
ABSTRACT

Energy security is key determinant for economic growth, automation, and modernization. This study was aimed to analyze the environmental and economic assessment of two types of distribution transformers i.e., 200 kVA conventional, and smart distribution transformer. Life Cycle Assessment (LCA) methodology has been used for impact quantification in three life cycle stages, production, use and end-of-life phase of both the transformers. Functional unit of 200 kVA power distribution capacity of the distribution transformer with 70% load was selected for impact analysis. Eight impact categories were selected and evaluated, and the highest impact scores were observed in Climate Change Potential, Fossil Resource Scarcity, Human Toxicity Potential and Terrestrial Acidification for both the transformers. The conventional transformer contributed $5.04\text{E}+04$ kg CO₂ eq., $1.50\text{E}+04$ kg oil eq., $6.23\text{E}+03$ kg 1,4-DCB eq., $1.88\text{E}+02$ kg SO₂ eq., respectively. While the smart transformer had impact contribution of $3.78\text{E}+04$ kg CO₂ eq., $1.20\text{E}+04$ kg oil eq., $5.11\text{E}+03$ kg 1,4-DCB eq., $1.65\text{E}+02$ kg SO₂ eq., respectively. The highest impact contributing life cycle phase of conventional transformer was the use phase while the smart transformer had the highest impact contribution in the production phase. In the second part, a comprehensive economic analysis was conducted for both types of distribution transformers using the Cost-Benefit Analysis (CBA) approach. The results concluded that the smart transformer accounts for 70% cost savings during the use phase. The smart transformer presents a promising economic scenario with 9% higher Net Present Value (NPV), 2% more Internal Rate of Return (IRR) and a higher B/C ratio in comparison to the conventional technology. It has a 3-year less Payback time than the conventional technology. This study presents a real time, scientific energy management scenario. This will assist transformer manufactures, utility companies and energy concessionaires to expand their knowledge and will enable them in decision-making and environmental impact mitigation.