Higher Education for Renewable Energy in Africa

Focussing on Master Education

Study commissioned by the Africa-EU Renewable Energy Cooperation Programme (RECP)

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Executive Summary

Worldwide, the use of renewable energy technologies has taken up a fast pace to substitute and/or complement fossil fuel based energy technologies. In developing countries, and especially in sub-Saharan Africa, renewable energy sources play a crucial role for the provision of sustainable energy access to rural areas and for the fulfilment of the increasing electricity demands by a rapidly growing urban population. In order to meet the need of emerging renewable energy markets for qualified manpower, the **Africa-EU Renewable Energy Cooperation Programme (RECP)** has recently started to implement its component on innovation and skills development, with a current focus on vocational training and higher education at master's level. This study focuses on the higher education sector in sub-Saharan Africa, delivering an overview on energy supply and renewable energy, identifying challenges and needs faced by the higher education sector, providing recommendations and entry points for support activities as well as developing a conceptual framework for future interventions. This study is targeted at African and European academic institutions planning to engage in the renewable energy sector, as well as development organisations aiming to support higher education for renewable energy in Africa.

The **energy sector in sub-Saharan Africa** is characterised by limited access to electricity, as well as low energy consumption. This situation has substantial negative implications for economic and social development. With the exception of the Republic of South Africa, energy consumption is still primarily based on traditional biomass, with severe ecological and social impacts. The share of modern renewable energy technologies such as wind energy or photovoltaic is still very low. Consequently, the renewable energy job market is still in its very early stages. This implicates for higher education in renewable energy that graduates have to be trained to become highly flexible and creative to support the development of this market, for example as entrepreneurs or for developing the political framework. Renewable energy master's programmes should be oriented towards inter- and transdisciplinarity instead of focusing on highly specialized areas.

On a global level, participation in **tertiary education** has become a mass phenomenon with enrolment rates of 60% and more in industrialised countries. In contrast, the tertiary enrolment rate in higher education in sub-Saharan Africa is by far the lowest in the world. Although the ratio doubled over the last twelve years, it is still less than ten per cent. Another global trend is increasing internationalisation and students' mobility. This applies especially for sub-Saharan Africa, were more than four per cent of all tertiary students study abroad, more than twice the global average. A third global tendency for higher education is the increasing share of female students. In 2012, already more female than male students were enrolled globally across all disciplines. This applies not only to the industrialised world, but also to Latin America, Northern Africa and Eastern Asia, however, sub-Saharan Africa is significantly lagging behind.

The general situation of the higher education sector in sub-Saharan Africa also applies to the renewable energy master's programmes. The significant shortfall on human and financial resources is very likely to stay for the near future. Therefore, any intervention proposal has to be very sensitive, knowledgeable and effective in addressing this structural lack of resources. Taking into account these considerations, a **Renewable Energy Curriculum Model** has been developed, which incorporates experiences and conclusions predominantly drawn from the European higher education system, but also takes into account African particularities. It provides a strategic approach and long term frame for renewable energy master's Programmes, based on theoretical considerations and empirical analyses. The model is able to connect with the core requirements which we consider as essential for any further planning and improvement of renewable energy master's programmes. These key features include comparability and modularity of curricula, competence-oriented teaching and learning, a close relationship between research and teaching, internationalisation, interdisciplinarity and transdisciplinarity as well as the implementation of quality assurance measures.

Finally, this study proposes a number of short-term and long-term **activities to support higher education** institutions in sub-Saharan Africa in order to strengthen their activities for renewable energy education and in addition, it provides corresponding selection criteria.

1 Introduction

1.1 Background

Renewable energy (RE) technologies are becoming a core player to substitute and/or complement fossil based energy technologies. Meanwhile, due to substantial support schemes from many national policies (e.g. Germany, Spain, USA, China), rapid technological development and corresponding drastic price drops for the leading RE technologies (PV and wind), the deployment of RE technologies has gained significant momentum. This applies also for the job market. Worldwide the RE market penetration is responsible for more than 6.5 million jobs (IRENA, 2014).

For parts of the developing countries there is an additional and important motivation for the implementation of RE technologies: Renewable energy sources will play a crucial role in meeting increasing electricity demands by a rapidly growing urban population, as well as in providing sustainable energy access to rural areas. The recent launch of the United Nation's "Sustainable Energy for All" initiative reflects the substantial interest by the international community in this sector.

Given this, the overall situation is characterised by the outlook of an increasing demand for RE experts, especially for the case of sub-Saharan Africa. Qualification profiles for the energy field are obviously facing a corresponding wide range, variety and diversity. Before addressing those profiles and the consequences for the concerned institutions and the corresponding qualification programmes, actual trends in the global higher education development have to be considered as well.

1.2 Objectives of this Study

Appreciating the demand of emerging renewable energy markets for qualified manpower, the Africa-EU Renewable Energy Cooperation Programme (RECP) has recently started to implement its component on innovation and skills development. With this study, the RECP aims to

- Give an overview on higher education for renewable energy and related initiatives in Africa;
- Identify challenges and needs faced by the sector;
- Provide recommendations and entry points for support activities; and
- Develop a conceptual framework for future RECP interventions.

This study is targeted at African and European academic institutions planning to engage in the renewable energy sector, as well as development organisations aiming to support higher education for renewable energy in Africa.

1.3 Context: the Africa-EU Renewable Energy Cooperation Programme

The Africa-EU Renewable Energy Cooperation Programme (RECP) promotes the development of renewable energy markets in Africa through (i) policy advisory, (ii) private sector cooperation, (iii) access to finance and (iv) innovation and skills development. RECP's focus in the area of innovation and skills development currently lies on supporting vocational training as well as higher education for renewable energy at master's level. One of the principles of the RECP is to complement existing donor initiatives, where possible. Moreover, by mandate, the geographical focus is on Africa.

2 Energy and Renewable Energy in Africa

2.1 Overview

Access to Modern Energy Services

Sub-Saharan Africa is characterised by a low electricity access rate. According to the International Energy Agency (IEA, 2014), more than 620 million people – nearly 50% of the global figure – live in Africa without access to electricity (Figure 1), almost 80% of these in rural areas and with over-representation of female headed and poor households. Although the share of households with access to electricity in sub-Saharan Africa has risen from 23% in 2000 to 32% in 2012, the total number of people without electricity is increasing due to rapid population growth. In contrast, the electricity access rate in the Northern African countries is almost 100%.

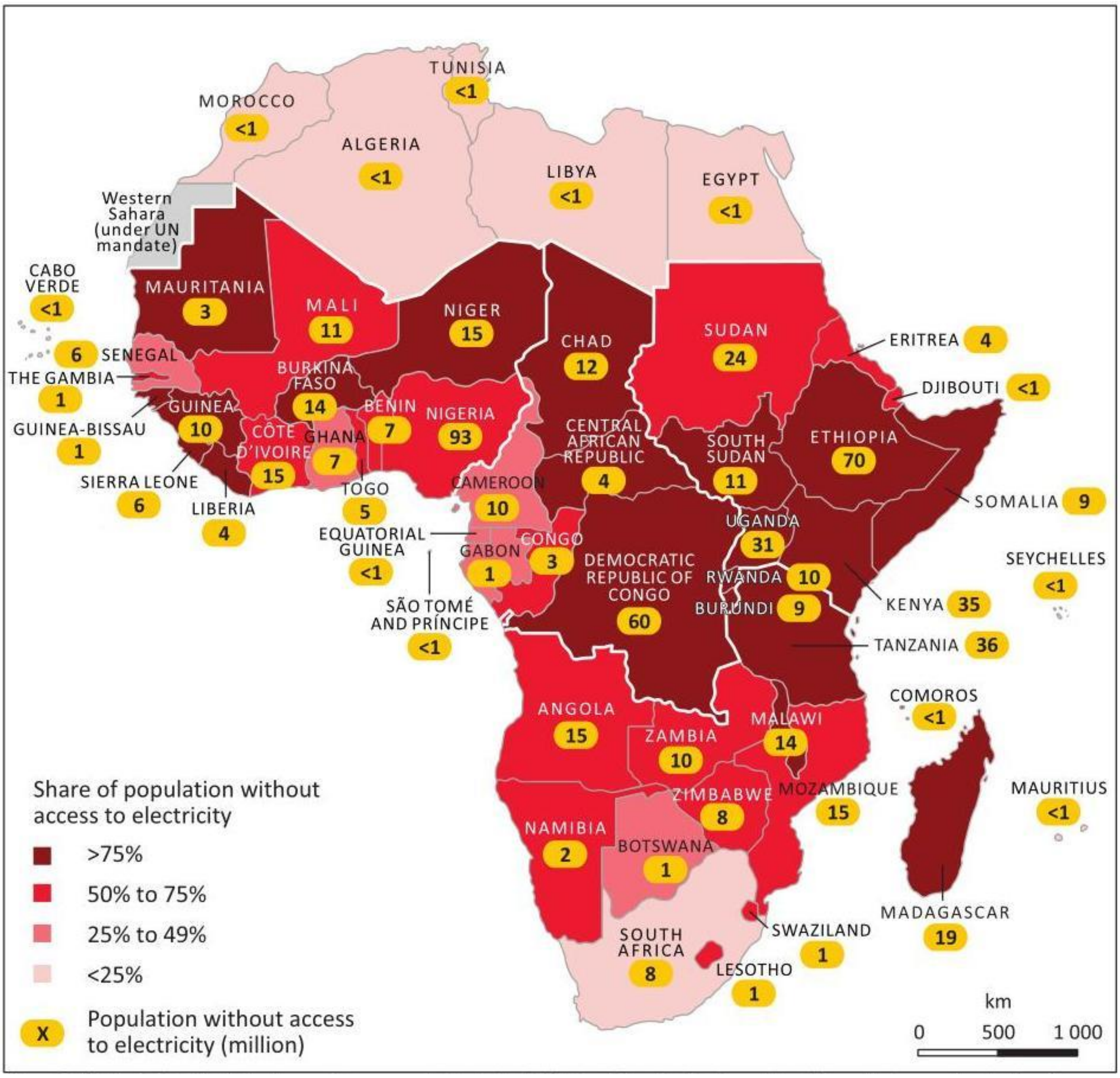

Figure 1: Number and share of people without access to electricity by country (IEA, 2014)

Even more people – nearly 730 million in Africa – have no access to clean cooking facilities, with more than 75% of them living in rural areas. Their dependence on traditional use of solid biomass has negative implications such as health problems, deforestation and high opportunity costs due to the collection of firewood. This situation is evident in most sub-Saharan African countries. In 42 countries, more than half of the population relies on traditional biomass, in 23 of these countries the share is exceeding 90% (IEA, 2014).

Energy Consumption

The energy consumption per capita in sub-Saharan Africa is far below the world average (2.1 toe/capita[1]), with only South Africa being above this average (Figure 2). Again, there are large differences between urban and rural areas. The energy consumption of the urban population is considerably higher, especially due to better access to electricity. Electricity consumption in sub-Saharan Africa stood at 352 TWh in 2012, which amounts to approximately 400 kWh/capita. The per capita use remained unchanged during the last decade and is the lowest in the world, again significantly below the average of North Africa (1,500 kWh). Electricity accounts for only 7% of the final energy consumption, compared to the global average of 18% (IEA, 2014).

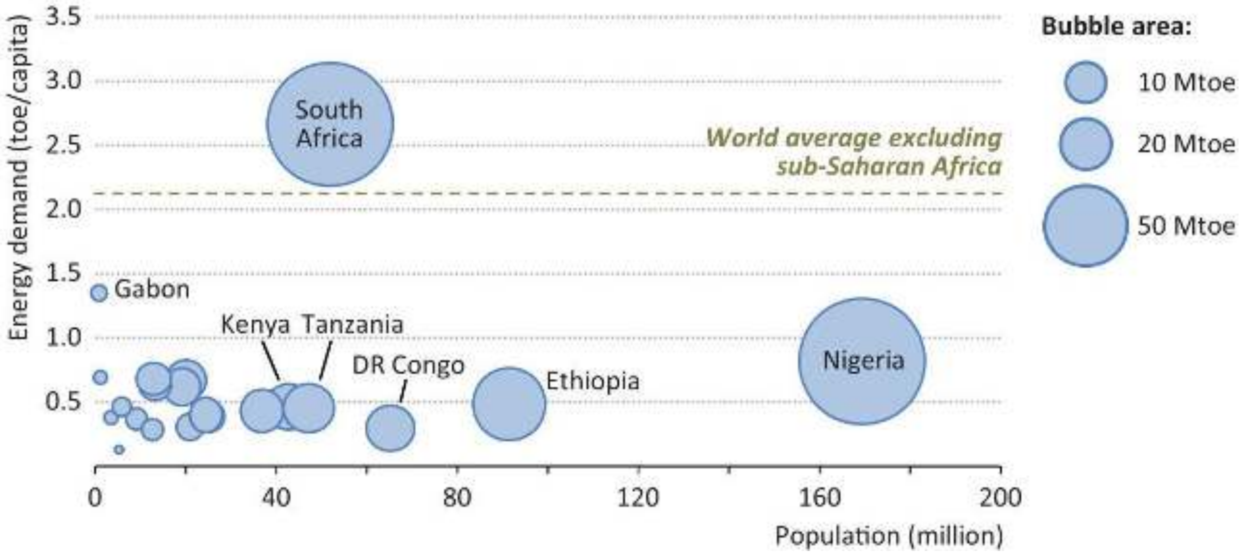

Figure 2: Population and per capita energy consumption (IEA, 2014)

2.2 Renewable Energy

With the exception of South Africa, **bioenergy** (traditional use of biomass) is by far the most important energy source. The current share of renewable energy, excluding traditional use of biomass, accounts for less than 2% of the sub-Saharan energy mix (Figure 3), comprising almost exclusively hydropower. Nevertheless, renewable resources are abundant across Africa, and the installed renewable energy capacity is growing rapidly, although from a very low basis.

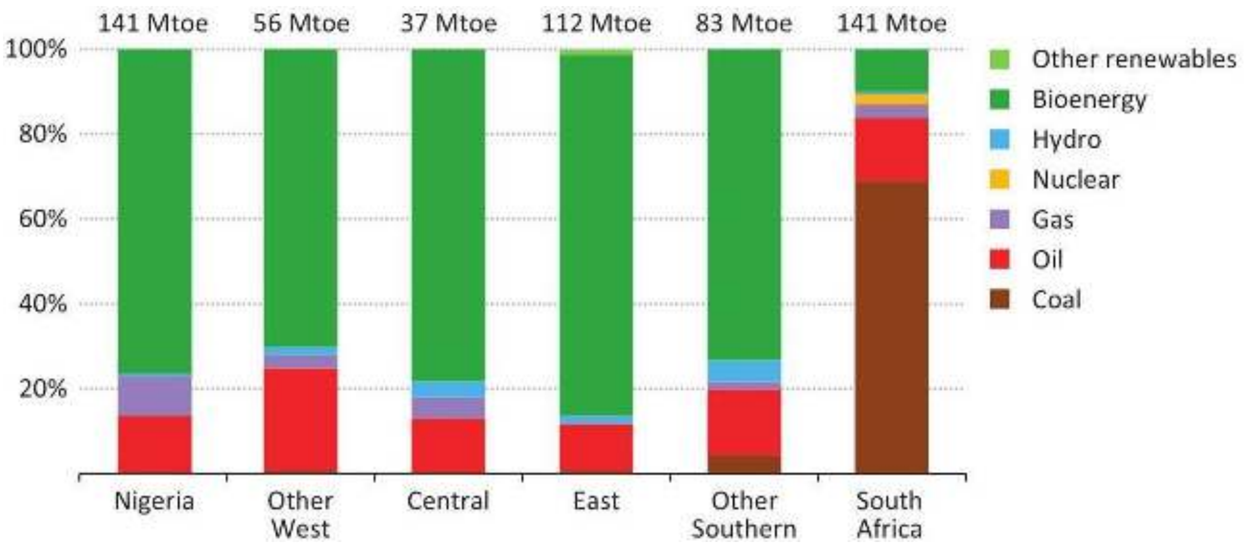

Figure 3: Sub-Saharan Africa primary energy mix (IEA, 2014)

[1] Tonnes of oil equivalent per capita

The **solar energy** potential in Africa is very high with an average level of 2,000 kWh/m²; e.g. twice as much as in Germany. Although the overall installed capacity is still low, solar energy is currently gaining momentum due to decreasing prices, with an increase in installed PV capacity from 40 MW in 2010 to 280 MW in 2013. Photovoltaic installations are especially competitive for off-grid applications (Solar Home Systems or mini-grids), as an alternative (or complement) to diesel generators. Further potential has the dissemination of solar water heaters.

Hydropower potential is estimated at 283 GW, with only 20 GW being currently exploited. Although in particular large hydropower projects have been in the focus of the political interest for a long time, there are economic barriers as well as environmental and social concerns linked to the development of such projects. Perennial rivers across sub-Saharan Africa provide opportunities for small hydropower projects, which may help to increase electricity access for communities in these regions.

Currently, only 190 MW of **wind power** capacity are installed in sub-Saharan Africa, although there is an estimated potential of 1,300 GW, mainly in the coastal regions. This includes mainly the Horn of Africa, eastern Kenya, parts of West and Central Africa bordering on the Sahara and parts of Southern Africa. Wind energy can be an economically sound solution for the integration of renewable energy into the electricity grid. Some countries have ambitious plans for the installation of wind power, for example Kenya has a target of 400 MW by 2020.

The resources for **geothermal energy** - estimated between 10 GW and 15 GW - are concentrated in the East African Rift Valley. There are already 250 MW capacity installed in Kenya with a target of 5,000 MW by 2030. Further countries in the region are carrying out geothermal explorations, including Ethiopia, Rwanda, Zambia, Tanzania and Uganda (IEA, 2014).

2.3 Energy Policy

In addition to national governments, several international actors are active in energy policy development at a continental and regional level, often integrated in infrastructure development plans. This includes the NEPAD Agency (New Partnership for Africa's Development), an economic development program of the African Union. NEPAD's development strategy (2001) includes the increased access to reliable and affordable energy supply from 10% to 35% within 20 years. More recently (2012), a Priority Action Plan (PAP) has been approved by the African Heads of State within the Program on Infrastructure Development (PIDA) as part of the NEPAD strategy. In the energy sector, it focuses on large hydropower projects and trans-regional power transmission lines. On a long-term perspective, PIDA sets the target to provide access to electricity for 70% of the population by 2040. Several multinational initiatives are dedicated to the development of the energy sector in sub-Saharan Africa, such as the Africa-EU Energy Partnership (AEEP), which also includes specific targets related to renewable energy to be achieved by the year 2020. The regional economic communities in West Africa (ECOWAS), Central Africa (CEMAC), East Africa (EAC) and Southern Africa (SADC) have developed energy master plans within their transnational infrastructure development strategies. These include the establishment of regional power pools in order to create common electricity markets within the regions (IEA, 2014).

Many countries in sub-Saharan Africa have national energy strategies in place. Most of them include targets to improve access to electricity, fewer address clean cooking. Several countries have set specific targets for renewable energy. The following three countries may serve as examples. Uganda has a Renewable Energy Policy since 2007, which includes the introduction of feed-in tariffs, tax incentives on renewable energy technologies and standardised Power Purchase Agreements for private power production based on renewable resources. The country aims to increase the use of modern renewable energy, from currently 4% to 61% of the total energy consumption by the year 2017. Niger has developed a National Renewable Energy Strategy (SNED) which includes the target to increase the use of renewable energy in the national energy balance from less than 0.1% to 10% by 2020.

3 Higher Education in Africa

3.1 Global Trends in Higher Education

Since the late 1950s, there is a clear tendency within the industrialised countries to host ever more students in their tertiary education sector. Enrolment rates of well below 10% in industrialised countries increased substantially and have today reached 60% and more. The tertiary sector participation developed from an elite qualification to a mass phenomenon and is about to become normality with all the consequences for the system and the individual, see i.a. (Altbach, 2007).In parallel, the “number of female students in tertiary institutions has grown almost twice as fast as that of men since 1970” (UNESCO Institute for Statistics).

Since the 1970s, this trend has been accompanied by a significant internationalisation of higher education. Ever more students are spending at least parts of their studies (master’s and PhD in particular) abroad (Figure 4). Meanwhile this tendency has gained impetus also in emerging economies, for example in Brazil, where support to students’ mobility is provided at different levels of intensity by a national policy framework.

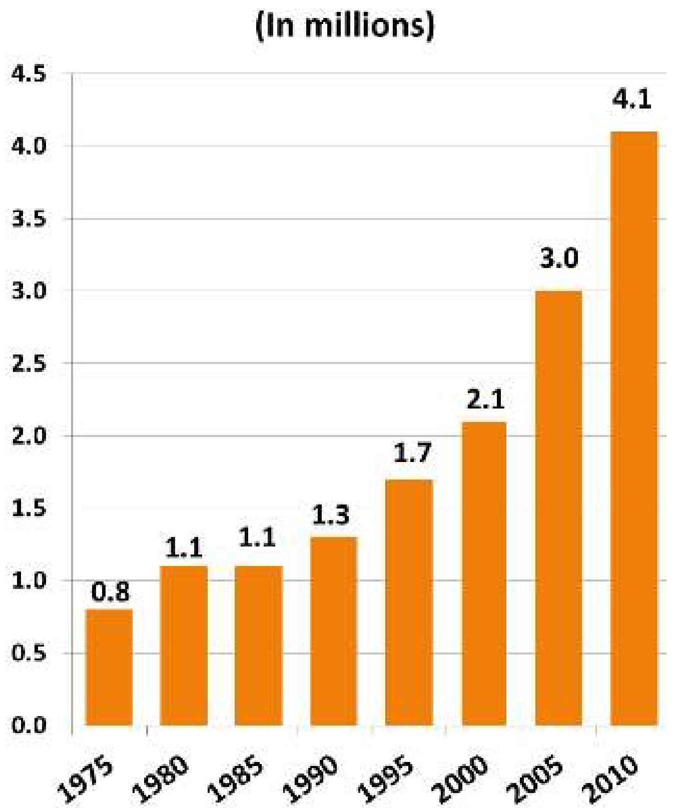

Figure 4: Number of students enrolled outside their country of citizenship (Kritz, 2012)

Currently, it can be observed that a still increasing number of tertiary students in industrialised countries study abroad. Nevertheless, the host countries for foreign students are still rather limited: First and foremost those are the ‘traditional’ Anglo-Saxon countries USA, United Kingdom, Canada and Australia, which are particular attractive for language reasons. Further preferred countries are France (in particular for students coming from North, Central and West Africa), Germany, Japan and e.g. the Netherlands (see Figure 5). The latter because of their long tradition as an open society, English proficiency and application oriented courses. The demand for highly qualified foreign students for national higher education institutions is further strengthened by the decreasing demographical development in all industrialised countries. A clear supportive system for integrating highly qualified personnel from other countries is necessary for research (such as in the USA, Canada or Australia). There is a substantial demand mainly for engineering and natural science.

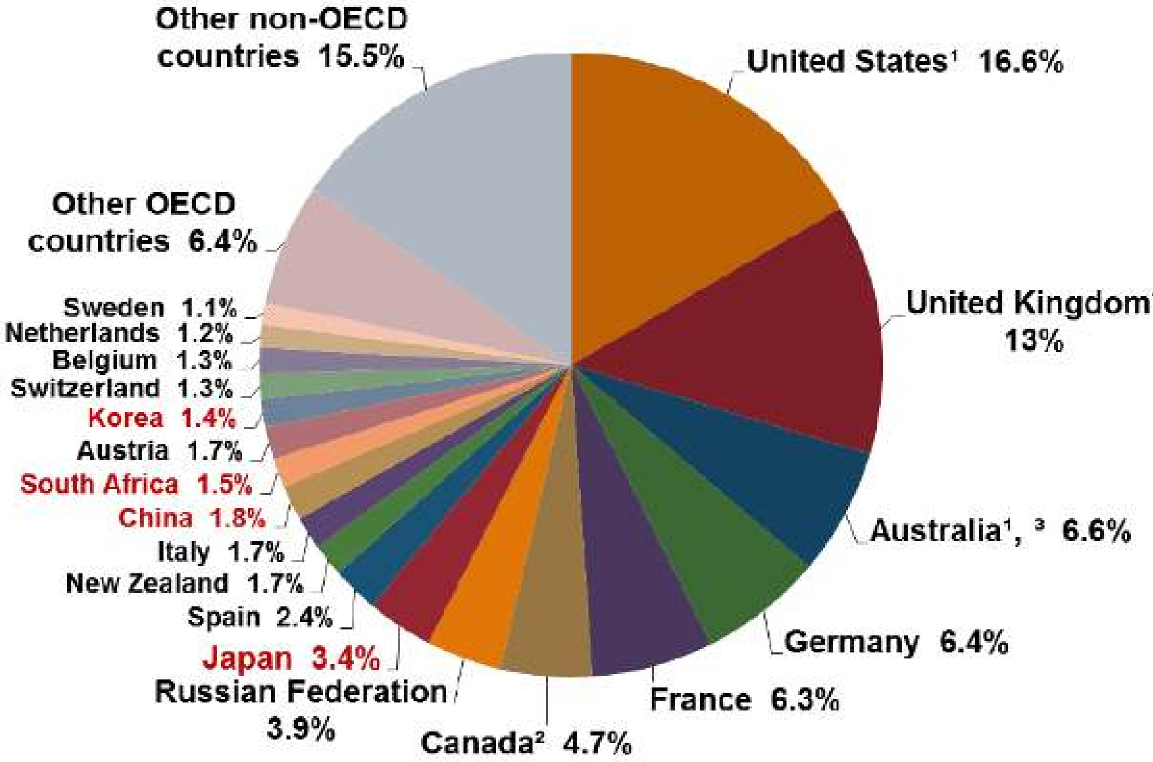

Figure 5: Share of foreign tertiary students enrolled in country of destination (Kritz, 2012)

Furthermore, universities particularly from Australia, the USA and Great Britain take on higher education as a business model to co-fund their universities. Financing schemes based on tuition fees seem to become even more promising for – at least the internationally leading - universities, when looking at the future mobility trends for higher education: One of the most recent studies of the British Councils still sees extremely fast growing tertiary market segments by the numbers, in particular in India, China, Indonesia, Saudi-Arabia, Pakistan, and also in Nigeria (British Council, 2014).

Those higher education 'market' tendencies lead to a certain matching of demand and supply, e.g. additional opportunities for individual careers for the middle classes of selected countries (including China, India, Brazil, Saudi Arabia, and Qatar). Obviously, this causes significant brain drain effects to the disadvantage of developing countries and corresponding brain gain effects for the industrialised countries. For sub-Saharan Africa its world high outbound mobility ratio[2] is still characteristic: Roughly four per cent of all African tertiary students study abroad (Figure 6 and Figure 7), and many of the students remain abroad. "The African diaspora provides powerful intellectual input to the research achievements of other countries but returns less benefit to the countries of birth. That is at least in part because of a chronic lack of investment in facilities for research and teaching; a deficit that must be remedied" (Adams, King, & Hook, 2010).

[2] Outbound Mobility Ratio: "Ratio of internationally mobile students of a country as a percentage of all tertiary students of that 'sending' or 'origin' country." (British Council, 2014)

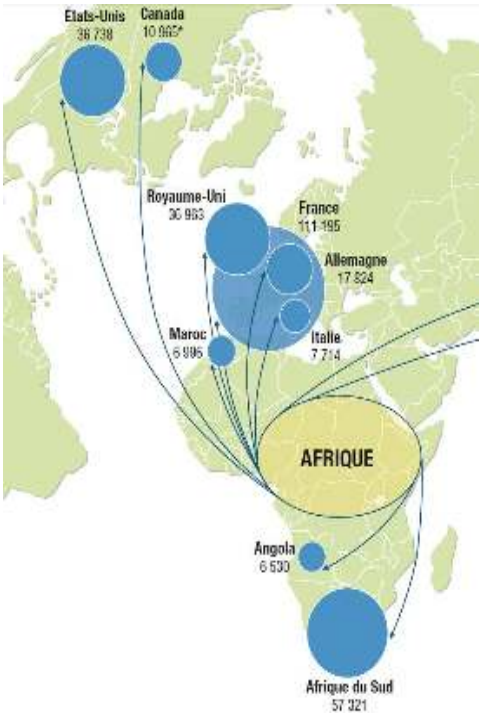

Figure 6: Mobility of African students (Les Notes de Campus France, 2013)

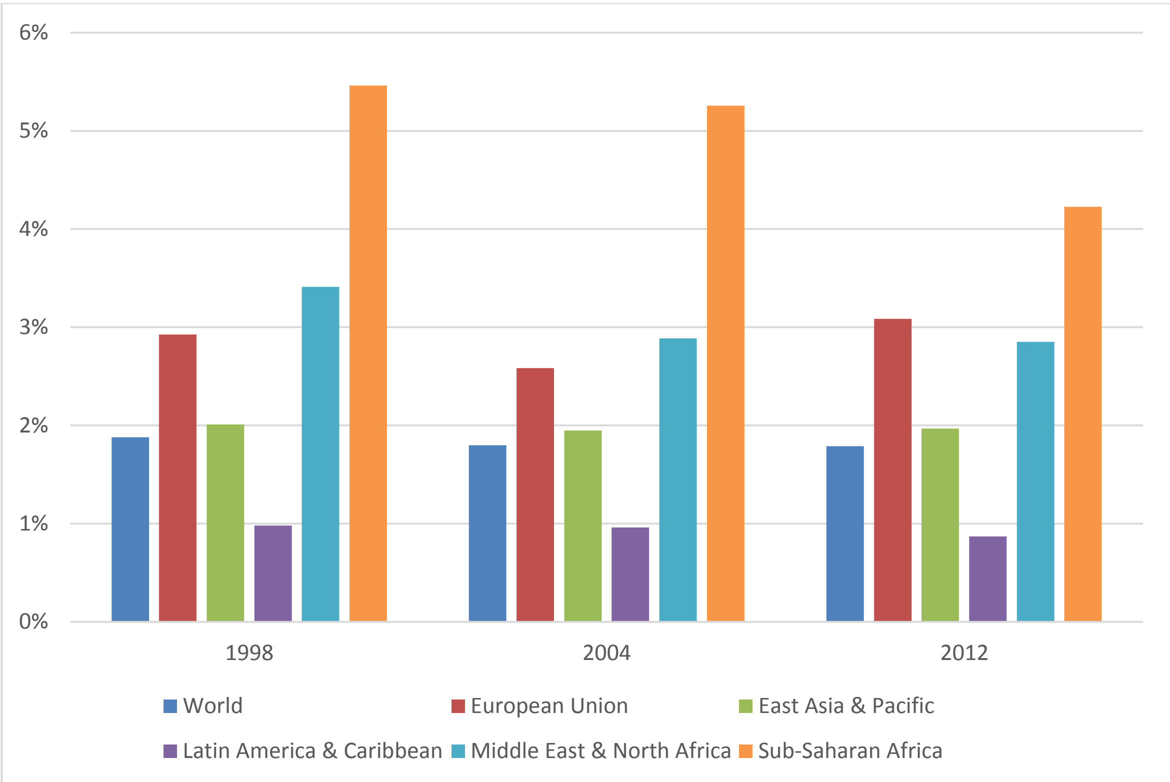

Figure 7: Outbound Mobility Ratio in the tertiary sector, based on (World Bank, 2014)

3.2 Status of Higher Education in Sub-Saharan Africa

Compared to the energy sector (section 2), it is less challenging to identify some general patterns and trends for the higher education sector in sub-Saharan Africa. In order to underline the specific situation in these countries, some characteristic data will be shown below in an exemplary manner.

Participation in / Access to Higher Education

Two indicators are selected to characterise access to higher education in Sub-Saharan Africa: Gross Enrolment Ratio and Gender Parity Index.

Gross Enrolment Ratio[3]

The sub-Saharan African enrolment ratio doubled over the last twelve years, yet, with 8% in 2012 it still remains by far the lowest in the world. In the same year Northern Africa and South-Eastern Asia stood at around 30%, whereas the global average was slightly above 30% (Figure 8).

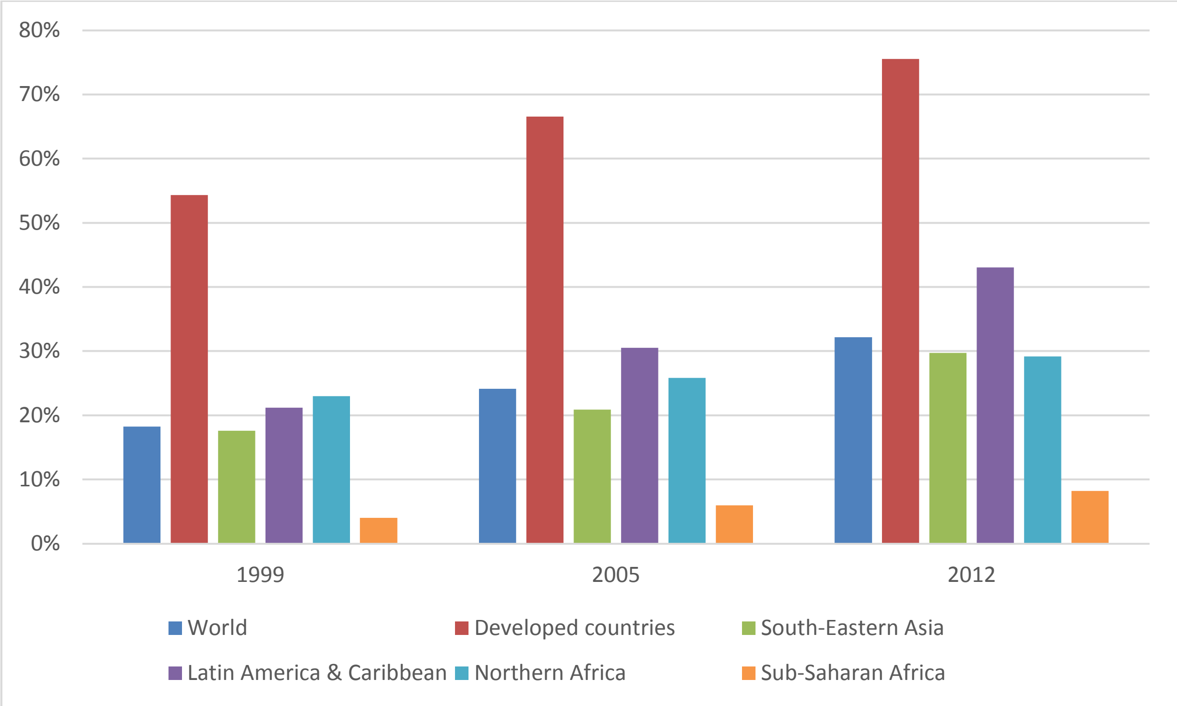

Figure 8: Gross Enrolment Ratio in the tertiary sector, based on (UNESCO Institute for Statistics, 2014)

In some African countries, the 2012 enrolment rates increased significantly compared to 2005. Ghana, Lesotho and Rwanda more than doubled the enrolment rates for instance and surpassed the sub-Saharan average of 8%, whereas in Burkina Faso, Niger, and Tanzania enrolment rates increased, but remained well below the average (Figure 9).

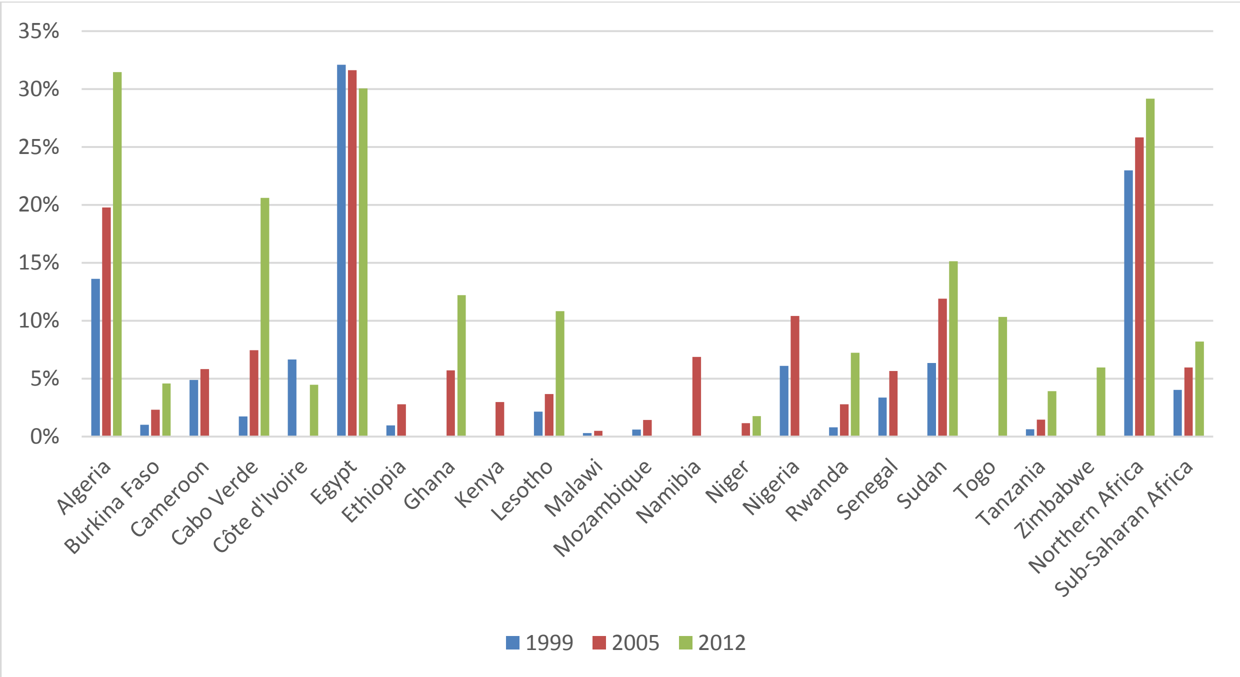

Figure 9: Gross Enrolment Ratio in the tertiary sector in selected countries, based on (UNESCO Institute for Statistics, 2014)

[3] The Gross Enrolment Ratio is calculated by dividing the number of students who are actually enrolled in the tertiary sector by the number of individuals at the corresponding age.

Gender Parity Index[4]

There is a clear global tendency that participation of women in higher education has increased over the last years. For 2012, the global ratio of female to male students already surpassed the benchmark of one, indicating that more female than male students are enrolled globally across all disciplines. Additionally to the industrialised world, this applies to Latin America, Northern Africa and Eastern Asia as well. Again, sub-Saharan Africa is significantly lagging behind. Its Gender Parity Index even decreased from 0.67 in 1999 to 0.63 in 2012 (Figure 10), indicating that only 37% of the students are female (2012).

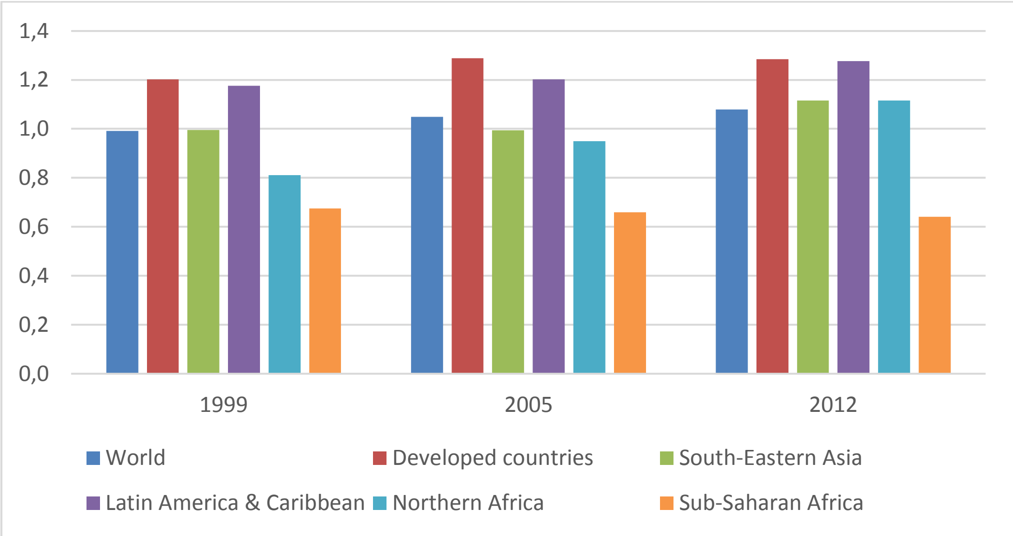

Figure 10: Gender Parity Index in the tertiary sector, based on (UNESCO Institute for Statistics, 2014)

The Gender Parity Index of selected sub-Saharan African countries shows that despite a high GDP growth in some countries over the last years, female enrolment in the national tertiary education sector still remained extremely low, e.g. in Kenya, Ghana, and Ethiopia (Figure 11).

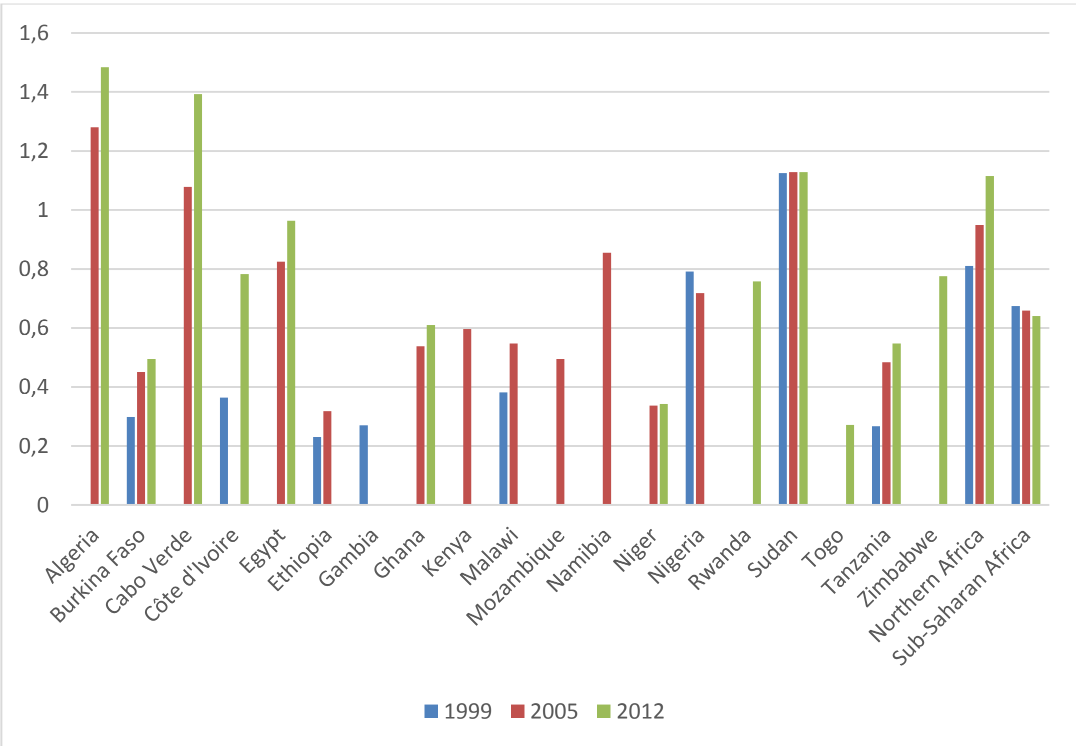

Figure 11: Gender Parity Index in the tertiary sector in selected countries, based on (UNESCO Institute for Statistics, 2014)

[4] The UNESCO defines the Gender Parity Index as the ratio between female and male students. A ratio higher than one indicates more females.

Research Activity Patterns

Scientific Publication

When looking into African research activities and their output, the number of scientific publications per annum can be used as an indicator (Adams, King, & Hook, 2010). From those figures it can be seen that the total number of about 27,000 scientific publications in 2008 all over Africa equal the number for the Netherlands alone in the same year. The USA with well above 100,000, as well as Germany, the UK and Japan with more than 90,000 each are hardly comparable. Within the African countries, South Africa, Egypt and Nigeria are leading in terms of research output (Figure 12).

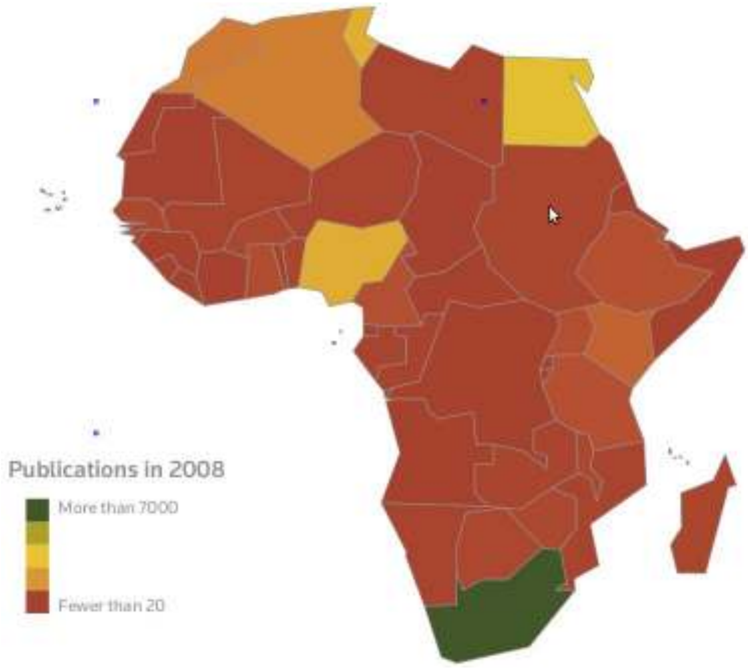

Figure 12: Scientific publications by country (Adams, King, & Hook, 2010)

Research Co-operation

When looking at research co-operation on the basis of scientific papers written with co-authors (Figure 13), four African research clusters can be identified:

- Northern Africa with a homogeneous culture and language (Arabic);
- Francophone West and Central Africa;
- Southern Africa complemented by Sudan and Gabon; and
- East Africa and Anglophone West Africa, complemented by Botswana, Malawi, Zambia and Zimbabwe.

Each group has one or two strong prolific countries: Egypt, Cameroon / Burkina Faso, Nigeria / Kenya and South Africa. Those are also acting as interlinks between the groups.

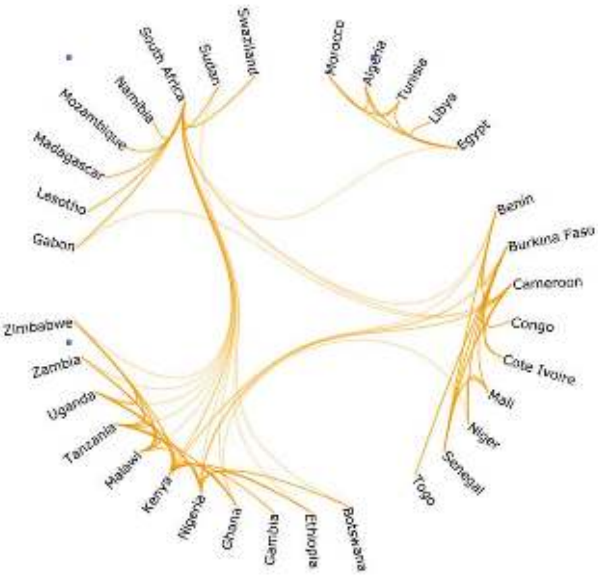

Figure 13: Network of collaboration (Adams, King, & Hook, 2010)

Another perspective is the research cooperation with non-African research partners (Figure 14), which is dominated by cooperation between countries with the same linguistic background.

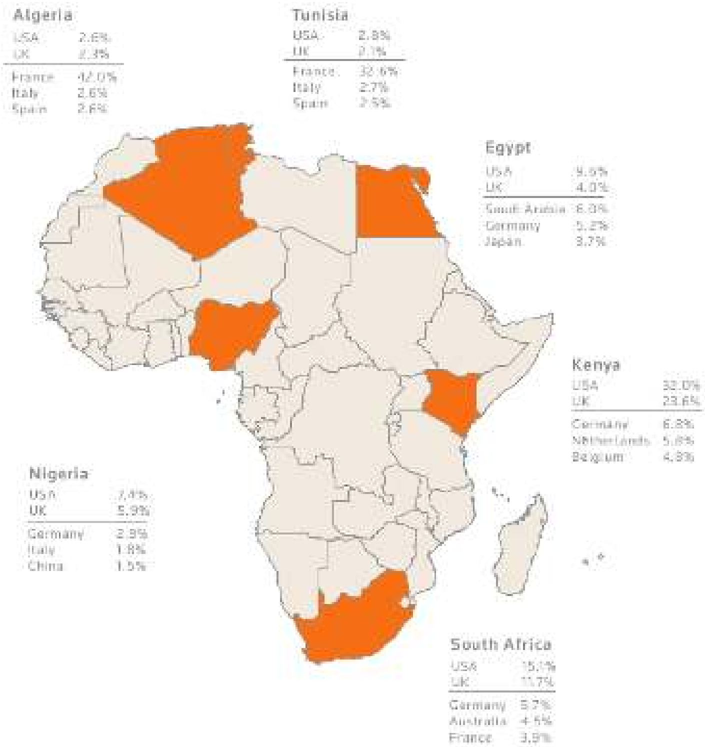

Figure 14: Top collaborating countries for six key African countries (Adams, King, & Hook, 2010)

4 Ongoing Initiatives and Programmes

4.1 Academic Institutions Active in RE Teaching and Research

During an RECP stakeholder consultation workshop in Kigali in July 2014, organised by the EUEI PDF, with more than 75 participants from over 20 African and several EU countries, a survey was carried out to identify African institutions involved in renewable energy teaching and research activities (see Annex A). 13 institutions from 12 countries reported to have master, bachelor or certificate programmes in place. Six more institutions are currently developing or planning additional master's programmes. The majority of the programmes are focussed on engineering and technology, but there are also some related to political, economic and planning aspects.

4.2 Examples for Higher Education Activities with European Support in Sub-Sahara Africa in the Infrastructure Sector

Renewable Energy Programme at the University of Zimbabwe – REP[5]

With the support from the German Academic Exchange Service (DAAD), providing a number of scholarships, and with a grant from the German Agency for Technical Cooperation (GTZ; now GIZ), financing laboratory and computer equipment, library functions and teachers salary, the Renewable Energy Programme (REP) at the University of Zimbabwe (UZ) commenced in August 1996, with five students and three lecturers. Additionally, for the first six years, two long-term external PhD lecturers from Germany were paid for. These combined support mechanisms, including Oldenburg University as facilitator, had to come to a full stop in 2002, due to political reasons.

The programme came to a halt in 2012 due to lack of qualified permanent teaching staff: University requirements for a minimum of 60% PhD holders as permanent teaching staff caused the closing down of several master's programmes at UZ.

REP is hosted at the Mechanical Department of the Faculty of Engineering Science at UZ. Since its start it has been a two years programme (4 semesters, intake in September each year), comprising two taught courses, plus one semester each for industrial attachment (internship) and master thesis.

The curriculum has been developed in close relation with Oldenburg University. It has a strong emphasis on technical (engineering and natural science) perspectives of renewables (e.g. radiation physics, energy meteorology) and from the very beginning valued hands-on experiences with laboratory experiments. It comprises solar (both electrical and thermal), wind, hydropower, biomass and storage technologies.

From 1998 till 2012 in total 86 students graduated from the REP. Ten of them were already awarded a PhD, another five are currently PhD candidates. Due to the slight recovery of the Zimbabwean economy quite a number of graduates have returned back home and are working in various government and private institutions. Approximately 60% of the graduates are back in Zimbabwe. At UZ alone there are about ten of them working as lecturers in the Faculty of Engineering, Faculty of Science and Faculty of Agriculture. Others are still in South Africa, Asia, USA, Britain, and other African countries like Botswana, Namibia and Lesotho. The female to male ratio of the alumni is about 0.17.

The challenges for the programme are manifold, and almost all are based on a substantial lack of resources or are closely related to that issue. This is clearly in direct relation to the general socio-economic situation in Zimbabwe. The most important deficiencies of the programme comprise the lack of qualified lecturers (PhD holders), shortcomings in the curriculum (e.g. recent RE technologies, simulation tools as well as interdisciplinary approaches), networking with external stakeholders (especially from the private sector) as well as out-dated laboratory and computer facilities.

In 2015, a pilot project is planned to commence under the RECP in order to resuscitate REP. The second

[5] Summary of an RECP scoping mission at the University of Zimbabwe in September 2014 (Golba, Cattelaens, & Hayek, 2014)

objective of this support intervention is to establish a long-term vision and internationalisation concept for the programme, including cooperation agreements – at first – with the University of Dar es Salaam in Tanzania and Makerere University in Uganda.

West African Science Service Center on Climate Change and Adapted Land Use – WASCAL

The West African Science Service Center on Climate Change and Adapted Land Use (WASCAL) is a research-oriented programme with a focus on climate change adaptation and mitigation measures in West Africa. The objective is to strengthen the research capacity and infrastructure in the region by combining the expertise of ten West African countries and Germany in order to "enhance the resilience of human and environmental systems to climate change and increased variability" (WASCAL, 2014).

WASCAL is organised as a regional international institute under the aegis of ECOWAS and with oversight from an International Governing Board. WASCAL is coordinated by the Center for Development Research (ZEF, Bonn University), funding is provided by the German Federal Ministry of Education and Research (BMBF). Figure 15 shows the ten partner countries in West Africa.

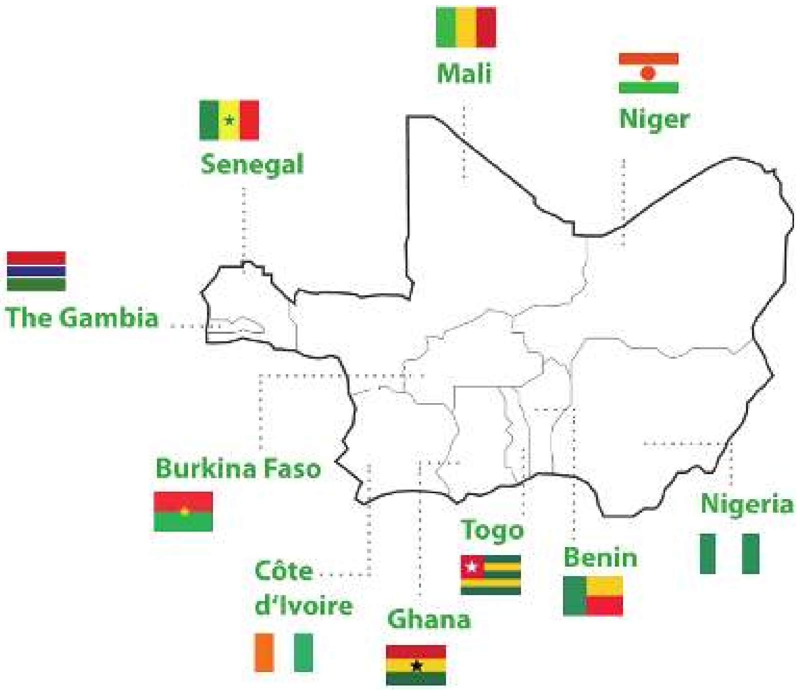

Figure 15: WASCAL partner countries (WASCAL, 2014)

WASCAL is organized around three principle components (WASCAL, 2014):

- The Climate Service Department (Ouagadougou, Burkina Faso):
  Collects, integrates and analyses data and generates policy advice from this data.
- The Research Department (Ouagadougou, Burkina Faso):
  Seeks ways and means to generate resilience in cultural landscapes.
- The Graduate Studies Department (Accra, Ghana):
  Strengthens human capacity through partnerships with universities in the region.

The WASCAL Graduate Studies Program consists of six Doctoral programs and four master's programmes which are supported by German counterpart institutions through curriculum development, visiting professorships and co-supervision of graduate students. Each programme has a specific focus in one of the ten identified priority fields. The master's programme at the Université Abdou Moumouni de Niamey in Niger is focussed on "Climate Change and Energy". WASCAL is dedicated to high quality research and education by combining the strengths of the participating institutes with an interdisciplinary approach, including teaching, student supervision, and exchange of cross-border experiences.

Capacity Development in Higher Education and Research for Development within the Fields of Energy and Petroleum – EnPe

The Norwegian Agency for Development Cooperation (Norad), a directorate under the Norwegian Ministry of Foreign Affairs, supports capacity development in higher education and research for development within the fields of energy and petroleum with its EnPe programme. The goal of this programme is to contribute to the education of staff in the energy and petroleum sectors through building capacity at the master’s level in higher education institutions (HEI) in selected partner countries.

The objectives of the EnPe programme include the development of local and regional master’s programmes and capacity building at the partner institutions, the enhancement of gender equality as well as the further development of competences of Norwegian higher education institutions to integrate global as well as developmental perspectives in their professional work (NTNU, 2014).

During the first stage between 2009 and 2014, four calls for applications have been issued and twelve projects are now supported by the EnPe programme. In total, the twelve projects were supported with a funding amount of 1 – 8 million NOK (0.1 - 0.9 million EUR) and a total budget of 55 million NOK (6 million EUR) (NTNU, 2012). Two projects in sub-Sahara Africa belong to the renewable energy sector, both in cooperation with the Norwegian University of Science and Technology (NTNU) in Trondheim: The development of a master’s programme in energy technology at Mekelle University (Ethiopia) as well as additional funding for the “Master Programme in Renewable Energy Systems” at Makerere University (Uganda), which has been initially funded by Norad's Programme for Master Studies (NOMA).

During the second stage (2013 – 2019), two calls for applications are scheduled for 2014 and 2015. Approved projects may receive support for up to five years, with opportunities for extension. The overall budget for the second stage is 100 million NOK (approx. 11 million EUR). The funding is mainly dedicated to the development of new study programmes or to strengthen existing programmes. It includes fellowships for students, exchange of lecturers, institutional development, equipment, joint research activities, staff development and administrative support (NORAD, 2013).

Pan African University Institute of Water and Energy Sciences - PAUWES

The Pan African University Institute of Water and Energy Sciences (including Climate Change) (PAUWES) is hosted by the University of Tlemcen, Algeria. PAUWES is part of the Pan African University – a project initiated by the African Union as part of a broad, integrated system of higher education across the African continent. Supported by the German government, the PAUWES offers graduate students access to academic research and training in the areas of water, energy and climate change (PAUWES, 2015).

The two-year programmes at PAUWES, first starting in October 2015, include Master of Science in Water and the Master of Science in Energy; students can choose between two tracks, engineering or policy. Three semesters of study are required, with the fourth spent on a master’s thesis. Graduates are awarded a joint degree from the University of Tlemcen and the Pan African University. They have the opportunity to apply for a PhD programme upon completion of their degree.

GIZ has supported the African Union Commission since 2011 in developing and implementing the Pan African University project; a dedicated GIZ programme currently supports the setting up of PAUWES. In addition, KfW is financing scholarships for students, personal expenses for teaching staff, as well as equipment and infrastructure. Subcontracted by GIZ, the German Academic Exchange Service (DAAD) is helping to recruit, select and finance teaching staff and to establish international networks.

Building capacity for water resources management in Southern Africa – WaterNet

The WaterNet programme was initiated and established in 1999 by the UNESCO-IHE Institute for Water Education, based in Delft (the Netherlands). The programme receives funding from the Government of the Netherlands. It aims to strengthen capacities of higher education institutions and professional organisations in Southern and Eastern Africa in the field of Integrated Water Resources Management (IWRM). A central activity of WaterNet is the regional master’s degree programme in Integrated Water Resources Management which became operational in 2003. The programme is organised by seven partner institutions: University of Western Cape (South Africa), University of Botswana, University of Zimbabwe, University of Kwazulu-Natal (South Africa), University of Dar es Salaam (Tanzania), University of Malawi and Polytechnic of Namibia.

The degree programme aims at enhancing the capacity to deal with cross-border issues in the region. The participating institutions contribute their specific water-related expertise to the network in order to offer a high quality, interdisciplinary postgraduate programme. Alumni shall be able to effectively communicate with experts from other areas, including e.g. scientists, economists, planners, community representatives or health professionals by "a common language of the central concepts in Integrated Water Resources Management" (UNESCO-IHE Institute for Water Education, 2014).

5 Concept and Recommendations for RE Master's Programme Development

5.1 Motivation

The training of academically qualified personnel in sub-Saharan Africa still is deficient regarding several aspects – inter alia enrolment figures for the tertiary sector, scientific publications, number of patents (see also section 3.2). This also applies to the renewable energy master's training. Since South Africa comes with significant higher figures concerning these higher education indicators, the country takes over a special role within the sub-Saharan region. This situation is accompanied, related and intertwined with the still weak development of national and regional sub-Saharan African renewable energy market and corresponding job market.

Since the job market for renewable energy in sub-Saharan Africa is yet limited, graduates have to be trained to become highly flexible and creative to give incentives to this market (e.g. as entrepreneur or developing the political framework). Instead of focusing on highly specialized areas, higher education RE master's programmes should rather be inter- and transdisciplinary oriented.

Any intervention proposal to the renewable energy higher education sector has to be very sensitive, knowledgeable and effective in addressing the structural lack of resources as well as the requirements of an immature market. As this significant shortfall on resources is very likely to stay for the near future and therefore, shall be considered seriously for any concept to be developed. At the same time, all proposed activities have been looked upon for their short and long term ability with regard to connectivity, both to respective internal structures and resources as well as to linkages to already further developed internal and external structures as well as globally already emerging long-term trends and developments.

5.2 Introduction to the Renewable Energy Curriculum Model

Taking into account all these considerations, a Renewable Energy Curriculum Model has been developed. It adjoins and incorporates experiences and conclusions predominantly drawn from the European higher education system, but also takes into account African particularities. Its objective is to provide a long-term frame for any RECP intervention with regard to higher education master's programmes in renewable energy, able to connect with the core requirements (below defined as central categories). The model shall also serve to minimise risk for any further planning in an age of increasing uncertainty and complexity.

Study programmes will have to deal with risk absorption strategies, addressing and reducing in particular the risk for candidates / students to embark on any particular career, and also to reduce the risk for institution / organisation (here the university) to establish a particular master's programme. It sees the higher education sector positioned into an environment, where the planners increasingly do have to consider variations, irritations and impulses, and where the responsible politicians are challenged ever more to react to – often unforeseeable - changes. Another aspect is the still very low (but unknown) number and types of available jobs in the renewable energy sector despite the huge potential (see also section 2). This applies also to the required skills and competencies. Thus, the master students need to acquire competencies to be able to react and reflect on fluctuating demands, including entrepreneurship qualifications and strategies to start their own business.

The Renewable Energy Curriculum Model presented here (Figure 16), provides a strategic approach for renewable energy master's programmes, based on theoretical considerations and empirical analyses. The model describes the frame for a four semester master's programme with an overall scope of 120 credit points (30 CP per semester; based on the European Credit Transfer System / ECTS), characterised by a modular and flexible structure. Nevertheless, this model in principal allows the establishment of shorter master's programmes as well, but in this case the 'bridging entry structure' and / or the 'tracking / specialising procedure' has to be provided outside the actual programme structure.

As a conclusion from the experiences and the analyses of measures to enhance mobility and compatibility in the European higher education system it is strongly proposed to use highly flexible programme structures. Nevertheless, simultaneously the still existing restrictions and drawbacks of this system have to be considered. The Credit Points, commonly already named as the 'currency' for the model of a unified European higher education area, come with two characteristic distinctions to an actual currency: Obviously, the credit points are strictly coupled to the person and hence, are not transferable from one student to the other. Secondly, they are – sometimes strictly sometimes loosely – coupled with the content: Credit points gained e.g. for the interpretation of a symphony are not accepted for a physics master's; CP certifying e.g. the understanding of the Hamilton Operator give no extra CP for any musician master's. This results inter alia in a still rather limited student exchange between study programmes within the European higher education area. Therefore, the proposal here is to establish a largely uniform core semester at every university, in terms of subject-specific competencies.

Ideally, the master's programme should be accessible for students from different educational backgrounds, ranging from engineering, natural and environmental science to economics, social science and jurisprudence. Nevertheless, the range and hence the flexibility regarding the educational background has to be defined by the individual programme on the basis of the particular resources. By several specialisation options, students will get the opportunity to qualify for a range of professions. Here again, the range of specialisations will depend on the decision of the individual university, closely related e.g. to each university's research activities. Consequently, each university is asked to define its specific profile. The model's intention therefore is not to harmonise the higher education systems, neither nationally nor regionally, but rather to encourage and enable comparability and mobility between the universities and strengthen each universities individual research and teaching profiles. Of course, the efforts should be accompanied by the establishment of institutionalised evaluation schemes: In East Africa, for example, the development of a homogeneous quality assurance system including a structured regional credit point system has already been started (IUCEA, 2015; Odongo, 2014).

The master's graduates will then gain the competences to work both in the public and private sector as engineers, entrepreneurs, planners or politicians as well as in academia and education as teachers, professors and researchers. It is aspired to impart a minimum of technical and non-technical knowledge to all participants, essentially independent from their educational backgrounds. In spite of the interdisciplinary qualifications, it still can be expected that students with e.g. a bachelor in mechanical engineering will rather work as engineers afterwards, whereas the majority of graduates who decided for the political area may have a background in political science or jurisprudence.

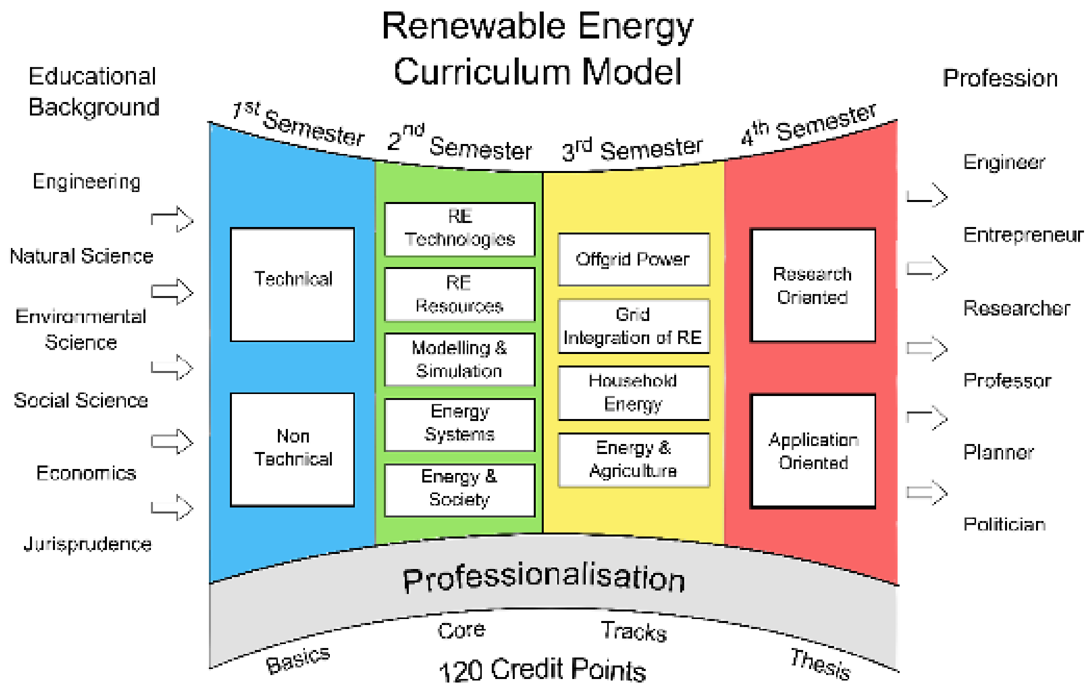

Figure 16: Renewable Energy Curriculum Model(Own work)

In the following, the concept of the Renewable Energy Curriculum Model will be explained in more detail.

The **first semester ("Basics")** serves as a bridge between the already gained knowledge and competencies of the students from their previous studies and professional experiences on the one hand, and the requirements for the subsequent semesters on the other hand. The modules of this first semester should therefore include e.g. fundamentals of mathematics, material science, electronics, fluid mechanics, and biochemistry as well as the basics of economics and social science. In order to motivate the students as much as possible, the methods and the content should be taught by way of using examples from the renewable energy field., e.g. with exercises and exams applying practical examples. After completion of the first semester, students should have the necessary basic understanding, both in technical and non-technical areas, to follow the core semester.

The **second semester ("Core")** is designed to provide a thorough understanding of renewable energy technologies, resources, systems, and simulation and modelling methods and tools, and not least, should address the interface and interrelation between the energy system (the technology) and the society (the social dimension). With the module 'RE Technologies' the focus should be on the renewable energy technologies with the highest potential in sub-Saharan Africa, namely solar and wind energy, small-scale hydro power and biomass (geothermal for some regions). The technical knowledge concerning particular energy conversion processes corresponding with different RE technologies and its components should be complemented by a module specifically addressing RE resources (RE Resources) including prediction approaches (Energy Meteorology), and of course a sound teaching of the RE system approach, including an introduction to energy systems (Module Energy Systems). Additionally, all students should receive a sound insight in modelling concepts and simulation tools. Complementary to these technical approaches, there should be lectures on economic and political aspects, e.g. regarding the complex relationship between the energy system and society (Module 'Energy and Society'), related to the uses of energy and its impact on markets and groups of society, including women and the poor. Whether these lectures are all mandatory or some will come as electives depends of course on the decision and the resourcing of each university.

With the **third semester ("Tracks")** several specialisation options should be provided. The track concept implies more than solely the specialisation. Actually, it comprises a limited number of by the university defined particular courses through the master's programme, with the specialisation and the final master's thesis at the centre. Each track is designed with a problem-centred approach, i.e. the topics will be discussed from different perspectives including technical, economic and political aspects. The specialisations shall be tailored according to the needs of the respective region / country in compliance with the specific scientific research profile at the providing university. The different tracks may widely overlap and also include specific foci, such as entrepreneurship, research or policy.

The tracks shown in Figure 16 serve as examples. "Off-grid Power" would focus on the electrification of rural areas, ranging from (Pico) Solar Home Systems to mini-grids powered by different renewable energy sources (e.g. including hybrid systems with Diesel generators). In addition to technical knowledge, students would also learn about social and economic aspects, such as gender roles or income generation. "Grid Integration of Renewable Energy" focuses on the electrification through grid extension in general, and for urban as well as semi-urban areas in particular. This should include technical knowledge about grid specifications or economic and political aspects comprising financial support schemes for renewable energy, e.g. feed-in tariffs and auction models. The focus of the specialisation "Household Energy" would be on the utilisation of biomass for cooking (small-scale biogas digesters, improved cooking stoves, including also household electrification), covering technical, social as well as environmental aspects, e.g. deforestation and climate change. The track "Energy and Agriculture" deals with the "Water-Energy-Food Nexus"[6] and refers to the actual debate: "Throughout developing countries, agriculture remains the most prominent source of livelihood for most households. […] Increasing the agricultural sector's access to clean energy technologies will enable farmers to mechanize their operations, add value to commodities through processing, and store fresh produce in

[6] see for example (FAO, 2014)

refrigerated containers to extend its shelf-life. These advancements will lead to more food in the market, increased incomes for farmers and traders, and decreased dependency of the agriculture sector on fossil fuels" (Powering Agriculture, 2015). Similarly to the before mentioned specialisations, this track covers technical and non-technical topics and can be tailored to different professions.

During their **fourth semester ("Thesis")**, students will write their master's thesis. They may choose between a "Research-Oriented" and an "Application-Oriented" approach. The first option is especially designated to future lecturer / researcher career and shall provide a basis to continue with a doctoral thesis. A research-oriented thesis will usually be pursued at a research institution - a university in many cases - and aims for a publication in a peer-reviewed journal. An application-oriented thesis should be conducted in close cooperation with an external public or private organisation, e.g. a company, a development organisation or a regulatory agency including research work on a real-life project.

The subject-specific knowledge (basic and specialisation) will be complemented by **professionalisation** modules throughout the whole study programme in order to prepare the students for their professional career. As an additional core component of the curriculum (see section 4.3.2), students will acquire key competencies as e.g. communication or (project) management skills. Practical experience will be gained during an internship for several months at an external organisation in the public or private sector. Also, the master's thesis can be written in cooperation with an external institution, to facilitate student's access to professional working environment. A coaching process should support the students during their thesis. Professionalisation skills and competences such as teamwork and language can be acquired in particular courses at the university, during internship or master's thesis in a professional working environment.

5.3 Key Features of a Renewable Energy Master's Programme

The following key features are considered to be essential for any further planning and improvement of renewable energy Master's programmes. For all these aspects, the permanent and close communication between the African higher education institutions and the international teaching and research community are considered as essential. The below listed key features may come with different formats, but planning must not neglect them.

Mobility and flexibility requiring comparability and modularity

Two core aspects will play a major role for any future changes and improvements of the African higher education system, independently to a large extend from any particular field of teaching and research: Firstly, the increasing requirement for mobility, first and foremost for the students, but in principle and in the future also for lecturers and additional staff at the universities. Secondly, flexibility of students regarding their selection of a particular subject, specialisation, venue, and also teaching format, including also late and unforeseeable changes. Flexibility is also required for the university and the master's programme respectively.

The core structural prerequisites to achieve both maximum mobility and flexibility are the implementation of comparability and modularity of the teaching units (lectures) into the system. The European approach seeks to achieve this by means of clustering individual lectures to modules and, by establishing a normalised 'currency' (based on the content independent workload) to make all lectures comparable with each other. Independently from the particular format – and of course from any inconsistencies, when establishing this structure in Europe, known as the Bologna process – any changes in the African higher education system have to address this issue.

Competence-oriented teaching, learning and examination

As explained in section 5.1, the increasing complexity, uncertainty and dynamics of societal changes place high demand on the individuals. The changing conditions require graduates with competences to act in different complex contexts and situations and to organize themselves in the situation. Against this background, a paradigm shift from input orientation towards outcome orientation has taken place in the education debate in recent years. The main focus in education is not anymore what knowledge should be acquired but rather what competences should be developed by the students. This competence-based approach gained increasing importance in the higher education sector in the context of the Bologna process and is characterized by a focus on the learner and a stronger orientation towards practical application of the acquired skills[7].

Academic skills should enable students to apply scientific concepts to complex contexts, to analyse and reflect unknown and uncertain problem areas scientifically, and to develop innovative concepts and solutions (Schaper, Reis, Wildt, Horvath, & Bender, 2012, p. 29). The integration of renewable energy technologies into the energy system can be seen as one example for a multidisciplinary approach, requiring technical and social knowledge, skills and competences.

The following aspects should be considered for a competence-oriented curriculum design and for teaching (Michelsen & Rieckmann, 2014):

- **Curriculum development**: The design of new programmes starts with the determination of the competence profile: What should the students be able to do after the end of the course? This includes the definition and detailed description of learning outcomes for the whole course as well as for individual modules. In addition to the lecturers, students and other stakeholders (e.g. from practice) should be involved in the process of formulating the objectives.
- **Competence-based design** of teaching and learning: Competences cannot be taught but must be developed by the students, accompanied by the lecturers. Especially suitable are activating teaching and learning methods such as research-based, problem-based and project-based learning. This leads to a change of the role of the lecturer from an expert towards a process facilitator.
- **Competence-oriented examination**: Exams should be designed to support the development of competences and give students feedback on their own learning processes. This requires that examination formats are based on the content of the expected learning outcomes. Here, a case study comprising the simulation of the energy supply system of a village can serve as an example.
- **Supervision and support**: Students need support and advice to facilitate the development of their competences, e.g. to enable reflections about their progress. This may include mentoring programmes, self-assessments, coaching offers as well as activities to foster the development of key competences. A gender sensitive approach is required here, in order to ensure equal opportunities for male and female students.
- **Competence-based evaluation**: The acquisition of competences should be the focus of teaching evaluation. The evaluation criteria should relate to the expected subject-specific learning outcomes, but also consider the development of generic competences. This may include questionnaires for the self-assessment of competence development as well as objective competence tests.
- **Training opportunities for lecturers**: Competence-based teaching requires a high degree of motivation from the lecturers, but also the development of teaching skills that enable them to design innovative teaching-learning settings. Academic teaching training may facilitate the development of the necessary teaching skills and provides opportunities for exchange and networking among the lecturers, and should explicitly be open for young and female staff.

Key competencies

Instead of focussing on a wide range of highly specialised and fast changing knowledge and skills only, it is becoming ever more important to support the development of so called key competencies, renewable energy education being no exception. These competencies can be roughly grouped into three clusters:

i) Competencies fostering to manage tools, in order to communicate with others, such as new technologies and e.g. languages

ii) Competencies enhancing the ability to communicate with socially / culturally heterogeneous groups of people, and

[7] See also (Michelsen & Rieckmann, 2014)

iii) Competencies enabling the individual to take over full responsibility for their own lives.

All competencies require the ability to reflect one's own behaviour and thinking at almost all stages. In an environment with increasing uncertainties for the individual and the organization in particular, the sensitive and continuous monitoring, control and reflection is of particular importance. It can be looked upon as an unavoidable risk absorption mechanism for the individual and the organization (OECD, 2005).

Close relation between research and teaching

Higher education teaching, in particular at master's level, substantially has to rely and relate to research. Within the here proposed RE Curriculum Model (Figure 16) the components 'Tracks' and 'Master Thesis' will be related closely to the research groups and hence will be shaped by the individual research profile of each university. Whereas the 'Basics' and to a certain extent also the 'Core' components of that model will be covered by well-established lectures, with to a certain extent standardised contents and methods.

Regarding the particular energy requirements in Africa, specific consideration should be given to the interdisciplinary field of access to modern forms of energy. It is therefore recommended that any renewable energy Master's Programme should address this issue as an applied research track.

Blurring of boundaries

With the following categories the actual tendencies in higher education to re-measure and re-define formerly well established and often unsurpassable boundaries come into the picture. This *blurring of boundaries phenomenon* however, cannot be understood as the disappearance of boundaries but rather as a frequent request to redefine new boundaries. The frequent process of re-measuring and redefining new boundaries will be – to a larger extent than ever before – required by the individual, in this case the student, and by the organisation, in this case the university and the programme. As a consequence, the student as well as the programme / university will themselves require additional consultancies for their decision making processes (Golba & Vajna, 2013).

Internationalisation

One of the mentioned blurring boundaries comes as the internationalisation of the master's programmes: Higher education programmes should therefore be open for international students and staff. They should have close relations to international partners (universities, research institutes, private companies, international organisations etc.), should go along with international standards and should facilitate the mobility of students and staff. As an example for regional cooperation with a close link to Europe is the WASCAL Project (see section 4.2) or the SASEI Edulink project in Southern Africa (Sendegeya, 2014). Therefore, the universities need to establish an internationalisation strategy for their individual university, defining their own priorities. They might, e.g. define individual regional student target groups.

In Africa the language issue is of particular interest for the francophone and lusophone countries. It is therefore recommended to mandatorily adopt English language courses, in order to foster English proficiency and thus enabling students and staff to cooperate internationally.

Interdisciplinarity

The second blurring of boundaries applies to the strict distinction of disciplines. HE programmes should facilitate interdisciplinary approaches: Development of projects, comprising research and implementation with the students should become a vital part of a master's programme. Since any substantial change in the energy infrastructure will have impacts on the social order, interdisciplinary approaches are fundamental, especially for renewable energy courses in sub-Saharan Africa, as they have to include technological, economic and social perspectives.

Transdisciplinarity

Another blurring of boundaries applies to the borderline between the academia and organisations from outside the academia. Higher education programmes should provide access, and hence have to establish close relations, to institutions outside the university, in particular to the public and private sector. It is essential, that universities permanently observe possible changes or irritations in their environment in order to adapt accordingly and in time. Furthermore, these relations can help students to do internships and conduct co-supervised master's theses. A transdisciplinary approach may include the involvement of external stakeholders in the curriculum development process, the participation of external representatives in the programme's advisory board or the frequent organisation of lectures and workshops with contributions from experts from outside the academia.

Quality Assurance

Evaluation

Continuous evaluation processes are required in order to assure the quality of the programme. It is necessary to implement international quality standards, in particular international accreditation. This issue comprises the qualification of staff, but also frequent tracer studies.

Institutionalised self and external reflection observation processes are required in order to prepare the organisation to adequately adapt to external changes. Therefore, quality assured processes should be installed and verified by accreditation agencies. The installation of an advisory board facilitates institutionalised external observation to assure the quality standard and to generate the legitimacy of the programme.

Selection process

Student's selection process for HE programmes is crucial - for the programme and the students. Together with an intensive supervision and guidance of the students this is one of the key elements to control a successful process for the students and the programme. This is increasingly so as the programme opens up for a wider range of educational backgrounds. Indicators like drop-out rate or successful completion of the studies within the specified time frame will allow monitoring the quality of the selection process. Special attention should be given to equal opportunities of male and female applicants in order to reach a reasonable gender balance among students.

Supervision and networking

As already explained the main objectives for the higher education system are to foster mobility and flexibility, both for the students and at university / programme level. Necessarily, this leads to an increasing demand for supervision and guidance by the students – and of course also from the university and the programme. The intensive supervision, counselling, advising and guidance of the candidates and students have to get highest priority (keyword: career coaching). Equal career prospects for male and female students and staff must be actively pursued. Graduates / alumni have to be integrated frequently into networking activities such as workshops or alumni seminars. Alumni networking activities provide more options for the actual students (see transdisciplinarity) but also facilitate the marketing of the study programmes by personal recommendations.

Further Options

In addition to the above features, long-term planning should also consider the following aspects:

- Involvement of distance education elements in order to overcome the shortage of lecturers
- Individually tailored model for the acknowledgement of existing qualification, especially for the basic knowledge in the first semester
- Provision of certificates for specific courses
- Extension of the target group by providing special further education

6 Proposed RECP Activities to Support Higher Education for Renewable Energy

Table 1: Activities to support higher education institutions

Activity	Role of Actors Involved[8]	Geographical Scope[9]	Duration
1. New RE Master's Programme Concept development and implementation of a new national or regional master's programme	**Host:** Concept development, implementation **RECP:** Technical support **External**: Feedback	Local / Regional / Transregional	2-3 years
2. Revision of already existing RE Master Programme Further development of existing RE Master programme including curriculum, staff qualification, infrastructure etc. as listed below	**Host:** Concept development **RECP:** Technical support **External:** Feedback	Local	1-1.5 years
3. Curriculum Development Further development of existing curriculum, e.g. considering labour market requirements, interdisciplinarity, professionalization	**Host**: Concept development, implementation **RECP:** Technical support **External:** Feedback	Local / Regional	1 year
Continuous and systematic dialogue with external stakeholders, including public and private sector, development organisations and partner universities, to address curriculum development, private sector needs, internships and attachments for master's thesis	**Host:** Initiation and supervision of dialogue **RECP:** Participation in dialogue **External:** Participation in dialogue, provision of attachments for internships and master's theses	Local / Regional	1-1.5 years

[8] Host: Institution(s) where the activity takes place; RECP: EUEI PDF staff or consultant; External: National or international stakeholders outside the institution and RECP

[9] Local: Only at one institution; Regional: More than one institution; Transregional: Across sub-Sahara Africa and/or with European partners

Activity	Role of Actors Involved[8]	Geographical Scope[9]	Duration
4. Research			
Strengthening the linkage between teaching and research, e.g. by supporting publications and involving research departments into teaching activities	**Host**: Concept development, implementation **RECP:** Technical support	Local / Regional	1 year
Facilitation of research cooperation between African as well as with European universities	**Host**: Concept development, implementation **RECP:** Technical support	Regional / Transregional	1.5-2 years
5. Distance Education			
Supplementing existing courses by purchased distance education modules	**Host:** Concept, implementation **RECP:** Technical support **External:** Financing, feedback	Local / Regional	1 year
Mapping and analysis of existing courses	**Host:** Concept, implementation **RECP:** Technical support	Transregional	6 months
6. Staff Qualification			
Staff exchange / training within the country, region and with European universities (lecturers and administrative staff) for teaching and research	**Host:** Concept development, administration **RECP**: Arrangement of European partners, Technical support	Regional / Transregional	1.5-2 years
Development of strategic and institutionalised PhD qualification structure	**Host**: Concept development, implementation **RECP:** Technical support	Local / Regional / Transregional	4-5 years
7. Infrastructure			
Procurement of additional lab, computer and other equipment in accordance with a suitable lab concept	**Host:** Concept, implementation **RECP:** Technical support **External:** Financing	Local	6-12 months

Activity	Role of Actors Involved[8]	Geographical Scope[9]	Duration
8. Gender Mainstreaming			
Intensive communication of the role of gender mainstreaming	**Host:** Concept, implementation, financing **RECP:** Technical support **External:** Feedback	Local	6-12 months
Establishment of new structures for gender equality	**Host:** Concept, implementation, financing **RECP:** Technical support **External:** Feedback	Local	1.5-2 years
9. Quality Assurance			
Implementation of multi-stakeholder Advisory Boards	**Host:** Invitation of members, implementation **RECP:** Technical support **External:** Membership	Local / Regional	3-6 months
Implementation of continuous internal evaluation processes comprising current students' feedback	**Host:** Concept, implementation **RECP:** Technical support **External:** Feedback	Local	6-12 months
International workshops on quality assurance between RE Master programmes and with external stakeholders	**Host:** Initiation and realisation of workshop **RECP:** Technical support **External:** Participation	Regional / Transregional	6-12 months
Accreditation by external certification bodies	**Host:** Preparation, implementation, financing **RECP:** Technical support **External:** Accreditation	Local / Regional	1.5-2 years
10. Internationalisation			
Regional / international cooperation with universities and other external stakeholders, including Memoranda of Understanding	**Host**: Initiation, formalisation **RECP:** Technical support **External:** Participation	Regional / Transregional	1.5-2 years

Activity	Role of Actors Involved[8]	Geographical Scope[9]	Duration
11. Marketing			
Development and implementation of a marketing concept	**Host:** Concept, implementation **RECP:** Technical support **External:** Feedback	Local / Regional	1-1.5 years
12. Financing			
Funding schemes for scholarships to overcome the financial restrictions of potential master's students	**Host:** Concept, administration **RECP:** Technical support **External:** Financing	Local / Regional	1.5-2 years
Concept and implementation of tuition fees	**Host:** Concept, administration **RECP:** Technical support **External:** Feedback	Local / Regional	1.5-2 years
Concept and implementation of consulting activities, e.g. accompanying research to development projects from public and private organisations	**Host:** Concept, administration **RECP:** Technical support **External:** Feedback	Local / Regional	>1.5 years
13. Alumni			
Establishment and continuous update of alumni database, e.g. conducting regular tracer studies	**Host:** Preparation and conduct of study **RECP:** Technical support **External:** Feedback	Local	1-1.5 years
Establishment of professional / alumni network.	**Host:** Concept, implementation **RECP:** Technical support **External**: Participation	Local	>2 years

7 Selection Criteria for Higher Education Activities under the RECP

Table 2: Selection criteria for higher education activities under the RECP

Internal Framework Conditions of the University / Host Institution		
Selection Criteria	**Description**	**Priority**
The university's commitment to the activity at all levels	Support through the head of the university, faculty, institute, department, lecturers and coordinator	High
Human resources	Academic staff qualification (e.g. number of PhD holders in the RE field) Experiences in research, implementation and operation of renewable energy projects Qualification of administrative staff	Medium
Infrastructure	Research, education and lab facilities, computer, library etc.	Low
Institutional setup	Already established (RE) master's programme and individual courses	Low
External Framework Conditions		
Selection Criteria	**Description**	**Priority**
Commitment of responsible ministry	Clear support for the activity through national / regional ministry	High
Renewable energy market	RE market needs / requirements Ability of the local / regional market to absorb graduates	High
Renewable energy policy	Support of renewable energy by national / regional RE policy framework	Low

Quality of the Concept for the Activity		
Selection Criteria	**Description**	**Priority**
Clear, realistic and measurable objectives	Defined work packages, milestones, start and end of activity Feasible and quantified objectives	High
Detailed and feasible work plan	Including work packages, milestones, schedule, responsibilities and budget	High
Development of the national / regional RE market	Long term employment generation impact Match with RE market needs / requirements	High
Quality assurance measures	Systematic monitoring and evaluation scheme during and after project	High
Reflection of the internal and external framework conditions	Realistic implementation strategies against the internal and external background	High
Sustainability of the activity	Connectivity to further projects and beyond the activity's time frame Donor independence after end of activity	High
International (regional), interdisciplinary and transdisciplinary approach	Consideration of these aspects	Medium
Social development impact	Addressing gender equality, income generation, social cohesion etc.	Medium
Reproducibility	Potential as role model	Medium
Reflection of existing activities	Potential for complementing (while adding value to) existing programmes and interventions Relationship to investment perspectives (e.g. donor projects)	Low

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Annex A:

List of Academic Programmes for Renewable Energy in Africa (non-exhaustive)

During an RECP stakeholder consultation workshop in Kigali in July 2014, organised by the EUEI PDF, with more than 75 participants from over 20 African and several EU countries, a survey was carried out to identify African institutions involved in renewable energy teaching and research activities. 13 participating institutions from 12 countries reported to have master, bachelor or certificate programmes in place. Six more institutions are currently developing or planning additional master's programmes. The majority of the programmes are focussed on engineering and technology, but there are also some related to political, economic and planning aspects. A list of programmes identified during the workshop is given below.

Country	Institution	Programme	Focus	Status	Students/y.	Contact
Burkina Faso	2iE Ouagadugu	Engineering Master in Electricity and Energy	• Conventional Energy • RE • Management	2007	40-50	www.2ie-edu.org
Ghana	The Energy Center KNUST	Renewable Energy Technologies	• PV • Thermal • Bioenergy • Wind	2011	24-45	www.energycenter.knust.edu.gh ahmadaddo@gmail.com
Kenya	Strathmore University SERC	MSc RE & EE	• Entrepreneurship • Technical • Economic • Policy	starting	15	idasilva@strathmore.edu
Liberia	Stella Maris Polytechnic	Certificate in Sustainable RE	• RE	future prospect	NIL	peternatte@yahoo.com
Namibia	Polytechnic of	SASEI	• EE	under dev.	>10	www.polytechnic.edu.na

Country	Institution	Programme	Focus	Status	Students/y.	Contact
	Namibia		• RE			nei@polytechnic.edu.na
Namibia	Namibia Energy Institute	Soltrain	• Solar thermal short courses for professionals	2009-2016	100	www.soltrain.com.za
Niger	Abdou Moumouni University	Climate Change and Energy	• Climate change	2014	10	aabdouy@yahoo.com
Niger	Abdou Moumouni University	Renewable Energy	• PV • Wind • Hydro • Bioenergy	to start in Sept 2014	10-20	aabdouy@yahoo.com
Nigeria	Imo State University	MSc RE & EE	• RE	planning	NiL	asldikvin@yahoo.com
Nigeria	Kwara State University	MSc	• PV • LED	2012	300 level	www.kwasu.edu.ng
Rwanda	University of Rwanda	MSc in Renewable Energy	• Hydro • Solar • Biomass • Geothermal • Energy • Economics	starting Sep 2015	20-30	emazimpaka@yahoo.fr
Senegal	UN African Institute for Economic Development & Planning (IDEP)	MSc in Energy Policy	• Policy • Development planning • Economics	planning	25	h.robinson@unidep.org

Country	Institution	Programme	Focus	Status	Students/y.	Contact
Senegal	UN African Institute for Economic Development & Planning (IDEP)	Energy Policy for Development (short course, postgrad level)	• policy • development • economics	expected late 2014	25	H.robinson@unidep.org
Sierra Leone	Gout. Technology Institute	Renewable Energy Studies	• PV • Thermal • Solar Food Dryer • Bio digesters • building design	2006 on-going	10-30	renewableenergycentersl@gmail.com
South Africa	Energy Research Centre (UCT)	MSc (Eng.) Energy Engineering	• RE • EE • Systems Analysis &Modelling	early 1990s	<20	www.uct.erc.ac.za
South Africa	Energy Research Centre (UCT)	MPhil Energy & Development	• Energy & Climate Change • Energy & Poverty • Governance	early 1990s	<20	www.uct.erc.ac.za
Tanzania	University of Dar es Salaam (in cooperation with Makarere Universtity)	MSc in Renewable Energy	• Solar • Biomass • Hydro • EE • Energy in Buildings	2007/08 on-going	10-20	Prof. Cuthbert Z.M. www.coet.udsm.ac.tz
Togo	Université de Lome	Materiaux - Energie	• RE & EE	2013	15	silnap@yahoo.fr
Uganda	Ndejje University	MSc in Renewable Energy	• RE	planning	20-30	cwasswasebuwufu@gmail.com

Country	Institution	Programme	Focus	Status	Students/y.	Contact
						+256773148692
Uganda	Makarere University CEDAT (+ University of Dar es Salaam)	MSc RE & EE	• Biomass • Hydro • Solar • EE	2006 on-going	15-20	Wilson Musinguzi
Uganda	School of Women and Gender Studies (SWGS-Makerere)	Gender and local economic development: • BA • MA • Postgrad diploma	• RE and EE for Sustainable Development	BA: 2008 MA. 1992 Diploma: 2010	56	http://wgs.mak.ac.ug/ genderandled2@gmail.com
Zimbabwe	University of Zimbabwe	MSc Renewable Energy	• Hydro • Solar PV • Biomass • Economic • Solar Thermal	1995 on-going	10-20	cshoniwa@eng.uz.ac.zw shocle@yahoo.com
Zimbabwe	University of Zimbabwe	BSc Honors in Renewable Energy	• Hydro • Solar PV • Biomass • Economic • Solar Thermal	2004 on-going	30-40	cshoniwa@eng.uz.ac.zw shocle@yahoo.com

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Acronyms and Abbreviations

CEMAC - Economic and Monetary Community of Central Africa

DAAD – German Academic Exchange Service

EAC – East African Community

ECOWAS – Economic Community of West African States

ECTS – European Credit Transfer System

EU – European Union

EUEI PDF – EU Energy Initiative - Partnership Dialogue Facility

GIZ – Deutsche Gesellschaft für Internationale Zusammenarbeit (GIZ) GmbH

GW – Gigawatt

HE – Higher Education

IEA – International Energy Agency

ILO – International Labour Organization

IRENA – International Renewable Energy Agency

kW – Kilowatt

kWh – Kilowatt hour

MW – Megawatt

NEPAD – New Partnership for Africa's Development

NORAD – Norwegian Agency for Development Cooperation

NTNU – Norwegian University of Science and Technology

OECD – Organisation for Economic Co-operation and Development

PIDA – Program on Infrastructure Development

PV – Photovoltaic

RE – Renewable Energy

RECP – Renewable Energy Cooperation Programme

REP – Renewable Energy Programme

SADC – Southern African Development Community

toe – tons of oil equivalent

TWh – Terawatt hour

UNESCO – United Nations Educational, Scientific and Cultural Organization

UZ – University of Zimbabwe

WASCAL – West African Science Service Center on Climate Change and Adapted Land Use