ABSTRACT BOOK OF THE CONFERENCE

SUSTAINABLE ENERGY FOR AFRICA

Financially supported by

Introductory session

keynote speech 3

Dr. John F. May

10:35 **The Demography of Africa: Impacts on Economy, Energy and Governance**

Prof. John F. May, Dept. International Health, Georgetown University, Washington, DC

ABSTRACT

The population of Africa, and particularly of sub-Saharan Africa (SSA), is growing rapidly. The continent has already a population of 1.2 billion people and is expected to have a population of 2.5 billion persons in 2050. Should the demographic trajectory of Africa follow current assumptions of a rather slow fertility decline, the total population of the continent could be 4.4 billion at the end of the century. At that time, the population of SSA alone could be close to 4 billion—a quadrupling of the SSA population in 2016.

This huge population increase in Africa will have far reaching consequences on many development sectors. First and foremost, African population will migrate and urbanize rapidly, fueling the current megacities and their slums. The formation of human capital (education and health) will be another major challenge. Last but not least, SSA will need to create during the next quarter century 18 million new jobs every year—this is about the current population of Burkina Faso.

Three dimensions will need particular attention. First, should fertility decline more rapidly, active people would become relatively more numerous than their dependents and this could generate a production surplus (i.e., a first demographic dividend). Second, the rapid population growth will have a major impact on the energy needs of the continent, and countries will need to accelerate their energy transition. Last but not least, in order to capture a demographic dividend and to plan for their energy requirements, SSA countries will need to improve their governance. This will be a sine-qua-non condition for countries to be able to charter the way forward and seize the potential opportunities.

Keynote speech 4

Prof. Wail Benjelloun

10:55 **African universities and science diplomacy in favour of alternative sources of energy (based on exchanges with 100 universities during COP22 in Marrakesh)**

Prof. Wail Benjelloun, President Mediterranean Universities Union (UNIMED), Former president of the Conference of the University Presidents of Morocco

ABSTRACT

During the climate change conference in Marrakesh (COP22), close to a hundred university presidents and directors of research academies met at the invitation of the Moroccan Conference of University Presidents and the Hassan II Academy for Science and Technology. The event was sponsored by UNIMED along with several other international organizations. Most of the participants were from Africa, with several presidents from other continents. The objective was to convey to COP22 negotiators scientific information concerning climate change in Africa and to lobby for political and policy support for the adoption of mitigation measures.

The meeting also considered the role of universities in addressing climate change, with reference to education, training, research and social responsibility and the setting of a climate research agenda for Africa. The second day was devoted to mitigation, adaptation and resilience to climate change in Africa: Role of science, technology and continental cooperation.

It became clear from the discussions that African countries must prioritize adaptation and mitigation strategies if current growth is to be sustained. In 2012 70% of major global droughts occured in Africa, affecting more than 16 million people. The fact that Africa relies so heavily on rain-dependent subsistence agriculture means that rainfall variability (drought or flooding) can seriously hamper GDP growth. Africa must thus work to make its voice heard in international fora, adopt mitigation measures to decrease deforestation and opt for alternative sources of energy (the Moroccan wind and solar program was commended). It must also empower the poor through the adoption of appropriate social safety nets.

At the end of their deliberations, participants in this summit adopted a Joint Official Declaration of African Academies of Science and Presidents-Rectors of African Universities recommending actions to be undertaken in the academic and scientific areas to face the challenges of climate change in Africa. The Declaration insisted on the necessity for the United Nations, decision makers in the developed world and international organizations to set up a special fund to financially support initiatives that need to be implemented in Africa, including support for research.

The Marrakesh proclamation, adopted by the heads of state and of government at tthe end of COP22 included these recommendations, calling for an increase in funding, in mobility and in access, together with an improvement in technological capacity building for Africa as well as the transfer of technology from developed to developing countries.

Topic 1 - Energy is crucial for achieving the Sustainable Development Goals

(7 lectures, Q/A session 23 October, late morning and afternoon)

Lecture 1

Dr. Emmanuel Kofi ACKOM

11:15 **Energy for sustainable development in Africa: Successes, challenges and possible way forward**

Dr. Emmanuel Kofi ACKOM, E.K., Haselip, J.A and Mackenzie, G.A., UNEP, DTU Partnership (UDP), Technical University Denmark (DTU), Copenhagen

ABSTRACT

In this paper, we present some of our experience based on 25 years of UNEP DTU Partnership's (UDP) work on energy for sustainable development in the African continent. Modern energy is an enabler for economic growth, poverty alleviation and sustainable development, yet approximately 70% of the population in sub Saharan Africa (SSA) are without access to this very essential service. The rather low access to modern energy in Africa could be attributed to a myriad of factors including but not limited to geopolitical, governance, institutional, policy, cultural, finance and human capacity. Working with government departments, key institutions and scholars in Africa, through a combination of technical assistance, capacity building, and academic and field research, and facilitating a South-South knowledge network, UDP has gained some very rich experience in sub-Saharan countries. Our paper will focus on the mechanisms employed by UDP, the extent to which, and how, our work in the continent has been able to influence change in climate-friendly energy policies and energy planning in the participating African countries. The challenges encountered in the implementation of our work and how we were able to overcome some of them will be highlighted. Finally, but not least, our paper provides recommendations for a possible way forward in surmounting some remaining barriers that hinder increased energy security and diversification of supply using cleaner energy options.

Lecture 2

Paul FRIX

11:35 **Financement des énergies renouvelables en Afrique : principaux enjeux et perspectives d'avenir pour les partenariats-publics-privés sous l'angle européen**

Paul FRIX, Senior Economist, specialized in Int'l Relations and Development, DG Honoraire Coopération belge et CDE/CDI, Conseiller CBL-ACP, Manager de PROPADEV SPRL

ABSTRACT

"The main Challenges for Financing Renewable Energy in Africa - Lessons from the past and new Opportunities for PPP, viewed from an European Point of view".

Access to energy is a critical enabler for economic, sustainable and inclusive development particularly in the fields of education, health, enterprises and job creation. Yet, because of little installed capacity, **at least 600 million people in Africa have today no access to electricity.** Even those connected to the main grids experience frequent blackouts which request costly domestic generators. The public utilities in the sector often face under-capitalization, poor management, inappropriate tariff collection, financial difficulties and insufficient maintenance. It is predicted **that in 2100, Africans will represent 40% of the world population. Under the joint pressure of demography and urbanization the electricity needs will explode in the coming decennia.**

Fortunately, the energy sources of the continent are extremely important and diverse, combining traditional and renewable energy. The potential of clean energy is particularly huge: (abundant solar, hydro, geothermal, maritime and biomass sources…). The mounting international common awareness about the climatic dangers of global warming and the need to react at world level combined **with the new management and communication tools (ICT) should logically allow Africa a leapfrog to base the future of its economic development mainly on a post carbon model.** In this framework, various types of sustainable and renewable energies are to be developed and based as well on central and interconnected grids as on decentralized and off-grid solutions.

The needs for investments in the clean energy sector are enormous and request: peace and stability, coherent policies, favorable business environment, and involvement of the private sector namely trough appropriate Public-Private-Partnerships (PPP) capable to mitigate risks and able to mobilize domestic, regional and international resources. At the COP-21 (Paris, 2015), developed countries committed to mobilize jointly $100 billion a year starting from 2020 from a wide variety of sources to address the needs of developing countries to combat climate change. According to Ed Wells, expert and head of global markets policy at HSBC Bank in London, the main problem is not at the level of financing; the supply of well-defined projects is what's short.

Up to now the EU cooperation in the field of energy in Africa has been diverse but relatively modest, channeled mainly through the "Investment" and "Infrastructure" facilities located at the EIB and the

"Energy Facility" financed by the European Development Fund in the framework of the Cotonou Agreement . The volume of EU financing should gradually and substantially increase and diversify in the future trough new blending approaches, green bonds, impact loans, multi-stakeholder's initiatives and new programs as "Electrifi" and the European External Investment Plan for Africa. Innovative financial instruments and "special purpose vehicles" for the implementation, management and financing need also to be developed in parallel, namely for important or huge projects as e.g. the Grand Inga Dam in the DRC.

Domestic and foreign resources can also be mobilized through green bonds, private foundations, crowd funding schemes and specific guarantee and management systems for more modest and decentralized projects at local, communities and regional levels (see e.g. the decentralized approaches applied in the Virunga Park in the DRC with the support of the Howard G. Buffet Foundation and crowdfunding).

Amongst the tools and channels getting the support of the EU, it is worth mentioning: the "EU- Africa Energy Partnership, the UN "Energy4all" Program, IRENA and AREI, etc…[1]

One of the key challenges will be to ensure a sufficient mobilization of the needed resources at private and public levels without triggering a new unbearable spiral of external debt as it was the case in the years 70 and 80. After 30 years of painful Structural Adjustment Programs 90% of the sovereign debt of the eligible "Heavily Indebted Poor Countries" (HIPC) were finally cancelled by the International Community. Certain lessons from the past may, from this point of view be very useful to prevent, limit or cure resurgence of the catastrophic evolutions endured by many African countries in the last decennia of the 20th Century.

Examples of new approaches were e.g. concretely proposed in the years 1980's and discussed at OECD level with a view to solve the DRC external debt thanks to "Debt Project Swaps". The approach was tested on a modest scale by the Belgian Development Cooperation in Guatemala, Bolivia and Congo Brazza. Since then, countries like France are using this type of mechanism to finance social and development programs in post-HIPC beneficiary countries. To limit the risk of non-reimbursement of its loans in the infrastructure sector in Africa, China has been using preventively and massively the swap system consisting in exchanging "Infrastructures for Raw Materials". In two decennia, this allowed China to become the first External Direct Investor provider in the African Continent before the EU and US (see the 2017 Africa Investment Report of the Financial Time).

[1]IRENA: Inernational Renexable Energy Agency.
AREI (African Renewable Energy Initiative): Launched in 2015, the AREI's objective is to install 10 GW of renewal energy power plants on the continent by 2020 and 300 GW by 2030. The AREI has already obtained the support of several investors, which promised to provide 10 billion USD by 2020 to reach that objective.

In its own interest and if it wants to remain one of the important partners of Emerging Africa, the EU, with its member states, should rapidly develop coherent, dynamic, proactive and structuring approaches in the fields of PPP. Risk lowering for private investment and the partial redefinition of the public aid concept and role at the level of the OECD/DAC (DAC = Development Assistance Committee) will be key factors to allow the EU to contribute efficiently to the rapid emergence of a post carbon economy in Africa.

Lecture 3

Prof. Ed Brown

11:55 **Governing decentralised energy provision: exploring the role of local governance in articulating nexus approaches to energy transitions**

Prof. Ed Brown, Jon Cloke, John Harrison and Richard Sieff (all at Department of Geography, Loughborough University, UK)

Presenter: Prof. Ed Brown, National Co-Coordinator, UK Low Carbon Energy for Development Network and Senior Lecturer in Human Geography, Loughborough Univ.

ABSTRACT

Nexus thinking, increasingly advocated as an integrative approach to building synergies and reducing trade-offs across the water, food and energy sectors (e.g. Hoff, 2011), has coincided with a period of dramatic transformations in the political and energy contexts of the Global South. Widespread political decentralisation has taken place, while the global prominence of debates surrounding energy access and decentralised energy provision has risen substantially.

These changes prompt the question of what role decentralised governance structures could take in realising nexus approaches to decentralised energy transitions, yet existing literature in this field has been critiqued for a lack of attention to the crucial part played by local governance and changing national-local political relationships (Stevens & Gallagher, 2015). This is of particular surprise given the extensive nature of many current political decentralisation drives in developing countries.

This paper aims to bridge the gap between the literatures on political decentralisation and nexus approaches to decentralised energy, which have hitherto largely been discussed as separate entities. Drawing on work conducted for a recent EPSRC/DFID/DECC-funded research project which focused on Renewable Energy and Political Decentralization and ongoing work on local energy governance in Kenya and Malawi the paper combines a more conceptual consideration of how best to cross-fertilise insights from these literatures with a more practical focus on what the **future local governance of energy** might look like as the drive towards rapid electrification across Africa continues to take form. Focussing predominantly on Kenya, site of one of "the most rapid and ambitious devolution processes in the world" (World Bank, 2015), this discussion attempts to better understand the role of local governance in implementing a more harmonised nexus and how political decentralisation might facilitate and enhance this process.

A range of issues within this context will be explored including:

- How the various scales of governance interact within the energy, water and food sectors
- How they might be most effectively coordinated and
- How institutional disconnect, power imbalances and the increasing complexity of greater cross-sector integration might be resolved?

Lecture 4

Bruno BENSASSON

14:00 **Centralized and decentralized energy solutions for Africa: cutting edge technologies supported by and co-developed with the African actors**

Bruno BENSASSON, ENGIE, Africa Business Unit, CEO, Paris

ABSTRACT

The development of a balanced portfolio of activities which delivers an acceptable growth while taking into account risks is a necessary approach for any international company wishing to do business in Africa. None of the African countries are coming with a low risk profile, we have to understand those risks and above all make the right decisions on the development of an energy infrastructure which is in line with the Continent's needs.

Africa will need both centralized and decentralized energy solutions. As baseload is required, the mix of solutions will much depend on the progress of storage systems.

Installation of centralized power will have to provide the competitive, low carbon, solutions, Africa needs for its economic growth. We also see a role for the growth of natural gas in Africa, in large LNG-to-power projects, but also small scale LNG and gas distribution. The African economies need energy services that will make their businesses more competitive, thanks to expert externalization. Development of decentralized innovative solutions will bring power – and beyond power, many applications : water, mobility, etc. – to rural Africa. As the access to power in rural Africa progresses, there will be a real need to also help larger cities tackle the challenges of a sustainable growth through the deployment of cutting edge technology.

This whole process and evolution has to be supported by and co-developed with the African actors, authorities and regulators, off-takers, industrial clients and potential partners.

Africa will write its own energy story, capitalizing on innovating technologies and taking advantage of the know-how and experience of both international companies and local players.

Lecture 5

André Bouffioux

14:20 **Digital Solutions for Growth**

André Bouffioux, CEO, Siemens Belgium-Luxembourg (also responsible for the assigned countries: Algeria, Morocco, Tunisia and West-Central Africa)

ABSTRACT

The world has never been as closely connected – or as digital – as it is today. After electrification – the backbone of all industrial development – automation is making it possible to boost the effectiveness and reliability of industries across all sectors. And digitalization is opening up new perspectives towards as yet unexplored business models. How does digitalization represent a unique opportunity to strengthen competitiveness, add value locally and increase growth sustainably in Africa?

Lecture 6

Valérie Quiniou

14:40 **Integrating Climate into Strategy for an Oil & Gas Company: focus on Africa**
Valérie Quiniou, Vice-President, Climate - Strategy - Innovation, TOTAL S.A., Paris

ABSTRACT

With operations in more than 130 countries and 98,000 employees, TOTAL is a leading international oil and gas company and aims to be the responsible energy major by helping to supply affordable, reliable and clean energy to as many people as possible. To accomplish this goal, TOTAL leverages its integrated business model, which enables it to capture synergies between the different activities of the Group.

The Group's strategy is based on four main priorities:
– driving profitable, sustainable growth in Exploration & Production's hydrocarbon activities, with priority given to reducing production costs, disciplined investments and cash flow generation;
– continuing to enhance the competitiveness of major integrated refining and petrochemical platforms;
– increasing the distribution of petroleum products, particularly in high-growth regions, and offering innovative solutions and services that meet customers' evolving needs above and beyond the supply of petroleum products; and
– expanding along the full gas value chain by unlocking access to new markets, and developing profitable low-carbon businesses, in particular renewable energies.

This strategy incorporates the challenges of climate change, using as a point of reference the 2°C scenario of the International Energy Agency and its impact on energy markets. TOTAL's challenge is to increase access to affordable energy to satisfy the needs of a growing population, while providing concrete solutions to help limit the effects of climate change and supplying its clients with an energy mix featuring a progressively decreasing carbon intensity.

Since 2011, the Group has been developing its off-grid solar product offering, and consequently has contributed to improve the lives of more than 10 million people in some forty developing countries, chiefly in Africa.

For Total, being able to meet these needs is part of its climate strategy, as energy demand comes mainly from countries with a carbon-intensive energy mix due to their reliance on biomass and generators.

This product offering, initially comprising individual solar lighting and phone charging systems, has evolved towards more comprehensive and powerful solutions, such as solar kits for powering radio and TV sets on top of providing electricity, and mini-grids for communities of 200 to 500 households.

This constant expansion of the offering in off-grid energy solutions helps to meet growing needs in emerging countries.

Lecture 7

Prof. Dr. El Tayeb Idris Eisa

15:00 **Sustainable energy mix for African and MENA region countries**

Prof. Dr. El Tayeb Idris Eisa, Ph.D. Univ. of Reading UK, National Energy Research Center, Khartoum, Sudan, and Prof. Dr. Mustafa El-Tayeb, President Future University, Sudan, Former Director UNESCO, corresponding member of RAOS

ABSTRACT

This paper reviews the current applications of energy mix of renewables, fossil fuels and nuclear energy in specific countries in the African and MENA region. The analysis indicates that Africa is rich in energy resources but poor in energy availability, supply as most of the energy resources are not yet fully utilized.

This severe energy poverty and extreme supply shortages hampers the economic development of the countries in the region.

North-African, Gulf Countries and South Africa are major exceptions with significiant higher levels of electrification and overall energy consumption. Meeting the current and future energy demand is the major challenge to all African and some MENA region Countries.

The paper addresses also the impacts of the applications of the technologies of renewable energy, fossil fuels, and nuclear energy (in specific countries) on; energy supply, costs, effects on environment and the benefits and the left constraints. Also, the paper highlighted some of the successful stories in the region.

The last chapter also focuses on the necessary policy, strategies and the transformations needed in the institutional energy structures, legal framework, and financial challenges facing the implement optimal and sustainable energy mix program in the selected countries.

Topic 2 - Energy mix: towards robust, equitable and socially acceptable energy systems

(17 lectures, Q/A sessions

24 and 25 October)

Lecture 1

Prof Jean-Pierre Tshibangu

09:00 **Towards a global partnership regarding mineral resources and energy production: contribution to sustainable development with focus on Africa**

Prof Jean-Pierre Tshibangu, UMons, Faculty of Engineering, Dpt of Mining Eng., RAOS member

ABSTRACT

The global demand of mineral resources and its impact on economy is growing at high rate since about two decades (http://minerals.usgs.gov/minerals/pubs/mcs). Ensuring industrial production needs the development of facilities to produce energy in such an amount to comply with the level of activity. Different definitions have been used for the development, the most recent being the "emerging" one.

The development of African countries relies mostly on the production of raw materials from natural resources: agriculture or mining. Specifically, the production of mineral resources and their transformation implies the use of great amount of energy (e.g. use of furnaces or electro-winning in metallurgy). The mining sector has to face different challenges: the increase of World population and demand ; the limited high grade resources (producing one tonne of metal will then need more energy); the variability of prices on the global market ; the development of activities in protected areas (example of Natura 2000 zones in Europe); the pollution of surface and underground water, etc.

The most recent boom in mineral commodities prices showed a big development of artisanal mining in Africa (2 to 3 million people in DRC) to supply industrial companies in the World. This situation is favoured by poverty and low technological level in Africa, and it can be shown that these operations do not improve the life conditions of local populations. In artisanal operations, people use to exploit very rich areas in deposits leading to their general premature economical depletion. Mineral resources are considered as "Earth heritage", their exploitation must then be conducted in such a way to ensure sustainability for future generations.

Another big issue is the perception of development model in Africa as can be illustrated currently by migration of young people trying to reach Europe. In terms of energy consumption, American people have been and are still the biggest consumer per inhabitant. With the recent boom of the mining sector in Africa, one can see that current reference for standard of life seems to be the Western one (South Africa, D.R. Congo,…). The resources of the earth in terms of mining commodities and energy resources (mostly petroleum) will not be enough to sustain such a standard for the growing global population.

How can Africa meet SDG 12 (Sustainable consumption and production) and 13 (Strengthen the means of implementation and revitalize the global partnership for sustainable development) in the global competitive market?

Statistics show that Africa has a huge potential in mineral resources both for mining and energy (coal in South Africa), but developing those resources to comply with SDG 12 and 13 will need an overall approach to deal with workforce (so improving education), technology (develop research) and capital (improve the level of economic risk and avoid capital evasion towards other continents). All these items are linked to the governance of African countries in order to improve the lifestyle of populations eco-friendly. Currently Africa produces mostly raw material. Mining products exported towards all over the World are reimported with big margins, so giving an unbalanced trade.

There is then a need for a new partnership between rich countries and Africa to develop a fair business that can be profitable for both parties.

In its current H2020 research program, European Union expressed three ways to address the new policy for the mineral commodities (https://ec.europa.eu/growth/tools-databases/eip-raw-materials). International cooperation is one the pillars of the European Innovation Partnership; it is intended to implement new technologies in exploration and modern mining through cooperation with international players, among which African countries. This pillar is aimed at developing ore metallurgy and processing techniques in an innovative way to increase metal recovery, decreasing energy consumption and improving the by-products recovery; engaging EU's partners in a dialogue on recycling technologies with the aim to improve the environmental performance of end-of-life products. It is important for Africa to develop such a cooperation with a clear view to what can be the target at the horizon of 2030 to comply with the United Nations objectives. The partnership to be developed by Africa can also be extended to other continents; some ideas will be developed in this presentation.

Lecture 2

Prof Per J. Agrell

09:20 **Sustainable Energy Transition: An Operations Research Perspective**

Prof Per J. Agrell, co-director for the "Center of Operations Research and Econometrics" (CORE), Anthony Papavasiliou, ENGIE Chair at UCL in Energy Economics and Energy Risk Management and Ignacio Aravena, senior researcher, all co-authors with CORE - Louvain

ABSTRACT

As an interdisciplinary domain that is positioned at the interface of engineering, mathematics and economics, operations research offers a ubiquitous set of methodologies for comprehensively addressing the engineering, institutional and economic challenges that result from the transition to sustainable energy systems. With its unique renewable energy potential, Africa is ideally positioned for a sustainable energy transition, and can be expected to be confronted with an array of challenges that have already emerged in numerous US and European systems. In this talk we will focus on how operations research can be used for addressing a number of these challenges, with specific case studies from California and Europe: (i) mitigating the variability of large-scale renewable energy integration in day-ahead scheduling; (ii) coordinating the operations of neighboring zones in order to absorb the renewable energy fluctuations of neighboring regions; (iii) designing markets that can maintain the economic viability of flexible technologies that can be used for balancing renewable energy resources.

Lecture 3

Dr Aymen Chaouachi

09:40 **On Power System Paradigm: Opportunities and Challenges**

Aymen Chaouachi, PhD, EGI (Elia Grid International, Brussels), Power System Operations & Security

ABSTRACT

The electric power system is facing increasing stress due to fundamental changes impacting both supply and demand dimensions. On the supply side, a sustained shift from large synchronous generators to scattered smaller distributed energy resources, increasing penetration of non-synchronous power injection (HVDC or power park modules) and variable uncontrollable resources (wind and solar farms). To meet the demand needs, the EIA's 2016 Energy Outlook projects that the total electricity generation will have to increase by 69 % through 2040 (predominately in non-OECD countries). Furthermore, new concerns in term of environmental impact marks the needs to integrate higher shares of Renewable Energy Sources (RES), which are yet still presenting major challenges in term of investment, operational costs as well as well as their controllability.

Against this background, resources both in financial and technologic innovation terms would present further obstacles to cope adequately with such expected paradigm. Entities engaged in the power sector's extensive value chain ranging from utilities, generation, transmission & distribution and regulating authorities are facing increasing challenges to manage such evolution in the medium and long term without compromising the system security, securing the necessary investment funds and the affordability of the electricity supply.

The EU identified three main pillars to address the forthcoming challenges namely: Sustainability, Competitiveness and Security of Supply, it is clear however, that from a systemic perspective, sustainability in its broader definition implicitly covers the two later pillars. In this presentation, we will highlight Elia Grid International experience and vision for electricity sector challenges prospects and the strategy to leverage sustainable opportunities.

Lecture 4

Prof Samuele Furfari

10:00 **Energy poverty in Africa: focus on challenges and solutions related to electric power and to energy for cooking**

Prof Samuele Furfari, Geopolitics of Energy, ULB, École polytechnique

ABSTRACT

We consume too much energy! It's a well-known familiar refrain. We seem to forget that the

quality of life in our Western countries - and has no equal in the history of mankind – is the result of this energy consumption. Without energy, there would be no health care, no health, no hospitals, no home comforts, no leisure, etc. But the reality is globally different ... A part of Humanity is suffering from "energy poverty". The situation is particularly dramatic in Africa.

There is in the world 1.3 billion people who have no access to electricity. Despite exact statistics, it is estimated that 2.5 - 3 billion have intermittent access. Few hours a day of electricity is infinitely better than those who have none at all. The average rate of access to electricity of Sub-Saharan Africa is 35%. In South Sudan, only 5% of the population has access to electricity, in Burundi 7%. In DRC it is 16% while hydropower that could be produced on the Inga River would suffice for much of Africa.

But there is worse than the lack of electricity! After all, if we want to do without comfort we can do without electricity. But we cannot go without food. Cooking is therefore a necessity.

There are 2.7 billion humans who eat meals prepared with renewable energy only (wood, green wood cut by women and children, dried dung), sometimes with plastic bottles. This causes severe respiratory disease and premature death that are largely documented by WHO. Should Burundi deforestation continue at the current rate in order to obtain the necessary energy, its forests will disappear in 24 years.

These countries must grow and get out of this extremely precarious energy situation. It is

therefore urgent that as citizens, academics and policy makers are aware of this injustice and act quickly to end the scourge of fuel poverty in Africa. If there is a humanitarian and moral urgency for rich countries, there is also for them major economic concerns, geostrategic and credibility.

There is no doubt that some leaders of countries lacking modern energy will not follow the

solutions recommended or imposed by NGOs, in particular in relying on China already funding and building infrastructure using fossil fuels and hydroelectric dams they need.

In this vibrant plea in favour of the poorest people in Africa, the speaker proposes a series of pragmatic solutions reconciling economic development and environment, rich and developing countries, economic interests and human development.

Lecture 5

Prof. Ndaye Nkanka Bernard

10:50 **Modèle de prospective énergétique avec évaluation des coûts et des effets sur l'environnement pour la République Démocratique du Congo**

Prof. Ndaye Nkanka Bernard, Institut Supérieur de Techniques Appliquées, Kinshasa

RESUME

Dans une problématique énergétique mondiale marquée par des contraintes d'ordre social, économique, environnemental et de disponibilité des ressources primaires toujours croissantes, la principale préoccupation pour chaque pays reste la satisfaction de ces contraintes sur le long terme tout en pensant aux générations futures. Le domaine scientifique qui permet d'étudier en profondeur ces contraintes et de proposer aux décideurs les options politiques à suivre est « la Planification Énergétique », outil d'analyse chiffrée de l'avenir énergétique d'un pays et base scientifique des orientations à suivre. Les modèles de prospective énergétique constituent alors des supports précieux à l'analyse chiffrée de différents scénarios de développement énergétique des pays. Cependant, tous les modèles de prospective énergétique qui existent actuellement sur le marché mondial ne s'appliquent pas facilement dans la plupart des pays en développement où généralement une base de données riche, désagrégée et structurée fait défaut.

Dans cet article, nous présentons un modèle de prospective énergétique que nous avons développé et nommé « RDCONGO », pouvant s'adapter aux réalités des pays en développement. Il s'agit d'un modèle de prospective énergétique sur le long terme, permettant l'élaboration de plusieurs scénarios énergétiques et d'en évaluer les coûts et les effets sur l'environnement. De quoi rendre le choix des scénarios allant dans le sens souhaité plus facile.

Son application au cas du système énergétique de la République Démocratique du Congo (RDC), pays en développement, dont l'évolution économique, démographique et sociale pourrait déjouer les pronostics actuels et nécessiter un apport énergétique important, nous a permis, dans un scénario de référence (Business As Usual – BAU), d'avoir des résultats qui démontrent que le modèle énergétique actuel de la RDC n'est ni acceptable ni durable sur le long terme. Le scénario BAU, considéré comme « Scénario Éclaireur » pourrait donc être utilisé pour faciliter l'élaboration d'autres scénarios dans l'objectif d'orienter le système énergétique de la RDC dans le sens voulu. Ce qui constitue avec le modèle lui-même, la valeur scientifique de notre démarche.

Lecture 6

Dr Ir Pépin Tchouate Heteu

11:10 **Renewable energy deployment in Africa : opportunities, challenges and perspectives**

Pépin Tchouate Heteu, Ph.D. in applied sciences from UCL, managing Director of DEECC Consulting (Energy, Environment, Climate change mitigation)

ABSTRACT

Sub-saharan Africa (SSA) is the world's region with the lowest access rate to electricity, only 35% in average, with a stark disparity between urban (69%) and rural areas (15%). This is due to the electrification strategy, adopted by SSA countries for the past 60 years, based on centralized grid extension and a monopolistic electricity supply system. Paradoxically, majority of SSA countries are endowed with untapped renewable energy resources which are beeing seriously considered since the UN launched the Sustainable Energy For All (SE4ALL) Initiative. In fact, achieving universal access to electricity by 2030 will demand to strategically increase renewable energy generation to supply both on- and off-grid population, businesses and industries.

This communication will address:

- Update of electrification status in SSA
- Overview of the SE4ALL objectives in selected countries, with emphasis on access and renewables share in the electricity mix
- Overview of Renewable Energy resources in Africa
- Benefits and Challenges associated with Renewable electricity development in Africa including green minigrids, regulatory and tariff issues as well as economic, health and environmental impacts.
- Perspectives and way forward.

Lecture 7

Carl De Maré

10:50 **Steel: a key resource for a sustainable and circular economy in emerging countries**

Carl De Maré, Vice-President ArcelorMittal, Group CTO, Head of Technology Strategy

ABSTRACT

Steel was 2 centuries ago at the start of the industrial revolution and has become an unavoidable resource for development of the world. However, the model of steel comes more and more under pressure due to its environmental footprint. The presentation will address the question on how much steel will be required in the 21th century to develop all regions and how can this be done in a sustainable way with respect with the environment.

The key drivers for the use of steel will be explained, together with the major technologies to produce steel (primary steel from iron ore and secondary steel from scrap). These insights enable to predict the long-term steel use and production in the different regions world-wide. During the next 50 years, the growth of steel will come from recycling steel scrap. However also steel production from iron ore will still be required during a long period and carbon will be required to reduce iron ore to fresh primary steel.

Although steel is one of the most GHG friendly man-made materials, it requires carbon to reduce the iron ore and is contributing to the Climate Change problem. The strategy of ArcelorMittal however is not to leave Carbon, but to create new options to re-use the carbon in a much more circular way, as is already done today with the steel itself.

A portfolio of options has been studied and developed as use low caloric value BF gas to reheat steel before rolling, filter CO2 out of the waste gas with only waste heat, reform CO2 with cokes gas and renewable power. The most innovative breakthrough technology however is the use of microbes to convert the waste carbon of the Blast Furnace into bio-ethanol. This innovation allows to create how valuable transport fuels and avoid the use of fossil oil.

ArcelorMittal with his partner Lanzatech has worked years in order to scale up the technology upto the level that is can convert a significant part of the waste carbon of a steel plant. Currently ArcelorMittal is building a first large scale demonstration plant in its steel plant in Gent, Belgium, where it will produce 80 million litre of bio-fuel.

This use of bio-technology open a new field. It allows to store renewable energy over a long period, but also it creates a stock feed made out of waste carbon which can be used to produce plastics, paints and even food.

The steel plant of the future will more than ever be a corner stone to further develop the real circular economy. Steel has showed it is able to re-use a lot of the waste materials generated in the society. ArcelorMittal is now also showing it can generate other stock feeds for other high value add business

development. For this reason, ArcelorMittal is convinced that Steel will become the material of choice of the 21th Century.

Lecture 8

Henri Boyé

14:00 **Hydro-electricity in Africa : remaining economically exploitable capacity and impact assessment study (including social acceptance)**

Henri Boyé, USAID Electrification Advisor / Electricity Sector Reform Project, and Michel de Vivo, General Secretary of International Commission on Large Dams

RESUME

L'acceptabilité sociale et environnementale des barrages

Notre planète Terre a de plus en plus besoin d'eau et d'énergie, du fait de la croissance de la population et des consommations, surtout dans les pays en développement. Les ressources en énergie fossiles émettrices de CO2, hydrocarbures, gaz naturel, pétrole, charbon, sont consommées à un rythme croissant, et les réserves sont inévitablement en voie d'épuisement, au détriment des générations à venir. Après la COP 21, le recours accru aux énergies renouvelables est une nécessité renforcée par l'Accord de Paris. Parmi toutes les énergies renouvelables, c'est l'hydroélectricité qui est la plus économique, car compétitive sans subventions couteuses, et sans problème d'intermittence ni de stockage pour les gestionnaires des réseaux électriques. Elle offre de plus des avantages uniques pour la gestion du réseau électrique (réglage de la fréquence et de la tension).

Par ailleurs les besoins en eau douce, en eau potable et en irrigation, vont aussi beaucoup augmenter, avec le changement climatique annoncé. Sans eau, il n'y a pas de vie sur notre planète. Les ressources en eau douce sont limitées et mal réparties. Il existe des régions où la fourniture d'eau conditionne toute amélioration du niveau de vie, actuellement trop bas, et même la survie des communautés existantes, ainsi que la satisfaction de la demande toujours croissante résultant de l'accroissement rapide de leur population. Dans ces régions, on ne saurait se passer de la contribution des barrages-réservoirs pour l'utilisation des ressources en eau. Il faudra beaucoup augmenter nos ressources en eau et construire de nouveaux barrages.

Les infrastructures de stockage d'eau sont considérées comme des outils indispensables à la fois pour le développement durable et pour l'adaptation au changement climatique.

Pourtant le développement des barrages est controversé, au Nord comme au Sud, du fait des impacts potentiels, et les projets nouveaux se heurtent souvent à des oppositions parfois fortes.

L'acceptabilité sociale des barrages est donc une question très importante, et le présent article s'efforce d'apporter quelques réponses et réflexions, en matière de prise de conscience sur les questions d'environnement et de démocratie, avec des exemples d'actions dans les pays en développement.

Lecture 9

François Misser

14:20 **Grand Inga, le plus grand complexe hydroélectrique du monde : ambition nécessaire mais à mûrir**

François Misser, diplômé de l'École supérieure de journalisme de Lille, chercheur indépendant, spécialiste des relations entre pouvoir et ressources naturelles en Afrique

ABSTRACT

La plus grande richesse du Congo, outre ses hommes, c'est le fleuve dont le pays tire le nom, et son bassin, l'eau qui lui apporte un potentiel agricole, forestier et énergétique considérable. Mais la mise en valeur de ce potentiel, notamment hydroélectrique est laborieuse. L'article entend rappeler l'enjeu de d'Inga 3, première étape du projet Grand Inga, qui vise à faire du site, le plus grand complexe hydroélectrique mondial. C'est un projet dont l'envergure est telle *(+ou- 40 GW* qu'à lui seul, il représente près de la moitié du nouvel en énergie hydroélectrique qu'il faudrait développer à côté d'autres sources d'énergie, pour atteindre l'objectif de **l'énergie pour tous à l'horizon 2030**.

Bien conçu, l'aménagement du site peut conférer au pays et à la région, grâce à l'énergie la moins chère du monde, une compétitivité dont ils manquent cruellement, rendre des services environnementaux considérables, en générant une énergie propre, alternative aux centrales thermiques d'Afrique australe et fournir une alternative à la destruction des forêts congolaises, sans compter les services rendus à des secteurs comme l'agriculture et la santé.

Dans un deuxième temps, sera examiné l'état d'avancement du projet de construction de ce troisième barrage, dont le démarrage, annoncé pour octobre 2015 par le gouvernement congolais, n'aura lieu au plus tôt qu'en 2017. Les causes des retards dans la mise en œuvre, qui tiennent à sa taille, défi à la fois géologique, hydrologique, technologique et financier seront examinées.

Nous nous pencherons enfin sur la finalité de ce projet extraverti, largement configuré selon des critères de solvabilité de la clientèle de l'électricité produite par le barrage et de sa capacité à garantir la bancabilité du projet. Le traité international signé entre le Congo et l'Afrique du Sud en 2013 fait passer les besoins de la société sud-africaine ESKOM et de l'industrie minière du Katanga, avant ceux du reste du Congo. La société civile congolaise s'exprime de plus en plus à ce propos. La question est maintenant de savoir comment sera gérée cette attente et si dans les étapes à suivre du développement d'Inga les aspirations des Congolais seront davantage prises en compte par l'État congolais et ses partenaires.

Lecture 10

Prof. Patrick Hendrick

14:40 **Using small low cost, robust and easily maintained decentralized hydraulic power stations in Central Africa**

Prof. Patrick Hendrick, ULB, École polytechnique

ABSTRACT

Central Africa suffers from a recurrent lack of electrical energy. That prohibits its locally-based industrial development but also its daily life through, for example, the education of the children and students but also the working condition of women.

Though the hydro-electric potential is, in most of these countries, huge but has been and is still poorly or non-adequately exploited.

One of the reasons has been the uncorrect use of a too heavily centralized hydraulic power generation and another one is the use of too expensive, too delicate and too difficult and expensive to maintain small power generation units.

Two solutions that bring new technical and maintenance features will be presented here.

One is the old Archimedes screw specifically designed for and used in turbine mode. This application will be described for rivers that have been monitored in the Katanga province of the RD Congo.

The other solution proposed is using the very robust cross-flow turbine concept and it is analyzed for an application in the Kayanza province in Burundi.

Lecture 11

Prof. Peter Baeten

15:00 **The development of Small Modular Reactor (SMRs) for emerging nuclear countries in Africa**

Prof. Peter Baeten, SCK•CEN & VUB Kernenergie, and Prof. Hamid Aït Abderrahim, Deputy Director-General International Affairs SCK•CEN & UCL Ecole Polytechnique

ABSTRACT

The renewed interest in nuclear power in Africa driven by a rapidly growing energy demand, persistent concerns over climate change and dependence on overseas supplies of fossil fuels has

increased the prospects of considering this option in national energy strategies to ensure access to affordable energy for sustainable development. Many African countries have begun revisiting the nuclear option over recent years with a view to establishing long-term sustainable energy supplies.

A first prerequisite is the development of national and regional planning for nuclear power development. Secondly, adequate legal and nuclear safety and security measures and infrastructures need to be installed. Thirdly, government leadership is necessary for the initial programme development, while continued government support is required throughout the life of the programme. Also, funding and financing during the initial programme development are necessary and critical. Moreover, in Africa the compatibility and integration in the electrical grid should also be considered as an important infrastructure consideration. Last, but not least, one needs to address the human resource requirements of a nuclear power program.

Based on the previous considerations it is clear that large NPP's of 1000 MWe and beyond are not that well suited to respond to the demand. Small Modular Reactors with a typical power of maximum 300 MWe show the following benefits. First of all, from the point of view of grid considerations, SMR's are better suited to respond to: (1) electrical grids with limited capacity; (2) remote areas requiring smaller localized power centers to avoid long and expensive transmission lines; (3) geographically dispersed small- and mid- size urban centers; (4) incremental production capacity.

Secondly, SMR's require a smaller capital investment cost and have the potential to reduce the cost uncertainties and construction timeframes associated with conventional NPPs. Because of the smaller size they could even be used in remote African locations.

Large NPP's require also grid-connection for decay heat removal after shut-down. Due to the limited and low reliability of the external grid in most African countries, the availability of this grid-connection might not be all-time assured in these African countries. SMR's with lower power can be designed more easily for passive decay heat removal without the need for a reliable external grid. The easier implementation of intrinsic and passive safety of SMR's also make them more robust with regard to different initiating events to might endanger the safety of the plant.

The smaller and more standardised SMR units might additionally also result in a reduced need for highly skilled engineers and technicians. Since human resources is a major issue, SMR's might also from this perspective be more compatible.

Besides electricity production, SMR's could also address the need for desalinisation of water.

Today, several concepts based on the current Light Water Reactor technology are becoming ready for industrial deployment. However, these concepts based on water as a coolant will generate the same type of long-lived spent fuel as we encounter today in the Western world. To go also for a more sustainable solution of nuclear energy production with SMR's in Africa, a shift towards so-called fast neutron SMR's, not based on water as a coolant, is recommended. In this respect, a liquid lead cooled based SMR's could be the solution as it offers high intrinsic and passive safety features (high thermal inertia for passive residual heat removal, non- exothermic reactions with air and water and good inherent shielding properties) while responding to the sustainability challenge. Moreover, such a fast neutron SMR will allow to have long refueling times up to 10 to 15 years, resulting in only 2 or 3 reloads over its lifetime. Not only from a sustainability point of view, this represents an advantage, but also from a proliferation point of view and easiness of operation and associated needed human resources and operating costs.

The development of such a liquid lead reactor can be based on the technology developments currently underway for the MYRRHA project and could make the commercial deployment of a liquid lead SMR possible at the horizon of 2035-2040.

Lecture 12

Prof. Dr. Ir. Jozef Poortmans

15:50 **The potential and challenges related to photovoltaic electricity generation and local (DC) microgrids**

Prof. Dr. Ir. Jozef Poortmans, Scientific Director PV@imec, Director R&D strategy@EnergyVille and Part-time Professor at KULeuven and Univ. Hasselt

ABSTRACT

The presentation will review the technological and cost challenges related to the deployment of photovoltaic electricity generation. Thanks to the rapid price decline of PV-generation the present levelized cost of electricity from PV-source would be in the range of 4-7 Eurocent/kWh making PV economically perfecly conceivable. The presentation will also highlight the challenges related to the reliability of this electricity generation taking into account the specific climate over the African continent. From this it will become clear that reliability ensuring lifetimes > 20 years will require specific solutions for the tropical regions as compared to the subtropical regions.

However, even with all the solutions becoming affordable, large-scale deployment will also require the development of nano- and microgrids including local storage as to deal with the intermittency of solar electricity generation. These nano- and microgrids could be based on DC-solutions rather than pure AC as this could reduce the investment costs by 10-20%. Such development is to be taken seriously as at least 2-thirds of the generation/lead would be essentially DC-based (PV, batteries, LED-illumination, ICT-systems, ...)

Lecture 13

Marcel Bial

16:10 **The value of concentrated solar power for developing countries: another look on energy transitions**

Marcel Bial, Secretary General of the European Solar Thermal Electricity Association

ABSTRACT

The main priority for any society is to trigger growth, creating jobs and improve living standards.

Growth is at the beginning of the 21th century to a large extent achievable as "green growth", based on an energy supply model designed as the most efficient combination of renewable sources. This will deliver reliability and affordability of a system, in which a centralized bulk energy supply to energy intensive industries will coexist with decentralized generation serving mostly local demand and "circular" or "participative" economy sectors.

The energy transition towards renewables that started in Europe is an irreversible process, even if the pace of this transition will vary from country to country. It might of course just be accelerated or delayed by price swings on raw materials and fossil fuels or any major accident...

Energy investments need time from any decision to implementation,

- effects on the system (re-balancing a generation portfolio) until the effects on technology costs get real (effects of scale and bankability of innovation) and until the behaviour and interest of users (prosumers/consumers), also as voters change.

The time metrics for this process is at least a decade, which means that longer-term planning is key and that opinion-drivers and decision-makers understand the value of an energy transition in its various dimensions.

The value of any energy transition is 3-fold:

- business (cost/return ratio) value leading to concepts such as primary affordability,
- macro-economic value (GDP metrics, up into "social welfare" understood as the well-being of the entire society, including the quality of life, quality of the environment (air, soil, water), availability of essential social services, even religious and spiritual aspects of life.
- both together means a political value: The energy transition is already now an instrument for policy makers to offer their voters an active role in modelling their own future: the citizen has suddenly a "real say" about how and when his energy needs shall be covered

The key issue is system responsibility. But which one?

- Although energy policy remains in most countries (including EU!!) a national competence, even if progress is being made towards integration of the power systems: soon, power systems will constitute larger physical entities (more than a single market) where any structural unbalance or

any abrupt supply disruption in a given country impacts all participating countries in the system. Herein lies the importance of a robust „grid integration“ of VARIABLE renewable energy sources such as PV and wind.

- Countries in Europe claiming they can manage penetration levels of intermittent generation “of nearly 100%” are either exporting system stability issues to their neighbours or manage such situations over short periods (sunny or windy weekends).
- This means that the reliability of a power system will soon no longer be managed at national level

The good things ahead of us:

- In this context, the supra regional system responsibility (i.e. the task of real-time balancing generation and demand) in todays power systems is to stay as the core task of TSOs.
- In order to manage intermittency of more generation sources, it will need to be increasingly coordinated with DSOs and new agents (independent power producers, “prosumers”, etc..).

But someone MUST take responsibility..

Both for the system operation and the market design, correcting what no market will deliver a full-value approach of investments that leads to a better balanced ratio between generation investments in intermittent and non-intermittent sources.

The less good things…

- Energy regulators are said to defend the interests of consumers. Doing so, they have been following mainly a “technology-neutral”, “market-fits-all-issues” policy.
- However, energy markets that are today largely financial markets cannot (by essence) and will not cover all value aspects.
- Current market mechanisms alone do not ensure that generators in the power system are remunerated for their effective contribution to system responsibility, do not take into account externalized societal costs such as industrialization effects, business opportunities, health effects, dismantling costs, etc...
- It tackles only the short-term affordability and completely misses the strategic and political values of the energy transition.

We have the choice between 3 scenarii:

- Either to end with a system with approx. 30% of renewables that a still fossil-fuel based system can more or less cope with, without incentive to go further. coal, oil and gas industries will come back on stage and …citizens will pay also with their health.
- Or both the system operators and the demand side will sooner or later call for a new clean and cost efficient balance between intermittent and non-intermittent generation sources. At that moment, dispatchable generation will reach extreme price peaks due to not timely investments and the resulting scarcity; the energy transition will come to a hold – possibly inverting the energy transition back into fossil fuels.

The better scenario, the better choice is to use CSP as soon as possible – as Morocco has impressively demonstrated

- A smooth energy transition built on a balanced technology mix building on non-intermittent generation technologies incorporating commercially proven bulk storage solutions is of course possible

- However, these should be built now so to be available in larger volumes and at much lower costs demonstrating thus to the world the complementarity of technologies for a common objective: full decarbonization. Natural gas may be to a certain extent further used to increase firmness of deliveries.

Lecture 14

Prof Dr Ir Eric Pirard

16:30 **Development of solar energy in Africa : A challenge in terms of resource availability and recycling**

Prof Dr Ir Eric PIRARD, RAOS member, and Dr Sandra BELBOOM, Ulg

ABSTRACT

Africa is a booming continent in terms of population, GDP or electricity consumption. From 2000 to 2014, population has been multiplied by 1.42 to reach 1155.8 million people, GDP by 1.9 and electricity consumption by 1.6 (International Energy Agency 2012). Based on these facts, increasing their electricity production using their local resources is mandatory to be able to increase their energy security supply and to continue their economic development.

Focusing on Africa, sun is a renewable resource, free of charge, without any dependency of supply from other countries but implying technologies to transform this resource into electricity. Photovoltaic panels are dedicated to this goal and present several advantages as the free cost of the fuel and no emissions during the production of electricity. These advantages are counterbalanced by the high amount of mineral resources needed, the lifetime of installations, the decreasing yield during operation years and the very limited recycling potential.

Based on published literature, this study will highlight environmental considerations of the use of PV panels in using the Life Cycle Assessment methodology (International Organization for Standardization (ISO) 2006b; International Organization for Standardization (ISO) 2006a). This study will consider polycrystalline-silicon panels and highlight the advantages and drawbacks of PV as well as limitations in the environmental evaluation of PV electricity production. Boundaries of the system will begin with the production of the panel with the raw material extraction and will end with the end-of-life. A special focus will be put on the recycling of the panels and the depletion of the mineral resources. Production of silicon used in the photovoltaic panels is assumed to be produced from an inexhaustible source (silica sand), but only a very limited part of this resource is adapted to produce solar silicon.

As the amount of PV panels is increasing through years, and their lifetime is about 30 years, some recycling routes should be implemented and should influence the design of panels to avoid a landfill at the end of their life.

Lecture 15

Dr Rainer Janssen

09:00 **Overview of bioenergy policies for sustainable development in Africa**

Rainer Janssen, PhD, Head of the Biomass Department at WIP Renewable Energies (WIP = "Wirtschaft und Infrastruktur GmbH & Co Planungs-KG"), Munich, Germany

ABSTRACT

The agricultural sector in most Sub-Saharan African countries is currently dominated by subsistence farming with very low investment levels and yields. The development of modern biofuel projects offers opportunities for investment and infrastructure improvements with the promise to diversify agricultural production and thus to stimulate socio-economic development, including an increase of yield levels and value creation within subsistence farming schemes.

Primary drivers for modern bioenergy promotion in Africa include security of energy supply, a reduction of the foreign exchange burden of oil importing countries, as well as environmental benefits such as the restoration of degraded land, reduced land abandonment, and the mitigation of greenhouse gas emissions.

On the other hand, concerns exist that biofuel expansion in African countries may have severe negative impacts on biodiversity and the use of natural resources through increasing competition over land and water resources. Rising prices of agricultural commodities may negatively affect food security of the poor in developing countries and the implementation of large-scale biofuel projects may cause negative social impacts such as conflicts over land ownership and displacement of rural communities.

It is widely acknowledged that sound legal and regulatory frameworks for biofuels are needed in African countries to ensure environmentally, economically and socially sustainable production, promotion and use of biofuels.

In order to minimise risks and maximise benefits, in recent years several African countries have launched initiatives to establish sound policy frameworks for bioenergy in order to ensure environmentally, economically and socially sustainable production, promotion and use of biofuels. Significant progress has been achieved in Mozambique with the National Biofuels Policy and Strategy (NBPS) published in May 2009 and the Biofuel Sustainability Framework in its final stages of development.

This paper presents current policy initiatives for sustainable biomass in several Southeast African countries (i.e. Mozambique, Malawi, South Africa, Tanzania) and discusses conclusions of the "Workshop on Sustainable Biomass Production in Southeast Africa" which was organised by WIP Renewable Energies on behalf of Netherlands Enterprise Agency in Maputo, Mozambique in 2013.

Lecture 16

Jean-Noël Marien

09:20 **Wood: an ever-present domestic energy priority for people in emerging Africa**

Jean Noël Marien (*) ; Régis Peltier (**) ; Emilien Dubiez (**) ; Théodore Trefon (***)
(*) Retired (since 1 October 2014) from « Centre de coopération internationale en recherche agronomique pour le développement » (CIRAD) UR Forêts et Sociétés – Montpellier France ;
(**) CIRAD UR Forêts et Sociétés – Montpellier France ;
(***) « Musée royal de l'Afrique centrale » (MRAC) - Tervuren Belgium

ABSTRACT

Wood-energy in Africa (including charcoal) mainly meets domestic energy needs as there are no specific wood cultivation projects dedicated to supplying industrial energy plants. We shall describe how this informal but highly organized sector operates, covering the entire process moving from the standing tree to the kitchen oven. We also shall present some basic data showing the significance of increasing needs and consumption, especially in urban areas, with regard to rapidly depleting natural resources.

Some examples of contrasting situations in Africa will highlight the diverse issues raised by wood energy. An analysis of the situation in 16 African towns will show different solutions to the pressures generated by domestic energy needs. Other examples will present two pathways of natural resource degradation (in Guinea and DRC) induced by the supply of wood energy to large cities.

In most African countries, the use of wood for domestic energy involves multiple, interacting issues.The wood mainly comes from degraded natural forests (e.g. shifting cultivation) and is generally produced within traditional agricultural systems. The demand grows continuously, due to ever increasing populations domestic needs. We will address the relations between wood energy and environmental and social issues, and examine the economic weight of the sector. Finally, we shall indicate some institutional and governance means to address (or not) the populations' domestic energy needs.

The sustainable management of wood-energy resources is possible and is one of the keys for the future. We shall present some results of the Makala project, an EU funded programme in DRC and Congo Brazzaville, from 2008 to 2014 (1). The project has developed on a large scale various operational tools for a sustainable wood resource management. These range from simplified, but efficient, management planning for rural communities, to various methods to create or regenerate a large area producing wood resources through the natural regeneration of degraded forests, agroforestry systems, or the plantation of fast-growing species. Achieving a more efficient carbonization process is another important issue. The feasibility of improved stoves also will be discussed.

Given that urban population growth will in many cases lead to an increase in household energy requirements which will surpass what can be provided by tree formations, the authors argue that planners should consider the development of energy mixes that combine the sustainable production

of wood-energy with a partial transition to other energy sources (fossil, hydro-electricity, solar or biomass). The importance of the carbon economy will also be discussed by examining some international processes as REDD initiative or Green Fund for the Climate (UN).

Finally, some conclusions from a recent prospective analysis of Central African forest ecosystems will focus on the evolution dynamics, expected impacts and strategic actions able to address positively the wood-energy challenges that will face Africa in the future.

(1) Makala project: www.makala.cirad.fr (EU EuropeAid DCI-ENV/2008/151-384)

Key words : Domestic Energy, Africa, Wood, Charcoal, Natural Resource Degradation, NR Sustainable Management, Agroforestry

Lecture 17

Prof Hervé Jeanmart

09:40 **A locally manufactured gasification technology for the valorization of agricultural wastes in West African countries**

Prof Hervé Jeanmart (1), Séverin Tanoh (2), Wilfried Ouedraogo (3), Yohan Richardson (2), Sayon Sidibe (2), Frédéric Bourgois (1) and François Pinta (4)

(1) Université catholique de Louvain, Louvain-la-Neuve, Belgium; (2) Institut International d'Ingénierie de l'Eau et de l'Environnement, Ouagadougou, Burkina Faso; (3) Institut de Recherche en Sciences Appliquées et Technologies, Ouagadougou, Burkina Faso; (4) Centre de coopération internationale en recherche agronomique pour le développement, Montpellier, France

ABSTRACT

A locally manufactured gasification technology for the valorization of agricultural wastes in West African countries

Rural populations in Africa depend nearly exclusively on woody biomass to satisfy their energy needs that are usually limited to cooking and some food processing.

Nevertheless, this limited use together with the biomass exported to the cities lead to an unsustainable pressure on the resources. At the same time, agricultural activities lead to the production of large quantities of residues (cotton stalk, rice husks, etc.).

These wastes have an energetic potential that could be exploited locally. But, contrary to woody biomass, the combustion of these residues is complex. Gasification could help converting efficiently these residues into more useful forms of energy: not only heat but also electricity. Downdraft fixed bed gasifiers are the most suitable technology for the range of power (50…200kWth) and feedstocks considered. While gasification could significantly improve the access to energy in rural areas, the imported technologies (e.g. from Europe and India) are too complex and thus not resilient.

Existing local technologies do not sufficiently take into account the peculiarities of the gasification process and of the available feedstocks. A technology designed to be efficiently manufactured, operated, and maintained locally could overcome the barriers that prevent the development of gasification in rural areas of West African countries.

Such a concept entails many challenges. The characteristics of the feedstocks, especially the moisture and ash content, may vary a lot. The quality of the available steel makes it unsuitable for high temperature processes and prone to corrosion. The local manufacturing techniques must be adapted to produce airtight vessels from available parts. The cooling and cleaning requirements for the syngas must be matched without producing hazardous liquid effluents. Yet the numerous challenges can be overcome with suitable designs for the different parts of the gasification facility.

After a description of the potential contribution of agricultural wastes to the energy needs in rural Africa, these challenges shall be detailed and illustrated with results, including experimental data, taken from the development steps of a gasification technology manufactured in Burkina Faso for the production of heat and electricity.

Topic 3 - Research, innovation and education in support of sustainable energy policies

(3 lectures, 25 October)

Lecture 1

Prof. Pierre Dillenbourg

13:30 **MOOCs for Africa: Lessons Learned**

Dr Dimitri Noukakis, Program Manager, Center for Digital Education (including "MOOC Afrique), Ecole Polytechnique fédérale de Lausanne (EPFL), and Prof. Pierre Dillenbourg, EPFL, academic director of Center for Digital Education (MOOC Factory)

ABSTRACT

In 2012, EPFL has launch a MOOC initiative with African universities that belong to RESCIF, a North-South network of French speaking universities of sciences and technologies. The MOOC initiative especially targeted sub-Saharan countries. Some MOOCs developed in French for our own students have been integrated into related courses from African campus. Other MOOCs have been co-developped by teachers from EPFL and from African universities and produced at EPFL. An obvious difficulty has been and still is the bandwidth inside and outside African campuses. A more fondamental issue concerns the nature of skills to be acquired in a MOOC, from vocational skills to academic skills. This dilemma is not specific to the African context but also depicts the evolution of MOOCs produced by Coursera, Udacity or EdX. In this talk, I will report the successes and pitfalls we encountered and the solutions we develpped.

Lecture 2

Nicolas Roland

13:50 **Massive Open Online Courses : an answer to the issues facing higher education in sub-Saharan Africa ?**

Nicolas Roland (responsible of "ULB Podcast"), Eric Uyttebrouck, ULB, Cellule PRAC-TICE (Pédagogie, Recherche-Action & TICE), and Prof. Philippe Emplit, ULB, Director of the Département de support aux activités académiques

ABSTRACT

Massive open online courses (MOOCs) represent nowadays a global phenomenon in the education and distance learning fields (Karsenti, 2013). Following the success of these courses on the African continent (Caramel, 2015), the research « MOOC Afrique : analyse des besoins, étude de faisabilité et recommandations » (Roland, Stavroulakis & Emplit, 2016) provides a state of the production and usage practices of these MOOCs in sub-Saharan Africa – supported by study visits in Senegal and Cameroon – and looks at how they can provide a relevant answer to the issues facing higher education. Moreover, this research initiates reflections on the quality of education and its control in view to deploy such schemes in the African context.

This communication proposes, in the first instance, to view historically how universities ensured this quality control in their distance training schemes as well as an overview of the current practices in the MOOCs' production. Secondly, we will present the methodology of the "MOOC Afrique" research, which combines a user-centric methodology (Roland, 2012), a design-based research approach and a participatory audit (Aubert-Lotarski & al., 2006). We demonstrate that the complementarity of these different approaches aims to place such a development in an efficient quality assurance process involving the final users from the early stages of the project development. By interviewing different levels of stakeholders through a number of methodological instruments, the results allow us to grasp the meaning that African users give to these MOOCs, the way they appropriate them – or would like to appropriate them – and modify some of their functions in order to answer in an optimal way to their needs regarding teaching and learning. In the third and final phase, we will describe the main recommendations provided by this research in order to offer solutions (in technical, pedagogical and development terms) that are adapted, perennial and promoting the empowerment of the local populations in the development of distance learning and MOOCs.

(lecture 4)

Prof Sandra Soares-Frazão

14:10 **Sharing knowledge online and improving education using MOOCs**

Prof Sandra Soares-Frazão and Emeritus Prof Yves Zech, Génie Civil et Environnemental, UCL Ecole Polytechnique

ABSTRACT

The development of the Internet offers a wide range of new opportunities for the world of education. Massive Open Online Courses (MOOC) are developed by several international renowned institutions in different fields related to their course programs. A MOOC is typically conceived as a series of short videos where the professors explain the key topics of the course, complemented in some case with additional documents to be read by the learners. Associated to the videos, exercises are provided, mostly under the form of quiz, to check the understanding and progresses of the learner. Open forums and discussions between the learners and with the professors provide a certain level of interaction, so that a community of learners is formed during the course. In the field of engineering for example, anyone in the world can follow courses about programming, basic fluid mechanics, mathematics, thermodynamics, river hydraulics, etc. Some of these courses, while open to the worldwide community, are closely linked to courses offered by these institutions to their regular students, and the professors often combine classical teaching with online material provided to the students. Some other courses are developed specifically for learners all around the world, allowing them to acquire specialised knowledge in an interactive way, without any official registration as regular students from these institutions.

Such open courses that can generally be followed free of charge really constitute an opportunity for Southern countries: with this new, up-to-date and interactive material, students and learners from these countries can access knowledge that was before restricted to a limited number of institutions.

Of course, this new world of knowledge also opens new questions, especially about evaluation and certification. What is the real value of a certificate delivered after completion of a MOOC? How to be sure that the person registered to the MOOC is the right real person who completed the graded activities? Then, in Southern countries, a frequent concern of the professors is the possible loss of responsibility and power of decision in the evaluation process. Can the professors still decide whether a student passes or not? Will the professors all be replaced by computers? Technical issues also arise: following a MOOC usually requires a good quality Internet connection to watch the videos, download the additional course material, participate in forum activities and discussions and perform the graded assignments. Can such an Internet connection be guaranteed all over the world? Certainly not.

To propose adapted answers and solutions to all these questions, a new and innovative way of thinking teaching activities is required. Based on the recent experience of a MOOC in Fluvial Hydraulics developed at the Université catholique de Louvain in collaboration with the State University of Haiti that was followed by a large number of learners issued from Southern countries, these questions will

be discussed with the aim of proposing possible solutions for making these new technologies affordable and useful to anyone in the world.

Conclusion session

Keynote speech 1

Prof Emanuela Colombo

14:50 **Measuring sustainable energy projects to orient strategies for access to energy: why does it matters?**

Prof Emanuela Colombo, Dr Lorenzo Mattarolo, UNESCO Chair in Energy for Sustainable Development, Department of Energy, Politecnico di Milano, Dr Mariano Morazzo, Head of Climate Change and Renewable Energy Policies at Enel.

ABSTRACT

Over the last decades, the interest of the international community for sustainable development and the multiple interconnections among energy, environment and society have widely increased. This holistic approach of sustainable development has been clearly remarked in the 2030 Agenda with the centrality of energy within the 17 Sustainable Development Goals: energy is an instrumental right for unleashing development, supporting local enterprises and creating new jobs, improving health and education, in addition to assure sustainable and equitable access to basic needs. Despite the relevance of energy in the development framework, 1.1 billion people today still do not have access to electricity, 2.8 billion depend on traditional biomass for their domestic use and around another billion lack access to a reliable electricity grid. These numbers are not likely to change significantly in the near future, even under the most optimistic scenarios. Moreover, the perspective counting in 2040 still more than 0.5 billion people without access to sustainable energy is really far from being compatible with the claim of the 2030 Agenda.

So, what are we missing? Why is it so difficult to scale up successful strategies that can keep paces with population growth? Reasons are different and worth a deep analysis which may also vary from country to country, however there is a common and general perspective is shared by the majority of the researchers in energy access: we need to know more in details the effects of any energy strategy in order to better distil best practice and drivers of success and, equally important, be able to dig bad practises and the reasons of failure.

Given this framework, a proper e**valuation metric able to assess the effects of energy projects on the changes of community livelihoods and the positive effects on social, economic and environmental levels is strongly needed to assess future strategies and policies**

Relying on some recognized evaluation frameworks, as the DAC-OECD criteria (Relevance, Efficiency, Effectiveness, Sustainability and Impact), and the process perspective of the Results Chain (Input, Activities, Output, Outcome, Impact), our research proposes a framework for Performance and Impact Assessment of energy project. **This approach may provide a model-based set of information** for comparative analyses among projects and feedback for decision making, in order to orient policies. **It is structured in two phases**:

1. ***A project-based step****, which assesses projects in terms of process performance,*

In the first phase, four DAC-OECD criteria may be calculated with common metric (adopting exergy-based technique or recent Life Cycle extensions). In this way, a 'proxy' of the total (non-renewable) primary resources undertaken during the project may be captured. Different projects may so be compared in term of efficiency or effectiveness (and other DAC-OECD criteria). This step gives a measure of the performance of the project in term of resources consumed to obtain a given set of results, creating a data base of benchmarks and standards.

2. A ***people-based step****, which assesses the project impact on the beneficiaries*

The second phase aims at measuring the effects of the project on the local livelihoods, assessing in terms of target community's capitals, like natural, physical, human, social and financial. Taking the original idea from the "Sustainable Livelihoods Framework", the proposed methodology for impact assessment requires an application procedure where the definition of the evaluation hierarchy, often done via knowledge-based approaches, represent a crucial step.

Application has been conducted on real case studies by private players, public institution and NGOs in Malawi, Ethiopia and Chile. Currently POLIMI is working with ESMAP (World Bank) and Enel Foundation to evaluate synergies between PIA and the Multitier framework

Impact on development cannot be reduced to a single quantitative number or compressed within an engineering procedure, but rational methodologies may help policymakers or donors to better assess their decision and evaluate long term strategies in order to fasten the process toward universal energy access to all.

POSTER PRESENTATIONS (36 in total)

(poster 1)

Private sector involvement in energy production: experiences of the Belgian Development Agency from Rwanda and Mozambique

by Muriel Lambert de Rouvroit, Frederik Van Herzeele, Benoît Legrand (as unit coordinator) and Paul Verlé (as head of department), all in Infrastructure and Environment Unit, Belgian Development Agency (BTC)

ABSTRACT

The article describes the shift that was made from grant-financing of energy production towards other models to increase energy access in the two countries where energy is a concentration sector of the Belgian Development Cooperation. Some issues with the public sector are discussed, and the private sector is looked at as part of the solution.

In Rwanda, the Belgian Development Agency (BTC) grant-financed the construction of several mini-hydropower plants for a total of around 3MW installed power. In retrospect, these plants were rather poorly managed, and operated well below their capacity. These plants were privatized 2 years later, and their operation has drastically improved since. Solar installations on off-grid hospitals faced a similar fate : first breakdown turned out to be the end of the system's life.

In the new energy portfolio of BTC in Rwanda, the focus is now investment in (public) on-grid extension, on capacity building of the utility to operate and maintain the grid and on private sector support for power production. Under the proper regulatory framework, including attractive tariffs, investments in energy production have become viable, and are left to the private sector.

In Mozambique, the Belgian Development Agency installed over 700 solar installations on health centers, schools and administrative buildings. Problems arose quickly due to bad maintenance, in turn due to a lack of capacity, budget, planning, monitoring, combined with a culture of "free" energy provided by the government leading to a low willingness to pay from beneficiaries. Maintenance, in general, has the disadvantage of being invisible when well done, it's hard to recuperate politically. Therefore, a public operator, often has low interest in maintaining solar systems.

In the second phase of the energy program, BTC will invest in mini-grids that are designed, built and operated by the private sector, who has a higher incentive to maintain installations than the public sector. As these investments are costly (often around 1€/kWh distributed), either subsidies or high tariffs are needed to make these mini-grids viable investments. A second intervention will build capacity at the ministry's level, working on policy, planning and regulatory framework, in order (among others) to attract the private sector, who is currently still reluctant to invest in Mozambique.

Despite the huge differences between Rwanda and Mozambique, some common lessons can be learned from these experiences, and common challenges are faced by the future interventions. The private sector needs to be properly regulated, without creating more barriers, and needs to be given proper incentives to deploy, without oversubsidising.

(poster 2)

Our goal: 600 million connected Africans connected to electricity by the year 2025

Smaïla Camara, ENA/Dauphine and HEC Paris Business School, Special Advisor to Jean-Louis Borloo, President of “Energies for Africa” (Ministre d'État, ministre de l'Écologie, 2007 – 2010, France)

ABSTRACT

The facts

Each year, 10 additional million Africans do not have access to energy.

Energy is a prerequisite to any development. Yes, Africa witnesses a fast 5% growth per year, but it's not the case throughout the entire continent. Development through electrification certainly isn't a new idea, though it never went through. But the urgency is here: 650 million people today do not have access to electricity on the continent, and this number is susceptible to significantly grow considering the African population will double by 2050.

The urgency to act

We are obviously facing a social urgency. For kids to be able to do their homework at night, for women to stop giving birth in the dark, for medicines to be preserved in fridges, for the African youth to consider a proper future on their own continent, we need to generalize the access to electricity. We are also facing an economic emergency. The development of electrification will offer new perspectives to African companies, therefore benefiting European and worldwide economies. Let's keep in mind that if the growth of African countries raises from 5% to a double digit per year, it will raise ours of 2%. Africa represents an incredible perspective of growth, especially for Europe.

The launch of Energies for Africa (Energies pour l’Afrique)

It is in this perspective that we are advocating for the creation of an Energy access instrument, with the ambition to gather all initiatives and international investments in favour of developing access to electricity, and to promote those projects matching technical, institutional, legal, or financial African needs.

The current situation is not a fatality. A real opportunity does exist to bright light to a continent that will host 40% of the world's population at the end of the century. And this instrument will be the key to such development. We created Energies for Africa to accompany all common interest actions promoting the access to energy for Africans, and especially to electricity, starting with the creation of this instrument led by Africans in partnership with Europe and all mains contributors.

The goals

Our main goal: 600 million Africans connected to electricity by the year 2025. Electricity is a prerequisite to agriculture, health, access to water, to economic, cultural, social and democratic development. Obscurity calls for obscurantism, when light calls for Enlightenment. Today, Africa and the world take action for the whole continent to have access to electricity.

(poster 3)

Collaboration between Northern and Southern organizations with the aim to facilitate and analyse technology impact on society

Jean-Pierre Raskin (Université Catholique de Louvain) and Stéphanie Merle (Louvain Coopération)

ABSTRACT

Higher education is the time for many students to focus on the complex functioning of our society and to reflect on social inequalities and environmental issues it generates. In science and technology, initiatives are emerging to integrate these questions to training. Many universities and colleges are motivated to develop the teaching of social and environmental complexity linked to the technical choices, to develop critical thinking with students against models of society conveyed by technology... We are talking about scientific citizenship, ethics applied to engineering, socio-technical integration, political technology assessment, ...
Higher education is fully active in sustainable development and can help to promote more equitable and sustainable societies in forming the European civil society of tomorrow with alliances and synergies.

The purpose of this seminar is to share current practices for developing a civic education of science and technology to students. The reflection will also focus on possible partnerships between NGOs and universities to introduce the themes of sustainable development and social issues in the curriculum, the role of the multidisciplinary and the need to address issues with a multi-stakeholder approach. With the objective to strengthen partnerships and to demonstrate that scientific citizenship is an inseparable element of a European active, aware and informed citizenship multiple causalities of the human development process.

(poster 4)

Barriers to the uptake of renewable energy in the East Africa region: an enabling environment, access to finance, awareness and access to technical support services

Prof. Izael Pereira Da Silva

B.Sc. (Eng), MSc., PhD in Power Systems Engineering from the Univ. of Sao Paulo (Brazil) Deputy Vice Chancellor – Academic Affairs Strathmore University in Kenya

ABSTRACT

The spread of solar and other modern energy technologies in African countries is considerably low. Despite the global viability and growth in the solar energy market, African countries continue to lag behind. They represent less than 1% of the market demand for solar energy.

The region accounts for only 9% of the global installed capacity of photo-voltaics (PV) which convert light into electricity using semi-conducting materials. The solar PV technology power generation rate rose from 1% in 2010 to just between 3% and 4% in 2013.

This is despite the fact that Africa has the best solar resource in the world. Most countries on the African continent receive between 4 – 6 kWh/m2/day in most months of the year. This means that in a day, a square metre of solar panel can generate 4 to 6 kilowatt units of electricity. In simple terms, it could power 400 - 600 10-watt light bulbs for one hour.

In the past, the poor diffusion of modern energy technologies in developing countries, especially in rural areas, was attributed to poverty and ignorance. But recent market dynamics challenge this theory. Mobile telephony technologies, for example, have had huge success in market penetration in the same environments and under even tougher conditions.

So what is holding the solar energy sector back?

There is a range of factors that affect players at every level of the value chain - from the investors to the end user.

Four challenges

A study carried out in Kenya sheds light on what is holding solar back. It looked at the choice of lighting fuel in households, education levels and the household heads' income brackets. It also examined the average household expenditure, ownership of the dwelling, potential grid access, rural/urban setting of the household and the prevalence of solar home systems in the area.

The findings of theat study, corroborated by others, identifies four categories that can be seen to affect the growth of the solar energy industry in Africa. These are: an enabling environment, access to finance, awareness and access to technical support services.

An enabling environment refers to the conditions in a country or region that support the growth of a particular industry. It is mostly a function of the national government and regulatory bodies which can either be a hindrance or be helpful.

The "Kenya Least Cost Power Development Plan" provides a good example of how a regulatory body can fail to be of assistance. In its latest plan the country's energy commission makes no provision for the generation of electricity from solar energy resources at any point in the projected 20-year period. The decision to omit solar PV was based on previous assumptions that labelled this technology as too expensive, which is not the case today.

This plan limits solar energy applications to solar home systems, solar water heating and other off-grid uses in rural areas. These are far from the opportunities that large PV systems could provide when connected to the grid, generating cheaper electricity.

On the other hand, a positive example is the Kenyan government's VAT exemption which applies to all solar PV equipment such as solar panels, batteries and controllers. This reduces the cost of PV systems by 16% and increases the chances that they'll be adopted.

Access to finance and affordability

Access to finance has been identified as the most significant challenge to the penetration of solar energy technology in Africa. The effects of limited financing options are felt by all players from manufacturers to importers, distributors, dealers and end users.

Basically, local banks have high interest loans – between 15%-25% – making it very expensive to buy a solar system. All the savings obtained in not paying the utility are effectively "eaten" by the banks.

Meanwhile foreign investors, who could bring in more affordable interest rates, are wary of entering the market because of the perceived high risk of investing in developing countries.

Awareness

Consumer education is another key challenge, particularly in rural areas. Awareness about available energy options and their benefits needs to be increased. In addition, the hazards involved with using fossil fuels such as diesel and paraffin also need to be brought to people's attention.

The marketing of solar products and other modern energy technologies to end users has also been limited. This is partly because there is a shortage of entrepreneurial capacity in the energy sector, particularly in rural areas.

Finally there is the issue of substandard products in the market which result in users not trusting the technology. A study on LED torches in East Africa found that 90% of the users experienced quality related problems during the six-month study period.

Access to technical support services

End users having easy access to technical assistance is another key factor. The presence of technicians well versed in troubleshooting, repair and maintenance would increase consumers' trust. But the fact that consumers live far apart, coupled with their low buying power, makes the notion of setting up service centres in the distribution regions unsustainable.

There are a few interventions that could mitigate some of these challenges. These include:

1. **Green credit lines** - The French government, for example, provides loans to Kenya, with affordable interest rates, which can be obtained to install solar systems. Strathmore University in Nairobi is another case in point. It became the first zero-carbon footprint

university in Africa by installing a 600 kW roof-mounted solar system. The loan to achieve this will be paid back in 11 years' time at 4% annual interest.

2. **Tax exemption** - This includes VAT exemption on solar PV equipment and the introduction of concepts such as Feed In Tariff and net metering. In both concepts private individuals are allowed to produce electricity for themselves and feed the excess into the grid, so becoming independent power producers. This has been made possible in Kenya since 2012.
3. **Training of technicians** - This is rather obvious: would you buy a car if the closest mechanic was 200km away from you? Such is the case of most of Kenya's rural population with regards to solar PV technicians. More are needed, within reach. USAID has partnered with Strathmore Energy Research Centre to get 1000 technicians trained in different parts of Kenya. This is ongoing.
4. **School campaigns** - These are vital in helping to increase photo-voltaic penetration. This was done in Uganda where PV technology and other renewable energy resources were inserted into the primary and secondary school syllabus.

To close on a very positive note: all indicators point towards a massive adoption of solar technology in the developing world. All the above mentioned difficulties can be overcome as awareness increases, training is made more available, real and perceived financial risks decrease and the cost of solar technology becomes affordable. In a poetic manner we can say: you may pluck one flower, two flowers and three but you can never stop the coming of Spring.

(poster 5)

Mapping of the European Portfolio of Energy Development Cooperation on behalf of the EU Energy Initiative

Fiona D. Wollensack, EU Energy Initiative - Partnership Dialogue Facility (EUEI-PDF), Brussels, and Niklas HAYEK, Africa-EU Renewable Energy Cooperation Programme (RECP) and EUEI PDF, c/o Deutsche Gesellschaft für Internationale Zusammenarbeit (GIZ) GmbH, Eschborn, Germany

ABSTRACT

Europe is the world's largest donor of energy-related development assistance. In 2010-2014, European institutions and member states committed €287 billion to official development assistance; nearly one tenth of this (€22 billion) was dedicated to energy. Europe contributes annually around 10 % of what the IEA estimates is needed globally to achieve universal access to energy by 2030.

These are some of the key findings of a recent mapping of the European portfolio of energy development cooperation, conducted by the EU Energy Initiative Partnership Dialogue Facility (EUEI PDF). The EUEI PDF is a multi-donor facility that contributes to the achievement of the Sustainable Development Goals, in particular on energy. As a flexible instrument of the European Union, the EUEI PDF promotes sustainable energy for equitable development in Africa, Latin America and Asia.

The mapping is based on ODA commitments made in 2010-2014, as reported to the OECD DAC, and covers all African, Caribbean and Pacific countries. The data was also validated through stakeholder interviews with member states and European institutions.
Other key findings of the study include that:

- Activities focused on increasing renewable energy generation (42 %), extending transmission and distribution (29 %) to support energy access, and ensuring the necessary policy, research and training frameworks (15 %) help make efforts successful and sustainable.
- Most of Europe's energy assistance is focussed on Africa - €8,150 billion in 2010-2014;
- Over 50 % of energy development assistance directly contributes to climate change mitigation, with many more projects contributing indirectly.

The study represents a baseline for measuring Europe's contributions to achieving SDG7 and provides an effective point of departure for the further coordination of Europe's energy development cooperation activities.

(poster 6)

AGORIA's views and technology contributions for energy and sustainability in emerging countries (in particular, Africa)

Christian Dierick, Lead Expert, Energy Technology Solutions, Agoria ("Development through technology"), Multisector Federation of the Technological Industry, Brussels

ABSTRACT

Agoria as a multi-sector technology federation and its member companies are working on several societal challenges, such as supplying energy technology for people around the globe. Belgian companies have all the capabilities to support stakeholders according to diverse capacity needs and to supply best fitting technology according to local circumstances.

In particular, the African continent offers a huge potential for a very diversified combination of energy systems.

On one hand, fast growing cities and developing industries will need big centralized power generation plants. Fast growing African economies intend to build, amongst other, nuclear power plants. Chinese and Russian suppliers are very active to take market shares in this area. A missed opportunity for European industry.

On the other hand, rural areas may benefit from quick installation of smaller power units. Geographical and logistic challenges in such areas require deployment of small scale, robust, easily deployable systems, solving logistic problems of getting daily fuel to these areas.

Here, robust renewable energy systems may play an important role. Advanced technology has been developed by a wide range of Belgian companies. Think about sophisticated, but expensive Concentrated Solar Plants, or biomass plants with large local feedstock potential from locally available waste biomass.

On the other hand, hybrid systems with a broad capacity range of intelligently coupled power modules using PV installations, in combination with robust, easily mountable wind power systems and back-up diesel or gas motor units may offer a strong "energy supply package" for a wide range of user communities in the continent.

Belgian Governmental organizations and local responsible people should identify these local capacity needs and find appropriate financing means to supply our available technology as a response to these needs.

The concept of "Energy Assistance" is a perfect collaboration model in this respect and shows the way to go forward in this very important field of Belgian-African energy supply collaboration. http://energy-assistance.org/nl/over-ons/

(poster 7)

Development of advanced energy technologies in Africa: success stories obtained and challenges left from both technological and managerial points of view

Peter Koninckx, Director Power Generation & Transmission Systems, and Matteo della Volta, Power & Gas Business Development, Siemens S.A./N.V.

ABSTRACT

Siemens' power generation, transmission and distribution portfolio covers the whole value chain of electricity and important evolutions have taken place all over the continent in recent years, especially in the thermal sector. Without neglecting the enormous potential that PV and Hydro technologies offer, small and large thermal power generation projects have contributed to the building of the backbone on which growing countries like Ivory Coast are developing their energy mix.

Over the last years we've seen on a regular basis projects for small heat recuperation or cogeneration being realized. Typically based on a 1-2 MW steam turbine technology and all located within the palm oil and cacao industry, these power generation units are often dedicated to supporting the local industrial electricity consumption and not to the electrification of the society. Also, though biomass for power generation is abundantly available in the Equatorial Africa region and politics have now included it in their energy plans as part of the future energy mix, no project came to closure. Amongst others because suitable feed-in regulatory framework is missing.

As the large scale power generation installed under impulse of the energy ministries, the power plants being constructed are too often based on reciprocating engines running on heavy fuel or on gas turbines in open cycle. Both alternatives are decided upon because there is an urgent need of power capacity, a lack of long term planning and in the case of reciprocate engines, also a lack of availability of gas in the country. In any case, both solutions result in a high cost per MWh for the society and a high amount of emissions.

At Siemens we believe that, complementary to the strong increase in PV and Hydro, small to medium scale biomass and medium to large scale gas fired combined cycles are the best fit to lead West-and Central Africa to a more sustainable and a stronger energy system, that is necessary for the development of the industry and social welfare..

Different technological and geopolitical evolutions support that scenario:

- Small to medium scale biomass: the technical evolutions in boilers, exhaust gas treatment and turbines, make it possible to deliver more efficient and sustainable biomass solutions for small and medium scale applications. Under the condition that one masters the local supply chain for biomass, these projects have a strong contribution to local economy and they can be used in off-grid solutions complementary to PV and Hydro instead of diesel engines.

- The increased attention from international financing institutions will automatically help to shift from 'short term' engine solutions to combined cycle applications because of their lower CO2, NOx and SOx emissions and more competitive electricity for the local industry and population.
  Also, the numerous LNG Regasification stations being developed in the region show a good trend. The reduction in cost of these regasification units and the homogenization of gas prices worldwide, support this evolution. Once the gas available locally, it will enable power generation applications, but also allow the development of other local industrial activities today limited by a lack of this primary energy source.

- For utility scale power generation the F-Class combined cycles like the Siemens SCC-4000F achieving ~60% efficiency @ ISO conditions are of course state of the art. Their application in Africa however requires transnational cooperation because the smallest building block would be 400MW, too much for most of the local national requirements. However thanks to the WAPP initiative this becomes a real scenario, giving access to the lowest cost of electricity for several West-and Central African countries.

A new evolution is also the medium scale combined cycle SCC-800 which generates approx. 75MW in 1x1, or 150MW in 2x1 (2GTs on 1 ST) configuration while achieving an efficiency of >56% @ ISO conditions. This power range enables an easier integration in the power grid in case of weaker grid conditions and the 2x1 configuration ensures an even more flexible and available solution, fitting to the local grid requirements.

Because of its low cost of electricity and high sustainability, it clearly beats out the 'short term' engine solutions which are still too often being installed and might become the solution of choice for many African countries.

With these evolutions, biomass and combined cycle power plants are on a good way to becoming the preferred thermal power generation solutions contributing to the energy transition in Africa, paving the way for large renewable installations of PV and Hydro power, like it has been the case in many developed countries.

(poster 8)

Modern energy strategy implementation in Africa: success stories and challenges left in terms of central & decentralised power generation, integration of renewable energies, and power systems interconnections.

Joseph Dubois, Product Director of Tractebel

ABSTRACT

Sub-Saharan African countries have large and unexploited energy resources in gas, hydro and renewable energies. The global hydro potential of Africa is estimated at 88 GW and only 8% of this potential is exploited.

In terms of demand, in most of African countries the load demand is capped by the available generation capacities. The countries having the financial and organisational capacities to invest in new generation capacities like Ivory Coast or Ethiopia are observing growth rate of the load demand higher than the ones observed in developing countries like China up to more than 10% per year. It demonstrates the huge and urgent need of energy to develop the African economies. In terms of grid interconnection, many feasibility studies have demonstrated the solid economic and technical justification of reinforcing the electrical interconnection among African countries in order to optimize and share the energy mix and to improve the reliability and security of supply.

How to explain this inconsistency between from one end the energy potential and interconnection opportunities and on other hand the tremendous lack of energy and dramatic reliability indexes of energy supply?

Besides the well known reasons of unstable political conditions in some countries, corruptions and difficulties to secure the funds, we can point out 3 reasons:

- Most of countries don't have or don't follow a mid and long term roadmap for developing their generation, transmission and distribution assets;
- The countries are focusing on their national development without integrating the possible regional optimisation;
- There is a dramatic need of engineering and economist competences and few African Universities providing solid educational background.

This paper will present some examples of energy roadmaps of Sub-Saharan countries with a focus on Wester African Countries highlighting:

- Success stories of developing regional energy infrastructure;
- Impact of huge delays and continuous modifications of prioritized projects on the security of supply, cost of energy and environmental consequences;
- Current use of renewable energy potential and possible perspectives;
- Added values of decentralized Renewable energy sources.

(poster 9)

Growth, energy and climate: squaring the circle

Philippe Charlez, Mining Engineer, Senior Technical Advisor specialist of Unconventional Resources, former Rock Mechanics Expert in the Oil & Gas industry

ABSTRACT

The human being has never been able to build a growth society by the strength of his muscles. It is by transforming the magic power of fire into mechanical energy and then into electricity thanks to the steam engine and the electric generator that Watt and Faraday invented economic growth in the early nineteenth century. Today our growth society only gravitates around steam engines or generators a little more sophisticated. The engine of cars, the aircraft reactors or the gas turbines of the power plants are in fact only their great-grandchildren. Also, if technology is the endogenous catalyst of growth, energy is the exogenous food. For if the fire that feeds them should fail, the brilliant inventions of Watt and Faraday would become nothing but cold and immobile museum pieces.

Since the beginning of the Industrial Revolution, economic growth has relied heavily on energy, and more particularly on fossil fuels, which today account for 82% of the world's energy mix. But, through this fossil energy consumption, economic growth is also a hazardous process that irreversibly transforms finite natural resources into dangerous waste. The latter are a source of alteration of the ecosystem and represent in the medium term a major environmental risk. This is the case for anthropogenic CO_2, which is the main cause of climate change.

Modern society would thus be confronted with contradictory objectives: to satisfy an increasing demand for energy to ensure economic growth to 10 billion people while reducing GHG emissions to solve the problem of climate change. Growth, energy and climate: can the energy transition solve the squaring of the circle?

Philippe Charlez's approach is both historical and scientific and based on unquestionable figures. It proposes original and pragmatic solutions to promote renewable energy more rapidly and reduce coal consumption. Rather than a global transition the author proposes to develop regional solutions that would significantly reduce the energy intensity of emerging countries. Finally, the he advocates on behaviors one of the main levers of energy saving.

As the main challenge of the 21st century, energy transition must address itself in a dispassionate and rational way. Nothing is impossible but everything is not possible. Complex, transverse, involving multiple technological, economic and societal components, it deserves better than an ideological debate conveyed by accepted ideas. It must be treated and felt as a positive voluntary evolution and not as a revolution undergone.

(poster 10)

Role of renewable energies in the fight against global warming: the context of Africa

Prof Yezouma Coulibaly, PhD INP Grenoble, Scientific advisor to the General Director of 2iE (Institut International d'Ingénierie de l'eau et de l'environnement), and co-director of the joint centre 2iE/Penn State, Ouagadougou, Burkina Faso

ABSTRACT

Africa is the most vulnerable continent to the effects of climate change. To combat these effects, the governments of the concerned countries multiply the calls for aid while making the effort to reduce greenhouse gas emissions, as their own contribution to the fight against global warming. One of the most effective ways of this initiative in relation to energy use is the energy transition, which today consists in replacing the energies of stocks with renewable energies sources.

The objective of this presentation is to take stock of mature renewable energy technologies and their utility in solving energy problems in especially in Africa.

It is then an overview of energy problems in Africa. It deals with energy as a whole and its degradation. It also deals with renewable energies sources and how they can help to solve African Energy problems. It explores their potential uses, advantages and disadvantages for Africa.

2iE in Ouagadougou has been thriving for some years now in a scientific research for the development of these renewable energies. To this end, the centre has set up two large laboratories which are today a reference in Africa. These are the solar energy and energy saving laboratories (LESEE) on the one hand and the laboratory of biomass energy and biofuel (LBEB) on the other hand. The presentation focuses on this very pragmatic research undertaken within 2iE and how it contributes to solving energy problems in African countries.

The presentation ends with a conclusion in the form of perspectives and suggestions for the solution of energy problems by a rapid development of renewable energies for Africa.

(poster 11)

Generic lessons from EUROMED Research-to-Innovation projects in the field of Renewable Energy & Energy Efficiency: Innovation, Co-development, Capacity building

Claude Ayache, Senior Advisor, KIC InnoEnergy, Societas Europaea (SE), Business Development & European Affairs, Brussels

ABSTRACT

The present communication provides some evidence about a needed pilot action preparing the emergence of a structured co-development area in sustainable energies and energy efficiency in the Mediterranean area as well as in Africa.

Co-development actions target specific marketable clean energy solutions adapted to societal and economical needs in those geographical regions most affected by climate change and development challenges. In such a context, Innovation appears as mandatory for adapting generic technologies to specific regional targets. The latter, in turn, constitutes a strong driver to innovation in general.

North-South as well as South-South and public-private collaborations in this process are likely to be beneficial to all parties and to favour the emergence of a common regional clean-tech market. A coordinated EU policy appears as an essential factor for establishing and maintaining a virtuous dynamics along with this objective. This was recognised in the recent EC Communication " ccelerating Clean Energy Innovation" which states, amongst actions to promote the Leveraging Europe's global role, that 'the Commission will work with Member States to launch one or two joint deployment programmes in developing countries in the areas of energy efficiency and renewables, with a focus on frica as a privileged partner ', those programmes being expected to 'couple research and innovation with capacity building in the host country'

(poster 12)

Building sustainable partnerships in EU-Africa Research and Innovation Initiatives: Experiences from a Finnish University Network

Eva Kagiri, Finnish University Partnership for International Development (UniPID), Senior Planning Officer FinCEAL Africa, University of Jyväskylä, Finland.

ABSTRACT

Finnish international collaboration in Research and Innovation (R&I) has always been a priority for the country's Higher-Education Institutions and Research Institutions. The Finnish Ministry of Education and Culture has been central in creating opportunities for these institutions to strengthen R&I through various funding mechanisms and strategies. Collaboration with Africa in R&I has had very goold local support which in turn has translated to partnerships at EU-level. For instance, a case on Finnish-South Africa cooperation shows that between 2009 and 2015, the two countries carried out 42 projects through Finnish national funding mechanisms (the North-South-South funding instrument and Higher Education Institutions Institutional Cooperation Instrument HEI-ICI).

Partnership between the two countries has also been visible beyond bi-lateral projects. In EU-funded projects, Finnish and South African research institutions have been part of the same consortia in 6 different projects funded by H2020. The Southern African-Nordic Centre (SANORD), a network of Higher Education Institutions from South Africa and Nordic countries, has 4 Finnish Universities as members.

The Finnish University Partnership for International Development (UniPID), a network of Finnish universities was established in response to the Johannesburg Summit on Sustainable Development in 2002. The network has been instrumental in supporting collaboration in R&I between Finland-Europe and Africa. Mandated by the Finnish Ministry of Education to strengthen R&I between these regions, UniPID has been carrying out activities that support cooperation of Finnish institutions with other European institutions and counterparts in Africa through the FinCEAL project www.unipid.fi/finceal.

Beyond the FinCEAL project, UniPID has been part of consortia working at EU-Africa Science, Technology and Innovation Policy level (CAAST-Net Plus, ERAfrica, RINEA). UniPID's experience in these initiatives has led to deeper understanding on the constitution of enabling environments for EU-Africa R&I. In this presentation, I will highlight some lessons learnt on:

1. What national mechanisms and drivers are necessary for sustainable partnerships in EU-Africa R&I and how do these translate to bi-regional cooperation?
2. In the light of global changes, relations between Academia and other sectors have emerged as paramount for re-igniting innovation and sustainability. What are the roles of the different actors and what lessons can UniPID share on creating better cross-sectoral partnerships?

1 Eva Kagiri-Kalanzi, Unipid eva.m.kagiri@jyu.fi

(poster 13)

"Mini mill plants" for steelmaking: sustainable production of charcoal as fuel source while taking care of environmental and social issues in forest plantations

Roosevelt de Paula Almado, Health and Safety, Environment and Forest Research Manager, ArcelorMittal Bio-Florestas Ltda., São Geraldo – Martinho Campos - Brasil

ABSTRACT

FOREST PLANTATIONS: CLEAN AND RENEWABLE ENERGY

INTRODUCTION

Brazil is a potentially forested country, with a great territorial extension, deep soils of medium to low fertility, adequate climate and currently one of the best productivities of the world as well as a low cost of wood placement in the industry. ArcelorMittal BioFlorestas is the ArcelorMittal Group company responsible for the production of charcoal from wood from sustainable forests. The production of pig iron in Brazil can be done by two routes, one to coal and the other by vegetable charcoal from renewable eucalyptus plantation. The company has approximately 100,000 hectares of forest crops with species of the genus Eucalyptus, as well as 40,000 hectares of native forest areas for preservation. Forest Management is the management of forest resources with the objective of obtaining economic and social benefits, respecting the mechanisms of sustainability of the ecosystem. ArcelorMittal BioFlorestas has the FSC Certification. Our plantations are formed predominantly by eucalyptus hybrids selected to better adapt to local climatic and soil conditions, providing significant gains in productivity (40 m^3/ha/Year) and wood quality. Currently, on average, the wood is harvested at the age of seven, ranging from six to eight. After the first harvest of trees, the plantations are managed by reforestation (new planting) or regrowth management. The company's planning is two rotations of the plantation.

II. FOREST ACTIVITIES

1- PLANNING: The planning of the planting, harvesting and production of charcoal to supply the ArcelorMittal Brazil plants contemplates the short, medium and long term, seeking the best use of natural resources and minimizing possible social and environmental impacts.

2- ENVIRONMENTAL TECHNOLOGY AND RESEARCH: We have developed research to improve the genetic quality of plantations and improve the forest management system.

3- FORMATION OF NEW PLANTATIONS: ArcelorMittal BioFlorestas only performs forest implantation in areas that do not have native forest cover. In the preparation of soil, the company uses the Minimum Cultivation technique, which consists in the minimum possible stirring in the soil without the use of

fire, which favors the maintenance of its characteristics and avoids erosion, compaction and reduction of fertility.

4- DEVELOPMENT AND MAINTENANCE OF FORESTS: Forest maintenance consists of activities related to the forest growth phase, that is, activities that ensure the good growth of the planted forest, such as by controlling the infestation of competing weeds, pests and diseases, and the supply of nutrients throughout this development, like potassium, calcium, magnesium and boron.

5. FOREST PROTECTION: ArcelorMittal BioFlorestas carries out the continuous monitoring of pests, diseases and weeds through programs and techniques developed through partnerships with universities and / or conducting periodic surveys in their areas.

6- FOREST INVENTORY: Monitoring of the wood stock, growth and dynamics of the planted forest is done through the continuous forest inventory, which uses sampling techniques to obtain data that allow the projection of the volume per hectare and trees of the plantations to a desired age. With this information, it is possible to decide the most opportune moment for the harvest.

7- FOREST HARVEST: Harvesting uses equipment that enables efficient, safe and environmentally sound operation. At ArcelorMittal BioFlorestas, it is carried out by means of different systems: Feller, which makes the trees felling; Skidder, who pulls the trees from the field to the loaders and the tracing pin, which traces the wood and loads the wood. The harvest is the operation with the greatest impact, as it changes the landscape, causes animals to move and increases the traffic of heavy vehicles. The company seeks to reduce these effects by taking every precaution to avoid damaging native vegetation, using equipment with low soil impact and reinforcing the dialogue with neighboring communities.

III. VEGETABLE CHARCOAL PRODUCTION

It is the transformation of the wood of renewable forests of eucalypt into charcoal through masonry ovens, by the action of heat, in the presence of controlled amounts of oxygen. The charcoal produced by the company is used as a reductive term in the production of steel and is destined to the plants of ArcelorMittal Brazil, such as at ArcelorMittal Juiz de Fora. The furnaces are spatially fixed in a single location called the UPE - Energy Production Unit. Special attention is provided for the choice of locality such as the relationship between predominant direction of the winds and proximity to communities and natural reserves. ArcelorMittal, aiming at the reduction of atmospheric effluents, develops research related to its use for co-generation of energy.

IV. INCREASE ENERGY EFFICIENCY

Charcoal is one of the energy sources of the Brazilian energy matrix, and has a production efficiency of up to 35%; That is, every 100 kilos of wood can produce about 35 kilos of charcoal. ArcelorMittal BioFlorestas carries out this search through continuous improvement projects identified by the operational teams or signaled by the company's directives. This work counts on the academic support of partner federal institutions and knowledge management of the ArcelorMittal group technical team

(CTO), and through investment funds for R&D, such as ANEEL (National Agency for Electric Energy). In addition to initiatives in Energy Efficiency, ArcelorMittal BioFlorestas also experiences other sustainability pillars, such as Social Responsibility specially for communities in the region and feasibility of sustainable solutions: the adopted Energy Efficiency approaches must respect the investment premises of the ArcelorMittal group.

Another economic pillar is carbon credit projects, currently 3 are in progress: credit for forests planted to small and medium-sized farmers, credit for the replacement of coke by charcoal in blast furnaces and credit for burning methane in production of charcoal. ArcelorMittal BioFlorestas has among its energy efficiency improvement projects the Smoke Burner, the Wood Dryer and the Energy Cogeneration.

Smoke Burner: It consists of a combustion chamber that burns the process's carbonization residual gases by transforming methane into carbon dioxide. This transformation reduces the environmental impact of this residual gas by 21 times, related to the impact of methane on carbon dioxide. This burning process transforms the waste gas at 110 ° C into a higher amount of gas at 900 ° C, which becomes a renewable waste heat.

Wood Dryer: Is an equipment that works like a greenhouse. In it the wood that will be charred is stored and receives the residual heat from the aforementioned process in order to decrease its moisture. Thus, drier wood when carbonized reduces the need for energy to remove its moisture inside the kiln during the carbonization process. As the fuel of this process is the wood itself, through this process it is possible to increase energy efficiency by up to 30%, in addition to increasing the productivity and profitability of the activity by up to 10%. The drier wood, by promoting a higher productivity, reducing the burning of coal, also contributes to the improvement of the quality of the product, as the charcoal has a larger grain size (<15% fines) and a lower incidence of discharge fire, (lower % humidity and % fines).

Energy Cogeneration: Also benefits from the residual heat generated by the Smoke Burner. A stove receives this residual heat and also atmospheric air, which becomes superheated. An adapted gas turbine compresses this atmospheric air before it enters the heat recuperator and receives it after the long-overheated heat exchanger, when it is expanded, generating electric energy. We can consider that every thousand tons of charcoal produced can generate 1MW electric, increasing the energy efficiency of charcoal production by about 14%, and increase the profitability of the company by selling this energy to other companies in the group or to the grid. The potential of ArcelorMittal BioFlorestas is 30MW electric.

This initiative is carried out in partnership with CEMIG (Minas Gerais Energy Company) through ANEEL's research incentive program.

(poster 14)

Industrial waste heat recovery – Innovative solutions for steel industry

T. Steinparzer, A. Fleischanderl, M. Haselgrübler, P. Trunner / Primetals Technologies, Linz, Austria GmbH / A joint venture of Siemens, Mitsubishi HI and co

ABSTRACT

Keywords: Industrial waste heat recovery,steelmaking, integrated steelmaking, electric steelmaking

Africa's population is growing rapidly. Therefore, it is crucial to provide dedicated infrastructure and energy grids, especially electric energy, to a broad part of the population. A high diversity in energy production leads to a robust and stable energy network which is key for industrial and GDP growth. Power generation by industrial waste heat recovery can be a corner stone for an efficient and socially acceptable energy system.

Over the last years, waste heat recovery in steel industry attracted more and more attention. Additionally, the demand for increasing energy efficiency is one of the global megatrends of our time. The combination of steel production and waste heat recovery systems leads to a win-win situation for economic growth and decentralized power generation. Besides economic and social aspects, natural resources are saved and an economic value is created (e.g. by carbon emission trading). The presented waste heat recovery systems are based on simple and proven technologies (e.g.: hot water production, steam generation, ORC units, etc.). This fact makes an application also from a social point of view reasonable.

Waste heat recovery potential for mini mills (electric steelmaking) and integrated steel plants will be presented. Additionally, typical waste heat recovery solutions and possibilities for waste heat utilization will be introduced.

The objective of this paper is to demonstrate possibilities for energy recovery and utilization for integrated steel making as well as for the electric steelmaking route under consideration of the economic feasibility. Focus of the paper is electricity generation out of waste heat from steelmaking processes.

(poster 15)

Hydrocarbon resources in the Democratic Republic of Congo – a potential source of development for the country?

Bernard Respaut, Ir, MBA, Chief Executive, European Copper Institute, Brussels

ABSTRACT

The Democratic Republic of Congo (DRC) abounds in natural resources, be it minerals, precious stones or fertile soil. Yet it keeps being plagued by poverty, political instability and insecurity.

The DRC participates in the current regain of interest in Africa for the development of hydrocarbon resources, since such potential deposits have been previously identified in the country. Hence the question as to whether and if so, how a development in the exploitation of hydrocarbons in the DRC will contribute to its development.

Oil currently plays a minor role in the economy of the DRC: some 20'000 barrels per day are extracted from the coastal Muanda basin and are exported without refining due to a lack of such infrastructure. Thus, oil does not participate in the resolution of the acute energy deficit in Congo-Kinshasa, which hinders its economic development. Alternative energy sources exist, mainly hydroelectricity which however requires significant investments to be put into exploitation.

Oil and gas deposits have been identified in several parts of the DRC. The economic character of oil reservoirs in the Graben Albertine, the Cuvette Centrale and the Tanganyika Lake still need to be proven, but gas in the Kivu Lake presents a definite potential as its exploitation in the Rwandan part of this lake confirms. Additional oil resources could also be exploited in the Muanda basin. We can hence conclude that the DRC could enjoy a boost in its economic development through the exploitation of some of the hydrocarbons trapped in its subsoil.

The lecture will focus on the key elements which need to be in place to enable this development of hydrocarbons (a) to materialize and (b) to bring a positive contribution to the economy and living conditions of the DRC. Inspired by the concept of "Positive Peace" developed by the Institute for Economics and Peace, a set of five key elements or "variables" has been identified and their interrelations will be analyzed. These five elements are infrastructure, key competencies, governance, local and international actors. After describing their current state, two limit scenarios will be built: a positive one leading to a virtuous circle where the five variables reinforce each other and a negative one, creating a vicious circle in which the development of hydrocarbons actually, contributes to more poverty, instability and insecurity in the DRC.

The comparison of these two limit scenarios enables to identify which concrete actions a country like Belgium (which shares a part of its history with the DRC) could initiate, alone or through international institutions, to favour the development of a positive scenario in the DRC. These actions pertain to the three classical instruments of international influence: diplomacy, development and defence ("the 3Ds").

(poster 16)

Cartographie de l'énergie électrique en République Démocratique du Congo (de l'époque colonial à nos jours)

Prof. Liassa Nkoy, Département de Génie Electrique, faculté Polytechnique, Vice Doyen chargé de la Recherche, Université de Kinshasa

(poster 17)

Variable-speed pumped hydro energy storage: bringing flexibility to the South African grid in order to accommodate future developments in nuclear energy and renewables

Thomas Mercier, PhD student & Research Assistant (Université Laval and Université catholique de Louvain)

ABSTRACT

Pumped hydro energy storage (PHES) is the most established technology for largescale energy storage. While it is mainly used for balancing the grid on an hourly basis, with fixed power set points in pump and turbine modes, guide vanes control enables PHES units to provide frequency control in turbine mode. Recent developments in power electronics have provided PHES with a variable-speed feature, thereby extending the operation ranges and enabling new, more precise and rapid control strategies. South Africa has a relatively infant but growing renewable energy industry.

According to its department of energy, renewable energy will contribute to a total of 18.2 GW by 2030 (about 42% of the new build). Regarding nuclear energy, 9.6 GW will be added by 2030. In order to ensure the reliable operation of the power grid while integrating significant amounts of renewable intermittent generation on the one hand, and of non-flexible nuclear generation on the other hand, flexibility will be needed. PHES is a good candidate to provide this flexibility, and this is not a coincidence if South Africa has already several PHES plants, as Ingula 1332 MW, Palmiet 400 MW, and Drakensberg 1000 MW, all with reversible fixed-speed Francis pump-turbines. In this poster presentation we will discuss the operation ranges of fixed- and variablespeed Francis pump-turbines. The presentation will emphasize the capabilities brought variable-speed machines and how it can help South Africa to accommodate new renewable and nuclear generation capacities.

(poster 18)

Archimedean screw turbine: opportunity for rural electrification in D.R. Congo ?

Prof. Jean Paul Katond Mbay, Université de Lubumbashi, DR Congo, and Prof. Patrick Hendrick (ULB - Belgium)

ABSTRACT

Located in the center of Africa, DR Congo is a country populated by nearly 70 million people, including more than 70% who live in rural areas. The country has an electricity service rate that ranks as the lowest in the world (less than 1%). DR Congo has a significant energy potential. It is estimated that exploitable hydropower potential of 100,000 MW.

Today, it is urgent to make use of this potential to increase the rate of access to electricity using small rivers around the villages to build micro-hydro power plants. As part of my PhD work at École Polytechnique de Bruxelles (ULB) in partnership with the University of Lubumbashi in DR Congo, we have designed and manufactured locally (in Lubumbashi) a test bench of Archimedean's screw turbines having two blades and large pitch.

The goal is to simplify manufacturing and reduce the amount of steel used for the screw relative to the screws used in Europe. The optimal combination is the configuration of the screw inclined at $\alpha = 22.5$ ° relative to the horizon and which is oriented helix $\beta = 45$ ° on the cylinder of the screw. Currently, we are in the process of installing a prototype on a farm.

(poster 19)

Small hydropower development in Burundi

Jean Bosco Niyonzima (1), Patrick. Hendrick (1*),

(1) Université Libre de Bruxelles, Aero-Thermo-Mechanics, (ULB Polytechnic School), Belgium, and (1*) Promoter and Head of Department Aero-Thermo-Mechanics (ULB)

ABSTRACT

There is no clear and commonly accepted international definition of small scale hydropower. The European Directive accepts a small hydropower at 10 MW, Canada defines small hydropower as the power plant which has a capacity between 20 and 25 MW, US Directive accepts small hydropower of up to 10 MW in total. The context of Burundi classifies the small hydropower plant as a plant with a capacity lower than 10 MW. In Burundi, all existing hydropower plants are classified within the small hydropower units excluded the ones of Rwegura with a capacity of 18 MW.

Firstly, this paper aims to describe small hydropower in Burundi and examines the strong need of electricity of the country. The first hydropower plant was implemented in 1980 while the last one was implemented in 1986.

The total national installed capacity is around 35 MW (in 2016) compared to an electricity demand of 250 MW by 2020, not including the required electricity for mines. Several conflicts took place in the country after the independence (1962), which slowed strongly down the socio-economic development of the country and resulted in the limitation of the hydropower infrastructures. Currently, several hydropower projects are under study while others are under construction in order to boost the electricity production and consequently facing well to the country energy challenges. The country looks like a no power country. There is no available tool that can be used to inform about the energy situation of the country.

Finally, the second aim of this paper is to propose a Sankey diagram in which we can find global information on the Burundi energy situation, the so- called “Energy flow chart”.

(poster 20)

Turbulent Hydro - Decentralized low-head micro-hydro power for Africa, inspired by nature

Geert Slachmuylders and Wim Verheirstraeten, Turbulent Hydro, Innovator Under 35 EU 2016, Best start-up in Start-up Nations Summit 2015

ABSTRACT

TURBULENT HYDRO | POSTER SUMMARY / TECH OVERVIEW

Turbulent develops micro hydro-power plants based on “biomimicry” to create clean, reliable and affordable energy for even the most remote communities. Turbulent’s unique technology enables the use of very low height differences in rivers (1 - 3m) in an efficient way, without impact on the local ecosystem. Adding an easy to install product – without the need for a dam - combined with a modular design and control software, Turbulent delivers the first micro hydropower plants, profitable without the need for government grants.

WHY

Africa has problems with maintenance and follow up of current power plant initiatives. Hydropower solutions usually need a high level of maintenance. Most on a daily basis. A classic scenario is locals will forget to tend to the turbine which will be damaged over time. Replacement parts and skilled workers are then needed with high costs. Turbulent requires close to no maintenance and the turbine blades can be repaired as a car body.

Africa typically needs off the grid, independent solutions. Turbulent is a Turn-key solution that can be installed by low skilled workers. All that is needed is a small truck delivery and a few batches of concrete. Turbulent hydro plants can be up and running in a week with close to no civil engineering.

WHAT

Micro Vortex turbine producing 5 to 100 kW depending on flow and height difference.

Low height difference needed, as small as 1 to 3 meters.

Creating energy from centripetal force rather than water pressure.

NB

Guinean project confirmed through feasibility study, awaiting financial support.

4 turbines of 30kW.

VISUALS

ON LAND, SHORT BYPASS /DROP ON LAND, LONG BYPASS

(poster 21)

Nuclear Energy and Sustainable Development in Africa: Challenges and Ways Forward

Vincent Lukanda Mwamba, François Kazadi Kabuya (1) and Petrus Bompere Lemo (2)

(1) Commissariat Général à l'Energie Atomique, PO BOX 868 Kinshasa XI, DR Congo

(2) Comité National de Protection contre les Rayonnements Ionisants, Kinshasa, DR Congo

ABSTRACT

Despite the lack of consensus on the compatibility of nuclear energy with sustainable development, today nuclear technologies are regarded by many as a viable option to satisfy specific needs countries related. In a recent IAEA's update for projections of nuclear power, it is expected that up to 20 new countries will be operating nuclear power plants by the year 2030 worldwide. Approximately twenty countries of them in Africa region are considering or have expressed interest in developing nuclear power programs.

On one hand, the safe and secure introduction of nuclear power plants can only be realized through the adherence, by concerned countries, to the major international instruments related to safety, security and non-proliferation, and the establishment of competent and sustainable national infrastructures that include effective and independent nuclear regulatory systems.

On the other hand, implementing a nuclear power program involves important challenges associated with the long-term safety and security of nuclear materials and radioactive sources, in terms of adequate storage and disposal facilities, the procurement and management of spent fuel and radioactive waste and, financial arrangements for decommissioning as well. How can these countries ensure that plans for introduction of nuclear power plants do not proceed more quickly than the plans for establishing the necessary infrastructure for safety and security? While current sustainable development frameworks are still in the cradle, how can these concerned governments expect that their approaches within the nuclear energy systems are fairly consistent with sustainable development goals?

This paper presents results of study and analysis carried out on ten African countries, interested in acquiring nuclear power plants. The emphasis is put on challenges faced in terms of consistency of their nuclear programs with the sustainable development goals, in particular in terms of available resources, policy and infrastructures and funding as well. Also addressed are perspectives and opportunities for these countries to move their nuclear programs forwards.

The main prerequisites discussed are national energy needs and financing, legal and regulatory frameworks, safety and security, and human resource requirements. It appeared from this study and analysis that key elements to comply their nuclear programs with sustainable development goals consist in strong political commitment and effective leadership among Policy makers and nuclear Regulators. Committed Government will ensure provide nuclear safety regulators with both financial and skilled human resources, show the necessary transparency to national and international community. Appropriate regulatory leadership will guarantee effective and efficient implementation

of the regulatory framework to support smooth introduction of nuclear power plants in compliance with goals of sustainable development.

(poster 22)

Fuel cells in emerging countries: a flexible device for the production of electricity from 1W to tens of MWs

Dr. Jean-Luc Delplancke, Ecole Polytechnique - 4MAT, Université Libre de Bruxelles, former Programme Head of Unit of EU Joint Undertaking “Fuel Cells and Hydrogen”

ABSTRACT

Fuel cells, discovered by Schönbein and Grove in 1838 correspond to an old technology with a very complex history. They are efficient electrochemical generating power devices invented more than 40 years before the classic dynamo generators, the combustion engines or the gas turbines. But they were more or less completely forgotten until the launch of the NASA Gemini and Apollo development programmes in the sixties. There is today a renewed interest for this technology generated by the concept of « Hydrogen Economy » and sustainable growth.

A fuel cell is a static and compact electrochemical device transforming a fuel (natural gas, biogas, hydrogen…) and an oxidizer (oxygen or air) into electricity, heat and pure water. Fuel cells allow a very efficient use of fossil or renewable energy sources, do not generate green house gases (if powered by hydrogen), NOx, SOx, particulates or noise and are highly modular with power ranging from 1 W to tens of MWs. The list of fuel cell applications includes portable applications like the replacement of batteries for cellular phones, laptop… transport applications like passenger cars, delivery vehicles, buses, trains, boats… electricity micro-generation for distributed residential use or off-grid locations, medium power plant for co-generation, industrial processes, malls, hospitals, airports and large power plant (largest power plant in 2016 located in South Korea – 59 MW).

Hydrogen is not only the most abundant element in the universe but is also an essential energy carrier, should mankind target to limit climate global warming and to achieve the ambitions of multiple international agreements like the COP21. Hydrogen may be stored for long durations and offers a clean, sustainable and flexible solution for a low-carbon economy when produced by water electrolysis and renewable energy sources (RES). These renewable energy sources are not evenly distributed throughout the world. Hydrogen transport at scale and over large distances, e.g., from areas with a high potential for renewable power generation to areas with high demand of energy may become an economically attractive option for emerging countries.

The objective of this poster is to highlight the potentials of hydrogen generation from renewable energy sources in combination with electricity and drinkable water production by means of fuel cells for the local and international development of emerging countries with a special focus on Africa.

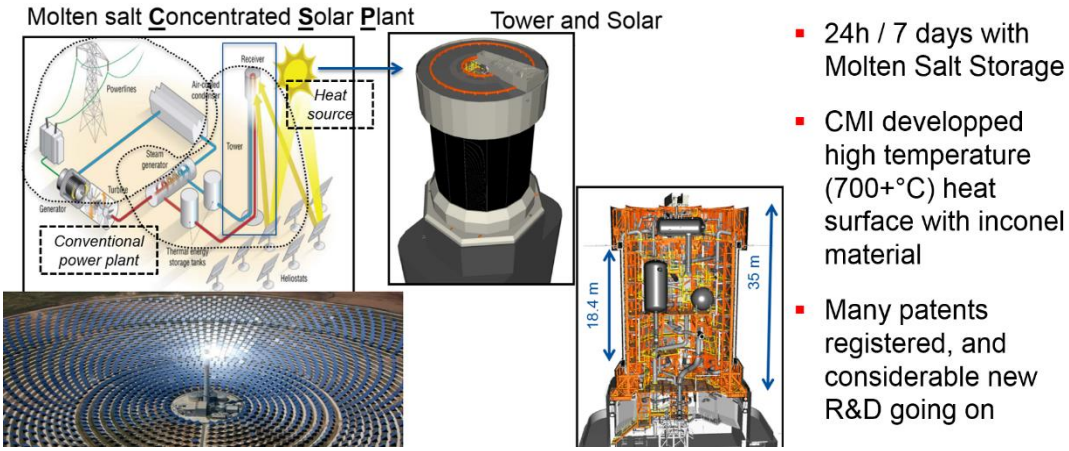
(poster 23)

Concentrated Solar Power, Battery Storage for Solar photovoltaic (PV) flexibility, Solar PV for Water pumping, and Biomass: solution for sustainable and flexible power

Michel Lalmand, Vice President Solar, Sales & Marketing, Yoshie YONEKURA, Marketing & Business Development Manager, and Marianne NOEL, Sales Manager, Cockerill Maintenance & Ingénierie (CMI) Energy

ABSTRACT

1. **Central tower solar thermal electricity – Storage by molten salt**
   a. **Technology :**
      - Thousands of heliostats concentrating solar radiation towards the solar receiver
      - CMI receiver collects this energy to heat "cold" molten salts (290°C) pumped from the cold tank up to 565°C thanks to the heat exchanger with a special heat and corrosion resistant material.
      - The hot molten salts, which is stored in the tank, will produce the high temperature steam which will generate the electricity on demand via steam turbine.



   b. **Reference :**
      - Atacama solar plant in Chile :
        i. Nominal power 110MWe - largest molten salt power plant in the world
        ii. Annual electricity production : ~940 000 MWh
        iii. Storage ability for 17.5 hours of operation - electricity production 24h a day
        iv. Ramp up time : ~50min to heat up molten salt from 290°C to 565°C by CMI solar receiver, ~45min to obtain maximum steam turbine output
        v. Thermal Efficiency : 90.5%
        vi. Availability : 99%

2. **Battery Storage for Solar photovoltaic (PV) flexibility**

- CMI proposes a robust and long lifetime (20+yrs) battery storage, by Flow Battery. This type of battery is particularly suitable for African continent thanks to its capacity for high ambient temperature, inflammability, low maintenance and others.

3. **Water pumping by Solar PV for off-grid rural area**
    - CMI installed 50 deep water wells (up to 200m), capacity of 1 to 3 m^3/h, to provide water to local population and cattle, in Kajiado, Kenya, Rural semi-arid areas, very limited access to water and electricity. The pumps are powered by Solar PV directly (DC), and when necessary a small back-up genset will counter-balance the power to ensure the stable water pumping.
4. **Biomass power with feedstock torrefaction**
    - CMI has also advanced Multi Hearths Furnace technology for the biomass feedstock torrefaction, which increase its calorific density by ~30%. CMI proposes Biomass Power and/or Combined Heat and Power, with its highly efficient and robust boiler and auxiliary equipments.

(poster 24)

Concentrated Solar Power (CSP) technologies for electricity generation in Harare, Zimbabwe: comparison of two options, Solar Tower (ST) and Parabolic Trough (PT)

Luckywell Seytini, Great Zimbabwe University, Department of Physics, Geography and Environmental Science

ABSTRACT

Sub-theme: Sustainable Environment and Resource Management

Keywords: Concentrating solar power, Solar Model Advisor, Solar tower, Parabolic Trough.

Capacity utilisation of solar energy in Zimbabwe is still low. Currently, only small scale photovoltaic (PV) solar systems are dominating in the market mainly for domestic applications. This study analyses the feasibility of investing in concentrating solar power (CSP) technologies for electricity generation. The software, Solar Advisor Model (SAM) developed by the National Renewable Energy Laboratory (NREL) was used to design a 100 MW solar thermal power plant in Harare using different technologies namely Solar Tower (ST) and Parabolic Trough (PT) CSP technologies. The performance and financial predictions for the power plant were analysed and compared for the two technologies used. The results of the annual electricity output (GWh), plant installation costs and levelised cost of energy ($/kWh) were used to determine whether it is technically and economically viable to invest in CSP technologies and recommend to policy makers and potential investors which technology is better.

(poster 25)

Electricity and heat generation solutions from renewable energy sources for remote households in Central Africa

Maarten Vergote, Dr Ir, Major – Associate Professor, Department of Physics, Ecole

Royale Militaire - Koninklijke Militaire School

ABSTRACT

In this contribution, we summarize the results of a study executed by the Royal Military Academy at the request of the Staff Department of Belgian Defense. The aim was to investigate the feasibility – mostly economic – of setting up in Lokandu (DRC) a stand-alone electricity generating system, based solely on renewable energy (solar PhotoVoltaic or PV).

The case study concerns an electricity production to satisfy a realistic demand profile of an average family, living isolated on a remote location with sufficient direct sunlight. Cooking is supposed to be done on other primary energy sources. Alternatively, one could apply the electricity production e.g. to pump water for purposes of living, irrigation, etc.

The study focuses on the realistic gain that can be expected by tilting – once or twice a day – the solar PV panels around a north-south axis. This increments, for the same installed capacity (Wp) of PV panels, the daily production easily with 10-15%. The conclusions can be used to lower further the minimal investment in terms of capacity of PV-panels to be installed in order to foresee in electricity for meeting living standards in all of Central Africa.

(poster 26)

Development of energy efficiency and passive technologies in buildings for improving users' comfort: experience of the Belgian Development Agency in Uganda, Senegal and Palestine

Benoît Legrand (as unit coordinator) and Paul Verlé (as head of department), both in Infrastructure and Environment Unit, Belgian Development Agency (BTC), and Jan Van Lint, BTC- Uganda

RESUME

Depuis 2010 la Coopération belge s'efforce de façon plus explicite à promouvoir l'efficience énergétique des bâtiments dont elle appuie la construction. L'approche se base sur une analyse détaillée du contexte local et de son climat afin d'adapter la conception architecturale de manière à assurer un meilleur confort des usagers sans apport d'énergie supplémentaire.

Le premier champ d'investigation fut la Palestine au travers d'un programme de constructions scolaires. Il fut possible de convaincre les autorités d'ériger l'école pilote de Wadi Al Mughayer, construite en 2014 en y intégrant différentes technologies appropriées visant à combattre le froid en hiver et de se prémunir de la chaleur durant les mois d'été.

Outre une réflexion sur l'optimalisation de l'orientation des locaux, le renforcement de l'isolation et la systématisation de systèmes de protection solaires amovibles, trois types d'approches furent testées : (i) la géothermie avec l'installation de puits canadiens ; (ii) la ventilation forcée par des cheminées solaires ; (iii) le chauffage solaire via des murs solaires. Tant le personnel enseignant que les écoliers, se sont, dès l'ouverture de l'école, montré très enthousiastes par rapport à ces différents équipements, le ministère central exprimant de son côté certaines réserves. Différentes salles aux caractéristiques similaires disposent d'équipements diversifiés, permettant une analyse comparative. Un monitoring continu sur une période d'un an est en cours visant à objectiver l'évaluation de ces différents équipements et leur combinaison. Les conclusions de l'analyse sont attendues pour juin 2017. Elle devrait confirmer la perception d'une faible plus-value apportée par les puits canadiens et les cheminées solaires pour un coût important à la différence de murs solaires, ou des brise-soleils amovibles particulièrement efficaces pour un investissement limité.

Une approche similaire fut mise en œuvre en Ouganda au travers de la réhabilitation/extension de 3 centres de formation des enseignants. Les conditions climatiques relativement clémentes n'impliquent pas d'investissement majeurs. L'approche s'est axée, d'une part, sur l'apport de lumière naturelle sans surchauffe, l'optimalisation de la ventilation naturelle, des aménagements extérieurs ombragés et, d'autres part sur la promotion des énergies renouvelables via l'installation de panneaux photovoltaïques, le biogaz ou des fours améliorés, permettant à la fois de sensibiliser les étudiants à ces alternatives mais également de les former.

L'expérience acquise dans les 2 précédents projets a influencé la conception de bureaux d'assurance maladie (UDAM) dans deux localités du Sénégal. L'emploi de la terre crue, de cheminées solaires, de puits canadiens et de tours à vents furent envisagés. La faiblesse de l'expertise locale tant pour la conception que la mise en œuvre des bâtiments à contraint la CTB de réduire ses ambitions. Une part seulement de ces technologies sera finalement mise en œuvre.

Ces trois exemples sont illustratifs de certaines difficultés récurrentes dont la réticence de certaines autorités à l'innovation ou l'emploi de technologies perçues comme rétrogrades, mais aussi la difficulté de trouver l'expertise nécessaire pour les concevoir et les mettre en œuvre. Ces obstacles levés, le niveau de satisfaction des usagers est par la suite généralement très positif.

(poster 27)

Affordable Mobile Solar Water Pumps for Small Farmers

Ahmed Abbas, SunCity Energy / The American University in Cairo, Egypt

ABSTRACT

KEYWORDS: Solar, Pump, Irrigation, Mobile, Farmers

The agriculture sector in Egypt employs more than 29% of the Egyptian work force. Out of 8.4 million feddan of agriculture and cultivated land, around 60% of the holders own less than 1 feddan, and another 20% of the holders have between 1 to 3 feddan (El-Nahrawy, 2011). Surface water is by far the major and dominant source of irrigation in Egypt, representing 83% of irrigation water. Due to technical difficulty and high initial costs, most farmers are not able to connect to the national electricity grid to be able to use electric pumps. This has resulted in a vast use of diesel pumps, a mature technology that has been there for decades and farmers are very familiar with.

Under new subsidies reform plans and regulations, diesel prices have increased 78% in July 2014 (GHANY, 2014). Following this increase, prices of oil and lubricants have followed the same trend. In a country with a total bill of about $17 Billion of annual subsidies (Heerwig, 2013) – 20% of annual budget – these structural changes are investable. However, implications of these regulations have hampered; an already poor and marginalized group of small farmers. Small farmers aren't able to switch from diesel to solar energy due to several reasons. Solar pumping systems come at a very high initial price tag, beyond affordability of this segment.

Moreover, economically existing solar pumping solutions fail to provide an economically viable alternative to diesel pumps. Installing a solar pump for one or two feddan is not a feasible solution. My research started with unstructured interviews with farmers in Tema, Sohag to understand their agriculture practices, irrigation methods, average number and time of irrigation per year, cost of irrigation, source of water and available alternatives. Data compiled and analyzed from these interviews along with primary data from FAO and other sources were used to design a comprehensive model of irrigation needs of small farmers; less than 2 feddan.

Based on this model, we have put a technical design for a new product that would meet the needs of these farmers at a feasible cost and innovative business model. My product is a Mobile Solar Pump that is capable of pumping up to 60 cubic meters of water from surface water. This unit can irrigate one feddan in 6 to 8 hours, almost the same time as diesel pumps. "Mobile" means a group of farmers can share the system and eventually split the initial cost, or one person can use it as a source of income by renting it to other farmers. Using a very efficient pump and solar system helps in reducing the power and the price tag of the unit considerably. In addition to that, the system has zero operating cost and is almost maintenance-free. We anticipate that for each 1000 units we produce and sell locally, we will be able to create 7 to 10 permanent green job, reduce emissions by thousands of tons annually.

(poster 28)

The cogeneration in sugar mill: an energetic deposit opportunity for sustainable development in Sub-Saharan Africa

Kana-Donfack P., Prof. KAPSEU César and TCHEUKAM-TOKO D., Department of Electrical Energy and Automatic System Engineering, ENSAI, University of Ngaoundere, Cameroon

ABSTRACT

(PPT no 1) Introduction

Context

Electricity production dominated by hydroelectric and thermal power stations face to the following problems

Problem: While in countries like Cuba, sugar can produce 25% of the national electrical energy. In sub-Saharan Africa, technology is obsolete and requires some sugar mills to stop production because of the poor quality of steam from the boiler.

objective. Analyze the potential contribution of this technology to sustainable development in sub-Saharan Africa

(PPT no 2) A comparative study of the various bagasse conversion technologies to produce electrical energy.

Following the fact that 1 tons of cane milling can produce 100 kwh of energy, we analyze production potential for country en potential contribution to the national grid

- Sub-Saharan energy situation was present
- Analysis with typical case from Cameroon sugar factory.

(PPT no 3) Result and discussion

1-contribution of the technology to sustainable development

No environment impact,

Reduction of pollution risk du to firing and methanisation during the storage,

availability of fuel and no cost (waste)

Create businesses activities to local community,

Technology transfer,

reduction of nation fossil fuel importation for power generation

2- energetic situation of sub-Saharan Africa

Energetic deficit of 700 MW mean up to 4O % of the rate of growth,

Loss of 10% of GDP due to shedding,

Low electrification rate (22.5%)

3- potential contribution to national demand (tab. 1)

Up to 30% for some country

Up to 2% of the national demand

4- analyze: typical case of Cameroon

Up to 3 % of national demand, but seven (07) time the surrounding population

(PPT no 4) Conclusion

Even if to the national scale, the contribution is not considerable, they can permit to reduce the price input to the transport (40%) when the production factory is far from the consumers.

The operation can be multi fuel (Coal…)

(Poster 29)

ECOmakala : meeting energy needs, fighting poverty and protecting the forests of the Virunga National Park, eastern Democratic Republic of Congo

by Mone Van Geit, World Wide Fund for Nature, WWF-Belgium, International Programs Manager (Brussels)

ABSTRACT

The Virunga National Park (ViNP) situated in the East of the DRC, in the North Kivu province, is Africa's oldest and most biodiverse park covering 784,368 ha's going from primary rain forest, savannah and volcanoes to a high mountain's massif. North Kivu is one of DRC's most dense populated provinces where more than 90% of the population relies on wood for their energy needs. Goma, North Kivu's provincial capital, has seen the arrival of many families fleeing the fighting and its consequences in rural areas. Goma's population currently stands at 1 million inhabitants following a population boom which has led to a steep rise in energy demand. Since electricity is scarce, people rely on energy wood, and in urban areas, mostly used under the form of charcoal or "makala" in local language.

As a result, the resources of the ViNP encounter an enormous pressure. Above this, the illegal wood energy cut down in the ViNP and the resulting charcoal is subject to an illegal business which doesn't favour the local population. At present, one bag of charcoal costs between 25 and 30$, where a couple of years ago the price lied around 10$. In a region like the Kivu's, large scale reforestation initiatives in collaboration with local communities are a relevant alternative for the forest resources of the park while contributing to local development.

The ECOmakala program (2007-2016; EU/Dutch Cooperation/IFDC/CIFOR/CBFF/WWF) reforested up to 10 000 hectares of small holder lands (with an average of 1 ha) in the territories surrounding the ViNP, for the provision of legal and sustainable energy wood to the local communities. In 2015 and with the support from the Belgian Development Cooperation, WWF initiated the "Makala kwa mafa yetu" project focusing on the organisation of the eco-makala value chain, through the structuration of the farmer planters in groups or cooperatives in view of the marketing of the eco-makala while assuring a fair revenue for the farmer planter.

Another objective of the project is to diversify pure reforestation activities by introducing trees into crop land. It is important to make sure that the sources of makala production are also supporting food production systems while protecting the soil, increasing the quality of crops, and easing climate change. The ECOmakala program also tries to contribute to decrease the makala consumption needs in the short run, by promoting the use of efficient wood stoves, requiring up to 50% less makala. Since 2013, ECOmakala is part of the REDD+ program for the DRC which aims to reduce emissions from deforestation and forest degradation as well as to increase conservation, with the greater objective of mitigating climate change.

(poster 30)

Science and diplomacy in Central and Western Africa : remarkable achievements and challenges

César Kapseu, Ambassador of science, and Liliane D. T. Atoukam, Humanities and Social Sciences, University of Ngaoundere, Cameroun

ABSTRACT

Cameroon is the interface between the regions of Central and Western Africa. To this end, it can play a role in scientific diplomacy. One of the assets of this Africa in miniature also concerns the languages: English and French are two official languages. Cameroon borders with 5 countries (Nigeria, Chad, Central African Republic (CAR), Congo and Equatorial Guinea). Two neighbors have insecurity problems (Nigeria and CAR).

The objective of this article is to identify cases related to science and diplomacy to our knowledge in Central and Western Africa. Indeed, Cameroonian teachers have formed critical masses in Chad, Congo and the Democratic Republic of Congo (DRC). The lessons have given hope to young people in difficult situations and post-conflict situations. The partners that support these courses are the "Agence Universitaire de la Francophonie (AUF)" and the Association of African Universities.

Joint projects between researchers from Cameroon, Chad, Congo and DRC have resulted in the revitalization of laboratories and the promotion of research in both grade change and publications. Indeed, several Congolese and Chadian teacher-researchers have gone from Assistants to Masters of Conferences. A teacher researcher from Burkina Faso who attended a conference in Cameroon became a Minister in his country.

The 10 regional and international conferences organized played a major role in mutual understanding and trained young researchers. These events strengthened science and diplomacy capacities in the central and western regions and promoted multidisciplinarity. Regional functions as representative of the African Network for Solar Energy, the African Committee for the Future of the Earth, the Francophone Network of Process Engineering Researchers in Agro-Food (GP3A) Francophony and the network of innovation researchers have strengthened the bonds of solidarity between scientists.

Collective books at the end of congresses on topical subjects such as renewable energies, biodiversity, climate change, waste recycling and innovation, in collaboration with the French and German Embassies in Cameroon, of Belgium in the DRC and development partners such as AUF (Canada), the Research Institute for Development (France) and the World Academy of Sciences (Italy) have given weight to the interface between science and technology. Diplomacy.

Keywords: science, diplomacy, central and western Africa, network, research, teaching, conference, project

(poster 31)

Zero Emissions Energy in an African context

Tim Berckmoes, CEO / Gedelegeerd Bestuurder of Anglo Belgian Corporation (diesel engines for shipping, railways and power generators)

ABSTRACT

The energy need in Africa is immense as still 80% of the rural population does not have access to electricity.

Belgian companies have special expertise in these hybrid power solutions in combination with zero emissions and zero carbon footprint.

Energy solutions in Africa should satisfy following criteria:

- Neutral in CO2
- Zero exhaust emissions
- Maximum solar production
- Maximum Wind energy
- Use of local fuels
- Easy installation
- Easy transport of equipment to inland sites
- Simplicity in use
- Low maintenance
- Financing of the projects to be provided
- If not connected to the grid then distribution till final customer

ABC has developed hybrid power solutions based on a maximum solar panel electricity production in combination with diesel gensets for compensation during the night or during clowdy conditions. As reference Kiffa hybrid power plant in Mauretanië.

Hybrid containerised solutions exist with Photo-voltaic cells in combination with Xant wind turbines and ABC engines on biofuels such as local palm oil. Maximum use of solar and wind energy is guaranteed while the ABC generatings sets compensate any drop in production from the solar cells or during low wind conditions on site.

ABC contracting foresees the distribution of the energy from the power plant upto the local consumers from 120 kV high voltage down to 400V low voltage distribution. Also renovation of existing hydro power plants can bring quick improvement to the critical situation in Africa. ABC contracting has references in Mukungwa (Rwanda), Inga and Ruzizi (RDC). All equipment is foreseen in 40 feet containers allowing easy access to difficult sites and short installation time without complex civil works.

Because ABC produces their engines in factories with ultra low C02 emissions and because of the group renovating in average 130 MW of hydro power per year and because the ABC group is the owner of 35.000 hectares of plantations in RDC and also an arboretum in Burundi, the remaining low CO2 emissions are compensated at a rate of 10 ton/hectare/year. All remaining exhaust gases after combustion are neutralysed by Selective Catalytic Reduction techniques.

In this way the energy production is adapted to African needs with zero emissions and zero carbon footprint.

(poster 32)

Use of Distributed generation to improve operation of overloaded grids in Africa

Okana M.N., Kitoko L.S., Kamabu T., Atundezi A. G., Laboratoire de Génie électrique, Département d'Electricité, Faculté Polytechnique, Université de Kinshasa, R.D. Congo

ABSTRACT

Power systems in central Africa are most of the time unable to meet the demand. In many cases, equipments are overloaded and load shedding programs are established to protect them. Instead of upgrading the whole electrical system, the following paper propose the integration of Distributed generation units indistribution grids to improve their operation

The paper investigates the benefits of the proposal by simulating the integration of various types of electrical power sources (synchronous and induction generators, solar panels) in the LV grids of Kinshasa city. Load flow calculations done with Power Factory DIgSILENT15.2 show that Distributed Generation is a good solution to improve operation of overloaded grids.

Keywords:

Distributed generation, renewable energy, induction generator, synchronous generator, solar panels, distribution grid.

(poster 33)

Linking Sustainable Energy with Soil Health and Carbon Sequestration through Frugal Innovation

Venkata Ramayya Ancha, Professor of Mechanical Engineering & Sustainable Energy Engineering, Institute of Technology, Jimma University, Ethiopia

ABSTRACT

Considering the need for integrated initiatives addressing interrelated problems like deforestation, land degradation, malnutrition, climate change, inefficient biomass burning with associated health risks while providing social and financial benefits, a carbon negative strategy utilizing biochar has been employed in this work to realize the complementary and synergistic objectives of effective environmental management for sustainable development. Considering the amenable properties of biochar for soil amendment, water retention and the resultant multi-dimensional benefits encompassing energy security, agricultural yield enhancement, beneficial waste management, climate change mitigation through carbon sequestration and substitution of inorganic fertilizer, experimental investigations have been carried out resulting in the development of prototypes through frugal innovation approaches.

New energy efficient allothermal and autothermal pyrolysis cook stove configurations co-producing biochar have been developed, deployed and field tested using agricultural residues, waste biomass and other agro-industry waste for integration of cooking with low cost domestic carbon sequestration. Pyrolysis kilns for agricultural residues and bone waste have been developed and tested at farm scale. An innovative biochar based indigenous organic fertilizer employing bone char rich in phosphorous, branded as Abyssinia Phosphorous, has been developed along with pelletizer machines for packaging and marketing by micro enterprises promoting climate smart agriculture. Keeping subsistence farming prevalent in the local context, both researcher and farmer managed agronomy trails have been conducted and the data gathered over a four year period demonstrated clearly and unambiguously the beneficial impact of biochar on enhanced grain as well as biomass yield from different crops in this regard.. As part of agro-ecological intensification, studies have also been conducted on different soil types collected from different regions in Ethiopia for subsequent scale up and adaptation of the approaches developed in this work.

The work carried out in this work amply demonstrates the fact that bichar production from sustainably grown and waste biomass feed stocks coupled with its use as a soil amendment provides a convenient link promoting both energy and food security while at the same time offering a low cost and effective carbon sequestration route for climate change mitigation. The present work also helps to demonstrate the role of frugal innovation towards the development of affordable prototypes that fit in the local context which can greatly help in the attainment of most of the Sustainable Development goals, i.e. 1,2,3,5,6,7,8,11,12,13 and 15.

Keywords: Sustainable energy, Biochar, Soil amendment, Pyrolysis cook stove co-producing biochar, Pyrolysis kilns. Carbon sequestration, Biochar based fertilizer, Frugal innovation

(poster 34)

Sustainability of Solar Mini-Grids in Nigeria

Adedoyin Adeleke and Chuks Diji

(Centre for Petroleum, Energy Economics and Law, University of Ibadan, Nigeria)

and Debora Ley

(Central America Regional Clean Energy Initiative, Guatemala City, Guatemala)

ABSTRACT

Despite the abundant solar energy resource in Nigeria *vis-a-vis* the high deficiency energy of the country, the uptake of renewable energy in Nigeria is abysmally low. However, while the average lifespan expected of a solar photovoltaic (PV) system is 20-25years (with replacement of some components at intervals), many PV systems in Nigeria fail within 2-3years of operation. This anomaly has been identified with solar mini-grids alongside other applications for which the solar PV technology has been deployed in the country.

To identify the factors responsible for the failure of mini-grids in Nigeria, the study assessed the sustainability of solar mini-grids from five perspectives, namely; technical, economic, social, institutional and environmental. Facility assessment, focus group discussions and interviews with key informants were the methodologies of data collection employed in the two case studies selected from the northern and southern Nigeria.

Findings from the study reveal that the sustainability of solar mini-grid projects is multidimensional. A project could fail due to a failure in one or a combination of the multidimensional factors. That is, the study shows that the sustainability of a solar mini-grid project does not only depend on its technical viability but also on its performances from economic, social, institutional and environmental perspectives. Furthermore, technical failure could result from the failure in other dimension(s) of the project.

Based on the multidimensional factors identified to be responsible for the failure of solar mini-grids in Nigeria, the study recommends the adoption of standards for components of PV systems that are being imported into the country, and development of a national curriculum for training of installers. High level of stakeholder engagement, community participation, operation of mini-grids with business models, strategic planning for productive use of energy and adequate institutional framework for monitoring and maintenance are also recommended for the sustainability of solar mini-grids in Nigeria.

The case projects assessed in the study were selected from the two major climatic zones in the country which makes the factors identified typical of the factors that determine the success and failure of other projects in the country. However, taking more case studies will be of advantage to identify more site-specific factors responsible for the success and failure of solar mini-grids. In addition, high rate of failure are also being experienced on the solar PV applications in Nigeria and other African countries. Such applications include solar home systems and solar street lighting systems. Hence, a similar study

on the sustainability of solar home systems and solar street lighting systems will provide insights on the factors responsible for their early failure.

Keywords: solar, photovoltaic, mini-grid, sustainability, failure

(poster 35)

Historical path of sustainable energy promotion in African rural areas : case study with the FERDEDSI Network (« Forum Énergies Renouvelables pour le Développement Durable par la Solidarité Internationale »)

Dr Marthe Djuikom Vandenbergh (1) and Benjamin Bender (2)

(1) FERDEDSI / IPEED (« Institut Populaire de l'Eau et l'Energie pour le Développement »)

(2) PhD student, Univ. of Kassel & Baobab e.V. (training centre and cultural encounter)

ABSTRACT

From an ongoing process that starts in 2003 by a master student field research on energy problems in African's rural areas[2], this paper shall first of all illustrate the historical path from academic work to multi energy organizations in Africa and then show a way to support the process in all aspects, in order to make the whole system sustainable and helpful, as well to any African institution and communities as to any North and South organization engaged in an energy partnership with Africa.

This paper links the output of an achieved thesis[3] project at university of Kassel (2004-2009) to expectable results of a new thesis topic[4] (ongoing). The new research also studies the impacts of the previous thesis work in the African universe of integrated research and actions for real social, economic, technic, scientific and cultural sustainable development. The both research work follows the logic of Solidarity Economy with the involvement of endogenous visions for local development.

The aim of this paper is to show the various local actions on energy entrepreneurship and the promotion of renewable energies as a strategy of fighting against poverty in African rural areas. One of the great output since 2006 is the creation of various local energy organizations and the network Ferdedsi / IPEED[5] in Africa.

These organizations help highlighting the energy dimension of poverty in all its various forms; among which the various social exclusions and the forgotten energy needs of people and communities in all activities dimensions. For instance, it shows the nature degradation and the women painful work with their struggle in all spheres linked to energy. It also shows the weakness of putting research and academic work in action and putting universities in interdisciplinary interventions.

---

[2] Dr. Marthe Djuikom Master work on 1- women organizations work in northern Cameroon (2002) and 2- Solar Energy in Northern Cameroon for socio economic development (2003-2004).

[3] Dr. Marthe Djuikom thesis at University of Kassel (2004-2009) : „Nachhaltige Energie für ländliche Entwicklung in dem Sub-Sahara Afrika: interdisziplinäre Herangehensweise und organisatorische Herausforderung" for: "Sustainable energies for rural development in Sub-Saharan Africa: interdisciplinary approach and organizational challenge " (300p). This work was improved and completed with field experiences, new analysis..etc to a book in French (612p)

[4] Benjamin Bender actual thesis work at Uni-Kassel : « Bildung über Wasser und erneuerbare Energien als Ausgangsthemen für ein Curriculum zur Förderung von ländlicher Entwicklung in Kamerun" (working title)

[5] FERDEDSI is in French. Nowadays this means: "Renewable Energies Forum for sustainable Development and International Solidarity ". This name is in process to become in French : ''Forum Energies Renouvelables pour un Développement Economique Durable Solidaire et Intégré'' (FERDEDSI) meaning "Renewable Energies Forum for sustainable Solidary and Integrated Development" and "IPEED also in French stands for Institute of Practices on water and Energy for Development. That is the training institute links to the whole Ferdedsi Process in Africa.

Various up-to-date and useful studies on energy problems done since 2003, with the involvement of various partners from international Development cooperation, universities and enterprises will be part of this paper presentation. They were mainly done in Cameroon (from 2003 to date), the Gambia (2008), Niger (2009), Burundi and RDcongo on various topics as: socio economic, technical, cartography, organizational, communities as well as households energy needs' analysis, their affordability and capacity to pay for alternative energy..etc. The studies also identified areas having potential resources (physical, human, organizational…) for supporting renewable energies pilots and experimental projects in our learning process. That help indeed for sensitization on renewable energy promotion but mostly for a local training program.

The first training frame was the training by doing (practice during installation of energy systems). It was quickly follows in second steps by the in-house training and practice in a process of building a new generation of local energy entrepreneurs. Finally a third and fourth steps raised up and were on course's delocalization at local and regional level with local communities and authorities' awareness on various energy matters. This involves the southern regions and international interns (students from various universities). Since beginning 2016 we are improving southern expert's qualification with very short training and visit of local experts to European enterprise (1 to 3 weeks).

The vision behind this local experts preparation is the negotiation of; as well the various international courses for Africa, adapted to the African context and problems, as to help increasing the capacity building of local researchers , academics and practitioners that we are struggling to connect to our trained local energy entrepreneurs.

(poster 36)

EU-Africa Research & Innovation Partnership on Climate Change and Sustainable Energy - A RINEA technical paper for priorities"

Arthur Guischet (1), Mokhtar Sellami (2), Jean Albergel (1)

(1) IRD, French Research institute for Sustainable Development,
(2) (2) MESRS Ministry of Higher Education and Scientific Research

ABSTRACT

The EU-Project RINEA (Research and Innovation Network for Europe and Africa), especially its Work Package 3, is supporting the EU-Africa High Level Policy Dialogue (HLPD) on Science Technology and Innovation in developing a roadmap on Climate Change and Sustainable Development (CCSE) for approval during the 4th Senior Officials Meeting of the EU-Africa High Level Policy Dialogue on Science, Technology and Innovation, planned in October 2017, in Brussels. One of this way was to assist the HLPD Members to identify a new priority for cooperation between Europe and Africa. Similar to the process that led to the adoption of the Research & Innovation Partnership on Food and Nutrition Security and Sustainable Agriculture (FNSSA), the senior officials have asked the EU-Africa HLPD Bureau in 2016 to develop a detailed initiative on global change for endorsement at the Africa-EU Summit 2017. The proposal is to work towards a long-term, jointly funded and co-owned EU-Africa Research and Innovation (R&I) Partnership on Climate Change and Sustainable Energy (CCSE). This future Roadmap is the final paper of a close and long cooperation between RINEA and the HLPD members.

Here is the background of this future Roadmap:

Several papers were drafted and presented to the HLPD on:

- Safe and Efficient Transport policies, Waste management, Earth Observation
- Renewable Energy
- Climate Change
- Global Health
- Global Change

After discussion, the HLPD requested RINEA to develop further some of those aspects by drafting technical papers on:

- Global Change: A multi-pronged, systems dynamic approach for adapting the way we live and reducing the human footprint
- Technical input to a potential EU-Africa Research and Innovation Partnership on Climate Change and Renewable Energy

This Technical Paper was developed within the RINEA partners but also during 2 workshops that took place in Brussels in February 2017 and in Addis-Ababa in July 2017. In Addis, experts worked on a document called "Climate Change and Sustainable Energy (CCSE), in the framework for the EU-Africa Research and Innovation Partnership".

RINEA focused on the technical aspects of this future cooperation, targeting the partnership on Climate action for adaptation and mitigation and on sustainable energy and proposed a technical paper as follows:

1. Research and Innovation pillar 1: Climate Action for adaptation and mitigation
2. Research and Innovation pillar 2: Sustainable Energy
    a. Renewable Energy
    b. Energy Efficiency
3. Cross-cutting issues related to climate change and sustainable energy
    a. Capacity building
    b. Open Data & Open Access