Global Warming Effect Assessment in the Electricity Sector Using Hybrid Life-cycle Inventory Assessment

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The global warming effect (GWE) calculation utilizes global warming potential (GWP) factors applied to results from life-cycle inventories. This presentation demonstrates the application of GWE to a comparison of renewable and non-renewable electricity generation options: wind, hydro, solar, coal, and natural gas power plants. The inventory includes the direct and supply chain emissions from construction, burning of fuels, flooded biomass decay in the hydroelectric plant's reservoir, loss of net ecosystem production (NEP), and maintenance of the power plants. Land use by these facilities is also assessed. The inventory assessment uses a combination of process-based (SETAC-EPA-ISO) and economic input-output analysis-based LCA. Such a hybrid LCA method allows for an integration that enhances the advantages and reduces the disadvantages normally observed in an LCA. All power plants reflect U.S. conditions, and have been scaled and co-located so that a comparison becomes appropriate. The results indicate that a wind farm and a hydroelectric plant in an arid zone (such as the Glen Canyon Dam on the Colorado River) have lower GWE than the other electricity technologies. The type of ecosystem displaced by the reservoir and the period of analysis is fundamental to the assessment of the alternatives. Sensitivity analysis includes the periodic upgrades that power plants are put through, as well as ecosystem variations for technologies where NEP is important: hydropower plants (reservoirs) and solar farms. After 20 years of operation, the upgrade of the Glen Canyon hydropower plant (in 1984) increased the power capacity by 39%, and resulted in a mere 1% of the CO_2 emissions in comparison with the initial construction effects. No additional emissions from the reservoir occurred, making a periodic upgrade an important action for a hydropower plant.