European Commission

Science for Environment Policy

New tool assesses the life-cycle impact of emerging technologies — despite data gaps

Researchers use life-cycle assessment (LCA) as a tool to evaluate the environmental impact of products and technologies across their entire lifetime — from extraction of raw material to end-of-life (disposal or recycling). It is challenging to apply the conventional LCA method to new or emerging technologies, however, due to the sheer quantity of data needed for such studies. This study proposes a screening-to-LCA method that uses available data to systematically evaluate the performance of such technologies, and support the uptake of those that are most environmentally sustainable.

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Source: Hung, C. R., Ellingsen, L. A-W & Majeau-Bettez G. (2018). LiSET: A Framework for Early-Stage Life Cycle Screening of Emerging Technologies. *Journal of Industrial Ecology*. DOI: 10.1111/jiec.12807.

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While the European Commission supports LCA as the best framework for assessing a product's potential impact on the environment, it has called for more consistent data and a consensus on the best way to practice, apply, and interpret LCA methodologies across Member States. These are goals of the Commission's European Platform on Life Cycle Assessment, which targets open communication and data sharing for business and government.

Strategies for streamlined or 'screening' LCAs, which are 'slimmed down' or offer a quick initial overview of a product or technology, have been proposed before, but have been criticised for lacking the transparency and consistency needed for large-scale analysis of products or technologies with sparse data or at early stages of development. Early-stage candidates, such as those at lab scale or design phase, benefit most from comprehensive environmental assessment early in their development — but this is precisely when data is most lacking.

The Lifecycle Screening of Emerging Technologies (LiSET), is a new method, proposed in the study, to assess new technologies as they develop, and to facilitate later progression to a full LCA, if desired.

LiSET brings together quantitative measurements, qualitative descriptions and estimates, and presents results in a matrix-style table with an assigned 'traffic light' colour grading based on performance and sustainability. The format considers numerous environmental aspects and is well suited to the high uncertainty inherent in assessing new products and technologies, as it uses a decomposition analysis (breaking down a technology's life cycle into a number of individual contributors to environmental impacts) and data not traditionally used in full LCAs (such as qualitative data or those derived from expert judgement rather than observation).

LiSET comprises four key steps to be repeated as the product or technology matures:

- **identification of environmental impact sources** from both the technology and its value chains, tailored to the technology and its development stage via a decomposition analysis;
- **translation of these into evaluable metrics** — so-called 'life-cycle aspects' — according to the available data and distinguishing between intrinsic and extrinsic aspects (those immutable aspects inherent to the technology itself, or those depending on the value chain design that may be altered, respectively);
- **evaluation of these aspects and assigning of a colour grade** based on a traffic-light system — green (advantageous), yellow (intermediate) and red (poor). Criteria with a lack of data are left blank;
- **iteration of the assessment across the candidate's entire life cycle**, thereby increasing the completeness, resolution, robustness, and precision of the data and screening.

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A fifth step is progression from LiSET to a full or streamlined LCA, as the LiSET matrix matures alongside the product or technology (and, for instance, amasses sufficient data to evolve to quantitative inputs).

The method presents the individual strengths and weaknesses of a technology, highlighting trade-offs and areas of improvement. It also notes areas in which data are insufficient, without influencing the final evaluation (as is the case in some numerical scoring systems), and tailors metrics to the specific technology and available data.

While LCA aims to comprehensively assess multiple environmental impacts, say the researchers, LiSET aims to quickly map a large number of new products and technologies and pinpoint hot-spots of damage to human health, ecosystems and resource availability. The researchers describe the method as iterative in nature — new data, drivers and strategies can be added over time to reduce the uncertainty of the assessment for a given product or technology — so it can grow alongside a product or technology as it develops and matures.

Tools, such as LiSET, that are geared towards assessing early-phase technologies will help the investigation of novel technologies in order to identify those that are most promising, and guide further research towards minimising their environmental impact.