

Digitalisation of the Bioenergy Sector: Insights from Industrial Surveys and Workshops

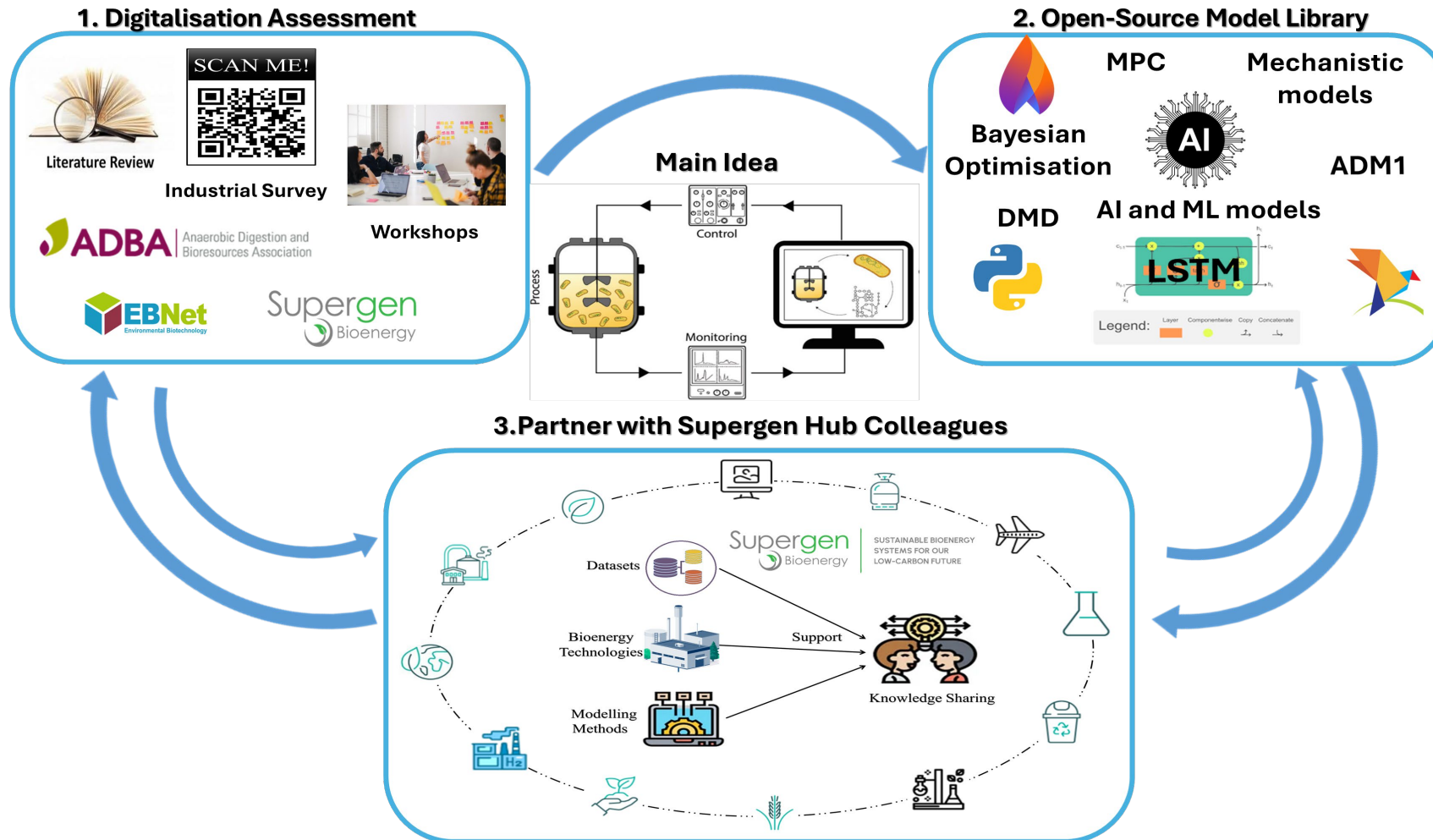
By
Dr. Michael Short and Benaissa Dekhici



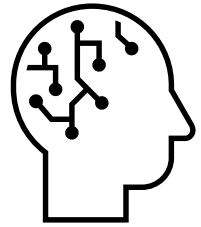
DIGITALISATION AND AI FOR BIOENERGY



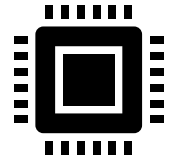
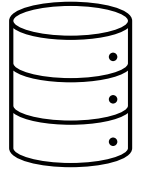
- ❑ Rapidly advancing digitalisation within bioenergy, with an integrated roadmap and open-source optimisation toolkit.
- ❑ Development of real-time predictive models and uncertainty-aware digital twins for flexible decision-making.
- ❑ Aim to improve efficiency and flexibility in bioenergy operations through digital technologies.
- ❑ Outputs will feature hybrid AI-driven control systems and an accessible, integrated decision-making platform.



WHAT IS DIGITALISATION?

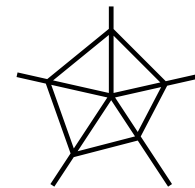
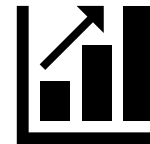
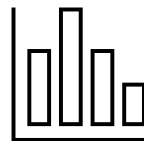


“Digitalisation” is connected to the *application of digital technologies and digitalised data*, but also even more to do with *new and changing business models and revolutions in behaviour*.



Our definition:

Digitalisation is the application of **digital decision-making tools** in the bioenergy industry for optimising operations, improving efficiency, and ensuring sustainability.



Klitkou, A., Bozell, J., Panoutsou, C., Kuhndt, M., Kuusisaari, J. & Beckmann, J. P. (2017). Bioeconomy and digitalisation (Mistra Background paper).



Increasing Uptake of Digitalisation and Artificial Intelligence in the Bioenergy Industry



Event:

*Supergen Bioenergy Impact Hub Annual Assembly in Sheffield
the 5-6 November 2024*



Discussion Questions



1

What are the main challenges you face in adopting digitalisation technologies in bioenergy processes?

2

What opportunities do you see for leveraging digitalisation to enhance bioenergy processes?



Engineers



Academics



ECRs



Policy Makers



Industrialists

80+ Participants

SURVEY OVERVIEW – DIGITALISATION IN BIOENERGY



Industrial Survey on Digitalisation in Bioenergy Processes

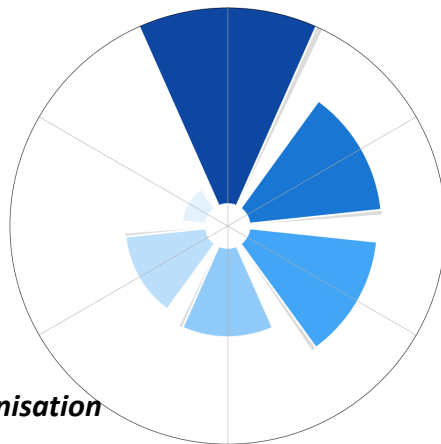
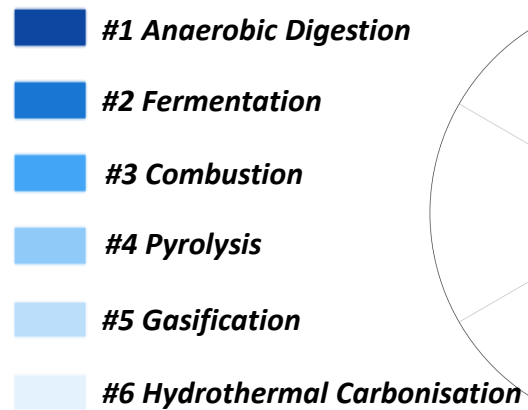


22 Survey
Participants

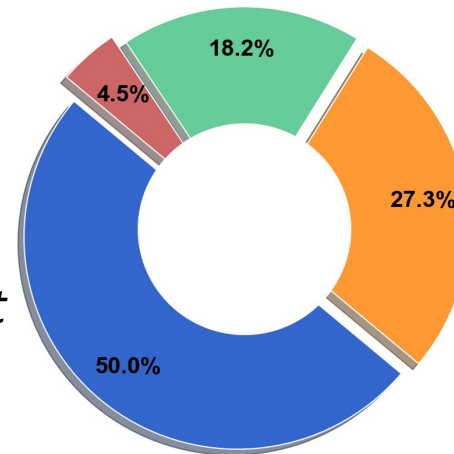


Targeted

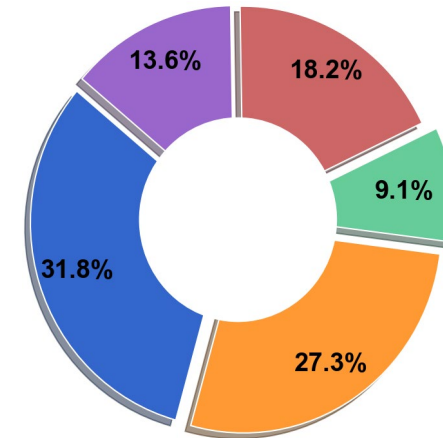
Process Familiarity Ranking



Participants Roles

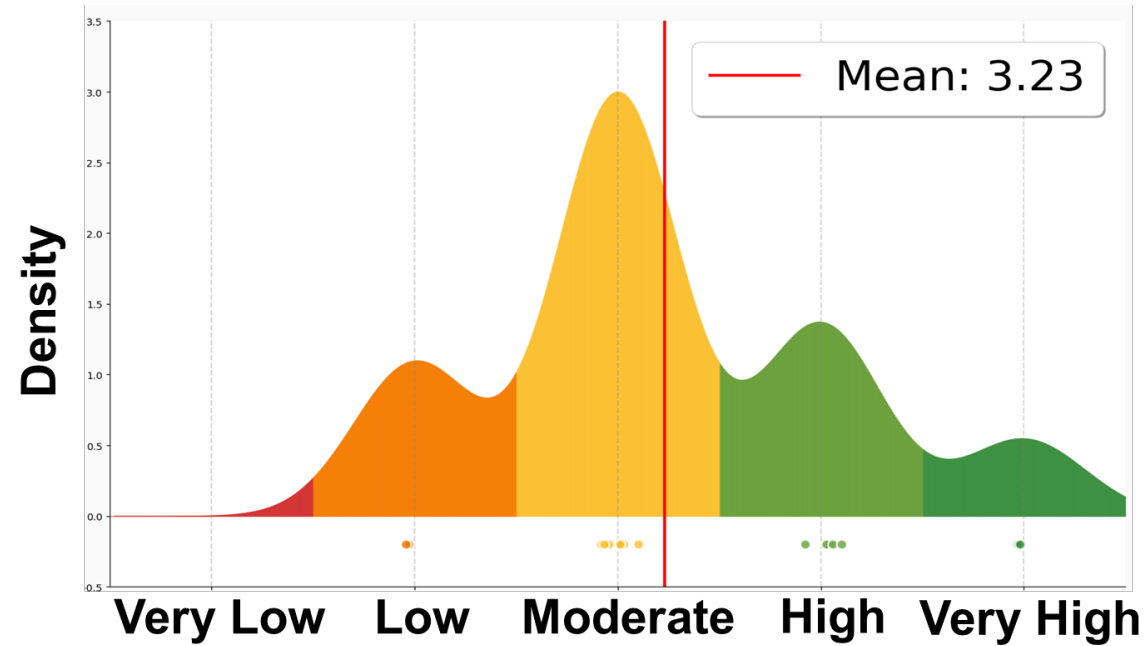


Years of experience

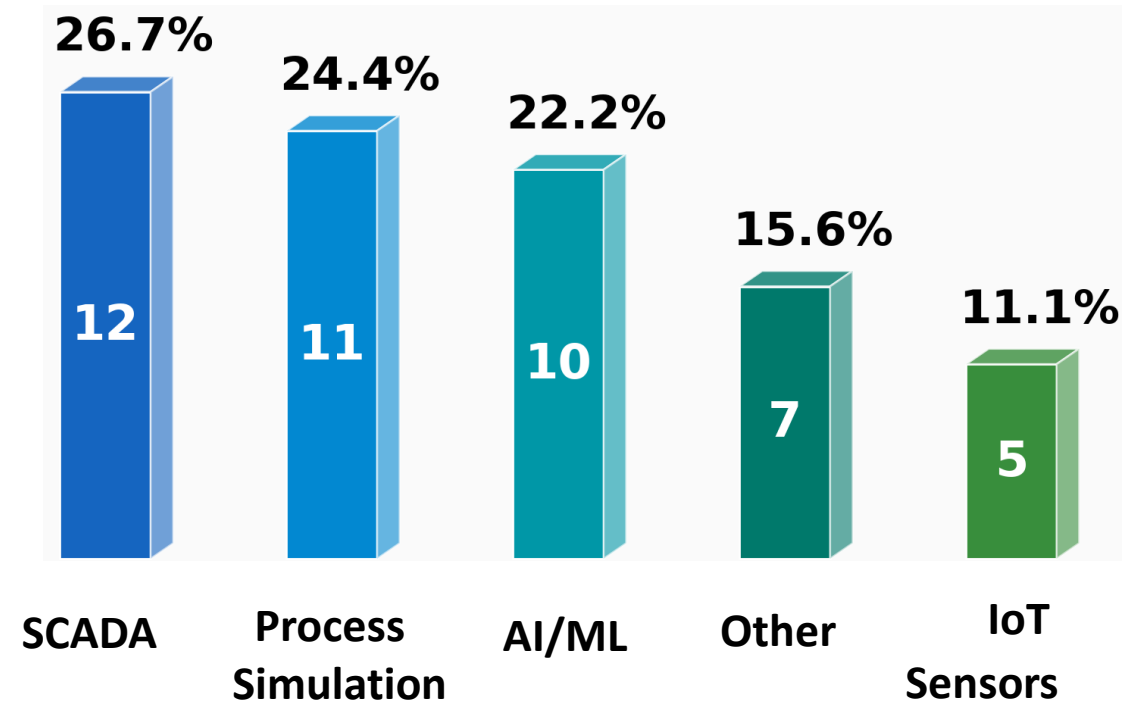




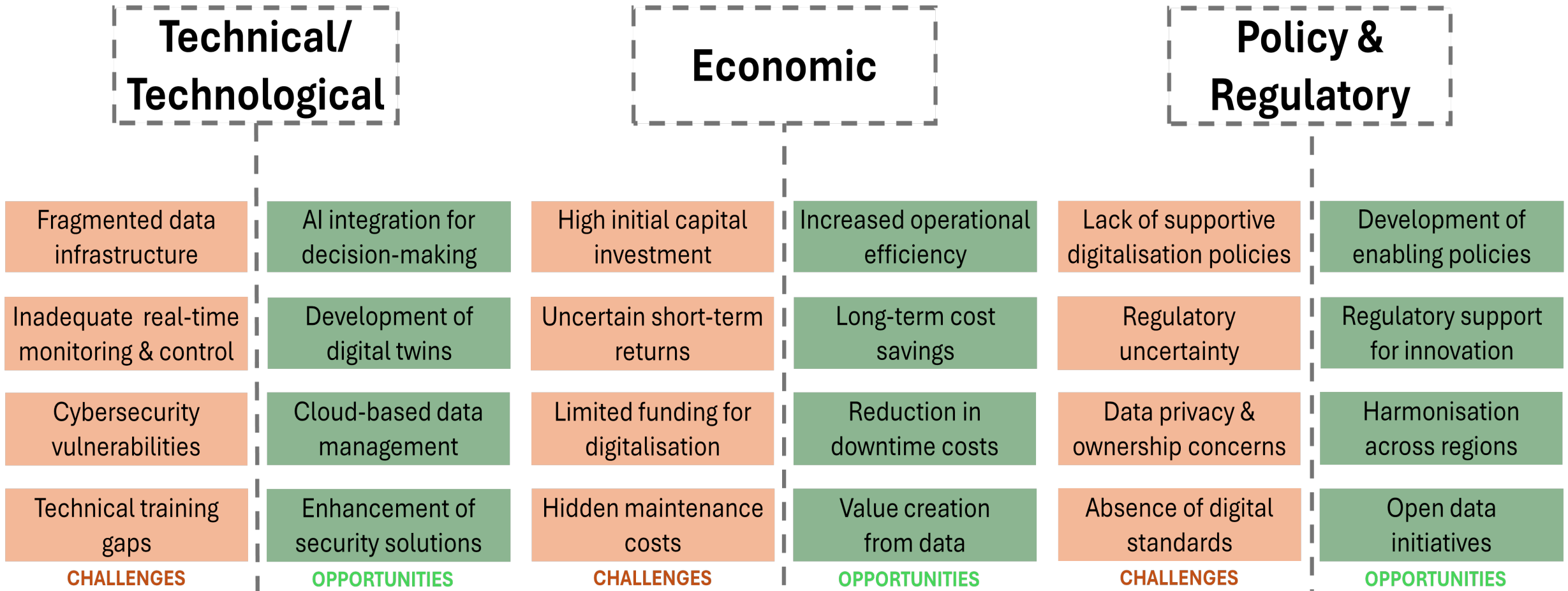
Organisational Digitalisation Level



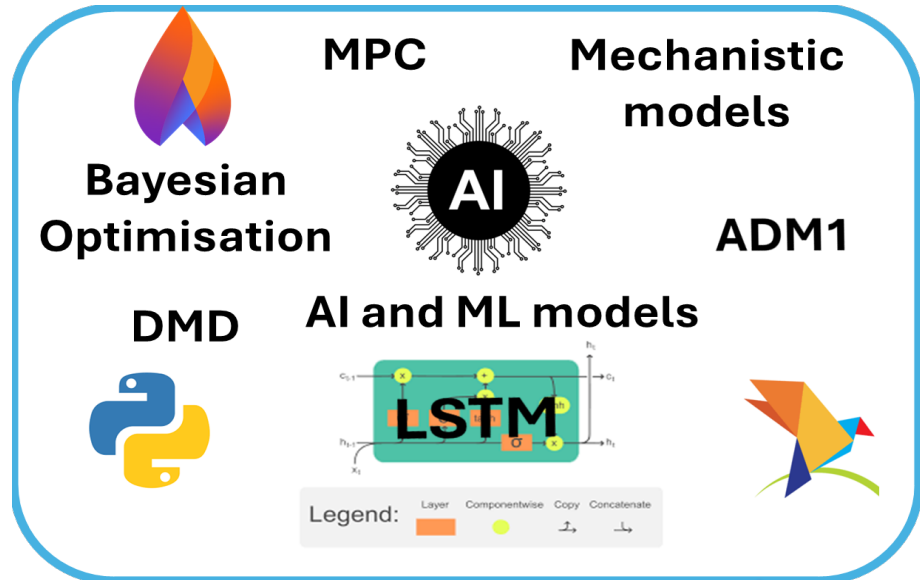
Digital Technologies in Bioenergy Processes



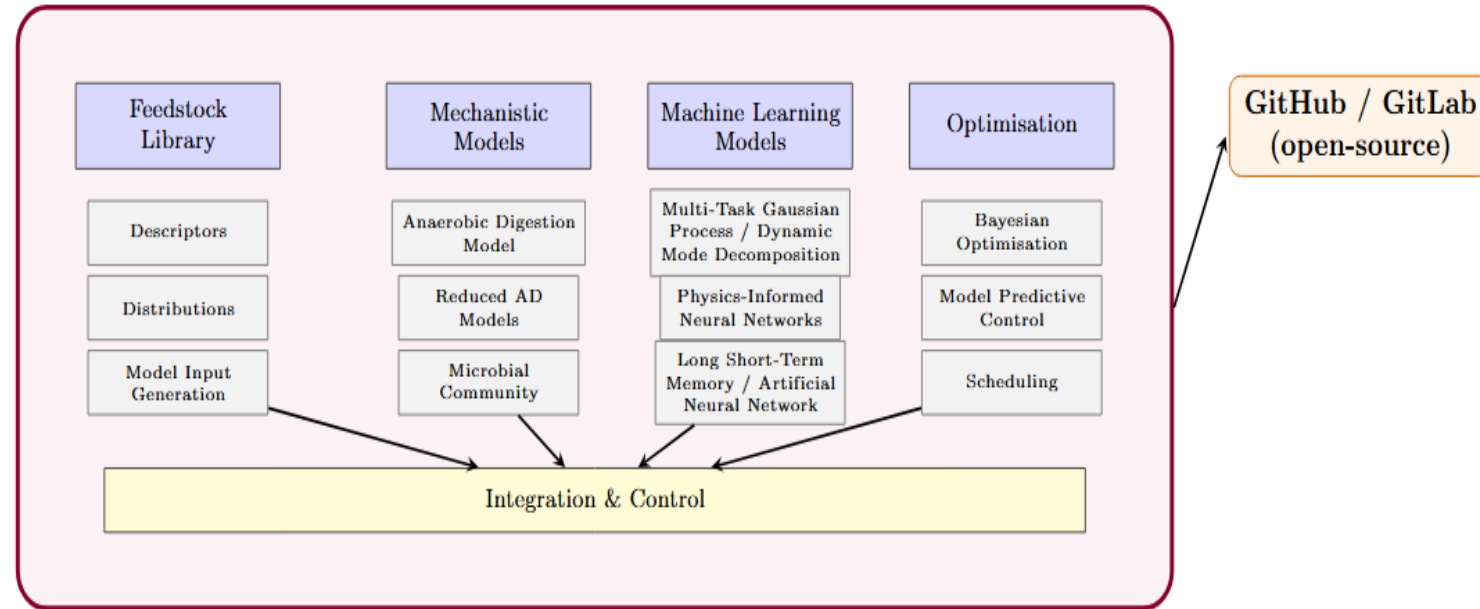
IDENTIFIED CHALLENGES AND OPPORTUNITIES



OPEN-SOURCE TOOLKIT FOR RAPID DIGITALISATION OF BIOENERGY



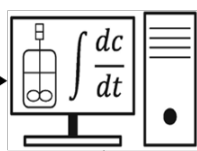
Library Architecture



Biogas Production Plant



Physical Model



ML Model



Improved Model

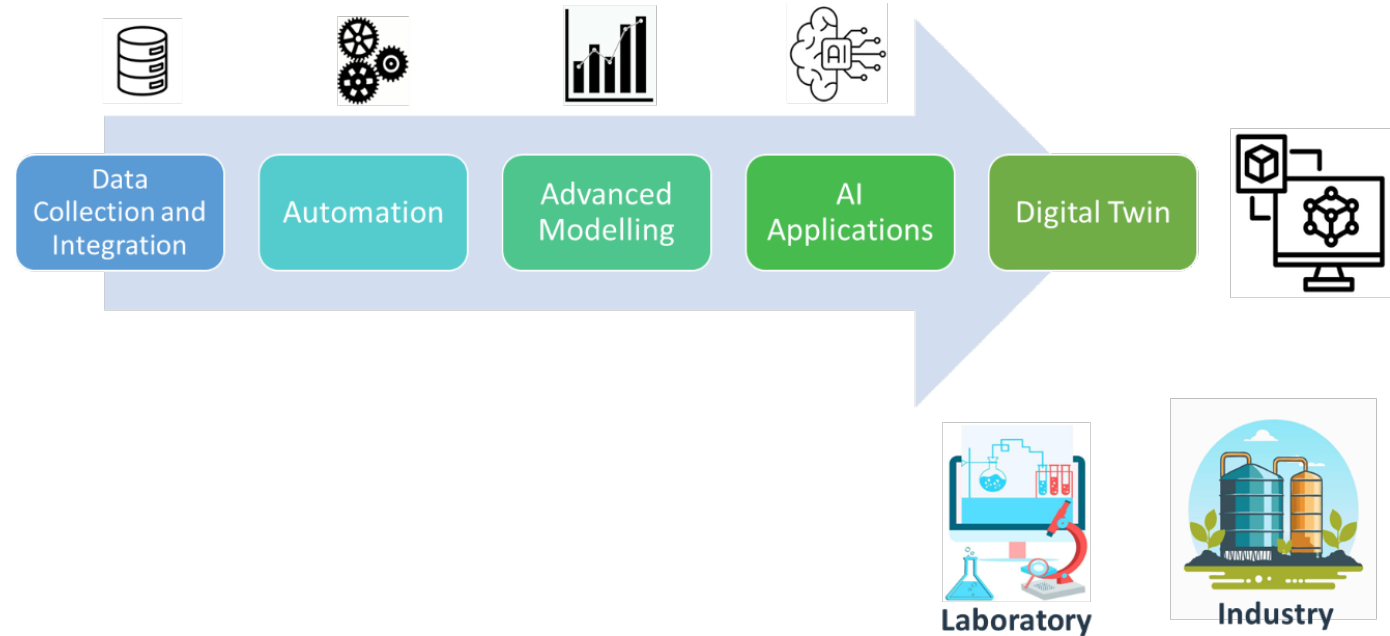
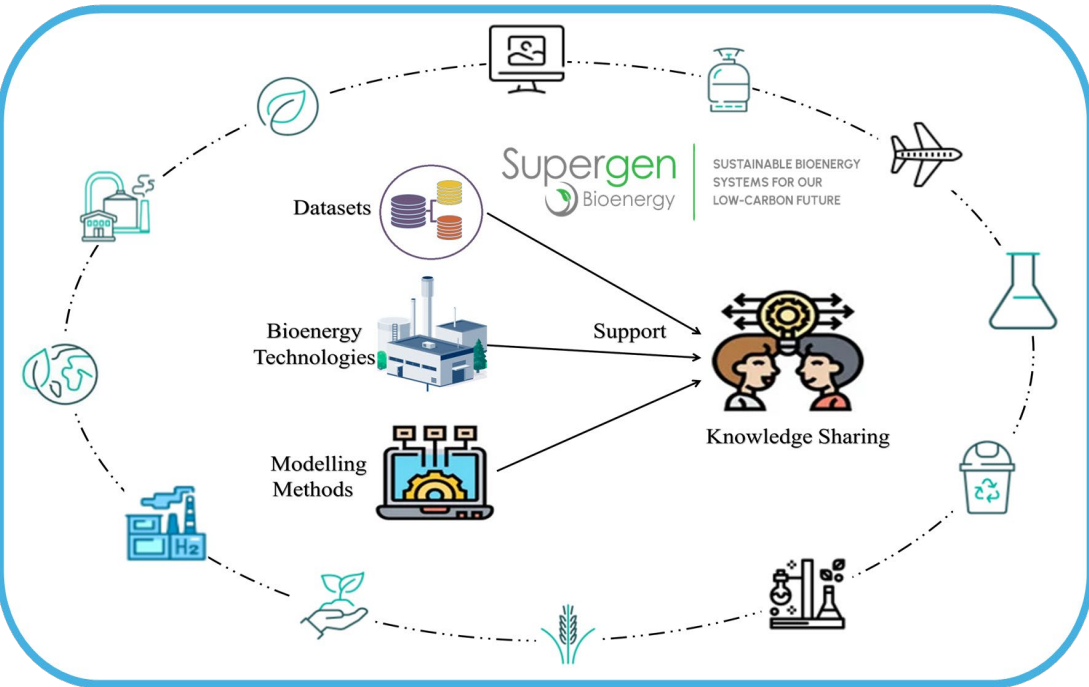


bioprocess-digitalisation-lib/

- data/
 - raw/
 - processed/
 - external/
- notebooks/
 - ad_case_study.ipynb
 - bayesian_doe.ipynb
 - lstm_vs_ann.ipynb
 - pinns_demo.ipynb

- # Root directory of the project
- # Directory to store data files
- # Directory to store raw data files
- # Directory to store processed data files
- # Directory to store external data files
- # Directory to store Jupyter notebooks
- # Notebook for AD case study
- # Notebook for Bayesian DoE example
- # Notebook for LSTM vs ANN comparison
- # Notebook for PINNs demonstration

DEVELOP DIGITALISATION ROADMAP WITH HUB PARTNERS





MANCHESTER PRIZE

- Manchester Prize finalists
- Have £160k to commercialise and compete for the £1M prize



KEY TAKEAWAYS



<i>Insight</i>	<i>Evidence from participants</i>
<i>Industry remains largely analog & not data-driven</i>	<i>“AD, biogas and bioenergy is a well studied topic... However there is still a big gap in modelling, controlling and optimising the system...”</i> <i>“ Lots of potential, but it’s the correlation of data which... is the most difficult to achieve. ”</i>
<i>Plant operations are isolated, inconsistent & experience-dependent</i>	<i>“In a decentralised industry with uncommon process it represents a huge opportunity to identify best practice...”</i>
<i>Data is fragmented & under-utilised, blocking optimisation</i>	<i>“Data is fragmented... limiting process optimization. ”</i> <i>(implicit in multiple responses)</i>
<i>Digitalisation can boost prediction, efficiency & product value</i>	<i>“ Digitalisation can improve prediction, efficiency, and product value. ”</i> <i>“ We are already considering how digitalisation will help us... plan in at very early stage.”</i>
<i>Economic competitiveness with fossil fuels is essential (not just environmental)</i>	<i>“ Sector must achieve economic competitiveness with fossil fuels, not rely solely on environmental arguments. ”</i>

Thank You!

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