O.I.E.

Centre Observation, Impacts, Energie

PhD Position

Short title:	*Combining Life Cycle Assessment and Risk Assessment for a comprehensive environmental evaluation of energetic systems*
Subject:	*Towards an integrated approach for the inclusion of risk assessment in the life cycle assessment of energetic systems – Accounting for and communicating the uncertainties in the environmental impact assessment results*
Keywords:	*Renewable energy, life cycle analysis, environmental impact, risk assessment, probability of occurrence, Bayesian inference, sensitivity analysis, uncertainty and variability analysis*
Type of contract:	*Doctoral contract limited to 36 months*
Dates and duration:	*36 Months from 1st of October 2021 to 30th of September 2024*
Degrees and profile:	- *Engineering degree or Master 2 degree with a focus on Statistics or Environmental Engineering* - *Motivation for research* - *Consistent professional project* - *Good knowledge in Applied Mathematics and Statistics* - *Programming skills in Python, Matlab or R* - *Experience in life cycle assessment and knowledge of an LCA software such as Brightway2, openLCA or SimaPro is an asset* - *Good level of scientific and general culture* - *Fluency in English, Knowledge of French is an asset* - *Good analytical, synthesis and communication skills* - *Adaptability and creativity skills* - *Pedagogic skills* - *Knowledge in risk assessment applied to energetic systems is an asset*
Location:	*Hosting Laboratory* Centre « Observation, Impacts, Energie » (O.I.E.) MINES ParisTech – ARMINES Département Energétique et Procédés SOPHIA ANTIPOLIS (06 - France) http://www.oie.mines-paristech.fr
Institution overview:	*The Center "Observation, Impacts, Energy" (O.I.E.) is a joint Research Laboratory MINES ParisTech/ARMINES that focuses on energy. It addresses the temporal and spatial issues linked to renewable energy resources as well as to the environmental impacts of energy pathways.* *MINES ParisTech trains high-level engineers and scientists since its foundation in 1783. Originally in charge of the training of civil engineers of Mines and of the Inspectors of Mines, the School has developed research and third cycle programs (specialized masters, PhDs) since the 1960s, linked to industry and international academics. MINES ParisTech is one of the founding members of ParisTech, and of PRES Paris Sciences et Lettres (PSL University)* *ARMINES is the first contractual research association in France, and was created in 1967 as an initiative of the Ecole des Mines de Paris. It focuses on industry-oriented research.* *MINES ParisTech and ARMINES are distinguished with the Institute Carnot label since 2006.*

Mission:	*Context* *Life Cycle Assessment (LCA) is a standardized method, accepted at national and international level, to evaluate the potential environmental impacts of a product or system considering its entire life cycle, ranging from the raw material extraction until its end of life (ISO 14040, 2006). Despite the global scope of the LCA method, its usual application focuses on evaluating scenarios describing average or steady state, thus not accounting for the potential environmental consequences of extreme or unlikely events. Some research has shown the relevance of combining LCA approaches to risk assessment techniques to overcome these limitations and allow environmental assessments more in line with a system's life cycle.* *The integration of LCA and risk assessment requires to account for the probability of occurrence of several scenarios specific to a system's life cycle (Sauve and Van Acker, 2021). The integration of this probability of occurrence adds complexity to the epistemic and stochastic uncertainty already influencing LCA results. These uncertainties are linked on the one hand to the operational parameters (e.g. efficiency, lifetime), which make up the "foreground" system, and on the other hand to the data found in databases aimed at representing the "background" system (e.g. uncertainties of generic data used to model ecoinvent inventories (Wernet et al, 2016)). Evaluating the effects of these different uncertainty sources on LCA results combined with the integration of the probability of occurrence of scenarios or events requires advanced statistical tools.* *Finally, the uncertainty in LCA results resulting from the combination of LCA and risk assessment is likely to make the interpretation phase, and thus, decision making based on this interpretation, more difficult. This aspect should also be considered.* *Objectives* *The objective of this thesis is to define a methodological framework for the combined application of LCA and risk assessment focusing mostly on energetic systems.* *To reach this objective, the PhD candidate will:* - *explore, from a methodological point of view, the integration to LCA of probability calculation to account for the potential environmental effects of risks associated with the operation of an energy production system;* - *propose a framework to analyze the effects of uncertainties, linked to an imperfect knowledge of the system, and variability, linked to inherent sources of variations, on environmental assessment results. The approach will account for uncertainties related to the "foreground" and "background" systems. Uncertainties of the foreground system are linked to operational parameters such as the lifetime, installed power, transport distance etc., and these of the background system are linked to the quality of the data found in LCA databases over which one has little control. For example, what is the uncertainty of the generic estimate of the background database, ecoinvent, of the electricity quantity used for the manufacturing of silicium ingots by a manufacturer prior to the production chain of a photovoltaic module?;* - *applying the methodological framework to a representative case study in the context of renewable energy systems;* - *identify the difficulties of interpretation linked to the uncertainty ranges of the environmental impact estimates, expected to be larger when combining risk assessment and LCA compared to LCA alone. Check how this approach can still support the decision-making process and suggest improvement options for this interpretation phase.* *This PhD will address the following aspects:* - *the distinction between uncertainty and variability? How can they be characterized? How sensitive are the results to the definition of the probability distributions?* - *How can one account for the uncertainties of the background processes simultaneously to the uncertainties of foreground processes? How to make definitions based on different principle compatible (e.g. definition of probability distributions from experimental data vs definition from data quality indicators following pedigree approach)?* - *How can the modeling be guided to reduce "avoidable" uncertainty?* - *How can risk assessment contribute to a more representative environmental impact assessment of energy production systems?* - *How can the results of the combination of LCA and risk assessment be interpreted, especially considering the likely (much) larger uncertainty of the results, and the decision-making support be guaranteed?* Références : - Barbeiro G, Scalbi S, Buttol P, Masoni P, Righi S. 2014. Combining life cycle assessment and qualitative risk assessment: The case study of alumina nanofluid production. Science of the Total Environment 496, 122-131. - Breedveld L, 2012. Combining LCA and RA for the integrated risk management of emerging technologies. Journal of Risk Research 16, 459-468. - ISO 14040, 2006. Management environnemental — Analyse du cycle de vie — Principes et cadre. - Jeswani HK, Azapagic A, Schepelmann P, Ritthoff M, 2010. Options for broadening and deepening the LCA

	approaches. *Journal of Cleaner Production* 18, 129-127. - Sauve G, Van Acker K, 2021. Integrating life cycle assessment (LCA) and quantitative risk assessment (QRA) to address model uncertainties: defining a landfill reference case under varying environmental and engineering conditions. *The International Journal of Life Cycle Assessment* 26, 591–603 - Wernet G, Bauer C, Steubing B, Reinhard J, Moreno-Ruiz E, Weidema B. 2016. The ecoinvent database version 3 (part I): overview and methodology. The International Journal of Life Cycle Assessment, 21(9), 1218–1230.
Application deadline:	*Deadline for application :* 20th of June 2021
Submit applications to:	*Please send a motivation letter and a CV to :* à l'attention de : Paula PEREZ-LOPEZ, Responsable des activités « impacts environnementaux » Centre O.I.E. (Observation, Impacts, Energie) MINES ParisTech - ARMINES Rue Claude Daunesse – CS 10207 - F-06904 SOPHIA ANTIPOLIS CEDEX Tél. : +33 (0)4.93.95.74.53 ou, par e-mail à : paula.perez_lopez@mines-paristech.fr
Contacts:	*Scientific and technical questions to* : Philippe BLANC, Enseignant-chercheur, DR., Responsable adjoint du département Énergétique et Procédés Paula PEREZ-LOPEZ, Enseignante-chercheure, Responsable des activités « impacts environnementaux ». E-mail : paula.perez_lopez@mines-paristech.fr *Administrative questions to* : Thierry RANCHIN, Directeur du Centre O.I.E. E-mail : thierry.ranchin@mines-paristech.fr Sandra HASSAN, Assistante administrative. E-mail : sandra.hassan@mines-paristech.fr

Internet : http://www.oie.mines-paristech.fr
Date de mise à jour de la fiche – *Last update on*: 01/06/21