9. FINANCING THERMAL ENERGY SERVICES

Sustainable Thermal Energy Service Partnerships

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ECONOLER

STEPs
Sustainable Thermal Energy Service Partnerships

FOREWORD

A large-scale clean energy program for delivering thermal energy with Liquid Petroleum Gas, biogas or solar water heaters can be a financially viable undertaking. However, there are many challenges and risks, especially in developing countries.

This chapter focuses on the financial tools and sources of finance available to the program designer who is seeking to make participation in a thermal energy program attractive and affordable for entrepreneurs and consumers.

- Michael Philips, 2016.

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STEPs website: http://stepsproject.net/

Acronyms

ADB	Asian Development Bank
AFD	Agence Francaise de Développement
AfDB	African Development Bank
BMU	German Ministry of Environment
DECC	Department of Energy & Climate Change (UK)
DEFRA	Department for Environment, Food & Rural Affairs (UK)
DFID	Department for International Development (UK)
EERSF	Energy Efficiency and Renewable Sources Fund (Bulgaria)
EIB	European Investment Bank
GEF	Global Environment Facility
GVEP	Global Village Energy Partnership
KfW	Kreditanstalt für Wiederaufbau (German Development Bank)
LFI	Local financial institution
MDB	Multi Lateral Development Bank
OPIC	Overseas Private Investment Bank (US)
PCG	Partial credit guarantee
SACCO	Savings and credit cooperatives
SHS	Solar home system
SMS	Short messaging service
SSA	Solar service agreement
SWH	Solar water heater
UNEP	United Nations Environment Programme
UNFCCC	United Nations Framework Convention on Climate Change
ZETDC	Zimbabwe Electricity Transmission and Distribution Company

Table of Contents

0. Introduction

Much has been written about the barriers to clean energy development. Within the realm of financing, there tends to be a lack of affordable financing at all levels. Commercial bank loans tend to carry high interest rates, short tenors and high collateral requirements. Rural areas are viewed as being particularly risky because of the poverty and uncertain incomes. In addition, staff of local financial institutions (LFI) – both commercial banks and development banks - tends to be unfamiliar with thermal energy technologies.

Despite these common barriers, there are notable cases of successful thermal energy financing programs that are discussed below. Tunisia has greatly expanded the purchase of solar water heaters in large part due to its on-billing financing initiative. Ghana is taking steps to eliminate the need for consumers to purchase of LPG cylinders by converting its already successful LPG distribution program to a cylinder exchange program. Much can be learned from experience financing small-scale electricity-producing projects, which have a head start on thermal projects in terms of widespread implementation of the clean energy technologies. As such, there are many examples of successful solar home system financing programs from Bangladesh, Sri Lanka and India, to name but a few.

Even as there are an increasing number of successful financing programs, there is also an increasing willingness to support thermal energy programs and clean energy programs generally by multilateral and bilateral lenders as well as specialized public-private investment funds. The support comes in the form of partial credit guarantees, concessional on-lending through LFIs, and various forms of targeted subsidies.

Subsidies are an essential element in the financial structuring of many clean energy financing programs, at least initially. The objective of most financing programs is to phase out the subsidies, and some have done so successfully. Ghana has been able to phase out LPG subsidies except in the most remote regions of the country.

All thermal energy financing programs should address financing risks. The main financing risks are the credit risks faced by both entrepreneurs and consumers, foreign exchange risk faced by businesses accepting loans denominated in foreign exchange, and LPG price uncertainty. If not addressed, these risks can undermine even the best designed thermal energy program. Fortunately, there are ways to mitigate these risks, although mitigating foreign exchange risk and LPG price uncertainty can be difficult and can create new problems even as the risks are mitigated.

1.0 – What needs to be financed?

On the household level, the main thermal energy technologies that need to be financed are biogas plants, LPG cooking systems, and solar water heating systems. Clean cook stoves also can require financing, although there is a wide range of stoves and stove qualities that are considered "clean."

There are a range of designs for biogas plants.[1] A basic design consists of six parts: fermentation chamber, gas storage, inlet tube, outlet chamber, removable or sealed cover, and a gas pipeline. The cost ranges from US$500 to US$1,000 depending on the size of the plant.[2][3]

Solar water heaters (SWH) consist of the solar panels, the water storage tank, and piping. There are a range of SWH designs, but an increasingly common design involves evacuated tubes. The size of domestic SWH installed under government programs are usually fairly standard. In Tunisia, where there is an ongoing, large-scale SWH program, a standard domestic SWH system costs about US$400. [4]

The main cost for a household LPG system is the cylinder containing the gas. There is a wide range in costs depending on quality, capacity and on whether the cylinder is imported or locally manufactured. A 14 litre capacity household cylinder can range in price between US$12 and US$20, sometimes even more. A cooking and burner might add another US$3 – US$5 to the investment. Under some programs, the cylinders are owned by an LPG enterprise and users trade in empty ones for full ones and there is thus no need to finance the cylinders at the household level.

In addition to the capital costs, all three technologies have maintenance costs, which can be included in the financing if structured on a service model as opposed to a hardware ownership model. In addition, using an LPG system involves ongoing fuel costs. The ongoing maintenance costs can be quite low, but they are greater than zero. Thermal energy program designers need to include maintenance costs as part of their cash flow analysis when designing a financing program.

From the perspective of an enterprise wishing to provide thermal energy equipment and services, it is difficult to estimate the cost of the operation because it depends on the scale, cost of labour, cost of equipment, inventory, transportation, taxes, etc. The cost is thus highly dependent on local conditions and preferences. A financial model has been developed for the entrepreneur considering entering the LPG distribution and sales business. It can be found on STEPs website (http://stepsproject.net/).

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[1] For a description of the different types, see *Domestic Biogas Development in Developing Countries* Loïc Rakotojaona, Enea Consulting, Paris, July 2013, http://www.enea-consulting.com/wp-content/uploads/2015/05/Open-Ideas-Domestic-biogas-projects-in-developing-countries.pdf

[2] *Household Biogas Digesters* ClimateTechWiki, http://www.climatetechwiki.org/technology/household-biogas-digesters

[3] The EcoTipping Points Project, China Biogas, Regina Gregory, 2010, http://www.ecotippingpoints.org/our-stories/indepth/china-biogas.html

[4] PROSOL Financing Solar Water Heating in Tunisia, UNEP, 2012, http://climatepolicyinitiative.org/wp-content/uploads/2011/12/Touhami-and-Hannane_PROSOL.pdf

In general, the cost of biogas and SWH businesses are more straightforward than the cost of an LPG business. For example, SWH are a fairly uniform technology and the water storage tanks can usually be manufactured locally. The evacuated tubes in the solar panel are typically imported and the flat-plate collector systems are locally assembled. Most of the components in a biogas digester can be locally sourced as well. LPG involves a more complex infrastructure (fuel storage tanks, refilling stations, offices, warehouses, fuel transport vehicles, other vehicles, repair shops), as well as the cylinders, ancillary consumer equipment, and fuel.

2.0 – Financial Barriers

The main financial barrier for consumers is the high up-front cost. This is the case for solar water heaters (SWH), biogas digesters and, to a lesser extent, LPG cylinders and burners. The high cost means some form of financing is needed if people are to acquire these technologies. However, there is often a lack of affordable financing. Most African commercial banks have high interest rates, short loan tenors and high collateral requirements. These are barriers not only for consumers but for small businesses as well that are seeking loans for working capital, equipment purchases and the acquisition of the energy products they will assemble and/or provide to consumers.

Some commercial banks and government development banks have an SME focus and are able to provide slightly better interest rates and loan tenors. But in many cases, they still have high collateral requirements. The high collateral requirements, sometimes exceeding 100 percent of loan size, are the biggest barrier for many entrepreneurs. Either they do not have the collateral, which usually must be in the form of property, or they are reluctant to take the risk of applying their limited collateral resources to a risky clean energy venture.

From the banks' viewpoint, many small-scale energy projects are inherently risky. Not only are the banks unfamiliar with the clean energy technologies, they "look through" the SME to see who the SME's customers are and they consider them to be a poor credit risk. After all, these customers are people who often have no credit histories but who will be relied upon to pay cash or borrow funds to purchase LPG cylinders or biogas digesters. To the banks, there is too much uncertainty, and thus risk, in relying on this kind of market.

Another financial barrier is that most thermal energy delivery projects are too small for investors who otherwise might be interested in the SMEs that operate them. Institutional money, such as pension funds, won't even look at investments until they reach a minimum in the tens of millions or even US$100 million and which are backed by solid performance data. The transaction costs are too high for anything smaller. Multilateral development banks have lower investment thresholds, but even MDB loans have a floor in the millions of dollars. The exception is when they establish funds or lines of credit operated by local financial institutions. These intermediary institutions can have lower investment minimums.

Finally, although there are informal financing structures in many countries that allow individuals to borrow money based on community members co-signing the loans, the individuals are reluctant to use their limited indebtedness capacity to purchase things like LPG cylinders and biogas digesters. Consumers tend to have higher priorities for the use of their borrowed money.

3.0 – Sources of Funds

3.1 Multilateral and Bilateral Sources

Many clean energy programs start with foreign funding, often with seed money in the form of grants or concessional loans from multilateral and bilateral institutions. Rather than investing directly in projects, the funds are often managed and on-lent by existing LFIs, typically commercial or development banks. This is because the local institutions already have the branch networks and banking functions in place that are needed by the international funds – banking functions such as intake, credit checks, loan supervision, reporting and collections. Some of the international institutions providing financing for clean energy in Africa include those listed in Table 1.

Table 1. Funding Sources for Clean Energy in Africa

Fund	Sponsor	Finance Mechanism
Multilateral		
GEF Trust Fund	Global Environment Facility	Grants, TA
Least Developed Countries Fund	Global Environment Facility	Grants, TA
Special Climate Change Fund	Global Environment Facility	Grants
Clean Technology Fund (under Climate Investment Funds)	World Bank	Grants, loans
Strategic Climate Fund (under Climate Investment Funds)	World Bank	Grants, loans, credit guarantees
Plot Programme for Climate Resilience	World Bank	Grants
Scaling Up Renewable Energy in Low Income Countries Programme	World Bank	Grants, loans
Global Energy Efficiency and Renewable Energy Fund	European Investment Bank	Co-financing, equity technical assistance
Seed Capital Assistance Facility	UNEP, ADB, AfDB	Co-financing, equity, grants
Green Climate Fund	UNFCCC	Loans, equity, guarantees
UNEP Renewable Energy Enterprise	UNEP	
Sustainable Energy Fund For Africa	AfDB	Grants, equity
Renewable Energy Performance Platform	EIB,UNEP	TA
CleanStart	UN Capital Dev. Fund	Microfinance, TA

Fund	Sponsor	Finance Mechanism
Bilateral		
International Climate Fund (UK)	DFID, DECC[5] and DEFRA	Grants, loans
Hatoyama Initiative	Japanese Ministry of Finance	Grants, loans
Global Climate Change Alliance	EuropeAid	Grants
SUNREF	AFD	Loans
Global Climate Partnership Fund	KfW, BMU	Loans, equity, TA
Sustainable Energy Fund for Africa	AfDB	Grants, loans, equity
The US-Africa Clean Energy Finance Initiative	OPIC	Project prep. grants

Source: Financing Low Carbon Energy Access in Africa, Energy Policy, 2012 and Econoler.

3.2 Private Sources

In addition to the larger, international funds, there are a range of smaller, boutique investments funds that are looking for small-scale renewable energy projects in emerging markets. Among these are:

- Generate Capital is a specialty finance company focused on using the no-money-down solar service model to finance a range of clean and efficient energy, water and food technologies. Website: www.generatecapital.com
- ResponsAbility, based in Zurich, is an asset manager that provides debt and equity financing to long-listed firms in emerging markets, with a focus on renewable energy and energy efficiency. Website: www.responsability.com
- SunFunder, a Tanzania- and San Francisco-based company, provides project finance loans and short-term inventory loans to SME's for off-grid projects in Africa, India, Pakistan and the Philippines. Website: www.sunfunder.com
- Persistent Energy Capital, a Tanzania- and New York-based investment bank, invests in, incubates and builds businesses providing distributed renewable energy to off-grid customers. Website: www.persistentnrg.com
- Acumen, a patient capital organization, uses charitable contributions to make debt or equity investments in developing countries that create social impact, including clean cookstoves, bio-gasification systems and solar lighting. Website: http://www.acumencapital.com
- GroFin is a development financier that provides debt financing to SMEs in South Africa, Zambia, Nigeria, Ghana, Uganda, Tanzania, Kenya, Rwanda, Egypt, Iraq, Jordan and Oman, with headquarters in Mauritius. Energy enterprises can receive financing but are not a specific focus of GroFin. Website: www.grofin.com
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[5] DECC's functions have been transferred to the UK's Department of Business, Energy and Industrial Strategy.

3.3 Domestic Sources

With the exception of some of the larger developing countries like South Africa, China, India, Indonesia, Mexico and Brazil, which have public and private institutions providing their own capital for clean energy projects, most countries have few domestic options for raising capital for small-scale, sustainable clean energy projects, including thermal energy projects. Many countries use a small energy surcharge on electricity sales or even all commercial energy sales to raise money to capitalize a fund for clean energy and energy access activities such as grid extension. However, where such surcharges already exist, it can be difficult to expand the focus of the fund to other activities like solar thermal projects. It also can be politically difficult to establish an additional surcharge for anything.

Rather than providing financing, governments can support thermal energy investment by providing a stable and transparent energy policy and regulatory environment that encourages thermal energy programs; establish an autonomous energy centre to provide technical advice to thermal energy projects; adopt performance and safety standards for thermal energy equipment such as solar thermal panels, storage tanks and LPG cylinders and refueling stations; package thermal energy project proposals for presentation to multilateral and bilateral donors for funding and financing, for example through each country's Sustainable Energy for All (SE4ALL) Investment Prospectus; and provide tax incentives to developers of thermal energy projects.

4.0 – Financing at the Enterprise Level

A small or medium-sized enterprise seeking to establish an LPG distribution operation or a SWH installation venture will face challenges raising both equity and debt capital, particularly if they are a start-up. Commercial banks are often reluctant to lend to new SMEs because the enterprises have no credit history. Likewise, SME's often do not seek loans from banks because of the high interest rates, short loan tenor, and most especially, the large collateral requirements. There are some banks that have special SME departments and programs, but they usually cannot significantly reduce their collateral requirements, which can exceed the value of the loan principal.

If an SME can qualify for financing, a number of instruments can come into play. At the most basic level is the term loan provided by local or foreign banks and investment firms. That debt can sometimes be structured as a convertible loan, wherein the lender holds the option to convert the debt to an equity share of the enterprise. Such convertible loans are particularly applicable to SMEs operating in an uncertain environment and which the lender regards as risky. The lender takes the risk, and in exchange it can convert the loan to an ownership share if the borrower is particularly successful and the value of the company has risen.

4.1 Partial Credit Guarantees

Experience in a number of countries shows that loan/credit guarantees can be used successfully to stimulate clean energy lending from primary lenders. The advantage of partial credit guarantees (PCGs) for the lender is that its risk is reduced and its willingness to participate in thermal energy financing is increased. The advantage for borrowers is that collateral requirements are reduced, a key feature in many countries where collateral requirements can exceed 100% of loan value. Collateralized loans can attract a higher PCG value. In Bulgaria, the EERSF offers collateralized credit guarantees, covering up to 80% of the credit value to secure loans for energy efficiency projects contractors.

From the perspective of the PCG provider, the advantage of providing a PCG is that the funds are only spent in the event of a default. Otherwise, the funds can be re-used to support additional thermal energy projects. If the PCG is provided by an investment fund, the fund's limited capital is stretched to support far more thermal energy projects than if it was provided in the form of a loan or subsidy.

An example of the successful use of PCGs for clean energy development is the series of PCG facilities set up in the 1990s and 2000s by the IFC and GEF to help mitigate risk for primary EE and RE lenders providing credit to energy service companies in Eastern Europe and China. The GEF typically provides a 30-50% guarantee on the EE loans, which means the primary lender still has a substantial share of its capital on the line and so will carefully appraise the creditworthiness of the borrower and the viability of the underlying transaction. In riskier or more difficult markets, proportionately larger guarantees (perhaps 50-70%) may be needed to stimulate commercial bank lending for small thermal energy projects. Likewise, GVEP International (now called "Energy 4 Impact") implemented a five-year Capital Access Renewable Energy Programme (CARE2) that supported micro-enterprises and SMEs with loan guarantees to reduce primary lender risk.

Not all PCG programs are successful. The Asian Development Bank approved $150 million in PCGs to India in 2011 to cover up to 50% of the payment default risk on loans from local financial institutions (LFIs) to solar power developers for projects ranging up to 25 MW in size. The UK's International Climate Fund provided a £6 million grant to help cover the 3-4% cost that the LFIs would normally have to pay to obtain the guarantees, thereby seeming to make the guarantees and the overall concept of solar lending more attractive to the LFIs. However, there was no uptake of the guarantees by the LFIs because by the time the guarantees were made available, solar projects were not considered so risky. Also, the guarantees did not cover foreign exchange risk (See "Foreign Exchange Risk" discussion below) which was considered very important for raising foreign debt.[6]

[6] Description and evaluation of the guarantee facility: https://www.gov.uk/government/uploads/system/uploads/attachment_data/file/471864/ADB_PCG_report_Assessment_Summary_Final_August2015.pdf

4.2 Subordinated Debt (Mezzanine Financing)

Subordinated debt is another instrument that can be used by donor governments and patient capital investors to increase support for thermal energy enterprises by primary lenders. Like a credit guarantee, subordinated debt reduces credit risk for the lender. Subordinated debt, provided by a donor, takes the first loss. The sub-debt does not shield the primary lender 100% just like a partial credit guarantee does not. Though not as common as credit guarantees, sub-debt has been used in Central America, among other places, to support small RE projects.

4.3 Portfolio Guarantee

Compared to PCG, a portfolio guarantee bundles many thermal energy projects and provides a first loss guarantee up to a certain defined amount. This mechanism lowers the credit risk for LFIs since a partial amount of the defaulted loan is covered by the portfolio guarantee. As is the case with PCG, the borrowing enterprises benefit from less restricting collateral requirements and LFIs benefit from lower overall risk of default. If the subsidy provided as guarantee is not consumed entirely in the first year, the remaining can be rolled-on to the next year and provide additional guarantees.

4.4 Secondary Market Support

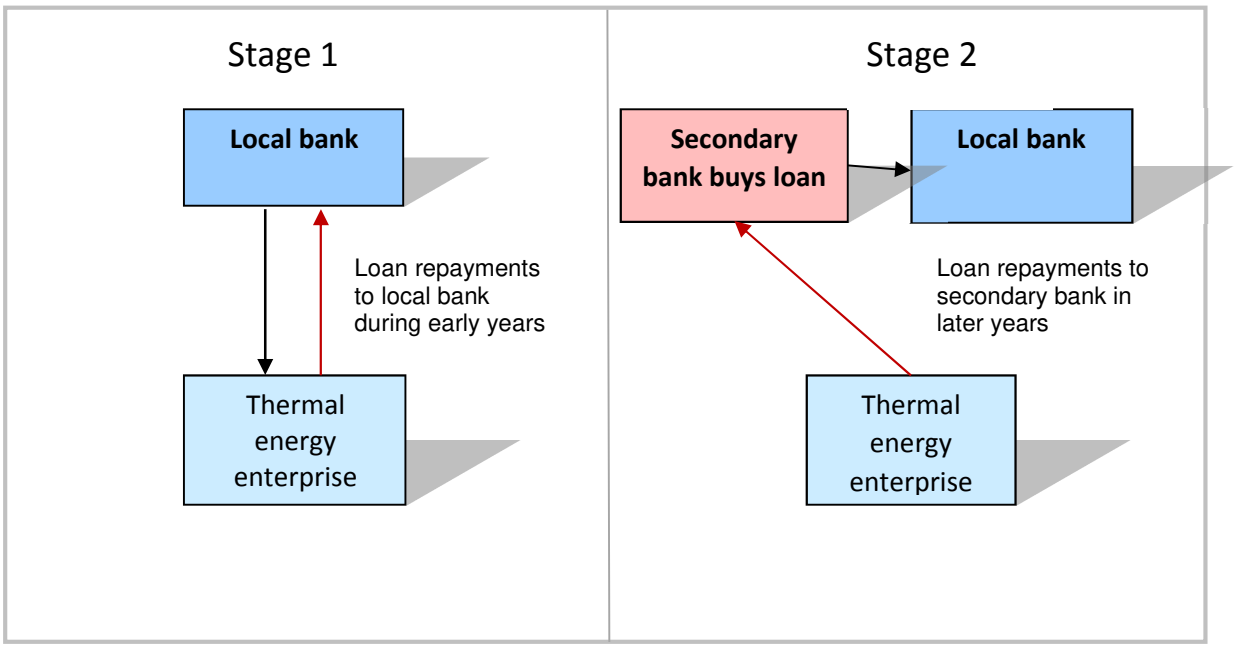
As discussed, local commercial and development banks often have unattractive lending terms. High interest rates and collateral requirements are a problem, but from the standpoint of an enterprise's cash flow, the short loan tenor can be a particularly thorny problem. Short tenors mean larger debt service payments. Making large payments can be difficult for any business. But for a start-up in a risky venture like LPG distribution or assembly and installation of SWH systems, they can drain capital from other high priority needs even if there is a repayment moratorium for the first few years.

A local bank may be unwilling to extend loan tenors, but a secondary bank - such as an international financial institution or specialized foreign private bank - could play a role in providing longer tenors by purchasing loans from a local bank at maturity. For example, if a local bank will only offer a 3-year tenor and the enterprise needs an 8-year tenor, the secondary bank can purchase the loan from the local bank at year three and hold it for the next five years, thus providing the enterprise with an effective 8-year loan. The secondary bank works with the local bank from the beginning to structure the loan as an eight-year loan, thereby allowing the enterprise to have lower payments. The secondary bank would only purchase performing loans, so the local bank would face the full credit risk during the first three years.

The advantage of this approach for the local bank is that the enterprise will have lower payments and thus there is a greater assurance that the enterprise will be able to afford them. The advantage for the enterprise is that it will have lower loan repayments and improved cash flow. The advantage for the secondary bank is that it faces relatively low credit risk because it is only purchasing loans that have already been performing for three years. Finally, this technique can incentivize the local bank to take on somewhat smaller or riskier projects because it can sell the debt to the secondary bank after, say, two years, or even one year.

The administration of this two-loan approach does not have to be complex. The secondary bank does not literally take over management of the loans. It buys them out, but has the local bank continues to administer the loan repayments, collections, etc. for a fee. So from the borrower's perspective, he/she is dealing with just one financial institution for the duration of the loan.

Figure 1: Funds Flow for Commercial Loan Buyout Model



Source: all graphs and figures from M. Philips unless otherwise stated.

5.0 Financing at the Consumer Level

Over 70% of people in emerging markets do not have a formal bank account (Goss, Mas, Radcliffe, & Stark, 2011).[7] There are nevertheless a number of alternative approaches people are using to obtain consumer debt for clean energy investments such as SHS. These include microcredit loans, community credit union loans, village pools, utility on-bill financing, and vendors offering pay-as-you-go solar financing. In Kenya and Tanzania, Savings and Credit Cooperatives (SACCOs) provide small-scale loans to people who have no credit history but who can get community members co-sign the loans. SACCO-type institutions exist in other countries under a range of names.

But debt financing for household clean energy projects is waning in the face of various forms of the energy service model. That is, the emergence of energy performance contracting in the energy efficiency market, and the pay-as-you-go (PAYG) approach for SHS, the energy service model, have rapidly expanded because they require low or no down payments from consumers. Instead, the energy performance contractors and equipment vendors/installers own and service the equipment for the duration of a contract period. After the installation of the energy efficiency or renewable energy equipment, the customer merely has to continue purchasing electricity at roughly the same price they were paying in the past. But instead of the money going to the electric utility, it goes to the energy service provider.

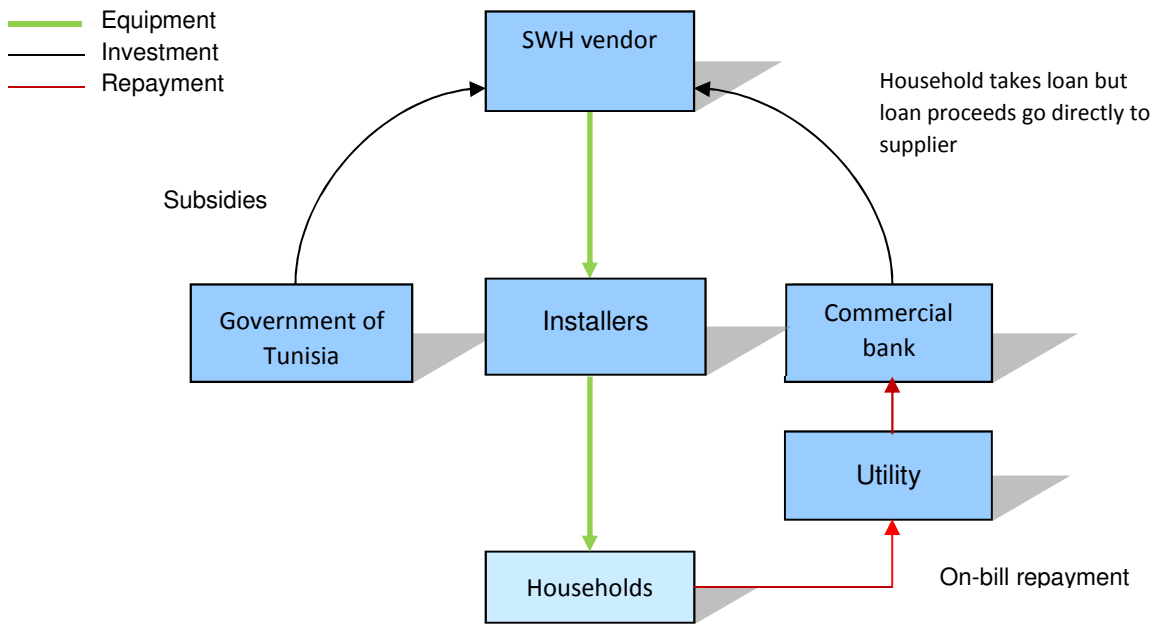
For energy efficiency projects, the energy performance contractor uses the consumer payments to cover its costs and earns a profit out of the energy savings. For solar projects, the vendor covers its costs and earns a profit through the customer's electricity payments plus any tax benefits that may accrue from ownership of the solar system. In both cases, the financial arrangement is a variation on a lease or lease-purchase.

The same approach is applicable to thermal energy delivery. In the case of domestic solar water heating systems, the financial structure is similar to that of the energy service model for domestic SHS's. A vendor supplies and installs the system on the residence. The customer makes no down payment, thereby removing concerns about payback. Instead, the customer pays for using the system in the form of a payment added to his/her electric utility bill. If the customer previously used electricity for heating water, they will see immediate savings. This approach of the energy service model combined with on-bill repayment is commonly used for energy efficiency investments. It is used with solar hot water systems in Tunisia, for example. (See Figure 2) and is being replicated in other countries as well.

[7] Goss, Salah, Ignacio Mas, Daniel Radcliffe, and Evelyn Stark. (May 2011). "The Next Challenge: Chanelling Savings Through Mobile Money Schemes." *The Mobile Financial Services Development Report*. The Bill & Melinda Gates Foundation. Retrieved from http://papers.ssrn.com/sol3/papers.cfm?abstract_id=1801743.

In Zimbabwe, for example, retrofitting of all residences, where physically feasible, with SWHs is now mandatory. On-bill financing will allow consumers to pay the cost over time with no down payment. Where customers have prepayment meters, the charges are added to their electricity replenishment purchase card. The motivation for the utility, ZETDC, to participate in this program is that the switch from electric water heaters to SWH will help reduce the utility's peak demand. The SWH program is thus a demand management tool.

Figure 2. Financial Structure of Tunisia's Solar Hot Water Program



The Tunisia/Zimbabwe approach works where the customer already has electric service because the repayments can be made on the electric bill. It can work for off-grid solar hot water systems as well, although it is more difficult.

Ensuring that customers make their payments is a key design feature of any of the consumer financing approaches. With OBF, there is close to zero default because customers know that if they pay only a portion of their electricity bill and not the full bill for electricity usage plus loan repayment, their electricity will be turned off. That is a powerful incentive to pay the full bill amount.

While term lending and bank accounts are uncommon in Africa, mobile phone use is high, with over 70 percent of the continent's population having a mobile phone.[8] Mobile phone companies offer mobile banking services to many areas of East Africa. Customers can pay their solar bills through an SMS-based texting service. When a payment is received, the SHS turns on. In the event no payment is received, the SHS is remotely switched off. Likewise, many systems work through mobile money services in which payments are deducted from mobile money accounts.

[8] *Cash Management in Africa*, The Treasurer's Wiki, Association of Corporate Treasurers, https://wiki.treasurers.org/wiki/Cash_management_in_Africa

6.0 – Subsidies

Financial subsidies in the form of grants or concessional loans have been a key component in many clean energy initiatives, including thermal energy projects. They are used as a tool to attract participants to a new energy program or technology. There is considerable debate about how to structure subsidies or whether to provide them at all. Oversized capital subsidies have been criticized for leading to boom and bust cycles, or example.[9] There appears to be a general agreement, however, that establishing a biogas or LPG program in a rural area where there is no pre-existing market for these products is an inherently risky venture that will face a number of financial, institutional, cultural and political hurdles. Subsidies are meant to help lower some of these hurdles, particularly the financial hurdle.

When subsidy programs are first established by governments or development institutions, the intent is usually to phase them out over time as the market is established. This was the case, for example, in Ghana, where the government subsidized the price of LPG when the LPG program began and then phased out the subsidies in 2015 for all except the very poorest rural regions. According to the Government of Ghana, the phase-out did not result in a reduction in LPG usage even though LPG is usually a more expensive cooking fuel than wood or charcoal. Subsidies can be used either to reduce the price of equipment such as solar hot water systems and LPG cylinders, or to reduce the price of a commodity like LPG. Equipment subsidies are typically one-time payments intended to reduce the high up-front cost of the equipment. But if the equipment is financed and there is little or no down payment required, then the upfront cost barrier is eliminated as is the need for an upfront subsidy.

If consumers lease or buy the equipment on credit, there may still be a need for subsidized lease or debt-service payments. However, the leases/loans can be structured with low monthly payments; no subsidy may be needed even though the amount of interest paid may be higher over the life of the lease/loan. From a public policy perspective, having consumers pay more interest over time may be problematic, but many consumers, especially low-income consumers, tend to be more concerned about their day-to-day cash flow than about how much they ultimately pay over time for interest. If the price of the thermal energy equipment is acceptable to most consumers, experience with energy efficiency programs shows that here may still need to be a subsidy or incentive payment to make participation more attractive. But it is not as essential as it would be if customers had to pay the full upfront cost of the equipment or make a substantial down payment.

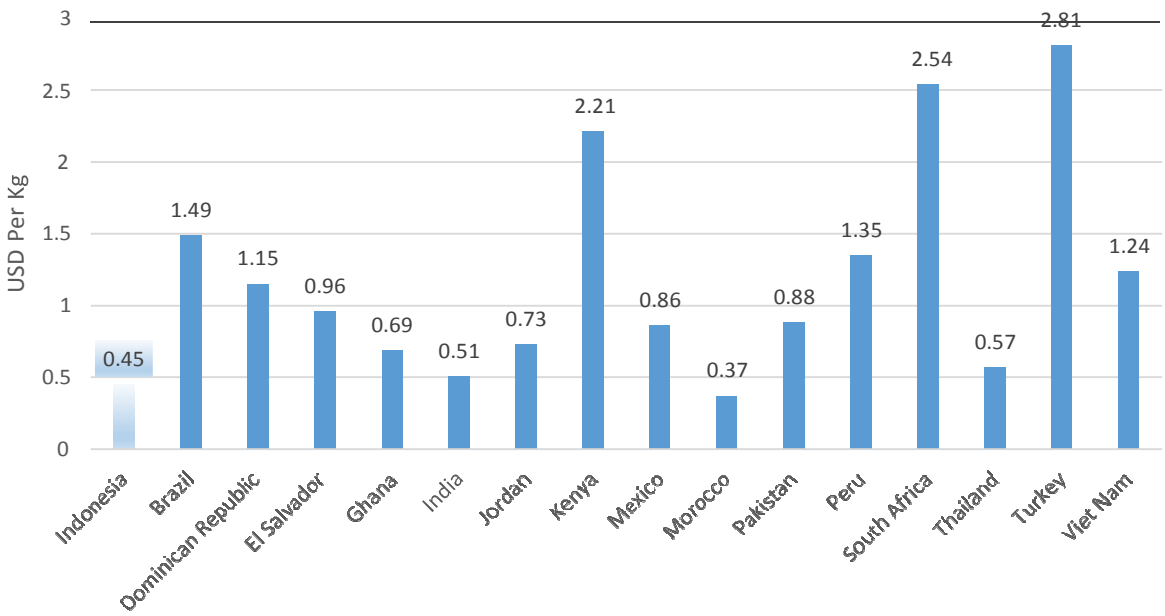
It is a different situation with commodity subsidies, such as price subsidies for LPG, because they may need to be kept in place over the long term, depending on the market price of LPG. There may even be a need for them to be brought back into existence after being phased out in the event world LPG prices increase. This is because the subsidies are based on bringing the cost of LPG down to a competitive level. The size of the subsidies is thus dependent on world LPG prices. As world LPG prices vary, the amount of funds needed to provide price subsidies will vary as well.

[9] *Exploring Energy SME Financing in Emerging and Developing Countries*, Sustainable Business Institute, 2013, http://www.cfi21.org/fileadmin/user_upload/pdfs/Berichte/2013-SBI-MEI-Studie.pdf

In general, whether for equipment or commodities, economic theory states that subsidies should be provided early in the value chain in order to "get the most bang for the buck." So instead of providing subsidies for solar water heaters to consumers, they should be provided to the manufacturers or importers, and then passed down the value chain to the consumers. It is less costly to the subsidy provider (generally the government) this way. Likewise, LPG price subsidies should be provided to refiners and importers, not the final customers, who will still receive the same level of subsidy but at a lower cost to the subsidy provider. This approach can have practical implementation problems due to misappropriation of fund and transparency/corruption issues. A public or private "watchdog" institution should be engaged to monitor the subsidy program and make sure the program results in the intended price reductions for consumers.

Despite the economic efficiency of providing subsidies early in the value chain, most subsidies are provided directly to consumers. Brazil, India, Indonesia and Ghana, among others, provide LPG price subsidies directly to consumers. **Figure 3** shows the variation in retail LPG prices based on level of subsidy.

Figure 3. End-User Prices of LPG in July 2012



Source: International Experiences with LPG Subsidy Reform, IISD, 2016.

One advantage of providing subsidies directly to end-users is that low-income consumers can be targeted, whereas upstream subsidies are passed down to all consumers, including affluent ones who become free riders. India has an LPG program that transfers subsidies directly to people's bank accounts.

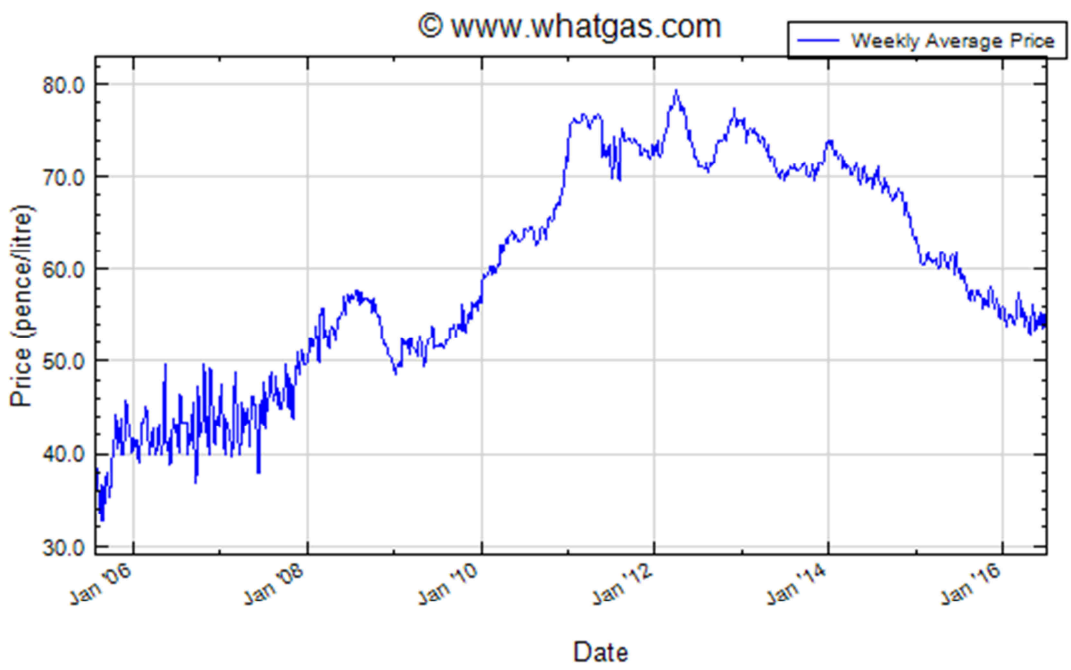
7. Financial Risks and Risk Mitigation

7.1 LPG Price Risk

Price volatility is not a concern for solar thermal or biogas projects. They may experience some inflation, but in most cases, the relative price of components remains fairly stable over time. This is not the case with LPG. Unless there is domestic production of LPG along with government price controls on it, he domestic LPG price reflects the international LPG price, which is "closely linked" to world petroleum prices[10]. The world LPG price can vary widely, as shown in Figure 4. So in considering an investment in an LPG enterprise, the investor will want to know how the enterprise is going to hedge the price fluctuations or how the government is going to provide some protection for the enterprise.

While LPG prices have been stable in recent years (as of June 2016) and in fact have been dropping, that can quickly change. In general, LPG prices in developing countries tend to be lower than in industrial countries.

Figure 4. World LPG Price – Ten Year Trend



[10] "Propane, Other Fuel Prices Feel the Burn as Oil Declines," *Wall Street Journal*, December 21, 2014.

A range of instruments exists at the corporate level for hedging the price volatility of various fuels. These include derivative instruments like futures and option contracts traded on the NUMEX and over-the-counter transactions entered into with financial institutions and energy companies, such as contracts-for-differences. Governments can use these instruments for their own benefit or to reduce their domestic companies' exposure to price volatility. But they generally do not get involved with hedges because, while it can be beneficial, it can also be very risky. Even with notoriously unreliable prices for commodities like oil, "most of the world's resource-reliant governments remain unwilling to step into the world of hedging."[11]

A government can potentially reduce the impact of LPG price volatility by establishing a strategic LPG reserve. In this scenario, the government would engage in purchasing LPG in the world market in order to fill the reserve. In the event of a global increase in the price of LPG, the LPG in the reserve would be released gradually and sold at or near the pre-inflationary price. The domestic LPG price would then be a blend of the pre-inflationary price and the price of newly imported LPG. That price would be lower than the new inflationary price. If the reserve is not large, the price of the reserve LPG could be gradually raised until the reserve is empty.

The resulting LPG price will be burdensome, but it would be reached gradually instead of all at once, thus providing some insulation and relief from a price shock. Conversely, in the event of an LPG decrease, the reserve managers would purchase more LPG. Although strategic petroleum reserves have been established in industrialized countries, no LPG-specific reserves have been created. Cash-strapped developing country governments would have difficulty purchasing large enough levels of LPG even when prices are low.

7.2 Foreign Exchange Risk

Emerging market currencies are constantly gaining or losing value. Thermal energy businesses that have debt denominated in dollars or other foreign currencies have exposure to foreign currency risk. An otherwise well-structured and well-capitalized thermal energy enterprise that borrows in foreign currency can end up failing if the local currency loses value. There are some basic options for managing this risk.

The most obvious way to successfully manage currency risk is to match local currency denominated assets, such as income streams from customer payments, with local currency liabilities, such as a loan from a local bank. That is, the enterprise should seek to borrow as much as possible in local currency. This is contrary to the instincts of many enterprises because of local lenders' high interest rates, short tenors and high collateral requirements. But local interest rates are high precisely because they reflect the market's expectation of future currency devaluation. So while it may seem prohibitive to borrow locally at 25-30% compared to a dollar-denominated loan at 10%, accepting the dollar loan will expose the enterprise to a high level of currency risk.

[11] "Oil price hedging by governments can be a smart bet or a bad gamble," by Paul Haavardsrud, *CBC News, Canadian Broadcasting Corporation*, April 13, 2016, http://www.cbc.ca/news/business/hedging-oil-provincial-budgets-1.3530084

There are two alternatives for mitigating currency risk. The first is a cross currency swap in which the enterprise exchanges a hard currency liability for a local currency liability. The second approach is an FX Forward, which fixes a future hard currency liability in local currency. The result is the same as with the cross currency swap: The enterprise has a fixed local currency liability. These approaches will likely be beyond the expertise of most thermal energy enterprises. Thus, a country's finance ministry or an international player like the World Bank or IFC should play an advisory or hand-holding role in helping the enterprises with them.

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