SPACE POWER SYMPOSIUM (C3)
Space-Based Solar Power Architectures / Space & Energy Concepts (1)

Author: Dr. Thijs Versloot
European Space Agency (ESA), The Netherlands

Dr. Daniel Hennes
ESA, The Netherlands
Dr. Leopold Summerer
European Space Agency (ESA), The Netherlands

OPTIMISING A GLOBAL RENEWABLE ENERGY GRID – ROLES FOR SPACE

Abstract

Environmental awareness, energy import dependency and technological progress have led to a solid movement to gradually change the energy mix from fossil fuel dependency towards higher levels of renewable energy sources (RES). The European Commission has placed a target of 20% renewable energy by 2020 and committed in 2011 to reducing greenhouse gas emissions to 80-95% below 1990 levels by 2050 in an ambitious "decarbonisation objective". Various research projects are carried out to investigate the feasibility of achieving contributions from renewable energies up to 50% and even 100% in both national and continental zones. An essential and enabling element for such high renewable shares over large areas are so-called 'SuperGrids' or wide area energy transmission networks. Different concepts of such a grid are proposed and studied (e.g. Desertec, Europagrid). The next step for such a grid would be to expand to connect continents and finally towards a global interconnected grid.

One of the main benefits for establishing a global grid is the smoothing of the hourly electricity demand. Only a small variation remains due to the non-homogenous spatial distribution of population areas. In addition, a global coverage of interconnected RES has the effect of averaging out their inherent intermittency. As a whole, the reduction in mismatch between supply and demand could lower the requirements on the level of local energy storage.

Obviously, such a widespread network would require, beyond a large-scale infrastructure, also robust demand management and load levelling control. The choice of the spatial infrastructure relies on the exact time variation in both the electricity demand and the temporal nature in the supply. Operating such a grid will depend on accurate forecasting based on earth observation data, for example, cloud coverage, solar irradiance and wind speeds.

This study focuses on optimizing a potential global grid infrastructure by minimizing the storage capacity required, spatially distributed renewable energy sources and the total interconnection length between zones. By combining earth observation data with demand figures from electrical grid operators, an assessment is made on the hourly grid load. Using a multi-objective optimisation technique, we determine the topology and location of possible RES sites within a feasible green global grid. This results in requirements for future earth observation data, in particular key temporal and spatial RES-relevant climate variables and a best estimate concept for comparison with alternative, global integrated space and earth renewable energy systems.