

# Capacity Building for Sustainable Energy Development: The Role of the Academia

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## ABSTRACT

Higher Education (Academic) Institutions (HEIs) should occupy an important and envisaged central role, in contributing to capacity building for sustainable energy development. In this paper the concept of sustainable energy and its development is presented. Education, capacity building and sustainability form an interdependent and interrelated nexus which is important in sustainable energy development. To show how the trio (education, capacity building and sustainability) are central in achieving positive results in Sustainable Energy Development programmes, the concepts of capacity building, sustainability in the energy context and the importance of education and research as a catalyst for capacity building are discussed. The trio are the core pillars of any training institution upon which it can achieve the ultimate objective of imparting knowledge. The paper is strongly linked to one of the United Nation's (UN's) Sustainable Development Goals (SDGs), which focuses on sustainable resource development. The commitment is to promote resource and energy efficiency, sustainable infrastructure, and providing access to basic services, green and decent jobs and better quality of life for all. The achievement of this goal depends on the level of knowledge of the population on sustainable development. It has been realised that Sustainable Energy Education is an increasing and exciting knowledge stream that requires both well organised and well-structured systems to ensure sustainable and meaningful development. Wide consultation of, and among, all stakeholders is vital in the successful development of viable training programmes which meet the community needs. Therefore academic institutions have a central role in the development and dissemination of sustainable energy programmes by structuring training that addresses the needs of the industry and community. Both long-term and short-term training programmes, which address all issues of energy development, should be developed. The designing and implementation of new training programmes is an endeavour which requires human capital, time and funding. This paper argues that, although academic institutions are seen as being at the centre of capacity building initiatives for the energy sector, the development of the energy sector will depend, to a large extent, on the concerted and collaborative effort of all key stakeholders.

**Key words:** *sustainable energy, renewable energy, education, capacity building*

## INTRODUCTION

In all aspects of sustainable energy the following key issues are always highlighted: affordability, reliability, accessibility, clean (which refers to low CO<sub>x</sub>, SO<sub>x</sub>, NO<sub>x</sub>, toxicity etc.), renewable sources, energy efficiency and conservation, and consumer empowerment. All these concepts are more understandable among technocrats and academia than key stakeholders, who often times include policy makers, financiers, developers and users of energy and technology developments. It is important to bring these issues to the community in a clear and concise context for sustainability of the energy sector. With the modern energy mix, renewable energy sources contribute positively to the realisation of these issues. Despite all the opportunities for economic and human development provided by renewable energy resources, and the promising growth in the technologies experienced so far the sector still faces a number of obstacles. The sector needs intellectuals and material investment to reach a remarkable scale. According to International Renewable Energy Agency (IRENA), there are various critical regulatory and infrastructure obstacles facing the development and large scale deployment of renewable energy worldwide. Furthermore, IRENA classifies barriers to renewable energy deployment as:

- 1) institutional and policy barriers,
- 2) market failures and economic barriers,
- 3) education and training barriers,
- 4) data, information and awareness barriers and
- 5) socio-cultural barriers

Gope et al (1997) highlighted the importance of technology development, education and finance and their interdependence in the development and commercialisation of photovoltaic technology in particular, and in general, renewable energy on the African continent. The ability to break the barriers to

renewable energy deployment, as cited by IRENA, depends on the inherent capacity of the populace in terms of its skills and knowledge that it can bring to bear and to turn these barriers into challenges and opportunities. The notion of planning with people, as opposed to the traditional dogma of planning for the people must be to be recognised in sustainable development planning. Studies have indicated that education and training contribute to both short-term and long-term institutional building, and support human resource development (Keith M. Lewin, 1997). Both formal and informal education systems contribute significantly to the development and dissemination of any technology. To ensure long term sustainability and continuity of sectorial development, professional, technical training and research at tertiary level (technical and vocational institutions, colleges and universities) should be given high priority. This paper proposes "Capacity Building for Sustainable Energy Development" as an approach to build abilities, relationships and values that will enable organisations, groups and individuals to improve the development, utilisation and performance of energy systems in an efficient and sustainable manner. Hence education and training can be used as a tool to overcome the barriers to wide-scale deployment of sustainable energy programmes, technologies and systems.

It is anticipated that capacity building in this context, can easily be achieved through education and research, especially so if these are provided for at tertiary institutional level. This depends on the readiness, capacity to adapt and a willingness to facilitate by these institutions. It should be noted that the academia are still faced with the challenge of providing updated and/or entirely new programmes to address the growing needs in the renewable energy sector. The designing and implementation of new programmes is a task which requires human capital resources, time and funding. Therefore key stakeholders (e.g. governments and industries), in any development planning, should be engaged with in order to help in the development of up-to-date training programmes. However, the renewable energy sector is still relatively new and comparatively is still developing such that, the availability of experienced professors, instructors, trainers and course materials is still very limited, especially in sub-Saharan Africa. As a result this presents a serious challenge for most academic institutions to initiate and embark on renewable energy training programmes. Despite the challenges, this paper advocates that academic institutions should be at the centre of capacity building for sustainable energy development. Though academic institutions, in this paper are put at the centre of capacity building for the sector, the development of the sector will depend on the concerted and collaborative effort of all key stakeholders.

## Concept of Sustainable Energy Development

The concept of sustainable energy stems from the universal definition of sustainability as presented in Figure 1. The sustainability concept ensures an effective balance between three aspects of global interest: society, economic and environment. These can be taken as the fundamental pillars of stable and effective development. The development of resources is aiming at economic growth for the betterment of the society in an ecologically conducive manner. However, sustainability should ensure proper interaction among socio-economic activities, and the environment, with an ultimate objective of achieving a harmonious balance among the three aspects of global interest at the same time not compromising the ability of the future generation to benefit harmoniously from this tri-existence.

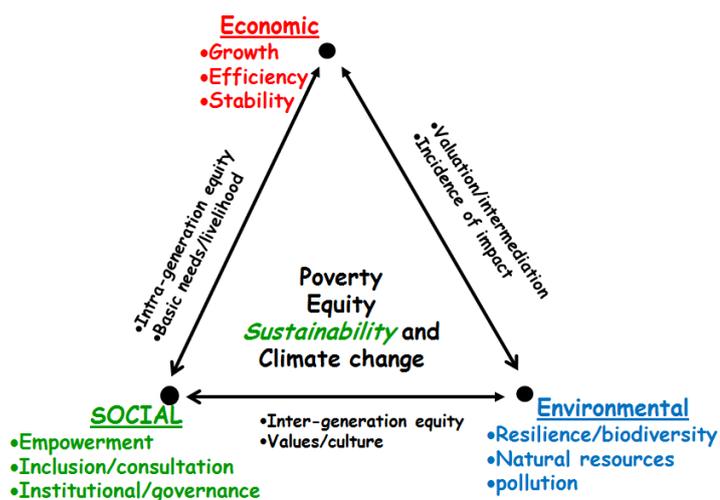


Figure 1: A Conceptual Framework of Sustainability

Globally, the significant driving forces for the adoption of sustainability in the energy supply chain include: *fluctuating and drastic increase in prices, and deteriorating reserves of conventional fuels (oil, natural gas, uranium and coal)*. In developing countries, increases in prices of fossil fuels have negative economic consequences. The situation is even worsened in countries which are already overwhelmed with poverty,

where oftentimes the challenge would be to choose between energy and *fuel for machines and food, health care, education for the people*. A sustainable energy programme refers to the strategies put in place towards the development, provision and utilisation of clean energy which meets the needs of *present society* without compromising the ability of *future generations* to meet their energy needs. Throughout the energy supply chain (resource development, generation, delivery, consumption and decommissioning), environmentally friendly and efficient mechanisms and technologies should be given utmost priority. Sustainability in the energy supply chain often entails the consideration of strategies which may include: promotion of renewable energy, energy efficiency and energy management. Also included in these strategies is the promotion of sustainable energy policies that can spur economic growth while protecting the environment.

With reference to the "Sustainable Development goals (SDGs)" the United Nations (UN) has committed itself to promote resources and energy efficiency, sustainable infrastructure, and providing access to basic services, green and decent jobs and better quality of life for all (Source: <http://www.un.org/>). The ultimate goal is to achieve the overall development plans, reduce future economic, environmental and social costs, strengthen economic competitiveness and reduce poverty. For example the 12<sup>th</sup> SDG focuses on the *Sustainable consumption and production*. In this regard the objective is to "do more and better with less," in order to help to increase net welfare gains from economic activities by reducing resource use, degradation and pollution along the whole lifecycle, while increasing quality of life (Source: <http://www.un.org/sustainabledevelopment/>). The goal is directly applicable to all resources and hence energy resources are intrinsically part of this approach. The success in achieving this SDG, will depend on the *involvement of various stakeholders*, including business, consumers, policy makers, researchers, scientists, retailers, media, and development agencies, etc. It is postulated that academic institutions will play a central role in helping all the stakeholders, in all sectors, to build capacity and contribute appropriately, to sustainable energy development.

The concept of sustainable energy development should embrace all factors of sustainable development. The issues which need consideration are:

- **Affordability:** The energy provided should be cost-effective and modestly accessible by the population, especially the economically disadvantaged population segment.
- **Reliability:** The energy and power provided must be able to meet and perform its intended function so as to support economic development.
- **Accessibility:** The services of clean energy must be available and obtainable by all and most especially by the economically disadvantaged population
- **Environmentally benign:** The entire energy cycle starting from exploration, delivery, conversion and generation, transmission, usage and decommissioning must be clean and environmentally benign. For example the generation and delivery must ensure low CO<sub>x</sub>, SO<sub>x</sub>, NO<sub>x</sub> and low carcinogenic content.
- **Renewable Sources:** The development and utilisation of renewable energy sources play a significant role when considering sustainable energy development. Renewable Energy technologies have the advantage of possessing a regenerative characteristic and less pollution during generation. Their long term environmental impact is potentially minimal compare to conventional resources.
- **Energy Efficiency and conservation:** In the entire energy cycle efficiency must be emphasised to ensure using less energy for the same productive activity and/or delivering more productive activity for the same energy. Energy conservation must be a routine process encompassed in the entire energy cycle.
- **Consumer empowerment:** The success of energy development depends on the empowerment of a key stakeholder, being the final users or consumers of the energy. Building capacity of the consumers especially in energy saving technics, so as to derive benefits from the energy saving opportunities, is among the key issues at the centre of sustainable energy development and promotion. User awareness campaigns and programmes can be geared and facilitated through training technocrats, practitioners and energy service providers who are knowledgeable in identifying and disseminating the appropriate energy saving opportunities. Higher institutions of learning play a central and pivotal role in the knowledge creation and dissemination thereof.

## Concept of Capacity Building

The knowledge offered by academic institutions is always a catalyst in capacity building for any country. The key terms in the objective of education by and from academic institutions are "develop abilities, skills and capacities", of individuals and to create knowledge. Therefore the development and success of sustainable energy systems depends on enhancing capacities of the local population through education. There are various definitions of capacity building. The definition adopted in this paper stems from the word "capacity". Some of the sample definitions of capacity-development as in (Horton et al, 2003) are: Capacity of an organisation is its ability to function as a resilient, strategic and autonomous entity (Kaplan, 1999, p20). Capacity stands for the potential to use resources effectively and maintaining gains in

performance with gradually reduced levels of external support (La Fond and Brown, 2003, p7). Capacity is defined as the potential to perform (Horton et al, 2003, p18). Capacity is the ability of people, organizations and society as a whole to manage their affairs successfully (OECD, 2006, p12). Capacity is that emergent contribution of attributes that enables a human system to create development value (Morgan, 2006, p8). Capacity is the ability of a human system to perform, sustain itself and self-renew (UNEP, 2006). The definition given by United Nations Environment Programme (UNEP) uses the term 'human system', which implies that the capacities exist in and across different scales or levels of human organisation. In this regard, individuals can have capacities, teams have a capacity to do what they do, organisations have a capacity, networks of actors have a capacity to co-produce certain results and even socio-technical 'sectors' or nations have a capacity (UNEP, 2006). This approach applies to the development of human capacity in a holistic capacity development process in sustainable energy systems and applications. Capacity development is literally, therefore, changes in capacity over time. It is important to note that capacity development is in that sense a continuous process.

In this paper, let us consider the definition of capacity building as presented by UNEP (UNEP, 2006) which includes the term "sustainable development". This is vital in promoting sustainable energy in a broad manner and encompassing a number of activities in the energy sector. Thus, "Capacity Building for Sustainable Energy Development" is described as building abilities, relationships and values that will enable organisations, groups and individuals to improve the development, utilisation and performance of energy systems in an efficient and environmentally benign manner. In this aspect capacity building can also be referred to as initiating and sustaining, processes (i.e. sustainable energy processes) of individuals and institutions to cause change. This change can equally be reflected to change within a country, society/community or the private sector. Therefore the concept puts emphasis on three aspects: (a) capacity building as the catalyst and constant fuel for a process of change, (b) the importance of building institutional capacity, and the (c) involvement of a wide range of different groups in society.

There are many barriers to wide spread adoption and use of sustainable energy technologies and systems in developing countries as presented earlier and elsewhere in this paper (*source: IRENA Report, 2012*).

Though education and training is among the key barriers, addressing this barrier will be the solution to all other barriers. Thus, all these barriers can be overcome through capacity building, but this needs strong, concerted, prioritized effort by all key stakeholders. It is postulated that, in order to ensure long-term sustainability, it is vital to build capacity in the following issues related to sustainable energy development:

- ✓ **Energy and Environment:** The relationship between all stages in the energy cycles (ranging from development up to decommissioning) and environment must be clearly explained to relevant stakeholders (planners, developers and classified users)
- ✓ **Energy Efficiency and Renewable Energy:** It is necessary to develop and promote technologies, strategies and methods to implement energy efficiency throughout the energy cycles starting from exploitation of resources, resource delivery and conversion, generation, transmission, distribution, usage and decommissioning of energy systems. The role of renewable energy technologies in sustainable energy development must be clearly understood. The development of renewable energy technologies must embrace energy efficiency and energy conservation.
- ✓ **Socio-economic and financial aspects:** The development of skills to link energy usage and socio-economic aspects is vital. The issues related to financing mechanisms for sustainable energy projects should be part of matters considered in capacity building.
- ✓ **Policy and Management issues:** The success of implementing sustainable energy training programmes depends on the availability of clear policies. Therefore the issues related to building capacity in energy policy and management should be a continuous process in any country.
- ✓ **Research and Development (R&D):** R&D in all the above issues should be a concerted effort by all key stakeholders including the industrial sector, government and academia. In this regard the academic institutions should play a significant and/or central role to come up with innovative ideas and strategies to address dynamic problems in the community.

The role of academic institutions in sustainable development is demonstrated using the model given in figure 2. The arrows show how the various sectors are linked to each other in terms of support and provision of information. The system is modelled as a community which forms part of the environment. The central part is the world or the environment which the current generation must share with future generations. The idea is to ensure that the community utilises the scarce resources without compromising the future generation capacity to meet their own demands. In order to sustain the economic system of the community, different entities (government, social groups and industrial sector) must work harmoniously together, for economic development. The community must have capacity to manage systems of development. The capacity can be built when institutions offering academic programmes work hand-in-hand with other research institutions to solve problems of the community. The strategies put in place to address community needs should be based on wide consultation between and among key stakeholders. Both research institutions and academic institutions use theoretical knowledge to interpret and solve

problems of communities. The institutions should develop appropriate training programmes and conduct relevant research based on the findings from needs assessments. In this model, the linkage between academic and research institutions is the development of postgraduate programmes (at Masters and PhD levels) which are related to problems of the community. This approach epitomises the concept of Applied Research (AR).

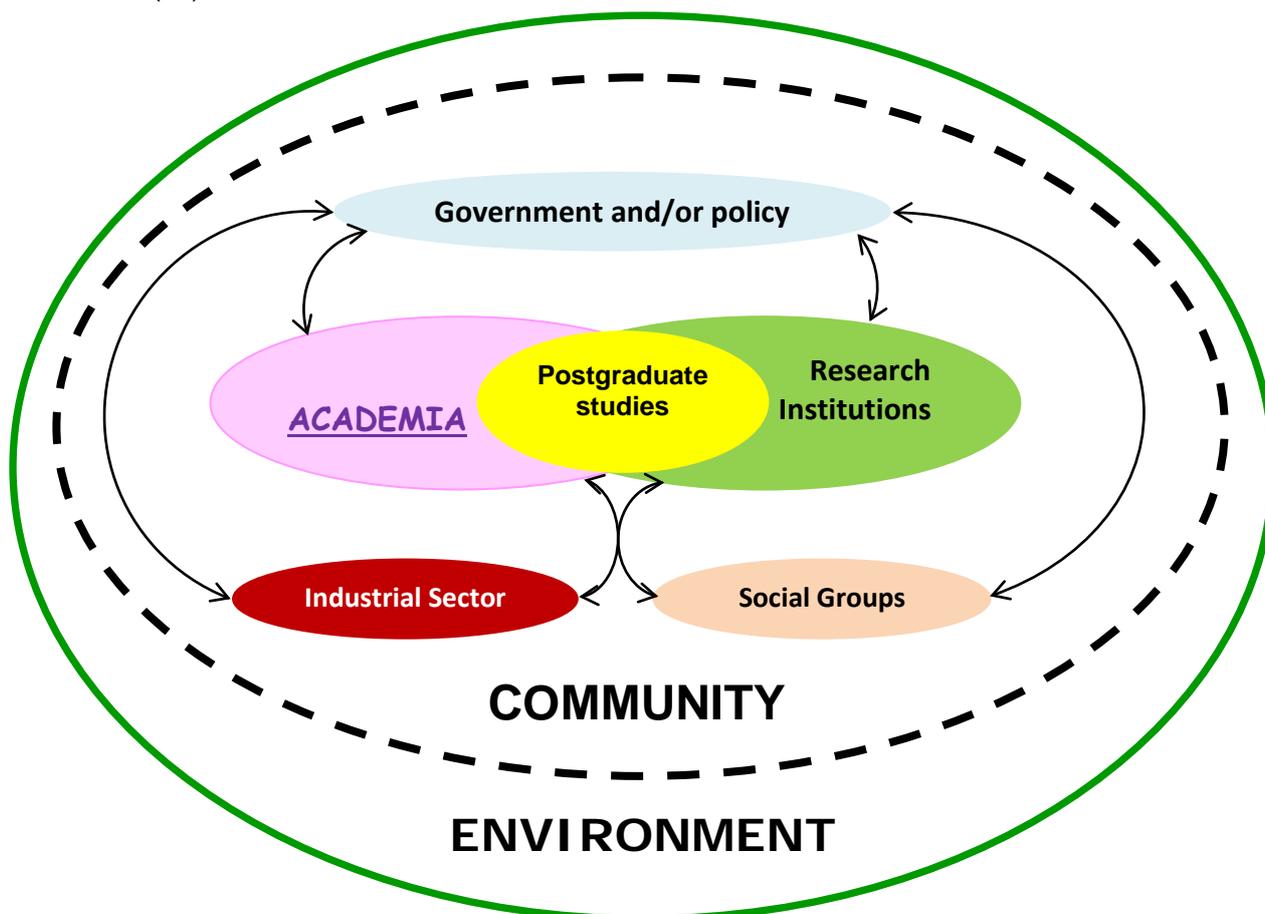


Figure2: The Interaction of Key Sectors in a Sustainable Energy System

## KEY STAKEHOLDERS

The energy sector involves various stakeholders who play different roles at different levels of energy supply chain which starts from exploration down to decommissioning. The development and operation of sustainable energy systems depends on the level of knowledge and understanding in all aspects of energy system possessed by all stakeholders in the sector. To ensure sustainability in the development of energy systems the linkage between key stakeholders and academic institutions are summarised in Figure 3. Besides having a direct link with academic institutions the operations of various stakeholders are inter-linked. For example in terms of policy the government is responsible for proper operations of the energy sector at all levels, regulating activities and cooperation among stakeholders. Generally, the government is responsible for handling all policy matters in the sector. The academic institutions also work hand-in-hand with all stakeholders to develop relevant programmes addressing or covering skills needed to contribute to the development of sustainable energy system in the country. All stakeholders need professionals with relevant skills.

The enhancement of sustainable energy development requires putting up a number of measures and policies affecting the full range of society's energy needs. Usually it is the responsibility of the governments to coordinate the policies and actions that aim to improve the living standards of its people, balance stakeholders' interests and expectations, reducing market and government failures, reduce transaction costs and information asymmetries which may frustrate the actions which are meant to advance sustainable energy development. The national Energy Ministries play a central role in coordinating all energy activities among other government institutions and ministries. The government requires skilled human capital to execute all the necessary duties. The academic institutions are responsible for developing training and academic programmes which address the needs of the community and the government at large.

The industrial sector and business entity also play a significant role in the dissemination of sustainable energy technologies and systems. The success of this group of stakeholders also depends on the availability of manpower with the following skills: technical, entrepreneurship and financial. The academic institutions should promote, adapt and adjust training programmes so as to meet the needs of industry.

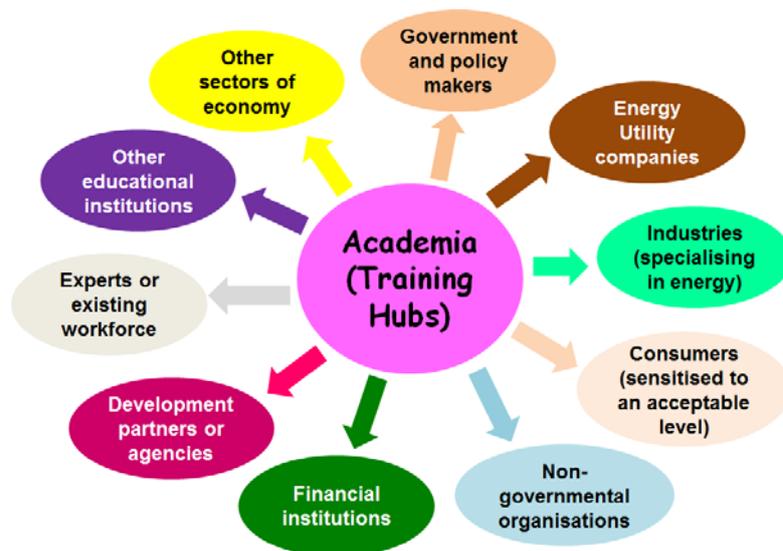


Figure 3: Linkage between stakeholders and Academia

Some stakeholders may need tailor-made training programmes. Some of these stakeholders may include: utility companies, professionals working in energy sectors, financial institutions, development agencies, non-governmental organisations (social groups), government institutions and ministries, and consumers. Training-of-trainer (TT) programmes should also be prepared to support institutions and individuals involved in capacity building. For example to support other educational institutions (such as vocational and technical institutions, *Corporate, Utility, Telecommunications and other training providers*) training-of-trainers (TT) programmes for instructors working in these institutions should be organised. Training programmes in technical and vocational institutions should be tailored to address relevant issues of sustainable energy development at appropriate levels. *Some of the key programmes in vocational and technical institutions may incorporate lower level training for technicians working in the field of sustainable energy development.*

The success in the implementation of sustainable systems depends on the awareness levels of consumers or final beneficiaries (Source: <http://www.un.org/sustainabledevelopment/>). Therefore it is important to continuously increase consumers' awareness. It is vital for the public to receive substantial level of training about sustainable energy development, technologies and programmes. In this regards the implementation should consider:

- ✓ Involving consumers or beneficiaries at all levels of development; for example engage consumers through awareness-raising and training on sustainable consumption and lifestyles when using resources and in this case, energy resources;
- ✓ Providing consumers with adequate information through standards and labels and engaging in sustainable public procurement, etc.

## TRAINING NEEDS

A wide range of types of training are needed to facilitate large scale sustainable energy development and promotion. It has been realised that sustainable energy development is not part of the general formal educational structure for most developing countries. It is anticipated that in order to address the issue of capacity building for sustainable energy development, it is necessary to consider both long-term and short-term programmes. The Long-term programmes are considered to be academic programmes developed by institutions to offer formal professional qualifications. The formal professional qualifications should range from vocational certificates to higher or postgraduate degrees like Masters and PhDs. The short-term programmes can be organised for professionals already existing in the work force to address real life problems and increase awareness. The short-term programmes can be tailor-made courses, training-of-trainers courses and/or special workshops. These should be organised for different stakeholders who include technical personnel, policy-makers, social-workers, financial institutions, industrialists etc.

## Long-term academic programmes

The development of long term academic programmes at various qualification levels should provide skills required to develop and promote energy concepts in the context of sustainable development. The first stage of building capacity requires empowering academic institutions. Academic institutions should put in place strategies to upgrade the skills of teaching staff to develop such programmes and provide the necessary facilitation. Also working with other stakeholders, institutions are advised to explore the possibilities of integrating sustainable energy concepts into existing courses and curricula. Under special circumstances, the institutions can consider development of new courses and programmes based on needs assessments for a particular country. Investment in the provision of adequate training facilities to support the relevant training should be a collective effort by key stakeholders, such as the industrial sector and government and may not be left alone for the academic institutions to provide such critical investments.

The target groups for such long-term academic programmes may include: high end skills groups (such as engineers, researchers, designers etc.); entrepreneurial group which possess skills and have capability to learn and innovate and the technical skills group. Usually, graduates from the higher degrees are prepared to work in leading positions in national and international organisations as well as in businesses. The programmes must focus on key competences such as:

- ability to view problems /solutions in their entirety, i.e. a holistic approach;
- creativity and willingness to innovate and question the traditional approaches;
- ability to apply an inter-disciplinarily and multi-disciplinary approach;
- problem-solving ability;
- social competencies and the ability to operate in teams

The interdisciplinary study nature of the programme should focus on technology and management with emphasis on sustainable energy, project management and development studies, environment, socio-economical and socio-cultural aspects.

The academic institutions must work together with all stakeholders to develop academic programmes which address the needs of the community and industry. The training programmes at different levels should be coordinated and linked to avoid duplication which leads to inefficient use of resources. Besides ensuring standardisation and the accreditation of programmes, academic institutions should be advised to ensure that articulation processes are in place in the whole training process.

Sendegeya et al (2006) proposed a number of areas or fields where higher academic institutions should focus on addressing issues of energy development. In generic form, the fields which must be addressed by academic institutions in terms of training and research include:

- ✓ **Sustainable exploitation and utilisation of resources including renewable (e.g. solar, wind etc.) and convectional resources (Fossil Fuels and uranium):** *Although conventional resources are considered as polluting the environment and are exhaustible, there are still contributing significantly to the current energy mix of the world. The development and use of these resources require new and innovative approaches to reduce the risks of excessive exploitation. The exploration of these resources requires modern and innovative techniques to minimise the impact on the environment. The delivery of these resources is still a problem to the environment and requires innovative improvements. Sustainability is needed on the consumption side, especially in the development of innovative and efficient strategies in the conversion processes. Though renewable energy resources are considered to be sustainable due to their regenerative and environmentally benign nature, their intermittent nature and low density require innovative approaches in the conversion, delivery and usage processes. The technical and resource management aspects of the energy supply chain must be covered adequately in these long-term training programmes.*
- ✗ **Sustainable Energy use:** Energy efficiency and energy conservation must be advocated as a strategy to utilise the scarce resources sustainably so as to guarantee an economic benefit to the consumers. The programmes for promoting sustainable energy use should be linked to the future needs, economic benefit to the users and community and in general to the environmental benefits.
- ✓ **Energy policy and governance:** One of the challenges facing the success of sustainable energy development is lack of capacity in energy governance, policy development and monitoring. A academic institutions should have the ability to develop training programmes and/or modules which are aimed at producing professionals in energy policy development, implementation and monitoring. For instance, special postgraduate programmes in energy policy may be useful in addressing this need.
- ✓ **Energy Economics:** The focal points of Energy Economics should be on macro and micro economic issues (financial, business, management , promotion of energy entrepreneurs, etc). The long-term training programmes and/or modules should aim at professional training and qualifications. These may be linked to short-term programmes for existing professionals.

- ✓ **Energy and environment:** In general academic institutions have the ability to develop training programmes and/modules which help to link energy exploration, development, delivery and utilisation with the environment. Such programmes should target energy project developers, industrialists, government institutions and community/social workers.
- ✓ **Power Systems:** The power sector is experiencing a paradigm shift from the traditional unidirectional power flow (from utility to consumers) at Medium Voltage (MV) distribution level and below to bidirectional and/or multi-directional power flow at both High Voltage (HV) Transmission, MV distribution level and even Low Voltage (L.V) distribution (with possibility of generation on the consumer side) . The evolution of smart-grids and/or development of distributed generation may make the operation, control and management of power systems more complex. Thus, there is an increasing requirement for innovative ideas and approaches to handle the complex technical and economic nature in this sector. In general, academic and research institutions must have the ability to carry out research in this sector. It is necessary to work with power utilities and industries to enhance Research and Development (R&D) in order to manage changes in this sector.
- ✓ **Awareness:** There is a need to increase awareness among the population and most specifically among policy makers, politicians and users. The academic institutions should develop training programmes and/or modules which help in increasing public awareness. For example working with key stakeholders, such as community groups, government and industries, consumer's awareness programmes can be developed and disseminated as part of sustainable energy development.
- ✓ **Energy and Gender:** The role of gender issues in sustainable energy development requires serious consideration at both micro and macro levels of communities.

## Short-term training programmes

Short-term courses can be organised, which target special groups and/or individuals, specifically those who may already be in the practise in the energy and development sectors. Some training programmes may be in form of workshops as per the requirement of each sector. Tailor-made courses, which address real life problems in these sectors, can easily be handled by higher institutions of learning. The training should cover a broad range of aspects, including the education of high level decision makers in the economic, political, social and developmental issues related to sustainable energy technologies and systems. The training may be organised further and rolled-out downwards to the basic operational level which will provide the users of the technologies with the requisite information to be delivered to the general public.

Under the special arrangements to have short-courses and/or tailor-made courses, the academic institutions would be advised to cover all aspects of sustainable energy development. A summary of the training needs, possible target groups, contents and the training requirements and possible training providers are summarised in Table 1.

Table 1: Summary of proposed types of training, training levels, contents and providers

| Type of training                                     | Level of training  | Possible contents  | possible provider                              |
|--|--|--|--|
| Energy policy and management                         | Senior energy officers, senior management in government and business     | Socio-economic analysis, resource assessment, energy technology characteristics, surveying methodology, data collection and analysis   | University (with strong international support) |
| Project design, planning and management              | Mid-level energy officers and middle managers in industries and business | Energy technology characteristics, needs assessments, budgeting, scheduling, economic and financial analysis, financing, human resource  | University (with strong international support) |
| System design  | Senior technical personnel   | Performance estimation methods, component characteristics, operating efficiencies, resource availability, potential problem areas, failure modes and risks,                            | University and technical institutions          |
| Preparing specification and purchasing of components | Senior and mid-level technical personnel                                 | Fitting specifications to needs and environmental constraints, purchasing methodology, tender preparation and evaluation, warranty and information needs, standards and certifications | Technical and vocational institutions          |
| Installation services                                | Mid and low level technical personnel                                    | Guidelines for installation of the target technology, Critical points for proper installation. Alternate methods for unusual circumstances   | Technical and vocational institutions          |

|   |  |  |                                       |
|---|--|--|---------------------------------------|
| Maintenance services                                | Mid and low level technical personnel                | Troubleshooting and maintenance procedures, use of test equipment, identification of incorrect operation, user interaction   | Technical and vocational institutions |
| Business skills for renewable energy implementation | Businesses interested in developing renewable energy | Market assessment, product pricing, after sales support, record keeping and analysis, marketing of the product or service, obtaining and efficiently using finance, forecasting of cash flows, development of service businesses | University and/or business schools    |
| Finance of renewable energy systems                 | Businesses interested in developing renewable energy | Sources of finance, incentives and special conditions for renewable energy, CDM and its effect, accessing grant funds, preparing financial applications  | University and/or business schools    |

## CONCLUSIONS

The paper has discussed the concept of capacity building, sustainability in energy sector and the importance of education as a catalyst for capacity building. The trilateral dependence of education, capacity building and sustainability is central to the achievement of positive results in Sustainable Energy Development programmes. Sustainable Energy education is an increasing and exciting knowledge stream that requires well organised systems and structures to ensure sustainable and meaningful development. Inclusion of stakeholders is vital to the successful development of viable training programmes, which meet the needs of the community. The paper shows that academic institutions have a central role in the development and success of sustainable energy development and its dissemination thereof, through coming up with training programmes which are informed by the needs of the industry and community at large. The Academic institutions are expected to achieve this through organising long-term and short-term training programmes which address all issues of energy development. Stakeholders' engagement helps to link and match training needs and specific training programmes which are required by the populace. Development of courses should address policy, social, economic and technology demands and changes. Academic institutions are expected to work as facilitators of innovation, conduct research and development (applied research) so as to match goals of sustainable energy development.

Academic institutions are required to institute internal processes in their training programmes which are more responsive to societal needs. There is a need to promote inter and intra institutional collaboration for value-addition in training and learning. The academic institutions must ensure collaboration with national and international agencies, benchmarking of curricula, and promoting human network so as to to share resources and experiences.. It is expected that academic institutions should provide training courses to up-skill the current labour force. The development of the training-of-trainers' (TTs) programmes to upgrade knowledge and skills should be encouraged. There is a need to promote collaborative training among and across academic institutions and key stakeholders. To sum-up, it is prudent for academic institutions to develop Centres of Excellence (CEs), with state of the art equipment and specialist laboratories, so as to adequately spearhead sustainable energy development programmes. Generally, and in view of the current prevailing situation, academic institutions can play a crucial role in the energy sector in four key areas, namely; research, education, training and expert consulting.

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