INTERNATIONAL ENERGY AGENCY

WORKSHOP REPORT 2017

Mission Innovation Challenge n°2: Off-grid Access to Electricity

12 July 2017 - Paris, France

Stakeholder Workshop – Identifying Innovation Needs and Opportunities

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INTERNATIONAL ENERGY AGENCY

The International Energy Agency (IEA), an autonomous agency, was established in November 1974. Its primary mandate was – and is – two-fold: to promote energy security amongst its member countries through collective response to physical disruptions in oil supply, and provide authoritative research and analysis on ways to ensure reliable, affordable and clean energy for its 29 member countries and beyond. The IEA carries out a comprehensive programme of energy co-operation among its member countries, each of which is obliged to hold oil stocks equivalent to 90 days of its net imports. The Agency's aims include the following objectives:

- Secure member countries' access to reliable and ample supplies of all forms of energy; in particular, through maintaining effective emergency response capabilities in case of oil supply disruptions.
- Promote sustainable energy policies that spur economic growth and environmental protection in a global context – particularly in terms of reducing greenhouse-gas emissions that contribute to climate change.
- Improve transparency of international markets through collection and analysis of energy data.
- Support global collaboration on energy technology to secure future energy supplies and mitigate their environmental impact, including through improved energy efficiency and development and deployment of low-carbon technologies.
- Find solutions to global energy challenges through engagement and dialogue with non-member countries, industry, international organisations and other stakeholders.

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Table of contents

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Introduction

Context and scope of the workshop

Energy is the bedrock of modern life, vital to economic development, social equality, health and longevity. Yet, according to the International Energy Agency's (IEA) World Energy Outlook (WEO, 2016), an estimated 1.2 billion people – 16% of the global population – did not have access to electricity in 2014. On average, these families spend between 1 and 2 USD/week just for lighting, using fossil fuels. The same IEA report identified 633 million people in Africa without access to electricity, and the World Bank estimates sub-Saharan Africa spends USD 10.5 bn/year on candles and kerosene for lamps. In other regions, isolated communities, for example on islands or in remote areas, are not connected to a large electricity grid and rely on often ageing diesel-powered generators. But as technology costs come down, the economics of renewable systems, as part of off-grid systems, become more attractive than those of the main alternatives and are often already cost competitive. The IEA has been consistently raising the importance of energy access on the international agenda. This topic is to be a special focus of the *WEO-2017* series, which will include a dedicated report entitled, *Energy Access Outlook: from Poverty to Prosperity.*

Mission Innovation (MI) is a global initiative, which aims to dramatically accelerate global clean energy innovation. Participating countries have committed to double their governments' clean energy research and development (R&D) investments over five years. MI Challenges were developed through a collaborative process between MI members to catalyse global research efforts. The second out of the seven Innovation Challenges (IC) focuses on off-grid access to electricity and aims to develop systems that enable off-grid households and communities to access affordable and reliable renewable electricity. **For individual homes**, the objective is to reduce significantly over the next 5 to 10 years the price of renewable power systems for lighting and communication device charging, while expanding the range of services delivered to household systems. **For remote communities**, the objective is to demonstrate, over the next decade, in diverse geographic and environmental conditions, the robust, reliable and autonomous operation of renewable power systems up to 100 kilowatt at a significantly lower cost than today.

Held under the Chatham House Rule[1], this Stakeholder Workshop focused on identifying R&D gaps and opportunities regarding off-grid access to electricity, to help implement the work plan of the MI Challenge n°2. It served to highlight successful existing projects, allowed participants to share best practices and offered an opportunity to:

- Build further consensus on priority actions for the implementation of the MI Challenge n°2
- Discuss targets and possible metrics to measure progress against implementation
- Identify stakeholders for the implementation of innovative solutions and products

Laurent Michel, Director-General of energy and climate change at the French Ministry for the Ecological and Inclusive Transition, delivered opening remarks, highlighting the need for new technologies to overcome barriers to energy access. He provided a brief overview of the seven MI Challenges launched at COP22 in November 2016 and particularly the one on off-grid access

[1] When a meeting is held under the Chatham House Rule, participants are free to use the information received, but neither the identity nor the affiliation of the speaker(s), nor that of any other participant, may be revealed. To respect this rule, the identity and affiliation of the speakers engaged in the panel debates and of the participants who offered comments are not revealed in this report. Only the names of the speakers who delivered keynote addresses and presentations are mentioned.

to electricity. He referred to it in the context of the Sustainable Development Goals (SDG) spearheaded by the United Nations (UN), and specifically Goal 7, which aims to ensure access to affordable, reliable, sustainable and modern energy for all. He pointed out that transformative clean energy technology innovations are needed, as well as innovative ways to enhance the availability of energy services. Mr. Michel also underlined the importance of leveraging resources by partnering with other organizations to avoid duplicative efforts. He informed participants that a report will be produced by the end of the year including targets and metrics to measure progress against implementation.

Fabrice Boissier, Director-General of ADEME, echoed the points Mr Michel had stressed on R&D and innovation needs, noting that local implementation has to be addressed and that business models should allow for a sustainable deployment. On behalf of ADEME, he announced the joint launch with the French Ministry for the Ecological and Inclusive Transition of a call for proposals[2] to support projects submitted by French Companies and Non-Governmental Organizations (NGO), which will help develop innovative solutions to off-grid access to electricity from renewable sources.

Dave Turk, the IEA's Acting Director for Sustainability, Technology, and Outlooks, recognized France's leadership in the energy access space and highlighted the issue as vital to overcome. While noting that the IEA and others have been consistently raising the importance of energy access on the international agenda, he emphasized the lack of investment and the fact that funding is not matching needs. He also pointed out the importance of empowering women. Mr. Turk underlined the IEA's broader aim to provide expertise, tools, and modelling capability on this vital issue, including through the network of world-class technology experts who are part of the IEA's Technology Collaboration Programmes (TCPs). Mr. Turk expressed how pleased he was that India, which recently joined the IEA as an Association Partner, is also showing real leadership in this space and co-leading with France this MI Challenge. He concluded by expressing enthusiasm for the wealth of human ingenuity in this space and around the table.

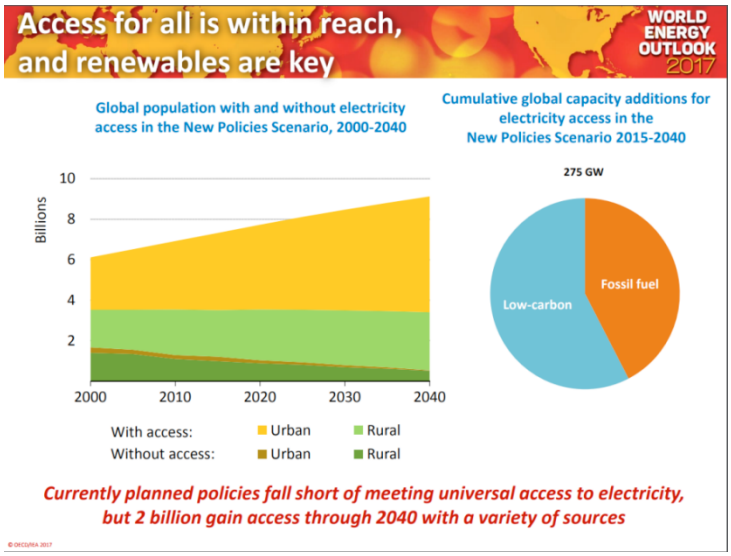
[2] Information on the call for proposals available at: http://accesalenergie.ademe.fr/

Mapping the state of energy access and off-grid systems

Although there has been much progress in expanding access to modern energy services, the world is not yet on track to achieving sustainable energy for all by 2030. This continues to serve as an impediment to economic and social development. The aim of this session, moderated by **Francois Moisan**, Executive Director of Strategy, Research and International Affairs at ADEME, was to discuss the current state of off-grid access to electricity, the pace of progress and paths being pursued, with a particular focus on positive examples that others may follow.

Laura Cozzi, the IEA's Head of the Energy Demand Outlook Division, introduced the topic by highlighting the mismatch between resources and what is delivered. She emphasized the need to look at supply and demand integration and break silos, recognizing India for having successfully integrated both and accelerating access. She noted that the quality of supply in urban areas where people are massively moving is the main issue, while using solar technologies and domestic resources is key in rural areas and Sub-Saharan Africa. She underscored that while climate policies can help, climate and development must go together. Implementing SDG 7 is central to achieving success in meeting other SDGs, poverty alleviation, education, health, and gender equality. The WEO team has been publishing country-by-country energy access databases since 2002. In its latest annual update, it remains clear that modern energy deprivation is still widespread, with 1.2 billion people who still do not have access to electricity[3]. However, renewed policy commitment, new business models and improving technology costs for decentralized renewables are coming together to improve progress. Ms. Cozzi emphasized digitalization as key to enabling electricity access, but noted that the path to modern energy is not a one-size-fits all. **Innovative solutions must be developed at the country and region levels, which have different needs and resources**. She noted that currently planned policies fall short of meeting universal access to electricity, but that 2 billion gain access through 2040 with a variety of resources (Figure 1). Renewable energy technologies could make a major contribution to universal access in a sustainable way if investments are going towards centralized and decentralized low-carbon sources.

Figure 1 • WEO-2017 Energy Access Report - New Policies Scenario 2015-2040



[3] In most developing countries, many households in villages that have been electrified remain without grid connection

Ms. Cozzi announced that the 2017 World Energy Outlook (WEO) Energy Access Special Report will be released on 19 October 2017. She concluded her presentation by stressing the link between energy access and productive use, and highlighted the importance of having women entrepreneurs at the table.

Emanuele Taibi, from the Power Sector Transformation Strategies Division of the International Renewable Energy Agency (IRENA), presented on the activities of the agency related to innovation in energy access through renewables. He highlighted the work of the International Off-Grid Renewable Energy Conference (IOREC) Platform in scaling-up off-grid renewable energy deployment and its outcome paper, which identifies the key elements of an enabling environment for off-grid renewable energy: technology innovation, policy and regulatory frameworks, the right institutional framework, financing and business models. He also underscored cooperation between public and private sector as essential. Mr. Taibi also addressed the lack of energy access as the key reason behind people moving to urban areas and drew attention to opportunities for renewable energy deployment in the agriculture sector. **He noted great untapped potential in Africa and Latin America for deploying renewable energy mini-grids. Technology innovation would make them an increasingly attractive alternative to traditional centralized grid planning**.

Vineet Saini, Principal Scientific Officer, Technology Mission Division, Department of Science & Technology, presented India's perspective on off-grid access to electricity. He highlighted that his country currently has the world's largest renewable deployment programme. The government has doubled funding to the Department of Science and Technology over the past two-and-a-half years and is targeting multiple innovations from laboratories that could be introduced to the market. Reliable off-grid clean energy technologies combined with innovative research models, market based solutions, and local community involvement have the potential to transform the lives of individuals and communities by providing better quality of life, modern amenities and economic opportunities. Mr. Saini provided an overview of the **Mission Innovation – India Funding Opportunity Announcement (FoA) on Off Grid Access to Electricity**. The call for proposals is expected to evolve technology and develop methodology and business models tuneable to local conditions. He noted that MI member countries are welcome to join the partnership and collaborate with Indian institutes and organizations, which will lead the work[4]. He concluded by stressing that solutions have to be developed in a sustainable manner and that R&D needs to address reliability issues.

El Hadji Diop, from the United Nations Development Programme (UNDP), delivered the last presentation of the session. He offered an interesting perspective on Senegal's experience with solar energy, noting that only 32% of the population has access to electricity in rural areas where more than 50% of the population lives. He pointed out that the sector of renewable energy in general and solar energy in particular, still play a marginal role as subsectors of the electricity sector in Senegal. However, the country's solar energy market presents a clear potential for growth and inclusivity. Mr. Diop also provided an overview of UNDP's work to promote the concept and implementation of inclusive business ecosystems (IBE) in Africa, highlighting the IBE Diamond, which outlines the four primary functions required to support inclusive businesses: information, incentives, investment and implementation support. Mr. Diop urged countries in the North, which are developing solutions, to seek feedback from end users in the South, as they don't often meet their needs. He stressed the importance of identifying local issues first and noted the lack of information sharing and **difficulty to reach low income people**. He added that

[4] Information on the call for proposals available at: http://dst.gov.in/callforproposals/funding-opportunity-announcement-foa-grid-access-electricity

tax incentives would enable the growth of off-grid renewable energy solutions, as the private sector is impacted by high taxes when importing solar panels and batteries. He underlined that there is currently no mechanism in place in Senegal to develop solar systems and that international organisations would have a higher impact if they were to work together. Mr Diop also announced a call for proposals on innovative solutions in Senegal[5].

R&D and innovation needs in the field of off-grid access

Renewable electricity systems (based on PV, wind, small hydro, depending on local resources) should respond to the needs of single families or remote communities (from the kilowatt level to 100s of kilowatts) without access to grid or still relying on inefficient fossil fuels. R&D is needed to bring down the cost of these solutions and enhance the range of energy services they can provide, either to equip people with no access or to modernize existing systems by switching to renewable energy. Innovation is also needed to enhance the availability of energy services such as installation, operation and maintenance, while drawing attention to standardisation issues.

Panellists were to address these crucial needs and also offer views on tools and funding mechanisms to support the technology development and deployment of affordable access to electricity for off-grid households and communities. All participants were invited to consider collaborative approaches in support of off-grid renewables' demonstration and pilot projects, feeding into the value proposition of MI Challenge n°2.

Debate on solutions

The founder and President of Energy Generation, **Astria Fataki**, winner of the 2017 Africa-European Union Energy Partnership (AEEP) Young Energy Leaders Award (France/Togo), delivered a keynote address. Ms. Fataki highlighted her organisation's mission, which is to foster the emergence of innovative entrepreneurial projects among Africa's youth in order to develop reliable, effective and affordable electrification solutions. To meet this challenge, Energy Generation created the Energy Generation Academy, a training program for young social entrepreneurs specialized in the field of energy access solutions. Energy Generation also organizes a pan-African invention contest for non-conventional energy generating solutions. **Ms. Fataki stressed that support starts with education and thinking at the local level**, as importing materials is costly and technology transfer can be challenging. Youth and ingenuity are the local resources that she aims to empower. Designing and manufacturing locally also aligns with a sustainable approach that creates jobs. **Abel Kidane**, winner of the 2016 Energy Generation Prize (Ethiopia), illustrated these efforts and presented the product for which he received a prize, a hand-crank portable charger that he designed to address local electricity problems in Ethiopia.

Following the keynote address, Paolo Frankl, the IEA's Head of the Renewable Energy Division, moderated the panel debate. He asked speakers to identify the specific research directions most likely to have the greatest impact on the availability of energy services. He also directed them to share views on the right mix of flexibility resources needed in order to operate an off-grid system

[5] Information on the call for proposals available at: http://ieeies.undp-wca.org/concours-dinnovation/

based on renewables in a cost-effective and reliable manner. Key messages from panellists and participants highlighted that **technology solutions are available, but that there is still a need to decrease costs**. The digital revolution is an asset, but there is a need for a paradigm shift regarding operation and maintenance, which should involve local training and revenue generating activities for local operators. **Areas for innovation relate mainly to system issues, standardisation, sustainable operation, business models and financing**. There is also an institutional issue to address as current solutions don't reach the poorest families and a need for pricing transparency. Taking a holistic approach, the focus should be on consumer needs and marketing energy services for the people.

Information and communication technologies (ICT) and digital technology acceleration are impacting rural electrification. Smart metering is key for distributed renewable generation for instance. The landscape is evolving and there is a need to adapt.

For solar PV, the technology is mature and provides multiple opportunities for off-grid access to electricity. Technology issues are mainly connected to environmental conditions (temperature, humidity, dust), but the technology gap is closing. **The main challenges linked to operating aspects include the system compatibility of components, standards, quality and reliability, interoperable payment systems, supply and demand issues and storage requirements**. Between centralized and decentralized approaches, there is a role for hybrid systems and mini-grids.

For wind energy, cost reduction is still needed for small and medium scale wind turbines, but new manufacturing strategies could help produce cost competitive wind technology adapted to local conditions. However, the manageability of new energy storage technology dealing with extremely variable wind energy is still unknown. Certification is the right way to increase reliability but is expensive. Development plans need to include local capacity building for wind technology operation and maintenance and keep installations at a reasonable distance from each other to allow for the establishment of viable local companies. Variable renewable energy sources are limited in terms of flexibility. This issue can be improved with hybridization (wind and solar PV are complementary), and energy storage. The right mix will depend mainly on the availability of resources and technology costs.

Micro and small hydro-power schemes can also provide a range of valuable energy services especially in rural areas and can be used as a baseline completed by solar and wind systems.

Innovative appliances and power equipment designed for off-grid conditions are needed to enhance economic development in remote communities. Energy intensive applications are also needed for economic activities such as agriculture or water desalination through the use of high-pressure pumps.

Innovative solutions should also address data collection and the monitoring of installed energy systems.

The European Commission is supporting the Sustainable Energy for All (SE4All) initiative via two funding instruments: the Global Energy Efficiency and Renewable Energy Fund (GEEREF) and the African, Caribbean and Pacific - European Union (ACP-EU) Energy Facility. While there is currently no specific programme on off-grid access, MI will be useful to identify research gaps and needs.

Debate on innovative business models

Appropriate business models and delivery strategies should ensure that the benefits of access to the stable supply of affordable energy are obtained. Closing the investment gap for energy access involves exploring innovative approaches to support the market-based diffusion of distributed renewable energy technologies.

Based on these premises, **Robert Stoner**, Deputy Director of the Massachusetts Institute of Technology (MIT) Energy Initiative and Director of the MIT-Tata Center for Technology and Design, set the stage. He first highlighted the work he has been conducting at MIT on the development of a computer program called REM, the Reference Electrification Model. REM assumes that electrification in developing countries will proceed in a hybrid fashion with a combination of grid extension, and off-grid technology deployment. It starts with a detailed description of the existing medium and low voltage distribution grid, and produces a highly granular description of what the system should look like at universal access – building-by-building, on a country scale – under user-specified assumptions about a host of inputs (the existing grid, location and size of loads, technology and financing costs, business models, fuel costs, grid reliability, etc.). It produces the combination of on and off-grid systems that gives the least expensive overall hybrid. If tariffs are specified, then it also computes detailed subsidy requirements. The goal is to make REM available to planners and developers so that they can optimize their decision making; and also to regulators, so that they can understand how to set tariffs and allocate subsidies efficiently under different assumptions. Mr. Stoner pointed out that there is an enormous possibility of misallocation of capital by big and small players, and lost time.

Focusing on business models, Mr. Stoner drew attention to a crucial issue regarding the anticipated collision of the grid and off-grid regions. Even as off-grid technologies improve and continue to fall in price, he advised that off-grid business models should anticipate grid-interactivity, or suffer displacement by the grid, and obsolescence. He also noted that this can be managed by regulators and policy makers. Mr. Stoner stressed that where they hope to coexist with the grid, small system providers must adapt their offerings and their business models. For off-grid businesses hoping to fend off grid encroachment, it means remaining competitive in terms of cost and reliability with grid service for residential customers, and increasing the use of automation in selling, servicing and bill collecting to appear grid-like to those customers. Fending off the grid may also mean finding innovative ways to serve larger commercial and industrial loads cost competitively as well. **Developing workable micro-grid business models in partnership with governments and regulators is a significant opportunity for enterprising off-grid entrepreneurs**. Mr Stoner concluded by emphasizing that the opportunities to monetize the extensive data many entrepreneurs are now gathering are substantial, and may enable them to expand their businesses not as utilities typically do simply by adding customers, but by offering a range of products and services.

Cathy Zoi, President and Co-Founder of ODYSSEY, delivered the second keynote address. She first offered general remarks highlighting that charity projects provide insufficient funding and that developing off-grid projects is much easier if you are a big player with access to capital, as the cost of selling to off-grid markets is expensive. She then presented the work of ODYSSEY, a web-based platform designed to meet the needs of rural communities and businesses, project developers, vendors, and financiers, by streamlining and reducing the costs of developing and financing rural electrification projects. The company aims to help transform the market and identified three requirements for that purpose: **strong techno-economics, innovative business models and supportive public policy, along with the necessary mobilization of private capital**. The software platform enables and centralizes opportunity evaluation, system design, project planning, financial forecasting, product procurement, project finance and data analytics. Projects are matched with financiers who receive standardized deal proposals with supporting data that meet lending or grant requirements. The structure enables collaboration to structure innovative blended capital funding.

Following the keynote addresses, **Lisa Dignard-Bailey**, Director of Integration of the Renewable and Distributed Energy Resources Program, Natural Resources Canada, moderated the panel debate. Panellists were asked to consider the state of play and latest trends in financing

technology development and deployment of off-grid access to electricity and the challenges and opportunities for non-technological innovation. They were also asked to identify which innovative business models and funding mechanisms can support continuous, safe, affordable and reliable off-grid access to electricity and the service bundles that off-grid access to energy can offer. Last, how to address the role of energy efficiency innovation in meeting off-grid access goals.

High costs, low returns and perceived high risks make investments in decentralised energy access low-income markets unattractive to mainstream private investors. There is a crucial role for public finance and innovative public partnerships with the private sector and civil society in delivering solutions that work for the energy poor. Big players should also partner with local players and work with mini-grid developers. Decentralized energy like solar home systems are viable options and sometimes the only solution to economically deliver fast, efficient, sustainable energy access in areas where centralized grids are slow and prohibitively expensive to deploy. Off-grid solar solutions for basic energy needs, such as electric lighting and charging mobile phones, are valued between $300 and $500 for a family of 5, while the full economic cost of grid connection in remote communities is more than $1000 per customer with continuing costs thereafter. This could significantly impact the debate on off-grid versus on-grid solutions.

Panellists and participants underscored the lack of consumer engagement and attention given to the impact on end users. **The productive use of energy was emphasized as key and should be aligned in such a way that it triggers economic and social development through enhanced local income generating activities**, while simultaneously contributing to global environmental protection. **Productive-use appliances** are also a way to drive socio-economic growth in remote areas. The development of solar welding machines, an innovative solution adapted to off-grid conditions and enabling the use of higher power systems (up to 800Wp), profit families, build local economies, and help utilize the rural youth workforce[6].

Modern ICT technologies allow innovative business models to play a critical role in leapfrogging to renewable decentralized energy supply by combining micropayment and mobile technology, and using smart metering for instance. As such, M-KOPA and Mobisol were highlighted as successful business models with pay-as-you-go (PAYGO) payment solutions, making high-quality solar products affordable to customers with no access to electricity. However PAYGO solutions may not be accessible to the poorest parts of the population. The falling costs of solar technology also results in more and more unreliable **low-quality solar products being found in local market stalls**. In this context, assessing the needs of consumers was reiterated along with involving local communities in off-grid projects.

State commitment was underscored as crucial in terms of providing necessary reassuring frameworks to businesses. While on-grid solutions are regulated by governments, off-grid is often not covered by public regulation, which raises the issue of electricity tariff policy between urban and rural areas. From the standpoint of businesses, there is not necessarily a need for R&D breakthroughs, but for removing barriers and training locally.

Solutions for off-grid access to electricity need to include more than access. High energy bills are common in buildings and homes that waste a lot of energy. Efficiency upgrades can lower those high bills and improve residents' quality of life by providing better comfort, yet making those upgrades often requires payment upfront. **Remote rural homes are underserved by energy-efficiency programs because rural areas lack the customer density necessary to make specialized loan products economical**. Inclusive financing through the Pay As You Save (PAYS) utility investment model was highlighted as providing a solution, with the potential to break

[6] Mobisol's video on the solar welding machine they developed was played during the workshop and is available for viewing at: https://vimeo.com/217472572

these barriers and quickly scale up investment in energy efficiency. These upgrades generate immediate net savings for consumers and make solar more affordable, whether through community solar or on-site rooftop solar.

Stakeholder Engagement

Access to affordable, low-carbon electricity for rural and urban households is a major challenge at the global level and is identified as one of the SGDs. Several international programmes and institutions are involved. While many R&D programmes conducted in MI countries aim to improve the performance of renewable electricity production and management (PV, wind, storage, smart grids), only a few public innovation programmes are specifically targeting low-cost, small-scale systems. This session sought to connect non-state actors and stakeholders, converging efforts under various partnerships in support of off-grid energy access.

Panel debate on linking partnerships to accelerate technology solutions

Mark Radka, Head of the Energy and Climate Branch, Economy Division, at UNEP, kicked off the discussion by delivering a keynote address highlighting two schools of thoughts: one claims that there is a need for technology R&D breakthroughs, the other that the technology is already available. Mr Radka emphasized that rich partnerships should be formed and target innovation on the social side. He mentioned that under the Sustainable Energy for All (SE4All) initiative, we now have access to a depth of data offered by the following two frameworks. The World Bank/Energy Sector Management Assistance Program (ESMAP) and the IEA have led a consortium of 23 international agencies to establish the SE4All Global Tracking Framework[7] (GTF), which describes how to measure baseline and progress towards the SE4All goals by gathering data on energy access, energy efficiency and renewable energy regularly. ESMAP has also developed the Multi-tier Framework (MTF) to monitor and evaluate energy access by following a multidimensional approach. MTF redefines energy access and measures electrification via seven key attributes: peak capacity, reliability, affordability, health and safety, availability, quality and legality. Using the MTF, **Mr. Radka stressed the low satisfaction of households using solar PV as the main source, the key issue being identified as the quality of the light provided, not the cost of the system.** He noted that there is still a long way to go before creating an enabling environment for stand-alone home systems and that collaboration is a prerequisite to move forward. Conditions for collective impact include influential champions, sustained and adequate financial resources and a sense of urgency for change around the issue. Other crucial elements include a common agenda, shared measurement, mutually reinforcing activities, continuous communication, backbone support and mindset shifts.

Frank van der Vleuten, Senior Renewable Energy Advisor from the Ministry of Foreign Affairs of the Netherlands moderated the panel debate. Panellists and participants noted that decentralized renewable energy is the fastest, most cost-effective and sustainable approach to universal energy access. Once again, they emphasized that the focus should not be on R&D breakthroughs, but on putting resources in the right kind of partnerships and doing work on the ground. It is time to rethink the private sector approach by embedding off-grid renewable energy technologies into holistic and integrative solutions. Successful companies listen to the

[7] 2017 Global Tracking Framework available at: http://gtf.esmap.org/downloads

communities, explore their needs and join forces with other players (interested private companies, NGOs, the public sector, local communities) to reduce risks and offer solutions that create sustainable development opportunities. **Triggering economic development requires a wider definition of electricity access that includes basic services as well as energy levels for productive use**. **Electrification needs to be coupled with quality inputs such as education and capacity building, access to markets, machinery and equipment**. Environmental sustainability is also a crucial aspect of this holistic approach and should be included in the scope of private sector engagement. With a limited lifespan, the large number of solar lanterns and home systems being distributed in sub-Saharan Africa is adding to the region's existing problems with electronic waste for instance. There is a risk of reaching the target of lighting energy poor countries by producing a lot of waste**.** Products should be designed by local manufacturers with this in mind and locally assembled, creating employment.

Collecting and measuring impact data on energy companies allow to provide quality customer feedback to drive business decisions and demonstrate to governments, donors, and investors the value of energy access in addressing the larger problems of poverty. Governments can facilitate the market with policies such as reducing tariff barriers on renewables (duties and value-added taxes) and including distributed renewables in national energy policies. There is an urgent call for leaders to take greater, more focused action to deliver sustainable energy for all. On closing the energy access gap, 1.02 billion people still live without electricity and we only have thirteen years to meet the SDGs. **As stressed by the IEA, currently planned policies fall short of meeting universal access to electricity and lead to 800 million people still with no access by 2030, which is perceived as a failure.** There should be a willingness to take financial risks

The importance of having African countries at the clean energy table when discussing energy access was stressed.

Evidence shows that women disproportionately bear the burden of energy poverty. Distributed renewable energy solutions can not only empower women economically and socially as end users, but **the sector itself can significantly benefit by proactively integrating women across the value chain as designers, educators, trainers, managers, and entrepreneurs**. Innovative business models should be inclusive and empower women as agents of change in the energy sector. More concerted policy action is needed to ensure that electricity access helps reduce gender inequality.

The IEA Technology Collaboration Programme on Clean Energy Education and Empowerment (C3E TCP), [8] formally established in June 2017, seeks to recognise and build a community of women leaders in the field of clean energy across diverse sectors; create a framework for co-operation and information sharing among participating countries; and share best practices for effective strategies to advance women in the clean energy field. The objectives will be pursued by collecting, integrating, synthesising and distributing information on promising practices and policies to engage women in clean energy careers and leadership positions.

Stressing the need for enhanced discussion between the public and private sector, Mexico extended an invitation to MI members to attend and participate in the MI-World Economic Forum (WEF) Strategic Dialogues on Effective Public Private Cooperation on Clean Energy Innovation, held on 12 September, 2017 in Mexico City, in the context of the Dialogues for the Future of Energy, Mexico 2017 (DEMEX) [9] meetings.

[8] More information on the C3E TCP is available at: https://www.iea.org/tcp/cross-cutting/c3e/

[9] More information on the DEMEX meetings available at: http://demex.mx/en/

Closing Remarks

Mr Moisan offered closing remarks highlighting a few takeaways from the meeting. There are still important barriers to overcome. There is a need for a technology push, but the focus should be on consumer needs, operation and maintenance, the digital revolution and increasing capacity building. The low quality of products remains an issue, along with addressing their environmental impact. Governments have an important role to play, as well as banks, which should take bigger risks. There is a sense of urgency and the need to keep the momentum going. Upcoming meetings under this MI Challenge should also involve representatives of countries that stand to gain most from enhanced worldwide off-grid access to electricity, including countries from Africa that currently do not participate in MI.

Mr Turk wrapped up the event, emphasizing that through MI countries' commitment to double their governments' clean energy R&D investments, there can be an extra 15 billion dollars coming online every year. He hoped that some of these funds will be guided to the access space. Mr Turk noted that should there be interest from governments in Africa and other regions, partnerships can happen through this MI Challenge. He reiterated the need to hear from consumers as crucial, and highlighted the appetite for different types of technologies and cost reductions. He also drew attention to the importance of political ownership and commitment from development agencies, and encouraged risk taking to try out various models. Finally, he underscored that solving the energy access problem will also fundamentally depend on human ingenuity.

Key Takeaways / Recommendations

The workshop was successful in bringing strong expertise to the table. While various stakeholders have been tackling the issue of energy access for quite some time, continued and urgent efforts are needed to reach universal access to energy for all. Here are some of the key points raised by speakers and participants during the meeting:

Technological issues

- The digital revolution is key to enabling energy access
- Further cost reduction of off-grid renewable technologies, operation and maintenance is needed
- Solar home systems are viable and affordable options for remote communities
- Hybridization (wind and solar PV) and storage can solve the issue of flexibility of variable renewable energy sources
- Micro and small hydro-power schemes coupled with solar and wind can provide valuable energy services
- Energy efficiency should be part of the solution, especially for productive- use appliances

Systems issues including maintenance and quality control

- Need to integrate supply and demand
- Need to link solutions to productive use and take a holistic approach
- Need for a sustainable deployment of technologies, factoring in environmental impact
- Quality of products found in local markets is an issue
- Access to a depth of data on energy access is useful to provide quality customer feedback

- There is untapped potential for deploying renewable energy mini-grids

Business models

- Business models should anticipate grid interactivity
- Need to increase access to finance: cost of selling to off-grid markets is expensive

Socio-economic issues

- Innovative solutions must be adapted to each country's needs and resources
- Importance of involving end users, as current solutions not supporting needs
- Need to empower youth through education

Governance and stakeholders involvement

- Collaboration is a prerequisite to move things forward
- Crucial role of public finance and innovative public partnerships with the private sector and civil society
- Businesses need reassuring frameworks and commitment from governments
- Women-inclusive business models can empower women as agent of change

The following next steps and recommendations should be considered for action by MI countries:

- Identify clear individual and collaborative research and innovation priorities for off-grid renewable energy technologies
- Further engage with the IEA TCPs as vehicles to implement collaborative innovation efforts in support of off-grid access to electricity. In particular, the PVPS TCP, the Wind Energy TCP and the Hydropower TCP can offer cost-effective frameworks for multi-lateral collaboration in this space.
- Conduct a survey addressed to NGOs so they can further share on the ground knowledge of consumer needs.
- Leverage resources and increase knowledge sharing by partnering with other international organizations and stakeholders
- Invite representatives of countries that stand to gain most from increased access to electricity to participate in future MI meetings under this Innovation Challenge, notably from Africa.
- Extend the invite to non-state and private sector representatives, including women entrepreneurs.

ANNEX I. AGENDA OF THE WORKSHOP

OPENING **9:30 – 10:00**	**Welcome and opening remarks** • **Mission Innovation -** Laurent Michel, Director General, French Ministry for the Ecological and Inclusive Transition • **ADEME –** Fabrice Boissier, Director General • **IEA –** Dave Turk, Acting Director for Sustainability, Technology, and Outlooks
SESSION 1 **10:00 – 11:20**	**Mapping the state of energy access and off-grid systems** *Moderator*: **ADEME** - Francois Moisan, Executive Director of Strategy, Research and International Affairs *Interventions*: • **IEA –** Laura Cozzi, Head of the Energy Demand Outlook Division (WEO) • **International Renewable Energy Agency (IRENA) –** Emanuele Taibi, Power Sector Transformation Strategies • **India -** Vineet Saini, Principal Scientific Officer, Technology Mission Division, Department of Science & Technology • **United Nations Development Programme (UNDP) -** El Hadji Diop, Co-ordinator IEEIES Platform Senegal
Coffee break (20 mins)	
SESSION 2 **11:40 - 13:00**	**R&D and innovation needs in the field of off-grid access** ***2.1. Panel debate on solutions*** *Moderator:* **IEA -** Paolo Frankl, Head of the Renewable Energy Division *Keynote:* **Energy Generation -** Astria Fataki, President and winner of AEEP Young Energy Leaders Award 2017 (France/Togo); and Abel Kidane, winner of Africa Energy Generation Prize 2016 (Ethiopia) *Panellists:* • **French National Solar Energy Institute (INES) -** Philippe Malbranche, Director-General • **European Commission –** Fabio Belloni, Policy Officer • **Schneider Electric –** Thomas Andre, Access to Energy Strategy Director • **IEA Photovoltaic Power Systems TCP (PVPS TCP) -** Stefan Nowak, Chair of the Executive Committee • **IEA Wind Energy TCP** – Ignazio Cruz, Operating Agent Small Wind Project • **French Development Agency (AFD) -** Christian de Gromard, Project Manager
Lunch (60 mins)	
SESSION 2 ***(CONTINUED)*** **14:00 – 15.30**	***2.2 Panel debate on innovative business models*** *Moderator*: **Natural Resources Canada** - Lisa Dignard-Bailey, Director of Integration of Renewable and Distributed Energy Resources Program *Keynotes:* • **Massachusetts Institute of Technology (MIT) -** Robert Stoner, Deputy Director of the MIT Energy Initiative and Director of the MIT-Tata Center for Technology and Design • **ODYSSEY -** Cathy Zoi, President and Co-Founder *Panellists:*

	• **Practical Action** - Aaron Leopold, Global Energy Representative • **Mobisol** - Thomas Duveau, Chief Strategy Officer • **Electricien sans Frontière (ESF)** - Marc Gratton, General Manager • **M-KOPA –** Jon Ridley, Director, M-KOPA Labs • **Clean Energy Works –** Holmes Hummel, Founder
SESSION 3 **15:30 – 17.00**	**Stakeholder engagement** ***Panel Debate*: linking partnerships to accelerate technology solutions** *Moderator*: **Ministry of Foreign Affairs of the Netherlands** - Frank van der Vleuten, Senior Renewable Energy Advisor *Keynote:* • **United Nations Environment Programme (UNEP) –** Mark Radka, Head of the Energy and Climate Branch, Economy Division *Panellists:* • **GOGLA –** John Keane, Program Manager • **RES4AFRICA -** Marco Aresti, Program Manager • **Acumen –** Kat Harrison, Associate Director, Impact & Lean Data • **Power for All** - Kristina Skierka, CEO
17:00 – 17:30	**Closing remarks and wrap up** • **ADEME** - Francois Moisan, Executive Director of Strategy, Research and International Affairs • **IEA** – Dave Turk, Acting Director for Sustainability, Technology, and Outlooks

Workshop presentations are available at:

http://www.iea.org/workshops/identifying-technology-innovation-needs-and-opportunities-under-mission-innovati.html

ANNEX II. LIST OF PARTICIPANTS

LIST OF PARTICIPANTS by organisation / country (alphabetical order in English)

Name	Position	Organisation / Country
Kat HARRISON	Associate Director of Impact & Lean Data	Acumen Fund
Willy FAUVEL	Manager	Aemi
Kevin Chika URAMA	Senior Policy Advisor	African Development Bank (AfDB)
Elena BARBIZET	CEO	Atoll Energy
Hendrik ZECHNER	Counsellor for Energy, Trade, Industry and Science	Austria – Permanent Representation to the OECD
Alexandre HULIN	Senio Manager	Bertin Technologies
Antonia ORSONI	Off-Grid Solution Manager	Blue Solutions
Lisa DIGNARD-BAILEY	Director, Integration of Renewable and Distributed Energy Resources Program	Canada - Natural Resources Canada (NRC)
Alessandro CASOLI	Strategy Manager	Carbon Trust
Rodolfo LOBATO	Policy Research and Advice	Clean Energy Ministerial (CEM) Secretariat
Sarbojit PAL	Policy Research and Advice	Clean Energy Ministerial (CEM) Secretariat
Holmes HUMMEL	Founder	Clean Energy Works
Andres GONZALEZ	Researcher	Comillas Pontifical University of Madrid, Institute for Research in Technology (IIT/Comillas)
Toby COUTURE	Founder & Director	E3 Analytics
Olivier PETETIN	Development Manager	ECOCINETIC
Bruno POISSON	CEO	ECOCINETIC
Daouda KOULIBALY	Project Manager, Off-Grid Department	EDF Énergies Nouvelles
Marc GRATTON	Délégué Général	Electricien sans Frontière (ESF)
Hervé GOUYET	President	Electricien sans Frontière (ESF)
Marilyn SMITH	Executive Director	En-Act (The Energy Action Project)
Madeleine POST	Manager	ENEA CONSULTING
Richard SCOTNEY	Manager	ENEA CONSULTING
Jose Alberto GARIBALDI	Director General	Energeia (Mexican NGO)

Astria FATAKI	President and founder	Energy Generation
Abel KIDANE	Winner of Africa Energy Generation Prize 2016	Energy Generation
Fabio BELLONI	Administrator	European Commission
Gerd SCHONWALDER	Policy Officer	European Commission
Yves MAIGNE	Director	Fondation Énergies pour le Monde (FONDEM)
Laurent MICHEL	Director General	France - Ministry for the Ecological and Inclusive Transition, Directorate-general for Energy and Climate
Cédric THOMA	Chargé de Mission	France - Ministry for the Ecological and Inclusive Transition, Directorate-general for Energy and Climate
Nastassja HOFFET	Climate & Energy	France - Ministry of Foreign Affairs and International Development
Guy-Cédric WERLINGS	National Focal Point for the International Solar Alliance	France - Ministry of Foreign Affairs and International Development
Christian DE GROMARD	Référent énergie	French Development Agency (AFD)
Nicolas GUICHARD	Responsable adjoint Division Energie	French Development Agency (AFD)
Jacques BARBERYE	Chargé de mission international	French Environment and Energy Management Agency (ADEME)
Fabrice BOISSIER	Director General	French Environment and Energy Management Agency (ADEME)
Laurent CAILLIEREZ	Coordinator	French Environment and Energy Management Agency (ADEME)
Dominique CAMPANA	Directrice de l'Action Internationale	French Environment and Energy Management Agency (ADEME)
François GRÉAUME	Chef du service coordination géographique inernationale	French Environment and Energy Management Agency (ADEME)
Philippe MASSET	Head of Unit	French Environment and Energy Management Agency (ADEME)

François MOISAN	Executive and Scientific Director	French Environment and Energy Management Agency (ADEME)
Hervé PERNIN	Chagé de mission innnovation	French Environment and Energy Management Agency (ADEME)
Hélène SABATHIÉ-AKONOR	Chargée de Mission Afrique Sub-saharienne / Océan Indien / Amérique Latine	French Environment and Energy Management Agency (ADEME)
Solenn ANQUETIN	International Project Manager	French National Solar Energy Institute (INES)
Philippe MALBRANCHE	Director-General	French National Solar Energy Institute (INES)
Sven REUTZEL	Counsellor Energy, Trade and Environment	Germany - Permanent Representative to the OECD
John KEANE	Program Manager	GOGLA
Minh Cuong LE QUAN	Program Officer - Energy	GRET
Mathieu LE GAGNEUX	Référent Filière - Pôle Énergie	ID
Stefan NOWAK	Chair of the Executive Committee	IEA Photovoltaic Power Systems TCP (PVPS TCP)
Ignacio CRUZ	Operating Agent Small Wind Project	IEA Wind Energy TCP
Vineet SAINI	Principal Scientific Officer	India - Department of Science & Technology
Patrick COUSINS	CEO and Co-Founder	Infinite Fingers GmbH
Simon BENNETT	Energy Technology Analyst	International Energy Agency (IEA)
Laura COZZI	Head of Energy Demand Outlook Division	International Energy Agency (IEA)
Hannah DALY	Energy Modeller	International Energy Agency (IEA)
Paolo FRANKL	Head of Renewable Energy Division	International Energy Agency (IEA)
Simone LANDOLINA	Head of International Partnerships and Initiatives	International Energy Agency (IEA)
Sara MOARIF	Energy Analyst - Environment and Climate Change	International Energy Agency (IEA)
Bruce MURPHY	India Programme Manager	International Energy Agency (IEA)
Alexandra NOWAK	Analyst	International Energy Agency (IEA)
Cedric PHILIBERT	Senior Energy Analyst Renewable Energy Technologies	International Energy Agency (IEA)

Carrie POTTINGER	Programme Manager Technology R&D Networks	International Energy Agency (IEA)
Dave TURK	Acting Director for Sustainability, Technology and Outlooks	International Energy Agency (IEA)
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William ADAM	Sales Engineer	Mascara NT
Robert STONER	Director of the MIT-Tata Center for Technology and Design	Massachusetts Institute of Technology (MIT)
Jon RIDLEY	Director	M-KOPA
Thomas DUVEAU	Chief Strategy Officer	Mobisol GmBh
Paul BERTHOMIEU	CEO	MyJouleBox
Mitsuhiro YAMAZAKI	Deputy Director	NEDO Europe
Frank VAN DER VLEUTEN	Senior Renewable Energy Advisor	Netherlands - Ministry of Foreign Affairs
Cathy ZOI	President & Co-Founder	Odyssey Energy Solutions
Peik STENLUND	Co-Founder	Pamoja Cleantech
Paulo AREOSA FEIO	Counsellor	Portugal – Permanent Delegation to the OECD
Kristina SKIERKA	CEO	Power for All
Aaron LEOPOLD	Global Energy Representative	Practical Action
Rana ADIB	Research Coordinator	REN-21
Marco ARESTI	Manager	RES4MED&Africa
Ana ROZVAR	International Relations Advisor	RES4MED&Africa
Thomas ANDRÉ	Access to Energy Strategy Director	Schneider Electric
Cyril CARABOT	Secretary General / Responsible for International Relations	Syndicat des Energies Renouvelables
Daniele BESSIS	Senior Advisor	Talan
Maxence BOCQUEL	Consultant	Think Smart Grids

Florent GIORGI	Responsible for Sourcing Access to Energy	TOTAL
Jennie DODSON	International Energy Innovation Advisor	United Kingdom - Department for Business, Energy and Industrial Strategy (BEIS)
El Hadji DIOP	Director	United Nations Development Programme (UNDP)
Mandredi CALTAGIRONE	Programme Officer – Energy and Climate Branch	United Nations Environment Programme (UNEP)
Mark RADKA	Director	United Nations Environment Programme (UNEP)
Marissa FERGUSON	DOE Assistant	United States – Permanent Delegation to the OECD
Blair PASALIC	Senior Analyst	United States – Permanent Delegation to the OECD
Arnaud MILLIEN	PhD Candidate	University of Paris I

Acronyms, abbreviations and units of measure

Acronyms and abbreviations

ADEME	French Environment and Energy Management Agency
AEEP	Africa-European Union Energy Partnership
ACP-EU	African, Caribbean and Pacific - European Union
C3E TCP	Technology Collaboration Programme on Clean Energy Education and Empowerment
DEMEX	Dialogues for the Future of Energy, Mexico
ESMAP	Energy Sector Management Assistance Program
GEEREF	Global Energy Efficiency and Renewable Energy Fund
GTF	Global Tracking Framework
IBE	Inclusive business ecosystem
(ICT)	Information and communication technologies
IEA	International Energy Agency
IOREC	International Off-Grid Renewable Energy Conference
IRENA	International Renewable Energy Agency
MI	Mission Innovation
MIT	Massachusetts Institute of Technology
MTF	Multi-tier Framework
NGO	Non-Governmental Organization
PAYGO	Pay-As-You-GO
PAYS	Pay As You Save
PVPS TCP	Photovoltaic Power Systems TCP
R&D	Research and Development
REM	Reference Electrification Model
SDG	Sustainable Development Goals
SE4All	Sustainable Energy for All
TCP	Technology Collaboration Programme
UN	United Nations
UNDP	United Nations Development Programme
UNEP	United Nations Environment Programme
WEO	World Energy Outlook
WEF	World Economic Forum

Units of measure

kWh	kilowatt hour


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