Energy Strategies to Power Our Future

Session Co-chairs: Katherine Dykes, National Renewable Energy Laboratory, and Jeremy Munday, University of Maryland

Power consumption is a good proxy for quality of life, and as a society, we currently consume about 18 TW globally. Over 60% of our power is currently derived from fossil fuels. In many countries, there has been an increasing use of renewable energy due to national policies that seek to increase energy security and decrease the environmental footprint of the energy sector as well as the decreasing costs of renewable energy. In this session, we aim to address the question, “how will we power our future?” The answer will likely be multi-faceted and involve not only power generation and storage, but also new grid technologies, as well as transportation electrification.

Over the next few decades, new power generation technologies will be deployed at a large scale to match power demand with the lowest cost and environmental impact. As a resource, solar power is abundant (>10^5 TW at the earth’s surface); however, it only makes up about 1% of the US electricity generation. Challenges to widespread adoption include a need for reduced cost, improved efficiency, and storage solutions over a range of time scales (hourly to seasonal). For wind energy, a substantial US market has developed and wind now supplies nearly 6% of the US electricity demand. However, the complexity of mesoscale flow as it makes its way down and through the plant, transforming into electricity as it goes, involves many open research challenges. Both solar and wind energy provide significant promise to becoming a prominent source of electricity generation. However, the variable nature of these resources means that our current grid system needs to adapt as solar and wind energy are added. This situation necessitates substantial technology innovation to transform the grid to support high levels of variable generation. Not only that, the grid of the future is likely to support a significant amount of electric transportation on the distribution side. The transportation sector consumes nearly 30% of the US energy production, with 90% coming from fossil fuels. Electrification would result in a significant reduction of petroleum use; however, it also has consequences for the grid in terms power generation and distribution. Concurrently, new opportunities also arise in terms of storage and new grid technologies as large numbers electric grid evolves for this future with high renewable penetration and dynamic distribution systems.

The first speaker, Tim Heidel (National Rural Electric Cooperative Association), will set the stage by discussing “deep decarbonization” and what it will take for moving from a carbon-rich energy system to one that is dominated by renewable energy. This will require substantial changes to how electric power systems are planned and operated. The talk will describe technologies emerging from the research community that promise to improve real time grid state awareness, achieve more robust control over power flows, and enable comprehensive approaches to power system optimization. In combination, these nascent tools could significantly accelerate the full realization of the benefits offered by new energy resources. Next, Bouchra Bouqata (GE Global Research Center) will discuss how the merger of advanced physical models for wind energy with big data and analytics will enable a next generation of wind plants with substantially reduced cost of energy – increasing the competitiveness of wind with fossil fuels even at very low cost levels. Mariana Bertoni (Arizona State University) will talk about how imaging and machine learning will help design tomorrow’s energy conversion devices. Khurram Afridi (University of Colorado Boulder) will discuss wireless power transfer that allows self-driving vehicles to be fully autonomous. He will describe the state of the art for stationary and dynamic wireless power transfer or electric vehicles and identify the challenges in terms of performance, cost, and safety that need to be overcome for wireless power transfer systems to be widely adopted.