



BUSINESS MODELS FOR THE DELIVERY OF MODERN THERMAL ENERGY SERVICES: THE CASES OF GHANA AND TUNISIA

SUSTAINABLE THERMAL ENERGY SERVICE PARTNERSHIPS (STEPs)

Final Report

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ABBREVIATIONS

ANME	<i>Agence Nationale pour la Maîtrise de l'Energie</i>
CDM	Clean Development Mechanism
LPG	Liquefied petroleum gas
LPGMC	LPG marketing company
NPA	National Petroleum Authority
OMC	Oil marketing company
STEG	<i>Société Tunisienne de l'Electricité et du Gaz</i>
STEP	Sustainable Thermal Energy Service Partnership
SWH	Solar water heater
TOR	Tema Oil Refinery
UPPF	Uniform Petroleum Price Fund

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EXECUTIVE SUMMARY

Liquefied Petroleum Gas (LPG) Cooking Fuel Program in Ghana

In 1990, the Government of Ghana created a program to replace wood-based cooking fuels (wood and charcoal) with LPG, thus helping reduce forest-cutting and improving the living standard of households that rely on wood-based fuels.

The program began by having LPG produced by the country's only refinery, the Tema Oil Refinery. At that time, LPG was provided to large bulk oil marketers, which then sold it to LPG distribution companies, which then provided the LPG to a network of LPG filling stations. Households who wanted to use LPG had to purchase an LPG stove, a canister, and related equipment. The price was too high for many families. Despite subsidies and LPG price controls, nearly all the LPG consumption was in Accra and other urban areas. To encourage rural households to switch to LPG, the government even enacted a special subsidy for households living beyond 200 km from the Tema refinery. But the subsidy was insufficient to persuade rural communities to start using LPG. In addition, there were distribution problems and breakdowns at the refinery, resulting in supply disruptions.

There was another problem: since the price of LPG was subsidized by a surcharge on gasoline, taxi drivers and other commercial transport operators found that LPG was cheaper to use than gasoline. Many converted their vehicles to run on LPG and a significant volume of LPG was diverted from household customers.

Over time, the government modified the program. The Tema refinery's LPG output is now being supplemented by LPG imports. So, now there is enough supply of LPG, and even enough for taxi drivers. But at the beginning of 2013, the Government eliminated the price controls and subsidies. So it is no longer cheaper to fuel motor vehicles with LPG. There have been protests against the LPG price increases and the news media reported that charcoal sales were at an all-time high as many families switched back to charcoal from LPG. The Government denied this and said that the decreased LPG consumption was due to supply disruptions.

Although there are no figures regarding the impact of the LPG program on forest-cutting, the program has had a moderate impact on urban households' use of cooking fuels. While charcoal is still the dominant cooking fuel in 52.7 percent of the urban households, LPG is the main fuel in just under 20 percent of the households, with wood at 17.8 percent.

In rural households, wood is still the dominant cooking fuel, with 81.6 percent of the rural households using it as their primary fuel. Charcoal is used as the dominant cooking fuel in 11.6 percent of the rural households and LPG is the dominant fuel in just 1.1 percent of the rural households.

In 2014, the Government initiated a new subsidy program to attract rural users to use LPG. Cylinders and associated equipment are being provided to households free of charge. It is too soon to know if this latest initiative will be successful.

Solar Water Heater Program in Tunisia

In the late 1980s, the Government of Tunisia established a program to use solar flat plate collector systems to replace natural gas and LPG as the fuel for heating water in households. The purpose of the program was to reduce imports of natural gas and LPG, thus improving Tunisia's energy security.

The solar water heater (SWH) program progressed through several phases, during which various incentives and promotional programs were put in place by the Tunisian government. During the early years of the program, solar thermal equipment was exempted from VAT and their import duties were cut to 10%. Later, solar panels were subject to testing and labeling to ensure quality, and a certification program was established for SWH installers. Then, a EUR 75 per m² subsidy on solar panels was established, paid for by revenues from import duties on air-conditioners and taxes on automobile license plates. None of these measures caused a major increase in SWH sales, which were usually below 500 units per year until 2005.

In 2005, the program, renamed PROSOL, began to offer affordable consumer credit. The credit system allowed customers to repay their SWH loan over five years on their electric utility bills, a practice widely used in the West for financing home energy-efficiency improvements. Utilities have found that this "on-bill financing" approach has resulted in a very low default rate because households are aware that if they fail to pay the loan through their utility bills, their electricity can be cut off by the utility. As a result of the establishment of the on-bill financing program, sales of SWHs have started to rapidly increase from sales below 500 units per year and are now at over 3,500 units per year.

In addition to the credit system, the PROSOL program certifies SWH systems and installers. Households can thus be assured that they enjoy good-quality products installed by qualified contractors.

As of 2011, the PROSOL program installed 561,690 m² of solar collectors for an installed capacity of 393 MW_{th}, generating 41,054 toe in savings per year and reducing CO₂ emissions by 123,161 metric tonnes/year. The program is now being expanded to hotels and other commercial establishments.

In 2012, the PROSOL program became eligible to sell carbon emission reductions under the UNFCCC's Clean Development Mechanism (CDM), as a small-scale Program of Activities (SSC PoA), and the certified emissions reductions achieved by replacing LPG and fossil-based electricity generation with solar energy were sold to carbon brokers.

INTRODUCTION

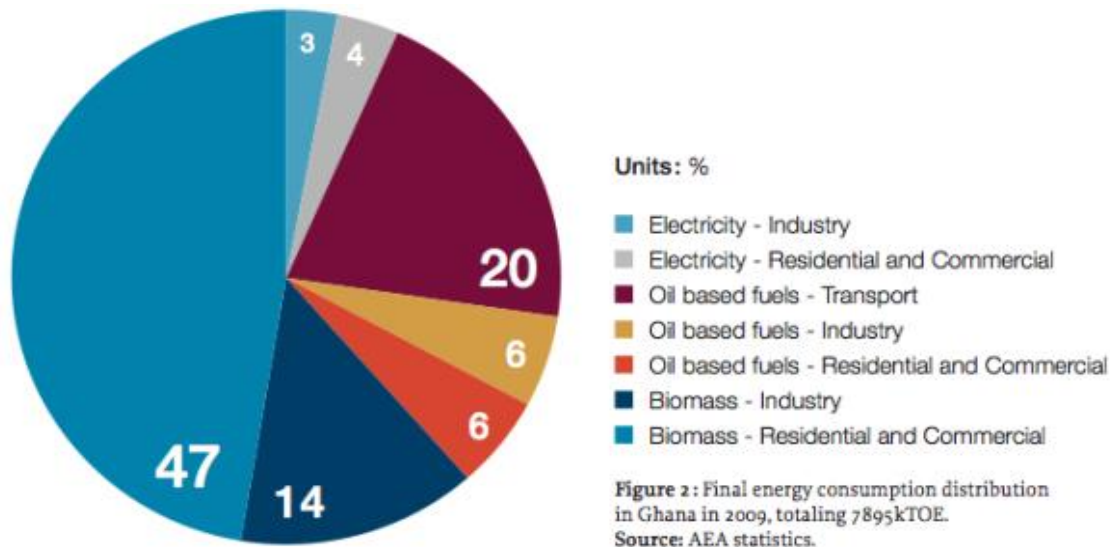
Over the years, initiatives made by governments and donors to deliver modern thermal energy services to households in developing countries have had mixed results. Why a SWH program or an LPG distribution program in one country has been successful while a similar program has failed in another? While the success or failure of a thermal service program is, to a large extent, due to a country's own characteristics, three crucial common aspects of program design tend to influence the success of all such programs, as summarized below.

- 1 It is crucial to ensure that all parties have a strong enough financial incentive to enable them to participate in the program.
- 2 It is crucial to properly certify the suppliers, products manufactured and installers.
- 3 It is crucial to make it very easy for households and other end-users to participate in the program.

The cases of Ghana and Tunisia can serve to illustrate these points.

LIQUEFIED PETROLEUM GAS IN GHANA

Ghana initiated an LPG distribution program in 1990 in order to replace wood and charcoal used for cooking to slow down the speed of deforestation due to firewood cutting in the country. Even in 2009, biomass still accounted for 61% of Ghana's total energy consumption, as shown in Figure 1. As a result of forest-cutting mainly for household cooking purposes, Ghana's forest coverage in 2004 was roughly 25% of its original size.



Source: *Ghana: West Africa's Emerging Energy Hub*, Pol Arranz-Piera, Revolve Magazine – Spring 2013, <http://issuu.com/revolve-magazine/docs/revolve07-spring2013/25>

Figure 1: Ghana Final Energy Use, 2009

The LPG initiative is overseen by the National Petroleum Authority (NPA), which was established in 2005 by the NPA Act No. 691-2005. To implement this program, the Government of Ghana carried out the following actions:

- 1 Upgraded the Tema Oil Refinery (TOR), which was Ghana's only oil refinery and also the country's only source of LPG at the time;
- 2 Established LPG storage and distribution facilities;
- 3 Set up operational standards for LPG filling stations;
- 4 Created the Ghana Cylinder Manufacturing Co. to fabricate LPG cylinders from imported, semi-finished cylinders because there were no domestic LPG cylinder fabricators (Now there is also a private cylinder fabricator, Sigma Gas);
- 5 Established an LPG promotional campaign;
- 6 Created a system, the Uniform Petroleum Price Fund (UPPF) as part of the NPA Act, for controlling LPG prices through subsidies and price caps.

In addition to the NPA, which manages the overall LPG promotion program, a number of other governmental bodies are involved in various aspects of the program, including the following¹:

- › the Ghana Standards Board (for ensuring compliance with government standards on locally manufactured and imported products, including LPG);
- › the Environmental Protection Agency (for LPG-filling station site approvals and periodic inspections);
- › the Ghana National Fire Service (for fire-permitting and certification of LPG facilities);
- › the Ministry of Energy (for the analysis and development of policy);
- › the Energy Commission (for strategic energy planning);
- › the Ministry of Environment and Science;
- › the Ministry of Private Sector Development;
- › the Factories Inspectorate;
- › the President's Special Initiative; and
- › Town and Country Planning Authorities.

Under the LPG program, the government sells LPG from its TOR (and now from LPG imports as well) to private LPG distributors, known as either oil marketing companies (OMCs) and LPG marketing companies (LPGMCs). The OMCs and LPGMCs transport and sell the LPG to LPG filling stations. The filling station operators function similarly to gasoline service station dealers. Some are owned and operated by LPGMCs; some are independently owned and have supply contracts with LPGMCs; and some are joint ventures between an LPGMC and an independent or other filling station owner.

As of 2014, there were 470 filling stations across the country. Households, food vendors and other customers who decide to use LPG for cooking, have to purchase the LPG cylinders, burners and other associated equipment. When they need LPG, they bring their cylinders to the filling stations.

The basic business model is shown in Figure 2. The supply chain is straightforward, except for the existence of the bulk oil marketers. In most countries, LPGMC can acquire their bulk LPG directly from domestic refiners or imports. But in Ghana, there is the extra layer of bulk oil marketers, which are the only companies allowed to purchase LPG from TOR and importers. They were created at a time when the TOR had financial problems and the government decided it needed a limited number of special companies to buy products from the refinery and resell it to the marketing companies. It is unclear whether they are a necessary step and cost in the LPG distribution process.

¹ Matthews, William G., and Zeissig, Dr. Hilmar, "Residential Market for LPG: A Review of Experience of 20 Developing Countries", Houson International Business Corp., for the World Bank, December 2011, p. 47.

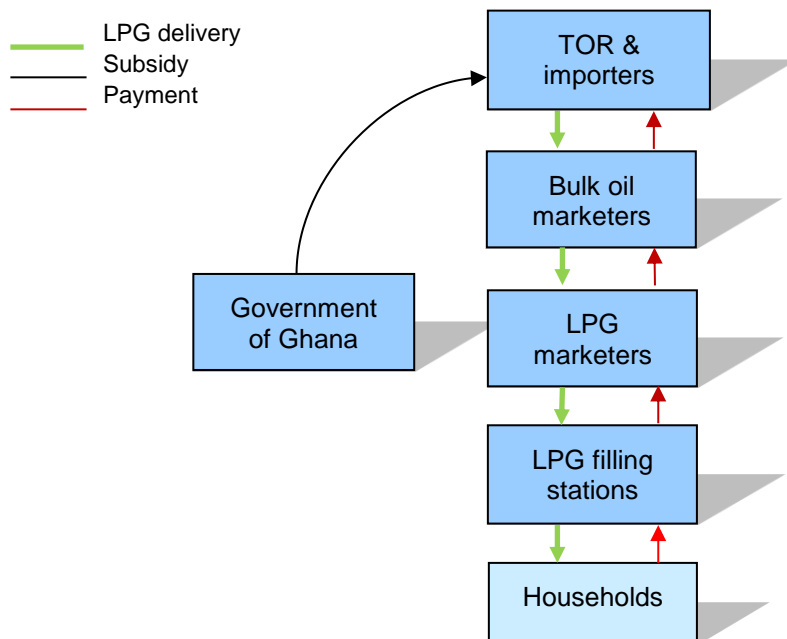


Figure 2: Ghana's Liquefied Petroleum Gas Distribution and Direct Payment Model

As in most countries, LPG is more expensive than the wood-based fuels. In order to incentivize LPG purchases, the government cross-subsidized LPG using revenues from a tax levied on gasoline sales. A higher subsidy was provided to LPG sold in areas more than 200 km away from the TOR. The government also placed a profit margin cap on LPG sales to ensure that LPG prices remained stable and affordable.

When the LPG program started up, a number of problems quickly arose. First, the price cap drove large players like Shell and BP out of the LPG distribution business, while smaller would-be distributors could not get financing for establishing operations and constructing the storage, transport, and filling station infrastructure. As a result, there were inadequate LPG supply operations from the start. Second, the tax levied on gasoline, combined with the subsidy on LPG, had the unexpected effect of incentivizing taxi drivers to switch from gasoline to LPG to fuel their taxis. This diverted a significant proportion of LPG supply away from its intended users. Third, low-income households could not afford to purchase the cylinders, burners, valves, etc. needed to allow them to switch from wood-based fuels.² Also, despite the extra subsidies offered to rural areas, the LPG price was still too high for most of these households. Fourth, relying on a single source of LPG meant that the TOR's periodic breakdowns, combined with insufficient LPG storage, resulted in serious LPG supply disruptions. Fifth, delays in the disbursement of government subsidy payments further aggravated the LPG supply disruptions because the prices faced by the marketers were too high. Sixth, a number of accidents occurred at LPG filling stations, prompting the adoption of a number of international standards on the design, construction, inspection and testing of LPG cylinders and valves.³

² A large tank and burner for a vendor costs USD 52. A smaller unit for a household costs USD 26.

³ Op. cit., Matthews and Zeissig, p. 47.

Despite these problems, LPG has successfully replaced wood-based fuels across the country, particularly in urban areas and the capital, Accra (Table 1). As of 2010, 41% of the households in Accra were using LPG.⁴ In other urban areas, 20% of the households use LPG.⁵ However, rural households have lagged behind in LPG use because of the high capital cost of cooking equipment, the high cost of LPG, and the persistent difficulties with LPG supply. Figures 3 and 4 show the percentages of households in urban and rural areas, respectively, using different energy sources as their primary cooking fuel source. As can be seen in the figures, LPG has had a significant penetration in urban areas, but charcoal is still the dominant fuel in those areas. In rural areas, fuel wood dominates, followed by charcoal. Fewer than one percent of rural households use LPG as their primary cooking fuel.

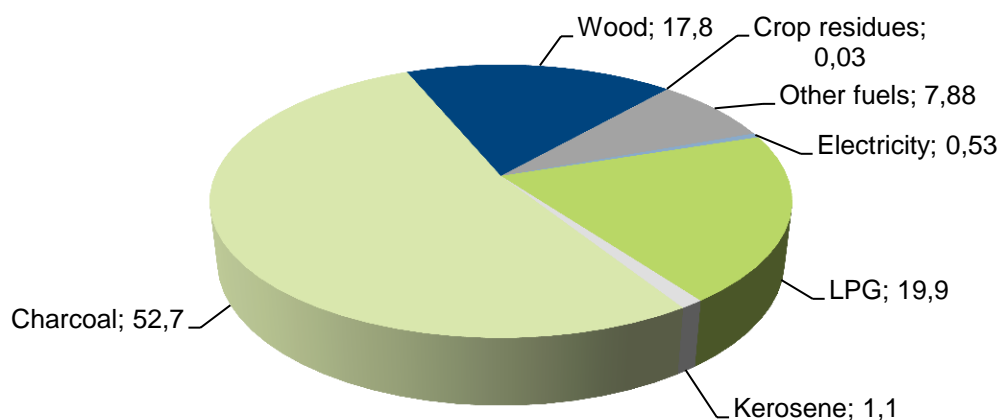
Table 1: Energy Consumption per Household, 2010

Region/Locality	LPG Consumption (Kg)	Kerosene Consumption (Litres)	Charcoal Consumption (Kg)	Firewood Consumption (Kg)	Electricity Consumption (KWh)
By Type of Population Center					
Urban	174	18.00	430.7	986.2	1,200
Rural	58	54.00	440.2	1,113.4	880
Accra/TOR	174	16.80	444.7	520.8	1,980
Other Urban	108	18.00	425.1	816.6	1,299
Other Regional Capital	174	18.00	463.0	1,299.0	1,200
Other District Capital	120	18.00	422.3	981.0	1,184
Coastal	116	46.40	406.1	1,011.8	1,164
Forest	108	41.20	444.5	1,085.2	996
Savannah	87	39.00	445.2	1,165.5	674
By Geographic Region					
Greater Accra	120	36.37	448.8	903.1	1,484
Ashanti	108	41.20	487.8	1,152.6	1,200
Central	87	52.34	418.2	993.7	1,200
Western	120	56.09	384.4	789.4	1,138
Eastern	116	38.02	367.7	1,005.2	1,148
Volta	87	46.40	373.6	829.7	856
Brong Ahafo	87	39.54	474.1	1,361.0	1,115
Northern	58	49.91	510.1	1,173.5	804
Upper East	87	35.18	363.9	1,037.4	824
Upper West	72	61.86	531.1	1,233.8	720
National	87	42.37	434.4	1,064.70	1,200

Source: Energy Commission, Ghana.

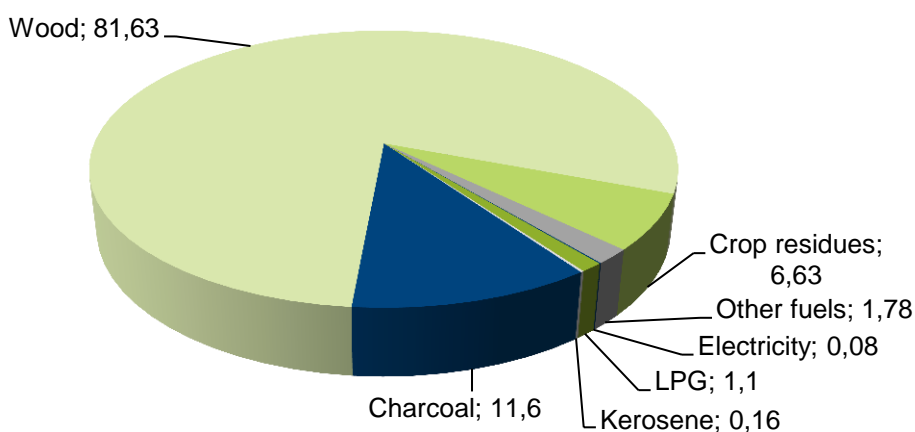
⁴ Ghana Living Standards Surveys and 2010 Population Census.

⁵ Adam, Faisal Wahib et al, "Relationships between Energy Use and Income Levels for Households In Ghana" , European Scientific Journal, Vol. 9, No. 16, June 2013, p. 237.



Source: Adam, Faisal Wahib et al

Figure 3: Percentages of Urban Households and their Primary Cooking Fuel, 2013



Source: Adam, Faisal Wahib et al

Figure 4: Percentages of Rural Households and their Primary Cooking Fuel, 2013

The program has since been reformed. LPG imports now exceed the TOR’s production and there is sufficient LPG supply for all users, albeit still with supply disruptions due mainly to equipment and transportation malfunctions.⁶ Although the LPG consumption by taxi drivers and other commercial vehicles now accounts for 58% of the country’s total LPG consumption, it no longer negatively affects the supply to other users.

In 2013, the government began eliminating the LPG subsidies and raised the LPG price cap. On February 1, 2014, the last subsidies were eliminated. The resulting LPG price increases sparked public protests and, according to news reports, prompted many households to switch back to the wood-based fuels, particularly charcoal. During the first few months in 2014, charcoal

⁶ Asamoah, David et al., “Analysis of Liquefied Petroleum Gas (LPG) Shortage in Ghana: A Case of the Ashanti Region”, International Journal of Business Administration, Vol. 3, No. 5, Sept. 2012.

demand surged to record levels, according to the reports. The U.N. Food and Agriculture Organization (FAO) has warned that the removal of the subsidies will erode the gains made in substituting LPG for wood fuels and will force marginal LPG users to switch back to wood.⁷ However, according to the NPA, the effect of price increases on demand has been insignificant and the dip in LPG consumption has been mainly due to the chronic supply disruptions. Furthermore, according to the NPA, many households use a combination of LPG and wood-based fuels; so, while there may be some increased use of wood-based fuels in these households, the overall number of LPG-using households is continuing to increase.

In early 2014, the government initiated two programs to further increase the use of LPG among households: 1) the Rural LPG Promotion Program; and 2) the Nation-wide Promotion and Recirculation Program. Financed with redirected subsidy funds, the first program is intended to distribute 350,000 free cylinders, cook stoves and associated equipment to thirteen low-access rural districts by the end of 2016, with the first phase of 53,000 to be distributed by the end of 2014.⁸ With the second program, the government intends to establish regulations that will encourage private investors, especially the LPG distributors (known as OMCs), to establish more refilling stations in urban areas and an LPG cylinder recirculation program.⁹

Both of these new programs will address one of the ongoing weaknesses of the current LPG program, which is safety of cylinders. Given that the LPG program has involved ownership of cylinders instead of a leasing or exchange program, safety tends to be compromised. Older, untested and unmaintained cylinders can stay in use for too long. As a result, the adoption of safety standards for cylinders and valves has taken longer to percolate into the cylinder market than if the cylinders were constantly being exchanged. While some filling stations perform voluntary cylinder inspections, there is no formalized maintenance program. There are no recertification dates and filling stations do not reject cylinders that are overdue for inspection and testing. That situation is changing under the Rural LPG Promotion Program, with the first cylinder exchange program. The first cylinder exchanges began in April 2014 at Derma in the Tano South District in the Brong Ahafo Region.¹⁰

Even with the free give-aways in rural areas, it is expected that supplying LPG to these areas will continue to be a challenge. According to the NPA:

“In the remote areas of Ghana, the main barrier to increasing availability of LPG is the low margins of demand compared to the high operational cost and risk of transporting the product by road. Since LPG is transported only by road, the nature of the access roads to a particular community affects the interest of the investors in that area.”¹¹

⁷ “LPG Subsidy Removal Will Revive Fuel Wood Use – FAO,” Modern Ghana, 1 April, 2014, <http://www.modernghana.com/news/532948/1/lpg-subsidy-removal-will-revive-fuel-wood-use-fao.html>

⁸ “Let’s Sensitize New Users Of Gas Stoves to Avoid Fire Outbreaks In Our Homes, Markets and Schools”, VibeGhana.com, March 1, 2014, <http://vibeghana.com/2014/03/01/lets-sensitize-new-users-of-gas-stoves-to-avoid-fire-outbreaks-in-our-homes-markets-and-schools/>

⁹ There are currently 470 filling stations across the country supplied by 106 petroleum-based marketing companies.

¹⁰ “Government Launches LPG Cook Stove Programme,” Modern Ghana, 8 April 2014, <http://www.modernghana.com/news/534312/1/govt-launches-lpg-cook-stove-program.html>

¹¹ Personal written communication, NPA, 2014.

Overall, Ghana's LPG program has been successful in terms of the introduction of LPG as a household cooking fuel, particularly in Accra and other urban areas. LPG use is ten times higher than it was before the LPG promotion program began, although a portion of that increase is due to LPG use in transportation.¹² The impact of the program on forest-cutting has not yet been determined. Charcoal and wood fuels continue to dominate in rural areas and are used in large quantities in urban areas as well. Because many households use a combination of cooking fuels, LPG price spikes and supply disruptions can prompt rapid fuel-switching. One continuing issue is safety in the transport, storage and use of LPG. According to one news source, from 2007 to 2014, 39 people died and 186 people were injured in the 11 reported LPG-related accidents. Of these, five were at gas stations, fuel stations and a fuel dump; three were gas tanker crashes; and three were domestic accidents.¹³

The future of the LPG program is uncertain. If the government successfully develops its own natural gas resources as planned and is able to produce 870 tonnes of LPG per day (compared to the TOR's 1,000 tonne output), then LPG users will be at least partially insulated from international oil price volatility. Furthermore, if the government's new initiatives can largely eliminate the supply disruptions, then LPG use and the LPG penetration rate among households will continue to increase.

¹²Bischoff, Robert et al, "Scenario of the Emerging Shift from Gasoline to LPG-fuelled Cars in Ghana: A Case Study in Ho Municipality, Volta Region", Energy Policy 44 (2012), Elsevier, p. 355.

¹³"LPG Stations In Residential Areas Raise Alarm", Modern Ghana, February 11, 2014, <http://www.modernghana.com/news/522262/1/lpg-stations-in-residential-areas-raise-alarm.html>

SOLAR WATER HEATER PROGRAM IN TUNISIA

A domestic SWH program was established in Tunisia in the late 1980s for the purpose of reducing the country's reliance on fossil fuel imports, primarily LPG, which, along with fossil-based electricity, is the main fuel used for domestic water heating in the country. Tunisia, a former oil-exporting country, is now increasingly dependent on imports of petroleum products. Its domestic production of oil and natural gas amounted to 0.258 quadrillion Btu in 2010 while its imports were 0.309 quadrillion Btu.¹⁴

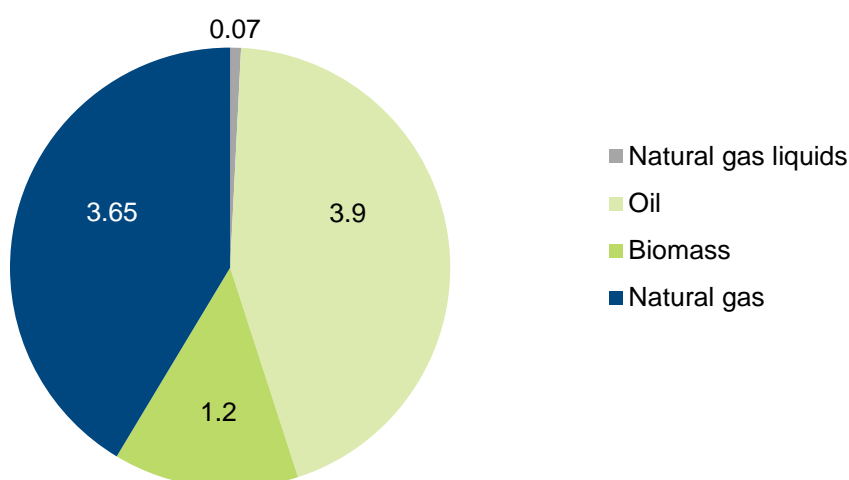


Figure 5: Tunisia's Energy Consumption (Mtoe), 2007

The country is still heavily dependent on oil and natural gas (Figure 5), but it embarked on a major energy-efficiency program in the 1980's that has resulted in a 25% decrease in energy intensity over the past two decades.¹⁵ It also has a range of initiatives and financial incentives for the development of biogas and solar electric power.

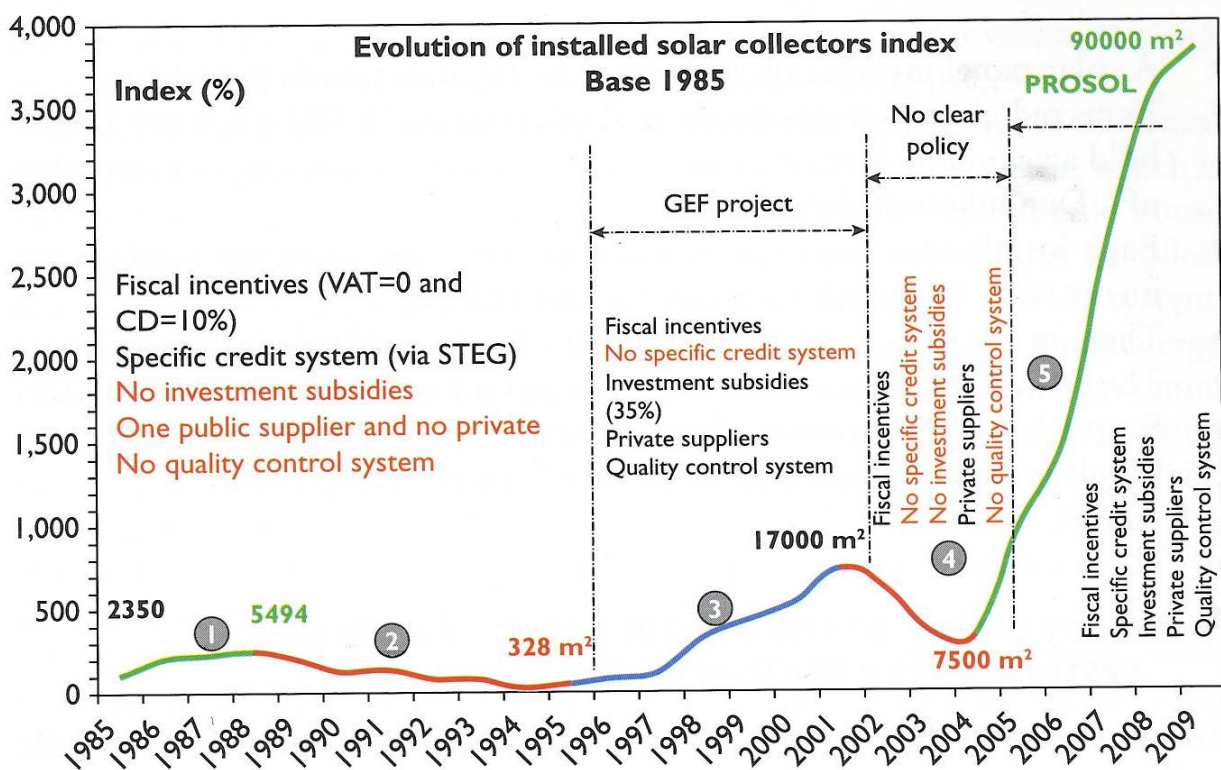
The SWH program progressed through several phases, during which various incentives, certification programs and measures were put in place by the Agence Nationale pour la Maîtrise de l'Energie (ANME), the national energy conservation agency) and the Tunisian Ministry of Industry, Energy and Small and Middle Size Enterprises. During the early years of the program, solar thermal equipment was exempted from VAT and their import duties were cut to 10%. Later, solar panels were subject to testing and labeling to ensure quality, while a certification program was established for SWH installers. Then, a EUR 75 per m² subsidy on solar panels was provided by the National Fund for Energy Management, paid for by revenues from import duties on air-conditioners and taxes on automobile license plates. None of these measures caused a major increase in SWH sales, which remained mostly below 500 units per year until 2005.

¹⁴ EIA 2013: <http://www.eia.gov/countries/country-data.cfm?fips=TS#ng>

¹⁵ *Tunisian Energy Sector At Crossroads*, SEE Hiaoui Al-Monitor, March 9, 2014, <http://www.al-monitor.com/pulse/business/2014/03/tunisia-energy-sector-critical-crossroads.html#>

In 2005, the program, renamed as PROSOL, began to offer affordable consumer credit. As a result, sales of SWHs started to rapidly go up and are now at over 3,500 units per year (Figure 6). The credit system allowed customers to repay their SWH loan over five years on their electric utility bills, a practice widely used in the West for financing home energy-efficiency improvements. Experience with this “on-bill financing” approach at many utilities shows that default rates are very low. This is because homeowners are rightly concerned that if they fail to make their solar loan payments, their electricity can be turned off by the utility. Thanks to the low default rate with the SWH on-bill financing program in Tunisia, the Attijari Bank, the commercial bank recruited by ANME to participate in the program, saw its credit risks lowered. So, this bank lowered the interest rate on SWH loans by 5-6 percentage points below the typical rate for home improvement loans.

In 2012, the PROSOL program became eligible to sell carbon emission reductions under the UNFCCC’s Clean Development Mechanism (CDM) as a small-scale Program of Activities (SSC PoA), and the certified emissions reductions achieved by the replacement of LPG and fossil-based electricity generation with solar energy were sold to carbon brokers.¹⁶



Source: IEA-RETD, 2013, “Business Models for Renewable Energy in the Built Environment”

Figure 6: Evolution of Tunisia’s Residential Solar Hot Water System Sales

The basic PROSOL business model and funds flow are shown in Figure 7. First, a household applies for a loan with Attijari Bank. Actually, ANME processes the loan application and the household has no interaction with the bank. Upon approval of the loan, the bank disburses the loan not to the household but to a solar supplier (selected by the household). The supplier also receives

¹⁶ Tunisia’s CDM documents:

http://cdm.unfccc.int/ProgrammeOfActivities/poa_db/7KX218NCPREWQ4YSB90MUI5T6FHZJA/view

a subsidy payment by the government, which is intended to lower the total cost to households. The supplier then provides the equipment to an installer (selected by the household) and pays the installation fee. The installer proceeds with the installation and then notifies the utility (the Société Tunisienne de l'Electricité et du Gaz [STEG]), which adds the solar loan repayments to the household's utility bills.

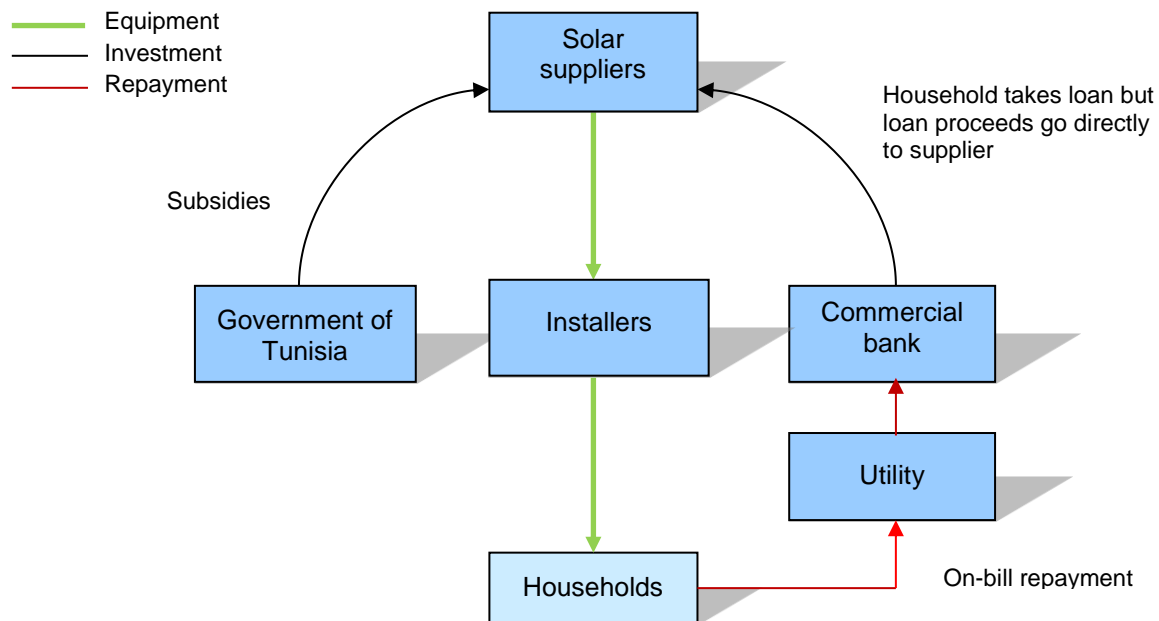


Figure 7: Tunisia's Subsidized Solar Loan Model with On-Bill Repayment

As of 2011, Tunisia's SWH program installed 561,690 m² of solar collectors for an installed capacity of 393 MWth, generating savings of 41,054 toe per year and reducing CO₂ emissions by 123,161 metric tonnes/year.¹⁷

The PROSOL program is a well-organized public-private partnership. Private firms manufacture, supply, install and finance the SWHs. The government not only provides overall program oversight and coordination, but also certifies the suppliers, installers and SWH models, provides subsidies and, perhaps most importantly, provides on-bill financing through the state-owned utility. It also promotes the program and takes actions in response to SWH failures or other problems.

¹⁷ "Solar Thermal in the Mediterranean: Solar Thermal Action Plan", the Observatoire Méditerranéen de l'Energie (OME), December 2012, p. 20.

DISCUSSION

Many companies, large or small, can manufacture and install SWHs in a country. There are major barriers to LPG's entry into a country's fuel market, so the sources of supply are limited. Furthermore, the prices of SWHs in the domestic market with many suppliers are strongly influenced by the competition among these suppliers. While there are worldwide prices for SWHs, the LPG retail price is linked to world oil prices. Increases in world oil prices will inevitably result in increases in LPG sold at filling stations in Ghana. Small variations in LPG prices will not harm the program. But when its price increases make other competing fuels more economical, either the program fails or the government must come up with sufficient funds for price subsidies to bring the LPG price down to a competitive and affordable level.

Interestingly, while Ghana is trying to increase LPG consumption, Tunisia is trying to reduce it. But both countries have a sound rationale for its choice. Ghana is trying to control the loss of its forest resources and needs a cooking fuel to replace wood and charcoal. Tunisia wants to reduce its imports of petroleum products to improve its energy security and its national security. Both countries have selected a seemingly appropriate substitute fuel. They both have achieved some success, although there is no information available regarding the impact that Ghana's program has had on forest-cutting or the impact of Tunisia's program on its petroleum product imports.

Both countries established public-private partnerships to carry out their programs. In a most basic form of partnership, the private firms implement the program and the government regulates and subsidizes it. However, the implementation of an LPG program requires the government to play a far more central role than for an SWH program. First, construction of physical infrastructure is required, from refining facilities to port facilities and storage facilities. This must be carried out, or at least overseen, by the government. Second, while both programs entail a government role in promoting a new technology, an LPG promotional campaign faces more challenges. Switching to LPG requires more changes on the part of users, from the way they cook their meals to the way they obtain the fuel, whereas an SWH program simply provides the same product, namely hot water, and does not require many behavioral adjustments. So, unlike a solar program, the government's LPG promotional campaign has to convince households to go through some essentially lifestyle changes.

Although LPG programs may require much more active government involvement, the Tunisian government has played a highly active role in implementing some aspects of its SWH program. The Tunisian government certifies all SWH equipment and suppliers, and plays a more active role in securing financing. While both countries have used subsidies, the credit system established by the Tunisian government, as discussed earlier, has made a decisive contribution to the success of its program.

LESSONS LEARNED

While unique lessons can be learned from each thermal energy service program, some lessons can apply to all programs. These common lessons learned, if well heeded, can help the government avoid pitfalls and better ensure its program's success.

Lesson 1: Ensure Credit Availability

Unless the energy equipment is given away for free, an affordable, low-risk credit program is essential. It must be affordable in the sense that the loan tenors should be long enough to allow for loan payments to be made from savings. It must be low-risk for the lenders so that, with a low default rate, interest rates can be kept low. However, the interest rate is not as important as the loan tenor. In Tunisia, a temporary interest rate subsidy phased out in 2006 has had no negative impact on SWH sales.¹⁸

There are also other sources of available credit:

- › micro-credit schemes like Grameen Shakti, the employer-supported or community-based savings and credit cooperative organizations (SACCOs) in East Africa;
- › remittances from overseas, such as those used to partially or fully pay the cost of solar lanterns in Haiti.¹⁹

Lesson 2: Carefully Manage Each Link in the Supply Chain

Whether distributing LPG, solar panels or energy-efficient cook stoves, a supply chain is only as strong as its weakest link. In the case of Ghana, there were several weak links starting with the refinery. In the beginning, the TOR was the only source of LPG. So when its operation broke down, the entire program was disrupted. This LPG supply problem was later mitigated by allowing imported LPG to enter the market and by increasing LPG storage capacity so that there was more than a week's supply of LPG in the event of a refinery shutdown.

Likewise, the LPG distributors in Ghana did not have sufficient incentives to persuade them deliver to rural areas and they were not certified, monitored or properly regulated. In addition, the government had no enforcement mechanisms to deal to with poor performance. By contrast, in Tunisia, the solar suppliers and installers have to be certified and the equipment has to meet international standards. Since there are also a large number of suppliers and installers participating in the program, bottlenecks in the supply and installation of solar systems are not a problem.

¹⁸ Tunisia Solar Thermal Program – Residential, Industrial and Hotel Sectors, presentation by Baccouche Abdelkader, ANME, March 17, 2011, http://www.solar-process-heat.eu/fileadmin/redakteure/WSED/2011/download_presentations/Baccouche.pdf

¹⁹ "Remittances and Solar Energy: A Bright Future for A Unique Partnership", Fomin Blog, the Multilateral Investment Fund, Inter-American Development Bank, www.fomin.org/HOME/FOMINblog/tabid/628/Remittances-and-solar-energy.aspx, 5/8/2013.

Lesson 3: Be Flexible on Product Standardization

The key lesson learned regarding standardization is that a program does not have to require product standardization, depending on a country's specific situation.

In Ghana, standard cylinders, burners and ancillary equipment are essential because cylinders are often replaced and must fit with standard burners. The country had some initial problems with the burner design and cylinder sizes, but the need for standardization was duly acknowledged from the start. There are also safety concerns, and standardized and certified design can help address these concerns.

Ghana also has standardized design for LPG filling stations for safety reasons. By contrast, in Tunisia, standardization of SWH products is not a concern. There are hundreds of SHW designs. As long as the products are all tested and certified, there are no design restrictions and no standardization requirements.

Lesson 4: Conduct Adequate Stakeholder Consultations

Consultations with all major players in the program are essential in the program's design phase. Stakeholders, including end-users should be consulted on product specifications, product ownership, performance, maintenance, replacement and financing. In Ghana, problems with end-users could have been avoided if they had been consulted early on. The LPG cylinders started out being too large and users were unsure about proper maintenance. Consequently, disputes arose over replacement of damaged cylinders. Another problem was that the LPG marketers did not speak with one voice. There was not a single representative trade association with whom the Government of Ghana could consult on matters of standardization and best practices.