

UNESCO CHAIR/UNITWIN NETWORK PROGRESS REPORT FORM

Title of the Chair/Network:	UNESCO Chair in Energy for Sustainable Development
Host Institution:	Politecnico di Milano
Date of establishment of Chair/Network:	03, 2012
Period of activity under report:	Report on the 4-years period (04, 2012 - 03, 2016)
Report established by:	Emanuela Colombo, Chair Holder Associate Professor at the Department of Energy Rector's Delegate to Cooperation and Development

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1. Executive Summary:

Major outcomes, results and impact of the Chair, including on national policies, in relation to its objectives as stated in Article 2 of the Chair Agreement (between the Institution and UNESCO)
(Not exceeding 300 words)

The Chair was established at Politecnico di Milano in March 2012 and is about to conclude the fourth year of activity.

In line with 2030 Development Agenda and the international framework, which recognize the importance of education in the process of sustainable development, and acknowledging the key role that academia plays in this process, the Chair has consolidated its mission towards the promotion of an integrated system of education, research, technological cooperation and community service, focusing on energy and sustainable development.

Besides the ordinary commitment for **education** activities, with the implementation of MSc courses on access to energy and global development issues, one of the most relevant achievement has been the introduction of the Honour Program "Engineering for Sustainable Development", a parallel training programme addressed to talented students, aiming at enhancing systemic and cross-discipline skills of future engineers. The Chair has consolidated the **research** activity on two main lines, with a focus on energy planning, and methodologies for project evaluation and impact assessment.

Acknowledging the complementarity of actors and the need for **effective partnerships**, the Chair has strengthened existing and running collaborations. It has enforced 'horizontal' partnerships with South universities, with the goal of enforcing local networks and contributing to foster the capacity building process, and established 'transversal' partnerships with other actors, which may support the interaction within the context of intervention. Three projects with universities in DCs granted by the EU and one education programme in Tanzania financed by the Italian Government have been implemented. The Chair has also worked on **joint researches and advocacy projects** with private companies, public institution and international organizations.

In the last years the Chair has also consolidated the presence in the international framework through increased cooperation with public institutions of MENA region and Sub-Saharan countries, and starting joint activities with the *Africa-EU Partnership*.

2. Activities:

Overview of activities undertaken by the Chair during the reporting period

a) Education/Training/Research

(key education programmes and training delivered and research undertaken by the Chair during the reporting period, target group and geographical coverage)

i) Education (leading to certificate)

In line with the role that energy has acquired in the promotion of sustainable development and its relevance in the Development Agenda 2030, the Chair has recognised the need to enrich the curricula of future professionals, by promoting and making effective the implementation of programs and courses able to combine engineering fundamentals with the aim of addressing global problems with an holistic approach. The main goal is to prepare professional figures having a broad knowledge in technical and scientific fields, able to operate in the energy sector at a multi-scale level, including the development of specific technologies and the energy analyses of different scenarios for promoting local sustainability and socio-economic growth.

The action of the Chair has been addressed on four main lines: (i) continuous implementation of the track 'Energy for the Development' (MSc in Energy Engineering), (ii) involvement in courses teaching within the MSc Environmental and Geomatic Engineering, (iii) coordination of a PhD school in collaboration with UNIDO, (iv) definition and implementation of the new Honours Program 'Engineering for Sustainable Development'.

(i) Track 'Energy for the Development' (MSc in Energy Engineering)

The Chair has coordinated the implementation of the courses characterizing the track on Energy for the Development (MSc in Energy Engineering), which has acknowledged an increased number of students attending the MSc (34 in the Academic Year 2012-2013, 88 in 2013-2014, 107 in 2014-2015, 120 in 2015-2016). The trend confirms the interest and the necessity that new generations attribute to global aspects of development and the attention to combine fundamental knowledge of engineering with a multidisciplinary approach.

- Engineering and cooperation for development (8 ECTS – ongoing)

Course Program

The course aims at introducing students to the theme of development and cooperation as well to the role of scientific research and technology within the field. The main goals are: to provide methodological tools of cooperation and development in order to widen the vision for facing the social challenge, to couple the engineering vision with the whole set of human factors and the principles of ethics, to develop a system of instruments and values that can generate innovation and development in different contexts. Students are involved with a participative approach, analysing real case proposed by NGOs and delivering a project on a case study.

(ii) MSc Environmental and Geomatic Engineering

- Energy for sustainable development (6 ECTS – ongoing)

Course program

The course aims at introducing basic concepts about energy as a tool for sustainable development. In this perspective, it addresses the following issues: exergy and thermodynamic analysis, renewable and non-renewable energy resources and conversion technologies, local and global emission, Life-Cycle Analysis and environmental impact. Emphasis is also made on political opportunities and legislation.

- Engineering and cooperation for global development (6 ECTS – ended in 2015)

	<p><i>Course program</i></p> <p>The course aims at providing a general overview of the various aspects of development cooperation analysed from a design perspective and at presenting the main technological solutions applied in development projects mainly in the energy field. These arguments are placed within a broader context that includes the evolution of the scenario in cooperative relations between nations, including through civil society, and also considers the concept of sustainable development.</p> <p><u>(iii) PhD School, February 2014</u></p> <p>Renewable Energies for Unleashing Sustainable Development in low and middle income economies</p> <p><i>Course program</i></p> <p>The course has been assigned by the PhD School of Politecnico di Milano on a competitive base to the Department of Energy under the UNESCO Chair. In cooperation with UNIDO and with the support of Fondazione Cariplo, the course has seen the participation of 19 PhD candidates of several nationalities and coming from different disciplines, on multidisciplinary themes such as access to energy and sustainable development, interconnections among energy, environment and social aspects, appropriate technologies, energy strategies in developing countries and the links between energy, economy and policies. With the support of international experts, students have faced real case studies through project works.</p> <p><u>(iv) Honours Programme ‘Engineering for Sustainable Development’</u></p> <p>Officially launched in October 2015, the Honours Programme entitled "Engineering for Sustainable Development" is a parallel training programme that takes place at the same time as the MSc programmes of the School of Industrial and Information Engineering and of the School of Civil, Environmental and Land Management Engineering. The aim of the Honours Programme is to enhance and develop the systemic and cross-discipline skills of future engineers, helping them understand and evaluate global challenges so that they may operate effectively in the field of sustainable development, deploying both theoretical and practical technical skills.</p> <p>The Honours Programme represents an innovative training programme aimed at young, talented, competent and highly motivated students, who are selected based on their profile, their academic career and a letter of motivation (or statement of purpose). The Honours Programme alternates the conventional teaching of extracurricular courses with more informal training experiences, such as seminars, in which students listen, gain new experiences and engage in group work. Finally, the programme requires students to develop a technological and/or methodological research project for the purpose of their thesis, complemented, where possible, by a field experience (in a national, European or non-European organisation) based on multidisciplinary issues connected with global development.</p>
<p>ii) Training (short term)</p>	<p>In line with the strategy of the Chair, several lectures and presentations have been organized, aiming at promoting a knowledge sharing network, through capacity building and dissemination towards different actors. Training were addressed to NGOs, Foundations, Italian and foreign students of Politecnico di Milano and other universities.</p> <p><u>Training in collaboration with Universities</u></p> <ul style="list-style-type: none"> • Laboratory of International Cooperation, Department of Architecture and Urban Studies (DAStU), Politecnico di Milano Postgraduate Program “Coopera(c)tion – Knowledge and Skills for Sustainable Cities in the Global South”

	<ul style="list-style-type: none"> • International Master Program in Cooperation and Development, IUSS Pavia, 19th December 2013, 12th January 2015, January 2016 Seminar “Global Energy Challenge and Sustainable Development” • Department of Design, Politecnico di Milano 26th March 2013, 1st April 2014 Lecturers at the open Seminar on “Design of Renewable and Distributed Sustainable Energy Systems for All” • “International Cooperation and Development” Course at Università degli Studi di Genova, 2nd October 2015 Lecture on “Cooperation projects: elements of project management” • Training at CAST (Centro per un Appropriato Sviluppo Tecnologico), 10th November 2015 Lecture on “Low carbon project and energy in DCs, climate change and carbon market” <p><u>Training in collaboration with International Organizations</u></p> <ul style="list-style-type: none"> • ICS-UNIDO, Trieste, 4th–8th June 2012 Lecturers at the Summer Course on “Renewable energies for decentralized systems: supporting tools and best practices for green energy and sustainable development” • ICS-UNIDO, Tunisi, 8th–12th October 2012 Lecturers at the Training Course on “Options and best practices for renewable energy technologies for productive uses in the Mediterranean region” • UNIDO Renewable Energies Course (e-learning) e-learning course presented by the ICS-UNIDO in joint collaboration with the Politecnico di Milano, the METID Service Area and the Department of Energy • Camera Tuniso-Italiana di Commercio e Industria (CTICI), October 2013 – January 2014 e-learning Course “Global energy scenarios and role of renewable energies in achieving Sustainable Development” • ISPI (Istituto per gli Studi di Politica Internazionale), 23rd October 2015 Accesso all’energia e sviluppo <p><u>Training in collaboration with Civil Society Organizations</u></p> <ul style="list-style-type: none"> • CeLIM, 13th October 2012 Energy, Environment and Development: challenges in the third millennium • OIKOS, 8th April 2014 Lecture “Access to energy in low and middle income economies” <p><u>Training in collaboration with Foundations</u></p> <ul style="list-style-type: none"> • AVSI Foundation, 20th November 2012 Lecture in the annual upgrading course for expatriates Access to Energy, Human Promotion and Sustainable Development • Fondazione Giangiacomo Feltrinelli, 4th February 2015 Lecture “Global energy challenge and sustainable development” • AVSI Brasil Foundation, 1st-3rd September 2015 Training “Energia e desenvolvimento. 1ª Formação: Serviços Especializados Eficiência Energética/AMPLA”
iii) Research	<p>The activities of the Chair are in line with the vision of the Research Group Blaise Pascal Lab of the Department of Energy. The Group focuses the research on the identification, definition and implementation of methodologies for energy</p>

	<p>planning and for the impact evaluation of energy systems, in order to meet the demanding constraints of economic, environmental and social sustainability.</p> <p><u>Research activity is mainly divided in the following lines:</u></p> <ul style="list-style-type: none"> • Strategies and technologies for access to energy: <ul style="list-style-type: none"> ○ Analysis of new models and testing methodologies of Improved Cook Stoves for developing countries. ○ Optimization of the performance of small scale biogas technology for improving access to modern energy services in rural areas; ○ Energy technologies for food security and safe water provision in humanitarian contexts; ○ Long-term planning methodologies for energy access in rural contexts; ○ Energy demand side planning; • Evaluation methodologies for energy project and systems: <ul style="list-style-type: none"> ○ Multi-criteria, multi-objective and multi-stakeholders evaluation and decision-making for selection of strategies in DCs; ○ Monitoring & Evaluation analysis and long-term impact assessment over the target community capitals; ○ Definition and implementation of a Performance Measurement System for Cooperation Project in the Energy field based on the DAC-OECD Criteria and on the Sustainable Livelihood Framework.
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<p>b) Conferences/Meetings (key conferences and meetings organized by the Chair or to which its Chairholder contributed)</p>	
<p>i) Key conferences and workshops hosted by the Chair</p> <p><u>International conference organized in cooperation with UNIDO and ICS-UNIDO</u> “Sustainable Energy Strategies in Low and Middle-Income Economies” Milan, 22nd-23rd November 2012</p> <p><u>International conference organized in cooperation with ENEL Foundation</u> “International Cooperation for Sustainable Energy Strategies, Energy Access and Nexus with Water, Food and Land” Milan, 4th-6th December 2013</p> <p><u>Festival dell’Energia</u> “Energy as a common good: a resource for the mankind”, Milan, 15th-17th May 2014</p> <p><u>International conference organized in cooperation with Enel Foundation and Edison</u> “Energy and the integrated management of resources: system thinking for technicians and policy makers”, EXPO Milan, European Pavilion, 25th June 2015</p> <p><u>Workshop at Department of Energy</u> “The issue of access to clean cooking facilities and fuels in developing countries: a workshop with the experts” with international experts Christa Roth (Food and Fuel) e Samer Abdelnour (Rotterdam School of Management), 12th January 2016</p>	
<p>ii) Other conferences/organizational activities undertaken by the Chairholder</p> <p><u>Conference organized by CUCS for the Italian Forum of International Cooperation, 27th September 2012</u> “The role of universities in cooperation”</p> <p><u>Fondazione Eni Enrico Mattei, Milan, 6th December 2013</u> “Feeding the plant – Energy for Africa”</p> <p><u>Meet Me Tonight, Milan, 26th September 2014</u> The European night of research</p> <p><u>Workshop on climate change, agriculture and food security in developing countries, 17th June 2015</u> “Standard protocols to measure emissions of improved cook stoves: pros-cons, challenges”</p>	

Chairing of workshop at AEEP at the Vienna Energy Forum 2015, 19th June 2015

"Energy Efficiency, an essential driver for urban development in Africa"

Conference organized by SET4FOOD project consortium in cooperation with the Ministry of Foreign Affairs, EXPO Milano 2015, 20th July 2015

"Energy and food for development in refugee camps and informal settlements"

Conference organized by CUCS in partnership with UNSDN, MED Solutions, UNESCO, MAE, CRUI at the European Pavilion, EXPO Milano 2015, 31st July 2015

"Education, Research, Scientific Networking and Trust Building within International Cooperation"

Chairing of session at RES4MED Day, Cairo, 28th September 2015

"The Capacity Building in Egypt: commitments, actions and guidelines for a suitable implementation"

iii) A selection of conference presentations by the Chairholder and other colleagues

Energythink V International Conference, Bocconi University, Milan, 21st November 2012

"Sustainable Energy for All, after Rio+20 UN Conference on Sustainable Development"

IX International Conference, CeTAmb, Brescia, 21st December 2012

"Research and Cooperation to Development: which synergies?"

Accademia di scienza e lettere, Istituto Lombardo, 17th January 2013

"Access to Energy for All beyond 2012"

South East European (SEE) Regional Forum of UNESCO Chairs, Istanbul, 12th-13th June 2013

organized by the UNESCO Venice Office and the Turkish National Commission

III Congress CUCS (Coordinamento Universitario per la Cooperazione allo Sviluppo, University Coordination for Development Cooperation), Torino, 20th September 2013

Panel "Partnership system between universities and NGOs" - Lecture "Beyond Traditional Education in Engineering: a Systemic Approach Open to Field Activity. The Case of Energy Engineering at Polimi"

Global Dimension in Engineering Education (GDEE), Cambridge, 24th September 2013

"1st European award for best practice for the integration of SHD (Sustainable Human Development) into technology and engineering education"

Air Exchange Thermal Assembly (ARETHA), Auditorium Depuratore di Nosedo, 23th October 2013

"ARETHA – The project and first results"

The World Academy Of Sciences (TWAS), Trieste, 8th-13th December 2013

"Workshop on Innovative Energy Policies for Sustainable Development"

Fondazione Eni Enrico Mattei, 10th-11th July 2014

"Energy Poverty and Energy Access: Global Challenges and Goals"

RECP workshop by EUEI PDF, Kigali, 10th-11th July 2014

"Developing Higher Education activities in the framework of the Africa-EU Renewable Energy Cooperation Programme"

CeTAmb, Brescia, 19th December 2014

"Dagli obiettivi di sviluppo del millennio agli obiettivi di sviluppo sostenibile"

Fondazione Eni Enrico Mattei, Milan, 26th February 2015

"Sustainability, the competitive advantage for virtuous companies workshop"

Ministry of Foreign Affairs and International Cooperation, Rome, 5th March 2015

"Nexus: food, water, energy in the sustainable development paradigm"

Conferences organized within Feeding Knowledge, EXPO 2015 Energia e cibo, dall'emergenza allo sviluppo, 12th June 2015

"Energia per gli usi domestici di cottura nelle aree rurali di paesi in via di sviluppo"

"Energia sostenibile per la gestione del cibo nei campi profughi del progetto Set4Food"

Chairing at the conference organized by Enel Foundation and Enel Green Power, EXPO 2015, 6th September 2015

“Powering Africa, energy for growth”

IV Congress CUCS (Coordinamento Universitario per la Cooperazione allo Sviluppo, University Coordination for Development Cooperation), Brescia, 20th September 2013

Sessions “From MDGs to SDGs and the role of academia” and “Water, energy and food”

Lecture at Salone della CSR e dell’innovazione sociale, Bocconi University, 6th October 2015

“Performance Measurement System for energy cooperation projects”

Africa-EU Symposium on Renewable Energy Research and Innovation, 8th-10th March 2016, Tlemcen, Algeria, organised by the Africa-EU Renewable Energy Cooperation Programme (RECP)

Scientific committee and lectures in the session “Renewable Energy Research and Innovation Needs in Africa”

c) Interuniversity Exchanges/Partnerships

(principal exchanges/partnerships between the Chair and other institutions including UNESCO Chairs/UNITWIN Networks)

In the last four years the Chair has consolidated the partnerships with other universities, national and international. ‘Horizontal’ partnerships among universities may represent a ‘scientific diplomacy’, which can enhance the establishment of strategic relations with the goal of enforcing local networks and contributing to foster the capacity building process.

Within the Italian context, Politecnico di Milano (with the direct involvement of the Chairholder) has coordinated the CUCS network, a protocol signed by 28 Rectors of Italian Universities on Cooperation and Development. At international level partnerships have been established with several institutions: European partners have been involved in joint projects and researches, while non-EU network has been enforced in particular with universities of the MENA region and the East African Community, mainly Kenya and Tanzania. The Chair has also strengthened partnerships with international agencies and public institutions, involved in the same pattern of contents focused on international cooperation, sustainable development and energy access.

The UNESCO network has been part of the partnership built. Indeed, the Chair has collaborated with Italian and European Chairs, and in the last year it has started an interaction with the UNESCO Division of Basic & Engineering Sciences.

- Africa-EU Energy Partnership (AEEP)
- International Energy Agency (IEA)
- The World Bank
- Italian Ministry of Foreign Affairs – Direzione Generale Cooperazione allo Sviluppo (DGCS)
- The World Academy of Sciences (TWAS)
- Italian network of UNESCO Chairs
- UNESCO Chair in Hydrological Change and Water Resources Management, RWTH Aachen
- Chaire UNESCO en alimentations du monde, Centre international d’enseignement supérieur en sciences agronomiques, Montpellier SupAgro
- Tempus partners:
 - RWTH Aachen University
 - The American University in Cairo, Egypt
 - Alexandria University, Egypt
 - Ministry of Higher Education, Egypt
 - SEKEM Development Foundation
 - Aswan University, Egypt
 - Heliopolis University, Egypt
 - Zagazig University, Egypt
 - Cairo University, Egypt
 - Heliopolis University, Egypt
 - Bibliotheca Alexandria
 - Technical University of Graz
 - Montpellier SupAgro
 - Fondazione Politecnico di Milano
- Edulink partners:

- Jimma University, Ethiopia
- Dar Es Salaam Institute of Technology, Tanzania
- Technical University of Kenya
- Technical University of Mombasa, Kenya
- TELMS partners:
 - Dar es Salaam Institute of technology
 - Mbeya Institute of Science and Technology
 - Arusha Technical College
- Framework agreement:
 - The Nelson Mandela African Institution of Science and Technology (NM-AIST)
 - Catholic University of Bamada, Cameroon
- Existing relationship for projects or research activities:
 - Ramakumar Research Group, Canada
 - NTNU Trondheim, Norway
 - KTH Royal Institute of Technology, Sweden
 - University of Cairo, Egypt
 - University of Sfax, Tunisia
 - University of Hassan II, Morocco
 - University of Saint Joseph, Lebanon
 - University of Aleppo, Syria
 - Technical University of Delft
- CUCS Network - Formal Protocol signed by 28 Rectors of Italian Universities on Cooperation and Development coordinated by Politecnico di Milano

d) Publications/Multimedia Materials <i>(major publications and teaching/learning materials)</i>			
<i>Please tick relevant fields of output and indicate volume of output:</i>		[tick]	[no.]
	Books	<input type="checkbox"/>	
	Books (edited)	<input checked="" type="checkbox"/>	2
	Books (chapters)	<input checked="" type="checkbox"/>	11
	Monographs	<input type="checkbox"/>	
	Research Reports	<input type="checkbox"/>	
	Journal Articles (refereed)	<input checked="" type="checkbox"/>	6
	Conference Proceedings	<input checked="" type="checkbox"/>	10
	Occasional Papers	<input checked="" type="checkbox"/>	7
	Teaching/Learning Materials	<input checked="" type="checkbox"/>	
	Multimedia Materials (CD-Rom)	<input type="checkbox"/>	
	Multimedia Materials (Video)	<input checked="" type="checkbox"/>	
	Multimedia Materials (Other)	<input type="checkbox"/>	
i) MSc Thesis			
<ul style="list-style-type: none"> ● Furlani V., <i>Stufe migliorate per i paesi in via di sviluppo: stato dell'arte e impatto ambientale in zone rurali (Improved stoves for developing countries: state of the art and environmental impact in rural areas)</i> ● Manzato A. G., <i>Exergy Based Evaluation for Energy Projects in Development Cooperation</i> ● Mapelli F., <i>Feasibility study and CFD modeling of thermoelectric modules coupled with an Improved Cook Stove for developing countries</i> ● Molina M., Rostoni L., <i>Caratterizzazione e processo di selezione di tecnologie commerciali per i paesi</i> 			

in via di sviluppo: minieolico e biogas (Process of characterization and selection of commercial technologies for developing countries: small wind and biogas), <http://hdl.handle.net/10589/69242>

- Negri M., *Exploring Nicaragua. Evaluation of small & mini hydropower potential in Costa Caribe*, <http://hdl.handle.net/10589/50121>
- Romeo F., *Gas flaring reduction: a comprehensive decision model for sustainable alternatives*
- Pesenti S., *Analisi di un impianto solare a concentrazione cogenerativo per applicazione in contesto rurale (Analysis of a co-generative concentrating solar plant for rural contexts)*
- Pellizzoli C., *Metodi di ottimizzazione per tecnologie energetiche appropriate in zone remote dei paesi in via di sviluppo : l'opzione Integrated Renewable Energy Systems (IRESs) (Optimization methods for appropriate energy technologies in remote areas of developing countries: the case of Integrated Renewable Energy Systems)*, <http://hdl.handle.net/10589/69101>
- Redondi A. D. C., Bernardi F., *Mini hydropower for increasing access to energy in Tanzania*, <http://hdl.handle.net/10589/51261>
- Faldrini N., *Sizing of an hydroelectric plant in the Farahantasana locality*
- Santachiara A., *Improved cooking stoves: state of the art, testing and case study of environmental impact for a development project in Malawi*
- Bonamini G., *Exergy and process analysis to assess primary energy resource consumption: a critical review*
- Grisa F., *A comprehensive methodology for the alternative selection of energy technologies in rural areas*
- Brivio C., *Off-Main-Grid PV Systems: Appropriate Sizing Methodologies in Developing Countries*
- Di Turi E., *Evolution of carbon markets: CDM and VER as tools for supporting NGOs' energy projects in developing countries*
- Pozzi F., *Micro-hydroelectric pumping plant as alternative storage system in rural areas: technical and economic feasibility analysis for the Yaho village (Burkina Faso)*
- Bernasconi D.M., Russotto M., *Sustainability Evaluation Model: a composite index to measure country sustainability*
- Riva F., *Feasibility study to reduce hospital's load of wood cooking biomass in Burundi*
- Brivio C., *Off-Main-Grid PV Systems: Appropriate Sizing Methodologies in Developing Countries*
- Crivelli A., Crivelli F., *Procedure for energy planning for grid connected and stand-alone systems*
- Turi E., *Evolution of carbon markets: CDM and VER as tools for supporting NGOs' energy projects in developing countries*
- Pozzi F., *Micro-hydro plants for pumping as alternative storage system in rural areas: techno-economic analysis for the village of Yaho in Burkina Faso*
- Capovilla M.F., Colombo M., *Energy assessment and possible intervention strategies for St. Mary's Lacor Hospital*
- Maraffio C., Frangi M., *Solar cooling for food preservation: technology review and design of a stand-alone system for fish preservation in Mozambique*
- Fortiguerra A., Moroni C., *Energy access and the nexus with water and food. Design of a pilot project for irrigation in a rural Indian village*
- Verre S., *Energy forecasting in a rural village in India*
- Ingenito R., *Application of game theory in the energy access: case study of a rural village in India*
- Puccini E., *Energy and Water Nexus in rural areas: energy analysis and feasibility study for Isiolo County (Kenya) of water pumping and off-grid PV systems*
- Giovannoni, *Powering water supply in El Salado (Colombia): analysis of scenarios and alternative*

selection

- Lusiani S., *A flexible solution for rural electrification*
- Espero A., *Energy Forecast Modeling and Tools: the case study of United Kingdom*
- Argenio H., *Water-Energy-Food Nexus methods: a case study in Eritrea*
- Jarach T., *Design of two small hydro power plants, Lower Kruisvallei and Middle Kruisvallei, South Africa*
- Agostinelli M., *WEF Nexus and energy forecast modelling in the Nile Basin*

ii) Publications

- E. Colombo, S. Mandelli, G. Cassetti, A. Berizzi, C. Bovo. *Access To Energy: Mini Integrated Renewable Systems For Facing The Technical Problem*, Proceeding of the 2012 Tech4Dev International Conference, Lausanne, Switzerland, 29/5/2012-31/5/2012.
- E. Colombo, S. Mandelli. *Facts and Figures. A Reasoned Approach*. Chapter 1 in the book "Access to Energy. Focus on Africa", ISBN 9788896726082, Ed EDIPLAN, 2012
- P.R. Ortigosa, E. Colombo, *Access to Energy. Focus on Africa*, ISBN 9788896726082, Ed EDIPLAN, 2012
- E. Colombo *Accesso all'energia e Cibo: dalla competizione alla cooperazione*, Extra Expo Tempi, January 2013
- E. Colombo, S. Bologna, D. Masera (eds.), *Renewable Energy for Unleashing Sustainable Development*, DOI: 10.1007/978-3-319-00284-2_1, ISBN 978-3-319-00284-2, Springer International Publishing Switzerland 2014

The book is intended as a contribution towards a more inclusive sustainable future, by conceptualizing energy as key element of development. By describing technical, economic and policy conditions necessary for the successful deployment of renewable energy, it provides recommendations for unleashing, in developing countries, a sustainable development based on more equitable distribution of resources.

- G. Cassetti, E. Colombo, *Minimization Of Local Impact Of Energy Systems Through Exergy Analysis*, Energy Conversion and Management. 2013;76(0):874-82, 2013
- E. Colombo, T. Scandroglio, *Povert  Energetica In Europa: Dimensione E Scenari Di Un Diritto Negato*, Oxygen, Nr 10/2013, pp. 110-121, 2013, Codice Edizioni
- E. Colombo, L. Mattarolo, *Access To Energy And Food: From Competition To Cooperation*, Tempi – Extra Expo, nr.9/2012 pp. 54-57, 2013
- IEA, *Africa Energy Outlook 2014*, OECD Publishing; 2014

The Chair has contributed to the part related to the traditional biomass usage and cooking facilities, with the development and review of data and contents.

- E. Colombo, J. Barbieri, A.G. Manzato, F. Mapelli, A.V. Ramayya, G. Shunki, *Energising the higher education system in Africa for promoting sustainable energy development tailored to local context*, INTED2015, 2015, Pages 1910-1918, ISBN 978-84-606-5763-7, ISSN 2340-1079
- E. Colombo, J. Barbieri, M. Brambilla, *Alternatives to gas flaring: a multicriteria decision approach applied to a case study in Russia*, International Journal of Sustainable Engineering, 2015
- J. Bonan, E. Colombo, S. Russo, *Global challenges, integrated solutions: a cooperation matrix against energy poverty*, Fondazione Eni Enrico Mattei, 2014
- E. Colombo, *Vale un mondo la gestione piu' equa delle risorse*, Nuova Energia, Vol 1-2014, pp 82-89, 2014
- E. Colombo, *Nuovi paradigmi per l'accesso all'energia*, Energia, Vol. 3, pp. 8-13, 2014
- S. Mandelli, J. Barbieri, L. Mattarolo, E. Colombo, *Sustainable energy in Africa: a comprehensive data*

and policies review, Renewable & Sustainable Energy Reviews 2014. 37:656-686.

- S. Mandelli, E. Colombo, M. Merlo, C. Brivio, *A methodology to develop design support tools for stand-alone photovoltaic systems in developing countries*, Research Journal of Applied Sciences, Engineering and Technology 2014. 8, 6:778-888.
- Mandelli S., Barbieri J., Mereu R., Colombo E., *Off-grid systems for rural electrification in developing countries: definitions, classification and a comprehensive literature review*. Renewable and Sustainable Energy Reviews, Volume 58, May 2016, Pages 1621–1646, DOI: 10.1016/j.rser.2015.12.338
- E. Colombo, J. Barbieri, A.G. Manzato, F. Mapelli, A.V. Ramayya, G. Shunki, *Energising the higher education system in Africa for promoting sustainable energy development tailored to local context*. INTED2015, 2015, Pages 1910-1918, ISBN 978-84-606-5763-7, ISSN 2340-1079
- J. Barbieri, E. Colombo (Eds.), *SET4Food guidelines on sustainable energy technologies for food utilization in humanitarian contexts and informal settlements*. Department of energy, Politecnico di Milano, 2015, ISBN: 978-88-941226-0-2
- J. Barbieri, M. Caniato, E. Colombo, *SET4food guidelines on sustainable energy technologies for food utilization in humanitarian contexts and informal settlements*. Boiling Point 68 - Energy in Emergency Settings, Bromley 2016
- G.Cassetti, M.F. Capovilla, M.Colombo, E.Colombo, *Energy cost reduction strategies in Developing Countries: the case study of a hospital in Uganda*
- E. Colombo, M. Morazzo, *Dove vanno i kWh? Oxygen*, Enel Foundation, 26-05.2015
- E. Colombo, L. Mattarolo, S. Bologna, D. Masera, *The Power of Human Capital: multi-level capacity building for energy access*, Status of Energy Access Report, Sustainable Energy for All Knowledge Hub, ESMAP [under review]
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e) Cooperation with UNESCO Headquarters, Field Offices

The Chair has strengthened the cooperation with UNESCO offices through a number of initiatives.

In 2013, it was invited to the ‘South East European Regional Forum of UNESCO Chairs’, held in Istanbul in June and jointly organized by the UNESCO Venice Office and the Turkish National Commission, to share perspective, challenges and role that the Chair is experiencing with a focus on the European and Mediterranean regions.

The Chair has also collaborated with the office of UNESCO WWAP (World Water Assessment Program) of Perugia (Italy), invited to participate in January 2015 at the Preparatory “Write-Shop” Expo Water Rooms meeting for the Project Concept for EXPO 2015: “Enhancing knowledge and understanding of freshwater resources”. The Chair has contributed to the event by sharing contents, data and key aspects related to the challenge of integrated management of water-energy-food. In May 2015, the Chair participated to the Conference “Water for a Sustainable World”, held at the Aquae Pavilion in Venice, to discuss the main findings of the World Water Development Report 2015. The event offered the opportunity to tightening relations with new partners interested in joining forces with UNESCO and WWAP towards the management of water and energy resources.

Collaboration has also started with the Division of Science Policy and Capacity-Building UNESCO. Dr Nalecz, as Director of the Division, was invited to the CUCS Conference in July 2015 to discuss the role of education in the sustainable development pattern and to discuss future coordinated actions in the promotion of engineering programs.

f) Other

(any other activities to report)

1. PROJECT

The Chair has continued in the mission of promoting international university partnership with developing and emerging countries, supporting the upgrading of higher education in the target countries, promoting joint research and staff exchange. After few years of running projects, the collaborations have strengthened and the presence of the Chair in the MENA Region (especially in Egypt) and with Sub-Saharan Countries, in particular with the East Africa, is now consolidated and with a higher effectiveness.

Politecnico di Milano, with the direct involvement of the UNESCO Chair, participates in the following projects.

Tempus IV TEMPUS-530611-2012-IT-JPCR (coordinator)

GIEP - Green Innovation and Entrepreneurship Programme (2012/2015)

The project, ended in October 2015, aimed at making Sustainable Development and Green Economy the new entrepreneurial frontier and business in Egypt. The objective of the project consisted in developing a joint/double MSc program on "Green Innovation and Entrepreneurship" with the cooperation of 3 European universities and 5 Egyptian Universities.

The experience done within GIEP and the faced challenges may represent an important case-study for universities, which aim to replicate the same experience in other countries. Indeed, the project has brought the implementation of multidisciplinary courses with a formal process of definition, recognition and approval. Feedbacks and data will be analysed; this will enable to better orient and target the program, and will represent useful information for further implementation in MENA region, as well as in the Europe context, where the approach to revise and update curriculum is very rigid and complex.

Tempus IV TEMPUS-544397-2013-IT-JPHES (coordinator)

TriNex – Knowledge Triangle Platform for the Water Energy Food Nexus (2013/ongoing)

The general objective of the project is to make Water, Energy and Food Nexus (WEF Nexus) the next research, education and innovation frontier for sustainable resource management and development within the framework of green economy in Egypt. The project aims at improving the role of universities in the Egyptian society by developing a national strategy and a university platform to promote the WEF-Nexus and the related synergy between Research, Education and Innovation (Knowledge-Triangle). It started in December 2013 and it is planned to end in December 2016. After the needs analysis to understand the current status of the perception about the Water – Energy – Food nexus in Egypt, the activities have focused on: 1) the creation of a table of experts and decision makers in Egypt on the topic of WEF Nexus; 2) the creation of coordination units within the Egyptian partner universities; 3) the implementation of Trainings for Egyptian young researchers from the partner universities; 4) the dissemination of the projects results. Next steps of TriNex include the organization of a PhD Summer School in Egypt bringing international PhD students and the final TriNex International Conference, where policy makers and experts will be invited.

ACP-EU Co-operation Programme in Higher Education EDULINK II – EuropeAid/132023/D/ACT/ACTPS ENERGISE (coordinator) - Enlarged Network in Education and Research for a Growing Impact of Sustainable Energy Engineering on Local Development (2013/ongoing)

The project has the objective to develop high quality, market-driven curricula in Energy Engineering focused on sustainability, innovative technologies and modern renewable energies relevant to the energy asset within the countries of Ethiopia, Kenya and Tanzania. The project involves 4 local universities and counts on the cooperation of local enterprises, NGOs, ministerial department and rural agencies working at different level on access to energy. A number of different activities have been developed. (i) A comprehensive assessment of current the status of education in energy engineering in Kenya, Ethiopia and Tanzania has been carried out at the beginning. In this framework, UNESCO Chair's students have developed three twinned theses in order to better understand strengths and weaknesses regarding this issue, and to suggest possible upgrading of didactic materials and facilities. (ii) Intensive courses for upgrading both the technical competences and soft-skills of the staff of the four partner HEIs have been delivered to more than 100 persons. (iii) An e-collaboration and e-learning platform has been developed (www.edulink-energise.polimi.it). Useful materials are accessible online, as well as an e-learning course on renewable energies. Moreover, a programme of interactive webinars has started, on both technical and soft-skills topics of interest. (iv) A new Master's curriculum in energy Engineering has been developed by the partner HEIs, and a pilot curriculum is now delivered at Jimma University. (v) The consortium promoted a number of joint actions, including technical workshops, participation in

international conferences, project proposals development and submission, and signature of bilateral MoUs.

ECHO/-SF/EDF/2012/01004

Set4Food – Sustainable energy technologies for food utilization (2014/2015)

COOPI, Politecnico di Milano and Fondazione Politecnico di Milano implemented the project “Sustainable energy technologies for food utilization” (SET4food), co-funded by the European Commission's Humanitarian Aid and Civil Protection department (ECHO). The project aimed at enhancing the capacity of humanitarian actors in identifying, implementing and monitoring efficient and sustainable energy technologies for food utilization in temporary / quasi permanent / permanent camps or informal settlements. SET4Food focused on the nexus between food utilization and energy availability, efficiency and sustainability. Starting from an extensive literature review, support tools for humanitarian actors were produced, namely a Decision Support System (DSS) for the identification of a ranking of potentially appropriate energy solutions, and guidelines regarding technologies potentially available). Innovative solutions were implemented in four pilot projects in Central African Republic (CAR), Haiti, Lebanon and Somalia. Finally, several training activities and dissemination events took place in different places (Italy, Belgium, Nepal, Kenya, Lebanon, Palestine, USA, Haiti, Colombia), in order to sensitize humanitarian workers, public officers, academic staff and the private sector regarding the topic, and provide them with some practical tools. The e-learning open course “Appropriate energy technologies for food utilisation in refugee camps and informal settlements: overview, selection criteria and pilot case studies” was developed in English, French and Spanish, in order to spread the information worldwide. All the information regarding the SET4Food project are available on the official platform: www.set4food.org.

Development Cooperation Program Technical Education and Labour Market Support (TELEMS) - CONTRACT NO PA/015/2013/2014

Capacity Building and Training Service between Dar Es Salaam Institute of Technology and Politecnico di Milano

Starting from an official request from the Government of the United Republic of Tanzania asking for support to the Technical Education Sector, the Italian Government approved and supported the implementation of a programme focused on Higher Education. This International Tender on capacity building in Tanzania was founded by the Italian Cooperation – Italian Ministry of Foreign Affairs, Direzione Generale Cooperazione allo Sviluppo (DGCS).

The project has been concluded, achieving the following specific objectives: to improve the teaching abilities of faculty staff members and to strengthen the institutional capacity of the involved Tanzanian HEIs. In particular, the research areas involved were: Mechatronics, Electronics and ICT, Telecommunications, Civil engineering for Building, Chemical engineering for mining and the administrative area. Essential elements to the project have been the training sessions, both planned in Italy and in Tanzania, and a virtual platform, for long term cooperation. The project has also led to start three PhD research at the Department of Energy of Politecnico di Milano, after a selection process carried out in the Tanzanian universities.

2. OTHER COLLABORATIONS

PMS4CP – Performance Measurement System for (Energy) Cooperation Projects (2013/2016)

Based on a literature review on Monitoring and Evaluation approaches, a Performance Measurement System for energy cooperation project (PMS) model has been developed in collaboration with Enel Foundation. The tool is based on the most known and shared evaluation and aims to support policymakers (public and private stakeholders) by providing useful information on the impact of cooperation projects on sustainable development for better tailor future program in the energy field. The performed activities has identified an evaluation framework for cooperation projects in the energy field based on an assessment of the DAC-OECD five Criteria (relevance, effectiveness, efficiency, sustainability and impact) along the Results Chain (inputs, activities, outputs, outcomes and impact), and by adopting the Sustainable Livelihoods Framework for assessing the long-term impact of projects on the target community capitals through a multi-criteria and multi-stakeholders approach. The project has recently ended and its implications might offer new tools to improve stakeholders’ performances and interests.

GDEE – Global Dimension in Engineering Education (2014/2015)

Global Dimension in Engineering Education (GDEE) is a EuropeAid Project, entitled “Cross-cutting development education into technology studies” which aims to stimulate the introduction of education for development in European Universities.

In these years the chair has contributed by writing two book chapters and producing two short online courses on the topics "Professional and international perspectives of Engineering: the case of energy" and "Rural electrification in Developing Countries via autonomous Micro-Grids”.

E4G – Energy4Growing project (2014/ongoing)

The project Energy4Growing (E4G), funded by the program PoliSocial, aims at studying, developing and setting up an off-grid power system to supply electricity to the school of Ngarenanyuki, a rural village in Northern Tanzania. Specifically, the project investigates a hybrid micro-grid architecture suitable to interface Renewable Energy technologies and energy needs in the most reliable way while exploiting advanced regulations and control techniques. The hybrid micro-grid, installed in April 2015, combines the power generation systems already available in the school (i.e. a run-off-river micro-hydropower plant and a back-up petrol generator) with new installations of PV panels and lead-acid battery pack together with an Interface Converter.

MOOC – Massive Online Open knowledge Courses

The course is addressed to students of Politecnico di Milano and Politecnico di Torino, energy stakeholders, politicians, institutions and journalists. It focuses on the global energy challenge that links energy uses with society's needs, environmental policies and geopolitical assets, while deepening the current scenario and forecasting the expected trends. The course is therefore organized in four main modules:

1. The secret driver of life: a deep analysis of world social events and of the physical phenomena will unveil the complexity of the energy concept as a main driver of natural flux and human society development.
2. Effect of energy uses in twentieth-first century: in twentieth-first century, the analysis of energy uses will help to address the material and immaterial items at the basis of the “energy question” including environmental issues and social challenges.
3. Global energy trends: will explain the recent trends and outlook in energy with a particular focus on the meaning of targets, the global and individual commitment.
4. Implementing the energy transition: will describe the main pillars of the next energy transformation including the role of science, technology and human being

3. ADVISORY

The activity of the Chair also includes advisory to NGOs and private companies. Indeed, ‘transversal’ partnerships with other actors may support the interaction within the context of intervention: civil society and NGOs have a direct and deep knowledge of the local community, public sector is often in charge of the management and control of the local resources and services, private sector may sustain and make effective actions of technological cooperation.

Pre-feasibility study: access to energy in north Mozambique, Cabo Delgado Province (2013)

The study was carried out for the Italian NGO AVSI. It allowed to state the actual situation of the energy sector in Mozambique, in particular in two focus areas in Cabo Delgado Province. Problems related to energy have been investigated thanks to both the analysis of policies, programmes and projects, and an on-field assessment of the actual situation of access to energy in the target areas. A preliminary identification of the problems and opportunities at the target level allowed to define some main actions to be considered in order to enhance access to energy in compliance with the principles of sustainable development.

Pre-feasibility study: Improved Cook Stoves and Thermoelectric Modules for domestic usage in Mozambique (2013)

The study was carried out as advisory service for the Italian company Eni SpA. The analysis of the context of Mozambique and the study of the household needs within this study underlined the massive use of traditional biomass and the problems coming from the traditional cooking devices. Since transition to modern fuels and technologies results unfeasible in the short term, a good intermediate solution is the use of “Improved stoves”, which have a good thermal efficiency of combustion, relatively low emissions and offer the possibility of integration with TE modules for island household electric generation.

Pre-feasibility study and planning methodologies for access to energy and water strategies in rural areas, Namibe and south Huila provinces, Angola (2014)

This work represents a pre-feasibility study with the aim to analyze the strategies for possible solutions to provide access to energy and water in rural areas located in Namibe and South of Huila provinces. The study defines a planning methodology for the process of identification, formulation and selection of the possible alternatives to be further implemented. The results are potentially adaptable to other areas in the provinces and may be scalable to different sizes of villages or cluster of villages. The work is based on an overview of the available documentation related to the energy and water sectors in Angola and on a field mission in the provinces of Namibe and Huila.

Access to modern energy services and community empowerment: improved cook stove and entrepreneurship development, Republic of Congo (2015)

The Project aims at proposing an integrated methodology of intervention that can contribute to increase access to modern energy services to empower the local community within the Hinda Project in the Congo Republic. The results of the project are: 1) Problem Analysis for domestic need in the area of Hinda Project - Analysis of national and local development plan of the next twenty years to define constraints and opportunities; 2) Stakeholder Analysis for energy sector - Scouting of country specific structures (universities, research centres) and local authorities or private players within Republic of Congo that have the methodological skills and techniques for the realization of the prototype of a stove developed by Politecnico di Milano; 3) Improved Cook stove design - Laboratory Testing to define a pattern of improved stove with Thermoelectric modules that can be produced locally for the communities of Hinda project.

“Community empowerment for efficient production, use and access of renewable and sustainable energy in rural areas in Malawi” (coordinator: COOPI) (2012/2015)

The Char has been involved as external evaluator of the project, implemented by the Italian NGO COOPI. The activities ended in July 2015, with the completion of the following final deliverables:

- Final study of the project evaluation, made by an initial part, which presents the developed methodological approach, followed by the application to the real case, using the data and information collected in the three field missions and with the continuous data collection;
- Analysis on the effect of the intervention on the local community, relating in particular with the activity of production and distribution of stoves, and the afforestation process. The document underlines the problem of the use of traditional biomass in rural areas, with a focus on the effect of the actions, the environmental impact and the estimation of CO₂ emission and sequestration achieved by the project;
- Report which estimates quantitatively and qualitatively the projection of the replication of the positive aspects and of the long term impact at national level.

Advocacy to Edison in Conference programme focused on climate change and Mediterranean region in preparation to COP21 (July/October 2015)

The chair has supported Edison company in the elaboration of the outcomes raised from the conferences organized in preparation of the COP21 planned in Paris in November 2015.

Field experience with NGOs and Foundations:

- LVIA (Kenya): design support tool development for solar pumping
- ACRA (Uganda): design support tool development for stand-alone PV
- Corti Foundation (Uganda): intervention strategy for energy assessment for hospital
- Sanjeevani (India): needs and energy resource assessment of farmers
- Semana Foundation (Colombia): powering water supply technologies

Joint Research and field experience with Academia:

- Ngarenanyuki (Tanzania) secondary school: MSc thesis on M&E of Energy4Growing project
- ACRA (Tanzania): MSc thesis on M&E of access to energy in rural villages
- DIT (Tanzania): design support tool development for micro-hydro
- ATC (Tanzania): implementation of hydro-PV-wind micro-grid
- NTNU (Norway): voltage/frequency control for hybrid rural grids
- AUC (Egypt): desalination plant

- NTNU (Norway): development of tool for electro-mechanical dynamic analysis of off-grid power systems
- AUC (Egypt): desalination plant

4. WEBSITE

The activity of the Chair have been promoted and disseminated in the website (www.unescochair-e4sd.polimi.it), which is also provided of an interactive platform to support the joint activities of the network of stakeholders created in these recent years.

3. Future Plans and Development Prospects

Outline of action plan for the next biennium and short/medium and long-term development prospects.

Please do not hesitate to refer to difficulties that the Chair has experienced

(Not exceeding 300 words)

Following the 2030 Agenda and the recent launch of the 17 Sustainable Development Goals, the Chair intends to consolidate its mission towards the promotion of an integrated system of education, research, technological cooperation and community service, focused on energy and sustainable development. Besides the usual commitment on teaching, education and research, in the next period the Chair is specifically engaged to organize a number of events and actions with the goal to be a multidisciplinary hub for the promotion of innovative and successful solutions within the public-private partnerships.

On the national context, the Chair is currently launching a new pilot experience, coordinating the activation of a 'Platform for Energy in Development', to define a first Italian pilot experience of multi-actors collaborations, which may count on a rich and extensive framework of Italian expertise and competence, and includes institutional and private sectors, civil society, academic and research sectors. The overall objective of the Platform is to identify, formulate and validate intervention strategies in line with the SDG7, to combine interventions of high impact for a local and autonomous development with an equal promotion of Italian of culture, education, research and industrial innovation. The platform will be likely active starting from the second half of 2016.

On the international context and on a long-term perspective, the Chair intends to consolidate the presence within the global framework of institutions and actors involved in the paradigm of energy and development. In particular the cooperation with the Africa-EU Energy Partnership (AEEP) will be enforced. A conference will also be organized in May 2016 and it will represent the Second Stakeholder Forum of the AEEP, hosted jointly by the Italian Government, the African Union Commission and the European Union Commission.