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ESCWA

Distr.
LIMITED
E/ESCWA/SDPD/2016/
May 2016
ORIGINAL: ENGLISH

Economic and Social Commission for Western Asia (ESCWA)

Capacity Building Workshop on "Promoting Green Energy Technology Market in Rural Areas"

Beirut, 24-25 May 2016

SUMMARY

The Capacity building workshop on "Promoting Green Energy Technology Market in rural areas" of the Development Account (DA) project entitled "Building Capacities in Developing Appropriate Green Technologies for Improving the Livelihood of Rural Communities in the ESCWA Region" was held on 24-25 May 2016.

The workshop tackled policy frameworks for off- grid rural electrification, financing mechanisms and required support policies, project setup and business models, socio-economic aspects and community involvement, and capacity building and training. Moreover, case studies on the Moroccan experience were presented on RE for off- grid electrification as well as some successful initiatives like that of the Electricity Access in Southeast Asian Countries.

It discussed ways to design and develop successful business models as well as a case study in business model design regarding Biogas household units. It identified technology aspects while focusing on cooking energy service and performance assessment of various cooking energy technologies.

INTRODUCTION

1. This Workshop falls under the United Nations Development Account (UNDA) project "Building Capacities in Developing Appropriate Green Technologies for Improving the Livelihood of Rural Communities in the ESCWA Region" which aims to strengthen the capacity of countries in the Arab region to mainstream appropriate green technology initiatives into national development programmes and policies, in order to enhance livelihoods of rural communities. The UNDA project aims to:

a) Build the capacity of public and private development institutions on assessing the appropriate green technology needs in rural areas and on understanding the mechanisms that support the mainstreaming of appropriate green technology initiatives;
b) Enhance the knowledge of policymakers and decision makers on policy options and building their capacity for using policy tools to enable an environment conducive for investment in appropriate green technologies in rural areas in the region.

2. This Workshop takes note of the outcome of the expert group meeting on "Promoting Market-Driven Access to Sustainable Modern Energy Services in the Arab Rural Regions" that was held on 18-19 April 2016 in Beirut and which focuses on identifying the drivers that support the establishment of a sustainable rural energy market and the challenges facing rural communities in the creation of such a market.

3. The UNDA project's outcome is in line with the framework of the "Sustainable Energy for All" initiative and SDG 7, which call for ensuring access to sustainable modern energy for all by 2030.

4. The objective of the Workshop is to build the capacity of the public sector in the Arab countries to enhance the sustainability of RE penetration in rural areas by fostering sustainable RE markets. It covered the following topics:

1. Off-grid electrification: policy framework, financing mechanisms, and community engagement
2. Case studies: Countries' experiences
3. Developing a winning business model
4. Case study: Bio-energy for Sustainable Rural Development Project
5. Selection of energy technology
6. Biomass energy as the basis for a rural energy service enterprise

5. Experts and representatives of the public sectors including energy experts, policy makers, rural social developers and development planners, representing the Arab countries of Jordan, Mauritania, Morocco, Oman, Sudan, and Palestine, were invited to the workshop.

6. The participants will benefit from the Workshop by acquiring knowledge and understanding on

(1) Factors that determine the appropriateness of green and sustainable energy technologies in local rural environment and resources,
(2) Potential and capacity for local manufacturing of appropriate green energy technologies,
(3) Guiding policy makers in developing policies promoting an investment environment conducive to market-driven penetration of modern renewable energy technologies (RE) in rural areas,

(4) Strength and weaknesses of different legal and regulatory frameworks for promoting RE technologies in rural areas as implemented in the Arab region and other regions with similar socioeconomic characteristics,
(5) Generic roadmap for instilling modern and sustainable energy entrepreneurship within the rural communities in the Arab

I. PRESENTATIONS & DISCUSSIONS

7. The workshop started by a welcoming speech by Ms. Radia Sedaoui, chief of Energy Section at the Sustainable Development and Policies Division (SDPD), on behalf of SDPD Director, Ms. Roula Majdalani. She gave a brief on the objectives of the project and its activities, and explained the expected accomplishment. She also provided an overview on the focus of the workshop and gave a brief on the organization of the sessions.

Session 1: Off-grid electrification: Policy Framework, Financing Mechanisms, and Community Engagement

8. The workshop took off by a presentation by Mr. *Taoufik Laabi, who is an energy policy expert, retired recently as Director of Strategy and Planning, Organisation Nationale d'Electricite et d'Energie (ONEE), Morocc.*

9. In his presentation, he talked about policy frameworks for Off- grid rural electrification, financing mechanisms and required support policies, project setup and business models, socio-economic aspects And community involvement, and capacity building and training.

10. Mr. Laabi displayed the key policies for promoting off- grid rural electrification, beginning with the strategies that should have long-term objectives and strategic goals, transparent overall rules and guidance regarding development plans and financial mechanisms, to roles and responsibilities among the relevant institutions and stakeholders that should be specified and distributed. Moving to development plans that should look into; energy access in the country, criteria for the selection of target areas/communities, resource mapping for target communities, action plans including prioritization of communities to be electrified, and data collection on location, socio-economic conditions, and electricity demand, etc. The financial incentives and electricity pricing policies should be specified based on types and amounts of financial incentives for off-grid electrification projects, and have to look into criteria for the entities eligible for financial incentives, and the general pricing principles for off-grid electrification. Finally, the financial mobilization, which is a mechanisms for mobilizing funds for off-grid rural electrification that should be set within a transparent overall rules and guidance.

11. Mr. Laabi stressed on the importance of setting up realistic and achievable targets for off-grid rural electrification, engage all levels of government in the decision making process, and clearly allocate the responsibilities among them, setting up a clear criteria for selecting the target villages for off-grid rural electrification. Moreover, he talked about the importance of establishing mechanisms for sharing the costs of off-grid rural electrification among different public actors, creating a suitable policy framework to successfully mobilize financing from international partners and an efficient national institutional structure for planning, coordinating and implementing of all off-grid rural electrification activities. He also reflected on the importance of using a bottom up approach rather

than a top-down one for planning off-grid rural electrification programs, and the importance of distributing roles and responsibilities between institutions involved.

12. After that the different financing mechanism were explained, with the key support policies required. These include; the private financing, and for that we should have a market-based electricity pricing policy in target areas, a clear legal framework on private financing in off-grid rural electrification, an indirect subsidies, and soft loans policy for RE-based rural electrification projects. Secondly, there is the public power utility financing, and for this, the off-grid electrification should be included into the utility's work program, and there should be policy on cross-subsidized tariffs, indirect subsidies, and soft loans policy for RE-based rural electrification projects. Moving to the government financing, there is a need for policy on off-grid rural electrification, and institutional setup to implement off-grid rural electrification programs. For the public private partnership financing, key support policies required include soft loans policies for RE-based rural electrification projects, and financial incentives including direct and indirect subsidies.

13. For the socioeconomic aspects and community involvement, it is important to involve the local community as much as possible in all stages of the project cycle, use participatory approaches when working with the local community, keep the community organization small and functional during project implementation, make sure that women are represented and involved in the project planning.ive support to the communities to develop a suitable management setup for the off-grid project. Moreover, it is important to establish a common guideline for monitoring and evaluating off-grid rural electrification projects.

14. In regards to capacity building, it is essential to conduct an adequate capacity building needs assessment at the beginning of the off-grid electrification activity, earmark sufficient resources for continuous CB&T measures during the whole project cycle, carry out a comprehensive training on power plant operation, maintenance and business management as a standard, utilize, whenever possible, local training institutions, and pay particular attention to capacity building measures for the local community.

15. Mr. Laabi ended the first sessions with different recommendations, these include;

- Policy makers shall develop the key policies for promoting off-grid rural electrification which shall include a development strategy and concrete action plans, a suitable electricity pricing policy, financial incentives and a framework on funding mobilization;
- A clear legal framework for private investment in off-grid rural electrification needs to be established in order to mobilize the private sector to become actively involved in this market;
- A central institution/agency shall be created to coordinate the planning and implementation of all off-grid rural electrification activities in a country;
- The public sector should use its resources to finance off-grid projects in poor rural areas where business models can hardly be established and projects are less or not profitable. Wherever possible and economically viable, priority should be given to the private sector to get engaged for investment and project development;
- The business model selected for an off-grid rural electrification project shall have some degree of flexibility and fit the specific conditions of the community implementing the project. The business model may have to be modified along the way in order to cater to the actual developments and changes in the project structure during project implementation;
- Whatever is the selected business model, care should be taken to ensure that end-users have access to quality of electricity services at affordable prices;
- Productive and institutional applications of electricity not only help to improve standards of living but also increase the economic attractiveness of the off-grid power project. The project developers therefore must consider initiating or enhancing productive activities as they significantly increase the sustainability of the project;

- Maximizing the awareness and involvement of the benefitting community in the early stages of the project cycle, especially during the project assessment phase, is vital to the success of off-grid project implementation. Key activities include public awareness campaign, regular meetings with community leaders and focus-group meetings;
- Capacity building and training to develop local capacities in design, implementation, management and O&M is essential for the success of off-grid rural electrification projects. Therefore, adequate resources should be devoted to developing local capacities.

16. At the end of the session questions and discussions were raised by the participants around;

- The importance of public private partnership was raised due to its efficacy in sharing cost and responsibilities.
- The effectiveness of individual and communities initiatives compared to pioneers projects that don't succeed in lots of the cases and this highlight the importance of community involvement and working with a bottom up approach.
- The importance of setting a survey to assess the already existing equipment aiming to work with high efficient ones
- Regarding the pricing for electrification, it is mostly related to subsidies, with a must to take into consideration the cost of capacity building of individuals, and the ability to cover the cost of the project.

Session 2: Case studies: Countries' Experiences

17. This session was presented also by Mr. Laabi, where he talked about the current situation of the Moroccan power system, the Moroccan energy strategy, and he reflected on the renewable energy perspectives and regulatory framework, and mostly talked about the rural electrification program PERG, while addressing its characteristics, design, achievements, and its financing mechanisms. After that, he talked about some local initiatives like that of the Electricity Access in Southeast Asian Countries, Rural electrification planning in Vietnam, Community selection approach in Lao People's Democratic Republic (PDR), Rural Electrification Fund (REF) in Cambodia, Creation of village energy committee in Lao PDR, and Capacity Building and Training in Vietnam.

18. Mr. Laabi explained that the current penetration rate of RE in Morocco, which accounts for 31% in term of capacity and 13,4% in term of energy, and rural electrification rate stands for about 99,12%.

19. The energy strategy in Morocco includes five directions;
- Diversified and optimized mix built around reliable and competitive technologies choices
- Mobilization of national resources through developing renewable
- Reinforcement of regional integration
- Sustainable development

20. These are based on four fundamental objectives, and these include,
- Generalization of access to energy at the best prices
- Security of supply and availability of energy
- preservation of environment
- Demand management

21. Regarding PERG, Laabi explained that the Moroccan government launched the Global Rural Electrification Program (PERG) in January 1996. The program has clear objectives to promote and facilitate social and economic development as well as rural world advancement, satisfying three levels:

- Territorial: To provide an electricity supply to all rural habitations of the kingdom in a short term.
- Technical: To examine all the electrification techniques available to meet the requirements of each Moroccan habitation in acceptable techno-economic conditions.
- Financial: To maintain PERG responsibility for all financial resources.

22. An inter-ministerial Committee for Rural Electrification Program was established to approve ONEE's Master Plan, which had to satisfy several predetermined criteria; the principle of village selection for electricity supplies is least-cost per habitation. Moreover, Local Committees were implemented for the technical and financial approval of the PERG.

23. The aim of the program was that rural electrification via the power grid should cover 40,600 villages by 2014. Mr. Laabi indicated that by far, rural electrification via PV has enabled to electrify 3,663 villages.

24. Mr. Laabi pointed out that the use of PV has been dictated by the need of achieving a less expensive and faster electrification of remote areas, and there have been three ways of implementing PV in Morocco:

- Fully Grant-Based Model: ONEE delivers the whole package (equipment+assembly+O&M);
- Operation-Maintenance PPP model: ONEE purchases the equipment but submits it to a subcontractor that ensures the assembly and O&M as well as receiving the payments from customers on behalf of ONEE;
- The third way is called "**Fee For Service**", which was chosen for the achievements for photovoltaic. Its objective is to accelerate the achievements, ensure a sustainable service with lower cost, and involve the private sector. This approach ensures the identification and sensitization of the potential customers, supply and installation of all equipment, provides after sale service and renewal of the material under guarantee during 10 years with monthly payments collected during 10 years, and its characterized with the possibility of intervention in less than 48 hours in case of breakdown, and provides recycling of the batteries.

25. Mr. Laabi explained the socio-economic outcomes of the program, which included; the widespread access to appliance equipments, agriculture benefits, where more wells are connected to electricity, and creation of jobs with 18,000 to 22,000 permanent jobs.

26. Success factors for such programs include; the support of government, management of the project by the National Operator, a tailored space-time program, implementation flexibility, support of lenders, tremendous effort in technical and cost optimization, and benefiting from an innovative, participative and well designed scheme.

27. One of the important local initiatives is the Community Selection Approach in Lao PDR, Mr. Laabi indicated that the Rural Electrification Master Plan (REMP) in Lao PDR sets a National Electrification Target of 94.7% on household basis by 2020, which will be achieved by on grid systems, i.e. grid extension (90.9%) and by off-grid systems using mini/micro hydropower and SHS (3.8%). He then talked about the criteria for select a suitable village for off-grid rural electrification, and these include;

- Average distance from the village to the existing medium-voltage grid is more than 3 km;
- There is no existing plan for grid connection in the next 5 years;
- Road accessibility to the village is ensured throughout the year;
- Affordability of the installation fee and monthly tariff for villagers is given; and
- Management skills are prevalent in the village

28. At the end of the session questions and discussions were raised by the participants around the following aspects;

- The importance of using an inverter for the solar cells in order to diversify the use, as such be used for different equipments.
- The ownership of the provided systems, which will be within the hand of the customer or the provider after the 10 years set for payment.
- Choosing the Fee for Service was not done based on a survey or study, but based on its important advantages and the urgency of demand on electricity and the easiness of the process
- After 10 years interval, the provider has the call on contracting whoever for the maintenance and monitoring that are the full responsibilities of him.
- No guaranteed are asked for initiating such programs, monthly payments and the commitment of the targeted communities insure the sustainability of such initiatives.
- Road accessibility is a common problem that most rural areas suffer from, as such improvement and development of such infrastructure is a must before initiating project in rural areas, and in this case, road development can be a part of the cost of electricity.
- It is important to learn from the Moroccan experience and approaches and evaluates them not based on less cost involved, but on the different socio-economic benefits and that is because electrification in Morocco is less costly than in other Arab countries, due to the share of coal power plants constituting 47% of the energy mix.

Session 3: Developing a Winning Business Model

29. This session was given by *Mr. Ahmed Medhat, who is a project manager, working on Bioenergy for Sustainable Rural Development, in Egypt.*

30. In his first session, Mr. Ahmed talked about a successful business model, and the way to design it and develop it. He addressed strategies and protocols for developing such policies, and explained about template and framework of a winning business model design he ended the session with a case study of SunRun is a San Francisco based company dedicated to providing energy using a home solar service and is the first company to offer a residential power purchase agreement (PPA) in the United States.

31. A business model describes the structure and strategy behind a business case, and includes elements such as value proposition, key activities, key resources, cost structure and revenue streams. The aim of a business model is to help structure an initiative in a way that leads to a positive business case, one that leads to initiating the activity.

32. Mr. Ahmed explained about the different blocks of designing a business models as follows;

Building blocks can be grouped, and are defined, under the following headings:

1. Infrastructure
   - **Core capabilities** are the capabilities and competencies necessary to execute a organization's business model,
   - The **Partner network** means the business alliances that make up the business model,
   - The **Value configuration** refers to the rationale that makes a business mutually beneficial for a business and its customers.
2. Offering
   - The **Value proposition** means the products and services a business offers.
3. Customers
   - A **Target customer** refers to the target audience for a business's products and services.

- **Distribution channel** is the means whereby an organization delivers products and services to customers. This includes the organization's marketing and distribution strategy.
- **Customer relationship** refers to the links an organization establishes between itself and its different customer segments and the management thereof.

4. Finances

- **Cost structure** refers to the way in which the company's products are monitored to produce revenue.
- **Revenue** is the way a company makes money through a variety of revenue flows, i.e. the company's income.

33. Governments create business environments and business models, which are configured to respond by extracting maximum value for the business from the opportunity available, keeping in mind that there is no universal business model that can be used to introduce and sustain all different forms of new and renewable energy technology in the market place,

34. Successful business models are those that conform to the existing business conditions such that they:

- Extract maximum value for the business,
- Control key elements of the value chain,
- Provide a positive value stream to all participants,
- Have multiple revenue streams,
- Are hedged against changes in product prices and other revenue determinants,
- Respond to customer requirements,
- Are sustainable over time.

35. All business models are subject to failure if there is a change in the commercial conditions on which they are predicated. If the project drivers change, or are removed, it is probable that the revenue stream will fail. An unsuccessful business model is one that is unable to adapt to changing commercial conditions. Moreover, the success of a business model often depends upon the people involved and the partnerships established.

36. At the end of the session questions and discussions were raised by the participants around;

- Micro financing in Arab countries is characterized with small time intervals given for payments (6 -12 months) compared to international banks
- Banks request no guarantees from participants but depends on covering investment cost though saving accounts
- ESCO Revolving Fund makes equity investment in Energy efficiency or renewable energy projects, it provides long term leasing service for entrepreneurs in purchasing equipment for energy efficiency or renewable energy, and allows the entrepreneurs to make constant repayment with low interest.
- ESCO Revolving Fund will cooperate with financial institutions or credit guarantee agencies to assist entrepreneurs in accessing to the long-term loan from bank by providing credit guarantee depending on the project risk at low premium rate. This approach has been used for spreading RE development in Arab countries like Jordan, and Palestine.

Session 4: Case Study: Bio-Energy for Sustainable Rural Development Project

37. Mr. Ahmed presented a case study in business model design regarding Biogas household units. He identifies a new concept of installing the units, named 60%

governmental subsidy. This new concept provided good number of customers with a more positive experience, since they will have more that 50% of the cost in the form of stove, Bioenergy Service Providers (BSPs) fees, as well as the after sale service. In contrast to the traditional system as managed by other pilot projects, they got to know that this subsidy will be gradually removed for the following number of beneficiaries.

38. Although the project sacrifices number of biogas stoves to its customers, it expects long-term values such as enhanced reputation or higher customer loyalty. This idea can be itemized as a barter model strategy in the revenue model perspective. In this case, there is no cost side as the main target of the project is to spread the technology and open the market. In order to reduce the overall cost, the project asked the beneficiaries to buy the material themselves to be able to buy it from the market in installments. According to this strategy, the project needed to change its partnership network to a scheme of revolving fund that offer loans with low interest rate.

39. Mr. Ahmed explained that the design template provides two kinds of benefits. First, it enhances the efficiency of the design, and second, it also facilitates business model analysis. He added that by tagging strategies and protocols, one can represent the business model in a more structured way. The framework identifies the required steps along with the representational schemes for translating the basic idea of the product and service elements into the rigorous business model structure. In addition to the conceptual design, the proposed framework also supports design methods for the value creation logic of each stakeholder involved in the business model.

40. Questions were raised by the participants around the following topics;

- A Preliminary study was done on socio-economic aspects of the village through the help of local entities prior to the beginning of the project
- All technical specifications for the success of the units were taken into consideration. The average temperature of the country which is in this case 22 degree in Egypt was identified, the retention time was calculated, and daily feeding of 50% biomass and 50% water was considered. The outcome was from 2m3 to 6m3 of biogas per day according to the unit size.
- Maintenance and monitoring services is followed by the BSPs for two years
- In regards to environmental problems or hazards, all precautions were taken into consideration with the building material as a start. The kind of bacteria in the process of digesting is anaerobic bacteria so contact with air will kill them. Moreover, gas leakage can be easily detected as the produced hydrogen sulfide has a strong uncomfortable smell. Furthermore, there is no risk of explosions due to the characteristics of the biogas produced, in which the gas is lighter than air and that the amount is small so there is no gas pressure.
- Present equipment (stoves) can be easily modified through the change of the nozzles to fit with the specification of the bio gas.
- Other renewable energy sources like PV or wind energy can be used with the biogas system for example to heat water or mix the feed into the digester, however in this project, with dealing with very poor communities, the least technical demanding and easiest process was chosen due to the small sizes of the units. Therefore, mixing was done manually in this case, and regarding heating, the average temperature was enough for the systems.

Session 5: Selection of Energy Technology

41. This session was given by Ms. *Priyadarshini Karve , who is the CEO of Samuchit Enviro Tech Pvt Ltd in India.*

42. Ms. Priyadarshini started her sessions with identifying the challenges of rural energy enterprise in developing countries, and elaborated the approach to solutions with the example of the cooking energy service parameters. Then she explained the AIREC cooking energy service energy service decision support tool and the performance assessment of the various cooking energy technologies.

43. Challenges of rural energy entrepreneurship would include; low energy demand per consumer, low density of energy consumers, low paying capacities of the consumers, and the high cost of reaching products to the consumers. Possible solution would include; decentralized energy generation, use local resource, local entrepreneur, and pay per use model that is the service approach discussed in the first session by Mr. Laabi, in which the different stakeholders (community, and regulators) are addressed for specifying priorities and concerns, which will help the problem to be solved and better addressed.

44. Different stakeholders can be involved in the cooking energy sector, these include; the funder, regulatory bodies (national or international), buyer, cook, manufacturer and technology developers, and the distributer and project implementer.

45. In order to answer questions of the valued service by energy consumers, and the cost consumers are willing to pay, the AIREC tool would be an important asset. The service parameters that are to address include:

- **Versatility_1:** Boiling performance, Roasting performance, Frying performance
- **Versatility_2:** Ability to modulate het input to cooking pot, Ability to cook multiple items simultaneously, Ability to deliver non-cooking thermal energy services
- **Economics:** Operating expense, Capital cost, Possible earning from use
- **Safety:** Smoke and soot emissions, Stability, Temperature of outer body
- **Device Supply & Support:** Durability as expected life in years, Support provided or not, Manufacturing capacity
- **Environmental Impacts:** Energy efficiency, Carbon emission reduction potential, Carbon Footprint over lifecycle
- **Fuel/Energy Source:** Multi-fuel or not, Availability of fuel/energy source locally, Fuel processing required by user or not

46. The tool provides the identification of preferences of all stakeholders, individually and collectively for the region, and marking of products on performance against all service parameters, which help to assess cooking energy products on the combined basis of performance AND regional preferences, in a comparable way.

47. Worksheet was distributed for the participants, in order to exercise the Energy Service Decision Support Tool, which is essential in; identifying delivery mechanism, designing awareness and marketing campaigns, identifying product service combination, and in helping the government in designing a more appropriate incentive policy to support the service enterprises.

48. At the end of the session, one of the participants has an enquiry about the source of funding to do such surveys, and this highlight the importance of public private partnership in where different entities can share the expenses of activities.

Session 6: Biomass energy as the basis for a rural energy service enterprise

49. This session was also given by Ms. Priyadarshini, in where she addressed the conversion of waste biomass into char, and the production of biogas from green organic waste.

50. Ms. Priya started the presentation talking about the importance of biomass as a fuel that can be a potential equivalent to fossil fuel and for many other petrochemicals depending on local resources and priority of community needs.

51. Renewable charcoal is a cooking fuel that can be obtained from biomass through the use of local production units "Portable Charring Klins", and hand or motor operated briquetting machine for converting char powder into briquettes. The feedstock (for char powder) includes; leaf litter, dry weeds, dry grass, dry bushes, agriwaste. The feedstock (for charcoal) includes; dead wood, wood waste, bamboo waste, woody agriwaste, etc. The raw material must be very dry, ideally with not more than 10-15% moisture. Therefore sun drying for a few days is essential. The drying period will depend on the moisture content to start with, as well as shape and size of the raw material. The outcome of the charring process is 30% of the feed amount by weight.

52. For applications other than cooking, it is advisable to first grind the char into fine powder, and thereafter use a mold or a press to shape into a desired shape and size for intended use. The mold/press may be hand operated or electric depending on the scale of the operation.

53. Therefore, different product can be obtained from charcoal and can give the opportunity for initiating businesses for the rural communities. These include; the production of biochar as soil amendment agent, biochar urinals, biochar bricks for air purification in buildings and biochar powder for cleaning purposes without the use of water.

54. Studying the economics of this kind of service, we need to look into;

- The capital expenses (charring kilns, grinder, mixer, briquetting machine, drying trays, transport vehicles, working shed, and land),
- Recurring expenses (fuel for transport, electricity binder, consumables, salaries and wages, and marketing expenses),
- Income potential (minimum for selling char briquettes/char coal as cooking or industrial fuel, low for biochar as soil additive, and high for renewable charcoal or biochar based substitutes for inorganic products).

55. Moving to the production of biogas from green waste, household biogas plant developed by Samuchit Enviro Tech is constructed out of LDPE tanks and PVC plumbing materials, and this can be assembled by any plumber. It includes two models, the balcony model with a size of 0.5 m3 digester, and needs up to 2kg of kitchen waste and gives up to 300g of biogas, and is capable of replacing 100g of LPG, daily, whereas the terrace model is of a size of 1m3 digester, needs up to 5kg of kitchen waste, daily, while producing up1kg of biogas, and is capable of replacing 300g of LPG, daily.

56. Moreover, there is the institutional/ commercial biogas plant, of a capacity of 10m3 digester for commercial LPG replacement and it produces 2-3 Kg of LPGeq/day. This system needs an area that is open to sunlight throughout the day and water quantity of 100 litre per day (water can be is recirculated through the system resulting in sufficient fertilizers), and up to 50 kg of food waste or any green plant matter. The capital expense is recovered in about 3 to 4 years through saving in the cost of LPG.

57. Overfeeding should be strictly avoided, because the food that cannot be consumed by the methanogens would serve to increase the number of the undesirable microbes in the system. The rule of thumb for the daily feed rate is 1 g dry digestible matter per litre of digester capacity. To estimate the dry weight of the feedstock, you may assume that cooked food (e.g., boiled rice) has about 80% water, and uncooked food waste (e.g., vegetable waste) has about 90% water. When starting the operation, it is necessary to start with small input as the number of methanogenic bacteria is still low in the system. The feedstock input should be gradually increased towards the maximum allowed limit for the given size. Thus, in the first week only 20% of the recommended daily feedstock input should be given every day. The gas should be used up before feeding new input daily. In the second week the feeding can be increased to 40%, and so on, till the full capacity is reached in the fifth week.

58. For operating of a biogas system, it is important to begin with grinding the waste into a paste before introducing it into the digester is necessary, because the microbes have evolved in stomachs of animals, in which they were exposed to material chewed up by the animals. Every day, the feedstock must be mixed with a bucketful of water to pour into the biogas plant. Fresh water will be used the first time, but thereafter the effluent water can be collected and reused.

59. Water vapour is also generated in the system along with biogas. It is therefore necessary to have the gas outlet in the shape of a T junction. One arm of the T is connected to the gas outlet from the plant, out of the remaining two the upper arm is connected to the biogas stove, and the lower arm may be connected to a cock that is normally shut off. Once a day, this cock is opened to remove water accumulated in the gas outlet.

60. The challenges that have proved to be barriers to acceptance of the biogas system are:

- At household level
  - Subsidised petroleum based cooking gas (even if it is not accessible)
  - Perceived ‘hassle’ of processing organic waste
  - Total substitution of petroleum based gas is not possible using only own household waste
  - Biological system, therefore needs the same level of care and attention as a pet
  - Service and maintenance support is not available
- At community level
  - Non-segregated garbage received
  - Challenging to distribute biogas to households
  - Waste to biogas to electricity is more expensive than grid power

61. As a next generation in biogas technology, Samuchit Enviro Tech has therefore come up with a system that combines the advantages of a community biogas system and a household biogas plant, and overcomes the challenges in both types of systems. This in turn also creates an energy service based entrepreneurial opportunity, particularly in the context of rural energy requirements. The enterprise also will provide the service of environment friendly waste management to the village. The heart of the system is a two-step biogas plant, wherein both the steps are anaerobic.

62. Regarding to the economics of such a service, the land for the centralized biogas plant may be provided by the village council/community. As the business is providing an important civic service of waste management this use of common land of the community is justified.

63. The entrepreneur needs to invest in the following capital goods:
- Biphasic biogas plant
- Vehicles for door-to-door waste collection
- Rubber balloons for use as biogas transporting media
- Tanks and stoves at customer sites
- Incinerator to deal with hazardous waste

64. The running expense is primarily labour cost, fuel cost for vehicles, and sundry repair, maintenance etc., costs.

65. The revenue is generated through multiple means as follows:
- Waste management service fee received from the village council/community
- Price received for recyclable inorganic waste sold to scrap dealers
- Price received for the biogas from the end user customers

66. The enterprise may also receive additional support in the form of tax rebates, low interest bank loan, carbon finance, financial support through CSR and other donor agencies etc. Donor and CSR support as well as government support is justified because the enterprise provides a number of social and economic benefits through scientific waste management, livelihood generation, and supply of locally produced renewable and clean energy source for cooking. There is carbon finance potential as the system avoids methane generation through landfills, and replaces a fossil fuel (petroleum gas) with a renewable fuel (biogas).

II. EVALUATION

67. An evaluation questionnaire was distributed in order to assess the relevance, effectiveness and impact of the workshop. A total of 16 experts responded to the questionnaire, where 15 out of 16 participants rated the overall quality of the workshop as good to excellent quality. A total of 94% thought that the objectives of the workshop were met “to a satisfactory extent” and “to a great extent”. In rating the preparations of the workshop a total of 94% found them good to excellent. In terms of the usefulness of the workshop for reaching its objectives a total 88% rated the relevance of one’s expertise to the subject as good to excellent. 82% of the participants rated the relevance of other experts’ expertise to the subject as good to excellent, a total of 88% rated the workshop provided a forum for exchange of information and experience among experts as good to excellent. Moreover, 88% of the participants rated that the workshop provided an opportunity to establish new useful contacts as good to excellent, and a total of 94% rated the workshop provided useful input for future work as good to excellent. 94% found that presentations have good to excellent clarity, and 100 % found that the organizational arrangements for and during the workshop were good to excellent. With regard to follow-up action 100% of respondents were positive.

68. Comments

- ✓ Stress a bit more on the aspects of business models and their link with the financing mechanisms.
- ✓ Involve some private sector representatives to present their experiences and expectations in the off-grid rural electrification field, which would have been very useful for the planners and policymakers.
- ✓ Focus more on the aspects of technology choice which is one of the most critical factors that affect the success and sustainability of an off-grid rural electrification project. In addition to the Biogas-based power system which has been widely discussed during the last session, there are several types of technologies that can be used for off-grid rural electrification like Hydro power (mini, micro or pico system), Wind power and solar PV. A presentation of the key features of these technologies would probably have been much appreciated.
- ✓ Reserve a session for participants to present their experiences in the field of Off-grid rural electrification. This session would, firstly, create a link between the approaches proposed by the trainers and the specific situation in each country, and secondly, provide solutions for particular problems encountered in the targeted countries.

69. Follow up action:

- ✓ Develop a workshop that addresses solar energy and its application and technical specification
- ✓ Develop similar workshops in Lebanon
- ✓ Develop similar workshops with focus on technical specificities of RE
- ✓ Address energy policy development
- ✓ Work on implementing pilot projects in Lebanon or in any other country that suffers from garbage accumulation to produce energy
- ✓ Focus on technical training
- ✓ Present more case studies and countries experiences
- ✓ Share presentations and outcome of the workshop

III. ORGANIZATION OF WORK

A. VENUE AND DATE

70. The capacity building workshop “Promoting green energy technology market in rural areas” was held at UN-House ESCWA in Beirut, Lebanon on 24-25 May 2016.

71. The Expert Group Meeting falls under the Development Account (DA) project on "Building Capacities in Developing Appropriate Green Technologies for Improving the Livelihood of Rural Communities in the ESCWA Region".

B. Opening

24. The capacity building workshop of the DA project was formally opened by Ms. Radia Sedaoui, Chief Energy Section, at UN-ESCWA.

C. Participants

25. The workshop was attended by experts and representatives of United Nations agencies, public sectors including energy experts, policy makers, rural social developers and development planners, representing Arab countries of Jordan, Mauritania, Morocco, Oman, Sudan, and Palestine. The list of participants is contained in the annex to this Report.

D. Agenda

26. The agenda of the event included the following:

(a) Opening and Introduction

(b) Presenting on Off-grid electrification: policy framework, financing mechanisms, and community engagement

(c) Presenting on Morocco and other countries' experiences in rural electrification

(d) Presenting on Developing a winning business model

(e) Presenting on Bio-energy for Sustainable Rural Development Project

(f) Presenting on Selection of energy technology

(g) Presenting on Biomass energy as the basis for a rural energy service enterprise

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