

## Conference “From Light Bulbs to Smart Grids: The Past, Present and Future of the Electricity System”

**Date:** 26/02/2015

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### Curriculum vitae

Barry is a native of Waterford, Ireland, and was educated at University College Cork, where he received the Bachelor degree in Electrical and Electronic Engineering in 2005. He worked as an engineer for Intel at their European headquarters near Dublin from 2005 to 2009, and also received a Master degree from the National University of Ireland Maynooth during this time.

He later received a scholarship from the UK Research Council to study at the University of Edinburgh, Scotland, where he completed his Ph. D. in 2013. During his doctoral thesis, he studied the integration of renewable energy sources into electrical transmission grids, and the development of new grid services through the management of distributed generators and electrical demand. As part of his Ph. D. studies, he spent time as a visiting researcher at National Grid, in the UK transmission grid control centre near London. He has also worked as a Research Fellow at the University of Edinburgh on several projects related to electrical power systems.

In 2013, Barry joined the Instituto Madrileño de Estudios Avanzados en Energía (IMDEA Energy) as a postdoctoral researcher, where his research is part-funded by the EU Marie Skłodowska-Curie mobility programme (FP7-COFUND). His work at IMDEA is focused on developing new tools and services for the operation of smart electrical grids. He has published more than 15 peer-reviewed papers in the area of electrical power systems, and has presented his research at international conferences in Europe and the United States. He is a member of the IEEE Power and Energy Society, and a founding member of the Marie Curie Alumni Association Spain and Portugal Chapter. In his spare time he enjoys travel, music, and playing Gaelic football.

## **From Light Bulbs to Smart Grids: The Past, Present and Future of the Electricity System**

Dr. Barry Hayes

Instituto Madrileño de Estudios Avanzados en Energía (IMDEA Energy)

Electricity is fundamental to modern life. It has become an essential part of almost all of our economic, industrial and domestic activities. We have reached a point where we now have a safe, efficient supply of electrical energy available to us at all times, with a reliability of electrical supply greater than 99.999% in most developed countries. Electricity is delivered to us at the speed of light, and is consumed in the same instant that it is created. When we plug in or switch on an appliance, we do not think about the many decades of scientific discovery and engineering advances which have made this possible. This talk will tell the story of one of the greatest technological achievements of our age: the electrical grid, and will describe its past, present and future.

We will begin by discussing the origins of the first interconnected electricity systems, or “grids”. These pioneering systems allowed electricity to be generated in large quantities and sold commercially, bringing light to the dark nights in cities such as New York and Paris for the first time. We will discuss the “War of the Currents”, the battle between two competing electricity technologies, the DC system of Thomas Edison and the AC system of Nikola Tesla, and which technology won and why. We will then move on to talk about the present electrical grid, explaining how it works, and also what happens when it goes wrong, for example, the largest blackout in North American history which occurred in 2003, or the European blackout in 2006 which affected customers across the continent, from Portugal to Poland.

The final, and most important, part of this talk will deal with the challenges facing the electricity system as we look towards the future. Climate change and concerns around pollution are forcing us to move away from an energy system based on burning fossil fuels to a system which relies on clean, renewable sources of energy, such as wind and solar. This requires us to completely re-think how we design, control, and manage the electrical grid, and represents the biggest change to the electricity industry since the early 20th century. In addition to renewable energy, other new technologies being connected to the grid: smart meters, intelligent buildings, electric vehicles, and energy storage. These new technologies are changing the way that we use electricity, and creating new opportunities for electricity users to increase their energy efficiency and participate in the operation of the grid. We will discuss some of challenges that we face in developing an improved, “smarter” electrical grid. There are huge technical and engineering challenges, but also economic challenges, such as creating new markets and financial incentives, and social challenges, such as encouraging electricity consumers to change their behaviours.

## Vocabulary

Electricity Grid	Electricity Distribution	Smart Grid
Direct Current	Blackout	Smart Meter
Alternating Current	Climate Change	Energy Storage
Electricity Generation	Renewable Energy	Electricity Markets
Electricity Transmission		

## Further Reading

- “Sustainable Energy – Without the Hot Air”\*, D. Mackay, ISBN-13: 978-0954452933, Uit Cambridge Ltd., 2009.
- “Power Systems Analysis”, J. Grainger and W. Stevenson, ISBN-13: 978-0070612938, McGraw-Hill, 1994.
- “Power Generation, Operation and Control”, A. Wood, B. Wollenberg, and G. Sheble, 3rd. Ed., ISBN-13: 978-0471790556, Wiley, 2013.
- “Final Report - System Disturbance on 4 November 2006”, UCTE, [Online]: [https://www.entsoe.eu/fileadmin/user\\_upload/\\_library/publications/ce/otherreports/Final-Report-20070130.pdf](https://www.entsoe.eu/fileadmin/user_upload/_library/publications/ce/otherreports/Final-Report-20070130.pdf)
- “Edison vs. Tesla”, U.S. Department of Energy, [Online]: <http://energy.gov/edison-vs-tesla>
- “What is the Smart Grid”, U.S. Department of Energy, [Online]: [https://www.smartgrid.gov/the\\_smart\\_grid](https://www.smartgrid.gov/the_smart_grid)
- “What if Everything Ran on Gas?” Nissan Leaf Television Commercial, [Online]: <https://www.youtube.com/watch?v=pCs8B-TlylY>

\* *Un ejemplar de este libro será sorteado al finalizar la conferencia entre los asistentes a la misma.*