NIGERIAN ENERGY SUPPORT PROGRAMME (NESP)
– COMPONENT 4: CAPACITY DEVELOPMENT –

TRAINING NEEDS ASSESSMENT FOR RENEWABLE ENERGY, RURAL ELECTRIFICATION AND ENERGY EFFICIENCY IN NIGERIA

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ACRONYMS

BOI	Bank of Industry
DGIC/AHK	Delegation of the German Industry and Commerce in Nigeria
DFID	Department for International Development
ECN	Energy Commission of Nigeria
ECREEE	ECOWAS Centre for Renewable Energy and Energy Efficiency
EE	Energy efficiency
EMDI	Engineering Materials Development Institute
FMP	Federal Ministry of Power
GIZ	German Society for International Cooperation
HND	Higher National Diploma
HYCOM	Hydro Power Competence Centre
JAMB	Joint Admissions Matriculations Board
MoU	Memorandum of Understanding
NAPTIN	National Power Training Institute of Nigeria
NASENI	National Agency for Science and Engineering Infrastructure
NBTE	National Board for Technical Education
NEP	National Energy Policy
NEPA	National Electric Power Authority
NESP	Nigeria Energy Support Programme
NIAF	Nigeria Infrastructure Advisory Facility
NUC	National Universities Commission
OND	Ordinary National Diploma
PHCN	Power Holding Company of Nigeria
PRODA	Projects Development Institute
PV	Photovoltaics
RE	Renewable energy
REEEP	Renewable Energy and Energy Efficiency Partnership
REMP	Renewable Energy Master Plan
RrE	Rural electrification
SHP	Small hydro power
TNA	Training Needs Assessment
ToT	Training of trainers
UNDP	United Nations Development Programme
UNIDO	United Nations Industrial Development Organisation

EXECUTIVE SUMMARY

Over the last decade, Nigeria invested heavily in the upgrading of the power sector of her economy in a bid to provide electricity to a teeming population of about 168.8 million, 82% of which are not connected to the national grid. The majority of these 82% of Nigerians live in rural areas which may not be connected to the national grid in the foreseeable future. For these communities the only way to get the much needed life improving electricity will be through rural electrification schemes using renewable energy (RE) as a backbone. As rural communities are often in locations that are difficult to access, local skills have to be developed to manage and maintain the renewable energy systems. This is expected to lead to a rise in the demand for skilled workers in the renewable energy industry.

Across the world, homes and businesses are making conscious efforts to adopt energy saving products and processes to reduce energy consumption. Especially in a country where power supply falls vastly short of the demand, increased energy efficiency (EE) through demand-side interventions is imperative for reducing the demand-supply gap.

The Nigerian Energy Support Programme (NESP) was established in 2013 by the German Agency for International Cooperation (GIZ) on behalf of the Ministry for Economic Cooperation and Development (BMZ). It seeks to ensure that conditions for the application of and investment in RE, rural electrification (RrE) and EE have improved. Activities encompass an improvement of the framework for RE implementation, improving the framework for introduction of EE including solar water heaters and the development of an RrE strategy and pilot projects. These interventions are being complemented by the introduction of selected training courses and the pursuit of strengthening selected partner institutions with particular attention on NAPTIN.

This assessment has two main objectives, namely to identify skills gaps and training needs in RE, RrE and EE vis-à-vis Nigeria's evolving market demand and existing educational courses as well as to define viable training courses capable of addressing the mid-term market demand that could be successfully introduced by NESP. These objectives are achieved through an analysis of market trajectories in RE and EE viewed side by side with existing educational offers in conjunction with an identification of skills gaps, drawing on industry engagement, interviews, a survey, desk research and market experience. Various stakeholders integral to identifying skills gaps were consulted, comprising of government institutions, educational institutions and private businesses.

The market for renewable energy in Nigeria is clearly growing, dominated by solar photovoltaics (PV). Grid-connected projects are at the doorstep while off-grid applications have already a fair market penetration, albeit paired with poor maintenance and often without viable business models, resulting in high failure records. There is a considerable risk that the continued absence of skilled personnel may exacerbate reputational damages already incurred, stifling prospects of further deployment. Small hydropower (SHP) on the other hand is beginning to enter the market backed by limited indigenous production and supported by still limited experiences and capacities in the country. This calls for interventions so that the favourable energy cost of SHPs can be leveraged on, in the pursuit of economic development of rural communities. Wind power has significant commercial potential particularly in offshore applications. Skills needs here are predominantly manufacturer specific. It is assumed that suppliers of mooted large wind park projects will meet these in their own capacities in the short and mid-term. Biomass has a proven potential too but developments have not gone beyond technology demonstration and are far from commercialisation. A surprising variety of institutions were found to offer educational programmes or courses related to RE within Nigeria. These are either ad-hoc in nature as is the case with research centres or are infused into curricula of undergraduate courses at universities. Since 2008 even stand-alone postgraduate courses are on offer. With some notable exceptions, courses are mostly academic and not skills based, which is identified as critical gap. The gradually evolving market has not resulted in strong demand for such training yet, giving rise to the need for funding to kindle skills development. However, most lack adequate funding to execute quality training and orientation on the market catered to is in a stage of infancy. With minor exceptions, existing courses are designed and conducted without involvement of the industry.

With energy efficiency, there is yet to be a concerted effort from a policy perspective to drive interest in its deployment thereby creating a need for skilled labour. Notwithstanding this fact, the need to introduce related professional training emerged with clarity so as to develop the skills necessary for any such initiative and no formalised approach has been launched in this respect in Nigeria yet, an issue NESP is committed to address.

From the findings, there emerges a need for establishing standardised courses of professional training offered and recognised across Nigeria focused on skills required by the emerging markets. This assessment therefore recommends six such courses to be developed by NESP in response to the short to medium term needs of the RE industry and EE needs. These courses shall eventually be entrusted to educational institutions of Nigeria willing and able to roll them out in response to growing market demand. Their absorption into course portfolios shall mark an entry point for the acquisition of relevant professional qualifications, increasing the employability of qualified Nigerians and reducing the country's dependence on foreign skills. The courses subject areas identified are:

1. Renewable Energy and Rural Electrification for engineers;
2. Small Hydropower Design for engineers;
3. Solar Photovoltaic Systems for technicians;
4. Energy Management for facility managers;
5. Energy Audit for engineers;
6. Energy Conservation in Building Design for building design professionals.

In addition to the structured courses above, it is recommended that selected partners of NESP receive short-term training on RE, RrE and EE in so far as these concern and support their respective work. These trainings shall be of an ad-hoc nature, delivered by NESP as part of programme interventions on an as-and-when-needed basis. Such training would be centred on government stakeholders at federal and state levels but may extend to financial institutions. There are also pronounced capacity development needs on part of local communities and entrepreneurs in planned RrE projects but these needs cannot be adequately met through training but require long-term engagement processes instead.

1. BACKGROUND

Access to power is integral to the growth and development of any country. The availability or lack of it has a direct impact on the socio-economic well-being of the people. With an estimated population of 168.8 million (2012), Nigeria has large proven fossil fuel reserves and abundant renewable energy sources. In spite of this wealth of resources, Nigeria's per capita electricity consumption is 148 kWh/a, well below the sub-Saharan average of 535 kWh/a.

Nigeria currently has an aggregate power generation capacity in the order of 4.5 GW with a target of 40 GW by the year 2020. Renewable energy is expected to play a major role in achieving this target, to which the National Energy Policy (NEP) of 2003 and the Renewable Energy Master Plan (REMP) of 2005 bear testimony. Renewables are particularly relevant for the 82% of the population that are not connected to the national grid[1]. The country has an abundance of renewable energy resources with a potential of about 734 MW of small hydropower, an average solar radiation of 4 kWh/m^2 in the coastal south and 7 kWh/m^2 in the far north[2] as well as a largely rural agrarian community. The considerable resources prompted government to look at harnessing renewable energy and to mainstream them into the energy mix of the nation, especially to provide electricity to rural dwellers who would otherwise have to wait decades to be connected to the electricity grid. Complementary to renewables, embracing the introduction of energy efficiency would reduce runaway demand, enabling Nigeria to supply adequate electricity to her citizens and as such emerges as an important pillar for achieving these goals.

However, there is also prominent and well-documented failure of solar photovoltaic (PV) projects. This situation prompted the Federal Government of Germany through German Agency for International Cooperation (GIZ) to assist in the development of skilled manpower necessary to support successful interventions. In 2012, a training-of-trainers (ToT) programme was hosted at National Power Training Institute of Nigeria (NAPTIN) with funding by GIZ. The ToT focused on solar PV, wind energy and hybrid systems. Upon completion it was observed that a larger and better targeted capacity development strategy was needed to achieve a more substantial contribution to skills development. Also institutional capacities for hosting courses need to be increased along with a market focused approach creating revenue from course delivery. Nevertheless, this training serves as a valuable precursor to the present capacity development approach of GIZ.

The Nigerian Energy Support Programme (NESP) implemented by GIZ seeks to improve the conditions for application of and investment in renewable energy (RE), rural electrification (RrE) and energy efficiency (EE). Activities encompass an improvement of the framework for RE implementation, improving the framework for introduction of EE including solar water heaters and the development of an RrE strategy and implementation of pilots. These interventions are being complemented by the introduction of selected structured training courses and the pursuit of strengthening of selected partner institutions with par-

[1] www.punchng.com/business/business-economy/23-73-million-homes-dont-have-electricity-nerc-committee/
[2] REMP 2005

ticular attention on NAPTIN. NESP started operations in March 2013 for a design period of five years with an initial outlay of EUR 9 million to which the European Union is expected to contribute a further EUR 15.5 million.

Capacity development under NESP seeks to enable local institutions to provide relevant training as well as build capacities among decision makers. The scope of work includes an assessment of needs – testimony of which is this report – the development of curricula and training material, the holding of ToTs and to assist selected training partners in the independent conduct of these training courses. It is further sought to certify or accredit these courses. The developed curricula are expected to respond to the needs of the RE and EE market with focus on marketability in the short and medium term. This approach corresponds to the needs identified by NEP and REMP which recognise capacity building as integral part of the successful deployment of renewable energy while this approach is expanded by energy efficiency.

2. OBJECTIVE

The primary objectives of this training needs assessment are:

a. Identification of market needs, skills gaps and training needs for renewable energy, rural electrification and energy efficiency vis-à-vis Nigeria's evolving market and existing course offers.

b. Definition of courses addressing needs identified that can be successfully introduced by NESP with short or mid-term marketability prospects.

3. METHODOLOGY

The methodology employed to determine training needs of renewable energy and energy efficiency training in Nigeria was a direct one. Broadly three questions were asked, which are:

1. What courses are already available in the Nigerian educational system relating to renewable energy and energy efficiency?
2. What is the market trajectory for RE and EE technologies?
3. What knowledge and skills are required by the market for the successful deployment and implementation of RE and EE schemes in Nigeria?

To answer these questions, the following steps were taken:

1. Identification of stakeholders including:

a) Government institutions: FMP, NAPTIN, NUC, NBTE, ECN, JAMB, NASENI, BOI, NERC and REA.

b) Educational institutions: Universities, polytechnics, monotechnics and colleges of education.

c) Privately owned businesses: Multinational corporations, renewable energy practitioners, large energy consumers.

d) International funding/donor organisations: UNIDO, UNDP, GIZ, NESP, DFID, NIAF and ECREEE

2. **A review of relevant literature as listed in Appendix 1.**
3. **Analysis of information from education apex bodies including:**

a) Study of information from JAMB (Joint Admission Matriculation Board) to identify courses (undergraduate and postgraduate) that seem to have a close relationship with renewable energy and energy efficiency.

b) A request to NUC and NBTE to provide detailed information (including curricula) on universities, polytechnics, monotechnics and colleges of education that offer courses associated with renewable energy and energy efficiency.

c) Desk research to identify institutions offering relevant courses in Nigeria.

4. **Analysis of information from relevant training institutions including:**

a) Requests for curriculum content to universities that were identified to offer undergraduate and post graduate courses in renewable energy.

b) Requests to research centres that have focus on specific technologies in renewable energy and energy efficiency.

c) Face–to–face interviews with private organisations that offer or provide training services in the field of RE or EE

5. **Analysis of information from market players:**

a) Survey of RE practitioners in Nigeria to determine their operational requirements as it pertains to the market of specific skills associated with renewable energy. 135 questionnaires were distributed to known renewable energy practitioners and businesses with 37 responses received representing 27%.

b) Survey of large consumers of energy in order to determine their receptiveness to energy auditing and energy efficiency interventions. 20 questionnaires were distributed to known large energy consumers. 3 responses were received representing 15%.

c) Interaction with RE industry representatives to determine which knowledge classes and skill sets are severely lacking and as such reducing their ability to deliver solutions in response to market needs.

4. MARKET DEVELOPMENT AND TECHNOLOGY OUTLOOK

4.1. Solar photovoltaics (PV)

Solar PV became mainstream in Nigeria only around the middle of the first decade of the twenty-first century. Centres conducting research into solar PV were however established already back in 1982, namely Sokoto Energy Research Centre (SERC) and National Centre

Energy Research and Development (NCERD), Nsukka. Since around 2005 the country witnessed an explosion of PV street lighting and water pumping projects executed by various government organisations. Unfortunately, these projects were often characterised by the use of substandard equipment, lack of knowledge and skills by installers and the perception that PV systems were similar to conventional power generating systems. Due to these problems, Nigeria is littered with failed solar PV projects and as a consequence of this, a widespread mistrust for solar PV has developed within the population.

Over the years, various governments, national and states indicated willingness to set up multi megawatt solar photovoltaic power plants in northern Nigeria. However, these have not materialised due to a number of reasons, amongst which are the perceived insecurity, high installations costs as well as absence of a buyer of the electricity from such power plants. The recommended tariff as per the Multi Year Tariff Order II (MYTOII) for 2014 of 79,116 NGN/MWh is above what any off-taker is willing to pay and consequently the regime is yet to be operationalised.

The epileptic nature of the Nigerian electricity grid creates the opportunity for small residential PV powered systems. As a result, numerous solar PV installation companies have sprung up catering to the domestic market. This market is unregulated and awash with equipment of various standards. Hence the proliferation of inferior quality solar PV system components in the country. This problem exacerbates the problem of widespread mistrust for the technology.

Amidst all this, National Agency for Science and Engineering Infrastructure (NASENI), a local public sector unit commenced operation of a PV manufacturing line of a capacity of 1 MW per annum. NASENI's facility in Abuja is determined to enter the local PV module market but is not competing well in terms of pricing, particularly in respect of low-cost substandard imports, which impedes commercial success. The absence of standards for PV modules clearly hinders the proliferation and acceptance of "made in Nigeria" PV modules. Also SERC in Sokoto and NCERD in Nsukka have acquired PV manufacturing lines though these are not known to be operational.

Even if these pursuits succeed in their quest, there is a significant skills gap for the installation of PV systems in Nigeria, a fact also emphasised in the regional capacity needs assessment by the ECOWAS Centre for Renewable Energy and Energy Efficiency (ECREEE). NESP being aware of the importance of qualified installers in the way PV technology is perceived in Nigeria is committed to bridging this skills gap.

4.2. Solar thermal

Unlike solar PV, thermal applications of solar energy have not gained any momentum in Nigeria at all. Technology wise, solar water heater (SWH) systems are well proven. But the equatorial climate of Nigeria does not make it a bestseller as hot water requirements are not high. In addition low electricity tariffs result into long payback periods and unfavourable economics as a study conducted by NESP has shown. Deployment in boarding schools and hospitals could however be viable while payback periods would be shortest for hotels. Based on this finding, there appears to be scope for grant as well as market based interventions by NESP to showcase the technology and stimulate demand with focus on institutional actors. Such promotion however is not expected to make any impact on the domestic sector for as long as there is no substantial increase in electricity tariffs.

Solar thermal electric power plants are not being discussed or planned due to reasons such as high initial costs and lack of knowledge. In addition to these, the arid conditions required for these type of plants to become financially available are only found in the extreme north of the country which has been battling with a terrorist insurgency since 2010.

4.3. Small hydropower

Small hydropower – pico below than 10 kW, micro less than 100 kW and mini less than 1 MW – is still at an early stage of development in Nigeria. In 2006 UNIDO launched a specific development programme and began establishing a regional competence centre headquartered in Abuja with the intention of serving entire West Africa. The focus was on indigenising manufacture and construction so as to harness Nigeria's considerable small hydro potential for the benefit of rural populations without electricity. These efforts resulted in several remarkable achievements, such as the development of several community hydropower projects in the range of 70-400 kW. Secondly, a local public sector institute was empowered to manufacture a proven 35 kW turbine design. And thirdly, several state governments were won as development partners. Although the existing projects speak of technological infancy, the absence of community ownership and revenue generations could result into the demise of these projects, proof of concept that water can generate electricity has been delivered and has inspired rural populations, local governments and state governments alike. A clear constraint till date is the absence of viable business concepts addressing revenue generation, maintenance costs and requiring specifically, the development of productive end uses in support of this fragile equation. These are aspects that NESP vouches to address and which give rise to expectations that this segment is likely to see a significant boost through the implementation of viable demonstration projects. In addition UNIDO has launched the Phase 2 of its small hydropower (SHP) programme which foresees a yet to be quantified expansion of implementation with a growing commitment to embrace economics, and ownership related concerns.

Currently, most turbines operating in Nigeria are Chinese made. The only local turbine manufacturer, Engineering Materials Development Institute (EMDI), Akure expressed willingness to transfer manufacturing knowledge on to small and medium scale enterprises (SMEs) when the market has matured sufficiently for private sector enterprises to come in. Furthermore, all indications suggest that with the exception of knowledge and skill related to civil works, the requisite skills required for the successful deployment of SHP interventions is not lacking in Nigeria.

Though it is difficult to speak of a market for SHP as yet, the prospects are encouraging. The technology might already be economically viable but marketability will need to await several successful projects that could inspire landslide replications, if planned and implemented well, which is where the present challenges lie. The other major risk is that till date there is little or no experience with community mobilisation and support necessary to back community based entrepreneurship, be it private or cooperative.

4.4. Wind energy

Nigeria, located close to the equator in a region where sites with adequate wind resources are minimal. Wind speeds in Nigeria range between 2–4 m/s at industry standard 10 metres measurement height. Modern utility scale wind energy converters require average wind speeds of 6–9 m/s to be cost effective. Not surprisingly, the prevalence of multi-megawatt wind turbines for electricity generation is low while small wind turbines (SWT) are commonly used in rural areas for water pumping and irrigation. So far, the only installed wind power plant in Nigeria is a 10 MW wind park in Katsina state. It consists of 37 two-bladed wind turbines, manufactured by Vergnet S. A., each of which with a nameplate rating of 275 kW and hub height of 55 metres.

However, Nigeria being a coastal country also possesses an abundance of offshore wind resources. Though yet to be exploited, it offers the opportunity to introduce wind energy into the energy mix. The high capital costs and perceived insecurity of Nigeria's coastal waters however add to other challenges, such as the need for assured feed-in tariffs.

4.5. Biomass and biofuels

Renewable energy can be derived from biomass such as firewood, food waste and agricultural waste. Rural populations depend on traditional sources of energy like fuel wood, charcoal, plant residues and animal waste. Currently, wood fuel accounts for over 50% of overall energy consumption in Nigeria and is a major source of energy in rural Nigeria. In developed nations, crops are cultivated for use as feedstock for biofuels either as briquettes, pellets or chips or for production of biodiesel. While this can be practised in Nigeria thereby providing a source of income for the biofuel feedstock farmer, it brings to the fore the age-old argument of food versus fuel.

Efforts have been made to exploit biofuels on a large scale in rural Nigeria with various research institutes actively involved in its research and commercial development. These institutes engage in community development projects as well as mass training programmes aimed at rural youth to create employment thereby boosting the local economy of these villages. Though biofuel production and use is still at its infancy, it has a role to play in the development of rural Nigeria. A long term strategy for the adoption of biofuels is necessary for the eventual success of its acceptance and utilization in Nigeria. At this time however, the development is yet to mature to a stage where commercialisation is conceivable.

4.6. Energy efficiency, management and conservation

Energy conservation does not have an actual footing in Nigeria yet. Purchase decisions are generally governed by other aspects and the cost of energy efficient products is a likely deterrent. There is also a common preference for used and often environmentally unfriendly equipment imported from developed nations. The question of choice does not even arise for many as 70%[1] of Nigerians live below the poverty line. That being said, the low price of often unavailable electricity (national average of 12.87 NGN/kWh for 3-phase residential consumers) coupled with the high proliferation of diesel and petrol generator sets created an attitude of apathy towards energy efficiency and conservation. Nevertheless, especially in a

[1] CIA World Factbook (2010 EST.)

country where power supply falls vastly short of the demand as it does in Nigeria, increased EE is imperative for reducing the demand-supply gap.

The establishment of the National Centre for Energy Efficiency and Conservation (NCEEC) in 2008 marked the beginning of the entry of energy efficiency in the country. Commencing operations in 2010, NCEEC is mandated to drive the adoption of energy efficiency concepts nationwide. To achieve this, the centre has embarked on an awareness campaign targeting students of primary and secondary schools but impacts cannot be ascertained. In 2009, the Global Environment Facility (GEF) approved a USD 3 million grant to Nigeria to promote EE in residential and public sectors, implemented by UNDP in partnership with the Energy Commission of Nigeria (ECN) and Federal Ministry of Environment (FME). This programme is linked to the widespread adoption of compact fluorescent lamps (CFL) nationwide. While this is an unprecedented success, further initiatives are needed to introduce the concepts of energy conservation. At this stage, it is difficult speak of any market for EE products and services yet, with sole exception of CFLs. But it has been reported that the Federal Ministry of Power and the Lagos State Electricity Board commissioned energy audits for the Federal Secretariat, Abuja and the Lagos State Secretariat, Ikeja respectively, which marks a beginning.

NESP commissioned several studies since inception in 2013 investigating the feasibility and viability of EE in buildings and industries amongst others. Designs favouring natural cooling and daytime lighting were identified as promising and their adoption requires both technical advisories and awareness campaigns among builders and administrators. Also industries offer scope for energy conservation but the absence of qualified energy auditors is an obstacle for tapping into this market. Results of the studies prompted NESP to consider the execution of pilot projects demonstrating the benefits of EE interventions.

5. EXISTING TRAINING OFFERS

5.1. Universities

According to information obtained from National Universities Commission (NUC), a number of tertiary institutions in Nigeria offer renewable energy related courses as part of undergraduate and postgraduate degree programmes. A perfunctory review of their curricula shows a clear focus on solar energy systems. Universities that are involved in focused renewable energy education include:

1. Covenant University, Ota, Ogun Sate: B.Sc. Industrial Physics with Renewable Energy;
2. Bowen University, Iwo, Osun State: B.Sc. Physics with Solar Energy;
3. Usman Dan Fodio University, Sokoto (UDUS) in collaboration with the Sokoto Energy Research Centre (SERC): Ongoing M.Sc. and M.Phil PhD in Renewable Energy Technology since 2008 while a B.Sc. course is under development.

In addition to these, most universities have a module within agricultural engineering and environmental engineering courses that briefly introduce the different RE technologies and their possible applications to students.

Courses listed above are academic and knowledge based. The undergraduate programmes offered by both Covenant and Bowen universities have a heavy focus on solar PV and its applications. On the other hand, the post graduate courses offered by UDUS encompasses the most common forms of RE as well as introducing the concepts of EE. While these university courses aim at the right direction, the fact remains that the lack of practical exposure of students inhibits the development of market-ready skills. An exemption to this may be the courses of UDUS but accessibility due to its geographical location and its capacity to cater for a growing student population are constraints. As is also evident in the 2012 capacity building needs assessment of ECREEE, one educational institution to provide RE education at postgraduate levels is not sufficient for a nation of almost 170 million people.

Also UNDP works on introducing EE at universities. A specifically designed curriculum module was developed for inclusion in general studies and submitted to National University Commission (NUC) for review. While being an excellent reference guide, the module may not find its way into mainstream education anytime soon. The fact that it has not hit classrooms since its submission three years ago may suggest that stakeholders such as NUC and teaching institutions may not have been taken on board of the development process early enough.

5.2. Polytechnics, monotechnics and colleges of education

Information of the National Board for Technical Education (NBTE), who supervises and regulates programmes of all technical institutions in Nigeria, shows that polytechnics, monotechnics or colleges of education do not presently offer training on renewable energy related courses.
However, NBTE collaborated with SERC, UNESCO and the World Bank since 2013 to develop curricula for Ordinary National Diploma (OND) Higher National Diploma (HND) courses. A review of both draft programme curricula indicates that graduates, if given adequate training, will acquire quite relevant skills during the 2-year course. Adequate training in this context would require however the availability of laboratory equipment and qualified teaching faculty, which is in doubt. Besides, these draft curricula are broad and general in their coverage of RE technologies and cannot address the perceived demand for focused courses on subjects where the marked is maturing.

5.3. Research centres of ECN

The Energy Commission of Nigeria (ECN) is funding six research centres across the country hosted by prominent federal universities. Of these five are closely associated with and focused on RE and EE but three of them have reported to conduct training.

5.3.1. Sokoto Energy Research Centre (SERC), Sokoto

SERC was established back in 1982 at Usman Dan Fodio University at a time when very few institutions globally concerned themselves with renewables. Funding and supervision were taken over by ECN subsequent to its own formation in 1988. SERC is the pioneer who succeeded mainstreaming renewables into education. It developed a Master degree course (M.Sc.) and a doctorate course (M. Phil Ph.D.) in Renewable Energy Technology in conjunction with Usman Dan Fodio University. Both courses have been running since 2008 with the intention '*to provide a vital stimulant for research and development as well as sustenance of renewable energy education to both secondary and tertiary institutions in Nigeria*.' Currently a bachelor programme is under development as well.

The centre also developed Ordinary National Diploma (OND) and Higher National Diploma (HND) in Renewable Energy Technology curricula with funding from World Bank. In 2013 these drafts were handed over to NBTE, who reported in 2014 to be in the process of finalising these with support from UNESCO.

In addition to this, SERC conducted various solar photovoltaic installer training programmes to foster entrepreneurship amongst Nigerian youths. Most of these training were carried out under the auspices of National Youth Corp Service (NYSC), National Directorate of Employment (NDE) and various state governments. It is reported that SERC has been offering and executing these training programmes since 2009, and so far over 540 Nigerian youths have benefited.

5.3.2. National Centre for Energy R&D (NCERD), Nsukka

Hosted by University of Nigeria and established in 1982, NCERD developed various competencies in the field of RE and EE including biogas digester design and construction, solar PV installations and energy auditing. The centre, staffed by 35 researchers in 7 different units and 20 technical staff is currently erecting a laboratory building for solar PV and solar thermal technologies which is slated to house their PV module manufacturing plant (4 MWp design capacity annually). Recognised as National Centre of Excellence in Clean Cook stoves Research by the Global Alliance for Clean Cook stoves, NCERD has been selected to host the National Stove Eligibility Testing Laboratory which is currently being installed.

Up till November 2012, NERCD offered training to artisans in installation and maintenance of solar photovoltaic systems, fabrication of solar thermal devices (i.e. solar water heaters) as well as the design and construction of biogas digesters. The centre has also plans to upgrade the aforementioned courses to diploma programmes and possibly masters degree programmes in the future. In addition to these, the centre trains an average of 20 students under the Students Industrial Work Experience Scheme (SIWES) and 15 National Youth Corp Service Members annually. A challenge reported is the inability to attract interest from potential trainees. This is caused by the low awareness of its training programme as well as the perceived high cost of the programme itself.

5.3.3. National Centre for EE and Conservation (NCEEC), Lagos

Hosted by University of Lagos and operating since 2010, NCEEC does not currently offer structured training yet. The centre reports to be developing an awareness programme aimed at students in primary and secondary schools to create awareness on energy efficiency. It also considers developing a training curriculum for EE based on a modular approach where trainees have to pass different levels to be fully accredited auditors but it is uncertain whether or when preparations would commence. These plans could have the potential to materialise into the much needed training requirement to back EE interventions but plans for realisations appear far from concrete. Up until now NCEEC conducts occasional one-off short-term trainings free of charge on modelling software for renewables (wind and solar) but surprisingly nothing in its area of mandate.

5.4. Other research centres

5.4.1. Ibrahim Shehu Shema Centre for RE Research, (ISSCeRER), Katsina

Hosted by Umaru Musa Yaradua University, UMYUK offers training courses targeted at rural communities. Courses have durations of 4 weeks with focus on diverse subjects such as training on solar food driers, biogas digesters, improved cook stoves and PV street light installation. Currently a training programme for EE and planning for policy makers is being developed. The centre is said to possess laboratory equipment for the study of biofuels, wind power, hydropower, energy modelling and electronics.

5.4.2. Centre for Renewable Energy Technology (CRET), Akure

Hosted by Federal University of Technology Akure, CRET is a newly conceived centre, Though it is yet to commence operation, it has reportedly received university approvals and budgetary sanctions and has developed a diversified ambitious programme of work that impresses through its market and entrepreneurship approach, synergies with other university centres and involvement of outside faculties. The training focus of the centre will be non-academic, skill based, practical, part time RE & EE courses to include solar power, hydro power, energy efficiency and biofuels. Training at CRET will be offered in conjunction with entrepreneurship education by the university's Centre for Entrepreneurship Training.

5.4.3. UniCal Renewable Energy Centre (UREC), Calabar

Hosted by University of Calabar, UREC has a mandate to conduct research and training with focus on biomass, solar, wind and hydropower. Currently, UREC offers both undergraduate and certificate level courses and seeks to include postgraduate studies in the future. UREC has begun a process aimed at researching into the use of indigenous non-edible seeds in the Niger-Delta region as resource for biofuels.

Considering the geographical location of the above organisations, a training emphasis in line with RE associated businesses in their immediate vicinity, wind energy in Katsina and hydropower in Akure, would develop their competencies on these RE technologies as well as provide support to the aforementioned industries. CRET especially is in a unique position where it can drive national hydropower training in collaboration with EMDI which is a manufacturer of cross-flow turbines used for small hydropower and a rural electrification project by UNIDO in Ikeji-Ile, Osun State. Both of which are in its close vicinity.

5.4.4. Centre for Renewable Energy, University of Ibadan

University of Ibadan has not reported conducting courses relevant to RE or EE. But it built a PV-SHP hybrid system on the campus with a small grant obtained from John D. and Catherine T. MacArthur Foundation in 2009. Noteworthy is that university decided to leverage this fund to grant students practical exposure by engaging them throughout the project development. Most system components were designed and fabricated by students and they acquired practical skills here which is exceptional for Nigerian universities.

5.5. NAPTIN

In 2009 the Federal Government of Nigeria (FGN), having envisaged a growing shortage of skilled manpower (technical and non-technical) for the soon-to-be privatised power sector established the National Power Training Institute of Nigeria (NAPTIN). Its primary purpose is to provide training for power sector by offering industry relevant skills based courses. Hence, NAPTIN is seen as vital to the government's bid to provide stable electricity to Nigerians. NAPTIN is headquartered in Abuja and carries out training through eight regional centres spread across Nigeria.

A renewable energy training of trainers was hosted by NAPTIN and executed by GOPA International Energy Consultants GmbH on behalf of GIZ in 2012 as precursor to NESP. Three subjects namely solar PV, wind energy and hybrid systems were taught in 4-week courses to a total of 62 participants nominated by various government agencies of which 39 were successful in the examinations conducted. Ownership for training material was passed on to NAPTIN with the original idea that NAPTIN would replicate the trainings at their Kainji Regional Training Centre (RTC) using participants of the programme as trainers. The Kainji facilities emerge as nearly ideal for that purpose on account of its state of the art laboratory facilities (made by Lucas Nülle, Germany) and a solar-wind hybrid demonstration plant under development paired with a hostel.

Although NAPTIN has not begun offering the courses to the general public, it has made strategic alliances with PNN Networks, a private organisation, by signing an MoU for the training of RE using NAPTINS's platform and facilities. A host of reasons exist as to why NAPTIN is yet to begin offering RE courses. Popular demand for such skills has not yet emerged due to the slow pace of development of the RE industry. Also the expectation that trainers from other government institutions would assist in conducting courses is in doubt as each one grapples with its own priorities while NAPTIN has not yet developed requisite in-house trainer capacity, a shortcoming that NESP seeks to address through the current cooperation. In important fact is further that NAPTIN is directing its resources to roll-out of new and modified training offers for the traditional power sector while inducting fresher trainers.

5.6. Siemens Power Academy, Lagos

Siemens Power Academy offers short-term RE courses for entrepreneurs, senior engineers and managers. Courses vary between one and four days, covering the following topics:

1. Introduction to renewable energy;
2. Solar photovoltaic;
3. Wind energy basics;
4. Integration of distributed and renewable power generation;
5. Network integration of wind power;
6. Solar plants monitoring – Operation and maintenance of PV plants;
7. Solar energy/solar power plants (PV design, specification, planning and realisation).

These courses were offered for a certain period beginning in January 2011 until Siemens pulled out of the photovoltaic market globally. Although interest in the courses was high, only a total of three sessions were held with an average of eight trainees per session. This could be due to the substantial course fees charged (average of NGN 50,000 per day). Although Siemens pulled out of PV globally, these short courses are still part of its training portfolio and are offered on request but no course has been conducted since 2011.

5.7. Other private institutions

Renewable energy practitioners and entrepreneurs nationwide having realised the skills deficit, have at various times embarked on providing training programmes to technicians. While these programmes are good intentioned, most of them do not have the necessary equipment or faculty to provide quality services. As such these programmes mainly focused on solar PV and its applications but often did not succeed providing adequate skills to trainees enrolled. Known organisations currently involved in training for RE in Nigeria include but may not be limited to the following:

BAS Associates Consulting offers consultancy services on renewable energy and energy efficiency and conducted various short-term trainings at in 2006 during their International Renewable Energy Conference (IREC). Other RE trainings programmes aimed at all sections of the general public seeking a career change, employment and knowledge have been executed since 2008 for an average fee of NGN 12,500 per trainee.

Prime Solar Power (Prostar Global Energy Group) partnered with Yaba College of Technology, a foremost Nigerian polytechnic, in 2013 to execute training sessions on PV power generation and applications. Prime Solar Power also offers PV installer training to the general public in two training sessions which cover basics (40 hours) and software tools (30 hours). The costs for training are on average NGN 55,000 and NGN 75,000 respectively.

Renewable Energy Training Institute (RETI) is a subsidiary of MIDATCO Group and executed two remarkable training sessions in 2010 and 2012 of 4 weeks each for solar photovoltaic engineers and installers for an averaged fee of USD 2,500 per participant (includes feeding, accommodation, study aids etc.). 80% of the 200 participants in both training programmes were deemed to have successfully completed the course. Of these 160 successful candidates, 25 were hired by MIDATCO group to be part of TechVille, a PPP between the Ondo State Government and MIDATCO Group. In 2012, 3000 candidates purchased application forms, at a cost of NGN 6,000 each, to be enrolled into the RETI programme. The curricula covered most aspects of renewable energy technologies apart from a brief introduction to energy efficiency of 1 day. Though RETI is currently partnered with PNN Networks to conduct training on NAPTIN's platform under an MoU drawn up in 2012, the implementation is on hold as the pertaining programme for electrification of 744 Local Government Areas (LGAs) with solar PV is on hold.

Isaac Boro Energy Training College is headquartered in Grenoble, France. This is an initiative between the FGN, the French Ministry of Education and Schneider Electric. It was created specifically for the rehabilitation and training of militants from the Niger-Delta region of Nigeria under the Niger-Delta amnesty programme. 30 Nigerian students are currently being trained at the college in energy management for a duration of 1 year.

International Energy Academy (IEA) was set up based on American standards in Ibadan, Oyo State. IEA reports to offer six courses covering solar PV design and installation, small hydropower and small wind turbine technology at the technician's level. Of the 401 students (390 in PV, 5 in wind, 6 in solar water pumping) to have undergone training at the academy, only 30% are able to pay the average tuition fee of NGN 66,000 for these 1-2 week courses. Others rely on scholarships from governments and private organisations. The centre calls on the expertise of professionals from the United States of America to serve as facilitators and trainers. This explains why only 8 training sessions have been executed since its inception in 2007.

5.8. UNIDO

The United Nations Industrial Development Organization (UNIDO) developed 14 programme modules at its Austria headquarters that address every aspect of SHP development. UNIDO's Regional Centre for SHP at Abuja offers these courses on request of government agencies. It is assumed that this course offer cannot be construed as training offers accessible to the general public. UNIDO also facilitated the training of trainers programme for eight engineers from the Engineering Materials Development Institute (EMDI) a subsidiary institute of the National Agency for Science and Engineering Infrastructure (NASENI) and Projects Development Institute (PRODA) in the manufacture of cross-flow hydro turbines at the Hydro Power Competence Centre (HYCOM) in Indonesia in 2010. In addition to this training, UNIDO also purchased manufacturing licences from Entec AG, to enable local manufacture of the turbines by these organisations.

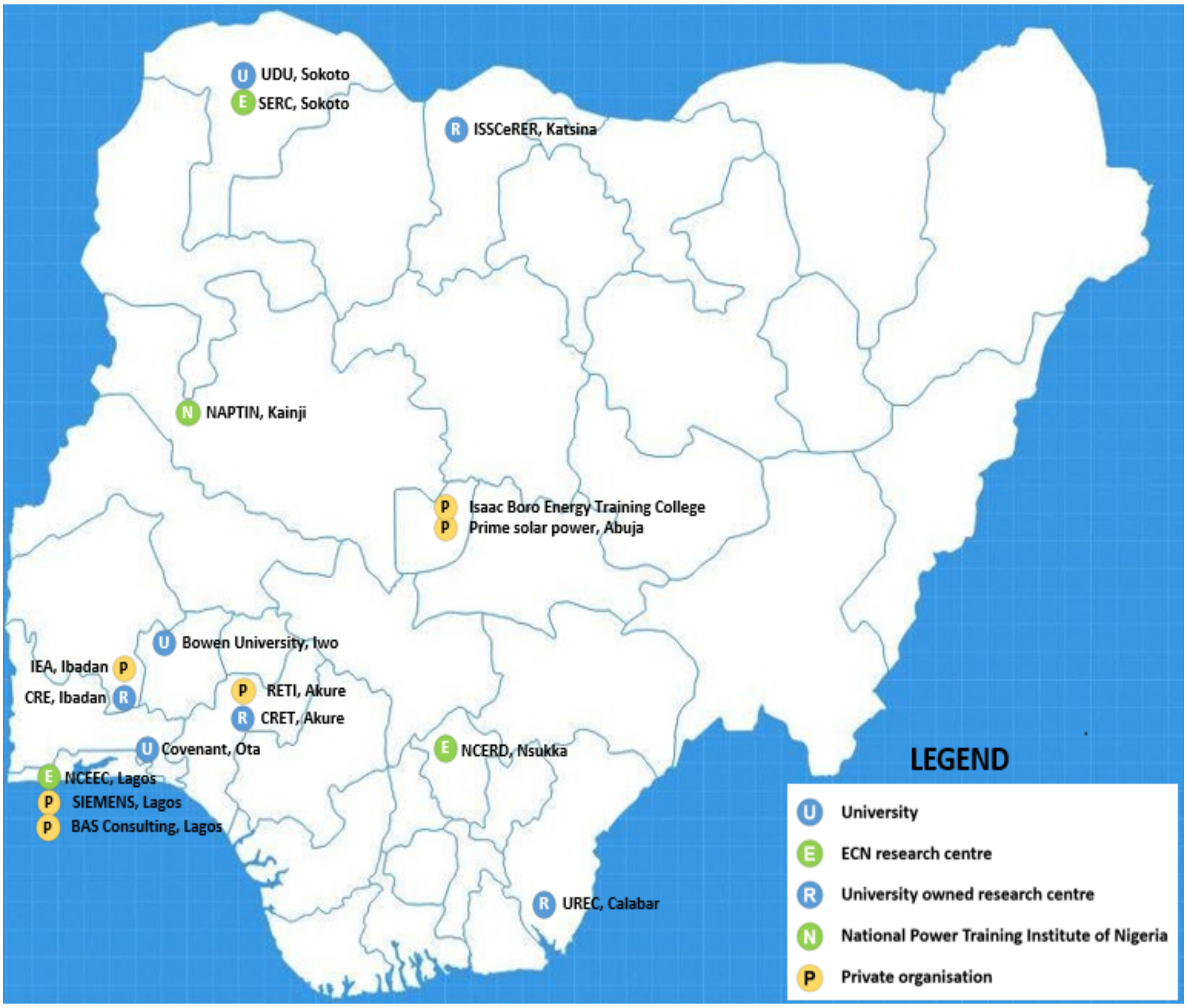

Figure 1: Locations of existing and previous RE & EE training institutions in Nigeria

6. INDUSTRY FEEDBACK

To assess the current state of the renewable energy the training needs required, an online survey was conducted in which the responses highlighted the fact that the government (federal, state and local) is the single largest procurer if renewable energy in Nigeria. It was however noticed that most government officials do not possess the requisite knowledge in respect of technology concepts, regulation, economic viability and social aspects.

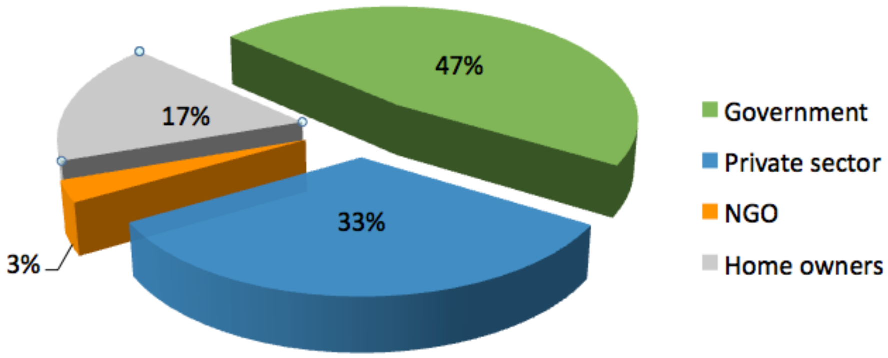

Figure 2: Distribution of RE clientele of respondents (NESP survey)

In the same vein, 97% of a total of 37 respondents are involved in solar PV business while only 20% engage in small hydropower in Nigeria. There is also a substantial involvement in wind energy and biomass/biogas of 39% and 22% respectively that appear to contrast the finding of chapter 4 that biogas is nowhere near commercialisation. These figures are corroborated by the needs assessment undertaken by ECREEE for the West African sub-region in 2012.

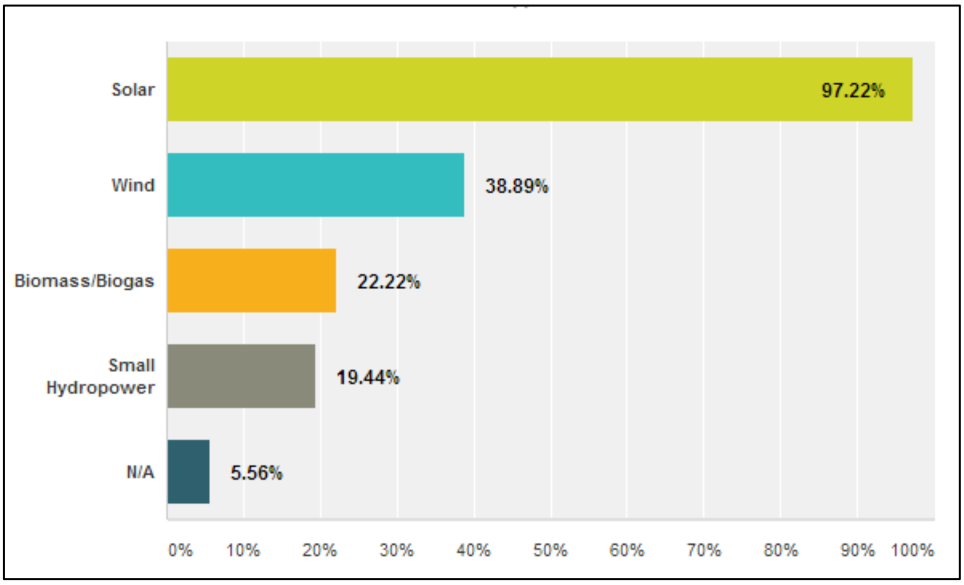

Figure 3: RE projects developed by businesses in Nigeria (NESP survey)

9 out of 10 respondents in RE businesses agree that the required know-how in the employment market is only partially available. This takes into account experiences with the employment market notwithstanding the fact most training and education offers presented in

chapter 5 have been in operation since several years. This suggests that existing offers have made some but only a fractional contribution to the development of needed capacities. 42% reported skills deficits in respect of installation while economic analysis skills were found lacking by 47%. However, system design was flagged as deficient by a surprising 8 out of 10 respondents, which makes reference to engineering rather than vocational skills. During a 1-day interaction with about 25 industry practitioners in Lagos 2013 participants overwhelmingly agreed that training needs are considerable. But contrasting the findings in the survey above, practitioners see greatest needs for RE capacity building at the skills and vocational level.

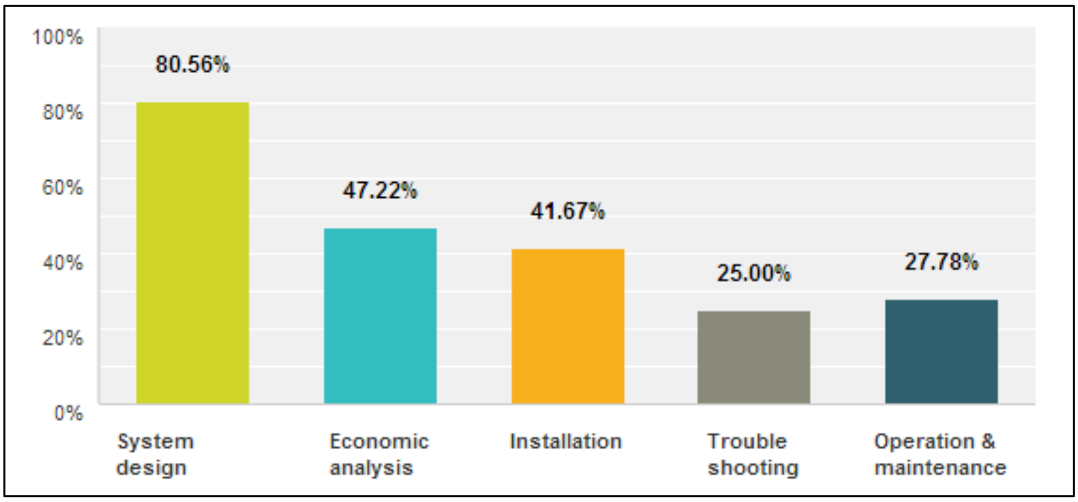

Figure 4: Skills gaps in the RE industry identified by RE businesses (NESP survey)

The fact that most of the RE businesses are micro to small scale enterprises (78% employ less than 20 technical employees), and employees will carry out multiple tasks as regards to RE solutions increases the importance for training to be provided locally. RE businesses would benefit from being able to improve the performance of their employees with market relevant training sessions.

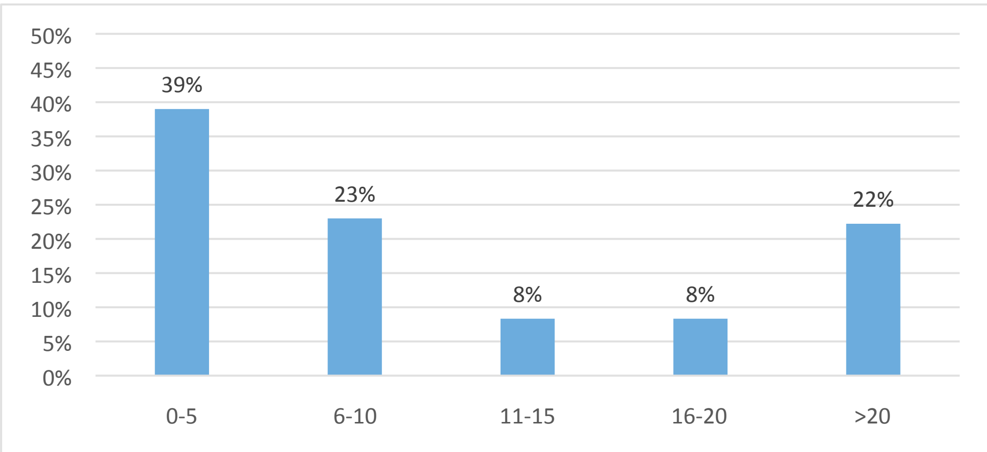

Figure 5: Number of technical employees (NESP survey)

With respect to energy efficiency, in response to 20 enquiries only 3 responses where obtained from large energy consumers. This is considered too insignificant to provide insights and aid conclusions concerning the needs for energy efficiency training. However in departure from the recommendations of the capacity needs assessment of ECREEE, NESP gathered from consultations with various stakeholders that EE capacity building should focus on engineers, plant managers and facility managers rather technicians because of the intrinsic needs of technical and economic assessments, projections and communication capacities for persuasion of management on matters concerning investment.

7. EMERGING TRAINING NEEDS

7.1. Outline of training areas

Although there is a multitude of educational offers in RE, these offers are either proprietary, not market focused or no longer offered. In SHP, EE and building design no relevant course offers have been identified in Nigeria. From the findings therefore emerges a need for establishing standardised courses of professional training firmly focused on skills required by the emerging markets that can be offered across Nigeria by recognised institutions.

This assessment recommends six such courses to be developed by NESP in response to the short to medium term needs of the RE industry and EE needs. These courses shall eventually be entrusted to educational institutions of Nigeria willing and able to roll them out in response to growing market demand. Their absorption into course portfolios should mark an entry point for the acquisition of relevant professional qualifications, increasing the employability of qualified Nigerians and reducing the country's dependence on foreign skills. The courses subject areas identified are:

1. **Renewable energy and rural electrification:** Engineers require skills to design, plan and implement RrE projects, including regulations and economics.
2. **Solar PV systems:** Installers need to be able to install, troubleshoot and maintain PV applications, paired with a basic understanding of designs.
3. **Small hydropower design:** Engineers need to be able to design civil structures and supervise execution while mechanical and electrical designs appear adequate.
4. **Energy management:** Facility managers need to be able to carry out technical and economic assessments, projections and develop the capability to communicate conclusions and persuade management on investments.
5. **Energy audit:** Building on the requirements for the energy manager, energy auditors require additional training in industry specific process technology.
6. **Energy conservation in building design.** Builders and architects have a key role with respect of leveraging opportunities for day-light use and designs favouring natural cooling contributing to energy conservation.

Apart from the six courses identified above, there could be a future market for training on the following subjects. These however lie beyond the current scope and timeframe of NESP and their introduction into the market would require a longer-term approach coupled with promotion mechanisms not presently in place.

- **Solar water heater (SWH) system design and installation**. The use of domestic solar water heaters is not economically viable in Nigeria at this present time. Boarding schools, hospitals and hotels however may offer scope that is currently being explored.
- **Wind energy systems for engineers and technicians.** Investors indicated interest in developing wind farms and there is a considerable offshore potential. However, the technology-centricity of skills for off-shore development combined with the fact that NESP closes down in 2018 renders development of related courses unviable in the programme context.
- **Biomass, biofuels and waste to energy**. Albeit the tremendous potential, the fact that the technology is still far from commercialisation renders development of related courses unviable in the programme context.

7.2. Proposed course designs

Although there is an immense need for capacity development across technologies associated with RE and EE in Nigeria, the industry focus and trends inform of the immediate need to develop curricula for six structured courses. These courses shall be developed by NESP and are expected to lead to a professional certification.

7.2.1. Renewable energy courses

Renewable energy and rural electrification: Responses from the online survey indicate that there is insufficient knowledge and understanding of the limitations and adaptability of renewable energy technologies. In order to bridge the knowledge and skill gaps, a course introducing and grounding participants at engineer's level in RE technologies, mini-grids, economics and financing, grid interconnections and the regulatory framework is required. Participants of this course are expected to have a strong engineering background and exhibit a high level of motivation towards the course.

Small hydropower: UNIDO's SHP promotion programme already assists Nigeria in building indigenous manufacturing capacities for turbine technology and load controllers. Complementary to that, a course developing civil engineering skills for the considerable civil structures which are the most cost-intensive component of SHPs is deemed required.

Solar PV systems: Solar photovoltaic street lights, water bore holes and electrification systems are the most prevalent renewable energy installations in Nigeria of which most are poorly installed while maintenance arrangements are lacking. This is a major point highlighted through interaction with industry practitioners. A solid and extensive technician's course is needed to address all these practical aspects on the ground. It should cover all types of PV applications, system components, the basics of system design, installation materials, tools and techniques as well as maintenance and troubleshooting.

Table 1: Tentative outline of courses of professional RE training to be developed by NESP

Renewable Energy and Rural Electrification for engineers	***Solar Photovoltaic Systems Installation, O&M***	***Small Hydropower Civil Engineering***
Objective: Enable electrical engineers to plan, design, analyse and commission renewable energy systems, supervise construction and provide related advisory services. **Probable duration:** 6 Weeks **Probable entry requirements:** HND (Engineering), B.Eng, B.Sc. (Engineering); Must possess a basic knowledge of electrical power systems. **Tentative content outline:** 1. Basics of electricity - AC/DC networks 2. Offgrid – Ongrid 3. Technologies & resource assessment: Solar PV, wind energy systems, small-hydro, biofuels, Generator backup, solar water heaters 4. Balance of systems: Inverters, charge controllers, energy storage, battery chemistry 5. Mini-grids: System sizing & design 6. On-Grid: Medium voltage AC networks, distributed generation, grid integration, smart grids 7. Energy management 8. Economics, electricity markets and business models for RrE 9. Social issues 10. Operation & Maintenance 11. Kyoto protocol, Carbon emissions, Carbon markets 12. Software tools	**Objective:** Technicians and craftsmen should be able to install, maintain and troubleshoot solar photovoltaic systems. **Probable duration:** 12 weeks **Probable entry requirements:** Age: 18-35 yrs; SSCE, OND (Electrical Engineering); Interview to determine the skill level of potential applicants. **Tentative content outline:** 1. On-grid / Off grid 2. Off Grid 3. Balance of Systems • Inverters • Charge Controllers • Energy Storage 4. Hybrid systems 5. Mini-grids 6. Generator Back-up 7. Installation materials, Tools, Techniques 8. Maintenance requirements 9. Troubleshooting	**Objective:** Enable civil engineers to plan, design and commission civil works for small hydropower projects, supervise construction and provide related advisory services. **Probable duration:** 4 weeks **Probable entry requirements:** HND (Engineering), B.Eng, B.Sc. (Engineering). **Tentative content outline:** 1. SHP fundamentals 2. Diversion structure and intake – weirs, intake types: purpose, design considerations 3. Sand traps & desilting basins: purpose & function, design principles, operation 4. Headrace, channels & structures: design principles, linings 5. Forebays & storage facilities: design principles, maintenance 6. Trash rack: materials, design principles, types, maintenance 7. Penstock: materials, design principles, support structures, installation, 8. Losses: losses due to friction, local losses, 9. Computations & Design: pipe roughness, economic pipe diameter, pipe thickness, effect of temperature on pipe 10. Power house design 11. Monitoring & maintenance

7.2.2. Energy efficiency courses

Energy management: Both power generation and consumption incur huge costs to manufacturers and business. There is a need to develop a course specifically for facility managers of large energy consumers so as to extend their role to energy conservation. Participants should learn about key standards such as ISO 50001, energy consumers, the efficacy and cost of a wide array of technology options, energy reporting and trend analysis, maintenance of energy systems and life cycle cost assessments. It is recommended to model the course structures and content on GIZ India's successful course for energy managers.

Energy audit: Besides the above course for the energy manager, an additional need for energy auditors was identified in this assessment. It emerges from the fact that knowledge of industry specific process technology would exceed the scope and possibly capabilities of facilities managers. Course content would thus include all of the content from the energy management course to which process technology, energy auditing and performance analysis would be added. Also it is recommended to model the course structures and content on GIZ India's successful course for energy auditors.

Energy conservation in building design: Builders and architects should be familiarised with energy conservation options pertaining to building design. These include but are not limited to optimising the use of day-light and designs favouring natural cooling contributing to energy conservation. Courses should include global best practices, climate-zone specific designs, materials and life cycle costs.

Table 2: Tentative outline of courses of professional EE training to be developed by NESP

Energy Management for facility managers	***Energy Audit for engineers***	***Energy Conservation in Building Design***
Objective: Enable facilities managers, to identify and implement energy saving measures while considering life-cycle costs. **Probable duration:** 4 Weeks **Probable entry requirements:** TBD **Tentative content outline:** 1. ISO50001 2. Energy Consumers: Lighting, Refrigerators, Heating, Air-conditioners, Motors – Pumps & drives, Boilers & Furnaces, Compressors, Transformers 2. Energy saving methods 3. Planning of energy systems 4. Maintenance of energy systems 5. Energy consumption reporting & trend analysis 6. Renewable energy applications 7. Software Tools	**Objective:** Enable engineers to undertake full-fledged energy audits for industries, hotels, hospitals and office complexes on energy saving opportunities while considering life-cycle costs. **Probable duration:** 6 Weeks **Probable entry requirements:** HND (Engineering), B.Eng, B.Sc. (Engineering). **Tentative content outline:** 1. Same as Energy Manger 2. In addition, special technology modules on industry processes across sectors	**Objective:** To enable building design professionals to plan and design thermal and electrical energy conservation concepts as part of building design while considering the economics. **Probable duration:** 4 Weeks **Probable entry requirements:** TBD **Tentative content outline:** 1. Thermal characteristics of buildings 2. Solar thermal systems 3. Passive solar systems 4. Heat pumps 5. Solar water heaters 6. BIPV 7. Thermal properties of building materials 8. Humidity & ventilation 9. Natural lighting 10. Planning & architecture: building orientation, micro-climate

7.2.3. Options for course ownership

NESP will develop structured courses for professional training identified in this report along with a certification system. Eventually, these will be handed over to existing Nigerian institutions who, so is expected, will be conducting these against a fee as and when the market is developing. The handing over will effectively include a transfer of ownership for not only the course material but also the certification and make it open to future adaptations. Future adaptation is necessary in order to keep courses focused on developing market demand, changing priorities and changing skill gaps. Such function should in principal, be assumed by NESP until the end of its operational period in 2017 but not thereafter.

The question of adequate institutional anchorage is therefore of vital importance to the future relevance of courses developed and the programme's pursuit to make and keep relevant training content locally accessible. Several bodies exist whose mandate or functions could lend themselves to being considered for assuming and safeguarding certification, including:

- National Universities Commission (NUC)
- National Board for Technical Education (NBTE)
- Council for Regulation of Engineering in Nigeria (COREN)
- Nigerian Society of Engineers (NSE)
- National Power Training Institute of Nigeria (NAPTIN)

The acceptance of courses and certified practitioners by the industry is reliant on the independence of certificate awarding body and the relevance of course content to industry. In this light the above institutions are being considered and preliminary review on their suitability are presented are at the table below.

Table 3: Preliminary review on possible entities for course ownership

	Strengths	*Weaknesses*	*Opportunities*	*Risks*
NUC	Established certification body	Not concerned with courses outside the context of universities	Formal education sector buy-in	May lack industry trust as seen with JAMB
NBTE	Established certification body	Insufficiently linked with market to update courses	Formal education sector buy-in	May not have industry trust as seen with JAMB
COREN	Engineering course regulation and certification body	Not concerned with course development	Professional/ industry buy-in	Might not have resources
NSE	Independence	Not a certification body, membership based	Professional/ industry buy-in	Might not have resources
NAPTIN	Professional training institution	Not an certification body	Recognised power training institution	May not have industry trust

7.3. Identified partner training needs

7.3.1. Renewable energy and rural electrification

Whenever a renewable energy or energy efficiency project is being contemplated, great care should be taken to ensure that the various stakeholders involved in the project are educated on the strengths and weaknesses of these projects as a whole as well as each individual component. In the case of off-grid rural electrification projects which can be hundreds of kilometres away from the nearest city, projects have to run in a self-sustaining manner. Various stakeholders are involved or need to be taken on board to ensure the success of these projects. Knowledge required depends on the specific roles these stakeholders have or may assume in the course of planning, implementation and operation. Specific needs identified include:

Government stakeholders: At federal level, training needs identified include requirements in terms of technology, economics, the social dimension and regulatory aspects to make officials facilitators of such processes. State and local government owned agencies that are tasked with rural electrification should be able to identify potential sites as well as assist the federal level in general planning as well as the project evaluation, monitoring and support. Appropriate shot-term courses with content should be conducted to aid the implementation of NESP in states where RrE pilot projects are being implemented and the federal level. At the level of LGAs these courses may need to be informed of project contexts to address project specific needs in relation to specific stakeholder roles. ■ ***Action:*** *Study tours to other GIZ countries, particularly in Africa and Asia that have successfully implemented RE.*

Financial institutions: Financial institution and potential investors require some form of training to enable them understand renewable energy projects. Training to inform financial institutions and potential investors of the opportunities, risks and their mitigation in RrE projects to encourage investment. However, an impediment right now is the fact that envisaged pilot projects may not or only to a very small degree rely on private finance. Public funding on the other hand may be detrimental in conveying plausibly the viability of returns on investment. ■ ***Action:*** *Conduct training as and when needed by NESP.*

Electricity supply companies: Financial gain from the supply of electricity is the only means by which adequate maintenance of the RrE project can be guaranteed. Capacities need to be built to familiarise potential electricity suppliers with business models, liabilities, operation and maintenance requirements of a given project sufficient to run it successfully and sustainably. However, such interventions would need to be based on the specific business model developed for the respective project and require longer-term engagement processes. Training may be inadequate for achieving this. ■ ***Action:*** *Foster capacity building through engagement processes for each pilot project.*

Community entrepreneurs: The success of RrE will vitally depend on productive end-uses of energy generated. Productive uses enable income generation for the community and supporting payments towards maintenance. Productive end-uses depend on the local context and opportunities. Each pilot project therefore requires a study identifying viable end-use of electricity in conjunction with feasibility studies. Thereafter communities will need to be familiarised with opportunities, implications, requisite skills, processes and potential market and their adoption has to be encouraged and fostered. This will require a sustained community engagement processes. Training would be inadequate for achieving this. ■ ***Action:*** *Foster capacity building through engagement processes for each pilot project.*

7.3.2. Energy efficiency

Main actors in building energy efficiency: Workshops and seminars will need to be conducted to promote of energy efficiency in the building sector, which is receiving impetus from interventions from NESP. These should introduce concepts of energy efficiency, management and conservation and should serve as a platform to encourage the creation of relevant policies to foster nationwide acceptance and implementation. Main actors are currently being identified. ■ ***Action:*** *Conduct training and study tours to countries that are successfully implementing EE.*

Main actors in energy efficiency in the industrial sector: A baseline study for energy efficiency and management in the industrial sector is currently being carried out by the NESP. Among other things, it is expected that it will identify key stakeholders whose induction into the programme could facilitate the introduction and implementation of energy efficiency in industries. Therefore capacity building on energy efficiency in industries and customised energy management, energy monitoring, and energy awareness programmes should be conducted**.** ■ ***Action:*** *Conduct training as and when needed by NESP.*

Technicians and engineers of solar water heating systems: Though successfully adopted in many countries around the world, SWH systems are still absent in Nigeria, chiefly on account of unfavourable economics. Boarding schools, hospitals and hotels however may offer scope that is currently explored by NESP. Consequently is expected that NESP will implement some pilot SWH projects in selected areas excluding the domestic sector showcasing the viability and encouraging replication. Capacity building will be required here for installation, maintenance and operation, including technicians, engineers and end users. It is assumed that selected supplier of the solar water heating systems or the manufacturer would provide the required trainings, specific to equipment installed. ■ ***Action:*** *If affirmative, training by equipment supplier.*

8. SELECTED INTERNATIONAL COURSES

Many universities and private institutions worldwide offer training courses for RE and EE. A few courses that appear relevant for Nigeria have been profiled below.

8.1. EE course of GIZ India

The highly successful EE training programme by GIZ in India covers all information relevant for training energy auditors and energy managers. The course material, divided into four books, is freely available online. It covers all aspects for training to become an energy auditor or manager. Due to the similarities in climate of Nigeria and India, the course material is not only relevant to but also largely applicable to Nigeria. The programme enables professionals who have achieved the minimum entry requirements the opportunity to prepare for certification as energy managers or auditors at their own pace and time. This approach has a solid foundation and would be warmly accepted by industry due to the fact that employers would not be comfortable granting prolonged leave of absences to key members of staff who may be interested/shortlisted to acquire the said skills.

8.2. Renewable Energy and Energy Efficiency Partnership (REEEP)

REEEP is a non-profit organisation, located in Vienna, Austria, whose objective is to accelerate the marketplace for RE and EE especially in developing countries and emerging markets. A training course was developed in collaboration with UNIDO. The content of REEEP covers information pertaining to electricity regulation, power sector reform, energy access in rural areas, energy efficiency in domestic commercial and industrial environments and financing of renewable, energy, rural electrifications and energy efficiency projects. It does not provide for technical training as required for the training of engineers and installers.

8.3. EUREM

The European Energy Manager course is a proprietary course administered by the German Chamber of Commerce and Industry (IHK). It is a fee-based internationally acclaimed course available in 28 countries and targets facility managers and technicians alike. EUREM aims to create a skill base for the proper management of these energy consumers. The programme consists of 160 classes, each 45 minutes. Currently, there is no EUREM course in Nigeria or sub-Saharan Africa. In Africa, the course is offered in Egypt for a fee of 35,000 Egyptian Pounds (approx. NGN 830,000). The course is technology centred and fails to deal with the all-important financial considerations that are always necessary to successfully convince and subsequently execute EE interventions.

8.4. RENAC Renewables Academy

The Renewables Academy AG (RENAC), based in Berlin, Germany, is a world-renowned RE and EE training provider. Founded in January 2008, RENAC has trained over 3,000 students from over 110 countries. RENAC offers a full range of proprietary courses from master's degrees for engineers and business to trainings for installers and technicians. In as much as RENAC has been a front runner in RE and EE training over the past 5 years with extensive international experience, the costs associated with acquiring training could be prohibitive for most Nigerians who might be interested.

APPENDIX 1: BIBLIOGRAPHY

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APPENDIX 2: LIST OF UNIVERSITIES CONTACTED

1. Ahmadu Bello University, Zaria, Kaduna State
2. Bowen university, Iwo Osun State
3. Covenant university, Ota, Ogun State
4. Ladoke Akintola University of Technology, Ogbomoso, Oyo State
5. Lagos State University, Ojo, Lagos State
6. Federal University of Technology, Akure, Ondo State
7. Federal University of Technology, Minna, Niger State
8. Federal University of Technology, Owerri, Imo State
9. Joseph Ayo Babalola Unioversity, Ikeji-Arakeji, Osun State
10. Markurdi University of Agriculture, Markurdi, Benue State
11. Modibbo Adama University of Technology, Yola, Adamawa State
12. Obafemi Awolowo University, Ile-Ife, Osun State
13. Salem university, Lokoja, Kogi State
14. Umaru Musa Yaradua University, Katsina, Katsina State
15. University of Benin, Benin, Edo State
16. University of Calabar, Calabar, Cross River State
17. University of Ibadan, Ibadan, Oyo State
18. University of Ilorin, Ilorin, Kwara State
19. University of Jos, Jos, Plateau State
20. University of Lagos, Yaba Akoka, Lagos State
21. University of Maiduguri, Maiduguri, Borno State
22. University of Nigeria, Nsukka, Enugu State
23. Usman Danfodio University, Sokoto, Sokoto State

APPENDIX 3: NESP-AHK RE PRACTITIONERS ONLINE SURVEY

1. What does your business do?
    a. Consultancy
    b. Engineering
    c. Services
    d. Researcher
    e. Other

2. What technology are you dealing in?
    - ☐ Solar
    - ☐ Wind
    - ☐ Biomass/Biogas
    - ☐ Hydro
    - ☐ Other
    - ☐ N/A

3. How many full-time technical employees do you have?
    a. 0-5
    b. 6-10
    c. 11-15
    d. 16-20
    e. Above 20

4. Where are you located?
    a. South – South
    b. South – West
    c. South – East
    d. North – Central
    e. North – West
    f. North – East

5. Who are your primary clients?
    a. Government
    b. Private sector
    c. NGOs
    d. Home owners

6. Do you find sufficiently trained manpower in Nigeria?
    a. Absolutely
    b. Only in partly
    c. No
    d. Don't know
    e. N/A

7. What skills are particularly lacking?
    - ☐ System design
    - ☐ Economic analysis
    - ☐ Installation
    - ☐ Trouble shooting
    - ☐ Operation & maintenance
    - ☐ Other, please specify: ________________________

APPENDIX 4: NESP-AHK LARGE ENERGY CONSUMERS ONLINE SURVEY

1. What does your business do?
   a. Services
   b. Manufacturing
   c. Other

2. Where are you located?
   a. South – South
   b. South – West
   c. South – East
   d. North – Central
   e. North – East
   f. North - West

3. How many employees do you have?
   a. 0-5
   b. 6-10
   c. 11-15
   d. 16-20
   e. Above 20

4. My electricity consumption accounts for
   a. Less than 10% of operating cost
   b. 10 to 20% of operating cost
   c. 20-30% of operating cost
   d. Above 30%

5. I am able to identify the large energy consuming equipment at my office/factory?
   a. Yes
   b. No
   c. Don't know

6. My business could improve competitiveness by reducing energy consumption?
   a. Yes
   b. No
   c. Don't know

7. My business would be interested in receiving training on energy efficiency?
   a. Yes
   b. No
   c. Don't know

APPENDIX 5: RESULTS OF ONLINE SURVEY

RE Practitioners survey

	a	b	c	d	e	f
Q1	Consultant	Engineering	Services	Others		
	20%	52%	20%	9%		
Q2	Solar	Wind	Biogas/Biomass	Hydro	N/A	
	97%	39%	22%	19%	6%	
Q3	0-5	6-10	11-15	16-20	>20	
	39%	22%	8%	8%	22%	
Q4	South-South	South-West	South-East	North-central	North-West	North-East
	14%	51%	11%	38%	8%	3%
Q5	Government	Private sector	NGO	Home owners		
	47%	335%	3%	17%		
Q6	Absolutely	partly	Impossible	Don’t know	N/A	
	6%	89%	6%	0%	0%	
Q7	System Design	Economic analysis	Installation	Trouble-shooting	O&M	
	81%	47%	42%	25%	28%	

Large Energy Consumers Survey

	a	b	c	d	e	f
Q1	Services	Manufacturing				
	100%					
Q2	South-South	South-West	South-East	North-central	North-West	North-East
	33%	67%	0%	0%	0%	0%
Q3	0-5	6-10	11-15	16-20	>20	
	0%	0%	0%	0%	100%	
Q4	<10%	10%-20%	20%-30%	>30%	I don’t know	
	33%	33%	33%	0%	0%	
Q5	Yes	No	I don’t know			
	67%	33%	0%			
Q6	Yes	No	I don’t know			
	67%	0%	33%			
Q7	Yes	No	I don’t know			
	67%	0%	33%			