



A Network for the Coordination and Advancement of Sub-Saharan Africa-EU Science and Technology Cooperation

REPORT OF AN EXPERT WORKSHOP ON RENEWABLE ENERGY AND BIOFUELS, HELD IN DAKAR, SENEGAL, ON 13TH AND 14TH MAY, 2009

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LIST OF ACRONYMS

AUC	African Union Commission
AIDCO	EuropeAid Co-operation Office
CAAST-Net	Network for the Coordination and Advancement of Sub-Saharan Africa-EU Science and Technology Cooperation
EC	European Commission
FP7	Seventh Framework Programme for Research and Technological Development
ICSU ROA	International Council for Science, Regional Office for Africa
INCO-NET	International Cooperation on Science and Technology Network
NCP	National Contact Point
NEPAD	The New Partnership for Africa's Development
RCREEE	Middle East and North Africa's Regional Centre for Renewable Energy and Energy Efficiency
REEEP	Renewable Energy & Energy Efficiency Partnership
SICAs	Specific International Cooperation Actions
UCAD	Cheikh Anta Diop University

BACKGROUND

CAAST-Net is an INCO-NET supported under the Capacities Specific Programme of the European Union's Seventh Framework Programme (FP7). CAAST-Net's goal is increased African participation in the framework programme through enhanced cooperation in science and technology between Europe and Africa.

CAAST-Net undertakes activities of research prioritisation related to the enhancement of African participation in FP7 through experts' workshops held in Africa which aim to identify researchable topics areas of mutual interest to European and African researchers.

Workshops take place in consultation with, and where possible, the participation of the relevant EC directorates, in order to maximise opportunity for cooperation and exchange. Accordingly, on 19th September, 2008, CAAST-Net and Directorate K representatives held a meeting in Brussels at which the international cooperation dimension of the energy work programme was explained in general terms, as well as the specific interest of Directorate K in cooperation with Africa.

Directorate K referred to their support for the development of industrial technologies making reference to a solar power initiative which is more advanced than others, as an example of an initiative with a strong cooperation dimension with North Africa. "Interconnectedness" between EU and Africa was seen as a possible focus for EU-Africa cooperation, with such an approach contributing to many EU policies. Generalised priorities outlined by Directorate K priorities for cooperation with Africa include:

- Solar energy in North Africa.
- Biomass energy in Central Africa.
- CO₂ storage and clean coal technologies in South / southern Africa

For continental Africa, the priorities were said by Directorate K to be less obvious, but with the need for capacity building and support, synergies between the FP and EC's development programmes would be desirable.

Referring to the AUC book of lighthouse projects, Directorate K regretted the absence of energy related projects and hoped that this could be addressed.

In the absence of specific instruments at the time of the meeting to identify researchable topics or SICAs of mutual EU-Africa interest, Directorate K

indicated that the workshop proposed by CAAST-Net would be of interest, as would an exploration of opportunities for synergy with DG Dev and other development instruments.

According to the areas covered by the FP7-Energy Work programme and the recommendations of Directorate highlighting the renewable energy area, the experts identified the following FP7-Energy activities as focal points for the CAAST-Net expert workshop:

- Energy Activity 2: Renewable electricity generation;
- Energy Activity 3: Renewable fuel production;
- Energy Activity 5: CO₂ capture and storage technologies for zero emission power generation.

ENERGY THEMATIC WORKSHOP

A two-day energy workshop, held at the Cheikh Anta Diop University (UCAD) in Dakar, Senegal on 13th and 14th May 2009, was attended by 10 experts (Annex 2) specialized in renewable energy, biofuels and rural electrification.

Invited participants were chosen based on their expertise in a related field and because of their representation of, participation in, or relationship with a larger network, institution, or organisation.

The expert panel has been established as follows:

- Experts recommended by CAAST-Net members, the EC, the AUC, multilateral institutions, continental, regional and member state organisations in Africa and Europe;
- Experts having participated in previous relevant international S&T events held in Africa.

The first half-day of the workshop was devoted to presentations by meeting facilitators (the Ministry of Scientific Research of Senegal, IRD, the CAAST-Net project coordinator and the representative of NEPAD in Dakar) to set the context and provide background information. Experts were also provided with two draft papers. The first (Annex 1), a report drafted by the South African Energy NCP, indicates broad areas of potential EU-Africa cooperation taking account of articulated priorities under the EU's FP7 and Africa's continental priorities as expressed in the CPA¹ and the ICSU-ROA² energy plan. The same paper alluded to some of the major obstacles faced by the African scientific community when collaborating in European programmes. A second draft paper, prepared by South Africa's Department for Science and Technology³ reviews African science policy objectives and scientific strengths best suited to FP7 cooperation.

Following these presentations, experts accepted the activity areas proposed by Directorate K and adopted a series of three thematic discussion sessions to identify researchable topics.

Each thematic session followed the same process: A review of the topics listed in the Energy WP, identification by experts of researchable priorities of

¹ Africa's science and technology consolidated plan of action. NEPAD 2007.

² International Council for Science, Regional Office for Africa

³ South Africa's DST is a partner in CAAST-Net, which together with the UK's ACU, has with responsibility for analyses of EU-Africa cooperation.

mutual EU-Africa interest, impact of research, identification of research capacity in Africa.

For each topic, experts, guided by facilitators, attempted to draw out researchable constraints which could be addressed by both regions, to identify the objectives of addressing researchable topics of mutual interest, and the likely impacts. Most experts were perhaps naturally drawn to institutional, local and regional research priorities, and capacity building was also closely linked to experts' priorities.

TOPICS IDENTIFIED DURING THE WORKSHOP IN ENERGY

Energy Work Programme Activity 2: Renewable Electricity Generation

Topic “Rural electrification via small scale networks based on renewable energies”

Experts identified two research streams under the topic of “rural electrification via small scale networks based on renewable energies”. The first dealt with photovoltaics as a likely major component of rural networks, and specifically considered the costs, the materials & the components of both the current and the next generation of photovoltaic technology, and the implicit impact of these issues on quality control which, according to experts is an issue with the current generation. The second research stream recognises that successful rural networks may need to draw on a diversity of renewable energy sources and experts therefore drew attention to understanding networks and particularly to the integration of renewables in micro-networks for rural electrification, and the support tools and management services.

Researchable constraints and researchable topics identified by experts included the need for decision support tools for choosing appropriate energy sources; technical research on specific energy sources; socio-economic studies on the acceptability of clean energy vs. (higher) costs; LED-based lower cost solutions for photovoltaics; power storage and recycling of solar waste; the toxicity of current materials used in the current generation of photovoltaic cells; relative energetic efficiencies of renewable energies; integration of multiple locally appropriate energy sources for sustainable micro-networks; full economic costing of dirty technologies’ externalities plus public awareness and education to influence policy; standardisation and quality control.

The objectives, in addressing these researchable constraints and topics, in the two research streams are listed below:

- Development and understanding of the micro-network approach to the rural electrification;
- Development of new and appropriate technologies for rural electrification based on well identified and economical renewable energies in the African context;
- Diversification of materials, equipments and infrastructures adapted and economically acceptable in an African context;

- Development and integration of combined systems involving multiple energy sources for sustainable rural electrification;
- Reinforced legislative and juridical frameworks to encourage development of clean energy resources;
- Development of local capacity for manufacturing of renewable energy technology components, and technology transfer along the value chain.

Expected impacts:

- Rural electrification via micro-networks drawing on integrated multiple renewable energy sources;
- Enhancement and innovation of the rural electrification sector and associated technologies;
- Equipments and infrastructures diversified and available at adapted costs;
- Improvement of living conditions.

Energy Work Programme Activity 3: Renewable fuel production

In considering energy work programme activity 3, experts' debated two separate topics: The first focuses on agronomic issues of energy crops; the second on the process of extraction and transformation of plant derived oils to biodiesel. CAAST-Net acknowledges that agronomic issues may be more appropriate to Directorates other than Directorate K, or to cross thematic approaches.

Topic 1: "Exploitation of 2nd generation crop species in order to avoid competition between energy and food crops

Under this topic, experts identified the following researchable constraints and topics: 2nd generation crop species for avoiding competition with food crops; comparative cropping systems; sustainable & increased yields with low water & low N inputs; land suitability assessment & spatial data analysis; comparative energetic potential of different energy crops; agronomic issues such as GM for increased yield, reduced cropping cycle & disease resistance; management of biofuel crop species seen as invader species; decision support process around finance & economics (energy balance, carbon balance); biofuels for bioremediation; use of biofuel crop residues; genetics &/vs. agronomy as drivers of traits.

In this topic, experts raised diverse issues of national priority with emphasis on nationally or even locally important biofuels crop species. The risk of prioritisation at local and national levels was the alienation of European

interests. Facilitators acted to encourage experts to identify higher-level priorities with appeal to bi-regional interests.

Objectives proposed:

- Evaluation of the energetic potential of the pool of 2nd generation crop species, taking account of socio-economic and environmental contexts;
- Comparative analysis between different kinds of crops in order to identify the culture that should be prioritized for the production of biofuel and to ensure food security;
- Develop studies related to the *Jatropha* genome, fertilization, water needs;
- Establishment of a partnership between the Energy and the Agro food Industry areas;
- Specify the legislative framework around production and sale of biofuels and for existing technologies applied in African and European States

Expected impacts:

- Development of productive models;
- Rational management of energy resources for a sustainable development;
- Reduce or remove the threat to food crops from direct competition with biofuels crops, increasing food security;
- Better definition of the juridical and legislative framework

Topic 2: Development of technologies related to the extraction and transformation of oil to biodiesel

Experts agreed that, while individual biofuel crop species may have different oil extraction parameters, relevant at the local and national level, higher-level researchable constraints and topics of mutual interest can be identified.

Researchable constraints and issues discussed by experts include the following: Mechanical vs. chemical transformation; relation between plant chemistry and conversion efficiency; catalysis options to reduce transformation time; acidity of *Jatropha* oil and impact on end-user equipment; feedstock matching (i.e. balancing chemistry against end use); impact of soil/climate/environment on biofuel feedstock => multi-site trials; legislative framework around production and sale of biofuels.

Objectives proposed:

Innovation of new technologies well-adapted to extraction and transformation activities;
Modelling of strategies related to extraction and transformation activities;
Evaluation and valorisation of sub-products from identified renewable energy resources.

Expected impacts:

- Better knowledge and control of the energy resources and related-technologies
- Advantages and disadvantages well identified of the development of technologies related to the extraction and transformation of oil to biodiesel
- New technologies in the frame of the extraction and transformation of *Jatropha* oil to biodiesel in Africa,
- Valorization of sub-products and harmonization of legislation for clean production of biofuels

Energy Work Programme Activity 5: CO₂ capture and storage technologies for zero emission power generation

Topic “Energy efficient households (buildings and their content), building materials and carbon sequestration”

Researchable issues raised by experts: Appropriate and locally adapted building design for low energy use; inter-regional trade in used equipment; energy efficient cooking equipment; locally adapted alternative building materials to concrete, traditional building materials offering carbon storage possibilities; co-generation.

In addition to these researchable issues, experts recognized a raft of additional constraints: Legislation, policy, standards, security and design influence, environmental impact assessment guidelines; energy policy and distributed production / consumption of electricity.

Objectives proposed:

- Identification and demonstration of new technologies CO₂ capture and storage for the production of clean energy (e.g. “Passive solar energy)
- Conception of new building materials
- Research on local traditional building materials offering Carbon sequestration qualities
- Definition of rational domestic practices related to the energy consumption
- Propose revisions to some aspects related to energy policies

Expected impacts:

- Development of new technologies
- Diversification of building material, equipment and infrastructures in urban and rural environment
- Reduction of CO₂ emission and positive effects on climate change
- Revision proposals to some aspects related to energy and interregional trade policies

CROSS-THEMATIC TOPIC BETWEEN ENERGY AND SOCIO-ECONOMIC SCIENCES THEMES⁴

In addition to the topics identified by experts above, it would be appropriate to envisage a cross-thematic topic focussing on the lack of ownership, absence of political commitment and proper framework and policy agreements between African states to set the stage for a serious commitment to sustainable energy production systems.

⁴ This topic has been recommended via Email by an expert from South Africa that could not attend the workshop

EC ENERGY DIRECTORATE RECOMMENDATIONS

A meeting was held on June 11th 2009 between representatives of CAAST-Net and Directorate K in order to present topics identified by workshop experts. Participants highlighted various recommendations and actions to be undertaken in the next months. Directorate K agreed with the research topics proposed in the preliminary report arising from the Dakar workshop but expressed reluctance to develop these topics further until there was assurance that the best experts from Africa could be reached, and that suitable means of diffusion to these experts is identified if, or when a call for African participation is published.

In response, possible diffusion mechanisms have been identified as follows:

- The anticipated NEPAD network of centres of excellence in energy would probably provide the assurance requested by the EC Directorate⁵;
- The African Diaspora may be considered as a potential source or experts, or mechanism for diffusion of a call;
- The African science academies are in a period of expansion. Many have links with EU science academies;
- The EU-ACP energy facility;
- The South African NCP network.

Exploring future joint actions with Dev and AidCo in which research actions could be combined with capacity building actions. This is a theme which CAAST-Net could address under an expanded configuration from 2010. An approach between DG RTD and AIDCO may be envisaged with a view to exploring possible joint activities.

Strong support was expressed for policy coherence, but at the same time the EC Directorate stressed that it is not the role of the EC thematic Directorates to tackle capacity building work in order to avoid any duplication of the capacity building work of the EU-ACP energy facility.

FAB is putting agronomic aspects of *Jatropha* into WP2010 so it could be avoided in Dir K.

⁵ CAAST-Net has since discussed the subject with a senior NEPAD representative, present at the Dakar workshop. NEPAD is establishing criteria to identify Africa centres of excellence in energy and would be pleased to learn more about EU's partnership interests with such centres.

The leadership of South America in bio-ethanol production was highlighted, hinting at a possible trilateral initiative?

The EC Directorate indicated support for industrial partnerships, and to concrete projects with large scale experimentation, while being less committed to comparative projects.

CALENDAR OF ACTIONS UNDERTAKEN

- 19 September 2008: Initial meeting between CAAST-Net and Directorate K.
- 13/14 May 2009: Workshop Energy, Dakar, Senegal;
- 11 June 2009: Briefing meeting with the Directorate K to present the main areas identified by the experts;
- June 2009: First draft of a workshop report completed and circulated to experts for comment.
- August 2009: Submission of a final report and recommendations for researchable topics to the EC's DG RTD Energy Directorate.

ANNEX 1: BRIEFING PAPER ON ENERGY RESEARCH

INTRODUCTION

One of the CAAST-Net WP1 documents (Tema, 2009) outlines potential areas of collaboration between the EU and Africa in Health, Energy, Food Security and Biotechnology, Global Environmental Change, Earth Observation and Capacities. This paper expands on the potential for energy research collaboration between the EU and Africa by identifying existing barriers for African participation, existing energy research capacities in Africa and suggesting frameworks for accelerating collaboration.

In the other CAAST-Net document (Tema, 2009) a comparative analysis of European and African energy research and development priorities is carried out by comparing the FP7 programme priority areas and those of Africa's NEPAD Consolidated Plan of Action as well as the ICSU ROA's priority areas. This paper will outline how different the FP7 programme is from the African programmes that it is being compared to. Energy research priorities of other regional or country specific African research programmes will then be added for completeness and to suggest that even though such programmes are regional or country specific, there is a potential to expand them to continental participation following the network model that is suggested in the NEPAD document with the existing programmes acting as hubs for a specific research area.

In writing the paper, the author finds it very important that Africa articulates its primary objectives (and anticipated outputs and outcomes) of its appetite for collaboration. The objectives will largely drive the framework for collaboration including the priority research areas.

KEY RESEARCH STRUCTURES IN EU AND IN AFRICA

It is important to briefly describe the key structures that were studied in developing this document. Only regional or multi-national research and development structures were studied and incidentally all of them had energy as a priority or focus area. It is important that at some point an investigation is made to compile all countries that have energy research as a key R&D focus area together with their research priorities in energy R&D.

1.2 European Union's FP7 Programme

Even though individual member states of the EU may have R&D priorities, the current European Union research priorities are outlined in the 7th Framework Programme (FP7) of the European Commission.

Funding is on a competitive basis for the activities in FP7. The framework programme is by far the largest framework for EU research collaboration. Collaboration is enforced through a requirement for more than 1 member state institution in a research proposal for funding. Energy is one of the research themes of the EU's FP7 programme with a total budget of €2.265 billion for 2007-2013. The common energy research agenda is therefore being implemented through regional collaboration.

1.2 AU/NEPAD Consolidated Plan of Action

The African Ministerial Conference on Science and Technology (AMCOST) approved the NEPAD Consolidated Plan of Action (CPA) which identifies five flagship research and development programme clusters for Africa. The CPA research and development agenda was developed through a wide consultative approach among AU member state and NEPAD acts as the implementing agency encouraging intra-continental and international collaboration.

One of the CPA's five flagship R&D clusters is "Energy, Water and Desertification." It proposes the establishment of the African Energy Research and Innovation Network that will implement the priority research areas. The NEPAD science and technology office confirmed that the water research network strategy has been finalized and efforts to begin its implementation are underway. The energy research network strategy, however, is yet to be developed.

1.3 ICSU ROA

The International Council of Science (ICSU) established the Region of Africa (ROA) in 2005. The ICSU ROA is based in Pretoria, South Africa and has the objectives of “assisting ICSU and its members in their strategic planning for activities in Africa and ensure that their plans and activities are well linked to the science community in the region; to provide support and help with co-ordination, if needed, to scientific networks in the region and initiate new networks, where this has been identified as a regional priority; and assist the ICSU family in identifying scientists for membership of committees” (edited from the ICSU ROA website).

The ROA has “Sustainable Energy” as one of the four priority research and development science plans for Sub-Saharan Africa. Implementation of projects under “Sustainable Energy” is scheduled to begin in 2009. Invitations for participation in the projects have been made but it is not clear what the framework for participation is.

1.4 Middle East and North Africa’s Regional Centre for Renewable Energy and Energy Efficiency (RCREEE)

The Middle East and North Africa (MENA) countries have established a regional centre for renewable energy and energy efficiency to focus on policy formulation to enhance the implementation of RE and EE technologies as well as research and development of the technologies. The centre is funded by the founding member countries and projects are funded on a competitive bid process to the centre.

1.5 REEEP

“The Renewable Energy & Energy Efficiency Partnership's (REEEP) goal is to accelerate the global market for sustainable energy by acting as an international and regional enabler, multiplier and catalyst to change and develop sustainable energy systems” (REEEP website). REEEP achieves this goal through networking with policy makers and competitive bid funding for policy and technology research and development. REEEP has regional offices which includes a Southern African regional office.

EXISTING BARRIERS FOR THE AFRICAN PARTICIPATION

This section assumes that it is possible to have comparative country (and hence regional) participation in the FP7. For energy research, South Africa’s

participation in FP7 has been very limited (and discouraging) in the last 2 calls of the FP7.

So far under the energy theme of the FP7, only 10 of the 561 projects submitted had an ACP-African partner. There was no data to compare participation with other regions.

The barriers listed here are drawn from the South African situation and would require extensive input from other African countries to be comprehensive. The barriers identified so far are:

Strong research groups in Africa have links with “winning” EU partners while new/young researchers have no potential “winning” partners to partner with

The well established energy research groups in South Africa have strong networks with established research groups from Europe who have previously participated in FP activities (hence I call them “winning” EU partners). Such mutually beneficial partnerships have matured to the point now where there is good research funding and good partnerships with industry hence proposals by such groups always “win”.

On the other hand, “new” or “young” South African energy researchers have no networks with “winning” EU partners. They are discouraged from partnering with other “new” or “young” EU researchers knowing how competitive the FP funding is.

Perceived bureaucracy in applying for EU funding

Give a choice, South African researchers prefer applying for research funding from other sources as they view the FP reporting requirements to be too bureaucratic. The project leader (who has to be from the EU) obviously has more reporting to do but the South African partners have expressed concern as well on their reporting requirements.

Well established South African researchers will therefore tend to find alternative financing instruments for international collaboration (industry funding for example).

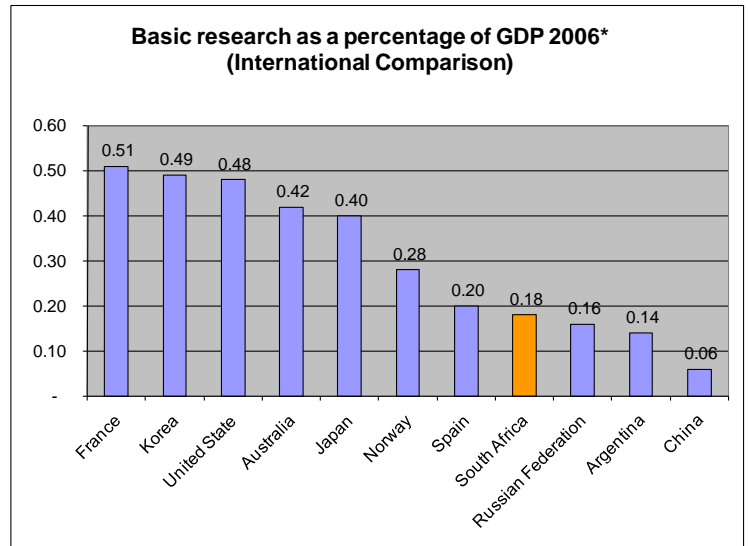
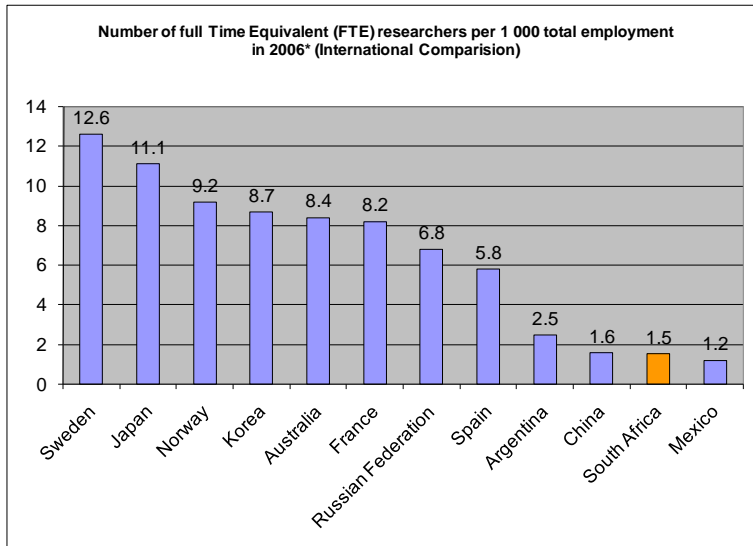
Hosting of flagship projects outside Africa

The fact that most key research activities are hosted outside South Africa means benefits of the Africa-EU in creating new knowledge, world class researchers are not made obvious to young researchers. The hosting of a EU_SA flagship project in South Africa would enhance the appetite for

international co-operation and demonstrate that there can be mutual learning in the partnership.

Comparatively less research resources in Africa

Human, financial and infrastructure resources are lower in South Africa compared to the targeted collaboration partner, the EU.



Figures 1 & 2. R&D Resource Comparison. (Source: DST, National survey of R&D, 2006/07, published by the HSRC of South Africa).

The figures above show there is 1.5 full-time equivalent researchers per 1000 total employment in South Africa compared to say 8.2 in France. This human resource potential should therefore be borne in mind when comparing the participation of Africa in the FPs. It could be that there is not that many researchers to participate! Gross expenditure on research and development in South Africa was 0.95% of GDP in 2006 (compared to 1.76% EU-27 average) while basic research expenditure in was 0.18% of GDP compared to say 0.51% in France. Not only are there less scientist, but there is less financial resource for them to create new knowledge.

ENERGY RESEARCH PRIORITY AREAS OF EU & AFRICAN INSTITUTIONS

	EU-FP7	NEPAD-CPA	ICSU-RoA	REEEP
Objectives	<ul style="list-style-type: none"> To identify & develop affordable, nonpolluting alternative energy solutions. To promote energy efficiency to address security of supply. 	<ul style="list-style-type: none"> To enlarge Africa's energy security through the generation & application of scientific knowledge & related technological innovations; 	<ul style="list-style-type: none"> To develop energy models and scenarios with related activities for optimizing, effectively managing and planning energy production, distribution and use in the region. Sustainably increase access to high-quality, reliable and affordable energy, especially for the rural populations and the urban poor. 	<ul style="list-style-type: none"> Research funding into policies and financial mechanism for increased implementation of renewable energy and energy efficiency Research funding for RE and EE technologies

Research Priorities	<ul style="list-style-type: none"> • Hydrogen & cell fuels • Renewable electricity • Renewable fuel production • Renewable heating & cooling • CO2 capture & storage technologies for zero emission power generation • Clean coal technologies • Smart energy networks • Energy efficiency and savings • Knowledge for energy policy making 	<ul style="list-style-type: none"> • Developing an African databank of Energy Research and Technologies. • Research & development of bio-energy technologies and other renewable energy sources 	<ul style="list-style-type: none"> • Setting up a harmonized data system suitable for scenario development and modeling; • Develop/enhance human and institutional capacity in energy modeling. • Electronic library to form the basis of a database on bio-energy programmes and to serve as a science information and communication platform on bio-energies; • Bio-energy technologies – quality characterization and adaptation • Energy efficiency in transport. • Bio-energy technologies – quality characterization and adaptation • Energy efficiency in transport. 	<ul style="list-style-type: none"> • Policy and regulations: assisting governments with regulatory policy frameworks. • Innovative financing: assisting with the creation of renewable energy funds, financing models, ESCO business models, tradable renewable energy certificates schemes, and bundling of small-scale projects; • Communications: knowledge dissemination, project finance matchmaking, local capacity building and in-country media support for renewable energy and energy efficiency projects.
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SUGGESTED AFRICA–EU ENERGY RESEARCH COLLABORATION AREAS

The targeted areas of collaboration should be derived from the overlapping areas identified in section 4 as well as Africa's natural resources. The list of suggested areas for collaboration must also identify a champion which could be a research institute, a regional entity or a specific country in a model similar to the network suggested by the NEPAD CPA.

The following areas have been suggested so far and are by no means comprehensive.

5.1 1st and 2nd Generation Biofuels

Research in these areas should not only include technologies for the production of the biofuels but also must build capacity for Africa's decision making capabilities to ensure that its resources are used sustainably and the new industries address its specific challenges (e.g. rural economic empowerment).

- Technologies for biomass to fuels conversion (2nd generation technologies)
- Improved conversion rates for 1st generation technologies
- Alternative energy products from 1st generation technologies
- Feedstock production including economic modeling of feedstock production
- Sustainable feedstock production

5.2 Solar Energy Research

At least 2 African countries, South Africa and Egypt, have advanced plans to commission >100MW concentrating solar power (CSP) plants. The deployment of solar water geysers remains low in Africa largely because of relatively high manufacturing costs and low skills base for the installation and maintenance of this technology. PV for rural electrification also remains underutilised.

- PV
- CSP
- Solar Water Heaters

5.3 Energy Efficiency Technologies

African economies remain highly (or sometimes even more) energy intensive while other economies are becoming more efficient. Energy efficiency in transport will help lower the impact of energy use on the environment. More energy efficient motors, lighting equipment, are also needed.

5.4 Carbon Capture and Storage (CCS)

South Africa's energy mix is primarily fossil fuel based. Research that would allow commercial scale deployment of carbon capture and storage technologies is being undertaken by South Africa's energy research institutes and industries. Collaboration with other African countries and the EU will help accelerate learning, sharing of knowledge and production of new knowledge from the unique geologies.

5.5 Hydrogen and Fuel Cell Technologies

Africa has very limited research capacity in this area but can we afford to remain behind?

EXISTING RESEARCH CAPACITY IN AFRICA IN THE ABOVE AREAS OF COLLABORATION

In section 3, the issue of limited resources for research and development in general in Africa was alluded to. This also applies to energy research. Time did not allow for data collection for Africa's research capacity in the 5 areas suggested for collaboration. This will involve collecting data on energy research groups, their size in terms of full-time equivalent researchers and research budget. It is important to have evidence of research activity as consultants and non-energy researchers may want to be included in such lists though they bring little benefit in terms of knowledge creation.

In South Africa's experience, the establishment of a dedicated energy research institute helped to construct and maintain a database of South Africa's capacity in energy research.

SUGGESTED FRAMEWORKS FOR ENHANCING COLLABORATION

To kick-start cooperation it is suggested that priority areas under section 5 be assigned to regional or multi-national research entities to drive collaboration in specific areas until a regional framework for collaboration is established.

The author suggests that is important to establish a clear framework that will increase Africa's cooperation with the EU. It is suggested that such a framework should include the following:

- **Objectives for collaboration** (increase Africa's ability to create new knowledge? Increase Africa's skills base in certain research areas?)
- **Intended outputs and outcomes** (Publications? Patents? Number of PhDs? Improved quality of life? Increase harvesting of natural resources? Deployment of new cleaner energy technologies? Development of rural/poor communities?)
- **Research priority areas** (will be influenced by the objectives, intended outputs and outcomes as well as resource availability)
- **Champions of each research priority research topic** (there needs to be a champion for each research priority area. This makes it so much easier to create a database of interested researchers, available resources for the specific area and identify potential partners for collaboration).
- **Sources of funding** (how will the collaboration be supported? Why would it be a continental programme if it is individual country funded?)
- **Guidelines for access to funding** (how will be continental funding be disbursed? Is it a competitive bidding process?)
- **Instrument for monitoring impact of collaboration** (all funders of the initiative would like to know if any progress is being made. How will this be measured? Number of proposals submitted and number retained? Number of publications? Number of PhDs from the programme? Number of researchers involved in the programme?)

ANNEX 2: LIST OF THE EXPERTS

Experts	Institution	Pays	Expertise	Contacts
AHAOUANNOU Clément	Université of Abomey-Cavavi	Bénin	Ph.D. in energy engineering and design, I conducted from October 2002 to November 2006 Béninoise Electrification Agency and Rural Energy Master of Benin, as Director General. I participated in the establishment of the Club-ER and RIAED. Expert in renewable energy and rural electrification, I am independent consultant.	01 BP 1175 Cotonou – Republic of Benin Tel: 21 31 87 43 / 97 60 33 23 ahouannou_clem@yahoo.fr
ATTA-OWUSU Franck	Kumasi Institute of Technology, Energy and Environment	Ghana	Deployment of sustainable energy systems and services in rural and peri-urban communities using appropriate, clean and efficient, new and emerging technologies Promoting the enterprise-centred approach as an option for the delivery of energy services Facilitating the diffusion of evidence-based information for the accelerated development of rural communities and the national economy	72 Olusegun Obasanjo Highway, Dzorwulu, Accra Postal Address P. O. Box AT 720, Achimota Market, Ghana. Tel:+233-21-256800 / 256 801 +233-24-4340734-6 Fax:+233-21- 256 801 info@kiteonline.net
BANDE Arba	Consultant	Burkina Faso	Expert in this biofuel jatropha	BP: 2682 Ouagadougou, Burkina Faso Tel: (00226) 76188746 bande_arba@yahoo.fr
DONNISON Iain	Institute of Biological, Environmental & Rural Sciences (IBERS) Aberystwyth University	Royaume Uni	Head of Division, Biorenewables & Environmental Change	Gogerddan, Aberystwyth, SY23 4AR, UK Tel. 01970 823092 isd@aber.ac.uk

Experts	Institution	Pays	Expertise	Contacts
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KLEYNHANS Theo	University of Stellenbosch	Afrique du Sud	Dr Kleynhans is an agricultural economist and his research team looks at the complete value chain for bioenergy production from feedstock production, transportation, energy generation as well as energy and carbon balances.	Dr. Theo Kleynhans, Department of Agricultural Economics, University of Stellenbosch, tek1@sun.ac.za
NJENGA Lydia W.	University of Nairobi	Kenya	Analytical Chemist, environmental and bioenergy expert	Prof. Lydia W. Njenga University of Nairobi Department of Chemistry P.O Box 30197-00100 Nairobi KENYA njengalydia@yahoo.com
NYAGA Stephen	Green Power	Kenya	Create lasting social change in rural Africa through decentralized micro hydro energy mini-grid systems that are largely financed, constructed, operated, and owned by co-venturing communities.	Jamhuri Park, Slade Road, Nairobi, 00502 Box 1247, Kenya Phone: +254 720 863 000 greenpower@wananchi.com nyagandiga@gmail.com
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Experts	Institution	Pays	Expertise	Contacts
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SANGA Godfrey	TaTEDO (Tanzania Traditional Energy Development and Environment Organisation)	Tanzanie	Advancing popular access to sustainable modern energy technologies in marginalized communities in Tanzania, through technological adaptations, capacity building, community mobilization and advocacy for increased access to sustainable energy	Off Shekilango Road, Near Institute of Social Work, Kijitonyama, Dar es Salaam, Tanzania. Postal Address:P. O. Box 32794, Dar es Salaam, Tanzania godfrey.sanga@yahoo.co.uk energy@tatedo.org Tel: 225.02.227.00438 Fax: 225.02.227.74400
MALANANE Antonio DNJ (*)	PROBEC	Moçambique	Ensure that low-income population groups satisfy their energy requirements in a socially and environmentally sustainable manner. It targets rural and urban households, as well as small business and institutions using biomass energy (woodfuel, agricultural residues) for thermal processes.	Deutsche Gesellschaft für Technische Zusammenarbeit (GTZ) GmbH German Agency for Technical Cooperation (GTZ) Av. Mao Tse Tung N. 858, R/C Maputo, Mozambique Tel. + 258 (21) 486 211 Fax. + 258 (21) 486 210 antonio.malalane@gtz.de
Prof. W.H. (Emile) van Zyl (*)	Stellenbosch University	Afrique du Sud	The Chair of Biofuels and Alternative fuels' research focus is on lignocellulose biofuels through biological (using enzymes) and mechanical methods. Enzyme strains that can perform the biological processing are being identified while pre-treatment methods are also being investigated.	Prof. W.H. (Emile) van Zyl, Department of Microbiology, University of Stellenbosch, P/Bag X1, Matieland, 7602, South Africa. Tel. +27 (0) 21 808 5854, Fax. +27 (0) 808 5846, Email. whvz@sun.ac.za
Dr. Phindile Masangane Dr. Thembakazi Mali (*)	South African National Energy Research Institute (SANERI)	Afrique du Sud	SANERI funds research and human capital development projects in non-nuclear energy. It acts as the national repository for energy research activities particularly public interest energy R&D.	Dr. Masangane/Dr. Mali, Block C, Upper Grayston Office park, 152 Ann Crescent, Strathavon, Sandton, 2146. Tel. +27(0) 10 201 4700, Email. phindilem@saneri.org.za, thembakazim@saneri.org.za
Dr. Steve Szewczuk (*)	Council for Scientific and Industrial Research	Afrique du Sud	Research on mini-hybrid electricity systems, bio-electricity generation and wastewater to retor conversion are the focus area of this research group.	Stefan Szewczuk, CSIR, Built Environment, P.O. Box 395, retoria, 0001, Tel. +27 (0) 12 841 2345, Email. ssszewczuk@csir.co.za

(*) Will not attend the workshop in Dakar but may contribute by email to the discussions related to the inputs of the Workshop.

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