# Analysing life cycle climate change impact savings by battery energy storage systems in the UK

Battery energy storage systems are essential to increase the proportion of renewable electricity in electricity mix due to intermittency of renewable resource electricity supply. The role of battery energy storage systems is diverse including shaving off peak demand reducing fossil electricity generation and electricity import, stabilising grid electricity and increasing reliability, security and efficiency of electricity sector. Battery energy storage systems also save maintenance of grid and electricity transmission and distribution systems. Its critical role has been identified in ancillary, transmission, distribution and customer services, to optimise an overall energy network. However, there is no data available in literature on environmental impact saving or energy saving by each service of battery energy storage systems. Thus, the global warming potential impact saving by battery energy storage systems in the UK can only be estimated from increase in renewable resources in electricity mix. It has been observed that without battery energy storage systems, upto 20% by energy penetration of renewable electricity in a grid electricity system is possible. Evidently, excess of 20% by energy contribution from renewable electricity is due to battery energy storage systems, resulting in overall environmental impact savings. Between 2017 and the first quarter of 2019, in the UK, renewable electricity makes up 27-35% by energy of grid electricity mix. Thus, 7-15% of renewable electricity are due to battery energy storage systems. From the known proportions of the various UK grid electricity resources and their life cycle global warming potential impact factors, the excess of 20% by energy contribution from renewable electricity can be translated into a global warming potential impact saving of 11.5-18 MMt (million tonne) $CO_2$ equivalent per annum. Distinctly, this saving is due to the implementation of battery energy storage systems in the UK. Furthermore, this comprehensive life cycle assessment based study establishes the key indicators, such as, a global warming potential impact of 0.524-2.9 kg $CO_2$ equivalent per kWh electricity provision of battery energy storage systems in the UK, depending on whether lithium or the battery pack is taken as the basis and global warming potential impact factors of the UK electricity resources and technologies. In addition, Impact 2002+ life cycle impact assessment methodology relevant for Europe has been applied for overall ranking of the UK renewable electricity resources, taking resource use, climate change, ecosystem quality and human health impacts into account. These are hydro, wind, solar and bioenergy in increasing order of overall environmental impact score. Within each system, renewable resources and battery energy storage systems, environmental impact hotspots have been identified. This study also comprehensively analyses global warming potential impact savings by battery energy storage systems across whole electricity systems in both attributional (constrained supply of renewable resources) and consequential (unconstrained supply of renewable resources) scenarios. Emergence of battery energy storage systems can enable decarbonisation of the UK electricity sector by 90%.

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