SMART VILLAGES
New thinking for off-grid communities worldwide

New technologies for off-grid villages: A look ahead

Workshop Report 1

CAMBRIDGE, UK

January 2014

Key words:
Off-Grid Energy, Smart Villages, Innovation, Entrepreneurship

Smart Villages

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.

www.e4sv.org | info@e4sv.org | @e4SmartVillages

CMEDT – Smart Villages Initiative, c/o Trinity College,
Cambridge, CB2 1TQ

Publishing

The Smart Villages Initiative is being funded by the Cambridge Malaysian Education and Development Trust (CMEDT) and the Malaysian Commonwealth Studies Centre (MCSC) 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.

MALAYSIAN COMMONWEALTH STUDIES CENTRE

CAMBRIDGE MALAYSIAN EDUCATION AND DEVELOPMENT TRUST

TEMPLETON World Charity Foundation, Inc.

Contents

SUMMARY

The purpose of the workshop was to bring together leading UK researchers to discuss emerging technologies for the sustainable production and use of energy in rural communities in developing countries, and to take a 'look ahead' at scientific developments and technologies that might be influential over the next 10-20 years. It was held under the auspices of the 'smart villages' initiative(www.e4sv.org), a three-year project to advance sustainable energy provision for development in off-grid villages in Africa, Asia and Latin America.

The workshop agenda and attendance are given at annexes 1 and 2 respectively.

WORKSHOP PROCEEDINGS

Introductions and setting the scene

Professor Sir Brian Heap, University of Cambridge and Dr John Holmes, University of Oxford

The driving motivation behind the Smart Villages Initiative (SVI) is that energy access acts as a catalyst for development, enabling education and local business opportunities, improving health and welfare,and enhancing democratic engagement. The SVI aims to help achieve the United Nation's goal of achieving universal access to electricity by 2030. In particular, it aims to help achieve rural energy a ccess through micro/mini-grids and home-based approaches. The SVI is currently funded by the Malaysian Commonwealth Studies Centre at Cambridge and the core team is applying for additional support from the Templeton World Charity Foundation.

The SVI aims to realise its goal through providing policymakers with insightful, bottom-up analyses oft he challenges of village-level energy provision for development, and propose recommendations about how these challenges may be overcome. This will be achieved with the support of international

Professor Sir Brian Heap, University of Cambridge experts in the natural and social sciences, and through the regional and global networks of organizations such asthe European Academies Science Advisory Council (EASAC) and the InterAcademy Panel (IAP). It is proposed to hold a series of six regional workshops that will bring together top African, Asian, American and European scientists and key stakeholders (e.g. entrepreneurs, NGOs, financers, policy-makers etc.).The workshops will start in June 2014 and be held in Tanzania (East Africa), Ghana (West Africa), India(South Asia), Malaysia (South-east Asia), Bolivia (South America) and Mexico (Central America).

Each workshop will be followed by a set of follow-up activities that include disseminating conclusions and recommendations through the workshop report, preparation of policy briefs and briefing meetings,training courses, entrepreneurial competitions and a final event with key stakeholders. Other activities will include preparation of a vision paper, a booklet of invited essays, and a pocket guide for the media and tertiary students, development of a website, and final workshops in Brussels and Addis Ababa.

Lighting, power electronics, communications and health

Professor Sir Colin Humphreys, Cambridge

Improving the energy efficiency of lighting would be one of the most straight-forward ways to decrease energy consumption, potentially by up to 50% according to the US Department of Energy. LED lights are made from light-emitting semiconductors and are much more efficient (30-60% efficiency) than incandescent (5%) or fluorescent bulbs (20-25%). LEDs have recently become so efficient that they can be used for off-grid lighting powered by solar PV with batteries. Their efficiency is anticipated to continue to increase for the next 10 years. LED lights are a good fit for off-grid villages because of they can be operated with only a solar cell and battery, and can provide continuous light for 100,000 hours(11 years), compared to about 1000 hours for incandescent bulbs.

Current LED lights use the man-made material Gallium Nitride (GaN) as the semiconductor material,grown on small sapphire or silicon carbide wafers, but these are expensive. Sir Colin's lab is developing LED lights which can be grown on 6-inch diameter silicon wafers in an automated process, therefore substantially decreasing the cost, which is currently approximately £15 for a high-power (60 Watt equivalent) replacement LED bulb. Plessey, the Plymouth-based company producing GaN bulbs based on the Cambridge technology has already received an order for 20 million bulbs from China, illustrating thei mpact these bulbs can have in both emerging and developed markets in the very near term.

In the longer term, GaN-based technologies have the potential to benefit rural villages in a number of ways. AlGaN-based LEDs producing deep UV radiation can be used to destroy pathogens that cause water-borne illnesses and can be powered off-grid using solar PV + battery, but efficiencies are currently too low to purify flowing water: a further 2 to 10 years research is needed. GaN power electronics are40% more efficient than silicon based technologies enabling easier off-grid charging and use of mobile phones, computers etc. LEDs can provide a cheaper and more energy efficient basis for transmitting wireless internet using light waves instead of radio waves although a further 3 to 10 years R&D is needed for commercial application. Multi-junction InGaN solar cells could in 5 to 10 years enable the production of more efficient solar cells.

Distributed energy for rural Africa: powering the un-grid

Dr Simon Bransfield-Garth, Azuri Technologies

Dr Bransfield-Garth's presentation brought forward the premise that markets in emerging countries are underdeveloped and the present focus should be on how to use the latest technology currently available to meet market needs. Recent technology developments with the capacity to make a difference include the use of mobile phones to pay bills, LED lights and drones to deliver medicines. Technology can help address market failures, for example the internet can create a viable market for crops.

There are leapfrog opportunities in developing countries. For example, an 'un-grid' vision of the future would replace conventional grid extension as the means of providing energy access with a distributed power approach in which electricity is generated from renewable sources at the level of the home or community. DC power would drive a new generation of low power, low voltage domestic appliances. A relevant analogy is the replacement of the landline by the mobile phone.

The presentation also established that there is significant demand for off-grid solar in Africa and that as a result of demographics and potential economic development pathways, the demand for affordable consumer electronics that meet information, entertainment, knowledge and entrepreneurship needs will substantially increase. The presentation also stressed the need to view the economic and social benefits of energy at the margin and advocated a tiered approach to energy demand and supply.

The presentation highlighted Azuri's Indigo project where a 2.5W solar home system is sold as a pay-as-you-go energy service to households. This business model overcame the common barriers of a high up-front cost and continued maintenance. Field data were presented that suggested that Indigo has allowed households to save money (around 50% of previous monthly bills for kerosene and mobilephone charging) and time, and that there have been social and economic impacts. Indigo has helped deliver aspirations to younger generations, primarily by helping the generation to step up and leave behind the expectation of being poor.

Dr Simon Bransfield-Garth, Azuri Technologies

Energy for development: business opportunities for community mini-grids

Professor AbuBakr Bahaj, University of Southampton

Professor Bahaj's presentation described the thought process and outcomes of building an exemplar solar driven project based on a community energy services company (ESCO) that supplies power through a mini-grid connected to businesses within the Kitanyoni's village centre, Kenya in 2012. Outlying villagers purchase LED lanterns from the ESCO which they electrically charge at the businesses in the village centre. The project team worked closely with local partners, government and the villagers themselves to assess available resources, build the solar-powered mini-grid system, and train villagers too operate and maintain the system. Establishing early community ownership through shares and membership was a key contributor to the project's success. Other important factors included local employment, the supply chain, and the training of local people. The project ethos is to develop applicable and tailored technologies that were easy to implement and replicate in rural communities.

The project was implemented with support from the Research Council's UK Energy Programme and focused on developing a system that would fit the needs of the local community and have a sustainable business model by delivering holistic value, especially in terms of productive enterprise enabled by access to power. As a result of building the mini-grid, villagers have constructed five new buildings,created new sources of income from charging devices, renting use of appliances, selling water collected from the canopy that holds the solar panels, and through the selling of power to the businesses. In addition, access to power has increased market activities by allowing shops to remain open after dark, improved conditions in the midwife's clinic, and brought new kinds of business activities within the community as well as out of school hours educational services. To be successful, future mini-grids for villages will need to take a broad range of factors into account including affordability, project economics,ownership finance, payment mechanisms, and systems for monitoring and evaluation.

Boosting the future efficiency of solar technology

Dr Andrew Musser, University of Cambridge

Dr Musser's presentation presented some of the research undertaken by the Optoelectronics group at the Cavendish Laboratory. The group is currently looking at the fundamental principles behind solar cells with a view to understanding what physical properties can be harnessed to improve cell efficiency.

Currently, single junction solar cells are limited by the Shockley-Queisser limit that sets the maximum power conversion efficiency at approximately 33%. One method to improve efficiency is to design and make multi-junction solar cells, which can achieve approximately 45% efficiency. However, design difficulty and high costs mean that multi-junction solar cells are not suitable for rural deployment.

An alternative approach, that is still in the early stages of research, is to harness the power of quantum mechanics and use 'singlet exciton fission' in combination with a conventional single junction cell to achieve a theoretical maximum efficiency of approximately 44%. Stemming from this research, it is possible that within 5 to 10 years it may be possible to apply singlet exciton fission to silicon solar panels.This would likely increase efficiency by 2-5% which, given that efficiency gains in silicon have saturated,is a helpful improvement for rural villages.

Workshop participants

Graphene-based dye-sensitized solar cells

Dr Tawfique Hasan, University of Cambridge

Dr Hasan's presentation looked at graphene-based dye-sensitized solar cells (DSSCs), which are interesting alternatives to conventional silicon-based solar cells due to their simple fabrication process,and lower materials and production cost. They may find application when portable and easily deployable economic solutions to energy in remote locations are envisaged. Two components of thecurrent generation of DSSCs, namely the counter electrode (CE) and the dye, still have significant potential for further cost reduction.

The CE commonly consists of a catalytic Platinum (Pt) film deposited on a transparent conductor like Indium Tin-oxide (ITO). Poor chemical stability, high cost and high temperature processing requirement are drawbacks of this well-established platinum counter electrode-based DSSCs. Graphene is a promising CE material in DSSCs due to its high exchange current density, low charge-transfer resistance,high specific surface area, and significantly lower cost than platinum.

Current DSSCs commonly use synthetic dyes to absorb light for the conversion into electrical energy. These synthetic dyes require tedious and expensive purification procedures. Natural dyes and the irorganic derivatives, which have comparable performance, are non-toxic, biodegradable, low in cost and abundant. Thus, both graphene and natural dyes are ideal candidates for next generation economic,environmentally friendly solar cells.

Dr Hasan described a current Cambridge-based project, in which graphene ink is employed, a technology pioneered in the Cambridge Graphene Centre. Titanium Oxide (TiO_2) photo anode inks are also being formulated. Natural tropical dye extracts from widely available leaf/flower extracts such as Pennisetumglaucum, Hibiscus sabdariffa and Caesalpinia pulcherrima are being used as photosensitizers. The Cambridge Graphene Centre's approach to printed devices and the use of graphene and natural dyes offer versatility, potential for mass production and cost reduction, as well as conformable device form factors.

The project is at Technology Readiness Level 3. The technology is well suited for academic investigation, leveraging the strengths of the Cambridge Graphene Centre (CGC) and the Centre for Advanced

Photonics and Electronics (CAPE) at the University of Cambridge Engineering Department. The technology will potentially be available in 5 to 10 years and is anticipated to be suitable for deployment in rural villages. The 6-month exploratory phase of the project was funded by the Cambridge in Africa program (CAPREx) and the Alborada Trust, and supported by the Royal Academy of Engineering.

Water for all: technological and cultural implications

Professor Michael Depledge, University of Exeter

Most stakeholders agree that providing access to clean water is a major priority for rural villages wherewater-borne illnesses are the top cause of hospitalisations. This presentation examined some lateral concerns of implementing new technologies in developing markets, particularly in relation to unanticipated environmental impacts, and suggested a number of questions for consideration. The LifeStraw was highlighted as one example of using affordable nanotechnology to remove both pathogens and contaminants in drinking water. The presentation stressed, however, that questions remain-whether technologies such as nanoparticles might themselves be harmful to individuals or the environment, and challenged workshop participants to consider all new technologies from alternative angles.

As an example, changing global patterns of water consumption and the substantial amount of energy consumed transporting water should be considered when discussing energy provision for off-grid villages. Questions were also raised about how to plan for both anticipated and unintended consequences of access to clean water, such as exponential increases in demand with changing patterns of agriculture and diets with higher proportions of animal products. Specific concerns were highlighted including how to manage waste generated from increased use of consumer products, cultural disruption by new technologies replacing roles held by community members (for example, collecting water),increased dependence on new technologies, and increased carbon and water footprints.

Bioenergy from plants and algae

Professor Alison Smith & Dr Beatrix Schlarb-Ridley, University of Cambridge

Recent developments and research on bioenergy from plants and algae were presented. Regarding bioenergy from plants, the presentation highlighted that further development is required for next generation biofuels that utilise the non-edible parts of crop plants, and that their usefulness in rural villages is likely to be limited due to the scale of infrastructure required for processing. Algae were-highlighted as a potentially game-changing alternative. However, algal agronomy is still in its infancy,and advances in understanding of algal biology will be key to sustainable production on a commercial scale.

A case study of a potentially deployable algal-culture system for energy production coupled with wasteprocessing designed by Cambridge-based Sustainable OneWorld Technologies (SOWTech) was presented. The culture system is currently being trialled in the UK and potentially in Malawi in the nearfuture. Another approach that is in its relative infancy was presented in which electricity is generated directly, via biophotovoltaics, rather than by producing biomass. Two examples of how this might be used were presented, one using algae in solar panels, and the other coupled with growth of crops(photosynthesis-fed microbial fuel cells). In addition, the potential use of microbial fuel cells for generating electricity while cleaning water was highlighted.

Biomass-fueled 5-20kW Stirling engine for off-grid applications

Mr Mike Dadd and Professor Nick Jelley,
University of Oxford

Stirling engines are currently being used to generate power in space travel but can potentially be adapted to generate electricity for off-grid villages. A Stirling engine converts heat to electricity by taking advantage of temperature differences to drive the expansion and contraction of gases to generate net power. For renewable heat sources (e.g. solar and biomass), Stirling engines of 1 to 20+kW capacity are better suited to converting heat into electricity than internal combustion engines. They can achieve up to around 40 % efficiency but this is not necessary for off grid villages – overall system efficiency allowing, for the drive for low manufacturing cost, is likely to be nearer 20 – 30 %.

The Oxford oil free linear design of Stirling engine contains no bearings or friction-wearing parts, so could potentially have an extremely long useful life. This would help to avoid the issues around maintenance and reliability that have been a problem with conventional designs. A bigger, multi-cylinder model, configured to use biomass as a fuel, is currently under development and could address some current operational hurdles.

Initial work to use solar energy as a power source for the engine led to the development of the OxfordSolar Cooker (funded by the Leverhulme Trust), which uses novel structures and reflectors to concentrate sunlight into an oven at a convenient height. It can be flat-packed for ease of transport and field trials in Africa are planned in collaboration with Dytecna in 2014.

Jugaad Innovation: challenges and opportunities in commercializing affordable solutions for lowincome communities

Professor Jaideep Prabhu, University of Cambridge

Western innovation processes are typically resource intensive, time consuming and focus on solutions for the wealthier portion of the world's population. In contrast, 'Jugaad' innovators overcome harsh constraints in emerging markets by improvising effective solutions with limited resources, and are inclusive of the four billion people who live at the base of the world economic pyramid, earning less than $9/day. Solutions for this segment of the world's population need to be designed around local behaviour and economics, including consideration of payment and distribution models since a significant proportion of the base of the pyramid is 'unbanked' and difficult to reach.

This presentation presented several case studies of successful jugaad innovation in developing countries where entrepreneurs were frugal, flexible and inclusive in their solutions. Innovations profiled include the Mitticool clay fridge which cools through evaporation alone, a baby warmer 100x cheaper than a hospital incubator, telemedicine approaches for managing diabetes in remote communities, solar energy as a service, the low cost Tata Nano and the Aakash tablet designed to deliver education through broadband. Several Western companies are starting to mesh jugaad approaches with their conventional innovation processes, including GE who have developed a battery-operated lightweight ECG machine, and Nokia who specifically designed the Nokia 1100 for emerging markets. To address payments issues, M-PESA has been particularly successful in Kenya and has had the added benefit of decreasing corruption by making payments trackable.

Professor Jaideep Prabhu, University of Cambridge

Engineering Sustainability

Professor Peter Guthrie and Dr Heather Cruickshank, University of Cambridge

The presentation drew on the experience of researchers at the Centre for Sustainable Development,University of Cambridge. A number of key points were raised and a final take-home message presented. One of the key points mentioned was the need to be wary of relying on simplifications of complex data,as well as tool kits and decision support systems. A second key point was that experience suggests that the provision of raw infrastructure by itself will not lead to development, and that there is a big disconnect between the top and bottom. For example, the values of a community, in relation to infrastructure, may differ significantly from donor or academic assumptions. A third point was that it may be beneficial to design and deploy solutions that are adequate rather than comprehensive, and allow for technology to be resilient. The take-home message was that achieving universal access to energy can only be achieved through holistic, integrated and interdisciplinary thinking.

Final discussion and overview: where we are and where we could be by 2030

Three streams of research or areas of research were identified from the workshop. The first stream focused on the transitional problem: how can we ensure that using today's technology does not inhibit the use of future technology? The second stream of research focused on social acceptability and the third stream of research on the business model. It was recognized that social acceptability and the business model are interlinked, and that it is only through developing a socially acceptable business model that sustainability can be achieved.

Annex 1: Workshop Programme

Wednesday 15, January

0900 **Registration**

1000 **Introductions and setting the scene**

Brian Heap/John Holmes Chair – John Holmes (Oxford)

1020 **Lighting, power electronics, communications and health**

Colin Humphreys (Cambridge)

1050 **Distributed energy for rural Africa: powering the un-grid**

Simon Bransfield-Garth (Azuri Technologies, Cambridge)

1120 **Break**

1135 **Energy for Development: business opportunities for community mini-grids**

AbuBakr Bahaj (Southampton)

1205 **Boosting the future efficiency of solar technology**

Andrew Musser (Cambridge)

1220 **Graphene-based dye sensitized solar cells**

Tawfique Hasan (Cambridge)

1235 **Water for all: technological and cultural implications**

Michael Depledge (Exeter)

1300 **Lunch Chair**

Bernie Jones (Strasbourg)

1400 **Bioenergy from plants and algae**

Alison Smith and Beatrix Schlarb-Ridley (Cambridge and Norwich)

1430 **Biomass-fuelled 5-20kw Stirling engine for off-grid applications**

Mike Dadd and Nick Jelley (Oxford)

1500 **Jugaad Innovation: challenges and opportunities of commercialising affordable solutions for low income communities**

Jaideep Prabhu (Cambridge)

1530 **Engineering sustainability**

Peter Guthrie and Heather Cruikshank (Cambridge)

1600 **Tea Chair**

Brian Heap (Cambridge)

1615 **Roundtable of network initiatives**

Moderator – John Enderby (Bristol)

Ed Brown (National Co-Coordinator, UK Low Carbon Energy for Development Network, Loughborough); Nalin Patel (Winton Programme for the Physics of Sustainability, Cambridge); Shailaja Fennell (Cambridge) and others attending.

1700 **Final discussion and overview – where we are and where we could be by 2030.**

1800 **Drinks and buffet dinner; The Tower Bar, Møller Centre**

Annex 2: Speakers

Professor AbuBakr S Bahaj is Professor of Sustainable Energy, Head of the Energy & Climate Change Division (ECCD), University of Southampton

Dr Simon Bransfield-Garth is CEO, Azuri Technologies, and has 25 years global experience building rapid growth, technology-based businesses including 7 years at Symbian, the phone OS maker, where he was a member of the Leadership Team and VP Global Marketing. He was founder of Myriad Solutions Ltd, was an Industrial Fellow at the Royal Society, and was named a Global Technology Pioneer by the World Economic Forum in 2013.

Dr Ed Brown Ph.D. (Edinburgh) is Senior Lecturer in Human Geography, co-chair UK Low Carbon Energy for Development Network, Associate Director of Loughborough's Sustainability Research School), and currently PI on three EPSRC projects in this field. Mr Mike Dadd is Research Assistant, Department of Engineering Science and works with Professor Nick Jelly, Professor and Tutor in Physics, University of Oxford and Fellow of Lincoln College. Oxford.

Professor Michael Depledge PhD DSc CBiol FSB FZS FRSA, was the founding Director and is currently Professor of Environment and Human Health, and Chair of the Board of the European Centre for Environment and Human Health at the University of Exeter. He was Chief Scientific Advisor of the UK Government's Environment Agency

Professor Sir John Enderby CBE FRS was the H.O. Wills Professor of Physics and Head of Department at the University of Bristol. He is a Fellow of the Royal Society and was Physical Secretary and Vice President of the Society, and President of the Institute of Physics.

Dr Shailaja Fennell is Lecturer in Development Studies at the Centre of Development Studies and the Department of Land Economy. Her research interests lie within the specialist fields of rural development and institutional reform. She was part of a six-member team that produced the first report, Overcoming Fragility in Africa through 2008-09, providing expertise on gender and rural development.

Professor Peter Guthrie is Director of the Centre for Sustainable Development in the Department of Engineering, and Fellow of St Edmund's College, Cambridge and works with **Dr Heather Cruickshank** (BEng BSc PhD CEng MICE MCIWEM) who is a University Lecturer, co-founder of the Centre for Sustainable Development in 2000, and a member of Clare College.

Dr Tawfique Hasan is a University Lecturer in Electronic Materials and Devices and a Royal Academy of Engineering Research Fellow in the Cambridge Graphene Centre of the Engineering Department. He works on solution processed nanomaterials such as carbon nanotubes and graphene for photonic, (opto) electronic and energy devices. He is a Title A Fellow of Churchill College.

Professor Sir Brian Heap CBE FRS is Research Associate, Centre for Development Studies, Cambridge, and former Foreign Secretary and Vice-President of the Royal Society, President of the European Academies Science Advisory Council, Director of Research at the Biotechnology and Biological Sciences Research Council, and Master of St Edmund's College, Cambridge.

Dr John Holmes is Energy Secretary, European Academies Science Advisory Council, Halle, Germany, Senior Research Fellow in Environmental Policy, Department of Earth Sciences, Oxford, and an OhD Cambridge in physics.

Professor Sir Colin Humphreys CBE FRS is Professor of Materials Science and Director of Research in the Department of Materials Science and Metallurgy, University of Cambridge and a Fellow of Selwyn College, Cambridge. He is a Fellow of the Royal Society and a Fellow of the Royal Academy of Engineering.

Dr Bernie Jones is Director of Media, Biosciences for Farming in Africa (B4FA.org), and was Head of International Policy at the Royal Society, and Executive Director, European Academies Science Advisory Council. He is a graduate of Edinburgh and Cambridge Universities in Cognition, Computer Science and Psychology.

Dr Andrew Musser is a Marie Curie Early Stage Researcher working at the Optoelectronics Group of Professor Sir Richard Friend at the Cavendish Laboratory, Cambridge.

Dr Nalin Patel (Winton Initiative, Cambridge) PhD Cambridge, MBA Warwick, is Winton Programme Manager, University of Cambridge, Cavendish Laboratory.

Professor Jaideep Prabhu is Professor of Marketing and Jawaharlal Nehru Professor of Indian Business and Enterprise at Judge Business School, University of Cambridge. He has held positions at Cambridge, Imperial College London, Tilburg University (the Netherlands), and UCLA.

Professor Alison Smith who is Professor of Plant Biochemistry in the Department of Plant Sciences, Cambridge, a member of Energy@Cambridge, works with **Dr Beatrix Schlarb-Ridley** who is InCrops Business and Innovation Officer, Coordinator, Cambridge Bioenergy Initiative, and Convenor, Cambridge Partnership for Plant Sciences

SMART VILLAGES

New thinking for off-grid communities worldwide

The Smart Villages initiative is being funded by the Cambridge Malaysian Education and Development Trust (CMEDT) and the Malaysian Commonwealth Studies Centre (MCSC) 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.