

# Chapter 6

## System Design For Sustainable Energy For All: A New Role For Designers



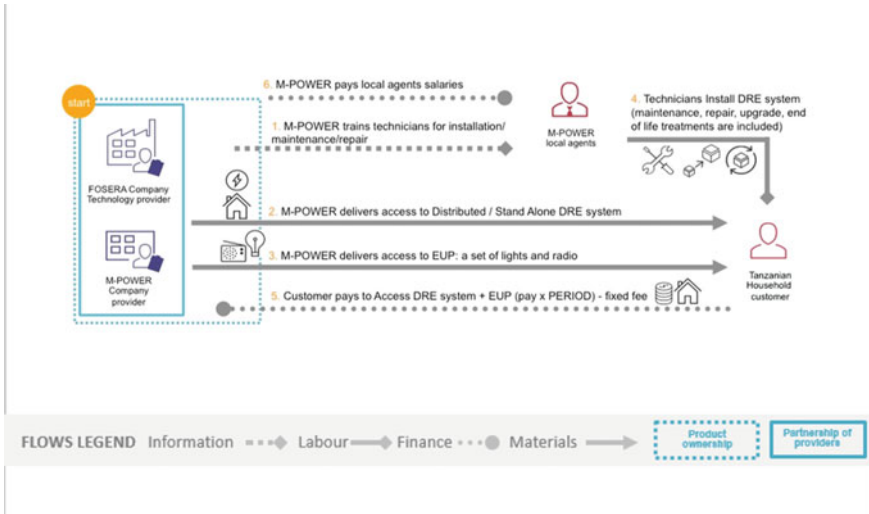
### 6.1 System Design for Sustainable Energy for All

We understood in the previous chapters that Sustainable Product-Service Systems (S.PSS) applied to Distributed Renewable Energy (DRE) represents a win-win opportunity to extend the access to sustainable energy to All. Indeed, this opens a new challenging role for designers, which claims for new knowledge-base and know-how, shortly defined as System Design for Sustainable Energy for All (SD4SEA). This role can be defined as follows:

the design of a **Distributed Renewable Energy Sustainable Product-Service System**, able to fulfil the demand of sustainable energy of low- and middle-income people (All) - possibly including the supply of the Energy Using Products/Equipment - based on the design of innovative interactions of the stakeholders, in which economic and competitive interest of the providers, continuously seek after both socioethically and environmentally beneficial new solutions.

This SD4SEA role could be described by highlighting the main approaches and the related skills:

- A. **‘satisfaction-system’ approach:** *design the energy access—possibly including the satisfaction of a particular demand (satisfaction unit)—and all its related products and services.*
- B. **‘stakeholder configuration’ approach:** *design the interactions of the stakeholder of the energy access system—possibly including those related to a particular ‘satisfaction unit’.*
- C. **‘system sustainability & energy 4all’ approach:** *design such a stakeholder interaction (offer model) for economic and competitive reasons which continuously seek after both socioethical and environmentally beneficial new solutions, while/by providing Sustainable Energy for All.*



**Fig. 6.1** Visualization of the System Map for an ‘Appropriate Stakeholder Configuration Design’. Source designed by the Authors

It is important to highlight that SD4SEA is a new role for designers that derives and is declined to design DRE with its peculiar characteristics. This vision supposes the couple of ‘Appropriate Technologies Design’ with ‘Appropriate Stakeholder Configuration Design’, addressed to S.PSS&DRE (Fig. 6.1).

To clarify this concept, let us take a look at the System map (Fig. 6.2) a visualisation of the results of a stakeholder configuration design process and design tool. It is built up by a set of stakeholders and by a set of interactions in between them, namely material, financial and information flows.

However, as we have mentioned before, not all S.PSSs are sustainable. Even though good ideas and solutions may seem sustainable at the beginning, looking into the whole system may not. Because of this reason, criteria and guidelines are needed (as well as coherent support *methods* and *tools*) to orientate design towards eco-efficient and socioethical stakeholder interactions. Within the LeNSes project, a set of criteria and related guidelines have been developed and are presented together with some examples in the following chapter.

## 6.2 SE4A Design Criteria, Guidelines and Examples

The following set of six design criteria and related guidelines could be used by the designer to develop Distributed Renewable Energy as Sustainable Product-Service System.



**Fig. 6.2** Indigo, Sub-Saharan Africa. *Source* [www.azuri-technologies.com](http://www.azuri-technologies.com)

First, the list of criteria is provided. Consequently, each criterion and related guideline is exemplified through case studies.

*Criteria to develop Distributed Renewable Energy as Sustainable Product-Service Systems.*

1. Complement the DRE offer with life cycle services (turnkey based);
2. Offer ownerless DRE systems as enabling platform;
3. Offer ownerless DRE systems with full services;
4. Add to DRE offer, the supply of ownerless Energy-Using Products and/or Energy-Using Equipment;
5. Delinked payment from pure watt consumption (affordable costs);
6. Optimise DRE systems configuration.

**1. Complement the DRE offer with life cycle services (turnkey based)**

This means to think about providing a business solution, which offers/sells to customers DRE systems (e.g. the energy generator, the storage or battery, the inverter and the wiring) complemented by different support services such as financial, design, installation, maintenance, repairing, upgrading and end-of-life treatment. The guidelines invite to design life cycle services that could be valuable in relation to the defined customer/s and unit of satisfaction.

- 1a. Complement the DRE offer, with financial services to support initial investment and installation costs, e.g. microcredit, crowdfunding and donation.
- 1b. Complement the DRE offer, with support services for the design and installation of its components, e.g. the generator, the storage, the inverter and the wiring.
- 1c. Complement the DRE offer, with support services during use, i.e. maintenance, repairing and upgrading of its components.
- 1d. Complement the DRE offer, with support services for the end-of-life treatment of its components.

### **1a. Example for complement DRE offer with financial services**

*Grameen Shakti/since 1996*

*Category: Solar Energy*

*Provider/s: Grameen Shakti*

*Customer: Households*

*Location: Bangladesh*

As introduced (paragraph 4.4.2), Grameen Shakti offers Solar Home Systems (SHS) with a service package which includes end-user credit, installation, maintenance and repair, and take-back services. End users can benefit from a *financial service*, which allows them to purchase the SHS with microcredit services and repay the loan in 3–4 years. This means no initial investment cost for customer who becomes owner of the SHS with effective after-sale services included.

### **1b. Example for complement DRE offer with support services for the design and installation**

*Indigo/since 2012*

*Category: Solar Energy*

*Provider/s: Azuri Technologies*

*Customer: Households*

*Location: 11 countries around Sub-Saharan Africa*

Indigo allows customers to purchase a Solar Home System (SHS) existing of a 2–5 W solar panel, battery, the charge controller, two LED lamps and a phone charge unit with cables, for only 10€. After the first payment, the SHS is installed by local dealer at the customer place, to use the SHS pays on a pay-as-you-go system: buying 1€ scratch card to access electricity for a week (eight hours of light each day and mobile phone charging) by inserting the code in the SHS charge controller. After 18 months, the purchase of scratch cards allows the system to be paid off and the customer can choose to either unlock his/her SHS or to upgrade to a larger model.

Indigo designs and produces the charge controller of the SHS, as key products to calculate energy expense and availability. The other components of the SHS come from other producers and are designed to meet the Lighting Global Quality Standards.

### **1c. Example for complement DRE offer with support services during use**

*Bboxx solar energy company/since 2010*

*Category: Solar Energy*

*Provider/s: Bboxx*

*Customer: Households*

*Location: Africa, Asia*

Aside its offer introduced (paragraph 4.4.2), Bboxx has built up 45 shops across six countries in Africa and Asia, where it sells its own Solar Home Systems (SHS) and related appliances. The units are SMART and GSM enabled, and are remotely connected to a central database. Bboxx uses its platform, called ‘SMART Solar’, to monitor energy consumption and the performance of the systems. Customers pay a monthly fee (from 10 to 20 USD) depending on the size of the system and their chosen accessories. Installation and maintenance are included in a service fee and are done by Bboxx’s local technicians. After complete repayment, the customer can go for a maintenance contract, which means he/she continues to get support and replacements for the unit, battery and panel. After around 3 years of payments, the customer owns the appliances. Analysis of data is used to optimise products and extend the life of the batteries, as such diminishing the frequency of replacement (Fig. 6.3).

## **2. Offer ownerless DRE systems as enabling platform**

This means to think about providing a business solution, which offers to customers DRE systems, owned by the provider, as platforms that enable customers to operate on them to access to energy.

The guidelines invite to design enabling services that could be valuable in relation to the defined customer/s and unit of satisfaction.

- 2a. The energy supplier (existing or newly established) complements an ownerless offer of the DRE system—micro-generator eventually with some of accessories (storage, inverter, wiring, etc.) and/or the mini-grid—with training/information services to enable the customer to either design, instal, maintain, repair and/or upgrade one or more DRE components.



**Fig. 6.3** Bboxx, Africa and Asia. *Source* [www.bboxx.co.uk](http://www.bboxx.co.uk)

- 2b. The micro-generator producer complements an ownerless offer of the micro-generator—eventually with its accessories and/or the mini-grid—with training/information services to enable the customer to either design, instal, maintain, repair and/or upgrade the micro-generator.
- 2c. The storage and/or the inverter, etc. producers complement an ownerless offer of their products with training/information services to enable the customer to either instal, maintain, repair and/or upgrade their products.
- 2d. A partnership composed by two or more stakeholders among the energy supplier, the micro-generators producer, the storages producer, the inverters producer, etc., complements an ownerless full package offer of their products with training/information services to enable the customer to either instal, maintain, repair and/or upgrade them.

**2a. Example for complement an ownerless offer with training/information services**

*Sunlabob solar energy/since 2000*

*Category: Solar Energy*

*Provider/s: Sunlabob, local committee*

*Customers: Inhabitants*

*Location: Laos*

As introduced (see paragraph 4.4.2), Sunlabob leases a charging station with Energy-Using Products (EUP—e.g. solar lanterns) to an established village committee who rents the products to the individual households. Sunlabob supports the setting and training of a local committee which is responsible for setting prices, collecting rents and perform basic maintenance. To use the charging station, the committee pays around 1.70 € per month, without having the ownership of it. People can participate to the income-generating activities being part of the village committee, this increasing local competence and income (Fig. 6.4).

### 3. Offer ownerless DRE systems with full services

This means to think about providing a business solution, which offers the final satisfaction, i.e. the access to energy, and the customers neither own nor operate the DRE system. The guidelines invite to design full packages of services that could be valuable in relation to the defined customer/s and unit of satisfaction.

- 3a. The energy supplier (existing or newly established) complements the ownerless offer of the DRE system—micro-generator eventually with some of its accessories (storage, inverter, wiring, etc.) and/or the mini-grid—with the offer of one or more life cycle support services, i.e. installation, maintenance, repairing, upgrading and end-of-life treatment.



**Fig. 6.4** Sunlabob, Laos. *Source* [www.sunlabob.com](http://www.sunlabob.com)

- 3b. The micro-generator producer complements the ownerless offer of the DRE system, with the offer of one or more life cycle support services, i.e. installation, maintenance, repairing, upgrading and/or end-of-life treatment.
- 3c. A partnership composed by two or more among the energy supplier, the micro-generator producer, the storages producer, the inverters producer, etc., complements the ownerless full package offer of their products, with one or more life cycle support services.

**3a. Example for energy supplier complements an ownerless offer of the DRE system with the offer of one or more life cycle support services**

*OMC Power/since 2011*

*Category: Hydro/Solar/Wind/Hybrid Energy*

*Provider/s: OMC Power*

*Customer: Telecommunication companies and communities*

*Location: India*

As introduced (paragraph 4.4.2), OMC Power offers energy solutions to telecommunication companies, through stand-alone power plants running on solar, wind and biogas. Telecommunication companies get the power plant installed on site and pay according to the energy they use (kWh). OMC Power retains the ownership of the energy system and provides operation and maintenance during the whole life cycle of the plant. The opportunity of having access to renewable and stable electricity increases reliability and continuity of companies in their work.

**4. Add to DRE offer, the supply of ownerless Energy-Using Products and/or Energy-Using Equipment**

This means to think of providing a business solution, which offers to customers, in addition to DRE systems offered (in one of previous three modalities), the supply of ownerless products that run on energy such as Energy-Using Products, e.g. light bulbs and radio, and/or Energy-Using Equipment, e.g. sewing machine and washing machine. The guidelines invite to offer Energy-Using Products/Equipment through S.PSS logic that could be valuable in relation to the defined unit of satisfaction.

- 4a. The energy supplier complements the offer of ownerless DRE system and its life cycle services, with the offer of Energy-Using Products and/or Energy-Using Equipment (ownerless and/or complemented with life cycle services).



- 4b. The micro-generator producer complements the offer of ownerless micro-generator and its life cycle services, with the offer of Energy-Using Products and/or Energy-Using Equipment.
- 4c. An Energy-Using Products or Energy-Using Equipment producer complements the offer of ownerless products and their life cycle services, with DRE system offer.
- 4d. A partnership composed by two or more stakeholders among the energy supplier, the micro-generators producer, the storages producer, the inverters producer, etc. and the Energy-Using Product producer, offer a full package of ownerless DRE system and Energy-Using Products or Energy-Using Equipment with their life cycle services.

#### **4a. Example for energy supplier complement the offer of ownerless DRE system and life cycle services**

*Husk Power Systems (HPS)/since 2007*

*Category: Biomass Energy*

*Provider/s: Husk Power*

*Customer: Households and companies*

*Location: India*

As introduced (paragraph 4.4.2), Husk Power System (HPS) provides energy solutions by installing biomass power plants and wiring villages to deliver electricity. The company retains ownership of the DRE plant and employs local agents for operation, maintenance and fee collection. In some villages with grid power, households and businesses choose to connect to the HPS supply because of its reliability and lower cost. HPS provides full medical benefits and retirement contributions for its full-time employees. Furthermore, farmers can earn an income from the sale of rice husks, and some residents have been trained to do maintenance and operation of the plant creating new income-generating activities (Fig. 6.5).

#### **5. Delink payment from pure watt consumption (affordable costs)**

This means to think of providing a business solution at affordable costs offering a type of payment dissociated from the energy consumption, e.g. customers pay either per demand, time or use/satisfaction, and the availability of energy depends on the maximum capacity of the DRE system installed. The guidelines invite to choose a payment modality that could be valuable in relation to the defined customer/s and unit of satisfaction.



**Fig. 6.5** Husk Power Systems, India. *Source* [www.huskpowersystems.com](http://www.huskpowersystems.com)

- 5a. Offer pay  $x$  period, i.e. the cost is daily, weekly, monthly or yearly fixed.
- 5b. Offer pay  $x$  time of access to energy, i.e. the cost is fixed per minutes/seconds of access to energy.
- 5c. Offer pay  $x$  use/satisfaction unit of (energy-using) product, i.e. the cost is fixed per product performance (e.g. km for a vehicle, washing cycles for washing machine).
- 5d. Offer payment based on hybrid pay  $x$  period, pay  $x$  time and pay  $x$  use modalities.
- 5e. Offer payment with the support of additional financial support from public administrations/entities.

#### **5a. Example for DRE offer as pay per period**

*OFF-GRID Electric/since 2012*

*Category: Solar Energy*

*Provider/s: M-POWER*

*Customer: Households*

*Location: Tanzania*

As introduced (see paragraph 4.4.2), M-POWER offers to Tanzania rural people Solar Home Systems (SHS) (Solar panel + Storage + Wires) and the related Energy-Using Products (EUP) (two lights + phone charger) as a pay per period with a daily/weekly/monthly fee. M-POWER retains the ownership of SHS and EUPs including their maintenance and repair.

### **5c. Example of DRE offer as pay per use/satisfaction unit**

*Solar-Powered Café/since 2001*

*Category: Solar Energy*

*Provider/s: Solar Charge*

*Customer: Inhabitants*

*Location: South Africa*

The Solar-Powered Café pilot project offers a solar-powered connection centre and charging point, bringing low-cost access to IT services. Ownership of the connection centre and charging point (and of all the included Energy-Using Products) is retained by Solar Charge. The customer pays per use with three different offers at same price: one internet access, one IT service and one phone charging. The connection centre has a highly trained administrator to manage any problems that may arise (Fig. 6.6).

## **6. Optimise DRE systems configuration**

This means to think of providing a business solution with the best-optimised configuration for the DRE system according to the context conditions. In other words, understand whether providing distributed or decentralised stand-alone systems for off-grid contexts or creating a distributed or decentralised mini-grid to share the energy surplus. The guidelines invite to optimise the DRE systems configuration in relation to the defined customer/s, unit of satisfaction and context of use.

- 6a. Offer stand-alone Distributed Renewable Energy (DRE) systems for homes or business sites (especially to off-grid and isolated sites).
- 6b. Offer local mini-grids connecting DRE systems, to enable local energy surpluses sharing (especially for context with nearby energy-consuming units).
- 6c. Offer Decentralised Renewable Energy stations as charging spot or energy use services spot with EUP/EUE for local communities.
- 6d. Offer Decentralised Renewable Energy systems to enable local supply of energy throughout a mini-grid for homes and/or business sites.
- 6e. Offer DRE system with connection to main-grid, enabling homes, small business and local mini-grids the selling/purchasing of energy.



**Fig. 6.6** Solar-Powered Café, South Africa. *Source* [www.kutengatechnology.com](http://www.kutengatechnology.com)

### 6a. Example for DRE offer as stand-alone DRE system

*Domestic Biogas/since 2007*

*Category: Biogas Energy*

*Provider/s: Biogas Sector Partnership, customer, partnerships with private companies*

*Customer: Households*

*Location: Nepal*

Biogas Sector Partnership installs biogas plants as distributed stand-alone DRE systems in households, providing biogas for cooking and lighting. A plant costs between 350 and 450€; about one-third of this is paid in-kind, through the family providing labour and materials. The remaining is paid usually in 18 months, with opportunity of micro-financing plans. Customers are trained for minor repairs and operations on plants; a 3-year guarantee period is included (Fig. 6.7).



**Fig. 6.7** Domestic Biogas, Nepal. *Source* [www.ashden.org](http://www.ashden.org)

### **6c. Example for DRE offer as decentralised DRE station**

*Solar Transition/Since 2011*

*Category: Solar Energy*

*Provider/s: Ikisaya Energy Group (Cooperative-Based Organisation)*

*Customer: Community*

*Location: Kenya*

Solar transition, settled in Ikysawa village in Kenya, is a village decentralised DRE station that provides renewable energy for a range of daily services: lantern and battery charging and renting, charging of mobile phones, IT services (typing, printing and photocopying), television and video shows. The decentralised DRE station is provided with the hardware to generate solar energy (Solar panel + Storage + Wires) and a configurable series of Energy-Using Equipment (EUE). Solar transition recharging station is owned and managed by the community itself who becomes local entrepreneur with competences on maintenance and repair. Customers have first to pay an initial membership fee; so forth they pay only for each service they use, as a pay per use payment. The opportunity to access several services related to energy (e.g. print, computer use) facilitates local communication with activities outside from the villages, and families can socialise in the common space.

### **6d. Example for DRE offer as decentralised renewable energy system throughout MINIGRID**

*Micro-hydro grid/since 1996*

*Category: Hydropower Energy*

*Provider/s: CRELUZ (Cooperativa de Energia e Desenvolvimento Rural do Médio Uruguai Ltda)*

*Customer: Community*

*Location: Brazil*

The project provides decentralised renewable energy plants, in the configuration of mini-hydropower plants, connected through local mini-grid (already existing), generating part of the community electricity needs. Customers pay the electricity used in their home connected to the mini-grid in the various payment points available. Local operators have been trained on the technical aspects of the hydro plant, as part of the educational project to make people aware of power generation. Maintenance and repair is done by CRELUZ, and emergency phone service is guaranteed 24 h.

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