Objectives of the workshop

The objectives of the workshop include:

- Discuss the practical application of complex science to energy (electric) systems within a broader context including economic shifts and volatility, consumer behaviour, weather and climatic uncertainty, and the growing need to address climate adaptation including emergency response, and to propose a path toward the application of complexity science through research and explicative applications;
- Verify current developments in related fields;
- Analyse the links/synergies among different approaches;
- Consider the possibility of establishing a working group of experts, research institutions, stakeholders, policy decision makers with different backgrounds and expertise ranging from social sciences to power systems, from ICT to economic, sharing the same systemic view of the problems;
- Discuss the usefulness of collaborative projects.

Scientific Committee

Marcelo Masera
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Stephen R. Connors
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Participation

By invitation – Registration required

For more information on the workshop including registration, please contact Anna Mengolini (anna.mengolini@ec.europa.eu)

Organised by JRC, IET Energy Security Unit, Smart Electricity Systems Action
http://ses.jrc.ec.europa.eu

European Commission

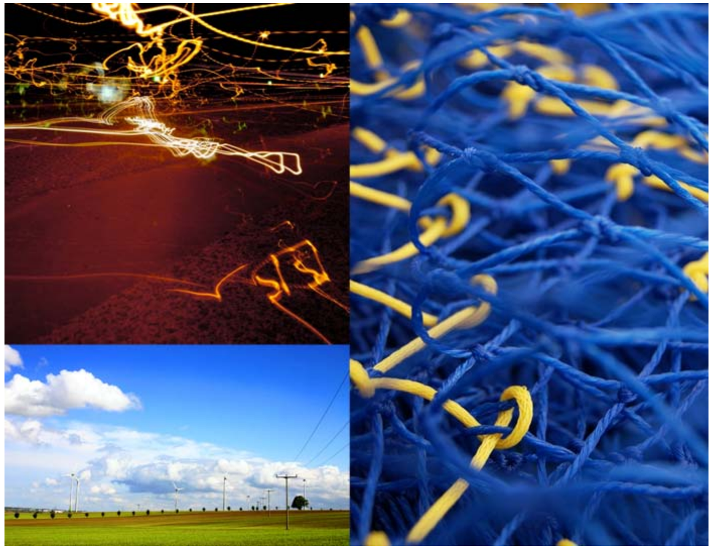
Workshop

Smart Energy Grids and Complexity Science

25 June 2012
Joint Research Centre - Institute for Energy and Transport
Petten, the Netherlands

Organized by

Joint Research Centre, Institute for Energy & Transport
Massachusetts Institute of Technology, Energy Initiative
Politecnico di Torino, Energy Department
University of Cambridge, Electricity Policy Research Group



Background

Growing concerns over energy sustainability, security of power supply, and market competitiveness—and the resulting need to integrate increasing shares of renewable energy and dispersed energy resources—are impacting the energy system operation and architecture.

Smart energy grids represent one of the key means for the decarbonisation and decentralisation of the electricity system. Their implementation will change the way we live our lives and interact socially and culturally. In this scenario, the business and social actors in the energy landscape will need to dramatically adapt their behaviours, strategies and means of producing, delivering, storing, and consuming energy.

The existing paradigm of passive distribution and one-way communications and power flows from large suppliers to final consumers will be replaced by an active distribution paradigm. In the future, smart grids—enabled by pervasive information and communication technologies (ICT)—bidirectional communication and power exchange between suppliers and consumers will be established. Many end-users will become independent *prosumers*, interacting within a physically constrained network through various ICT systems.

A smart energy grid is not only a diverse set of dynamic, distributed energy suppliers, it is also an energy system which connects smart (i.e., responsive, energy efficient, and variable) users to smart (i.e., low carbon, renewable) energy sources. And the grid itself is smart whenever it is able to modify its output, and able to monitor, control and meter the energy demands of consumers in a regulated and fair way.

In many ways, the concept of the smart grid can be extended to other (virtual and physical) complex networks characterising the urban environment, such as the transport of water, fuels, wastes, passengers and packages. Which of the aspects of complexity science, characterizing a smart energy grid, could also be applied to these other networks?

Challenge

Smart grid design and implementation needs to be coupled with broader social and cultural considerations in order for smart grids to be successful. Indeed, while smart grids need to be studied and understood as complex techno-socio-economic systems with multiple physical, cyber, social, policy, and decision making layers, these layers also interact with changing *external* conditions (economic cycles, technological innovation, and prevailing and changing weather and climatic conditions). Many actors interact within this broader "system of systems", such as prosumers, distributors, retailers, brokers, regulators and policy makers. They act via distributed decision making processes which impact the physically constrained network via diverse electronic means (from control and command systems to smart meters).

The complexity of the smart grid system rests on the multiplicity of interacting players that operate with and within a defined environment as independent decision makers, with autonomous behaviours, goals and attitudes. These broader socio-technical networks form a community with high levels of interaction and integration among its actors.

While much research has looked at the purpose and functionality of smart grid systems, smart grids themselves are one system in a "system of systems". As such, complexity is not just an attribute of the smart grid alone, but also the systems interacting with it. For example, the increasing complexity of weather and climate, the increased complexity of social behaviour and the interaction of individuals guided by narrow economic rationality, the complexities of crisis management and emergency response (including the need to envisage and militate against such events and risks), and the overall organisational structure needed to manage all those complexities, must all be studied and modelled to adequately meet the emerging challenges to modern society.

In this context, in order to understand the complexity of future smart grids, there is the need to move focus and attention from a component oriented to an interaction oriented view of the electric power system. The goal of this systemic understanding is to identify tools and techniques for optimal decision-making that will enable society to achieve its energy, environmental, economic and social goals. The framework that should be developed will enable the identification of emerging problems and will provide new solutions and approaches.

Main research questions

The research questions that the workshop aims to address are:

- Can complexity sciences help in understanding, modelling and simulating the emerging smart grid environment within a broader sustainability context including changes in economies, consumer and social behaviour, and climate variability and adaptation?
- Can sound policy decision making be based on theoretical models and simulation tools derived in the framework of dynamic multilayer interacting complex systems?
- How can the multi-layered, multi-actor energy system satisfy economic, environmental, security and social requirements? (The lessons learned from complex systems, social sciences and advanced ICT tools can help in answering these questions.)

- How might future energy systems be affected by different threats and risks? How can complexity science help in better addressing those threats and risks?
- How can future technological and social changes be anticipated, managed and integrated in policy and decision making? How can complexity science help in addressing these socio-technical challenges?
- What is the role played by "contextual" complexity due to the social environment, climate scenarios etc.? How can we properly to address such complexity?