Life cycle assessment (LCA) of electricity generation technologies: Overview, comparability and limitations - DTU Orbit (23/04/2019)

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Electricity generation is a key contributor to global emissions of greenhouse gases (GHG), NOx and SO2 and their related environmental impact. A critical review of 167 case studies involving the life cycle assessment (LCA) of electricity generation based on hard coal, lignite, natural gas, oil, nuclear, biomass, hydroelectric, solar photovoltaic (PV) and wind was carried out to identify ranges of emission data for GHG, NOx and SO2 related to individual technologies. It was shown that GHG emissions could not be used as a single indicator to represent the environmental performance of a system or technology. Emission data were evaluated with respect to three life cycle phases (fuel provision, plant operation, and infrastructure). Direct emissions from plant operation represented the majority of the life cycle emissions for fossil fuel technologies, whereas fuel provision represented the largest contribution for biomass technologies (71% for GHG, 54% for NOx and 61% for SO2) and nuclear power (60% for GHG, 82% for NOx and 92% for SO2); infrastructures provided the highest impact for renewables. These data indicated that all three phases should be included for completeness and to avoid problem shifting. The most critical methodological aspects in relation to LCA studies were identified as follows: definition of the functional unit, the LCA method employed (e.g., IOA, PCA and hybrid), the emission allocation principle and/or system boundary expansion. The most important technological aspects were identified as follows: the energy recovery efficiency and the flue gas cleaning system for fossil fuel technologies; the electricity mix used during both the manufacturing and the construction phases for nuclear and renewable technologies; and the type, quality and origin of feedstock, as well as the amount and type of co-products, for biomass-based systems. This review demonstrates that the variability of existing LCA results for electricity generation can give rise to conflicting decisions regarding the environmental consequences of implementing new technologies.

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