/courses/inverter/)
- "Grid Simulation & Control Lab" (online assignment http://éole.net/courses/grid/)

2014–2019: supervising a 5×4 hours lab session on industrial process control with a Programmable logic controller (using Grafcet and Ladder languages)

Other past courses: Model order reduction, Process identification lab.

Supervision of a few 1st and 2nd year students' projects each year.

2023–present

Temporary teacher *IMT Atlantique, Rennes campus.* Short introduction to Power Grids (4 hours).

2011–2013

Temporary teacher *IUT de Rennes, GEII department.* Tutorials and lab sessions in undergraduate electrical energy courses (84 hours).

2011–2013

Temporary teacher *Supélec, Rennes campus.* Lab sessions on AC electric machines (24 hours).

2011–2014

Temporary teacher *ENS Rennes, Mechatronics department.*

- Co-supervision of Master 1 class year-long project "Mechatronic System Design" (2×28 h)
- Continuing education: creation of a one-day practical courses "Programming & Scientific computing with Python" for preparatory classes teachers in Maths, Physics and Engineering.
- Others: teaching twice a 2 h Master course on wind energy, supervising one scientific programming project (10 h)

Curriculum in Electrical Engineering & Control

2011–2014

PhD on Energy Storage Sizing and Management for Wind Power, with the electric utility EDF, R&D department, and the SATIE CNRS laboratory at ENS Rennes, Rennes, France.

2007–2011

Electrical Engineering & Control dpt. of ENS Paris-Saclay, Paris, France.

2011: **Master degree** in Control & Signal Processing at CentraleSupélec.

2010: **Agrégation** in Applied Physics.
Ranked first in this highly competitive test which is required by the French Education Ministry for teaching high school and undergraduate students.

2008: **Licence** (~eq. of Bachelor) in Applied Physics at ENS Paris-Saclay and Université Paris-Sud (now Paris-Saclay).

2005–2007

Classes Préparatoires in Mathematics and Physics at Lycée Kléber, Strasbourg, France. This is the two-year French program to pass the competitive admission tests for leading engineering schools

Communication & Computing Skills

Scientific computing & data analysis

I'm interested in open source tools for reproducible scientific computing. GitHub: pierre-haessig

- **Scientific computing:** almost daily practice since 2011, often with Jupyter notebooks. Mostly Python, with more and more Julia; a bit of Matlab/Octave.
- **Statistics & Dataviz:** data analysis (e.g. time series) with Python (pandas, statsmodels) and extensive use of Matplotlib; small experience with R.
- **Optimization:** stochastic dynamic programming (created stodynprog), convex optimization tools (JuMP).
- **System modeling & simulation:** causal with Simulink; acausal with Modelica (multiphysics), SimPowerSystems (power electronics).
- **Development tools:** code and document versioning (git) used every day, documentation generator (Sphinx) and code unit testing used regularly.

Graphics & Publishing

- **Vector graphics, diagrams & image editing:** Inkscape, draw.io, GIMP.
- **Document authoring:** LaTex, Office suites (Microsoft's and LibreOffice), Markdown (slides with Marp), Sphinx (e.g. for online course assignments).
- **CMS/LMS:** Wordpress, Moodle (e.g quizzes authoring).
- **Web design:** HTML, CSS, SVG, with Javascript animations (Phaser).

Languages

- **English:** fluent. 9 months of scientific internship in the USA. TOEFL: 110/120, TOEIC: 990/990 in 2008.
- **German:** basic skills. Years of study, several visits and weeks of immersion in Germany, but lack of recent practice.
- **Spanish:** former beginner. Weekly evening courses during the year 2010–2011.

Research Projects & Publications

Fresh projects

- Optimization of energy systems by automatic differentiation of Julia code, with Evelise de Godoy Antunes, from a grant from GdR SEEDS, in collaboration with Benoit Delinchant, G2Elab (2021–2022)
- Optimal microgrid sizing considering uncertainty, PhD of Elsy El Sayegh (2021–2024)
- Optimal microgrid sizing with hydrogen-based seasonal storage, PhD of Jean Nikiema (2023–2026), with a grant from the Regional Council of Brittany.

Energy storage and renewable energies (2011–present)

Work on the optimal sizing and management of an energy systems including storage (batteries) and renewable power generation (wind, solar).

- E. El Sayegh, **P. Haessig**, N. Sadou, J. Bruschi, B. Jacquet, S. Nasr, and H. Guéguen, "Assessing the impact of uncertainties on the techno-economic performance of microgrids," in *27th International Conference on Electricity Distribution (CIRED 2023), Rome*, 2023. Paper n° 10762.[bib]
- **P. Haessig**, E. El Sayegh, E. de Godoy Antunes, and N. Sadou, "Microgrids modeling: which code architectures for which features?," in *SGE 2023, Lille, France*, 2023. in French.[bib | http]
- E. de Godoy Antunes, **P. Haessig**, C. Wang, and R. Chouhy Leborgne, "Optimal Microgrid Sizing using Gradient-based Algorithms with Automatic Differentiation," in *ISGT Europe 2022, Novi Sad, Serbia*, 2022. [bib | DOI | http]
- E. El Sayegh, N. Sadou, **P. Haessig**, S. Nasr, J. Bruschi, B. Jacquet, A. El Akoum, and H. Guéguen, "Towards avoiding microgrid design failures arising from an unrealistic operating strategy: an anticipative White Box model versus a responsive Black Box model," in *Jeunes Chercheurs en Génie Électrique (JCGE22), Le Croisic*, 2022.[bib | http]
- **P. Haessig**, J. J. Prince Agbodjan, R. Bourdais, and H. Guéguen, "Solar home 2020: expanding the open source energy management under uncertain inputs benchmark," in *SGE 2021, Nantes, France*, July 2021. in French.[bib | http]
- **P. Haessig**, "Convex Storage Loss Modeling for Optimal Energy Management," in *IEEE PowerTech 2021 Conference, Madrid, Spain*, June 2021.[bib | DOI | http]
- I. Kordonis, A. C. Charalampidis, and **P. Haessig**, "Optimal operation of a grid-connected battery energy storage system over its lifetime," *Optimal Control Applications and Methods*, 2021.[bib | DOI | http]
- I. Kordonis, A. C. Charalampidis, and **P. Haessig**, "Optimal Control of MDPs over a Long Operation-Dependent Time Horizon and Application to Battery Energy Storage Systems," tech. rep., 2021. submitted to IEEE Transactions on Automatic Control.[bib | http]
- **P. Haessig**, J. J. Prince Agbodjan, R. Bourdais, and H. Guéguen, "Energy management with uncertain inputs: which algorithms? Open source benchmark based on a solar home," in *SGE 2018, Nancy, France*, July 2018. in French.[bib | http]
- **P. Haessig**, B. Multon, and H. Ben Ahmed, "Effect of the timestep on the simulation of a wind-storage system," in *SGE 2016, Grenoble, France*, June 2016. in French.[bib | http]
- **P. Haessig**, B. Multon, and H. Ben Ahmed, "Energy Storage Control with Aging Limitation," in *IEEE PowerTech 2015 Conference, Eindhoven, the Netherlands*, June 2015.[bib | DOI | http]
- **P. Haessig**, B. Multon, H. Ben Ahmed, and S. Lascaud, "How important is the choice of the control policy when sizing an energy storage system?," in *SGE 2014, Cachan, France*, July 2014. in French.[bib | http]
- **P. Haessig**, *Dimensionnement & gestion d'un stockage d'énergie pour l'atténuation des incertitudes de production éolienne*. PhD thesis, ENS Cachan, July 2014.[bib | http]

- **P. Haessig**, T. Kovaltchouk, B. Multon, H. Ben Ahmed, and S. Lascaud, "Computing an Optimal Control Policy for an Energy Storage," in *6th European Conference on Python in Science (EuroSciPy 2013), Brussels, Belgium*, pp. 51–58, Aug. 2013.[bib | http]
- **P. Haessig**, B. Multon, H. Ben Ahmed, S. Lascaud, and L. Jamy, "Aging-aware NaS battery model in a stochastic wind-storage simulation framework," in *IEEE PowerTech 2013 Conference, Grenoble, France*, June 2013.[bib | DOI | http]
- **P. Haessig**, B. Multon, H. Ben Ahmed, S. Lascaud, and P. Bondon, "Energy storage sizing for wind power: impact of the autocorrelation of day-ahead forecast errors," *Wind Energy*, vol. 18, pp. 43–57, Jan. 2015. published online Oct 2013.[bib | DOI | http]
- B. Multon, J. Aubry, **P. Haessig**, and H. Ben Ahmed, "Systèmes de stockage d'énergie électrique," in *Techniques de l'Ingénieur*, p. BE8100, Éditions T.I., Apr. 2013.[bib | http]
- **P. Haessig**, "Caractérisation de l'incertitude de production éolienne, rapport de stage de Master 2," Master's thesis, ENS Cachan - Supélec Laboratoire Signaux et Systèmes, July 2011.[bib | http]

Resilient energy management (2017–2021)

PhD thesis of Jesse James Arthur Prince Agbodjan ("Design of resilient controllers for Buildings Energy Management" defended in 2021) on how to take into account rare and extreme events (like grid outages) in Model Predictive Control.

- J.-J. Prince Agbodjan, **P. Haessig**, R. Bourdais, and H. Guéguen, "Integrating stochastic discrete constraints in MPC. application to home energy management system," *IFAC Journal of Systems and Control*, p. 100168, jul 2021.[bib | DOI | http]
- J.-J. Prince Agbodjan, **P. Haessig**, R. Bourdais, and H. Guéguen, "Stochastic modelled grid outage effect on home Energy Management," in *2020 IEEE Conference on Control Technology and Applications (CCTA)*, pp. 1080–1085, Aug 2020.[bib | DOI]
- J.-J. Prince Agbodjan, **P. Haessig**, R. Bourdais, and H. Guéguen, "Resilience in energy management system: A study case," *IFAC-PapersOnLine*, vol. 52, no. 4, pp. 395 – 400, 2019. IFAC Workshop on Control of Smart Grid and Renewable Energy Systems CSGRES 2019.[bib | DOI | http]

Modeling multi-energy systems in Modelica for control (2020–2022)

PhD thesis of Joy El Feghali (defended in 2023) which covers Modelica model simplification (with energy-based indices) and optimization based control using Modelica models.

- J. El Feghali, G. Sandou, H. Guéguen, **P. Haessig**, D. Faille, H. Bouia, and D. Croteau, "Electrical Grid Flexibility via Heat Pump and Thermal Storage Control," in *IFAC Workshop on Control for Smart Cities, Sozopol, Bulgaria*, June 2022.[bib | DOI | http]
- J. El Feghali, G. Sandou, H. Guéguen, **P. Haessig**, and D. Faille, "Energy-based method to simplify complex multi-energy modelica models," in *Proceedings of 14th Modelica Conference 2021, Linköping, Sweden, September 20-24, 2021*, Linköping University Electronic Press, sep 2021.[bib | DOI | http]

Voltage control of distribution grids (2015–2016)

Collaboration with Marjorie Cosson on the stability of "Q(U) voltage control" schemes on distribution grids.

- M. Cosson, H. Guéguen, **P. Haessig**, D. Dumur, C. Stoica Maniu, V. Gabrion, and G. Malarange, "Stability Criterion for Voltage Stability - Study of Distributed Generators," in *IFAC and CIGRE/CIRED Workshop on Control of Transmission and Distribution Smart Grids (CTDSG´16), Prague, Czech Republic*, Oct. 2016.[bib | http]
- M. Cosson, H. Guéguen, **P. Haessig**, D. Dumur, C. Stoica Maniu, V. Gabrion, and G. Malarange, "Critère de stabilité analytique pour les régulations locales de tension des producteurs décentralisés ," in *SGE 2016, Grenoble, France*, June 2016.[bib | http]

Miscellanous collaborations

- D. Faille and **P. Haessig**, “Heliostat aiming points optimization for Concentrated Solar Power plant,” in *60th Annual ISA Power Industry Division Symposium (POWID), Cleveland, USA*, June 2017.[bib]
- B. Zhao, X. Wang, and **P. Haessig**, “A Novel SoC Feedback Control of ESS for Frequency Regulation of Fractional Frequency Transmission System with Offshore Wind Power,” in *2017 China International Electrical and Energy Conference (CIEEC), Beijing, China*, Oct. 2017. waiting final acceptance.[bib | http]

Real-time simulation of Power Electronics (2009–2011)

Research I did before PhD. This project has since become a company, Typhoon HIL, Inc., which produces Hardware-in-the-Loop emulators of power electronics converters.

- M. Kinsy, D. Majstorovic, **P. Haessig**, J. Poon, N. Celanovic, I. Celanovic, and S. Devadas, “High-speed real-time digital emulation for hardware-in-the-loop testing of power electronics: A new paradigm in the field of electronic design automation (EDA) for power electronics systems,” in *PCIM 2011, Nuremberg, Germany*, May 2011.[bib | http]
- J. Poon, **P. Haessig**, J. G. Hwang, and I. Celanovic, “High-speed hardware-in-the loop platform for rapid prototyping of power electronics systems,” in *IEEE CITRES 2010, Waltham, MA*, Sept. 2010.[bib | DOI]
- I. Celanovic, **P. Haessig**, E. Carroll, V. Katić, and N. Celanovic, “Real-Time Digital Simulation: Enabling Rapid Development of Power Electronics,” in *Ee 2009, Novi Sad, Serbia*, Oct. 2009.[bib | http]