# Guiding safe and sustainable technological innovation under uncertainty: a case study of III-V/silicon photovoltaics

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## Propositions

"Guiding safe and sustainable technological innovation under uncertainty: A case study of III-V/silicon photovoltaics"

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1. Innovation in photovoltaic (PV) technologies can introduce large variabilities in the expected environmental impacts of the PV sector (Chapter 2).
2. Feasible innovation pathways exist to overcome the energy intensity of III-V/silicon tandem cell manufacturing and make the cells competitive with regards to life cycle environmental performance (Chapters 3 and 6).
3. Combined and prospective application of Life Cycle Assessment and Risk Assessment indicates that III-V/silicon tandem cells can take an important role in safe and sustainable future energy scenarios (Chapters 3, 5 and 6).
4. In the face of numerous, large, and diverse uncertainties, global sensitivity analysis can guide technology developers in making robust safe-and-sustainable-by-design choices (Chapters 4 and 6).
5. Bayesian analysis offers important opportunities to refine and make ex-ante/prospective environmental assessments more transparent (Chapter 6).
6. *Safe and Sustainable-by-Design* innovation approaches need to give full consideration to the fallibilities and ubiquitous uncertainties inherent to the research and development process. Assessment models should fully illuminate - rather than mask- potential points of contention among technology specialists and the technologies' stakeholders at large (Genus & Stirling, 2018).
7. Sensitivity analysis is essential to bridge the gap between decision makers (that often do not directly develop or work with the model) and analysts (who work directly on the model) (Borgnovo & Plischke, 2016). Complex models and large amounts of information can then be more readily translated into meaningful actions.
8. Since forecasts go wrong more often than not, it may be legitimately asked whether there is a point in making prospective models. But their value lies in helping us understand how different factors can shape the future so that we can plan accordingly (Chase, 2019).
9. As the information age puts more and more information at our disposal, it becomes more difficult to find meaning in it (Beaudrillard, 1981).
10. Uncertainty in the presence of vivid hopes and fears is painful but must be endured if we wish to live without the support of comforting fairytales (Russell, 1945). We must therefore learn how to take decisive action in spite of irreducible uncertainties.
11. Planet Earth is blue and there is nothing I can do (Bowie, 1969).