出國報告（出國類別：參加研討會）

運用太陽能科技與微型混和電站
改善能源可及性

服務機關：國立中正大學
姓名職稱：徐千偉 副教授
派赴國家：德國
出國期間：2016 年 9 月 19 日至 2016 年 9 月 27 日
報告日期：2016 年 9 月 28 日

摘　要

筆者此次出國主要是赴德國法蘭克福（Frankfurt）參加「運用太陽能科技與微型混和電站改善能源可及性」（Solar Technology & Hybrid Mini Girds to improve energy access）國際研討會，並發表乙篇文章。此次研討會爲德國聯邦經濟合作與發展部（Federal Ministry for Economic Cooperation and development, Bundesministerium für wirtschaftliche Zusammenarbeit und Entwicklung）委託東巴伐利亞科技轉型中心（Ostbayerisches Technologies-Transfer-Institut e.V., OTTI）辦理。筆者發表的論文題目爲「建構鄉村家戶能源需求分析架構以改善發展中國家能源可及性：對太陽能發展合作計畫的啓示」A framework for analyzing energy needs of rural households to improve energy access in developing countries: Implications for solar energy based development cooperation」。

目　次

一、目的

筆者此次出國主要是赴德國法蘭克福（Frankfurt）參加「運用太陽能科技與微型混和電站改善能源可及性」（Solar Technology & Hybrid Mini Girds to improve energy access）國際研討會（會議日期爲 2016 年 9 月 21 日至 2016 年 9 月 23 日），並發表乙篇文章，會議議程請參閱附錄一。此次研討會爲德國聯邦經濟合作與發展部（Federal Ministry for Economic Cooperation and development, Bundesministerium für wirtschaftliche Zusammenarbeit und Entwicklung）委託東巴伐利亞科技轉型中心（Ostbayerisches Technologies-Transfer-Institut e.V., OTTI）辦理。筆者發表的論文題目爲「建構鄉村家戶能源需求分析架構以改善發展中國家能源可及性：對太陽能發展合作計畫的啓示」A framework for analyzing energy needs of rural households to improve energy access in developing countries: Implications for solar energy based development cooperation」，論文內容請參閱附錄二。

二、過程

筆者於 9 月 19 日（週一）晚間十一點半於桃園國際機場搭乘華航直飛法蘭克福的去程班機，並於 9 月 20 日（週二）上午抵達法蘭克福。

9 月 21 日（週三）上午十點參加研討會的 Side event「Making Universal Access Work! New Village Power Planning Tools」。這場 Side event 是由國際再生能源署 IRENA（International Renewable Energy Agency）主辦，主要介紹可運用在發展中國家新的鄉村供電規劃工具，並提供實務操作經驗，以改善發展中國家能源供應的問題。

9 月 21 日下午兩點研討會正式開始，並進行兩個場次的研討，第一個場次是「國際計畫與市場發展」（International Programs and Market Development），第二個場次是「工業論壇及海報發表」（Industry Forum and Poster Session）。筆者的論文是安排在第二個場次 C4 進行口頭發表。來自台灣的另一位與會者爲台大教授，亦安排在同一個場次發表。筆者所發表之論文亦另行製作海報展示研究成果，海報請參閱附錄三。第一天研討會於晚間八點左右結束。

9 月 22 日（週四）進行第二天的研討會，上午有三個場次，分別是「太陽能科技綜覽」（Solar Technologies Overview）、「再生能源混和電站科技」（Hybrid RE Power Plant Technology）及「太陽能爐具、太陽能海水淡化系統、太陽能抽水馬達」（Solar Cooking, Desalination, Water Pumping）。下午有四個場次，分別爲「實務工

作者圓桌論壇」（Practitioners Round Table）、「鄉村供電」（Rural Electricity）兩個場次、「太陽能在工業上的應用」（Solar in Industrial Application）。研討會於晚間六點半結束。七點半主辦單位邀請與會者參加研討會晚宴。

9 月 23 日（週五）進行第三天的研討會，上午有兩個場次，分別是「能力建構」（Capacity Building）與「田野經驗」（Field Experience）。研討會於下午一點結束。

9 月 26 日（週一）上午十一點二十分於法蘭克福機場搭乘華航直飛台北的回程班機，並於 9 月 27 日（週二）上午六點十分抵達桃園機場。

三、心得

本次會議與一百多位來自世界各國的太陽能專家、學者、政府官員、實務工作者、企業代表、工業代表共同討論如何運用太陽能科技來改善發展中國家人民的供電需求。主要收穫如下：

1. 建立研究相關領域的聯繫網絡
2. 瞭解研究相關領域的最新進展
3. 與其他專家學者分享及討論筆者的研究成果及再精進的發展方向
4. 瞭解太陽能科技的最新發展
5. 瞭解實務界的運用狀況
6. 瞭解太陽能市場發展情況
7. 瞭解太陽能科技在發展中國家鄉村供電的運用情形

四、建議

建議本校相關領域研究者未來可多參與類似的國際研討會，以交流研究成果，並激發新的研究構想。

附錄一：

研討會議程

International Conference


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Solar Technologies & Hybrid Mini Grids to improve energy access

Stadthalle Bad Hersfeld,
Metropolitan area Frankfurt, Germany
September 21–23, 2016


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Unter der Schirmherrschaft des

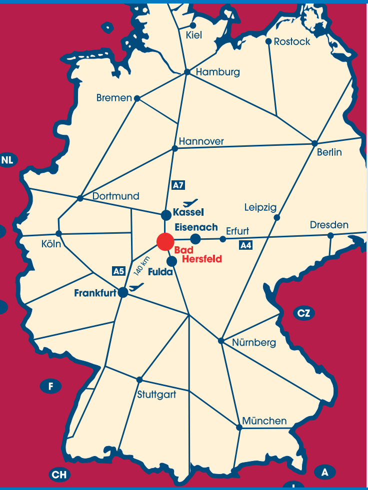
Bundesministerium für wirtschaftliche Zusammenarbeit und Entwicklung

OTTI

www.energy-access.eu

www.otti.eu

Conference Venue



Bad Hersfeld is located in the heart of Germany, close to the airport Frankfurt.

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Please book your accommodation as soon as possible by yourself.
Further information under: http://www.energy-access.eu/info/accommodation.html

Travel Information

Plane

Airport Frankfurt (150 km)

http://www.frankfurt-airport.com/content/frankfurt_airport/en.html

Phone: +49 180 6 3724636

Train

Bad Hersfeld has its own ICE train station with direct connection to Frankfurt Airport

https://www.bahn.de/p_en/view/index.shtml

You will meet

- Scientists, engineers, consultants, students
- Research institutes
- Implementation institutes
- Threshold countries: manufacturers, suppliers and installers
- Donors: programme planners, financiers from banks and foundations
- Politicians

Conference Chairmen

Xavier Vallvé
Trama TecnoAmbiental S.L., Barcelona, Spain

Werner Weiss
AEE-Institue for Sustainable Technologies, Gleisdorf, Austria

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Michael Wollny
Alliance for Rural Electrification, Belgium

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Includes all members of the Programme Committee as well as the following persons:

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CRES - Centre for Renewable Energy Sources, Greece

Prof. Dr. Roberto Zilles
Institute of Energy and Environment, Brazil

Chairmen's Message

Dear Colleagues,

We are pleased to announce that we are joining forces for the new international conference "Solar Technologies and Hybrid Mini Grids to improve Energy Access".

In an effort to create a more comprehensive, higher impact conference we have merged the following three very successful conferences into one:

- PV-Hybrids and Mini-Grids (7 editions)
- Small PV Applications (4 editions)
- Solar Energy Technology in Development Cooperation (one edition)

The challenge of energy access for all is of enormous magnitude and we have reached a point where joining forces will make a difference in the upcoming years. We recognize that the general international agreements that are focusing on pursuing sustainable energy for all have to be enforced by actions on the ground. If we are not able to implement renewable energy technologies in combination with energy efficiency measures these international agreements are not going to achieve their potential.

Future energy supply will be based on a smart mix of different technologies in order to cater to people's needs. Solar radiation is the most abundant source of energy that can be converted into electricity and heat. It is a widely distributed resource that can be harvested and consumed near to where the needs are. Solar thermal systems are able to meet not only the heat demand for all domestic needs like hot water and space heating, but it can also fulfill the heating needs of hotels, hospitals and industrial processes. Photovoltaics, and other renewable technologies such as small wind turbines, mini-hydro, biomass or their hybridization can provide quality electricity to those who do not have access to reliable modern energy services. This helps to significantly improve lives in terms of comfort, communication, health, education and income generating activities. It also opens up new opportunities for businesses and services.

Due to the intermittency of solar radiation, solar energy technologies include storage functionalities in order to make energy available for 24 hours a day. There are a number of new developments in the pipeline and components on the market for storing solar thermal heat and renewable electricity. Control and monitoring technologies and high efficiency appliances are also important enabling technologies where innovation is moving fast.

Whereas solar heating is usually consumed where it is produced, autonomous solar electricity increasingly tends to be integrated as well into mini grids (also called micro grids). Hybrid PV Mini Grids are a cost-effective and a quicker alternative to grid extension or to unreliable grids for many villages.

Therefore, an intelligent mix of the above technologies and micro grids is capable of providing electricity and thermal comfort not only at household level, but also to entire villages, institutions, hotels, and businesses. This also opens the door to bottom up approaches to energy planning and development.

The international character of this conference and exhibition will bring together academia, practitioners, industry and development institutions with the aim of sharing experiences and the latest technology developments, learning from each other and networking.

The objective of the event, and the challenge that we, as participants are facing, is:

- to consolidate the knowledge around solutions that have proven to work and their enabling factors,
- to present different models of financing, business models and technologies that enable the fast uptake of such solutions and
- to provide new roads for research and innovation;

All of it, ensuring the aspects of sustainability of such energy services, and demonstrating the feasibility of such endeavors in different scales of intervention.

The conference advisory board, the OTTI organizing team and we as chairmen are pleased to welcome you to the conference and to encourage you to actively contribute to a successful event.

Xavier Vallvé, Trama TecnoAmbiental S.L., Barcelona, Spain

Werner Weiss, AEE-Institue for Sustainable Technologies, Gleisdorf, Austria

Sponsors:

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SIDE EVENT:
Making Universal Access Work!
New Village Power Planning Tools

A pre-conference event by practitioners for practitioners

Stadthalle Bad Hersfeld, Germany
Wednesday 21st,2016, 10.00 – 12.00 hrs

Session Chairs:
Kilian Reiche, iiDevelopment GmbH, Frankfurt, Germany and Dr. Roland Roesch, IRENA, Bonn, Germany

The joint GIZ/IRENA side event will provide our Sep 21- 23 conference participants with an early opportunity to learn about some of the latest universal access planning tools, by practitioners for practitioners.

10.00 Opening

10.05 IRENA Project Navigator incl Q&A
Dr. Roland, Roesch, Irena

10.30 KENYA Village Power Planning Tools
Jasmin Fraatz, GIZ

10.55 HERA-EnDev Planning Tools and review of toolkits
Caspar Priesemann, GIZ

11.20 Trying the Tools on 5 laptop stations

12.00 End of the pre-conference

To register for this side event, please send an email to:
Michael Bauer, pr3-energie@otti.de
Only for participants of the International Conference on Solar Technologies & Hybrid Mini Grids to imrprove energy access (free of charge)

International Conference on Solar Technologies & Hybrid Mini Grids to improve energy access

Wednesday, September 21st, 2016

14.00 **Opening Address**
Gabriele Struthoff-Müller, OTTI, Regensburg, Germany
Xavier Vallvé, TramaTecno Ambiental, Barcelona, Spain
Werner Weiss, AEE-Institute for Sustainable Technologies, Gleisdorf, Austria

OPENING SESSION

Chair: Xavier Vallvé, TramaTecno Ambiental, Barcelona, Spain
Werner Weiss, AEE-Institute for Sustainable Technologies, Gleisdorf, Austria

14:15 Welcoming Speech
Alexander Karner, Austrian Development Agency, Vienna, Austria

14:20 Welcoming Speech
Roland Rösch, IRENA, Bonn

14:25 Key note speech
Multi-Tier Framework (MTF) and Sustainable Development Goals (SDG) – Implications for Energy Access Practitioners
Dana Rysankova, The World Bank, Wahsington, DC

SESSION 1: INTERNATIONAL PROGRAMS AND MARKET DEVELOPMENT

Chair: Gonzalo Piernavieja Izquierdo, Technological Institute of Canary Islands, Spain
Roberto Zilles, Institute of Energy and Environment, Brazil

15:00 The Global Microgrid Market: International Hotspots and Growth Markets
Ross Bruton, Frost & Sullivan, London, Great Britain

15:15 Deploying PV Services for Regional Development, Products and Future Activities of the IEA Working Group
Hedi Feibel, Skat Consulting Ltd., St. Gallen, Switzerland

15:30 Market and Technical Trends in Off-Grid Household Electrification with Pico PV and Solar Home Systems
Hans-Peter Birkhofer, GOGLA, Ebersberg, Germany

15:45 Innovative Renewable Solutions for Off-Grid Electrification in Namibia
Helvi Ileka, Namibia University of Science and Technology, Windhoek, Namibia

16.00 SOLTRAIN - Southern African Solar Thermal Training and Demonstration Initiative
Werner Weiss, AEE-Institute for Sustainable Technologies, Gleisdorf, Austria

16:15 Discussion

16:35 Coffee Break

SESSION: INDUSTRY FORUM AND POSTER SESSION

Chair: Joscha Rosenbusch, GIZ, Mexico City, Mexico
Boaventura Cuamba, Eduardo Mondlane University, Maputo, Mozambique
Michael Müller, Steca, Germany

17:20 SMA Sunbelt Energy GmbH. Niestetal, Germany
Studer Innotec SA, Sion, Switzerland

A1 A Framework for Analysis of Village-Level Power Supply in Context
Kirsten Ulsrud, University of Oslo, Oslo, Norway

A2 **A Monitoring System Based on Arduino for Remote PV-Diesel Hybrid Mini Grids and System Performance**
Jorge Solórzano, Madrid, Spain

A3 **Decentralized Electrification with Productive Use along Rivers. Hybrid Systems with Hydrokinetic Turbines are Proved to be Efficient and Economical Solutions**
Marius Weckel, Smart Hydro Power, Garatshausen, Germany

A4 **Geospatial Modelling and Implementation Plan for Electrification Strategies – The Case of Nigeria**
Catherina Cader, Reiner Lemoine GmbH, Berlin, Germany

A5 **Reducing the Cost of Solar Home System**
Asif Rabbani, Bangladesh University of Engineering & Technology, Dhaka, Bangladesh

A6 **Back to the Envelope: A Growing Set of Simple, Spreadsheet-Based "MiniXLS" Tools Helps Practitioners Improve the Planning and Implementation of Integrated (Village Grid and Stand-alone Solar) National Electrification Programmes, on the Way to Universal Access**
Kilian Reiche, iiDevelopment, Frankfurt am Main, Germany

A7 **Design and Operational Control of the Agios Efstratios Island Mini Grid**
Stathis Tselepis, CRES - Centre for Renewable, Athens, Greece

A8 **Case Studies of Mobile and Stationary Hybrid Generators for Industrial and Community Mini Grid Applications**
Matt Anderson, Studer Innotec, Sion, Switzerland

A9 **PV Based Mini Grids Simulation for Communities and Critical Infrastructure in Polish Pomerania**
Edyta Witka-Jezewska, Electrotechnical Institute Gdansk Branch, Gdansk, Poland

A10 **The Internet of Things (IoT) Revolution and its Impact on the Off-Grid Sector**
Roy Emmerich, Infinite Fingers, Kassel, Germany

A11 **A Proto-type Turret Design for Solar Gain through Azimuth Tracking**
Ivan Yaholnitsky, Bethel Business and Community Development Centre, Mt. Moorosi, Lesotho

B1 **Optimal Sizing, Performance Prediction and Economic Analysis of Solar Hot Water Systems for Three Hotels in Zimbabwe**
Tawanda Hove, University of Zimbabwe, Harare, Zimbabwe

B2 **The State of Solar Water Heating Research in South Africa - A Review**
Angela Karen Surridge-Talbot, SANEDI, Johannesburg, South Africa

B3 **Geographic Information System (GIS) Mapping, Monitoring and Verification of Solar Water Heating Installations in South Africa**
Angela Karen Surridge-Talbot, SANEDI, Johannesburg, South Africa

B4 **Design, Construction and Testing of a Low-Cost Flat Plate Solar Energy Collector**
Molibeli Taele, National University of Lesotho, Roma, Lesotho

B5 **Solar Water Heater Micro Systems**
Robert Buchinger, Sunlumo Technology GmbH, Perg, Austria

B6 **Large-Scale Solar Thermal Systems for Mozambique**
Fabiao Manuel Cumbe, ENPCT, Maputo, Mozambique

B7 **Expansion of Two Existing Solar Thermal Pump Systems (STPS) in Harare and Bulawayo for Demonstration, Performance Monitoring and Teaching Purposes**
Charles Murove, Hermit Sustainability Advisory, Harare, Zimbabwe

B8 **Prototype Development of a Solar Dryer for Biomass for Developing Countries**
Jan Schalk, Bielefeld, Germany

B9 **Solar-Thermal Coffee and Cocoa Beans Drying Systems Incorporating a Heat Storage Method Using Ground as Heat Reservoir and Complemented with Residual Biomass Energy**
Anja Lippkau de Pozo, Corporación para la Investigación Energética (CIE), Quito, Ecuador

B10 **Simulation of Solar Water Desalination System Coupled to a Compression Heat Pump**
Akrout Hiba, GABES, Tunisia

C1 **Risk Management for Mini-Grid Deployment in Rural Areas**
David Manetsgruber, Hochschule Neu-Ulm, Neu-Ulm, Germany

C2 **The NEED Project: Strengthen the Implementation of Renewable Energy Resources in the Southern African Region**
Stefan Schneider, Technische Hochschule Ingolstadt, Institute of new Energy Systems, Ingolstadt, Germany

C3 **Innovating for Energy Access "Inclusive Engagement - Exploring Multiple Alternative Distribution & Network Channels to Stimulate Off-Grid Electrification" - Experience from Pakistan**
Hira Wajahat Malik, Stimulus Private Limited, Karachi, Pakistan

C4 **A framework for Analyzing Energy Needs of Rural Households to Improve Energy Access in Developing Countries: Implications for Solar Energy Based Development Cooperation**
Chian-Woei Shyu, National Chung-Cheng University, Min-Hsiung, Chia-Yi, Taiwan

C5 **Electrical, Mechanical and Optical Analysis of Pico PV Systems after Use in Rural Areas of Peru**
Samuel Jorge Goda Asebey, PPRE University of Oldenburg, Germany

C6 **Vanuatu Rural Electrification Program- Pico Solar Home Systems Project**
Geoffrey Stapleton, Global Sustainable Energy Solutions Pty Ltd, Botany, Australia

C7 **Lake Victoria Islands Minigrid Project - The Challenges of Installing Minigrid in a Remote Rural Island Community**
Sayan Chakraborti, MRIGlobal, Kansas City, United States of America

C8 **Distributed Solar PV System for Industrial Application**
Bin-Juine Huang, National Taiwan University, Taipei, Taiwan

C9 **MASLOWATEN: The H2020 Project for the Market Uptake of Large Power PV Irrigation Systems**
Luis Narvarte, Universidad Politecnica de Madrid Instituto de Energía Solar, Madrid, Spain

C10 **A 360 kWp PV Irrigation System to a Water Pool in Spain**
Luis Narvarte, Universidad Politecnica de Madrid Instituto de Energía Solar, Madrid, Spain

18:45 Drinks and Visit to the Trade and Poster Exhibition

20:00 End of the First Conference Day

Thursday, September 22th, 2016

SESSION 2: SOLAR TECHNOLOGIES OVERVIEWS

Chair: Hansjörg Gabler, Zentrum für Sonnenenergie- und Wasserstoff-Forschung Baden-Württemberg (ZSW), Germany
Stathis Tselepis, CRES – Centre for Renewable Energy Sources, Greece

08:30 Renewable Desalination: Technology Options for Islands
Joachim Went, Fraunhofer-ISE, Freiburg, Germany

08:45 Market Trends in the Pico PV Sector and the Role of Development Cooperation
Carsten Hellpap, GIZ, Eschborn, Germany

09:00 Survey Results on PV Hybrid Trends in the 5 Coming Years
Jean-Christian Marcel, MJC PV Consulting, Grézieu-la-Varenne, France

09:15 5 Years BOSS Concept (Business Opportunities with Solar Systems) Lessons Learned from Implementing BOSS-Solutions in Africa
Tobias Zwirner, Phaesun GmbH, Memmingen, Germany

09:30 Discussion

09:50 Coffee Break and Visit to the Trade Exhibition

SESSION 3A: PARALLEL SESSIONS: HYBRID RE POWER PLANT TECHNOLOGY

Chair: Henrik Bindner, Risø National Laboratory, Denmark
Christos Protogeropoulos,Phoenix Solar EPE, Greece

10:30 PV Integration in Diesel Grids – Fuel Saving Technologies
Alexander Schies, Fraunhofer Institut für Solare Energiesysteme ISE, Freiburg, Germany

10:45 Benefits from Short-Term Photovoltaic Power Forecasts for Microgrid Operation
Franck Bourry, CEA, Le Bourget-du-Lac, France

11:00 Potential, Limitation and Field Experiences of Lithium Ion Storage Systems LiFePo in Combination with Energy Management System Smart1 Applied in Off-Grid Power Supply Systems
Hubert Deubler, Elektro-Mechanik Meisl GmbH, Berchtesgaden, Germany

11:15 First Experience with Li-ion Batteries in Solar-Diesel-Hybrid-Power-Systems on Larger Scale
Stefan Oexle-Ewert, Enerquinn GmbH, Weingarten, Germany

11.30 Dynamic Programming Optimization of Ressource Management in Hybrid PV Microgrids
Eiko Kruger, Commissariat aux Energies Alternatives et à l'Ener, Le Bourget-du-Lac, France

11:45 Discussion

12:10 Lunch and Visit to Trade and Poster Exhibition

SESSION 3B: PARALLEL SESSIONS: SOLAR COOKING, DESALINATION, WATER PUMPING (ROOM 2)

Chair: Angela Karen Surridge-Talbort, SANEDI, Johannesburg, South Africa
Joachim Koschikowski, Fraunhofer ISE, Germany

10:30 DASTPVPS Reloaded - a User Optimized, Matlab Based Sizing Program for Solar Photovoltaic Pumping System (PVPS)
Rakibul Hasan, University of Applied Sciences Rosenheim, Germany

10:45 A 140 kW Hybrid PV-Diesel Pumping System for Constant-Pressure Irrigation
Luis Narvarte, Universidad Politecnica de Madrid Instituto de Energía Solar, Madrid, Spain

11:00 Design and Construction of a Solar Thermal System with Heat Storage
Amos Veremachi, Eduardo Mondlane University, Maputo, Mozambique

11:15 Field Testing of an Innovative Solar Powered Milk Cooling Solution for the Higher Efficiency of the Dairy Subsector in Tunisia
Victor Torres Toledo, Universität Hohenheim, Stuttgart, Germany

11.30 Design of a Low Cost Mobile Solar Powered Desalination Unit for Rural Areas Saline Groundwater (Bringing Back the Smile to Gwanda)
Samson Mhlanga, National University of Science and Technology, Bulawayo, Zimbabwe

11:45 Discussion

12:15 Lunch and Visit to Trade and Poster Exhibition

SESSION 4: PRACTITIONERS ROUND TABLES – DIFFERENT ROOMS

13:45 – 14:30

1. **Quality, Cost and Capacity in light of massive scale up**
   Moderators: Xavier Vallvé, TTA., Barcelona, Spain and n.n.
2. **Customer Management Systems for Mini-Grid, pay-as-you-go, SHS and Lanterns**
   Moderators: Carsten Hellpap, GIZ, Eschborn, Germany and n.n.
3. **Simulation Tools and Sizing**
   Moderators: Kilian Reiche, iiDevelopment GmbH, Frankfurt, Germany and Ian Baring Gould, NREL, Golden, USA (tbc)
4. **The underestimated role of heat in developing countries**
   Moderators: Eugene Joubert, Stellenbosch University, South Africa and n.n.
5. **Which electric storage technology to choose?**
   Moderators: Georg Bopp, Fraunhofer ISE, Freiburg, Germany and Luis Arribas, CIEMAT, Madrid, Spain
6. **PV Diesel Retrofit**
   Moderators: Alexander Schies, Fraunhofer ISE, Freiburg, Germany and n.n.
7. **Capacity Building in the Field**
   Moderators: Geoffrey Stapleton, GSES, Botany, Australia and n.n.
8. **Attendants suggest a topic of their interest during registration**
   Moderators: n.n. and n.n.

SESSION 5: RURAL ELECTRICITY PART 1

Chair: Michael Wollny, Alliance for Rural Electrification, Belgium
John Chadjivassiliadis, Chairman of IENE, Greece

14:45 **Promoting Energy Access through Sustainable Mini-Grids - The Development of a Quality Assurance Framework for Mini-Grids**
Ian Baring-Gould, National Renewable Energy Laboratory, Golden, United States of America

15:00 **Learning from Brazil Village Minigrid Implementation: Lessons for other Emerging Markets**
Kilian Reiche, iiDevelopment GmbH, Frankfurt am Main, Germany

15:15 **Meshed PV Systems**
Walter Commerell, Hochschule Ulm, Ulm, Germany

15:30 **Energy Access for Sub-Saharan Africa with Focus on PV Hybrid Mini-Grids**
Philipp Blechinger, Reiner Lemoine Institut GmbH, Berlin, Germany

15:45 **Technical and Social Innovation through Electrification Small Communities in Palestine by Multi-User Solar PV Mini Grids – Case Study – Birin Community**
Imad Ibrik, Energy Research Centre -An-Najah National University, Nablus, Palestine

16:00 Discussion

16:25 Coffee Break

SESSION 6A: PARALLEL SESSIONS: RURAL ELECTRICITY PART 2

Chair: Walter Commerell, University of Applied Sciences Ulm, Germany
Bin-Juine Huang, National Taiwan University, Taiwan

17:00 Implementing a Solar Lantern Rental Model for Low Income Consumers
Charles Muchunku, Nairobi, Kenya

17:15 Solar PV-Biogas Hybrid Mini-grid, Rural Power with Integrated Farming
Syed Ishtiaque Ahmed, Rahimafrooz Renewable Energy Ltd., Dhaka, Bangladesh

17:30 Photovoltaic Lighting Kits: Financially Viable or Grant-Tied Technology? The case of Lebanon
Hassan Harajli, United Nations Development Program, Beirut, Lebanon

17:45 Modelling and Analysing the Success of Solar Home Systems
Hans-Gerhard Holtorf, University of Oldenburg, Oldenburg, Germany

18.00 Solar Energy Systems for Off-Grid Rural Electrification in Sub-Saharan Africa
Fabian Junker, Technische Hochschule Ingolstadt, Institute of new Energy Systems, Ingolstadt, Germany

18:15 Discussion

18:45 End of the conference day

19:30 Conference Dinner

SESSION 6B: PARALLEL SESSIONS: SOLAR IN INDUSTRIAL APPLICATIONS (ROOM 2)

Chair: Klemens Schwarzer, Solar Global e.V./Solarinstitut Jülich, Germany
Fabio Manuel Cumbe, ENPCT, Maputo, Mozambique

17:00 Elgin Valley Potential for Industrial Application of Photovoltaic (PV) Systems
Angelo Buckley, The Centre for Renewable and Sustainable Energy St Stellenbosch University, Stellenbosch, South Africa

17:15 Large-Scale Solar Thermal in South Africa: Status, Barriers and Recommendations
Eugene Joubert, Stellenbosch University, Stellenbosch, South Africa

17:30 The Potential Use of Solar Heat in Jordanian Dairy Industry
Ashraf Samarah, Zarqa Energy Research Center, Zarqa, Jordan

17:45 Financial Innovation – Using crowdfunding to finance energy projects
Marilyn Heib, bettervest GmbH, Frankfurt am Main, Germany

18:00 Discussion

18:30 End of the conference day

19:30 Conference Dinner

Friday, September 23rd, 2016

SESSION 7: CAPACITY BUILDING

Chair: Stefan Nowak, NET Nowak Energie & Technologie AG, St. Ursen, Switzerland
Jens Merten, INES-CEA, Le Bourget du Lac, France

08:30 Capacity Building for Solar Craft and Trade in Haiti
Willi Ernst, BIOHAUS-Stiftung, Paderborn, Germany

08:45 Solar Thermal Energy and SADC
Wolfgang Moser, SADC, Gaborone, Botswana

09:00 Solar PV in Rural Electrification
Karl Mikl, Strathmore Energy Research Center, Nairobi, Kenya

09:15 A Blueprint for Effective Action on Energy Access - Conclusions from the Waterloo Global Science Initiative's OpenAccess Energy Summit
Nigel Moore, Waterloo Global Science Initiative, Waterloo, Canada

09:30 Discussion

09:50 Poster Award Ceremony – 3 winners
Award Committee:
Chair : Joscha Rosenbusch, GIZ, Mexico City, Mexico
Boaventura Cuamba, Eduardo Mondlane University, Maputo, Mozambique
Michael Müller, Steca, Germany

10:05 Coffee Break and Visit to the Trade and Poster Exhibition

SESSION 8: FIELD EXPERIENCE

Chair: Peter Adelmann, University of Applied Sciences Ulm, Germany
Izael Da Silva, Strathmore University Research Centre, Kenya

10:45 Lessons Learned after Four Years of Operation of the PV Rural Mini Grid in the Island of Santo Antão (Cape Verde)
Maria Anzizu, Trama TecnoAmbiental, Barcelona, Spain

11:00 1st Year Field Experience of a 5 MW Solar PV-15 MW Diesel in Bolivia
Luis Arribas, CIEMAT, Madrid, Spain

11:15 Does Access to Energy Lead to Sustainable Development? - Evidence from Small Community-Based Projects
Willington Ortiz, Wuppertal Institute for Climate, Environment and Energy, Wuppertal, Germany

11:30 Solar PV for Productive Uses in Small and Medium Enterprises
Monika Rammelt, GIZ GmbH, Eschborn, Germany

11:45 Monitoring of Domestic Solar Water Heating Systems in the National Mass Housing Project of Namibia
Zivayi Chiguare, Namibia Energy Institute, Namibia University of Science, Windhoek, Namibia

12:00 Solar Systems into the Canadian Arctic
Klaus Doehring, Green Sun Rising Inc, Windsor ON, Canada

12.15 Discussion

12:45 Closing Remarks
Xavier Vallvé, TramaTecnoAmbiental, Barcelona, Spain
Werner Weiss, AEE-Institute for Sustainable Technologies, Gleisdorf, Austria

13:00 End of the Conference

Organisation Committee

Gabriele Struthoff-Müller and Bernd Porzelius

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International Conference on
Solar Technologies & Hybrid Mini Grids to improve energy access

	Sept. 21, 2016	Sept. 22, 2016	Sept. 23, 2016
08:30		SESSION 2: SOLAR TECHNOLOGIES OVERVIEWS	SESSION 7: CAPACITY BUILDING
09:00			
09:30			POSTER AWARD CEREMONY
10:00	GIZ/IRENA Side Event	Parallel Sessions	
10:30		HYBRID RE POWER PLANT TECHNOLOGY / SOLAR COOKING, DESALINATION, WATER PUMPING	
11:00			SESSION 8: FIELD EXPERIENCE
11:30			
12:00			CLOSING REMARKS
12:30			
13:00			
13:30			
14:00	Opening address	SESSION 4: PRACTITIONERS ROUND TABLES	
14:30	OPENING SESSION		
15:00	SESSION 1: INTERNATIONAL PROGRAMS AND MARKET DEVELOPMENT	SESSION 5: RURAL ELECTRICITY PART 1	
15:30			
16:00			
16:30		Parallel Sessions	
17:00		RURAL ELECTRICITY PART 2 / SOLAR IN INDUSTRIAL APPLICATIONS	
17:30	INDUSTRY FORUM AND POSTER SESSION		
18:00			
18:30			
19:00	Drinks and Visit to the Poster and Trade Exhibition.		
19:30		Conference Dinner	
20:00	End of the First Conference Day		

附錄二：

研討會發表之論文

A framework for analyzing energy needs of rural households to improve energy access in developing countries: Implications for solar energy based development cooperation

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1. Introduction

To better improve energy access for rural households in developing countries, besides the provision of energy systems and technologies for energy supply, it is also important to understand the energy needs of households, particularly those rural households in developing countries with low electrification rate. Although the electrification rate in sub-Saharan Africa has been improved from 23% in 2000 to 32% in 2012 (IEA, 2014), the electrification rate in this area is still very low compared to other regions with nearly full electrification rate. In addition, nearly 80% of population lack access to electricity is located in rural areas of this region (IEA, 2014). As for access to clean cooking energy in 2012, nearly 730 million people across sub-Saharan Africa still rely on the traditional use of solid biomass for cooking (IEA, 2014). Hence, this study intended to propose a framework for analyzing energy needs for rural households in developing countries and discuss the relevant implications for solar energy based development cooperation. The results can be used for energy based development cooperation to assess household energy needs to bridge the gap of system design and household needs, better improve energy access in rural areas of developing countries, and increase successful implementation chances of projects.

2. Methodology

The method applied in this research is reviewing the existing literature regarding how energy needs of rural households can be systematically identified and estimated. Based on the results of literature review, different approaches to identify household energy needs are proposed, designed, compared, and analyzed in this study.

3. Analysis of energy needs of rural households in developing countries

The Poor People's Energy Outlook (PPEO) in its 2010 Report details the actual energy needs of the households affected by energy poverty in developing countries and suggests a framework with attainable targets based on these needs (Practical Action, 2010: ix). It defines energy needs with a series of minimum standards for access to the key energy services to meet basic human needs, such as lighting, cooking and water heating, space heating, cooling, and information and communication (see Table 1). Take lighting as an example, the minimum energy needs for lighting is 300 lumens for minimum four hours per night at household level.

Table 1: PPEO's framework of energy needs

Energy service		Minimum standard
Lighting	1.1	300 lumens for minimum four hours per night at household level
Cooking and water heating	2.1	1 kg woodfuel or 0.3kg charcoal or 0.04 kg LPG or 0.2 litres of kerosene or biofuel per person per day, taking less than 30 minutes per household per day to obtain
	2.2	Minimum efficiency of improved solid fuel stoves to be 40% greater than a three-stone fire in terms of fuel use
	2.3	Annual mean concentrations of particulate matter (PM2.5)<10μg/m3 in households, with interim goals of 15μg/m3, 25μg/m3 and 35μg/m3
Space heating	3.1	Minimum daytime indoor air temperature of 18℃
Cooling	4.1	Households can extend life of perishable products by a minimum of 50% over that allowed by ambient storage
	4.2	Maximum apparent indoor air temperature of 30℃
Information and communications	5.1	People can communicate electronic information from their household
	5.2	People can access electronic media relevant to their lives and livelihoods in their household

Source: Practical Action, 2010: 33; Practical Action, 2012: 42; Practical Action, 2014: 48.

Based on the framework developed by The Poor People's Energy Outlook (PPEO), this study propose four different frameworks for how energy needs of rural households can be systematically identified and estimated: 1) Identify energy needs by purpose of energy use; 2) Identify energy needs by energy type; 3) identify energy needs by substance of energy services; 4) Identify energy needs by linking with socio-economic indicators. In each framework, indicators are suggested as examples to explain how energy needs of rural households in developing countries can be identified and estimated. These indicators can be further modified, developed, and elaborated in different national and regional contexts. More indicators can also be added into each framework. The integration of two or three frameworks into one framework is also possible.

3.1 Identify energy needs by purpose of energy use

Energy needs can be identified by difference purposes of energy use to meet basic human needs at household level (see Table 2). The Poor People's Energy Outlook (PPEO) suggested five different purposes of energy use at household level including lighting, cooking and water heating, space heating, cooling, and information and communications (Practical Action, 2010: 33; Practical Action, 2012: 42; Practical Action, 2014: 48). This study suggested seven different purposes of energy use at household level including lighting, electric appliances (e.g. Information and Communication, Entertainment), cooking, water heating, cooling, space heating, and transportation.

Table 2: Identify energy needs by purpose of energy use

Purpose of energy use	Minimum standard	
Lighting	1.1	__ kW/h per household per day
	1.2	__ lumens for minimum ___ hours per day per household
Electric appliances (e.g. Information and Communication, Entertainment)	2.1	__ kW/h per household per day
Cooking	3.1	__kg fuel per household per day
	3.2	__ kW/h per household per day
Water heating	4.1	__kg fuel per household per day
	4.2	__ kW/h per household per day
Cooling	5.1	Maximum indoor air temperature of __℃
	5.2	__ kW/h per household per day
Space heating	6.1	Minimum indoor air temperature of __℃
	6.2	__kg fuel per household per day
	6.3	__ kW/h per household per day
Transportation	7.1	__kg fuel per household per day

Source: Compiled by author.

3.2 Identify energy needs by energy type

Energy needs can be identified by difference types of energy to meet basic human needs at household level (see Table 3). Energy type at household level refers not to the primary or crude energy, but the energy ready for final consumption. At household level, two energy types, electricity and fuel, are the most commonly used energy type.

Table 3: Identify energy needs by energy type

Energy type		Minimum standard	
Electricity		1.1	___kw/h per household or per person per day
		1.2	___% below average electricity consumption per household or per person per day
Fuel	Gasoline	2.1	___liter gasoline per household or per person per day
		2.2	___% below average gasoline consumption per household or per person per day
	Diesel	3.1	___liter diesel per household or per person per day
		3.2	___% below average diesel consumption per household or per person per day
	Natural gas	4.1	___cubic meter natural gas per household or per person per day
		4.2	___% below average natural gas consumption per household or per person per day
	LPG	5.1	___cubic meter LPG per household or per person per day
		5.2	___% below average LPG consumption per household or per person per day

Source: Compiled by author.

3.3 Identify energy needs by substance of energy services

Energy needs can be identified by substance of energy services to meet basic human needs at household level. The Poor People's Energy Outlook (PPEO) in its 2012 Report proposes the Enterprise Energy Matrix to identify the demands and needs of enterprises for energy with four aspects, reliability, quality, affordability, and adequacy (Practical Action, 2012: x). This study suggested five aspects to identify energy needs at household level: Affordability, accessibility, reliability, quality, and adequacy (see Table 4). Affordability refers to the affordability of all types of basic energy services for meeting modern society needs at household level. Accessibility means people can access all types of basic energy services, the cost for people to access all types of basic energy services is affordable, and the time and distance for people to access all types of basic energy services is acceptable. Reliability refers to the availability of all types of basic energy services with enough amount energy provision with stable and predictable energy price. Quality means all types of basic energy service's quality is provided stable, well-functioned, healthy, safe, and clean. Adequacy refers to all types of basic energy services can meet people's basic energy needs, are convenient to obtain, and are provided without violating national environmental standards and emission caps.

Table 4: Identify energy needs by substance of energy services

Substance of energy services		Minimum standard
Affordability	1.1	Energy expense below ___% of household income
	1.2	___% below average household income spent on energy services
Accessibility	2.1	The distance for people to access all types of energy is less than ___km
	2.2	The cost for people to access all types of energy does not exceed ___% of energy expense
	2.3	The time for people to access all types of energy services is less than ___hours
Reliability	3.1	The time of interruption for all types of energy provision is under ____hours per year
	3.2	The increase of energy price are kept below ___% of energy price
Quality	4.1	The quality of energy meets ____ standards
	4.2	The quality of energy service meets ___ standards
Adequacy	5.1	The energy satisfaction of households is above ___ %
	5.2	The supply of energy meets ____ standards (e.g. national environmental standards and emission caps)

Source: Compiled by author.

3.4 Identify energy needs by linking with socio-economic indicators

Energy needs can be identified by linking with socio-economic indicators to meet basic human needs at household level (see Table 5).

Table 5: Identify energy needs by linking with socio-economic indicators

Socio-economic indicators		Minimum standard
Social welfare entitlement	1.1	Meeting energy needs for those households belong to certain social entitlement programs, such as unemployment, no income, low income, disability, senior people, children, etc.
	1.2	Meeting energy needs for those households who get certain social welfare benefits and subsidies.
Final energy consumption per capital	2.1	Meeting energy needs for those people belong to ___% below per capital final energy consumption
	2.2	Meeting electricity needs for those people belong to ___% below per capital electricity consumption
	2.3	Meeting fuel needs for those people belong to ___% below per capital fuel consumption
Average annual energy expense per capital	3.1	Meeting energy needs for those people whose annual energy expense belong to the lowest ___% of average annual energy expense per capital

Average annual income per capital	4.1	Meeting energy needs for those people belong to the lowest ___% of average annual income per capital
GDP (gross domestic product) per capital	5.1	Meeting energy needs for those people belong to ___% below GDP per capital
	5.2	Meeting energy needs for those people belong to ___% below GDP based on PPP per capita

Source: Compiled by author.

4. Conclusion: Implications for solar energy based development cooperation

Having access to energy does not necessarily lead to the use of energy and the improvement of living conditions for rural households in developing countries if the households could not afford the use of energy or the provision of energy does not meet households' energy needs. As indicated by The Poor People's Energy Outlook (PPEO) 2012 Report, energy access should not only secure minimum standards for access to the key energy services, but the key energy services should also be what "people need, want, and have a right to" (Practical Action, 2012: 41). This study provides four different frameworks for how energy needs of rural households can be identified and estimated. As for the implication for solar energy based development cooperation, these frameworks can be applied and integrated in different developing countries according to their different focuses on different aspects of energy needs and local conditions to improve energy access.

5. Acknowledgements

This work was supported by the governmental research grant from the Bureau of Energy, Ministry of Economic Affairs, Taiwan, Republic of China, under the research project 'Basic Energy Right: Concept, Scope, Dimension, and Affecting Factors'. The author also acknowledges the valuable comments and contributions from the researchers of the project's research partner at the Energy Research Division, Industrial Economics and Knowledge Center (IEK), Industrial Technology Research Institute (ITRI), Taiwan, Republic of China.

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附錄三：

研討會展示之海報

National Chung Cheng University

Department of Political Science

A framework for analyzing energy needs of rural households to improve energy access in developing countries: Implications for solar energy based development cooperation

Chian-Woei Shyu
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Framework 1: Identify energy needs by purpose of energy use

Purpose of energy use		Minimum standard
Lighting	1.1	__ kW/h per household per day
	1.2	__ lumens for minimum ___ hours per day per household
Electric appliances (e.g. Information and Communication, Entertainment)	2.1	__ kW/h per household per day
Cooking	3.1	__kg fuel per household per day
	3.2	__ kW/h per household per day
Water heating	4.1	__kg fuel per household per day
	4.2	__ kW/h per household per day
Cooling	5.1	Maximum indoor air temperature of __℃
	5.2	__ kW/h per household per day
Space heating	6.1	Minimum indoor air temperature of __℃
	6.2	__kg fuel per household per day
	6.3	__ kW/h per household per day
Transportation	7.1	__kg fuel per household per day

Source: Compiled by author.

Framework 2: Identify energy needs by energy type

Energy type			Minimum standard
Electricity		1.1	___kw/h per household or per person per day
		1.2	___% below average electricity consumption per household or per person per day
Fuel	Gasoline	2.1	___liter gasoline per household or per person per day
		2.2	___% below average gasoline consumption per household or per person per day
	Diesel	3.1	___liter diesel per household or per person per day
		3.2	___% below average diesel consumption per household or per person per day
	Natural gas	4.1	___cubic meter natural gas per household or per person per day
		4.2	___% below average natural gas consumption per household or per person per day
	LPG	5.1	___cubic meter LPG per household or per person per day
		5.2	___% below average LPG consumption per household or per person per day

Source: Compiled by author.

GIVING EVERYONE ACCESS TO ENERGY

Framework 3: Identify energy needs by substance of energy services

Substance of energy services		Minimum standard
Affordability	1.1	Energy expense below ___% of household income
	1.2	___% below average household income spent on energy services
Accessibility	2.1	The distance for people to access all types of energy is less than ___km
	2.2	The cost for people to access all types of energy does not exceed ___% of energy expense
	2.3	The time for people to access all types of energy services is less than ___hours
Reliability	3.1	The time of interruption for all types of energy provision is under ___hours per year
	3.2	The increase of energy price are kept below ___% of energy price
Quality	4.1	The quality of energy meets ____ standards
	4.2	The quality of energy service meets ___ standards
Adequacy	5.1	The energy satisfaction of households is above ___ %
	5.2	The supply of energy meets ____ standards (e.g. national environmental standards and emission caps)

Source: Compiled by author.

Framework 4: Identify energy needs by linking with socio-economic indicators

Socio-economic indicators		Minimum standard
Social welfare entitlement	1.1	Meeting energy needs for those households belong to certain social entitlement programs, such as unemployment, no income, low income, disability, senior people, children, etc.
	1.2	Meeting energy needs for those households who get certain social welfare benefits and subsidies.
Final energy consumption per capital	2.1	Meeting energy needs for those people belong to ___% below per capital final energy consumption
	2.2	Meeting electricity needs for those people belong to ___% below per capital electricity consumption
	2.3	Meeting fuel needs for those people belong to ___% below per capital fuel consumption
Average annual energy expense per capital	3.1	Meeting energy needs for those people whose annual energy expense belong to the lowest ___% of average annual energy expense per capital
Average annual income per capital	4.1	Meeting energy needs for those people belong to the lowest ___% of average annual income per capital
GDP (gross domestic product) per capital	5.1	Meeting energy needs for those people belong to ___% below GDP per capital
	5.2	Meeting energy needs for those people belong to ___% below GDP based on PPP per capita

Source: Compiled by author.

Financed by

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