



Toulouse Biotechnology Institute
Bio & Chemical Engineering

Postdoctoral researcher in hybrid modelling of anaerobic digestion using ADM1 and machine learning

Context

The shADow project proposes a digital shadow approach for anaerobic digesters, leveraging a hybrid model that combines ADM1 - the reference model for anaerobic digestion - with machine learning. This approach will improve biomethane production predictions through enhanced integration of physico-chemical and biological parameters while ensuring process interpretability and adaptability to real-time variations.

In the first phase, different model variants will be developed and compared using available physico-chemical and biological data from anaerobic digesters. In the second phase, semi-continuous digesters and their digital shadow will be implemented to evaluate predictive performance. A key focus will be assessing the impact of microbial data integration on prediction accuracy under inhibited conditions, where ADM1-based predictions are typically less reliable than under standard conditions. By optimizing anaerobic digestion through digital modeling, shADow takes a step towards the implementation of digital twins.

Work environment, missions and activities

The postdoctoral researcher will be hosted at the [Toulouse Biotechnology Institute \(TBI\)](#) a public research laboratory on the INSA Toulouse campus, jointly supported by INSA Toulouse, CNRS and INRAE. The position will be based within TBI's [Mathematics Cell](#), which focuses on mathematical modelling of biochemical and microbial systems and on AI/ML methods. The postdoctoral researcher will collaborate closely with experts from INRAE's national laboratories, including the [LBE](#) lab in Narbonne (dynamic modelling) and [PROSE](#) in Antony (experimentalists and data to use in this project). The position will involve research stays at both laboratories in order to strengthen collaboration and integrate experimental and modeling approaches.

Missions & activities

- Develop and refine ADM1-based models using laboratory and industrial datasets, with a focus on robust parameter estimation, sensitivity analysis, and uncertainty quantification.
- Design, test and compare hybrid modeling strategies that combine mechanistic ADM1 models with data-driven machine learning approaches.
- Apply machine learning methods (e.g., regression, sequence models, surrogate models) to improve prediction, state estimation, and scenario analysis.
- Implement and promote MLOps best practices, including reproducible workflows, version control, automated testing, and model deployment pipelines.
- Collaborate closely with experimentalists and process engineers to integrate data and provide actionable insights.
- Disseminate research results through publications, conferences, and project deliverables.



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Experience

- PhD in chemical engineering, environmental engineering, applied mathematics or a related field.
- Solid background in process modelling and simulation, ideally with experience in ADM1 or similar mechanistic models.
- Proven experience with machine learning methods applied to time series, system identification, or process modelling.
- Strong programming skills in Python, MATLAB, or similar environments.
- Track record of scientific publications in relevant fields.

What We Offer

- Mentorship and training: receive guidance from leading experts in the field and access to a comprehensive training program.
- Collaborative network: engage with a dynamic team of researchers and industry partners, both nationally and internationally.
- Career development: opportunities for professional development, including workshops, seminars, and networking events.
- Work atmosphere: You will be part of a team that takes their work very seriously. We pride ourselves on fostering a collaborative and supportive atmosphere where researchers and interns work together in a dynamic and friendly environment to drive innovative solutions for environmental sustainability.
- Great working conditions: 30 days of holidays per year (+ 15 if time recovery is affected); support for parenting; access to inexpensive collective restaurants; flexible schedule; access to on-site sports facilities; sunny weather.
- Salary (gross): 2550 - 2 840 €/month (including full social and health benefits).

Personal skills

- Strong motivation to work in an interdisciplinary and collaborative research environment.
- Ability to work independently and manage research tasks effectively.
- Excellent problem-solving and analytical thinking skills.
- Good communication skills in English (spoken and written).
- Open-minded, creative, and eager to contribute to both fundamental and applied research.
- Academic Background: PhD degree in Control, Process Engineering, Computer Science, Mathematics (or related field), or an equivalent engineering degree



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- Skills (recommended): experience in bioprocess modelling; scientific communication and writing skills.
- Language: fluent use of English; knowledge of French is an advantage but not required.

Location: [Toulouse Biotechnology Institute \(TBI\)](#). 135 Av. de Ranguel, 31400 Toulouse.

Contract: 18 months contract (CDD).

Start date: as soon as possible

Contact:

Interested candidates should submit the following documents:

- A detailed CV, including academic achievements and research experience.
- A cover letter outlining your motivation and suitability for the project.

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