

Dynamic Environmental Impact Study during the Construction of the French Nuclear Power Plants

Authors : A. Er-Raki, D. Hartmann, J. P. Belaud, S. Negny

Abstract : This paper has a double purpose: firstly, a literature review of the life cycle analysis (LCA) and secondly a comparison between conventional (static) LCA and multi-level dynamic LCA on the following items: (i) inventories evolution with time (ii) temporal evolution of the databases. The first part of the paper summarizes the state of the art of the static LCA approach. The different static LCA limits have been identified and especially the non-consideration of the spatial and temporal evolution in the inventory, for the characterization factors (FCs) and into the databases. Then a description of the different levels of integration of the notion of temporality in life cycle analysis studies was made. In the second part, the dynamic inventory has been evaluated firstly for a single nuclear plant and secondly for the entire French nuclear power fleet by taking into account the construction durations of all the plants. In addition, the databases have been adapted by integrating the temporal variability of the French energy mix. Several iterations were used to converge towards the real environmental impact of the energy mix. Another adaptation of the databases to take into account the temporal evolution of the market data of the raw material was made. An identification of the energy mix of the time studied was based on an extrapolation of the production reference values of each means of production. An application to the construction of the French nuclear power plants from 1971 to 2000 has been performed, in which a dynamic inventory of raw material has been evaluated. Then the impacts were characterized by the ILCD 2011 characterization method. In order to compare with a purely static approach, a static impact assessment was made with the V 3.4 Ecoinvent data sheets without adaptation and a static inventory considering that all the power stations would have been built at the same time. Finally, a comparison between static and dynamic LCA approaches was set up to determine the gap between them for each of the two levels of integration. The results were analyzed to identify the contribution of the evolving nuclear power fleet construction to the total environmental impacts of the French energy mix during the same period. An equivalent strategy using a dynamic approach will further be applied to identify the environmental impacts that different scenarios of the energy transition could bring, allowing to choose the best energy mix from an environmental viewpoint.

Keywords : LCA, static, dynamic, inventory, construction, nuclear energy, energy mix, energy transition

Conference Title : ICEIAM 2019 : International Conference on Environmental Impact Assessment Methods

Conference Location : Amsterdam, Netherlands

Conference Dates : November 04-05, 2019