Grid parity of solar energy: imminent fact or future's fiction

S. Papaefthimiou[a,*], M. Souliotis[b], K. Andriosopoulos[c]

[a] School of Production Engineering and Management, Technical University of Crete, 73100 Chania, Greece
[*] corresponding author

[b] Department of Mechanical Engineering, University of Western Macedonia, 50100 Kozani, Greece

[c] ESCP Europe Business School, 527 Finchley Road, London NW3 7BG, UK

Solar energy is the major exogenous energy source for our planet, and it can practically sustain the global primary energy needs. The most developed and promising technologies for practical exploitation of solar power are photovoltaics (PV) and concentrating solar power (CSP) systems. In both systems solar energy is converted into electricity: in the former directly through a semiconductor based device, while in CSP systems concentrating mirrors focus sunlight onto a receiver to produce electricity through a proper thermal conversion cycle. The debate around the potential development of PV and CSP has focused on high up-front investment costs, while the major questions have been when these technologies will become cost competitive compared to their fossil fuels counterparts, and which actions or policies would be necessary in order to facilitate this. A large part of PV or CSP generated electricity occurs during the summer noon hours, thus they coincide almost perfectly with utility system peak demand, while virtually all electricity generation is during the daylight hours when utility demands and costs are highest. Thus, the actual generation benefits of solar technologies are significantly higher than what a simple average comparison of electricity prices would suggest. In addition to higher production and investment costs, solar systems also entail a number of additional challenges mainly due to the need to upgrade the electricity grid to deal with dispersed and intermittent production. The rapid growth of the studied technologies in recent years is mainly due to favored policy actions. In order to sustain this trend, either the economic viability of the produced electricity needs to be proved or governments will have to continue providing financial incentives and prohibit regulatory barriers.

This paper evaluates the potential of both PV and CSP technologies to provide economically viable electricity generation, either nowadays or in the short term future. This is pursued through a methodological analysis of the current cost of electricity produced through PV and CSP, based on experience curves for both technologies and the respective grid parity thresholds by year 2030. The concept of grid parity has emerged as a key competitiveness indicator and refers to the time that the prices of the electricity generated by an alternative energy system and those of conventional electricity production intersect. The Levelized Cost of Electricity (LCOE) represents the minimum price per kWh that an electricity generating plant would have to obtain in order to break-even on its investment costs over the entire life cycle of the facility. In general the LCOE of a renewable technology depends significantly on specific investments, local conditions, operating costs, operational life of the power plant and financing conditions.

The estimated LCOE and grid parity values for PV and CSP by 2030 showed that regions with high solar irradiation and high electricity prices will reach grid parity first, whereas regions with high electricity prices and moderate solar irradiance will quickly follow. Islands show early grid parity events all over the world due to the high electricity generation costs as a consequence of use of highly priced oil-fired power plants. For the EU region, early grid parity events have already been noticed in Cyprus, Italy and parts of Spain. At the end of this decade, more than 80% of market segments in Europe are expected to be beyond residential grid parity. For CSP, expectations are rather different as special requirements occur mainly due to the need for larger areas with specific climatic conditions (e.g. dry atmosphere, increased solar potential, etc), and such areas are rare in Europe (only in southern Spain).

In order to sustain the evolution of solar technologies, policy actions on both global and national levels may be required. Further policy support would incentivize investments to innovations to improve the learning potentials in the field of PV and CSP technologies. Location-specific actions are necessary as several areas around the world (mainly countries close to the equator) exhibit increased solar energy potential, which is crucial to be targeted and deployed through large scale projects.