Findings from the Edinburgh Forward Look Workshop on Frontier Energy Storage Technologies and Global Energy Challenges

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The University of Edinburgh together with the Smart Villages Initiative held a workshop at the Edinburgh Centre for Carbon Innovation on 11 May 2016. The workshop brought together 27 social and physical scientists, industry representatives and entrepreneurs, energy and international development policy makers, and practitioners. The workshop provided an overview of new insights and research in battery storage and highlighted the social, environmental, and other impacts of battery deployments in developing countries in terms of end-of-life management and recycling. The focus of the workshop was technologies for off-grid rural communities.

The discussion was wide-ranging, with the goal of encouraging interdisciplinary and cross-sector collaboration in this rapidly expanding area of research and development. A large number of technical points and details were mentioned. Key takeaway points and recommendations for policy makers and other stakeholders are as follows:

1. Electrochemical storage in batteries is identified as a key storage technology for off-grid villages. Different energy uses will be suited to different battery options. Households and businesses must choose the correct technology based on cost-benefit analysis. Companies, governments, and development practitioners concerned with providing electricity services to villages should be prepared to incorporate different battery designs as new and improved technologies become available over the coming years.

2. Progress in increasing battery performance will be incremental but significant over the next 10 years. Physical, chemical, and engineering research focuses on improving capacity, stability, safety, and cost. Materials research is focused on new electrode materials, and materials between the electrodes for ionic conduction and charge storage. Lead times for the development and commercialisation of radically new battery technologies are long (typically 10 to 20 years), and disruptive breakthroughs in the next ten years based on fundamental research are unlikely. Nonetheless, our understanding of materials systems at the atomic and molecular level will lead to gradual but substantial advances in all aspects of battery device design.

3. There will be significant progress based on manufacturing learning curves, and scaling, and some manufacturing step changes introduced by the likes of the Tesla Gigafactory. These will provide the major sources of cost reductions in batteries over the next 10 years. Battery cost is predicted by many in the industry to reach below US$100 per kilowatt hour capacity by around 2020.

4. The price of lithium ion batteries will reduce significantly, and will become favourable for off-grid solar home storage compared to the currently dominant lead acid battery at some point in the near future, although the cycle life of lead acid batteries will improve. Lithium sulfur batteries, and sodium-based batteries are promising technologies in the immediate to mid-term (2–8 years) for increased capacity and lower price, respectively. Flow batteries are also promising for larger applications if their membrane price can be lowered as much as some predictions.

5. Typically, not much attention is given by chemists to the sources of materials and the local impacts of mining when they are developing new technologies. A more system-

atic approach to materials choice would be beneficial in this regard. Trends in looking at different materials should be based on thorough analysis (from social, economic, and physical considerations) to avoid research being conducted based on “myths” or misconceptions.

6. The circular economy is a powerful concept and may usefully inform battery research activities. Historically, batteries have not been designed to be recycled or easily repaired. This will become a much more important design consideration in future, and in particular for smart villages. For example, lithium recycling may become very important if lithium ion batteries take off.

7. Interest in energy storage as it relates to the developing world is exemplified by the availability of research funding, such as the Global Challenges Research Fund in the UK which has a budget of £1.5 billion over five years. Some of this funding should be used to look at the social implications of the large deployment of chemical energy storage across the developing world.

8. New businesses and social enterprises can play an important role in battery end-of-life management. The infrastructure and procurement chain requirements of recycling of lead acid batteries—and in the future, other types of batteries—are often too large for governments and businesses to achieve in the developing world. Engineers, entrepreneurs, and governments must work together to create new business models and new technical facilities that enable effective management of electrical and electronic technology wastes to avoid adverse environmental and health impacts. Fundamental research should also be conducted into developing new recycling technologies, and this research must be applied in the real world—as exemplified by the new lead acid battery recycling spin out from the University of Cambridge, Citrecycle.

9. Remote monitoring, as deployed by companies such as Bboxx and others, enables impressive improvements in battery lifetime and service and maintenance due to the ability to see in real time the state of charge and condition of the battery voltage and temperature. Proper battery management is key to improving the cost effectiveness of batteries. Being able to monitor the health of the battery without having to make field visits is a vital tool.

Notes

The Smart Villages Initiative

We aim to provide policymakers, donors, and development agencies concerned with rural energy access with new insights on the real barriers to energy access in villages in developing countries—technological, financial and political—and how they can be overcome. We have chosen to focus on remote off-grid villages, where local solutions (home- or institution-based systems and mini-grids) are both more realistic and cheaper than national grid extension. Our concern is to ensure that energy access results in development and the creation of ‘smart villages’ in which many of the benefits of life in modern societies are available to rural communities.

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The Smart Villages initiative is being funded by the Cambridge Malaysian Education and Development Trust (CMEDT) and through a grant from the Templeton World Charity Foundation (TWCF). The opinions expressed in this publication are those of the authors and do not necessarily reflect the views of the Cambridge Malaysian Education and Development Trust or the Templeton World Charity Foundation.