TRAIL Summer Workshop' 25
Project Proposal

Full Name of Team Leader	**Gauthier Renard**
Project Title	An hybrid method to assess artificial intelligence project's sustainability with scenarios modeling
Profile of the Team Leader(s)	• **(i) Gauthier Renard (UMONS)** Phd interdisciplinary (psychology, engineering, economy), Knowledge in: human sciences, degrowth theory, technology uses, Ideation and brainstorming (ARIAC) • **(ii) Virginie Vandenbulcke (UMONS)** Professor in Sustainable and Technological Entrepreneurship • **(iii) Lee Biber (UCLouvain)** Phd - ARIAC
Abstract	This project aims to design and test an innovative methodology for evaluating the sustainability of various use cases developed during the TRAIL Workshop, with particular emphasis on artificial intelligence applications—especially deep learning. By applying scenario modeling techniques, the project seeks to identify and quantify both environmental and social risks and opportunities associated with these technological innovations. To achieve this, the team will test a range of sustainability assessment tools, including Sustainability Impact Assessment (SIA), Social Life Cycle Assessment (S-LCA), Sustainability Life Cycle Assessment (SLCA), and Input-Output Analysis (IOA). These approaches will be critically compared to establish a standardized method adapted to AI project contexts. The project involves close collaboration with other teams to guide AI development toward more sustainable pathways. Empirical data will be collected via qualitative and quantitative interviews to fuel the scenario modeling process. The methodology will integrate technical, ethical, and social considerations, with special attention paid to labor conditions and broader social impacts of AI.
Project Objectives	The aim of the project is to explore and formalize an innovative methodology for assessing the sustainability of the various use cases developed by the other groups at the TRAIL workshop. To this end, we will be experimenting with scenario modeling methods, to identify and quantify the potential environmental and social risks and opportunities that these projects could generate. To achieve this, we will mobilize and compare several sustainability assessment tools, including, for example, Sustainability Impact Assessment (SIA), Social Life Cycle Assessment (S-LCA), Sustainability Life Cycle Assessment (SLCA) and Input-Output Analysis (IOA). These methods will be partially applied and compared to the specific context of artificial intelligence projects, with a particular focus on deep learning technologies. The aim will be to compare these approaches to identify a standardized method capable of highlighting the long-term risks and impacts associated with these innovations, via scenario modeling.

	As a first step, our team will collaborate with the other groups to guide the development of AI towards a more sustainable trajectory. Secondly, we will use qualitative and quantitative interviews to collect data for the requirements of the different methods and will assess the relevance and effectiveness of the scenario-modeling tools used. Our multidisciplinary approach will integrate technical, ethical and social dimensions to enrich the analysis of scenarios, particularly on issues linked to working conditions and the social impacts of AI technologies. Moreover, this project will include an in-depth literature review aimed at structuring the assessment of rebound effects, often neglected in the analysis of technological innovations. In addition, we intend to develop a simplified procedural framework for implementing scenario modeling in technology projects, with the aim of making these tools more accessible to researchers. Finally, in a perspective of interdisciplinary openness, we would be interested in the contribution of AI engineers to explore automated modeling and simulation techniques, likely to improve the robustness and accuracy of predictions in the context of artificial intelligence development.
Project Dataset	The dataset will be based on current projects developed in the TRAIL workshop. These projects will serve as case studies for testing our scenario modeling approach to sustainability assessment. Depending on the chosen methodological framework (see bibliography), sustainability data will be collected either quantitatively or qualitatively from all participants involved in project development. For example: for the LCA tool, we will need quantitative data on materials, waste and emissions from the model implemented in the project to carry out the analysis. For example, for the S-LCA, we will need to conduct interviews with the various project stakeholders. These data will then be integrated into the chosen methodological framework, or can be used to develop a new, adapted framework. In addition, a survey can be carried out with representatives of the participating companies, to extend the analysis to all relevant stakeholders.
Background Information	Scenario modeling is a key method for assessing sustainability, particularly in contexts where environmental and social impacts are uncertain or difficult to anticipate. It is based on three fundamental questions: What will happen? What could happen? And how can we achieve a given objective? (Börjeson et al., 2006). This method combines analytical (quantitative and qualitative) and procedural tools to simulate different project trajectories and assess their potential impacts. These tools include multi-criterion decision analysis (MCDA), life-cycle analysis (LCA), input-output analysis (IOA) and social life-cycle analysis (S-LCA). These tools can be used to prioritize technological scenarios, guide future strategic choices or assess the social and environmental consequences of a technology. Despite the existence of these tools, scenario assessment has received limited attention in the scientific literature. As Robinson (2003) points out, the final stage of the sustainability assessment process - the critical analysis of proposed scenarios - is often neglected. Moreover, research shows that the choice of assessment methods is frequently based on ad hoc logic, without any real structured methodological reflection (Fauré et al., 2016). It therefore appears necessary to develop a critical, well-argued approach to selecting the most suitable evaluation tools. In our project, this reflection will focus on the prospective evaluation of artificial intelligence (AI) projects. In the specific field of AI, and deep learning in particular, the absence of a clear methodological framework for prospective evaluation poses a significant challenge. Yet these tools have already been applied in various technological contexts. For example, LCA has been used to

	assess the environmental implications of implementing technologies in the renewable energy and waste management sectors (Münster et al., 2016), carbon capture and storage (Bouvard et al., 2011) or transport electrification (Singh and Strømman, 2013). However, these use cases concern large-scale projects, and the application of scenarios modeling to the optimization of deep learning models, the development of AI and the evaluation of their uses remains largely unexplored. This project aims to fill this gap, by developing a modeling methodology adapted to the context of the projects explored during the workshop. Finally, all these modeling approaches would benefit from incorporating second-order effects (e.g., rebound effects, indirect impacts), particularly in the field of information and communication technologies (ICT). These include direct and indirect economic rebound effects, as well as temporal effects linked to technology use (Rivera et al., 2014). Although a theoretical framework exists to capture them (Rivera et al., 2014; Achachlouei and Hilty, 2014), to date there is no operational tool for systematically integrating them into the evaluation of AI projects. This project will therefore aim to contribute to this challenge by conducting a literature review on the evaluation of rebound effects, and then proposing a methodology applicable in the concrete cases studied.
Bibliographic References	Ahmadi Achachlouei, M., & Hilty, L. M. (2015). Modeling the effects of ICT on environmental sustainability: Revisiting a system dynamics model developed for the European commission. In *ICT Innovations for Sustainability* (pp. 449-474). Springer International Publishing. Boot-Handford, M. E., Abanades, J. C., Anthony, E. J., Blunt, M. J., Brandani, S., Mac Dowell, N., ... & Fennell, P. S. (2014). Carbon capture and storage update. *Energy & Environmental Science*, *7*(1), 130-189. Börjeson, L., Höjer, M., Dreborg, K. H., Ekvall, T., & Finnveden, G. (2006). Scenario types and techniques: towards a user's guide. *Futures*, *38*(7), 723-739. Bouvart, F., Coussy, P., Heng, J., Michel, P., & Ménard, Y. (2011). Environmental assessment of carbon capture and storage deployment scenarios in France. *Energy Procedia*, *4*, 2518-2525. Fauré, E., Arushanyan, Y., Ekener, E., Miliutenko, S., & Finnveden, G. (2017). Methods for assessing future scenarios from a sustainability perspective. *European Journal of Futures Research*, *5*, 1-20. Münster, M., Finnveden, G., & Wenzel, H. (2013). Future waste treatment and energy systems–examples of joint scenarios. *Waste management*, *33*(11), 2457-2464. Rivera, M. B., Håkansson, C., Svenfelt, Å., & Finnveden, G. (2014). Including second order effects in environmental assessments of ICT. *Environmental Modelling & Software*, *56*, 105-115. Robinson, J. B. (1990). Futures under glass: a recipe for people who hate to predict. *Futures*, *22*(8), 820-842. Singh, B., & Strømman, A. H. (2013). Environmental assessment of electrification of road transport in Norway: Scenarios and impacts. *Transportation Research Part D: Transport and Environment*, *25*, 106-111.

Detailed Work Plan	**Day 1-2:** Networking & initial framing Create inter-group links, understand use cases, present our approach Presentations, ice-breaker workshops, project mapping **Day 3-4:** Methodological choice Select suitable analysis tools, define scenarios to be modeled Method workshops (SIA, SLCA....), co-construction of scenarios **Day 5-6:** Data collection, Gather qualitative/quantitative data Interviews, observations, collection of indicators **Day 7-8:** Scenario modeling Apply methods, create prospective scenarios Scenario construction, collaboration with IA engineers **Day 9-10:** Analysis & preparation of reports Compare results, summarize impacts Comparative analysis, preparation of media **Next steps:** Report & outlook Share results, report writing, debate, presentation of simplified framework
Other Remarks	

Optional: Add any relevant figure for the project