Sustainable Thermal Energy Partnerships (STEPs)

Literature Review: Rural Business Models in Asia

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ACRONYMS

ASERD	Afghanistan Sustainable Energy for Rural Development
BM	Build-Maintain
BOOM	Build-Own-Operate and Maintain
BSP	Biogas Support Programme
DfID	Department for International Development
FS	Fully Subsidised
GHG	Green-house Gas
GSWH	Global Solar Water Heating
HPS	Husk Power Systems
IDCOL	Infrastructure Development Company Limited
LaBL	Lighting up a Billion Lives
LPG	Liquefied Petroleum Gas
NGO	Non-Governmental Organisation
O&M	Operation and Maintenance
PPP	Public-Private-Partnerships
PV	Photovoltaics
PVPS	Photovoltaic Pumping Systems
SEA	Sustainable Energy Associates
SHS	Solar Home Systems
STEPs	Sustainable Thermal Energy Partnerships
SWHS	Solar Water Heating Systems
TERI	The Energy and Resources Institute
UID	Unique Identity
UNDP	United Nations Development Programme
VLE	Village Level Entrepreneur

1.0 BACKGROUND

Asia and Oceania are home to a significant share of the global population without energy access. The electrification rates as of 2010 in Oceania are 25%, South Asia at 75%, South-east Asia at 88%, Western Asia at 91% and East Asia at 98% , all of which compares to 32% electrification rate in Sub-saharan Africa[1]. Asia managed to provide electricity access to 788 million people over the period 1990-2010[2]. The growth in electrification rates were driven by South Asia and South-east Asia with minimal growth rates in Oceania. There are 8 Asian countries in the list of top 20 countries with largest electricity access deficits in terms of population. These are India with 309 million people without electricity access, Bangladesh with 67, Myanmar with 25 million, Afghanistan with 18 million, North Korea with 18 million, Philippines with 16 million, Pakistan with 14 million and Indonesia with 14 million[3].

Similarly Asia faces significant challenges in access to modern thermal energy. The rates of access to modern thermal energy in 2010 was 31% in Oceania, 40% in South Asia, 48% in South-east Asia, 55% in East Asia, 85% in Central Asia and 95% in West Asia which compares to 19% modern thermal energy access rates in Sub-saharan Africa[4]. During the period 1990 to 2010, Asia managed to provide modern thermal energy access to 760 million people[5]. This high rate of thermal energy access rates were driven by increased thermal energy access in West Asia, East Asia, Southern Asia, South-east Asia and Central Asia. There are also 11 Asian countries in the list of top 20 countries with the largest modern thermal energy deficits. These are India with 705 million, China with 613 million, Bangladesh with 135 million, Indonesia with 131 million, Pakistan with 111 million, Viet Nam with 49 million, Philippines with 46 million, Myanmar with 44 million, Afghanistan with 27 million, Nepal with 25 million and North Korea with 22 million[6].

Asia therefore continues to face significant challenges in ensuring electricity and modern thermal energy access to its population. While the share of the population without access to electricity and thermal energy is relatively low[7], the absolute number of people without access continued to be significant.

Of the top 20 countries with the largest number of people that have been provided electricity access during the period 1990 to 2010, 12 are located in Asia. The most impressive electrification efforts globally have also occurred in India, China, Indonesia, Pakistan and Bangladesh, all located in Asia[8]. Similarly of the top 20 countries that have provided thermal energy access to largest number of people, 12 are in Asia. The most impressive thermal energy access efforts were made by India and China in Asia followed by Brazil. So the Asian experience in providing electricity and thermal energy to its population at such high rates offers significant lessons in terms of policies, regulations as well as business models for rest of the world and especially for Sub-Saharan African countries.

This report by Sustainable Energy Associates (SEA) under the project Sustainable Thermal Energy Partnerships (STEPs) funded by a grant from the Department for International Development (DfID) examines the business models for electricity, lighting, mechanical energy, space heating, cooking and hot water from Asia. The objective of this review based on available

[1] Sustainable Energy for All (2013), Global Tracking Framework Volume 3.
[2] Sustainable Energy for All (2013), Global Tracking Framework Volume 3.
[3] Sustainable Energy for All (2013), Global Tracking Framework Volume 3.
[4] Sustainable Energy for All (2013), Global Tracking Framework Volume 3.
[5] Sustainable Energy for All (2013), Global Tracking Framework Volume 3.
[6] Sustainable Energy for All (2013), Global Tracking Framework Volume 3.
[7] Compared to Sub-Saharan Africa.
[8] Sustainable Energy for All (2013), Global Tracking Framework Volume 3.

literature is intended to serve as guidance for other regions and countries with significant energy access challenges, especially in Sub-saharan Africa.

2.0 BUSINESS MODELS

The business models that have been deployed have been classified on the basis of the nature of the energy service as follows:

- **Electricity Business Models**: these business models cover efforts that provide electricity to those without access mainly through the electricity grid. Examples of such efforts can be found in China, Viet Nam and Thailand in Asia.

- **Lighting business models**: these business models involve provision of lighting services to those without access to modern lighting devices. Examples of such programmes can be found in Bangladesh and Nepal in Asia.

- **Mechanical energy business models**: these business models involve provision of mechanical energy in locations where the traditional forms of mechanical power were animal and manpower. Such examples are available in India.

- **Space Heating or Cooling Business models**: these business models are used for providing space heating or cooling services to end-users. Examples of such programmes can be found in China and Afghanistan in Asia.

- **Cooking business models**: involve business models employed for promoting and diffusing clean and efficient cooking devices and clean fuels. Examples of such programmes can be found in Nepal and Viet Nam in Asia.

- **Hot Water Business Models**: these business models include models that have been used to provide hot water services to establishments and households. Examples of such programmes can be found in India.

These business models for different energy access services are explained in the sections that follow.

3.0 ELECTRICITY

The electricity business models for energy access have been the traditional business models where electricity is supplied by the utility through a reticulated electricity network. The electricity distributors or utilities provide electricity through a metered consumer connection and the user pays for the electricity consumed on a periodic basis. The key features of the electricity service business models in Asia are:

- The energy utility makes the capital investments in the generation equipment and the electricity network system required to supply households and economic activities.

- The energy access investments can be in grid-extension where the investment covers the cost of extension of the existing transmission and distribution network to the point of supply. The energy access investments can also be in mini-grid systems where in addition to a low-voltage distribution, investments in a generation system are also required;

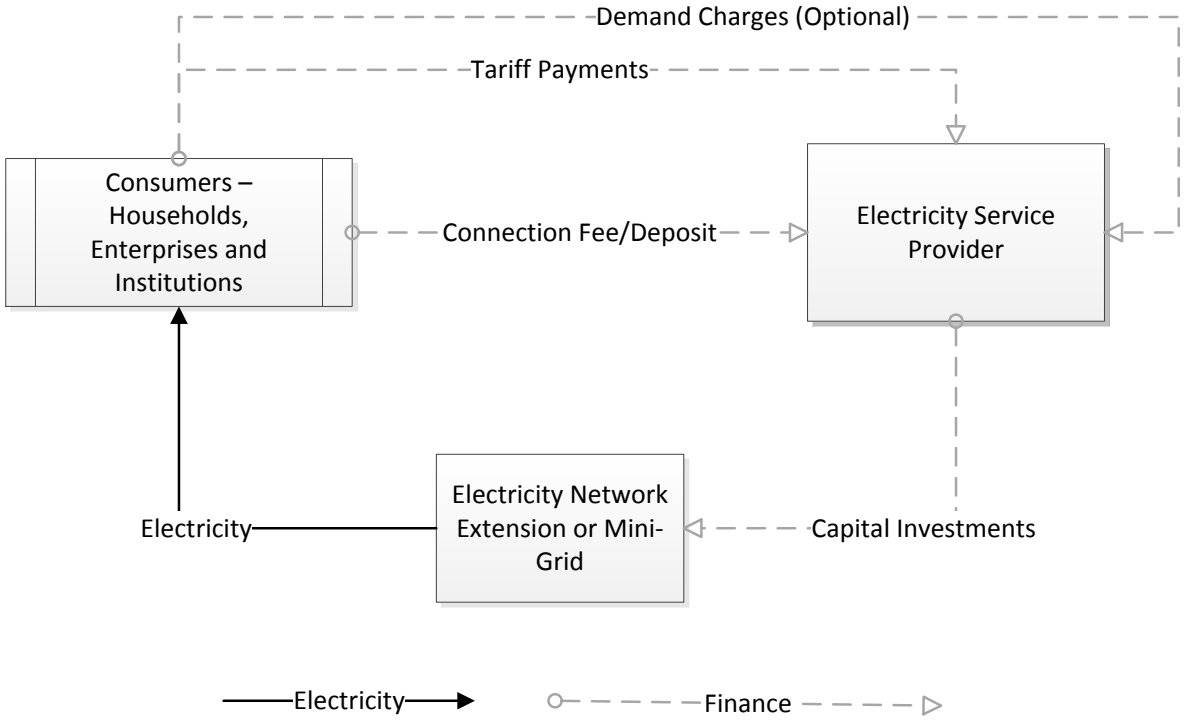
- The electricity consumers – households, enterprises and institutions usually make an upfront payment for offsetting some of the costs of investments by the utility. In some cases this is treated as a deposit and is will be returned by the electricity service provider;

- The electricity consumers then pay for the electricity consumption either on a pre-paid[9] or post-paid[10] basis. The electricity tariffs are generally differentiated and consumers pay different rates for each unit of electricity consumed. The tariffs are generally approved by an electricity regulator in countries where a regulatory framework exists.

- In some cases, the consumers also pay a demand change as part of the tariff where a fixed payment is made periodically based on the power demand of the electricity consumer. The basis for the demand charge is generally the rated power consumption capacity of the electrical equipment at the premises of the consumer.

The business models for electricity access in Asia are shown in fig 1 below:

Fig 1: Electricity Access Business Models in Asia



(Source: SEA)

- In a number of countries in Asia such as China, India, Thailand etc. have introduced policy and incentive frameworks which support rural and village electrification which offsets the cost of investments and supply in electricity access through grants and subsidies.

[9] Consumers buy electricity upfront and consumer it thereafter using a pre-pay meter with card readers.
[10] This is the more common form of service and the consumer pays for the electricity consumed based on the metered quantity of electricity consumed periodically – typically every month.

- In a number of countries the energy regulator and the governments favour a cross-subsidy system where the rural and village level consumers pay a lower electricity tariff. The revenue loss in the village and rural energy supply is offset by provision for higher tariffs to urban consumers as well as for commercial and industrial consumers.

Increasingly a number of business model innovations have been happening in Asia in the area of mini and micro-grid systems for village and rural electrification. Some of the innovative mini and micro-grid business models involve models such as Public-Private-Partnerships (PPPs) such as the Sunlabob Hybrid Mini-grids in Laos[11], private sector led profitable micro-grids which recover investment and operating costs like Husk Power Systems (HPS) in India[12], The New Zealand government supported 1 MWp solar mini-grid in Bamiyan, Afghanistan where the investment costs are fully subsidised and operation and replacement costs are recovered[13]. Countries such as Nepal, Sri Lanka, Lao, Mongolia and Viet Nam also have national rural electrification programmes that have mini and micro-grid components[14]. The micro and mini-grid business models in Asia have significant similarities with the electricity grid extension business models but some of the key differentiating features include:

- The investments in the mini-grid are mostly from public finance and cover the full or past cost of investments. There are some exceptions like the HPS and Desi Power in India which are fully financed by private sector investors[15].

- The energy service operators for mini and micro-grids have mainly been from the private sector and community organisations followed by some instances of PPPs and public sector operation;

- Most mini and micro-grids use a time-based tariff payment system where a flat tariff is paid by the consumer every month[16] with a load limiter. Some of the larger and publicly financed mini-grids grids used electricity based tariffs that are metered.

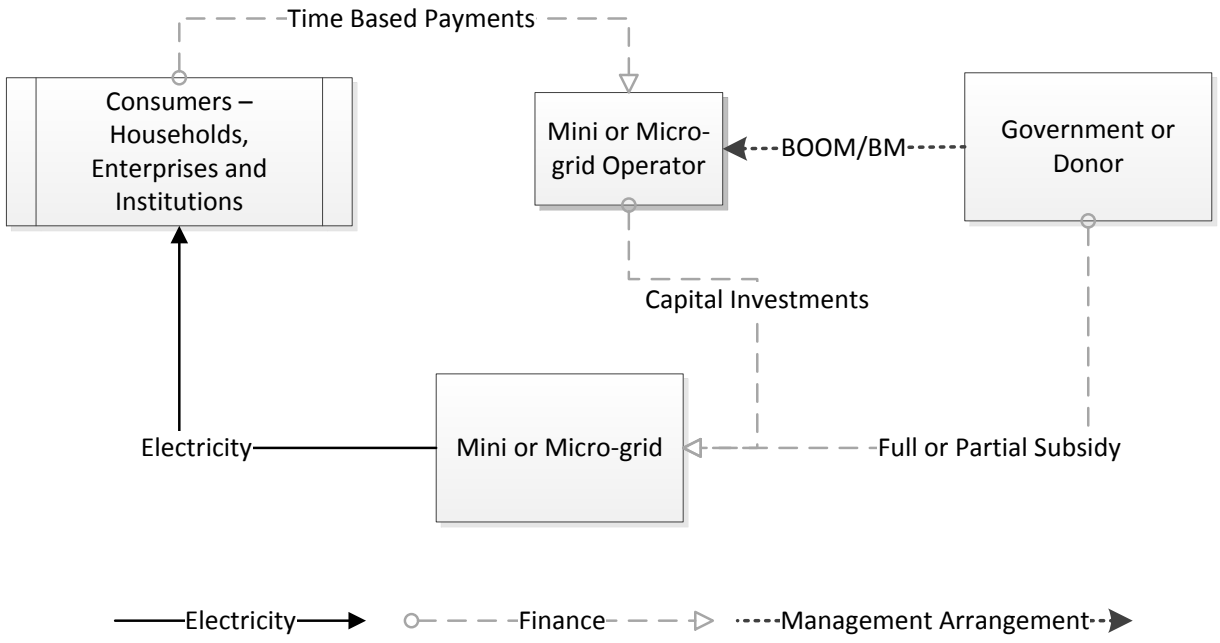
- The common institutional arrangements that have been used in mini and micro-grid developments have been Build-Own-Operate and Maintain (BOOM) and Build-Maintain (BM) involving the private sector. Public agencies have employed the Fully Subsidised (FS) model.

- Most mini-grid business models do not demonstrate financial and business sustainability and the tariffs only cover the cost of operation and maintenance (O&M). Cost recovery of capital and replacement costs are not normally factored in. One of the more sustainable models is operated by HPS which is able to cover investment, O&M costs and allow for profits[17].

The business models for electricity access using mini and micro-grids is illustrated in fig 2.

[11] Bellanca et al (2013), Delivering Energy for Development.
[12] Schnitzer D. et al (2014); Micro-grids for Rural Electrification
[13] Parthan, B(2014); Afghanistan Sustainable Energy for Rural Development
[14] UNDP (2013); Achieving Sustainable Energy for All in the Asia Pacific
[15] Schnitzer D. et al (2014); Micro-grids for Rural Electrification
[16] Sometimes daily payments and pre-payments have also been employed
[17] Schnitzer D. et al (2014); Micro-grids for Rural Electrification

Fig 2: Mini and Micro-Grid Electricity Access Business Models in Asia



(Source: SEA)

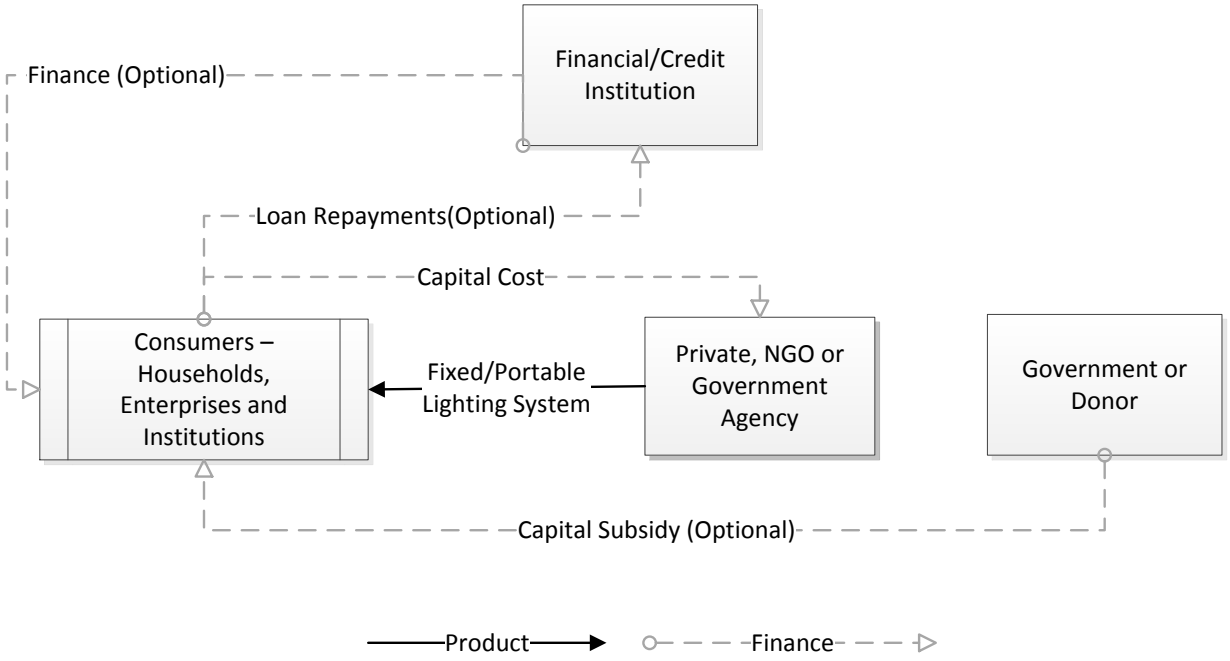
4.0 LIGHTING

There are also a number of business models employed in Asia that focus on addressing the lighting needs in un-electrified and remote locations. These initiatives seek to displace lamps that are typically fuelled by Kerosene with portable or fixed lighting systems. Most of this lighting energy access market segment in Asia is dominated by Solar Photovoltaics (PV) technology. There are two main business models used for lighting systems – direct sales and fee-for-service models.

In the direct sales model, the lighting system – either portable systems called solar lanterns or fixed systems called Solar Home Systems (SHS) are sold to the users. The sales can be through full upfront payment of the system[18] or through financing where the buyer pays for the system over a period of time. In both the models the user will own and operate the lighting system and the supplier will provide after-sales service and maintenance. The direct sales model may also involve a capital subsidy from governments which is aimed at making the systems affordable to more users and encouraging accelerated diffusion. The direct sales agent can be private sector entities, Non-Government Organisations (NGO) and Government agencies. The 'Solar Tuki' programme in Nepal is a direct sales programme without subsidies and the Infrastructure Development Company (IDCOL) Programme in Bangladesh is a large successful SHS direct sales programme with financing[19]. The direct sales model is illustrated in fig 3.

[18] Typically for small and portable lighting systems
[19] Palit, D. (2013), Solar energy programs for rural electrification: Experiences and lessons from South Asia

Fig 3: Direct Sales Business Model for Lighting Energy Access

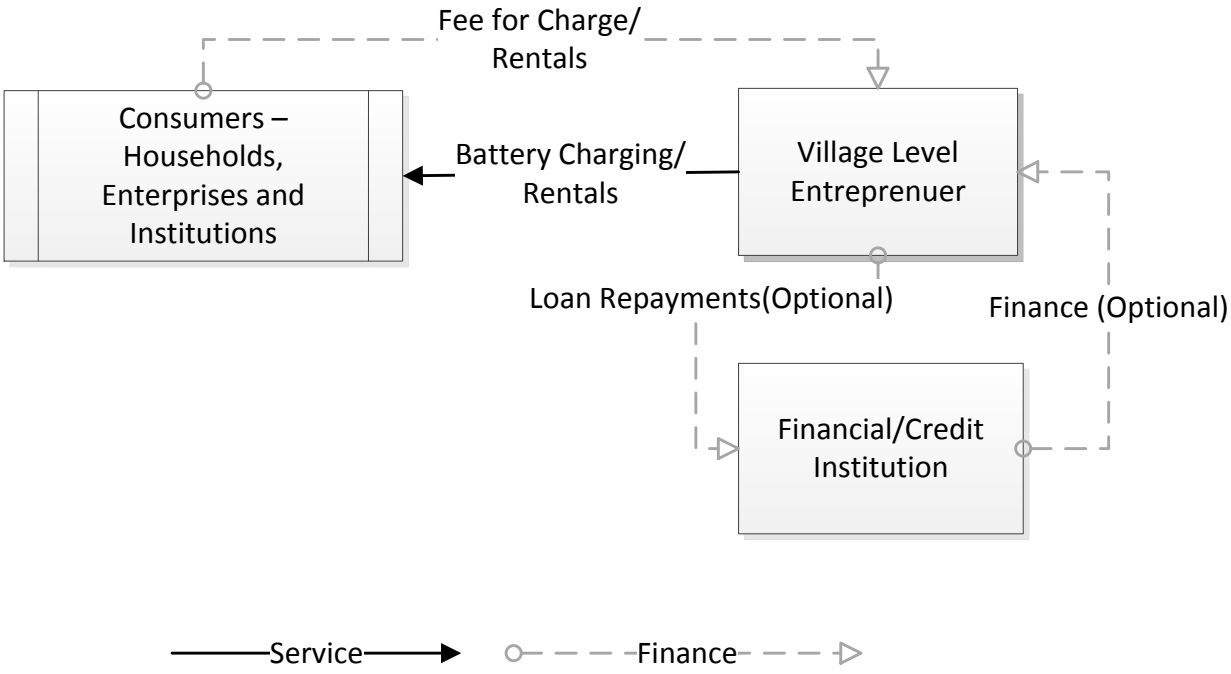


(Source: SEA)

In the fee-for-service model, the lighting system is either owned by the user or owned by the service provider. In the cases where the lighting system is owned by the user, the service provider owns and operates the generator, typically a diesel generator or a PV panel. The service provider recharges either the battery[20] or the system[21] and a payment is made for each recharge. A variation of this model is one in which the generator and the portable lighting systems are owned by the service provider and the portable lighting systems are rented out for time based payments – typically for one night. The Village Level Entrepreneur (VLE) led pedal power based charging systems by NuRu energy in India is an example of the fee-for-service where payments are made for each recharge[22]. The Lighting up a Billion Lives (LaBL) model implemented by The Energy and Resources Institute (TERI) using VLEs who provide centralised charging and daily solar lantern rental service is an example of the variant with time based payments[23]. Another model by Simpa Networks in India uses a pre-purchase arrangement where the user pre-pays for lighting through purchase of scratch cards and keying in the scratch card code through a mobile telephony enabled gateway to obtain a certain number of lighting hours[24] . Once the cumulative purchase of energy crosses a threshold, the ownership of the system is transferred to the user. The VLE may finance the charging and rental infrastructure from own resources or with loan finance from a financial institution. The fee-for-service model for lighting is shown in Fig 4.

[20] For fixed systems where the battery can be disconnected and transported.
[21] For portable systems where the lighting and electrical storage are integrated.
[22] REEEP (2011), Project Profiles 2011/12
[23] Palit, D. (2013), Solar energy programs for rural electrification: Experiences and lessons from South Asia
[24] REEEP (2011), Project Profiles 2011/12

Fig 4: Fee-for-Service Business Model for Lighting Energy Access



(Source: SEA)

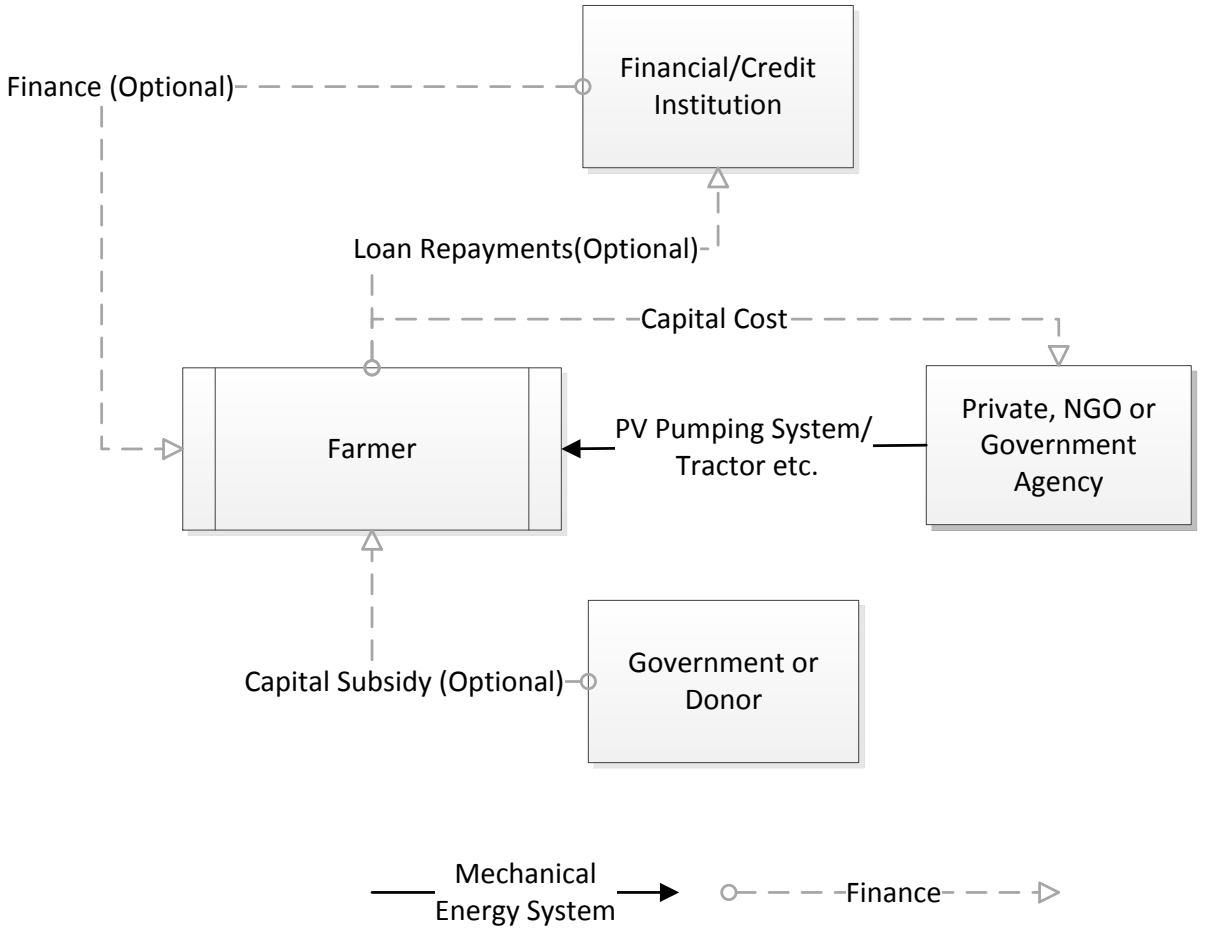
5.0 MECHANICAL ENERGY

Villages and Rural areas in Asian developing countries have traditionally relied on animals and manpower for their mechanical energy needs relating to pre-harvest land preparation, water-pumping for irrigation and domestic water supply, post-harvest agro-processing such as de-husking, hulling, grinding, expelling etc. Absence of modern forms of energy has constrained agricultural productivity and a key dimension of energy access is to provide energy for such productive use. There are two variants of the mechanical energy access business models similar to lighting energy access models which are direct sales and fee-for-service.

In the direct sales model a modern and mechanised energy system such as a Photovoltaic Pumping System (PVPS) or a tractor is directly sold to the farmer on an outright payment basis or with the help of loan-finance. The upfront payments and loan repayments are linked to agricultural cycles and sometimes the capital costs of the mechanical energy system is subsidised by the government or development agency. The Indian Solar pumping programme is an example of a programme promoted through capital subsidy and low-interest loans[25]. The direct sales model for mechanical energy is illustrated in Fig 5.

[25] Parthan B, Bakthavatsalam.V. and Hart TJ (1997) The Indian Solar pumping experience and commercialisation initiatives

Fig 5: Direct Sales Business Model for Mechanical Energy Access

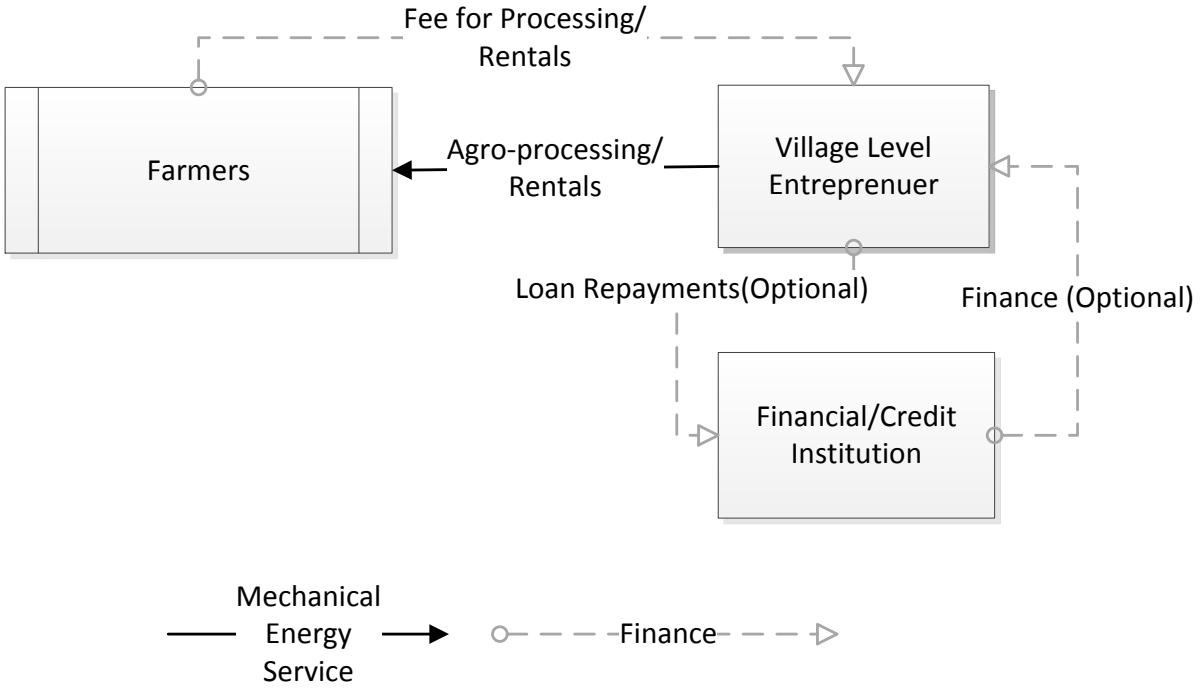


(Source: SEA)

The fee-for-service version of mechanical energy access is generally applicable for post-harvest agro-processing of the agricultural produce. In this business model a VLE establishes a local agro-processing centre where milling of wheat or rice, expelling oil from oil seeds etc. offered for a fee, normally depending on the volume of harvest processed. There are also VLEs who offer pre-harvest equipment like tractors, tillers etc. on time-bound rentals, typically daily or hourly rentals. The VLEs establish the agro-processing centre or the agro-machinery rental services with own funds or with loan finance from a financial institution. An example of such VLEs is the upgrading the hydro-mechanical systems of traditional water-mills in Nepal and India for efficient grinding services[26]. The fee-for service mechanical energy access business model is shown in fig. 6.

[26] Parthan B. et al (2000), Sustainable Hydro Projects : A case from the Himalayas

Fig 6: Fee-for-Service Business Model for Mechanical Energy Access



(Source: SEA)

6.0 HEATING AND COOLING

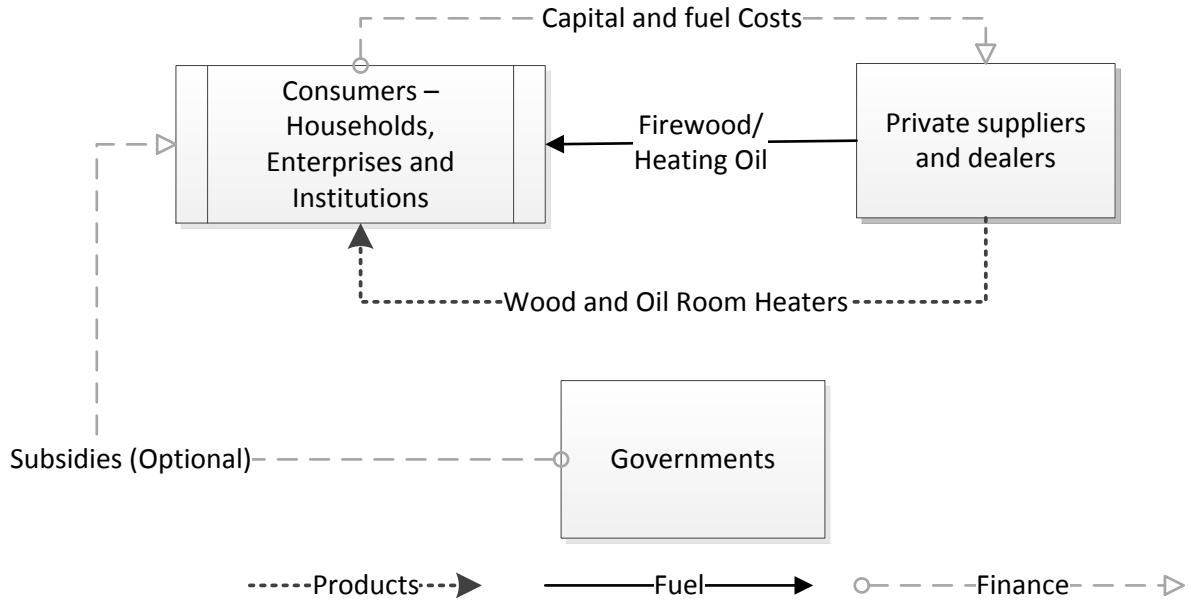
Access to energy for heating and cooling is an area without much programmatic and policy attention in Asia. Heating is required during the harsh winter in the higher altitudes surrounding the Himalayas as well as higher latitudes in countries such as Mongolia and China and Central Asia. Space heating for homes and institutions is normally provided using wood stoves called 'Bukharis'[27] and oil fired heaters[28]. There are also traditional space heating options like 'Tawa Khana[29]' which are being lost in the new construction and building practices. Firewood and heating oil are sold in commercial markets and are sometimes subsidised[30]. The room heaters are not often efficient and the buildings not properly insulated resulting in inefficient space heating. As for cooling during summer months ceiling mounted or pedestal mounted ventilators or fans[31] are used in buildings which have electricity supply.

The business model for heating involves purchase of fire-wood or fuel oil during the winter months. The prices of heating fuels are subject to market fluctuations and normally increase during the winter months. The space-heating wood stoves and oil stoves are purchased from the market based on the price rather than the thermal performance. Similarly ventilators and air conditioners are also purchased at market prices with similar considerations. This business model has more or less remained the same over centuries and there hasn't been much product,

[27] In the Hindu-Kush Himalayan countries of Afghanistan, Pakistan, Western China, Nepal, Bhutan, Myanmar etc.
[28] In Mongolia and north-china
[29] Practiced in the Himalayan region where the flue gases from the Kitchen pass under the floor of the living and bed room before discharged outside.
[30] China subsidises fuel oil for space heating in its colder regions
[31] Some establishments and affluent households also use room air-conditioners.

business process or financial innovation in this space. The role of development agencies and governments in this area has also been quite limited. A typical business model involving direct fuel and stove sales for space heating energy access in Asia is shown in Fig 7.

Fig 7: Direct Stove and Fuel Sales Business Model for Heating Energy Access



(Source: SEA)

There are also newer and progressive models in Asia such as the one which is planned to be implemented in Afghanistan under the Afghanistan Sustainable Energy for Rural Development (ASERD) programme which uses more progressive business models that involve space heating and cooking as well[32].

7.0 COOKING

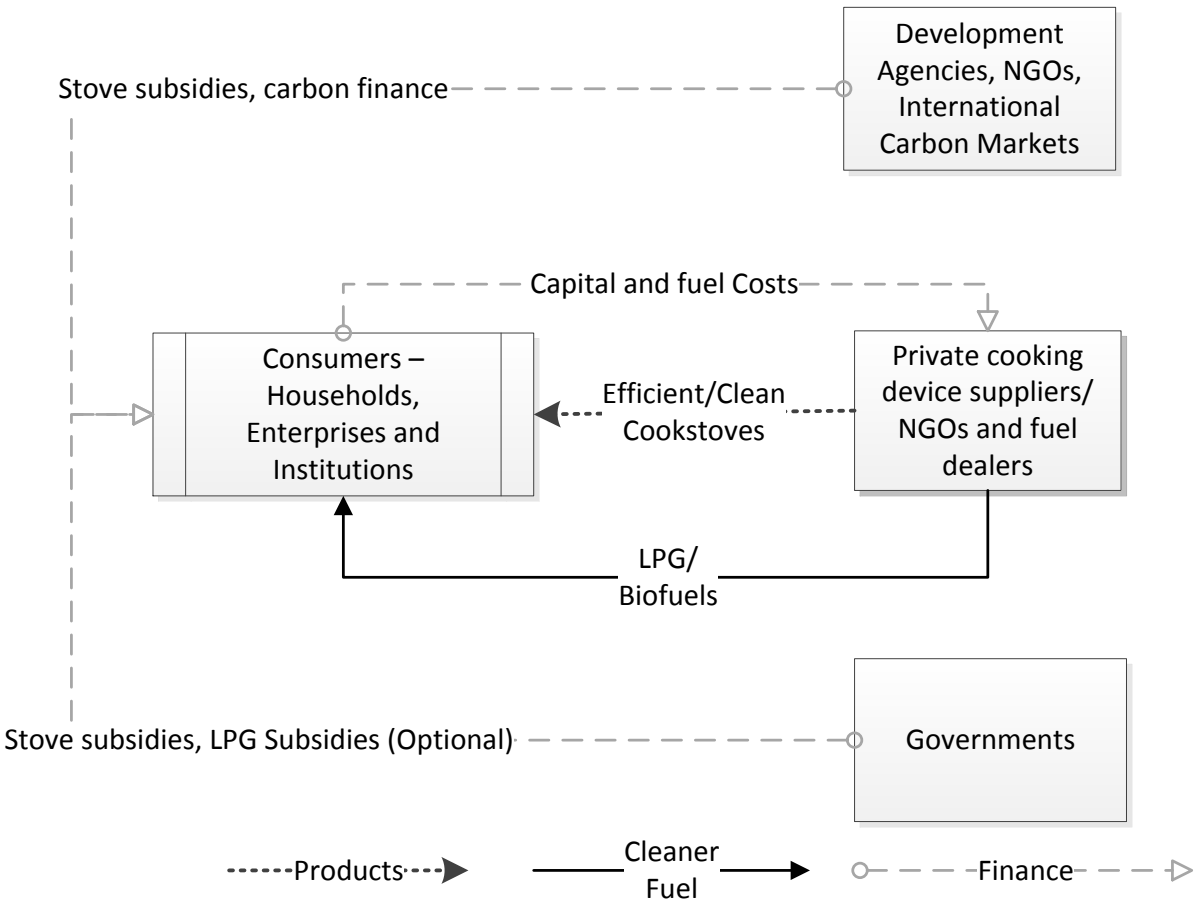
There have been a large number of national, international and private efforts over the years that have resulted in a number of energy access programmes that have focused on cooking. Many of such programmes have been driven by technology and the more common technologies have been improved cookstoves[33], biogas digesters, and solar cookers. There have also been efforts involving ethanol stoves and Liquefied Petroleum gas (LPG) stoves to encourage the use of such cleaner fuels.

Most of the cooking energy access business models in Asia have focused on establishing a supply chain for efficient or clean cooking device and fuels. The relatively high initial costs of the clean cooking devices were addressed through capital subsidies which made costs comparable to traditional cooking devices. Some programmes like the Biogas Support Programme (BSP) in Nepal have also made use of loan financing to cover the unsubsidised portion of the cost of materials and labour for construction of biogas digesters[34]. Increasingly cook stove and biogas programmes have been able to subsidise the systems through selling the Green House Gas

[32] Parthan, B. (2014), Afghanistan Sustainable Energy for Rural Development.
[33] Both wood and charcoal stoves
[34] Biogas Support Programme (2010), A short write-up on Biogas Support Programme

(GHG) emission reductions from the use of these systems in the voluntary or compliance carbon markets. The BSP in Nepal have been a pioneer in the use of carbon credits to promote biogas and cook stoves[35]. Countries like India provide a subsidy on the use of LPG for cooking purposes. The subsidy is directly credited to the bank account of the household and verified through a biometric Unique Identification (UID) number when LPG canister purchases are made. There is also a ceiling on the number of LPG canisters that can be subsidised. A generalised business model driven by subsidies for cooking energy access in Asia is illustrated in Fig 8 below.

Fig 8: Subsidy driven Cookstove and Fuel Sales Business Model for Cooking Energy Access



(Source: SEA)

The ASERD programme in Afghanistan is implementing a thermal energy service model where the households and institutions pay over a period of time to purchase an efficient cooking or space heating device. The periodic time-based payments will cover the cost of capital and maintenance and after the payments reach a threshold the system is owned by the user and only costs of repair or maintenance is paid for[36].

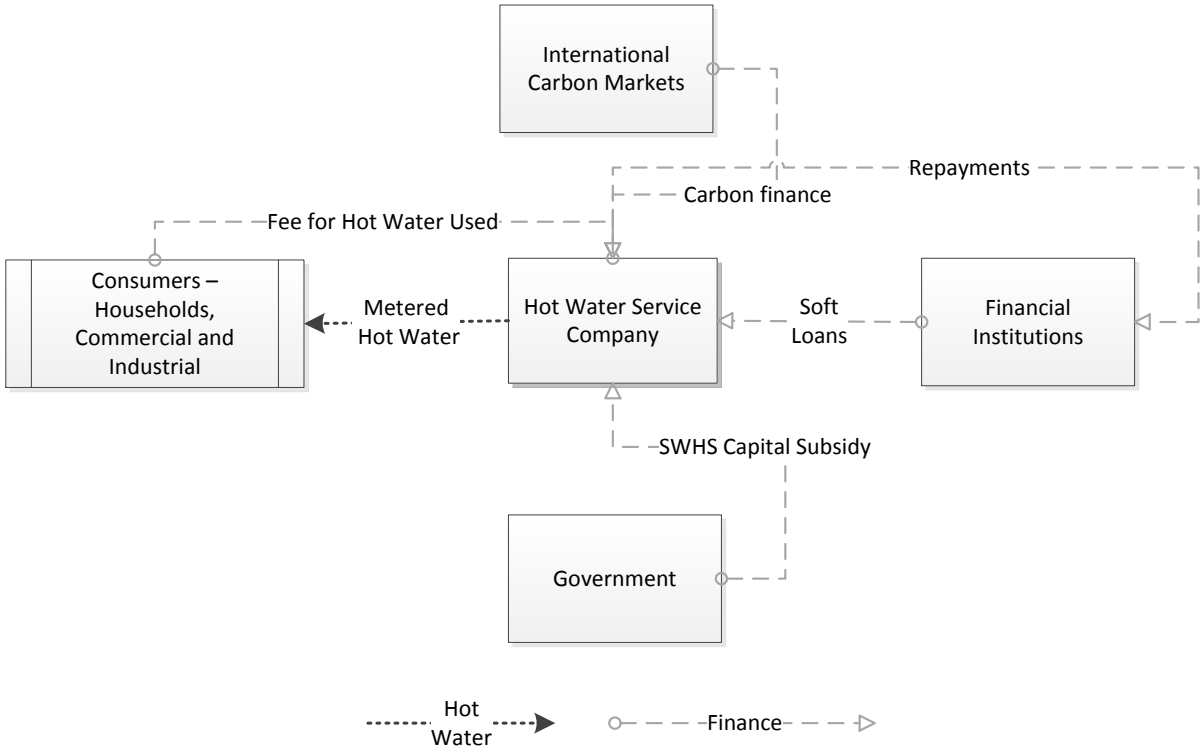
[35] Biogas Support Programme (2010), A short write-up on Biogas Support Programme
[36] Parthan, B. (2014), Afghanistan Sustainable Energy for Rural Development.

8.0 HOT WATER

The business model for hot water is similar to direct sales model for cooking and space heating devices and systems. The household or the institution purchases the water heating system through direct sales. Some hot water systems such as Solar Water Heating Systems (SWHS) have been subsidised by governments and larger institutional systems have been financed by banks. Electric geysers have been traditionally used by households and some establishments and governments and regulators have been encouraging efficient electric geysers and their replacement by SHWS or LPG. Energy utilities also offer rebates on tariffs for installation of SWHS.

UNDP's Global Solar Water Heating (GSWH) Project developed the concept for a fee-for-service operation in India that could target households, commercial establishments and industries that combine capital subsidy from the government, soft loans[37] and carbon finance revenue streams. Such a concept business model which will sell hot water to household and institutional users was found to be feasible[38]. The business model for a solar hot water service operation so developed in India is shown in Fig 9.

Fig 9: Fee-for-Service Business Model for Hot Water Supply



(Source: SEA – adapted from Mercados EMI, 2010)

[37] Loans that are offered below market lending rates, made possible through interest subsidies provided by the government.

[38] Mercados Energy Markets International (2010), Area Based Energy Service Company Model for Solar Water Heating in India

9.0 CONCLUSIONS

Based on a literature review of the Asian experience in electrical and thermal energy access business models, the following conclusions can be made:

- Asian countries have made significant achievements in electrical and thermal energy access in the past two decades and have employed a variety of business models to achieve accelerated rate of energy access;

- The Asian business models have ranged from direct sales, fuel sales, fee-for–service, progressive purchase to both capital and interest subsidies.

- The key stakeholders in the Asian business models have been consumers, governments, private sector, NGOs, development agencies, financial institutions, international carbon markets, and VLEs;

- The payments for products have been at full cost or partially or fully subsidised. The payments for services have been either based on the quantum of service provided or based on the time period of service where quantification is complex.

- There are some existing and proposed business models in Asia that focus on thermal energy which have elements such as integration of carbon finance, fuel sales and fuel subsidies, interest subsidies, business and enterprise loans, time based and unit based service payments etc. which are relevant for the STEPs project and its planned efforts in Africa.

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