FUTUREGRID
an australian research collaboration

futuregrid.org.au

Transmission

No.2 January 2014

Collaboration is the key

Collaboration between the universities and industry is an essential aspect of the Future Grid Research Project. It ensures the research addresses the major areas of concern for the energy industry moving into the future. It also ensures the findings are applicable in the real world and will work at a national level.

An Industry Reference Group (IRG) has been established. The initial meeting of the IRG, university project leaders and lead researchers was convened on Thursday, 19 September 2013 at the University of Sydney. The IRG is comprised of industry stakeholders, encompassing the east coast of Australia, South Australia and Tasmania and provides a whole of system expertise. The group will continue to meet formally at regular intervals to discuss research strategies and share information and insights about the electricity (and gas) transmission and distribution sectors. In addition informal communication throughout the project will ensure the team maintains critical and creative thought about how these sectors could and should develop in the future.

The initial meeting consisted of presentations on the four project areas: Power & Energy Systems Modelling & Security, Grid Planning & Co-Optimisation, Economic & Investment Models for Future Grids and Robust Energy Policy Frameworks. Discussion covered the challenge of the large range of possible modeling scenarios, and thus the need to limit the number without being too restrictive. The focus of project two was defined as planning gas and electrical networks to optimize energy supply for future demand. Various benchmarking models were also considered.

The collaborative effort of the Future Grid research will build upon the work previously undertaken by the CSIRO-led Future Grid Forum (FGF). The FGF united electricity generators, transmission and distribution network operators, energy retailers, end-user customer representatives, regulators and governments to map out future scenarios for the Australian electricity system. Their final **report** (csiro.au/future-grid-forum) was released on the 6 December 2013.

Further information on the Future Grid Cluster research, including how to subscribe to Transmission, is available from **futuregrid.org.au** or contact :

Danielle Turner
E danielle.turner@sydney.edu.au
T +61 422 973 082

Welcome to Transmission

Welcome to the second edition of Future Grid's newsletter, our quarterly newsletter for clients, research partners and others who are interested in the Future Grid cluster research.

The IRG members are:

Mr Stephen Clark
Executive General Manager, System Planning, Transgrid

Mr Paul Dunn
Director, Network Operations & Development, Australian Energy Regulator

Mr John Gaskell
Director, Electrical and Information Engineering Foundation, University of Sydney

Mr Tim George
Queensland Regional Manager, DIgSILENT

Mr Rainer Korte
Executive Manager Asset Management, ElectraNet

Dr Ashok Manglick
Consultant, Manglick & Associates

Mr Frank Montiel
Manager, National Planning, Australian Energy Market Operator

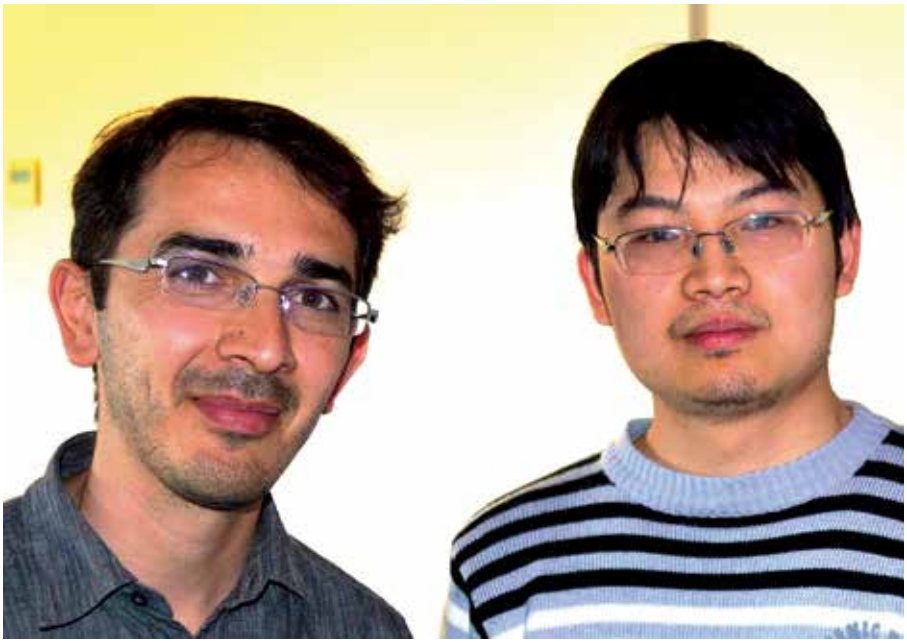
Mr Tim Nelson
Head of Economics, Policy & Sustainability, AGL

Dr Colin Parker
Consultant, formerly with Transgrid

Dr John Sligar
Consultant, Sligar & Associates

Mr Wayne Tucker
General Manager, Transmission Operations, Transend Networks

CSIRO · The University of Sydney · The University of Newcastle Australia · The University Of Queensland Australia · UNSW Australia



Left: David Hill
Right: Dr Rajab Khalilpour and Dr Guo Chen

Technical Nous and Systems Thinking to tackle Complexity: USyd

Ambition, excellence and engagement are key words for the research team from The University of Sydney (USyd). Professor David Hill is a globally recognised authority in systems engineering. Along with lead researchers Doctors Guo Chen and Rajab Khalilpour, he is inspired by the calibre of researchers on the Future Grid project and partnering with industry in a challenge of global significance.

Prof David Hill

"The Future Grid Research project is something truly world class and unique." High praise from David Hill, a world leader in systems engineering, who maintains senior academic appointments in Hong Kong and Sydney and is an elected fellow of engineering academies and institutes in Australia, Sweden, Russia and the USA.

David sees many parallels between Australia's and China's energy challenge. "China is seeking to reduce its environmental impact and improve reliability over large distances. However the difference in scale between the two countries is vast. China have been growing their power generation capacity at about the rate of Australia's total capacity each year." Despite the huge difference in scale David relishes being part of the Future Grid project as the research outcomes may well be transferable to other countries.

One of the main attractions of working overseas, particularly for extended periods in California and Sweden, was having the opportunity to work with those at the forefront of their field and being able to engage with industry to apply science to major real problems. While David acknowledges that China is not yet at the same level as the USA, he enthuses that China is advancing quickly and have the ambition "to be the best."

David sees the same opportunities in the Future Grid project. "There is a huge balancing act of lowering carbon, while not blowing out the costs and losing reliability. Even if you remove the renewable power aspect of this problem, the industry has encountered challenges recently. I see the Future Grid project as making a start on embracing all this in one big study." The study is unique in the world in two ways, says David, as "it combines all the technical areas with policy and economics and it takes a holistic national grid view."

Now is an exciting time in electrical power systems according to David, because there are new technologies such as electrical energy storage and new systems engineering ideas that can be applied to rewrite the whole electricity delivery story longer term. The main challenge for Australia is whether governments are willing to support such long-term work.

David recommends overseas travel not only to extend one's professional development but also to take time out. David enjoys scuba diving especially on tropical islands such as in Thailand and the Maldives and closer to home in the Great Barrier Reef. David's personal drive is also seen in his favourite fitness activities of hiking and cycling.

Dr Rajab Khalilpour and Dr Guo Chen

Senior research fellow, Dr Rajab Khalilpour, describes the most exciting

and challenging feature of the Future Grid project as "the multidisciplinary nature…which pushes academic comfort zones and explores new ideas." The other attraction is "the complex nature as all sub-projects are interlinked. At every stage the project requires numerous iterations with extreme levels of teamwork and intra-team collaboration." The other alluring facet is provided by the Industry Reference Group who validate the researchers theories with industrial realities.

Rajab's background is in petroleum, chemical and biochemical engineering gained in the oil and gas processing systems field before he concentrated on carbon capture and storage. Rajab sees Future Grid as a significant systems engineering challenge, involving complex bio/chemical and energy systems. "Unlike traditional grids, it includes a diversity of components such as biological (bioenergy), chemical (polygeneration and carbon capture), and electrochemical (batteries) in addition to mechatronics and power engineering. Added to this is the complexity of investment analysis and of operating such a complex network."

Collaboration is the key ingredient for Dr Guo Chen, another senior research fellow, who describes the Future Grid project as "a unique, industry-led initiative focused on advancing a whole-of-system approach." He relishes the challenge of working on "a comprehensive framework that needs to integrate many technologies to achieve solutions." He also enjoys collaborating with three other leading universities, Newcastle, Queensland and New South Wales, and many industrial partners.

Guo has been involved in several research projects for industry and the Australian Government. His main research interests include power grid security assessment and vulnerability analysis, renewable energy and distributed generation, generation and transmission expansion planning and energy systems modelling. While Guo's focus is on project one: Power and energy systems modelling and security, his work is interlinked closely with project two: Grid planning and co-optimisation, which Guo was previously involved with whilst working at the University of Newcastle.

Rajab relaxes by reading history and philosophy or perfecting his culinary skills in the kitchen. Guo enjoys travel and escaping to new places, both within Australia and abroad.

Energy storage: the future of network transformation

A significant interest for the Future Grid cluster is the potential use of energy storage in the form of batteries and related technologies. Energy storage offers the promise of transforming electricity networks, by providing a form of "shock absorber" for the system. Without energy storage, generators have to always respond to demand, increasing output when demand rises, such as during peak periods, and turning down during off-peak periods, such as late into the night.

Battery energy storage. Photo by Argonne National Laboratory (supplied under Creative Commons Licence).

In fact the existing grid has been built on the need to be able to have generation that can be brought on-line when needed, and gives rise to the concept of base-load, intermediate generation and peak generation. Base load generators are designed to run cheaply and continuously, meeting the lowest demand. As demand increases, the intermediate and peaking generators are brought on-line, and these are typically more expensive, gas fuelled power plants. As demand drops into the evening, these generators are turned down and off, with the base-load generators remaining in operation to meet the night time load.

Hydroelectric storage makes up most of the world's grid-based energy storage capacity, but there are limitations on expansion, and the nature of these projects means very long delays in

With more than 530 participants spanning 33 countries, the International Summit for the Storage of Renewable Energies, Dusseldorf, March 2013 demonstrated the importance of advancing practical and economical storage system solutions for renewable energy.

approval and in most cases, strong opposition from environmental parties. Also large hydro storage is not useful to distributed systems which are becoming much more important in modern grids. There are many other storage technologies that can and do play a useful role in modern grids. For example storing thermal energy for concentrating solar power (CSP) generation. Many commercial parabolic trough CSP systems use molten salt as the storage medium, which allows full power generation to continue (for up to 7 hours) beyond sunset, increasing revenue for the solar plant operator, compared to systems without storage.

However the grid is changing. Much of the newer generation comes from renewable sources such as solar and wind power. These sources generate when the wind blows and the sun shines – not when a computer or operator signals a need. While these sources currently make up a small fraction of the total power produced in our grid, there is enough flexibility in the other generators to manage the intermittency. However the Future Grid will have a growing fraction of renewables that will require a more efficient means to balance supply and demand. In principle, energy storage is the ideal way to manage this. When excess generation is available, for example during periods of low demand and high wind, electricity is stored until some hours later when demand has increased and generation from intermittent sources may have dropped.

Some of the research questions that need to be answered include; where to locate storage (at the customers premises, on feeders, substations, bulk connection points or with generation sources), how storage should operate (who owns it, who can or should control it) and how to value its services, given it will impact all parts of the market.

Currently, battery energy storage is too costly for widespread adoption in most networks, but it is expected that these costs will reduce significantly over the next 5-10 years. If storage costs decrease in a similar manner to photovoltaic (PV) panels, will customers choose to install their own storage - with or without PV? What effect could strong uptake of distributed storage have on the Future Grid? If electric vehicles become common, can their on-board storage capacity also be used while the vehicles are not in use? We hope the Future Grid cluster will answer these (and other) questions over the next couple of years.

Prof Anthony Vassallo

Delta Electricity Chair in Sustainable Energy, University of Sydney & Future Grid Cluster Leader