CLIMATE POLICY INITIATIVE

San Giorgio Group Case Study: Prosol Tunisia

Climate Policy Initiative

Chiara Trabacchi
Valerio Micale
Gianleo Frisari

June 2012

CPI Report

Descriptors

Sector	Multilateral Climate Finance
Region	Global
Keywords	Climate finance, Prosol, Tunisia, Solar Water Heater, Fossil Fuel Subsidies
Related CPI reports	The San Giorgio Group Inaugural Meeting: Expanding Green, Low-Emissions Finance
Contact	Chiara Trabacchi, Venice Office chiara.trabacchi@cpivenice.org Valerio Micale, Venice Office valerio.micale@cpivenice.org Gianleo Frisari, Venice Office gianleo.frisari@cpivenice.org

About CPI

Climate Policy Initiative (CPI) is a policy effectiveness analysis and advisory organization whose mission is to assess, diagnose, and support the efforts of key governments around the world to achieve low-carbon growth.

CPI is headquartered in San Francisco and has offices around the world, which are affiliated with distinguished research institutions. Offices include: CPI Beijing, affiliated with the School of Public Policy and Management at Tsinghua University; CPI Berlin, affiliated with the Department for Energy, Transportation, and the Environment at DIW Berlin; CPI Rio, affiliated with Pontifical Catholic University of Rio (PUC-Rio); and CPI Venice, affiliated with Fondazione Eni Enrico Mattei (FEEM). CPI is an independent, not-for-profit organization that receives long-term funding from George Soros.

Acknowledgements

The authors thank the following organizations and professionals for their collaboration and input, including, in alphabetic order, Agence Nationale pour la Maîtrise de l'Energie (ANME); ALCOR; Amen Bank; Chambre Syndicale des Énergies Renouvelables (CSNER); Credito Trevigiano; Deutsche Gesellschaft für Internationale Zusammenarbeit (GiZ); EcoSer; Energie del Sole; Italian Ministry for the Environment for the Protection of Land and Sea; Mediterranean Renewable Energy Centre (MEDREC), Organization for Economic Co-operation and Development (OECD); Société Tunisienne d'Électricité et du Gaz (STEG); The World Bank Group; Total, Tunisian Ministry for Industry and Technology; United Nations Environment Programme - Division of Technology, Industry and Economics (UNEP-DTIE). Experts in these organizations were critical in helping us better understand the available data, and our work has benefited substantially from the many discussions. The authors would like to acknowledge the helpful comments from Tahar Achour, Abdelkader Baccouche, Leila Bahri, Renzo Bee, Sergio Caimi, Jaqueline Cottrell, Jane Olga Ebinger, Habib El Bach, Abdelmoumen Ferchichi, Carmen Glorioso, Ghita Hannane, Ari Huhtala, Sina Johannes, Myriem Touhami Kadiri, Zied Kassar, Abdelhamid Khalfallah, Naomi Klein, Edith Kuerzinger, Sami Marrouki, Ottaviano Mattavelli, Rafik Missaoui, Salvatore Moretta, Jan Corfee-Morlot, Osman Nejib, Moncef Njeimi, Annalidia Pansini, Leonardo Pasinato, Ghazi Ben Salem, Amel Trifa and Eric Usher. Finally the authors would like to acknowledge inputs, comments and internal review from CPI staff: Ruby Barcklay, Tom Heller, David Nelson, Brendan Pierpont, Morgan Hervé-Mignucci, Anne Montgomery, Uday Varadarajan, Tim Varga. In particular, we thank Barbara K. Buchner and Jane Wilkinson for continuous advice and guidance.

San Giorgio Group Case Study Overview

This paper is one of a series – prepared by Climate Policy Initiative for the San Giorgio Group – examining the use of public money to catalyze and incentivize private investment into low carbon technologies and draw lessons for scaling-up green, low-emissions funding. The San Giorgio Group case studies seek to provide real-world examples of what works and what does not in using public money to spur low carbon growth. Through these case studies CPI describes and analyzes the types of mechanisms employed by the public sector to deal with the risks and barriers that impede investment, establish supporting policy and institutional development and address capacity constraints.

Contents

Executive Summary

In this case study, we analyze the experience of Tunisia's Prosol program, through which the Tunisian government seeks to achieve a long-standing goal of transitioning households away from water heaters run on fossil fuels to solar water heaters (SWHs). The Prosol example provides insights into how a developing country can align domestic and international support to level the playing field between low carbon technologies and heavily subsidized fossil fuel based alternatives.

Launched in 2005, Prosol is a joint effort of the Tunisian Ministry of Industry, Energy and Small and Middle Size Enterprises; the National Agency for Energy Conservation of Tunisia; and the United Nations Environment Programme. Prosol also received financial backing from the Italian-led Mediterranean Renewable Energy Program. The program built upon the experience of two earlier initiatives that failed to deliver long-term results. In particular, these previous efforts failed to address SWH market-specific issues (lack of an adequately mature supply chain, reliability of technology, lack of financing options), and did not provide a framework to tackle the market barriers, such as the up-front cost of the technology and subsides for fossil fuel-based alternatives, that rendered SWHs a less attractive investment option. Prosol itself developed in phases, with Phase II's enhancements based on learnings from Phase I.

The Prosol program was designed to address three main challenges:

1. Leveling the competitive playing field by offering subsidies for SWHs to help offset the subsidy advantage of the dominant liquefied petroleum gas-fired systems;
2. Building-up both the demand and supply sides of the SWH market, including by raising consumer awareness of and confidence in the technology, training installers, creating accreditation and quality certification programs as well as developing an after-sales maintenance network;
3. Overcoming the absence of consumer credit for renewable energy investments and reliable credit performances by involving the state utility to act as debt collector, guarantor and enforcer.

The following table summarizes how the Program addressed stakeholder-specific barriers to investment.

Who	Issue	Prosol Responses and Effects
Local Authorities	Fossil fuel subsidies distorted the economics of solar water heater investments	Prosol helped make solar water heaters more attractive relative to fossil fuel heating alternatives by subsidizing part of the upfront investment.
	Public resources are limited due to budget constraints	The Prosol investment subsidy for solar water heater was set to a level that helped even the playing field with the fossil fuel-based alternative, without providing more subsidy than necessary.
	International financial aid was not sufficient by itself to create sustainable long-term impacts	In the Prosol case, international aid played a specific role: to kick-start the Program by helping build infrastructure that addresses the needs of commercial banks, households, and the solar water heater industry. After the kick-start phase, the local authorities took over support of the Program, including: • investment of local resources • assigning an experienced local agency to be in charge of Program implementation and management • concerted engagement of the state owned-utility and local banks, which led to increased access to affordable credit.
International Donors/ Agencies	Both non-economic and economic barriers prevented deployment of renewable technologies	International aid addressed: • non-economic barriers by funding awareness initiatives targeting households and banks and training local government staff, technology suppliers and installers • economic barriers by supporting the incremental up-front cost of the technology with an investment subsidy and the cost of credit with interest rate abatement.
Households	Many households were not aware of solar water heaters' economic benefits, did not trust that they were reliable, and could not afford them.	Prosol raised awareness about the economic benefits of solar water heaters through targeted and continuous information campaigns, and built confidence in the technology through quality and certification measures. The program helped make solar water heaters more affordable by reducing up-front investment requirements and prompting banks to offer concessional financing.
	Will SWH investments still be appealing when public support is removed?	Prosol efforts to improve understanding of the value added of the technology may support a more responsible and long-term investment in solar water heaters, despite lower short term profitability. However, continued subsides on fossil fuels will make this transition challenging, and may undermine Prosol efforts once public support is removed.
Commercial Banks	Risk aversion and lack of understanding of green-technology financing contributed to capital shortages in the market.	The role of the state utility as debt collector, enforcer and loan guarantor shifted the credit risk from lenders to borrowers, unlocking financial resources, while improving the overall credit performance of residential borrowers. Training programs have built banks' expertise in financing renewable energies. Awareness-building initiatives have communicated the profitability potential of the market to banks.

Has Prosol been effective?

The CPI approach to effectiveness analysis relies on a framework which aims to illustrate that there is a causal relationship between inputs and returns/benefits. In order to apply this approach across different cases, we have adopted a common set of appropriate criteria and indicators that can be applied to systematically measure the performance of the investment in question.

Our objective in these case studies is to draw lessons for scaling up and replicating best practices to other sectors, technologies, and geographies. In the case of Prosol, we evaluate the main features introduced by the Program in terms of technology development, environmental benefits and economic results. These include the leveraging effects of public money to the amount of GHGs avoided, and take into account our assessment of the financial sustainability of the Program thanks to the savings obtained in fossil fuels subsidies.

Over the analyzed time frame (2005-2010), total public and private investment in Prosol amounted to USD 134 million. The outcomes achieved include savings in fossil fuel subsidy expenditures by the Tunisian Government, avoided CO_2 emissions, increased energy independence, and economic development. In particular:

- Prosol shows that targeting public resources to directly support renewable energy investments can effectively shift demand away from fossil fuels, even where fossil fuel subsidies are in place.
- The annual capacity installed, in terms of collector area, increased fivefold compared to the previous initiative, with a total installed base of about 119,000 systems.
- Remarkably, there results were achieved at a net gain for the public budget. The study shows that between 2005-2010 the shift in consumers' demand shaved USD 15.2 million off Tunisia's fossil-fuel subsidy outlay. These savings are projected to reach USD 101 million over the life span of the SWHs, which means that the Program will more than compensate the Government's original USD 21.8 million investment.
- Other benefits include 251 Ktoe of avoided fossil fuel consumption and 715 Kt CO2 emissions over the life span of the SWH installed.
- In terms of economic development, the domestic solar thermal industrial cluster grew significantly; it is also estimated that about 3,000 new jobs were possibly created – although job losses observed in more conventional industries should also be taken into account.

Current and planned SWH incentive programs in the MENA and Balkan regions are now assessing the feasibility and sustainability of scaling up and replicating the Prosol model in different institutional, regulatory, economic and cultural contexts.

Lessons for future low carbon investments:

Our analysis of Prosol suggests a number of lessons for how to encourage effective investments in renewable technologies:

- **Investments in mechanisms that offset the incremental cost of green technologies with respect to emission intensive alternatives can result in net savings for governments.** When fossil fuel subsidies are in place, financing support for the up-front investment must counterbalance market distortions in order to level the playing field between purchasing alternatives and divert demand for dirtier ones.
- **Tackling knowledge and information barriers from the outset can be decisive.** Initiatives that address these issues represent opportunities for international partners (including development agencies) to have high value and relatively low-cost impact.
- **The careful allocation of risks among key actors can help attract banks and other private investors.** In the Prosol case, the state utility STEG assumed default risks by taking on the role of debt repayment enforcer and loan guarantor, and passed these risks on to consumers by withholding services in the event of non-payment.
- **Quality standards and capacity-building can address technology risks or perception of such risks.** Prosol established a training program and accreditation scheme for suppliers and installers, SWH certification and performance labeling, supplier-provided SWH component guarantees, and after-sale maintenance contracts. These measures helped reduce technology failure rates to approximately 1%.
- **A sufficiently committed and capable national agency to (help) design, promote, implement**

and manage programs or projects is essential, not least, to build capacity at every stage of the value chain. The Tunisian National Agency for Energy Conservation (ANME) successfully addressed the implementation challenges by coordinating and engaging local and international stakeholders.

1. Introduction

In October 2011, Climate Policy Initiative (CPI) and the World Bank Group, in collaboration with China Light & Power (CLP) and the Organization for Economic Co-operation and Development (OECD), launched the San Giorgio Group, a new working group of key financial intermediaries and institutions actively engaged in providing green, low-emissions finance.[1]

The San Giorgio Group recognizes that a major barrier to scaling up climate investment flows is the limited availability and understanding of empirical evidence or 'on the ground' examples of financial practices, environmental policies and political signals that drive green investment. The goal of the San Giorgio Group is to fill this gap by drawing on the experience of its members to track and analyze the life cycle of existing projects, programs and portfolios, and assess results and mechanisms that affect financial and environmental performance of these investments. In so doing we aim to distill lessons about evolving financing practices and provide insights on how to scale up climate finance and spend resources more wisely.

Our inquiries are framed by four overarching questions:

- What is the role and reasons of public finance?
- How can public money be best delivered (instruments and institutional channels)?
- How to ensure alignment of international and national public investment flows with each other and with private investment?
- How can effective investment and continued learning be ensured?

San Giorgio Group case studies share a systematic analytical framework. They explore in depth the role of project stakeholders, the sources of return for the various stakeholders, the risks involved and arrangements to deal with them, and case-specific developments and lessons in replicating and scaling up best practices.

The Prosol Tunisia financing facility (Prosol) stands out as an example of how international and local public support addressed critical demand-side barriers that were preventing the widespread deployment of a commercially viable renewable energy technology – in this instance, Solar Water Heating (SWH) – in a developing country.

Prosol was initiated in 2005 by the Tunisian Minister for Industry, Energy and Small and Medium Enterprises and the National Agency for Energy Management with the financial support of the Italian Ministry of the Environment for the Protection of Land and Sea (MATTM) and the technical support of the United Nations Environment Programme (UNEP). As highlighted in Table 1, the Program aimed to target specific constraints along the SWH technology continuum, particularly those that were – and to some extent still are – preventing this mature technology from reaching market independence. Designed for the Tunisian residential sector, Prosol encompassed multiple interrelated measures that provided households with incentives to purchase SWHs, drew-in private investors by reallocating investment risks and drove reforms in the energy subsidy framework.

The Facility addressed competitiveness concerns by adjusting the market distortions generated by pervasive subsidies on fossil fuel-based water heating alternatives; provided access to concessional finance and tackled lenders' perceived risks about SWH technology and market potential, by setting up a system of guarantees. It overcame information asymmetries and the scarce awareness about the added value of 'green' investments through targeted capacity building measures for financers and suppliers; this, also allowed to improve the quality of the products offered.

This case study focuses on the 2005-2010 period of the Prosol Residential Program, which saw the transition from the donor-funded to the locally-funded phase. In section 2 we present the design characteristics of the Prosol financial mechanism, outline the policy context within which the Program developed and the main stakeholders involved. Along with its contextualization within the SWH technology continuum, this helps us to examine and evaluate the Prosol financing facility, understanding how, why and if it achieved its stated objectives.

In section 3 we explore the Program's economics and how the different types of incentives and measures influenced stakeholders' investment decisions, on both the public and private side. We present an analysis of investment economic and environmental returns for each stakeholder group followed, in section 4, by a detailed risk-analysis, examining the allocation arrangements adopted to mitigate the main risks involved in the Program, and address their potential impacts.

Section 5 focuses on the role played by Prosol in influencing the Tunisian energy subsidy framework,

1 For additional information see CPI website, http://climatepolicyinitiative.org/event/inaugural-meeting-of-the-san-giorgio-group/.

which ultimately resulted in significant savings for the public budget. In addition, it also examines the strategy adopted to engage local financial institutions in renewable energies financing that facilitated the scale up of available investment capital.

Finally, in section 6, we draw together the lessons learned across the life of the Program and assess the potential scalability and replicability of the Facility both in Tunisia and beyond. We identify those aspects that might be applied successfully in other contexts and explore the challenges that, quite likely, would need to be addressed by governments, suppliers and commercial entities to ensure the long-term viability of renewable energies deployments.

Our hope is that the lessons offered by Prosol will provide governments, financial intermediaries and private entities with some clear examples of successful approaches to promote green investment by shifting public resources and private demand, create opportunities, and establish enabling conditions for the deployment of renewable energies. In particular, this case study shows how a limited amount of public money has been used to 'crowd-in' private investment, helping to improve both the carbon footprint and the economic profile of Tunisia.

Table 1. The continuum of SWH technology development and the policy objectives, barriers, and public finance interventions at each stage

	RD&D	TARGET DEPLOYMENT	MASS MARKET DIFFUSION	COMMERCIAL MATURITY
POLICY OBJECTIVES	Innovation Proof-of-concept at scale	Support market-pull & scale-up		Ongoing market growth
BARRIERS	High tech risks & costs Uncertain economic payoffs	High initial investment Competitiveness concerns Fossil fuel subsidies Access to finance Lenders & borrowers low understanding/expertise		Market competitiveness Limits to economies of scale
PUBLIC FINANCE INTERVENTION	R&D/project grants Incubators Public VC Funds	**Investment grants; technical assistance grants; concessional loans; guarantee arrangements** Public private parnerships Mezzanine finance Public PE funds		

→ STAGES OF MARKET DEVELOPMENT →

Note: This case study focuses on the financial instruments used by Prosol, highlighted in red, above. SWH technology has already moved past the stages and instruments in gray text. Source: CPI elaboration based on Climate Bonds Initiative & Irbaris (2011), UNEP SEFI (2008), UNEP and Partners (2009) and UNEP SEF Alliance (2010).

- Even in the case of a mature technology such as solar water heating, bilateral public funding may be essential to 'tip the balance' and enliven policy interventions in order to drive uptake and promote market independence.
- A multi-stakeholder approach that employs a variety of ad hoc measures can address audience-specific barriers to renewable energy deployment.

2. Prosol Residential - Program overview

The Program entailed – and still entails – a combination of measures that aimed to overcome critical demand-side barriers to the development of a sustainable SWH market. It established:

- **an investment subsidy to lower end-users' capital cost and enhance SWHs[2] competitiveness** *vis-à-vis* conventional liquefied petroleum gas-fired systems that were (and remain) dominant in the market;
- **a mechanism to facilitate consumers' access to credit and overcome the lack of tailored end-user financing options** - by facilitating a temporary interest rate subsidy (7% in the first twelve months, 3% in the following six), a 50% reduction in interest rates (from ~12% to ~6%), and longer repayment terms (from 3 years to 5 years);[3]
- **a series of awareness-raising campaigns addressed consumers' skepticism about SWHs and informed commercial banks about renewable energy (RE) investments and associated market potentials**;
- **a capacity-building strategy** to ensure local domestic financial institutions and technology providers develop long-term knowledge and expertise;
- **an accreditation scheme** for suppliers/installers and SWH models, as well as monitoring procedures to ensure the **quality and reliability of systems** which are important factors in stimulating and sustaining demand;
- **the development of carbon credits under a programmatic Clean Development Mechanism** (CDM) – in phase two – that will be used to finance the continuation and scale up of the Program itself.

It should also be added that with the aim to improve technology levels, decrease costs and support the manufacturing and installation of SWH in the country, in 2006 the Tunisian Government reaffirmed VAT exemption for SWHs, and reduced custom duties to the minimum rate of 10 % (versus a general rate of 18%) (Decree n° 744-95; Decree n° 4-2006).

2 Only SWH models with 200 and 300 litres capacity compliant with certain quality standards were commercialized with the backup of Prosol Residential (ANME, 2005).

3 This implies that households contracting loans in the first 12 months of the Program were charged a 0% interest rate, 4% in the subsequent 6 months (Touhami, 2011; Menichetti and Touhami, 2007).

Prosol ('Program Solaire') is an end-user financing facility jointly developed by the Tunisian Ministry of Industry, Energy and Small and Middle Size Enterprises (MIEPME); the National Agency for Energy Conservation of Tunisia (ANME); and the United Nations Environment Programme (UNEP). Prosol was backed by the Italian-led Mediterranean Renewable Energy Program (MEDREP). **Launched in April 2005, it aimed to accelerate the penetration of SWH in the Tunisian residential sector by engaging local financial institutions to provide credit lines to consumers.**

Program Timeline

The Tunisian Government's (GoT) long-standing interest in exploiting its REs potential[4] – including SWHs policy support initiatives – dates back to the 1980s in the context of stagnating supply from national hydrocarbon resources,[5] rising international energy prices, and growth in the national demand (GIZ, 2009). Even though SWHs could potentially meet up to 70-80% of Tunisia's residential hot water demand (Menichetti and Touhami, 2007), over 70%[6] of it was met through heavily subsidized imported fossil-based sources – specifically, liquefied petroleum gas (LPG) – at significant cost to the national budget and the environment.

Prosol developed in a favorable institutional, legislative, and political framework for the deployment of renewable energies technologies,[7] building upon the experience of two earlier initiatives that failed to deliver long-term effects following their conclusion, hence demonstrating the value of learning lessons within the project life-cycle.[8] In particular, these previous programs failed to address SWH market-specific issues (reliability of technology, lack of financing options) and did not provide a framework to tackle the market barriers, such as transaction costs and fossil fuel subsides, that rendered SWH a less attractive investment alternative.

The Program timeline (Figure 1) shows the important milestones of the Prosol Residential Program and illustrates how the participation of stakeholders evolved over time.

The Program comprises two phases:

- **Prosol I** (2005-2006), which we define as 'the suppliers lending phase', since individual suppliers acted as indirect lenders and debt guarantors for consumers. It was kick-started with funds from the Italian Ministry of the Environment for the Protection of Land and Sea (MATTM) – an essential 'tip the balance' to make the Program possible – which provided a USD 2.2 million grant to support:
  - » the 20% subsidy on SWH capital costs (USD 1 million) funded via the Mediterranean Renewable Energy Centre (MEDREC);
  - » a temporary interest rate subsidy (USD 1 million) gradually phased out after 18 months – funded via UNEP. This facility aimed to create incentives for householders to apply for favorable credit terms to purchase SWH systems, and to help banks rapidly achieve a critical mass of loans;
  - » USD 0.2 million for capacity-building, awareness-raising campaigns, and Program support costs.

After a few months of operations, buoyed by the early results, the Tunisian Government (GoT) passed a legislation mandating that SWHs installed in the residential sector be eligible for a 20% capital cost subsidy.[9] The GoT committed to implement such change at the

4 MED-EMIP (2010) estimates the REs potential in terms of installed capacity of main REs technologies (PV, SWH, wind, hydro, biomass and municipal landfill gas) achievable in the country at 148 MW in 2010, with the potential to increase up to 2,365 MW by 2020. SWHs installed in the residential and commercial sector are estimated to represent about 20% of the total.

5 Tunisia, formerly in a relatively stable energy balance surplus of approximately 3 Mtoe/per annum in the '80s, thanks to its oil reserves, lately started to record declining production rates versus growing demand rates and, in 1994, registered for the first time a deficit of 124 Ktoe, that become permanent as of 2000.

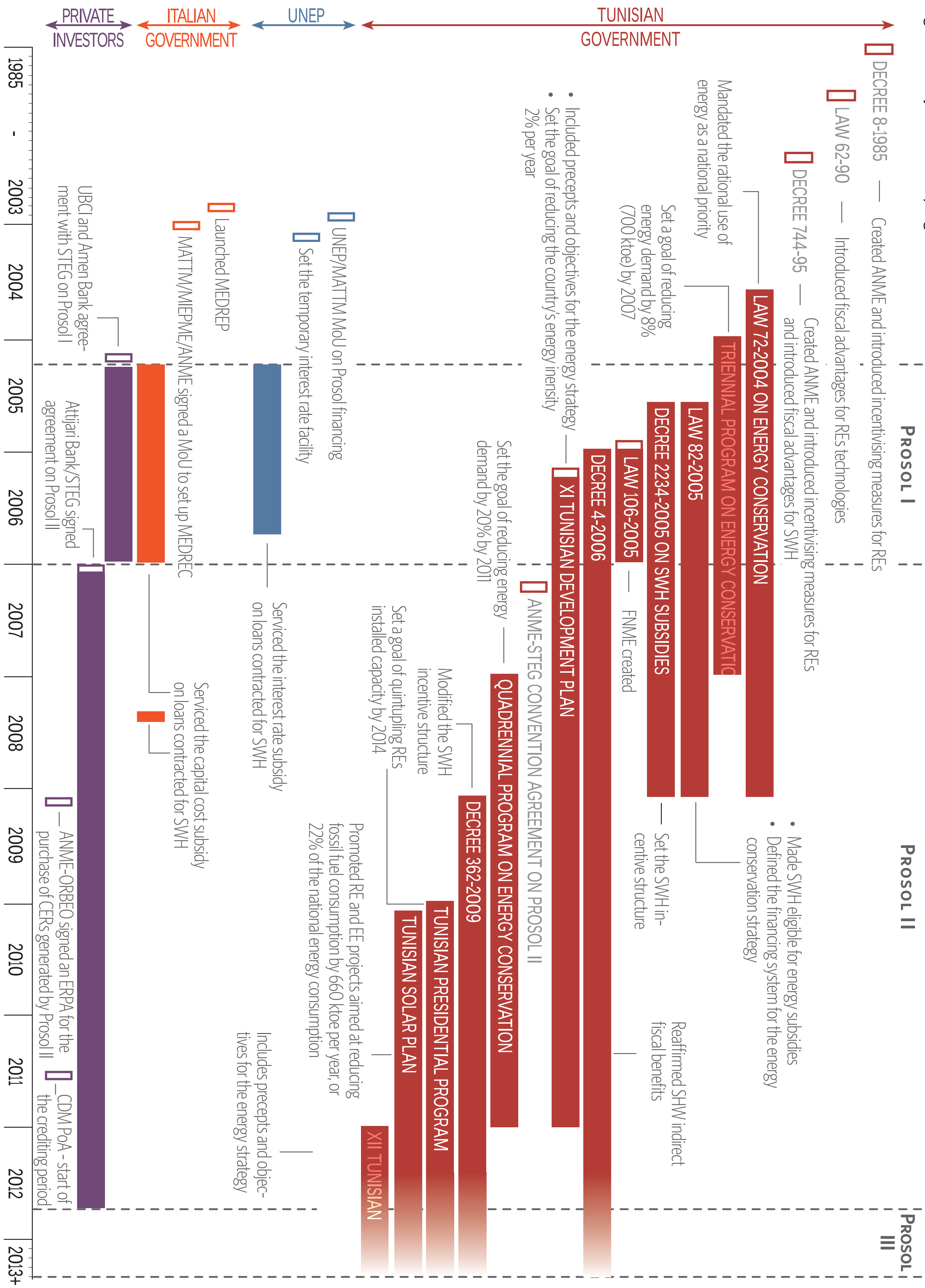
6 Before the start of the Program, in 2003, LPG-fired boilers represented 78.4% of the existing stock, electric system 10.4% while natural gas-fired 8%. Solar thermal appliances represented 3.2% only (Menichetti and Touhami, 2007 based on Missaoui and Amous, 2003).

7 The Tunisian Government started to promote a conducive regulatory framework as early as 1985 with the establishment of a dedicated National Agency for Energy Conservation (ANME), the promulgation of the Energy Conservation Law in 1990 – amended with Law No. 72-2004 that stated the rationale use of energy as a national priority – and of the Investment Incentives Code (1993). The Code (amended by subsequent legislative acts), a main point of reference for domestic and foreign investors, set a system of incentives and of direct and indirect financial allowances (e.g., VAT exceptions and reduced custom duties) aimed to support investments in energy conservation measures and in research, production and commercialization of REs, with the objective of promoting domestic exports (Republic of Tunisia, 1993; OECD, 2012a).

8 The Government started to incentivise the uptake of SWHs in 1984, through a series of advantageous financial and investment conditions that proved to lead to unsuccessful results due to quality and maintenance issues. This initial intervention was followed in 1996 by a second one funded by the Global Environment Facility (GEF) together with Belgian co-financing (USD 6.6 million in total), which comprised a direct subsidy of 35% of the SWH price and a capacity building component. Despite demonstrating successful in stimulating market growth, once donor funds ended in 2002, the SWH market collapsed from 17,000 m^2 installed in 2001 to 7,500 m^2 in 2004. Thus, the SWH market proved to be still commercially immature and to require additional public support (ANME, 2010a; Haselip et al., 2011). World Bank (2004) reports that the audience initially targeted by the GEF-funded initiative (namely, hotels, schools, sports centres, etc.) had a smaller market potential than the residential sector, owing to imprecise estimates undertaken at appraisal – then revised during the implementation – and, particularly, did not consider upfront how to bring the Program's effects forward.

9 Law n° 82-August 2005 – implemented by Law n° 106-December 2005 – and Decree n° 2234-August 2005.

Figure 1. Policy context and program timeline



Source: CPI elaboration based on various sources (see References).

outset of the Program, if a certain volume of installations were achieved during its initial phase. **It was the first policy intervention of this kind, as energy subsidies had previously been directed exclusively toward fossil fuel sources.**

Through the same legislative acts, **the Government also created an ad hoc National Fund for Energy Conservation (FNME) to be financed through fiscal measures**, in order to **ensure a stable stream of public financial support for REs and energy efficiency (EE) initiatives.**[10]

- **Prosol II** (2007-2012),[11] 'the consumers lending phase', introduced key improvements in the financing mechanism, namely, direct lending to households (via STEG) thereby relieving SWH suppliers from debt liability; STEG's involvement as guarantor of households; and a wider choice of credit lines. In addition, in February 2009, the GoT changed the incentive framework from the 20% subsidy to a bonus of USD 150 to USD 300 based on the SWH collector area.[12] This change was designed to overcome a slight impasse observed in sales when the funds granted by the MATTM ended, and to promote market diversification by making the product more attractive to low-income households.
- This phase was mainly supported with Tunisian resources with a small supporting grant (about USD 210,000) provided by MATTM.

Over Prosol phases I and II (2005-2010), more than 119,000 SWH systems totaling around 355,350 m^2 of collector area were installed in Tunisia, with a fivefold increase in annual deployment, achieving an average installation rate of about 59,225 m^2 per year during this time frame, compared to the 10,662 m^2 one observed under previous initiatives. Emboldened by these results, the GoT enhanced its target ambition and, with the Tunisian Solar Plan,[13] announced its aim to achieve 900,000 m^2 in installed capacity by 2016.

Program stakeholders

A broad group of international and national, government and non-government stakeholders was involved in the development and implementation of the Prosol Program. Each played a distinct role in bringing the Program to life. Based on publicly available sources of information, we have categorized and mapped the economic, financial and institutional linkages between the stakeholders involved in the two phases of the Prosol Residential Program in the 'tube map' (Figure 2).

We identify two main groups of stakeholders: those pertaining to the public sector, either international or national; and those belonging to the private sector: households, local banks and technology providers. Each of these had a particular role in the Program. The map is supported by a table that summarizes stakeholders' role and contribution (Table 2).

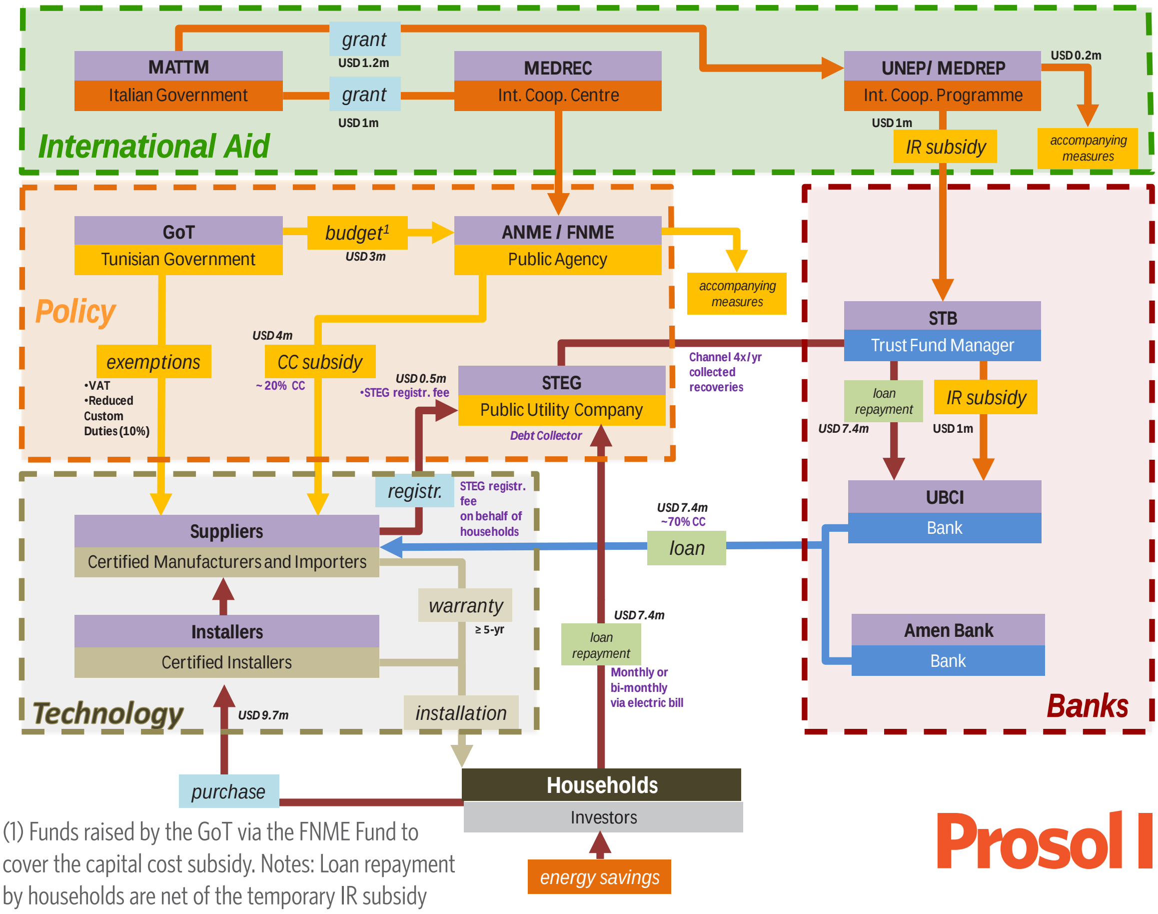
10 It was stated by law that the FNME would be financed through a tax on the first licence registration of vehicles, according to motor capacity, and custom duties on air conditioning equipment. See Law 2005-82 for details and exceptions: Official Printing Office of the Republic of Tunisia: http://www.iort.gov.tn/WD120AWP/WD120Awp.exe/CONNECT/SITEIORT.

11 The Program was intended to run till 2011, but it was recently extended to September 2012 as the USD 88 million (TND 117 million) plafond made available by Attijary Bank for the Program has not been exhausted as yet. MATTM supported Prosol II with funds unspent during Prosol I (USD 94,080) and by making an additional contribution of about USD 130,000 in 2008. Law 362-2009 was introduced to foster the manufacturing of SWHs with a smaller capacity (150 litres), which is more suited to low-income households' needs, and to broaden the customer base that, owing to the expansion of the gas pipeline infrastructure, is likely to be found in more isolated areas and in Tunisia's interior in the coming years.

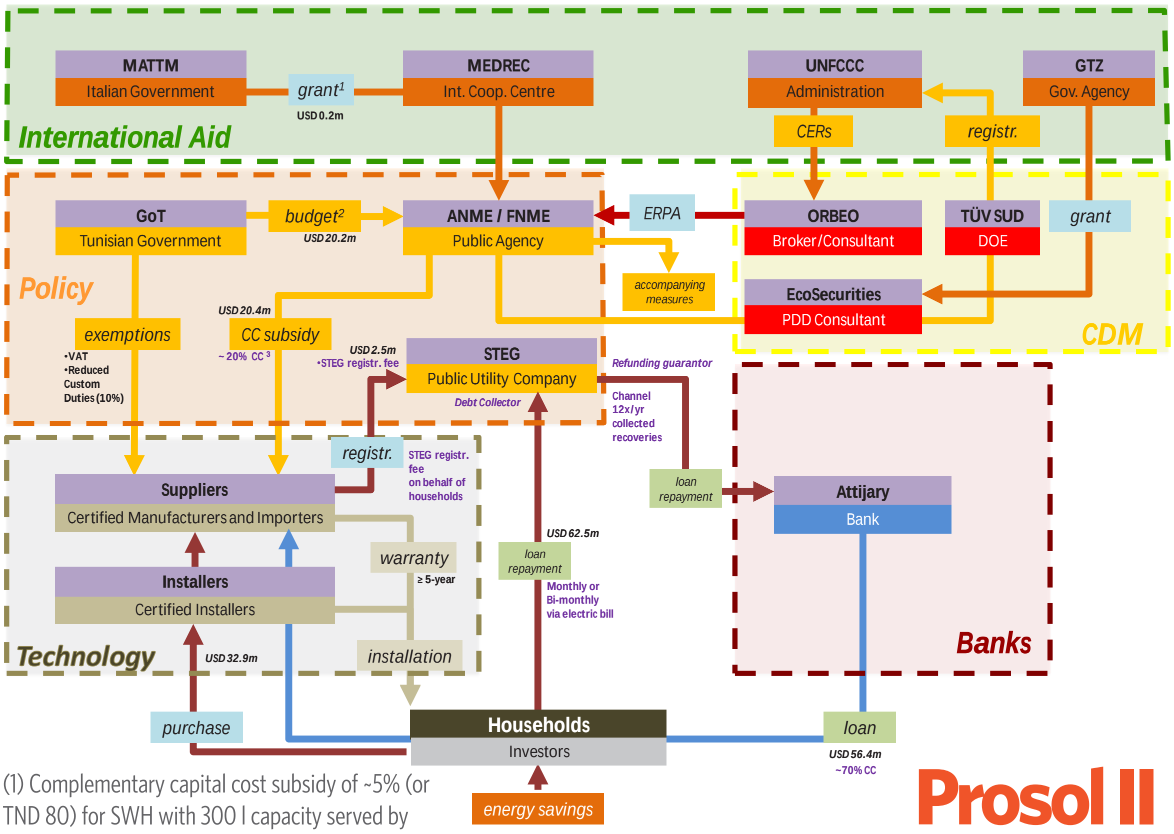
12 Law 362-2009 introduced bonuses of USD 150 (TND 200) and USD 300 (TND 400) for SWHs with collector area between 1-3 m^2 and 3-7 m^2, respectively.

13 The approximately USD 2.2 billion (TND 3.4 billion) Tunisian Solar Plan (Plan Solaire Tunisien – PST) is a two-phase initiative introduced in 2009, and part of the framework of international interventions that encompass the Mediterranean Solar Plan and the DESERTEC project. It provides a clear signal about the country's intention to become a key player in the production and export of solar energy. The first phase (2010-2016) aims to increase the share of REs in total electricity production by 16%, and achieve 25% in energy savings; the second phase, extending to 2030, fixes a 40% target for both RE and EE. The Plan, which includes Prosol, foresees 40 different projects in solar, wind, energy efficiency, and waste sectors, to be financed by private capital for 70% of the total. The Plan is expected to reduce fossil fuel consumption by 660 Ktoe/per annum, or 22% of the national energy consumption by 2016. Source: OECD (2012a) and http://www.pavingtheway-msp.eu/fileadmin/paving-the-way/Tunisa.pdf.

Figure 2. Key stakeholders involved in Prosol I and Prosol II and their linkages.



(1) Funds raised by the GoT via the FNME Fund to cover the capital cost subsidy. Notes: Loan repayment by households are net of the temporary IR subsidy served by MATTM via UNEP. Financial flows represent the sum of flows for the year 2005-2006, actualized to USD 2005.



(1) Complementary capital cost subsidy of ~5% (or TND 80) for SWH with 300 l capacity served by MATTM until exhaustion of funds. (2) Funds raised by the GoT via the FNME Fund. Notes: Decree no. 362 modified the GoT capital cost subsidy, establishing a fixed amount of between USD 153 and USD 306 (200 and 400 TND) varying according to SWHs' surface area. Financial flows represent the sum of flows for the year 2007-2010, actualized to USD 2007.

Source: CPI elaboration based on various sources (see Reference section). CC = Capital Cost; IR = Interest Rate.

Table 2. Stakeholder's description and role.

	Stakeholder	Description and role	Financing role[1]
International public	MATTM	Italian Ministry for the Environment and Protection of Land and Sea • actively engaged in bilateral and multilateral cooperation; • operated in Tunisia within the MEDREP Finance Initiative; • closely followed Program implementation through MEDREC.	**Source**: USD **2.4** million grant
International public	UNEP-DTIE	United Nations Environment Programme Division of Technology, Industry and Economics • operates in Tunisia within the MEDREP Finance Initiative;[2] • provided technical support and expertise to the Tunisian Government for the design and development of the Prosol financing mechanism; • organized stakeholders' consultations and engaged banks in the Program; • contributed to the awareness raising and communication campaign activities.	**Intermediary**: channelled **USD 1 million grant** from MATTM
International public	MEDREC	Regional Centre for training, knowledge sharing, and the development of REs pilot projects in the Mediterranean Region. • provided technical assistance and support in the establishment and management of Prosol; • carried out capacity building activities.	**Intermediary**: channelled **USD 1.2 million grant** to ANME/FNME to cover the capital cost subsidy
Domestic public	Tunisian Gov.	Ministry for Industry and Energy and Small and Medium-Sized Enterprises • actively promote rational use of energy via direct support to renewable energies and energy substitutions; • mandated by law an investment subsidy to lower the SWH upfront costs.	**Source**: **USD 21.8 million grant**
Domestic public	ANME[3]	National Agency for Energy Conservation • is responsible for the implementation of the state policy for energy conservation through the rational use of energy, the promotion of REs, and energy substitution; • participated in the design and promotion of Prosol; • is responsible for the overall implementation and management of Prosol; • manages the FNME and channels granted funds to SWHs suppliers; • designed the quality certification and the after-sales maintenance process.	
Domestic public	STEG	State-owned utility with a monopolistic position in the local power market (85% market share).[4] • recovers end-user loan repayments through bills, and acts as enforcing agent; • has acted as debt guarantor since Prosol II (2007).	
Domestic public	STB	Tunisian National Bank (Prosol I) • Trust fund manager for the interest rate subsidy granted by MATTM. It was involved in Prosol I as an intermediary because, per policy, UNEP cannot transfer donors' funds directly to private banks, unless via tender.	**Intermediary**: channelled **USD 8.4 million** in loans and interest repayments to local banks
Private Sector	Residential-consumers	Mostly middle-income households (around 45.6% of the population) with relatively high education levels and mostly home-owners.[5]	**Source**: **USD 50.3 million** in investment capital and interest repayments
Private Sector	Technology providers	SWH manufacturers, importers and installers • responsible for installation and maintenance; • act as financing intermediaries for the provision of credit to the households, and as debt guarantors in Prosol I.	
Private Sector	Banking sector	Private commercial banks (for Prosol I, total loans have been estimated from market share) • Amen Bank underwrote loans for almost USD 4.7 million (Prosol I); • Union Bancaire pour le Commerce et l'Industrie (UBCI) underwrote loans for USD 2.6 million (Prosol I); • Attijari Bank underwrote loans for USD 52.5 million (Prosol II).	**Source**: **USD 59.8 million** concessional loans

[1] Figures are actualized to 2005 with an average 2005-2010 inflation rate (IMF, 2011) and converted from the original currency to an average USD 2005-2010 exchange rate (Oanda, 2012).

[2] The MEDREP Finance Initiative is part of the broader Mediterranean Renewable Energy Program (MEDREP) launched by Italy in 2002 at the World Summit on Sustainable Development (WSSD) in Johannesburg.

[3] ANME is a non-administrative public entity operating under the authority of the Ministry of Industry.

[4] Until 1996 STEG had the monopoly on electricity and gas generation, transmission and distribution in Tunisia. Then, two IPPs were allowed to generate electricity to feed into the Tunisian grid. Market share data as of 2010.

[5] The AfDB (2010) defines 'middle class' as population with a daily expenditure of USD 4-20 per day. Across the African continent, the middle-class population represents, in averages, 13.4% of the total (AfDB, 2010). In 2010, Tunisia ranked 83rd out of 172 countries in the Human Development Index ranking (Haselip, 2011; UNDP, 2010). Haselip et al., (2011) reports that 80% of Tunisian households own their home, making them more prone to invest in a SWH than tenants would be. Data as of 2010.

- Each dollar of public finance invested in Prosol 'crowded-in' almost five dollars of domestic private capital.
- With bilateral backing, which helped to address the market uptake risk, local actors took crucial legislative steps to counterbalance distortion from fossil-fuel energy subsidies.
- The displacement of fossil fuel subsidies provides significant public revenue returns and has the capacity to provide self-sustaining financing for the Program over the long term.
- Program results need to be assessed within a broader framework encompassing financial as well as non-monetary benefits.

3. Prosol Residential - investments, returns and profitability

This section addresses two main questions of the San Giorgio Group: What are the public and private financial inputs and what are the main outcomes and results of Prosol? It assesses how public funds enabled investments in renewable energies on one hand, and on the other, how international and national public targets were aligned with private expectations to achieve financial and non-monetary benefits for all stakeholders involved. We begin the section by estimating the overall investment value of the Program, quantifying individual financial contributions across the public and private sectors before estimating the return streams accruing to each of Prosol's sponsors.[14]

Investments: Who pays for what?

We estimate the investment in the overall Program during 2005-2010 at approximately USD 134 million (see Figure 3). **The public sector provided 18%** (USD 24.2 million) of the total amount, while **82%** (USD 110 million) **was provided by local private investors**. Accordingly, **we calculate that every dollar of public resources was able to mobilize almost five dollars of private capital**.

Public Finance Inputs

The Italian Government through MATTM granted USD 2.4 million to UNEP and MEDREC. Over 90% of these resources were allocated to the first phase of the Program. USD 1 million, channelled via MEDREC, was used **to fund 20% of the capital cost of all new SWH installations, and USD 1 million financed UNEP's temporary interest rate subsidy facility**. USD 200,000 sustained accompanying measures and Program support costs.[15] The second phase was financed with undrawn resources from Prosol I and an additional USD 130,000 granted in 2008 by the Italian Government to the MEDREC to support the investment subsidy.[16] On the whole, the Italian Government contributed about 2% of the Program's value, a small overall contribution, which has been however critical to kick-start the Program.

Through the FNME, **the Government of Tunisia provided a USD 21.8 million grant to cover the capital cost subsidy**.[17] Due to data unavailability, this estimate does not include indirect subsidies[18] and administrative and human resource expenses incurred by ANME to run the Program.[19]

The costs incurred by the state-owned utility STEG are also excluded, as we assume these are covered by a file service fee of USD 27 (TND 35.4) per system sold to cover the administrative costs associated with loan payments collection. This fee was included in the SWH

14 The banks' perspective on the Program economics is treated separately in Chapter 5.

15 This category includes communication and capacity-building activities. These costs do not include either MEDREC or MEDREP Prosol-related operating costs.

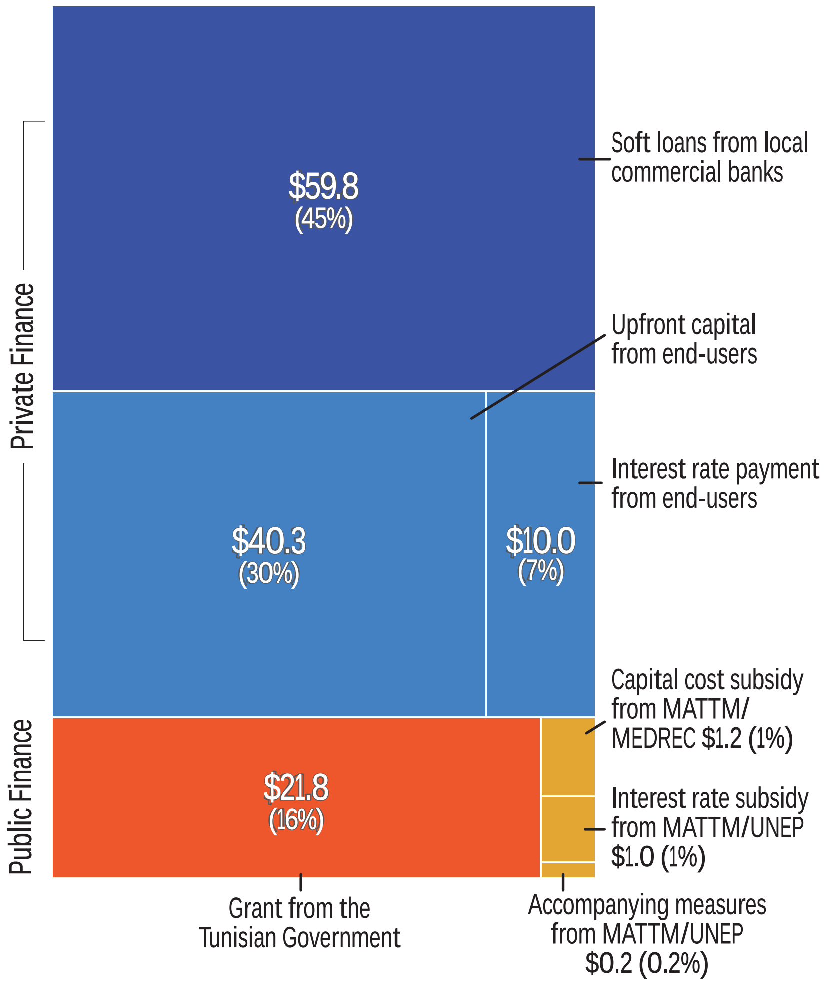
16 MATTM internal data retrieved on December 2011; ANME, 2010a.

17 The contribution of the Tunisian Government was estimated by applying the 20% capital subsidy granted to solar collectors installed, capped at USD 75/m² (100 TND/m²), the maximum level of subsidy offered by GoT until 2008. From 2009 onwards, it was computed considering a fixed subsidy of approximately USD 75/m² (TND 100/m²), to reflect changes that occurred in the incentive framework (Decree n. 2009-362).

18 We did not include the foregone revenue associated to VAT exemption on imported equipment and the reduced custom duties (10% versus 18%) introduced to foster local industry competitiveness, and to ultimately reduce the investment cost for end-users (Decree 4/2006).

19 Since 2007 ANME has an internal unit dedicated to the Prosol Program with, at present, 14 employees. Associated costs, along with office facilities expenses, are not incorporated in the overall grant served by the GoT, as it was not possible to separate ANME's administrative costs from those related to the FNME, since both are housed in ANME's budget.

Figure 3. Program contributions by stakeholder and finance mechanism.



Note: Figures are actualized to millions of 2005 USD with an average 2005-2010 inflation rate (IMF, 2011) and converted from the original currency to an average USD 2005-2010 exchange rate (Oanda, 2012).
Source: CPI elaboration based on various sources (see References)

costs and paid by suppliers (MEDREC, 2008; Missaoui, 2007). Over the 2005-2010 period, this charge totalled approximately USD 3 million.

Private Finance Inputs

Improved investment conditions generated by the involvement of public money, and the risk management arrangements defined by the Program, helped to attract USD 110.2 million from the private sector, of which USD 59.8 million comprised commercial bank loans covering about 70% of SWH system costs (e.g., Haselip et al., 2011). The remaining USD 50.3 million was made up of direct payments for the residual SWH investment cost and interest rates repayments by end-users.[20]

Public sector returns

We use a stakeholder-specific perspective to ascertain the public sector returns generated by the over fivefold increase in the annual deployment rate of SWHs. Some of these have tangible fiscal and financial benefits, while others are relevant in the context of broader economic and environmental considerations.

The Tunisian Government perspective

The Tunisian Government support, with the 20-year commitment to the 'maîtrise de l'énergie' strategy – which frames the support for SWHs – aims to achieve multiple objectives and deliver as many benefits: the reduction of the country's dependency on fossil fuels and related subsidies; the diversification of the energy mix through clean-energy generation; industrial growth and job creation;[21] and the benefits associated with reduced GHG emissions including Certified Emission Reductions (CER) revenues generated under the Clean Development Mechanism (CDM).

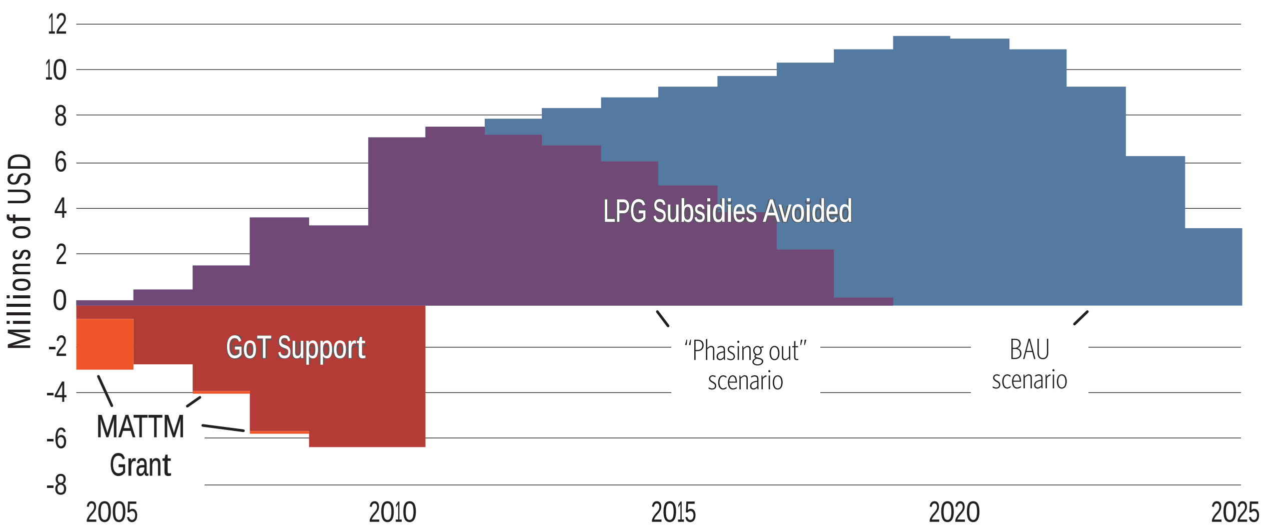
With an estimated USD 101 million savings achievable over the expected life-time of the deployed SWHs, of which USD 15.2 million were achieved over the 2005-2010,[22] avoided LPG subsidies represent the most significant gain accruing to the Tunisian Government's budget. Under the current policy scenario, USD 21.8 million of public resources will be paid back in less than 7 years, fully offsetting the GoT's initial investment outlay. We acknowledge that if the publicly announced gradual phase out of

20 We assumed that loans and interest rates are repaid in 5 fixed-rate instalments over the agreed repayment term. Values are netted of the interest rate facility served by MATTM for the initial 18 months, and actualized with an average 2005-2010 inflation rate (IMF, 2011). The concessional lending rate is 7% for Prosol I, while in Prosol II is represented by the Tunisian Monthly Money Market rate TMM+1% (approx. 6.25%) in 2007 and TMM+1.2% (approx. 6.10%) in 2008-2010 (Menichetti and Thouami, 2007; ANME, 2007). To compute the volume of banks' loans versus end-user finance, we apply an estimated credit-to-cash ratio of 50%-50% for Prosol I (2005-2006) and an average 76%-24% for Prosol II (2007-2010), based on STEG data.

21 Tunisia has long experienced high unemployment rates, stable above 14% during the 2005-2009 period, peaking at 44% among graduated young adult (15-29 years old). Source: Institut National de la Statistique, (2010); OECD (2012).

22 This figure is estimated under the current policy scenario and actualized to 2005 with the average inflation rate of the period considered (IMF, 2011).

Figure 4. Public finance returns under BAU scenario and fossil fuel 'phasing out' scenario.



Source: CPI elaboration based on various sources (see Reference section).

fossil fuel subsidies by 2017 occurs (ANME, 2012b), LPG subsidies savings from Prosol will decrease to approximately USD 46 million (purple area in Figure 4). However, we emphasize that were this to occur, the required SWH subsidies and dedicated financing mechanism would also be expected to contract, and would no longer be needed to correct the market distortion induced by the LPG subsidies.[23]

Energy savings from SWH deployment represent another relevant benefit for the GoT. SWH capacity installed over the 2005-2010 time-frame has so far generated savings of approximately 47 Ktoe, or an estimated total 251 Ktoe over the expected lifespan of SWHs. This corresponds to a reduction in CO_2 emissions by 135 KtCO_2 in the same period, or 715 KtCO_2 over the SWH life span.[24]

In addition, with respect to the second phase of Prosol, part of the CO_2 saved will translate into Emission Reduction Certificates (CERs)-related revenues because Prosol II has been registered as a programmatic CDM activity with estimated annual emission reductions of 7.2 KtCO_2 (TÜV SÜD, 2011).[25] In 2009, the CERs were sold through a bid process to Orbeo – an expert carbon assets broker (Orbeo, 2010). The associated revenue stream, potentially ranging between USD 350,000-700,000, will be attributed to the FNME, and hence used to sustain the Program itself (ANME, 2010a; Touhami, 2011; IEA/IRENA).[26]

While acknowledging the relatively small scale of these benefits, we highlight that SWH deployment could generate far more significant impacts as the Program scales up from the residential to more energy-intensive sectors.

Local economic development

Prosol Residential has stimulated the development of the domestic solar thermal industrial cluster, with local actors playing a primary role. Before the launch of the initiative, in 2002, only eight suppliers were active in the SWH industry. Of these, only one was a local Tunisian supplier. In 2009, attracted by potential growth offered by the stable policy framework, the number of producers rose to 45, including nine local manufacturers that represent approximately 80% of the market

23 Later, in Chapter 5 we show that in a 'free-market' scenario, in absence of both LPG and SWH subsidies, SWH technology results in a superior investment option for households.

24 See Appendix A for information on the methodology.

25 The amount refers to the SSC-CPA approved within the Program of Activity (PoA). Each PoA represents an umbrella within which may fall one or more CPAs. These, in turn, cannot exceed the applicable threshold, which for total installed thermal energy generation corresponds to a number of installed 64,000 m^2. Our calculations go beyond emissions eligible for CDM only.

26 The estimate provided, takes into consideration primary CERs prices ranging from USD 7-13 (EUR 5-10), the lower bound being the lowest price for primary CERs according to Gorina (2009), while the highest bound being the cost of 'pioneering credits' – as Prosol can be considered as such according to ICIS (2011). Providing a precise estimate is difficult because the details on the actual purchase prices and payment terms are confidential and included in the Emission Reduction Purchase Agreement (ERPA) signed between ANME and Orbeo in 2009 (Orbeo, 2010). Personal discussions with ANME suggest that CERs will be paid in equal annual instalments and that the first payment will occur at issuance of credit. Values are not discounted for taking into account the potential risks related to CERs-issuance, CERs prices and restrictive clauses potentially included in the ERPA.

(Baccouche, 2011).[27] Production is generally carried out in partnership with international operators,[28] suggesting that technology transfer is underway. Local manufacturing capacities are being developed and expanded, building potential export opportunities as well as market competition and diversification. In fact, the SWHs commercialized in the country have risen from only 20 models in 2004 to 206 in 2010 (Baccouche, 2011), and the number of qualified installers from less than 100 in 2002 to 1,200 in 2010 (Touhami, 2011), of which more than 400 are currently on the market (CSN.ER, MATTM, 2012).

We estimated an industry turnover during the 2005-2010 of about USD 120.3 million, of which we associate USD 106.8 with manufacturers and USD 13.4 million with installers.[29]

Industrial developments are likely to positively influence the local job market. The solar thermal industry is actually relatively labour-intensive, with the installation and maintenance phases accounting for more than half of total employment (Hardie, 2011). **Local stakeholders' analyses suggest that Prosol promoted the creation of over 3,000 new direct jobs in the manufacturing, supplying, installation and after-sales areas**, and up to 7,000 new indirect ones (e.g., ANME, 2012b; Baccouche 2011; Touhami, 2011). More in-depth analyses are required to assess the robustness of such figures, including whether job losses potentially occurred in more-conventional industries have been adequately taken into account.[30] We also acknowledge that capacity-building activities and informational campaigns, as well as the certification and accreditation process introduced within Prosol, specifically aimed to embed capacity and create a skilled labor force over the longer term.

The international donor perspective

Benefits that accrue to the Italian Government (MATTM) from its direct support to Prosol and on-going bilateral cooperation in Tunisia include:

- expanded markets and industrial co-operation opportunities for Italian companies;[31]
- strengthened economic and institutional relationships with local policymakers and stakeholders, in view of the development of cross-border electricity interconnections between the two countries (Terna.it).

Although it was initially envisaged, the Italian Government was unable to benefit from the Kyoto compliance credits generated by Prosol II that were sold through a bidding process to Orbeo. Following this experience, MATTM financing for other interventions in the country (Prosol Tertiary and Prosol Elec) was made conditional on an ex ante agreement on the purchase of CERs potentially generated (MATTM, 2011).

Program returns for UNEP include achievement of its mission to promote a transition towards a low-carbon development; enhanced experience, knowledge, reputation (including with donors), and expertise in financing sustainable energy initiatives in developing countries.

Private sector returns

The end-user perspective

We estimate overall reductions in households' energy bills to be approximately USD 605-1,325 per SWH over its expected life-cycle.[32] What makes the investment more appealing under Prosol is the possibility for households to use those bill savings to cover investment costs in an acceptable period of time, with affordable upfront investment costs.

The different incentive measures introduced by Prosol – the capital cost subsidy, the softened credit condition and longer repayment terms – significantly lowered SWH system costs for residential consumers: SWHs' Levelized Cost of Energy (LCOE)[33] decreased

27 Local stakeholders (March 2012) have however noted that out of this value, only 17 are actually operating in the market, which is, however, considered appropriate to satisfy local market needs.

28 For instance, Energie Del Sole-Italy, Soften-French, Sines-Greek, Techsol-Turkey, BSI-Germany.

29 Estimates are based on yearly sales and SWH prices. The turnover ascribed to installers is estimated considering an average installation cost of USD 113 (TND 150) and USD 151 (TND 200) for SWH with a capacity of 200 and 300 litres respectively (Missaoui, 2009a).

30 The International Labor Organization (ILO) – within the Green Jobs Initiative launched jointly with UNEP in 2007 – is currently engaged in a series of initiatives aimed at developing approaches and methodologies to map and measure 'green jobs' that stem from 'green' interventions.

31 Based on MATTM data we estimate that as of 2010 2.5% of the SWHs installed in Tunisia under Prosol Residential were of Italian origin. Around 11% of the suppliers working in the country have an Italian partner.

32 This range reflects results obtained for SWHs with 200 and 300 litres capacity over systems' expected life span (15 years), and considering that the purchase of a SWH replaces a LPG-fired water heating systems. Expected cash flows are discounted by the households' cost of capital (or opportunity cost), represented by the rate of Tunisian treasury bonds with 5 years maturity (5.44%).

33 The Levelized Cost of Energy is meant the (present value of) total investment costs and revenues for each kWh of energy generated by the SWH. This provides a single, aggregated measure of costs associated with energy

Table 3. Payback period comparisons for SWHs with and without Prosol versus conventional water heating alternatives

		w/o Prosol	Prosol I	Prosol II
Conventional water heating alternatives	Natural Gas	22	16	18
	LPG	14	10	11
	Electric	7	<1	1

Source: CPI elaboration based on various sources (see Reference section).

indeed from USD 9.7 cents/kWh to USD 7.3 cents/kWh during the first phase (around 25% less) and to USD 8 cents/kWh during the second (around 18% less). Breaking down in detail the contribution of the individual measures to the reduction of LCOE, capital cost subsidy represents the highest support, resulting in 11-12% of LCOE reduction. Improved financing, calculated as the benefits deriving from extended loan repayment terms and below-market interest rates (6-7% versus 13%),[34] contributes for about 4-6% to overall reduction. The interest rate subsidy, finally, accounts for an additional 9% reduction of LCOE.

We assume that these reduced costs resulted in direct benefits to household purchasers, namely:

- **Lower upfront investment barrier to SWHs.** Since SWHs cost around USD 950 and USD 1,300 respectively for 200 and 300 litres of capacity, these investments represent a burden of around 25-34% of per-capita annual income (IMF, 2011) narrowing the potential market to middle/high-income customers. Prosol overcame this initial cost barrier, bringing upfront payments down to – or even below – the level of conventional water heater market prices thanks to direct subsidization and to the provision of credit lines to be reimbursed at fixed rates via the electricity bill.
- **Improved profitability and payback of the SWH.** Prosol, in fact, reduced SWH payback by around 4 years, narrowing the 'competitiveness gap' with the LPG-based alternative. Nevertheless, the payback period is still somewhat long when compared to high-efficient conventional alternatives[35] (Table 3),[36] confirming that, alongside the improved financial profitability, other factors such as energy prices expectations, higher energy independence and environmental benefits, played a determinant role in influencing final investment choices. Local stakeholders today believe that Prosol had a tangible cultural effect on households, inducing changes in their investment behaviours (ANME, 2012b; MEDREC, 2011).

Has Prosol been effective?

A key objective of the San Giorgio Group's framing questions is to facilitate an overall assessment of whether money is being spent wisely. As a first step toward answering this question, we track progress from: initial financial inputs (public – made up of international and domestic resources, and private investment) and consider what that investment actually pays for (that is, the direct outcomes it enables). Next, we consider interim benefits that flow from (and are contingent on) direct outcomes, through to the final outcomes which go toward meeting the Program's overarching environmental and economic objectives.

- Our approach builds on CPI's effectiveness framework and aims to illustrate that there is a relationship between inputs and returns/benefits. In order to apply this approach across different cases, we have adopted a common set of appropriate criteria (such as LCOE baselines, energy saved, development of local industries, etc.) and indicators that can be applied to systematically measure the performance of the investment in question.
- In the case of Prosol, we highlight the main features introduced by the Program in terms of technology development, environmental

production, which can be compared across technologies (Varadarajan et al., 2011). See Appendix A for details. The higher LCOE of Prosol II reflects the fact that this phase did not benefit from the interest rate subsidy provided by MATTM through UNEP in the first 18 months of the Program.

34 The concessional lending rate is 7% for Prosol I while, in Prosol II, is represented by the Tunisian Monthly Money Market rate TMM+1% (approx. 6.25%) in 2007 and TMM+1.2% (approx. 6.10%) over the 2008-2010 time frame.

35 Investment in a SWH is compared to high-efficient conventional LPG-fired, natural gas-fired and electric water heaters (ANME, 2010a). It has to be noted that the choice of the level of efficiency of the substituted water heater has a strong impact on the expected revenue stream of the investment and associated payback period. In fact, when adopting low-efficient alternatives, e.g. for LPG, the payback is reduced up to 5-8 years.

36 These figures represent the midpoint of paybacks resulting from SWH system with 200 and 300 litres capacity. Estimates for alternative investments in conventional water heaters are based on data retrieved from ANME (2010a) and average 2005-2010 energy prices corresponding to: electricity USD 9.58 cents/kWh, LPG USD 3.15 cents/kWh, and natural gas USD 1.77 cents/kWh, with prices increasing over the time at the average annual growth rate observed during the same period.

benefits and economic results. These include the leveraging effects of public money to the amount of GHGs avoided, and take into account our assessment of the financial sustainability of the Program given the displacement of fossil fuel subsidies. The aim is to clarify the relationship between investments and returns and benefits which could be relevant for other sectors, countries or portfolios.

Table 4. CPI's effectiveness framework: from resources to ultimate results.

INPUT	DIRECT OUTCOME	INTERIM BENEFITS	FINAL OUTCOME
• Public finance: **USD 24.2 million** • Private finance: **USD 110.2 million**	• Policy reforms supporting REs. • LCOE reduced by **18-25%** • SWH payback reduced by about **4 years** • **Total 119,036** SWHs installed (or **355,350 m²**) • **Fivefold increase** in annual REs deployment (m²) • Public to private leverage: **1:5**	• Energy savings: **251 Ktoe*** • Displacement of fossil generation • Number of SWHs producers: **+ 37** • Possibly > 3,000 new direct jobs	• LPG subsidy avoided: **USD 101 million*** • CO_2 avoided: **715 ktCO_2*** • Reduced energy dependence on fossil fuel imports • Local economic development (local manufacturing, industrial cluster development) • Knowledge/ Expertise embedded • Scale up and replication of Prosol key features in the country, in the MENA Region and beyond

Note: (*) Timeframe of the Program considered, 2005-2010. LPG subsidies avoided, energy savings and CO_2 emissions avoided are computed over the SWHs expected life-time (15 years).

- There is evidence of effective risk-sharing between public and private entities in most parts of the Program, with individual risks allocated to the stakeholders best suited to bear them.
- The involvement of STEG, a low-cost, very efficient and highly enforceable debt collection agent was crucial. STEG's ability to suspend electricity and gas services for non-payment shifted the risk of default from banks to households, allowing a significant reduction of financing costs.
- Equipment risks were addressed through training, certification, and other support initiatives.

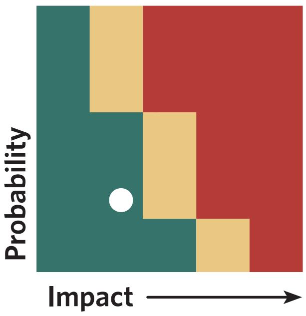
4. The importance of proper risk allocation

To understand how risks are allocated among stakeholders, we have applied a step-wise risk management framework to the Prosol Residential financing mechanism. We: (1) identify and assess individual risks; (2) analyze and present the mitigation instruments adopted to address critical risks; and (3) we outline the risk allocation implications for the Program's stakeholders. We also underline the changes that occurred between the two phases of Prosol, and their impact on shifting risk allocation among agents.

(1) Risk identification and assessment

To ensure we capture all the significant sources of risk, we have categorized risks along three major dimensions:[37]

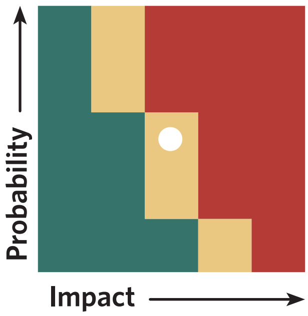
- **'Development' risks** refer to risks associated with the design and implementation phase of the Program; funds management and governance; accreditation criteria for suppliers and installers; SWH models' compliance standards;
- **'Operations' risks** include all risks associated with running the process, i.e., the functioning of systems installed; the ability to secure the required capital; debt default risks; interest rate flotation; delivery and pricing of carbon-related finance;
- **'Outcome' risks** cover risks more specific to high-level public policy objectives such as failure to meet energy, socio-economic, environmental and industrial targets.



LOW-RISK EVENTS

Risk events with low probability of occurrence and low to medium impact:

- **Failure to secure total capital costs**: accepted and shared between different capital sources, that is the public budget and commercial banks;
- **Interest rate flotation**: borne by the banks offering fixed-rate loans and managed through a periodic reset of a fixed margin over a floating interest rate (TMM).

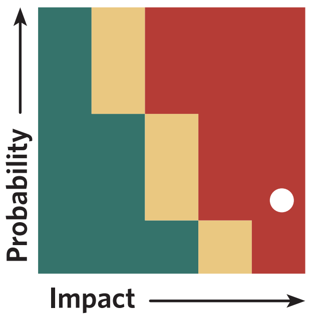


MODERATE-RISK EVENTS

Risk events with moderate-probability of occurrence, but medium-high impacts.

- **Households' default on debt repayment**: borne by banks but hedged via explicit credit guarantees (from the suppliers and, subsequently, from the STEG) and through the electricity/gas service suspension in case of non-repayment;
- **Program failure**: borne by the Program's proponents and sponsors (GoT, ANME, UNEP, MATTM) addressed through specific policy/mechanism design/implementation strategy arrangements.

37 This approach builds upon the typical project risk breakdown along development stages by adding the 'outcome' dimension, which is dedicated to the overarching results of the Program. Acknowledging the degree of subjectivity embedded in this approach, and that some risks are interrelated and may involve more than one dimension, the San Giorgio Group strives to systematically capture these three dimensions across case studies.



HIGH-RISK EVENTS

Risk events with high to very high impact whatever the probability of occurrence:

- **SWH equipment defect, malfunctioning, or other faults**: risks impacting both households and government's expected output, addressed through certification requirements, maintenance arrangements, and monitoring of system's performance.

Next, we systematically classify the identified risks according to two criteria: their probability/frequency of occurrence (from very low to very high), and their grade of impact on the Program's financial and non-financial objectives (from very low to very high).

(2) Risk analysis and response strategies[38]

This analysis focuses on the drivers and impacts of the main risks identified in the above categories, particularly: SWH equipment malfunctioning or faults, and households' debt default. Whatever the probability, the occurrence of any one of these risks could potentially undermine Prosol's objectives, and threaten its long-term sustainability.

I. SWH failure risks and associated impacts on the profitability of the investment

In Tunisia the probability of failure of installed systems primarily rests on the availability of skilled and trained laborers to install and maintain the systems, rather than on the technology itself which is now considered reliable and mature.

The theoretical cumulative default probability risk of a SWH, due to the absence of maintenance, tends to increase exponentially with time, from 11% after one year of operation, the first covered by full guarantee, to 81% at its 15th year, the end of its expected lifetime (Missaoui and Marrouki, 2009b). This 'no maintenance' scenario has negative effects on the investment payback – which increases on average by 10-14 years[39] – and on the energy bills savings generated over the system's expected lifetime, which decreases by as much as 32% (see Appendix B).

Given the diffuse negative perception of the SWHs' reliability owing to weaknesses in previous SWH initiatives (ANME, 2010a), and SWHs' lower competitiveness vis-à-vis alternatives, several mitigation measures were adopted:[40]

- accreditation scheme for suppliers/installers based on eligibility criteria, run by ANME, which helped to ensure that minimum standards were applied;
- training and capacity-building initiatives targeting installers to help build long-term job skills;
- certification of SWH models based on a series of technical requirements and performance standards set by ANME and, more recently, in 2010, the introduction of a quality labelling system;[41]
- random on-site spot checks of newly installed systems;
- guarantees of SWH components provided by suppliers: 1 year on the whole system, 5 years for the tank, 10 years for the collector (panel); and
- establishment of an after-sale service (via

38 Consistent with e.g., UNEP-SEFI (2008), we consider four typical risk responses: (1) risk avoidance (eliminate the risk or protect against it) by changing project scope or adding resources to it (e.g., by improving maintenance); (2) risk transfer (transfer of the financial impact) to a more suitable/capable party; (3) risk mitigation (reduce probability or impact to an acceptable level) and (4) risk acceptance (address the risk should it occur). See e.g., OECD (2012b) for a detailed analysis of the risks associated to low carbon projects.

39 These figures, which are computed as per Table 3, represent the midpoint of the payback increases resulting for SWH of 200 and 300 liters capacity when maintenance is not regularly carried out,.

40 Some of them became available (e.g. qualified installers, after-sale service) or were introduced (e.g., quality labels) over time.

41 Following up a customer satisfaction survey, during the Prosol I phase, the need for a quality system became evident. This was initially addressed through a Manual of Specifics then, during Prosol II, with a Quality Program (Qualité Solaire de Tunisie) developed by ANME and the Chambre Syndicale Nationale des Energies Renouvelables (CSnER). A quality certification system (called Qualisol), is now being gradually introduced for installers that want to operate under Prosol. For suppliers, instead, the Tunisian market is moving towards the European quality label for collectors (Solar Keymark), considered beneficial to foster the export of Tunisian products. Currently, only one Tunisian manufacturer is accredited as Keymark. At present, product quality labels are not mandatory as yet, but this is envisaged. Source: ANME website, http://www.anme.nat.tn/; CSnER website, http://www.csner-tn.com/fr/lien1.php?ID=15 http://www.csner-tn.com/fr/lien1.php?ID=15.

a maintenance contract)[42] and systems monitoring.

Thanks to such measures, cumulative equipment default rates observed under Prosol (2005-2010) corresponded to only 1% (ANME, 2012b).

ii. Debt-default and associated risks on benefits

Engaging banks by addressing their risk perception has been a key characteristic of the success of the financing mechanism (see Chapter 5). Ultimately, this allowed consumers to access credit at lower cost over longer repayment terms which in effect ensure market expansion and potential sustainability.

We estimated the impact associated with debt-default risk by applying different rates of default to a Prosol loan's cash flow stream. We noticed that, already with a hypothetical 5% annual default rate, Prosol would become an unprofitable business for banks, most likely prompting them to increase the interest rate charged. This would have a compounding effect by making the scheme less affordable, thus shrinking the demand for SWHs (see Appendix B).

This risk was significantly mitigated through a double-level loan guarantee scheme embedded in the Program's design:

- **third-party loan debt collector: the state-owned utility STEG collects loan repayments through electricity bills and may suspend electricity supply in case of delay/default;** and
- **third-party loan guarantor: suppliers initially (Prosol I) and then STEG (Prosol II).**

It is noteworthy to highlight here that the role of suppliers as guarantors in Prosol I put the overall supply chain at risk, as most of these firms were generally small family-owned businesses with limited ability to take on debt on their balance sheet. Acting on suppliers' and banks' complaints, ANME and UNEP with the launch of Prosol II, shifted the risk to an actor more suited to bear it, STEG.

42 To foster maintenance intervention and strengthen after-sale service, ANME introduced a maintenance contract, for an annual cost of USD 38 (TND 50). A survey launched by ANME in 2009 highlighted the fact that only 40% of the contacted households had signed an agreement for periodic maintenance (ANME, 2009). ANME has recently (2011) proposed to make maintenance mandatory to ensure SWHs functionality. ANME's proposal has fostered competition in the after-sales service, with installers currently offering price-competitive maintenance contracts.

(3) Risk allocation

The Program design features altered the share of risks allocated to the various parties (along the three main dimensions we mentioned above). We represent these effects in a dynamic risk allocation matrix which illustrates how risks are allocated among the different stakeholders involved in the Prosol mechanism, and the evolution occurred from the first to the second phase (Figure 5).[43]

Local and external public stakeholders are best placed to bear policy risks that reside within the public sphere. The GoT and ANME on one hand, and UNEP and MATTM on the other, necessarily bear the Program development risks (Prosol I), highlighting the particular role of bilateral aid.[44] Lessons learnt from previous experiences and reliance on an expert partner like UNEP reduce the probability of failure.

Public (ANME) and private entities (suppliers/installers) share procurement and technology risks, the former through the setting of compliance standards and accreditation criteria, the latter (the suppliers) bearing the responsibility of the effective functioning of the individual installations.

The role of the state-owned utility STEG is a key element of the banks' risk mitigation strategy. As previously discussed, by removing debt default risks from suppliers in Prosol II and with enforcement powers to suspend services to defaulting households, **STEG relieves the banks of a risk they are not willing of bearing, and shifts the risk of non repayment from banks to households**.

Under Prosol II there are also some delivery and price risks associated with the issuance of CERs to be mentioned. Local public entities that intend to benefit from CER revenues assume this risk, which is presumably shared with the buyer (Orbeo) by the means of an Emissions Reduction Purchase Agreement (ERPA).[45]

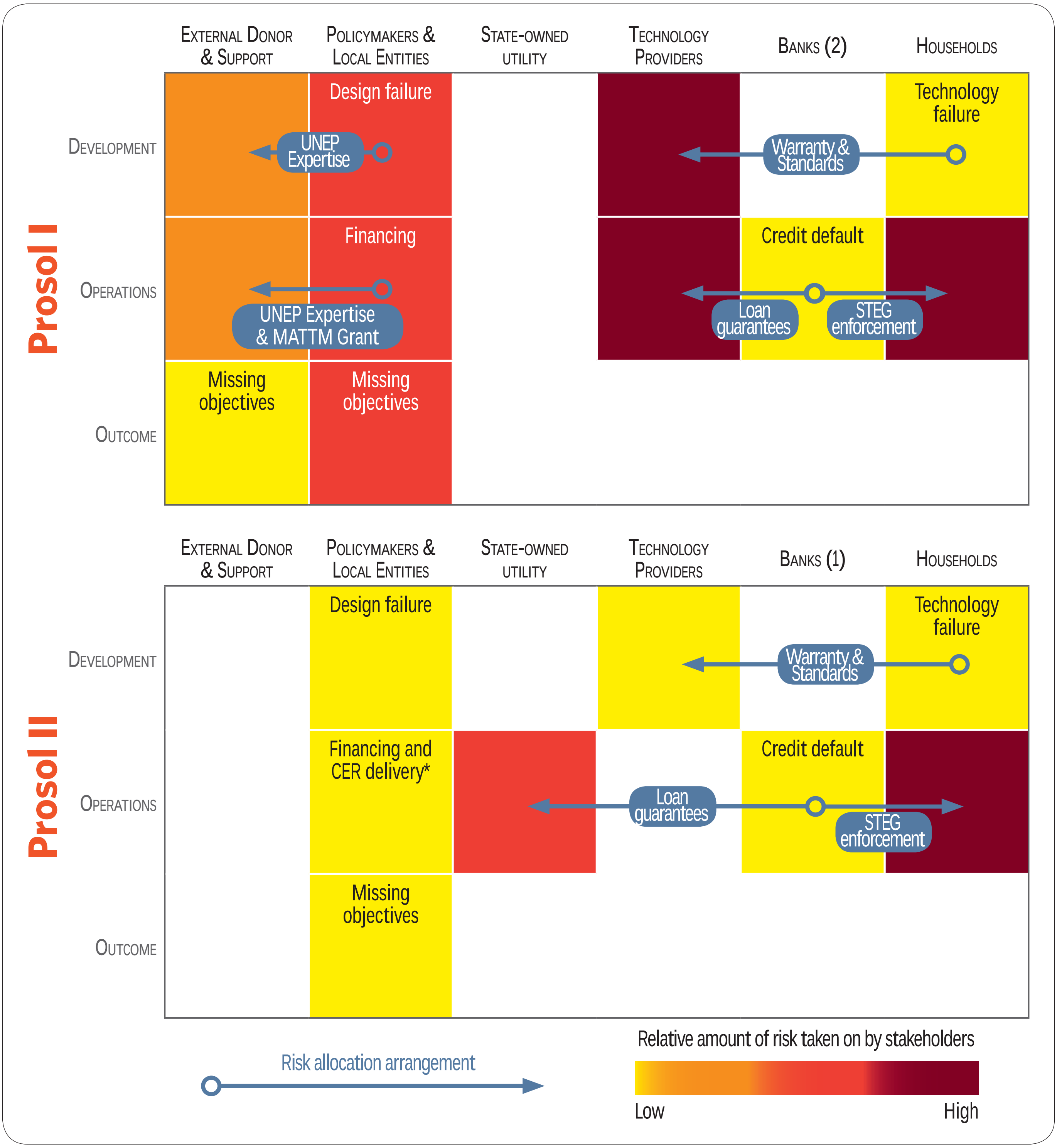
43 Risk allocations are colored according to some measure of 'magnitude of risk' times the 'likelihood of risk': 'very high' in red, 'high' in orange, 'moderate' in light orange and 'low' in yellow. While we acknowledge the subjectivity of this approach, we deem it useful to provide a straightforward overview on the risks at stake and who bears them. A more detailed matrix is presented in Appendix C.

44 For instance, with regard to Prosol Tertiary (discussed in Chapter 6), delays in setting up the Program and in the funds stream postponed the take off of the initiative, putting off the participation of some stakeholders (ANME, 2012b).

45 Confidentiality issues over the ERPA prevent us from properly characterizing and allocating CER-related risks.

There is an overall evidence of a balanced risk allocation under which risks are allocated to the stakeholder more suited to bear them: public entities retain those that private ones are not capable of or willing to take, notably, the risk of default.

Figure 5. Risk allocation matrices for Prosol I and Prosol II, organized by stakeholders (rows) and risk categories (columns).



Note: Specific risks are displayed in each square. Prosol II's relatively lower risk profile reflects learning-by-doing from Prosol I, especially among policymakers and local entities, and technology providers. *In Prosol II there are also CER-related risks, which are supposedly managed through an ERPA with the CER buyer, ORBEO. Confidentiality issues prevent us from properly characterizing and allocating such risks. Source: CPI elaboration based on various sources (see Reference section).

5. What can a finance mechanism do?

This section analyzes in detail the two most striking aspects of Prosol:

- first, the ability of the Program to indirectly displace fossil fuel subsidies by shifting demand patterns, ultimately benefiting the public budget; and
- second, how targeted capacity-building and risk allocation promoted profitable engagement by local commercial banks and increased the volume of capital available for investments in SWH.

FOCUS 1 – Displacing fossil fuel subsidy through indirect means

- Prosol is a successful example of how shifting end-users demand from conventional fuel-based technologies to green ones can indirectly reduce costly and inefficient fossil fuels subsidies;
- To fully exploit the potential of renewable energies, Prosol-like initiatives need to be coordinated with reforms to the fossil fuels subsidy framework.

We consider the influence of a Program aimed to enhance the deployment of renewable energies on existing policies, specifically, on the energy subsidies-framework. We first consider the fossil fuel subsidies context in Tunisia, their impacts on the overall economy, and the efforts in place to address what is often considered a difficult political and social issue. We then examine how Prosol – whose results incentivize the Government to counterbalance the market distortions generated by fossil fuel subsidies through a legislative act – indirectly contributed to shift end-users demand and, hence, displace a heavily subsidized fuel such as LPG. Then, we conclude with what we believe are the additional steps required to strengthen policy action and promote more incisive subsidies reform.

Fossil fuel subsidies in Tunisia: a burden for public finances and a 'brake' on green growth

The energy context in Tunisia is characterized by a chronic deficit in its energy balance, due to growing demand and reduced energy production patterns;[46] the country has been a net importer of energy since 2001. During the 2005-2008 net imports averaged about 15%, rising to an average 53% when oil products only are considered, 76% for LPG alone (PlanBleu, 2011; INS, 2010). The economic consequences of this circumstance have worsened with the outbreak of soaring international energy prices.

In Tunisia all energy products are directly or indirectly subsidized. According to local sources, LPG, which is widely used for water-heating, is subsidized at roughly 50% of its value, natural gas at 60% and electricity at 40%.[47]

Petroleum-related subsidies accounted for approximately USD 0.3 billion (TND 0.4 billion), or 1% of national GDP, in 2008 (IMF, 2008).[48] This is a burden on the public budget that seems unsustainable in the long run, particularly when expected trends in oil prices are considered (IEA, 2011). In addition, fuel subsidies represent a major obstacle to the deployment of renewable energy technologies, adding a competitiveness burden to technologies already distinguished by relatively higher prices, and in open contrast with the Government's policy objectives (Law 82/2005).

Nevertheless, subsidies have always been a highly politicized issue. Social welfare and political-economic objectives are called in as the rationale behind fossil fuel subsidies, which are seen as instruments to alleviate

46 In 2005, Tunisia produced approximately 75,000 bbl/d of crude oil, which represents a 37% decline from Tunisia's peak output of 120,000 bbl/d over the 1982-1984 period (INS, 2010).

47 Electricity is subsidized indirectly through the natural gas used to generate it, which is sold by the Government to STEG at administered prices. It is then subsidized directly by the Government to the STEG to equilibrate its financial balance (MED-EMIP, 2010; MIEPME, 2012)

48 The level of subsidy reported by IMF (2008) is here compared to the 2008 Tunisian GDP as per IMF (2012). RCREEE (2010) reports that USD 1.2 billion (EUR 0.9 billion) of country's resources served energy-products subsidies in 2007, approximately 4% of the country's GDP in that year (Panbleu, 2011). OECD (2012b) reports that fossil fuel consumption subsidies in 37 developing and emerging countries amounted to USD 409 billion in 2010; fossil fuel consumption and production subsidies in 24 OECD countries accounted for approximately USD 45-75 billion per annum between 2005 and 2011. At the global level, it is estimated that fossil fuel subsidies account for around 1% of the world's GDP each year (Lang et al., 2010). In 2009, at the G-20 meeting held in Pittsburgh (USA) the leaders of the world's largest economies encourage all countries 'to phase out and rationalize over the medium term inefficient fossil fuel subsidies', blaming them for encouraging wasteful consumption, impede investment in clean energy sources and hampering global effort to deal with climate change (G20 Leaders Statement, 2009).

energy poverty.[49] Governments are cautious about altering such a socially entrenched benefit, and in general prefer to maintain the status quo.[50]

In Tunisia, the level of subsidization has long been defined through the setting of end-users' prices artificially lower than the market value for fuel. In January 2009, as crude oil prices peaked, the Tunisian Government established an automatic adjustment mechanism for domestic hydrocarbon prices. According to such a mechanism, petroleum products are adjusted by an *a priori* fixed amount when the international price of Brent remains at least USD 10 higher than a pre-defined threshold for three consecutive months. This tool – which was considered as an intermediate step to move towards a liberalized market – has been only partially enforced and, in the midst of the recent political turmoil, temporarily set aside (ADB et al., 2011; ANME, 2012b).[51]

Displacing LPG subsidies by promoting green technologies with Prosol

In the challenging and complex context of fossil-fuel energy reforms, the Prosol Program represents a successful example of how the inability to directly phase out fuel subsidies can be addressed indirectly by shifting demand preferences.

Prosol, in fact, prompted the Government to mandate by law, for the first time in Tunisia, a counterbalancing subsidy for REs, leading to a partial revision of the country's energy subsidization system. Despite increasing the overall State influence in the energy economics, this intervention actually reduced the total public fund disbursement, as detailed below. UNEP, as well as the country's energy and economic contingency, did play a critical role on this regard, by showing to the Government the financial benefits of Programs such as Prosol on LPG subsidy displacement.

Our analysis focuses on LPG subsidies only because, with around 70% of the market share, LPG-fired water heaters represent the most direct alternative to SWHs in the Tunisian residential market (STEG, 2010). A general lack of transparency about fossil fuel subsidies and local prices severely limits the availability of accurate data (GTZ, 2010) and affects both external analysis and local institutions' ability to understand the real economic impacts associated with subsidy policies and ultimately undermine potential reforms initiatives. As a consequence, we estimated the level of LPG subsidy granted to end-users by employing a methodology based on the IEA's price-gap approach,[52] which compares the reference price of LPG – corresponding to its full cost of import and supply – to the end-user price set by the Tunisian Government for the 13 kg LPG bottle, the most widely used in the residential sector for water heating needs (STEG, 2010).

Our analysis reveals an average subsidization rate of 55% for LPG between 2005 and 2010, roughly in line with stakeholders' reported figures. During this time frame the level of subsidies increased, peaking at 60% in 2010 (INS, 2010), mainly owing to the Tunisian authorities intention to quell protest in the aftermath of the 'Arab Spring.'

Indeed, the Government adjusted end-user prices for LPG bottles used in the residential sector by only 5% a year (less than 2% in the last 3 years) – a much lower increase than the annual average 11% growth rate that occurred in actual cost of LPG (INS, 2012).

Based on these rates of subsidization for LPG, we estimate that a total of USD 15.2 million of subsidy savings accrued to the GoT in the period 2005-2010, corresponding to more than half of the financial support it granted to the Program in the same period,[53] or **USD 101 million if we include benefits generated during the expected life span of SWHs**.[54] In this case, fossil fuel subsidy savings are not only able to cover all

49 Nevertheless, several institutions and researchers disagree with the notion that fuel subsidies are an effective instrument for poverty alleviation, arguing that it rather tends to favor middle-income classes. In fact, IEA (2011) reports that only 8% of the USD 409 billion spent on fossil fuel subsidies in 2010 was distributed to the poorest 20% of the population (IEA, 2011; GBE, 2012).

50 Tunisia is not new to social unrest episodes following reform attempts, e.g., in 1983 and 1984.

51 The threshold price of Brent was initially set at USD 52 per barrel then, in early 2010, was increased to USD 60 per barrel. The a priori amount was fixed at TND 200 millimes (USD 130 cents) for LPG bottles of 13 Kg. The latest price adjustment undertaken with this mechanism took place on February 21, 2010 (Tunisian Ministry of Industry and Technology, http://www.industrie.gov.tn/fr/directdoc.asp?docid=281; GIZ, 2010; 2011).

52 The price-gap approach is the most commonly applied methodology for quantifying consumption subsidies. For additional information see the IEA website, http://www.iea.org/weo/methodology_sub.asp. This approach presents both advantages and limitations; Koplow (2009) provides a detailed discussion in this regard. Due to data unavailability, not all the parameters adopted by the IEA's methodology were included e.g., the price of butane was not adjusted for potential quality differences. See Appendix A for details on the methodology applied.

53 We apply the rates of subsidization for LPG to the substituted LPG boilers (identified based on their market share in the water heater market). See Appendix A.

54 Estimate based on a BAU scenario assuming LPG end-user prices adjusted by the GoT at the same rate observed in the past 5 years (5.01%).

Government costs, but deliver a significant return on its upfront financial commitment.[55] Annual LPG subsidy savings today correspond to around 2% of all subsidies allocated to oil products every year in the country, but their share is destined to rise given the Government's ambitious deployment objectives under Prosol.[56]

Options to move from an indirect to a direct approach to displace LPG subsidies

Our findings suggest that to date, Prosol has been mostly successful in indirectly displacing LPG subsidies in Tunisia and improving public finances.

We have shown earlier that from a households' perspective the incentivizing measures of Prosol significantly improved returns and payback of the SWH investment. However, the costs are still comparatively high and prevent such an investment from being appealing from a purely financial standpoint. This is mainly due to the LPG subsidies barrier.

Financial simulations show that in a 'free-market' scenario where supporting mechanisms for either fossil fuels or SWHs are removed,[57] RE technology is a superior investment option. In this scenario, while the LCOE of an average SWH rises from the current USD 8 cents/kWh to 9.7, the LPG-fuelled option would in fact experience a much larger increase: from current USD 7.8 cents/kWh to 14.8. Under these conditions payback related to an investment in SWHs in alternative to an LPG-based system decreases from the 10-11 years when both systems are incentivized, to 7 years, revealing an improvement in its competitiveness. Furthermore it shows that, despite the enhancements observed in the energy subsidization framework of Tunisia, overall public support today still favors more fossil fuels over renewable energies.

Alongside the implementation of REs Programs such as Prosol and the Tunisian Solar Plan, a clear reevaluation of the level of fuel subsidization will be essential if the Government's plan to phase out fossil fuel subsidies by 2017 is to be achieved. This goal implies, for the residential sector, a yearly 20% adjustment of end-user prices for LPG (13 kg LPG bottle).[58] This will be challenging for the country's institutions, especially in the current political context and particularly as end-user LPG prices have remained relatively unchanged over the past three years relative to the cost of imported fuel and that previous reform attempts have not been successful.[59] However, the unquestionable environmental and proven potential for significant financial benefits generated by initiatives such as Prosol should provide the necessary support for decisions despite initial unpopularity.

55 This return could be used to refinance the Program through the FNME in a sustainable way. The Fund is currently replenished via a registration tax on new vehicles, which could discourage the purchase of cleaner and more efficient models (Law 82/2005).

56 This is estimated as the ratio of the subsidies displaced by Prosol considering all installations up to 2010 and assuming that the amount of subsidies distributed to oil products remains close to the level reported for 2008 (IMF, 2008).

57 Both subsidy mechanisms and improved loan conditions are not accounted as measures of support for SWHs, and competition is restored to 'free-market' conditions by increasing the LPG end-user price for an approximated 55%, the level of LPG subsidies observed in the period 2005-2010.

58 20% is computed as the annual increase in end-user prices required to guarantee the gradual extinction of subsidy by 2017.

59 The GoT intention to progressively reduce fuel price subsidies by 2011 was also stated in the XI Development Plan (2007-2011) (IMF, 2008; RCREEE, 2010). A year after the 'Arab Spring', and few months after its first free elections, Tunisia's new Government has not as yet attempted to reform the distorted energy market given the widespread discontent related to living standards. In the aftermath of the revolution, reform attempts are going to be even harder because in 2010, in order to quell protests, the overall level of subsidies for fuel, food staples and transport was increased (AfDB, OECD, UNDP, UNECA, 2011; MIEPME, 2012).

FOCUS 2 – Incentivizing the private sector involvement

- Creating awareness of the market potential when engaging banks is crucial to channel credit through the banking sector and increase the available capital for SWH market.
- STEG's multiple role as debt servicer, repayment enforcer and debt guarantor greatly reduced risks perceived by banks, and facilitated a significant reduction of interest rates charged to end-users.
- The near-zero default rate of Prosol loans has made the initiative profitable for banks despite the lower interest rate charged, and more affordable for households, improving the prospects for the mechanism to be replicated.

In this section we consider if a financing mechanism can incentivize private investor involvement. Transforming the formerly cash-only SWH market into a cash-and-credit one has undoubtedly been a key success factor for Prosol, allowing a much higher market uptake compared with previous initiatives. **Channelling credit through the local banking sector increased the pool of private capital available for investments and helped to attract almost USD 5 dollars of private capital for each dollar of public finance invested.**[60]

We consider the different roles played by public stakeholders and explore issues and challenges they each had to overcome in the final risk allocation arrangements, emphasizing the significant effect of credit risk mitigation on banks' profitability and loan affordability. Finally, we estimate the Program's profitability and, more importantly, the overall SWH market potential from a banker's perspective, in order to assess the foreseeable long-term interest from local financial institutions.

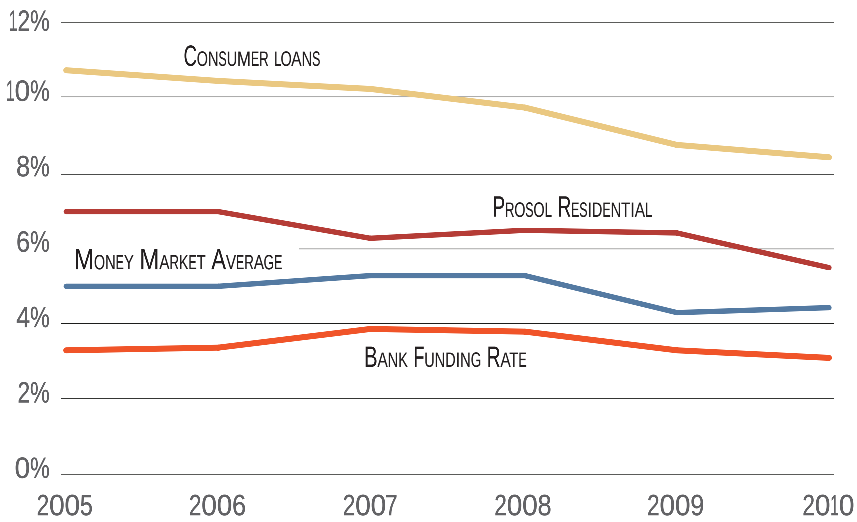
Addressing banks' (lack of) confidence

According to UNEP (2012a and 2012b), the initial Program coordinator and implementing agency, Tunisia presented the key features to successfully engage banks, namely:

- the availability of a commercially viable RE technology in the country (notwithstanding the very generous subsidies to fossil fuels), with the potential to support a local supply chain;
- The existence of a functioning local banking sector and a sufficient bancarization rate of the population; and
- the willingness of national authorities to support the initiative by addressing institutional barriers for market development.

Despite the evident potential, the initial interest of commercial banks in SWH financing was very limited. Much of this derived from the poor awareness among local financial institutions, which were experiencing high rates of defaults and were still unfamiliar with financing RE investments, that a low-risk and profitable market existed both in terms of achievable loan volumes and of loan quality. Besides, in the early 2000s consumer credit was still a novelty in Tunisia's financial market, despite remarkable growth rates (see Box 1). In this phase, it proved critical to have the availability and use of international donor resources to finance capacity-building among political and financial institutions.

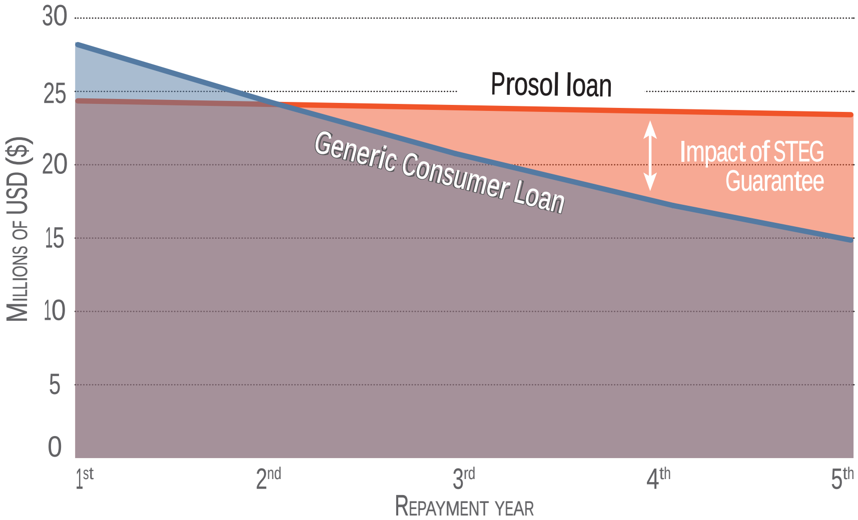
Figure 6. Average interest rate in the Tunisian consumer loans market



Note: The interest rate charged on Prosol loans reported here is the rate received by banks, hence gross of the interest rate subsidies. Source: CPI elaboration based on Central Bank of Tunisia, Tunisie Valeurs.

60 See Figure 3. 'Program Contributions by Stakeholder' in Chapter 3: Prosol investment, returns and profitability.

Figure 7. Comparison of hypothetical cash flows between a generic consumer loan and a Prosol loan



Note: Figure displays cash flow beginning the first repayment year. Hypothetical $100 million USD loan. General assumptions include a 7% interest rate and 1% default rate for the Prosol loan, and a 13% interest rate and 15% default rate for the generic consumer loan.
Source: CPI elaboration based on various sources (see Reference section).

To incentivize market uptake and rapidly reach a critical mass of loans for the banks, the Program's initial sponsors granted an interest rate subsidy for borrowers to abate the cost of financing for the first 18 months of Prosol.

While this did encourage access to credit for households, we believe that, in the case of Prosol, the creation of the credit market was mostly due to the involvement of STEG, the state-owned utility, as debt servicer, repayment enforcer and, for Prosol II, as debt guarantor. Indeed, STEG's role as debt servicer made the initiative almost costless for banks since credit checks, paperwork and repayment collection were all performed by STEG's personnel and imposed no burden on banks' resources.

More importantly, having STEG as repayment enforcer (that is, directly linking the default on the debt to the suspension of electricity and gas services) greatly decreased the perceived default risk of Prosol loans and prompted banks to offer credit at an interest rate about 50% lower than the market rate (see Figure 6). The near-zero default rates (UNEP, 2012a; STEG, 2012) realized in Prosol demonstrate how effective this tactic proved to be, but also expose, we believe, a political vulnerability of the Program.

Critically, while providing households with a cheaper financing source, this strong mitigation of credit risk had also a clear positive impact on banks' financial returns: Figure 7 compares realized cash flows originated by consumer credit loans at market-level interest (Touhami, 2011) and default rates, with those of a typical Prosol loan, whose interest rates are halved but whose resulting cash flows are more than 10% higher.

Regarding the debt guarantees, the initial setting with the supplier taking the credit on its balance sheet directly (hence providing a direct debt guarantee to the household) proved too onerous for the supplier and procedurally too complex. This ineffective and burdensome guarantee was then replaced by a direct and more effective one from STEG, decreasing further banks' perceived risk.

Affordable consumer credit

Looking at the interest rates generally charged on consumer loans over the years highlights Prosol's success in providing Tunisian customers with more affordable financing for the purchase of SWHs. Compared with an average 9.7% interest rate charged on generic consumer loans (500 basis points over banks' blended funding costs)[61], over the 2005-2010 period, Prosol loans were offered at an average rate of 6.3% (of which the customer paid only a fraction during the first 18 months of the Program), or 280 basis points over banks' cost of resources.

On this point, we stress once again how crucial the double-layered guarantee provided by STEG (as debt repayment enforcer and loan guarantor) and the resulting extremely low level of loan defaults have been in developing banks' interest for Prosol and the availability of affordable credit conditions.

Renewable energy markets profitability potential

In Prosol, commercial bank revenues arose mainly from the interest payments on the loans. In contrast with their usual practice banks did not charge any commissions on loans' processing, and conversely, nor did they sustain any significant direct costs[62] other than training staff to manage these new products and the opportunity cost of committing capital to finance the purchase

61 Central Bank of Tunisia (2006-2011 and 2012).

62 Loan applications were processed directly by suppliers of SWHs with STEG, and the debt itself was then serviced by STEG by embedding loan repayments in the electricity bills payment system.

of SWH instead of other potential uses.

Table 5. Prosol Profitability for Banks from 2005 to 2010.

Prosol (2005-2010)	Interest proceeds (in USD 2005 MLN)	Average contribution to top line	Capital committed (in USD 2005 MLN)	Average share of outstanding loans
Amen Bank (Prosol I)	0.9	0.2%	4.7	0.2%
UBCI (Prosol I)	0.5	0.2%	2.6	0.2%
Attijari Bank (Prosol II)	5.9	1.4%	52.5	1.2%

Source: CPI elaboration based on Banks' Annual Reports (see Reference section).

Given these considerations, we examine the profitability of the Program for the banks in terms of the contribution of interest revenues to banks' top line, that is, the contribution of Prosol's loan interest flows to the overall gross revenues from all lending activities (excluding commissions) that banks report annually. We acknowledge, but do not quantify, issues of constraints to capital available for lending, opportunity costs of forfeited interest, or different default rates among products. However, we assume that a banker could reasonably expect to more than recoup the forfeited revenues associated with lower interest rates charged on loans within Prosol given their near-zero default rate, compared with the higher default rate of traditional consumer loans (see Figure 7 for a simple simulation exercise, comparing the revenues from a loan within Prosol to a generic loan of equal nominal value, but different default rate). We assess that this alone would narrow the decision on whether or not commit capital to the initiative.

We estimate that, in total, the three banks contributed about USD 60 million to Prosol.[63] Amen Bank and UBCI together loaned USD 7.3 million in Prosol I, while Attijari Bank made loans for USD 52.5 million in Prosol II. Compared to banks' loan portfolios, the value of these loans was almost negligible for Amen Bank and UBCI, but more relevant for Attijari which steadily increased the value of loans to Prosol II from 0.7% to almost 2% of its whole loan portfolio, notwithstanding an average yearly growth rate of 15% of the bank's balance sheet. In terms of gross revenues from Prosol, **we estimate that banks collectively earned around USD 7.4 million**[64] **between 2005 and 2010**, with a growing and appreciable contribution to top line for Attijari Bank in particular.

Finally, we return to the issue of financial institutions' awareness of the profitability potential of renewable energy markets as the strongest barrier to their involvement, especially for initiatives dedicated to small scale financing. If we consider the Tunisian Government's objective of SWHs additional installed capacity of more than 400,000 m^2 by 2016 for the residential sector alone, the loan volume to meet the need would amount to approximately USD 92.5 million[65] over 5 years, with the potential to generate around USD 1.5-1.7 million in annual net interest proceeds.[66] While not insignificant, the likelihood of having to share these revenues among several financial institutions at the same time would render the prospect less attractive, hence making the challenge of scaling up the Program to different technologies (such as solar PV) or to new customers (that is service and commercial sectors) a significant issue, with new hurdles and barriers to be addressed (see the following Chapter on scalability and replicability of Prosol). To this extent the role of the banking sector would need to be assessed within the broader context of the Tunisian Solar Plan, which aims to mobilize almost USD 2 billion of private funds for investments in a wide range of RE technologies and programs.[67]

63 Figure adjusted for inflation rate of 3.68%. For Prosol I, total loans granted by Amen Bank and UBCI have been estimated from their overall market share (See the Box 1 on the Tunisian Banking Sector).

64 Adjusted for inflation rate of 3.68% (IMF, 2011).

65 STEG (2012): the loan volume implied by the Program's target has been estimated using unpublished projections by STEG of additional 110,000 credits with an average credit amount of USD 845, deriving from an additional 80,000 m^2 installed annually.

66 CPI elaborations, assuming a blended cost of resources for banks of 3.5% (CBT, 2006-2011).

67 Source: http://www.pavingtheway-msp.eu/fileadmin/paving-the-way/Tunisa.pdf.

Box 1. Tunisian Banking Sector

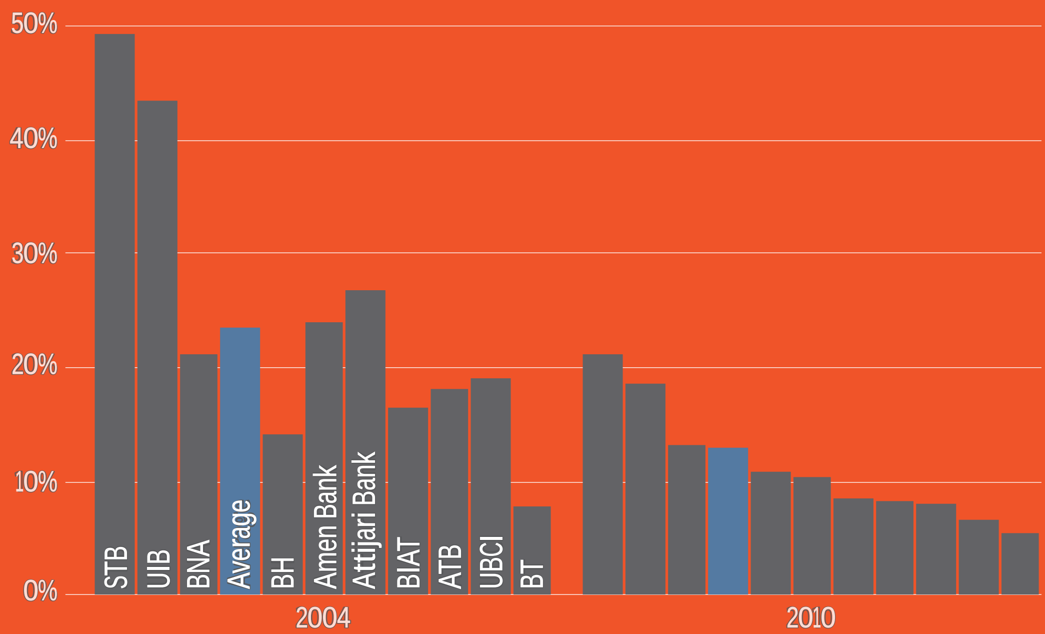
When the Prosol Program was launched in 2005, the Tunisian banking sector was in the midst of radical changes spurred by the central Government's decision to liberalize the sector, improve its profitability and competitiveness, and address the quality of banks' portfolios. These reforms, aimed to improve access to financing for economic players (OECD, 2012a), actually enabled a greater participation of private capital (both domestic and foreign) in the market. They also triggered the privatization of two large state-controlled institutions: the Union International de Banque bought by Société Générale in 2002, and, in 2005, Banque du Sud sold to AttjiariWafa Bank of Morocco and Banco Santander of Spain, leading to the formation of Attijari Bank of Tunisie.

Notwithstanding these reforms, the loan market – whose overall size almost doubled from USD 16.7 billion in 2005 to USD 29.6 billion in 2010 – remains significantly dominated by State-controlled banks, which represented 49% of the sector in 2005 and 38% in 2010.

The Prosol Residential financing mechanism was centered on consumer loans,[1] introduced in the market in 1999 as banks began to focus more on retail customers. In 2004, four years after their introduction, the volume of consumer loans was already 35% of the overall retail banking activity, and 5% of the total amount of outstanding loans in the Tunisian economy (Tunisie Valeurs, 2005). Three years later, in 2007 when Prosol Residential II was launched, the overall size of the retail banking market had doubled to USD 4.8 billion and the share of consumer loans had exceeded 40%.

As noted, over the last decade banks have struggled to address portfolios' poor quality compounded by a high incidence of non-performing loans (NPL) and a general low rate of provisioning.[2] To deal with this, authorities amended banking regulations in 2006 to mandate a provisioning rate of 70% and set a maximum level of NPL of 15%, to be met by 2009 (IMF/WB, 2006). On one hand, this helped to improve the quality of banks' portfolios (see Figure 8) but, on the other, it very likely increased their risk aversion and hesitation to enter new markets such as RE.

Figure 8. Banks' loan portfolio quality: percentage of non-performing loans in 2004 and 2010



Source: CPI elaboration based on Maxula Bourse, 2010.

1 Due to the supplier's guarantee, Prosol I was officially reported as a commercial loan despite being designed for the end-user consumer.

2 Provisioning ratio measures the proportion of total non-performing loans against which a provision charge has been made. The higher the number the more conservative the bank has been in charging provisions against profit.

- Scalability is not a trivial problem. It is necessary to embed in Program's design multiple building blocks able to address the technology and audience-specific issues preventing widespread deployment of REs.
- Fossil fuel subsidies may represent a significant barrier to scaling up and replicating the Program in Tunisia and beyond.
- The role played by STEG may be difficult to replicate. Alternative models will need to be developed to provide incentives to commercial investors and minimize default risks.

6. Is Prosol scalable and replicable?

The success of Prosol Residential and the simplicity and transparency of its financial mechanism has generated a strong incentive to scale up the Program to accommodate other audiences and technologies.

Building on this success, ANME with the support of UNEP and MATTM, promoted two other initiatives that extended the financing mechanism from households to commercial and more energy intensive activities. Prosol Tertiary, targeting the services sector and hotels in particular, was launched in 2007. Prosol Industry, targeting the textile, chemical and food industries, was launched in 2009 but, is still in its pilot phase.

On the technology side, the mechanism has also been applied to small-scale photovoltaic systems in the residential sector, with the launch in 2010 of Prosol Elec.

Each of these programs shares the essential Prosol structure, providing subsidies on capital costs, interest rates and, also for maintenance costs subsidies. The most important difference is the absence of STEG, or an equivalent entity, in the Programs aimed at the business sector.

Table 6 below summarizes the key features of the financing mechanisms designed for the each initiative.

Launched at the same time as Prosol II Residential, Prosol Tertiary aimed to install 45,000 m^2 of panels by 2009, targeting between 80 and 100 hotels out the 850 operating in the sector, which had an estimated overall potential of 170,000 m^2 of panels. With an expected need of 6,000,000 m^3/year of hot water and 28,000 Toe/year in total energy demand, of which 60% could be saved by investing in SWHs (Marrouki, 2009), the hotel sector was deemed an ideal target for Prosol. Due to the sector's higher sensitivity to financial metrics compared with households,[68] aggregate incentives on capital costs exceeded those for Prosol Residential. Notwithstanding this difference, at the end of 2011, fewer than 25 hotels participated in the scheme, and total installations hovered at around 3,000 m^2.

Procedural delays in the set-up phase, STEG's absence as debt servicer and guarantor, and the reported precarious financial outlook for the tourism sector, dampened the interest of private commercial banks. In fact, the state-owned STB was the only financial institution to offer loans at abated interest rates (TMM+2%, of which 2% was subsidized by MATTM). Interestingly, MATTM reports that the interest rate subsidy facility is yet to be tapped, implying that all installations so far have been financed either by cash or by existing (and unsubsidized) credit lines between hotels and banks. We attribute this lack of engagement by the hotel sector to several converging factors:

- an unfavorable economic environment for the sector;
- the diffusion among hoteliers of the tenant business model that disincentivizes capital investments; and
- their high rates of default that, very likely, make access to credit more onerous for these borrowers.

More importantly, it appears that the significant subsidization of fossil fuels again represents the strongest hurdle to investments in SWHs. Indeed, capital cost and interest rate subsidies manage to reduce the payback time to an acceptable level only when the SWH is considered as alternative to LPG-fired system (payback time down from 6 to 3.5 years).[69] Crucially, payback times are still too long if the alternative is natural gas (down from 13.5 years to over 10.5 with incentives)[70]

68 Consultations between hoteliers and ANME reported that payback times greater than 3.5 years are deemed unacceptable for hotels for investments such as SWH ones (ANME, 2011b).

69 A complete replacement is, however, not possible given the need to keep the fuel fired WH as back-up, complementary system.

70 Estimates based on financial modeling calculating the payback of the project before and after the supporting measures under Prosol Tertiary. Revenues are derived from the substitution of existing LPG / natural gas water heating

Table 6. Prosol Tertiary, Industry and Elec: key features of the financing mechanisms.

	BARRIERS TO BE ADDRESSED	CAPITAL SUBSIDY	INTEREST RATE SUBSIDY	MAINTENANCE SUBSIDY	LOAN REPAYMENT IN STEG BILLS
PROSOL TERTIARY	• No direct ownership of the Hotel facility • High rates of debt defaults • SWH competitiveness vs. subsidized natural gas	50% feasibility study costs 10% capital cost by MATTM 30% by FNME	2% yearly by MATTM	Support in first 4 years (circa 3% of inv. cost)	None
PROSOL INDUSTRY[1]	• SWH competitiveness vs. subsidized natural gas • Lack of familiarity and skepticism on the technology	100% feasibility study costs 30% capital cost by MATTM	To be defined	To be defined	To be defined
PROSOL ELEC	• Lack of familiarity and skepticism on the technology • High upfront costs	30% cap costs by FNME 10% cap costs by MATTM Free inverter by STEG	Full abatement of IR costs	None	5-year credit line offered by Attijari Bank

Source: CPI elaboration based on ANME website and direct communications.

1 The financial mechanism of Prosol Industry is currently in a testing phase, hence its elements might be subject to several changes before the Program is launched in its final structure.

which is becoming increasingly widely distributed in the country. In fact, while only one in every seven households has access to natural gas, more than half of the hotels use it as the primary energy source for thermal needs, significantly reducing the potential market for SWHs (at the current level of gas subsidization) to the third of the sector using LPG and electricity.

Prosol Elec and Prosol Industry were both launched just before the uprising of 2010, and are still in a pilot phase. Given these circumstances it is too early to properly evaluate their outcome. We only note that Prosol Elec targets a capacity of 15 MW installed by 2016 and has so far prompted the installation of 2 MW, experiencing a particular rapid growth between December 2010 and August 2011 (MATTM, 2011). Forty pre-feasibility studies and ten feasibility studies have been completed for Prosol Industry, and one pilot project carried out in the textile industry, but with only limited interest from commercial banks.

It would be difficult to replicate exactly the elements that made Prosol Residential successful. However, understanding what worked and what did not could assist the design and implementation of more effective interventions in other contexts, strengthening the use of public finance in the promotion of REs. In particular, we focus on whether Prosol's strategy is replicable by considering if the financing mechanisms can be duplicated, and what other countries could learn from Tunisia's example.

systems with 55% efficiency. We assume an average cost per square meter of USD 565/m^2 (TND 750/m^2) for a SWH system with a productivity of 866 kWh/m^2, and a debt coverage of about 70% of investment cost with 5 years maturity. Investment depreciation are also computed in 5 years. Financial resources provided for feasibility studies are not included in the calculation. Figures and specific information presented in this paragraph were retrieved directly from stakeholders, particularly: ANME, UNEP, MATTM and Energie del Sole between January and March 2012.

What worked in Prosol?

The key building blocks that contributed to the success of Prosol Residential were:

- the engagement and strong commitment of national public authorities[71] evident in the credible and stable support that bolstered investors' confidence;
- the involvement of the State utility STEG as guarantor and debt enforcer, which enhanced domestic financial institutions trust and resulted in lowered financing costs for residential end-user purchasers;
- an appealing financial scheme using soft interest rates and longer repayment terms;
- the implementation of pervasive and focused awareness raising, communication and capacity building activities; and
- a stakeholder-tailored approach that involved all relevant actors in the development of the SWH

71 The institutional capacity of an experienced 'Program leader' (ANME) entrusted of the overall management and implementation of the mechanism also played a key role.

market from national authorities to financial institutions, suppliers, installers and end-users.

We highlight that the administrative ease and minimal bureaucracy of the Prosol facility was made possible by STEG's pre-existing infrastructure, which helped to build demand by lowering transaction costs.

What did not work in Prosol?

The 'weakest' aspects of the financing mechanism were:

- indirect lending and guarantees provided by 'financially fragile' actors such as the provision of financing and guarantees by suppliers under Prosol I. These had the potential to undermine the Program and the industry value chain, if not promptly and properly addressed; and
- reliance on a single-financing institution (such as Attijari Bank in Prosol II) which can result in market distortions and potentially hamper the Program's long-term sustainability.

We note that the monitoring, control, supervision, governance arrangements and skills developed for and within Prosol are evidence of an effective learning feedback-loop. The 'weak aspects' identified above were overcome during the lifetime of the intervention: in Prosol II the debt guarantees were shifted from suppliers to STEG and, in Prosol III (forthcoming) the engagement of a larger number of commercial banks is envisioned.

In addition, it is worth noting that the role played by STEG – a pivotal element of Prosol Residential – limits the overall potential to scale-up the Program. Its participation in the Tertiary or Industrial sector, in fact, was deemed inapplicable and undesirable by public authorities. Moreover, in a liberalized energy market, the involvement of a STEG-equivalent might be difficult to secure or more limited, in the absence of a strong public mandate, as in the Tunisian case.

Against this background we ask: can Prosol be considered a 'game changer'? How are the lessons learned from Prosol being applied in like programs? How are other countries promoting the uptake of SWHs?

Building upon the experience developed with Prosol – as well from the other initiatives implemented in Morocco (Prosol) and Egypt (Egysol) within the MEDREP framework – the Italian MATTM and UNEP (and other Prosol stakeholders) have had the opportunity to learn the lessons, and to build on them in subsequent climate finance interventions.

Disseminating and sharing such lessons will be essential to create a positive 'multiplier effect' and promote successful replication.[72]

At the present stage, the SWH incentive Programs currently ongoing or under development in the MENA Region and the Balkans are assessing the feasibility and sustainability of Prosol's features in these distinct contexts.[73]

The replicability of Prosol is dependent upon institutional, regulatory, and economic as well as cultural realities, which will need to be adequately understood in the feasibility study phase.

For example, Tunisian experts have offered their knowledge and capabilities to help improve a SWH mechanism launched in Morocco in 2005 that has not been as successful as hoped.[74] Discussions undertaken with stakeholders highlighted the following culprits:

- the lack of a capital cost subsidy intended to increase the competitiveness of SWHs versus the subsidized conventional alternative;
- the relatively lower experience (compared to ANME) of the Moroccan counterpart, the Center for Development of Renewable Energies (CDER) which led and implemented similar country-wide initiatives (UNEP, 2012a; .ANME, 2012b, Eco-Ser, 2012).

More recent initiatives, such as those launched in Montenegro or currently under development in Macedonia, intend to replicate Prosol (UNEP-DTIE, 2010). In particular, the design of the Macedonian Facility already in operation, replicates almost all of the Prosol building blocks (interest rate subsidy, awareness-raising, capacity building, etc.) with the exception of a STEG-equivalent entity and the investment subsidy. Country-specific factors would appear to have prompted these decisions and these elements might be

72 On this regard, it is worth noting the web knowledge management and dissemination tool developed by UNEP: www.solarthermalworld.org. Such web-based portal represents the primary contribution of UNEP to the GEF-funded Global Solar Water Heating Market Transformations and Strengthening Initiative (GSWH), which is aimed to inform the development and implementation of six-country Programs across Albania, Algeria, Chile, India, Lebanon, and Mexico. Like in the Tunisian experience, in fact, such initiatives are framed to address finance, awareness and information, skills, technology as well as policy and regulation, the most common barriers to the development of a SWH market. Source: http://www.solarthermalworld.org/node/3301.

73 See Appendix C for detailed information on those Programs.

74 It achieved the 20% circa of its stated target. See UNEP website, www.unep.org.

reassessed at a second stage, given that the facility has only been operating for around a year.

Is Prosol Residential scalable and replicable?

Beyond challenges associated with specific contexts or target audiences, the major hurdle that the initiatives presented above aim to overcome is the initial capital cost of the equipment, which can be a barrier for both commercial and residential users.

As the Tunisian experience prior to Prosol highlights, financial incentives alone are not sufficient to create a viable market on a long-term basis. Non-financial measures, including concerted awareness and communication campaigns, capacity-building activities and rigorous enforcement of quality standards, are fundamental ingredients of a 'recipe for success'. These measures, however, are not meant to downplay the crucial importance of embedding incentive mechanisms in a coherent policy framework, taking into account audience and country-specific aspects.

A number of actions to establish enabling conditions are critical if the aim is to scaled-up and replicate the features of the Prosol financing mechanism. Notably:

- establish a conducive institutional and regulatory context (i.e., commitment of public authorities; stable and credible policy support; competence of implementing agencies);
- raise awareness amongst the target audience of the broad basket of benefits versus costs;
- engage the local Government to remove market distortions and take the role of the external donor(s) to bring forward the effects spurred from foreign aid money, leading the technology towards market independence (which has not occurred, for example, in the Moroccan experience discussed above);
- identify and implement a risk-sharing mechanism to increase/create incentives for local banks to invest in renewable energies;
- promote tailored capacity building measures to improve the 'readiness' of local financial institutions and supply chain players.

If a transformative activity has to support a 'state change' in the financing of REs technologies, it can be said that Prosol Residential did it. In fact, throughout its unique multi-stakeholder approach, it has been effective in addressing the multiple barriers that had previously prevented the wide-spread adoption of SWHs in the Tunisian market. It played a significant role to mobilise resources in the local context and ultimately, provides a successful example to inform similar initiatives.

Box 2. How are SWHs financed in other countries? What other mechanisms are in place?

Different nations have used a wide array of policies and financial incentives to promote the uptake of SWHs:

- capital-grants (subsidies) based on SWH collector-area or performance;
- tax incentives;
- third-party financing;
- fee-for-service schemes;
- market-based instruments (e.g. Renewable Energies Certificates – RECs);
- mandatory policies.

Direct grants and subsidies are, to date, the most prevalent financing schemes used to promote SWHs uptake. Some countries, such as Australia, the Netherlands and Sweden have opted to subsidize SWHs as a function of the systems' performance (Roulleau and Lloyd, 2008). Proxies to estimate such performances are essential to avoid potentially costly one-to-one monitoring of individual systems.

Fiscal measures incentives were, for instance, adopted by the Greek Government which set tax deductions to reduce the investment costs for households by around 30% (up to 2002) (GTZ, 2006).

Along with fiscal incentives, **third-party financing** in the form of **soft loans** or **loan guarantees** are less widespread instruments (Haselip et al., 2011) despite their success in the Tunisian experience. Soft loan arrangements have, for instance, been promoted in India where the Ministry of New and Renewable Energy (MNRE) provides them through 34 financial institutions, with interest rates that vary from 2-5% according to the category of users. Interestingly, as with the Tunisian case, the interest subsidy attracted local banks to the financing of SWH systems (Tampier et al., 2006).

The application of partial loan guarantee schemes for financing SWHs has been proposed, for instance, in the Caribbean Region with the aim of reducing commercial banks' risks through partial (50-80%) credit and a sovereign risk guarantee. However, the scheme was not ultimately implemented as key parties pulled out and no alternatives could be found (Van den Akker, 2011).

SWH **fee-for-service** programs have been pilot-tested in the Caribbean and in Brazil (MNRE and REEEP, 2010; MERCADOS, 2010). Such schemes aim to integrate distributed generation in the energy mix of utilities, either via *sale-of-energy*[1] or system *leasing or rental*[2] arrangements, the two most common options.

A 'fee-for-service' mechanism, in the form of Energy Service Company (ESCO) model, has been deployed in South Africa,[3] to stimulate large-scale deployment of SWHs. The company purchases, installs and operates the SWH at its own cost and retains ownership. SWHs can also be installed and maintained at households premises, always at the ESCO's own cost (MNRE and REEEP, 2010; MERCADOS, 2010). This model is attractive because end-users do not bear any capital costs and, for them, the system is 'hassle free'.

Some countries have opted for **market-based mechanism** such as the Renewable Energy Certificates (RECs). Australia, for instance, is one of few that have introduced a specific REC for SWHs that can be used for compliance with its Mandatory Renewable Energy Target (SEA, 2007).[4]

1 The sale-of-energy program – which is applicable to any water heater customer – relieves end-users from the capital investment for the SWH equipment. The ownership of the system remains of the utility or of any other energy service provider that sells the energy generated to the customer at a rate lower than that of the conventional electricity. Energy sales can be structured as a "performance" contract or "shared savings" (Guiney et al., 2006).

2 The leased and rental option – common in the business sector – implies that the SWH are owned or financed by a third party (the utility or energy service provider), who will realize a tax benefit by depreciating the system while receiving a payment for the use of the SWH being leased. The end-user's payments, hence, cover the decreasing value of the equipment plus a margin for the leasing entity (Guiney et al., 2006).

3 SWH ESCO program in Pretoria. ESCOs models are best suited for larger institutional and commercial customers. The ESCO can sell e.g. via a fix-term lease or hire/purchase agreement or at a fixed-monthly fee. For additional information see MNRE and REEEP (2010); MERCADOS (2010).

4 RECs can be issued to SWH buyers themselves but, generally, they assign the right to a third-party and obtain a financial benefit in exchange (discount or cash rebate). The number of RECs which a SWH systems is entitled to – generally ranging from 10 to 64 RECs – vary according to end-user's location (postcode) and system type (MERCADOS, 2010; Roulleau and Lloyd, 2008).

Mandatory policies for SWH deployment in new buildings, constructions restorations or refurbishments, in public as well as in private residences, are also in place in countries such as Israel, Spain and China as well as Tunisia (GTOR, 2005; MNRE and REEEP, 2010).

More recently **third-party Energy Purchase Agreements** (EPAs) have emerged as SWHs financing instruments. This model is similar to a Power Purchase Agreement (PPAs) as end-users acquire the energy needed to heat the water for a 10-20 year period from the EPA provider. The EPA installs, owns, and operates the system. There are no upfront and maintenance costs or operational risk for the end-users.

Sometimes, high penetration rates of SWH in the domestic sector or other sectors can be achieved without any financial incentives or government Program. This is the case of Palestine where – in contrast with its significant reliance on donor funding for energy projects – SWHs were spontaneously adopted by households, 72% of which opted for them for their water heating needs. This significant performance has been driven by **market forces alone** as the prevailing prices of conventional energy sources make solar heating a cost-effective option[5] (Consortium MVVdecon/ENEA/RTE-I/Sonelgaz/Terna, 2011).

5 The payback period of a basic SWH system compared to an electric one is said to be less than 2 years.

7. Conclusion

The Prosol Tunisia financing program promoted the installation of more than 119,000 SWH systems, totaling around 355,350 m^2 of collector area over the timeframe analyzed (2005-2010). **With a fivefold increased in annual deployment, the combination of measures introduced with the Program has been demonstrated to be effective in addressing the critical demand-side barriers that were preventing the deployment of a commercially viable renewable energy technology.** The achieved installations translated into LPG subsidy savings of up to USD 101 million over the systems' lifetime, more than compensating for the USD 21.8 million public money invested by the Tunisian Government. The added SWH installations translate into 251 ktoe of energy savings and 715 ktCO_2 avoided. With a leverage ratio of 1:5, public financing spurred USD 110.2 million in private investments, allowing households to save between USD 605-1,325 per SWH in energy bills.

Looking at the main drivers behind these achievements, and returning to the initial San Giorgio Group framing inquiries that guided our research, **we ascertain the crucial role of international and domestic public finance in Prosol Residential. On one hand, international resources acted as an enabling agent to build awareness about the market potential among local public institutions, local financial investors and, ultimately, households. On the other hand, the commitment from the Tunisian Government to financially support SWH investments in the short to medium term substantially leveled the playing field for renewable energy deployment in a market distorted by fossil fuel subsidies.**

Besides facilitating the disbursement of financial resources, international and local authorities also managed to form a coherent institutional and regulatory framework (comprising a committed local government, an ad-hoc national agency for energy conservation and management, the state-owned utility, and foreign aid actors in Tunisia) that addressed the multiple financial and non-financial barriers that previously prevented the development of the SWH market. This institutional and regulatory framework also reduced transaction costs for households when accessing credit, and improved confidence in the technology. Standards and technical capacity were systematically embedded, providing a long-term platform to support large-scale deployment of SWHs and quite possibly some net job creation.

In particular, **capacity-building activities proved pivotal in the engagement of the local commercial banks in unlocking the local credit market**. Strong institutional coordination and alignment of interests among local authorities allowed the Program to effectively 'crowd-in' private capital from local commercial banks, whose interest in the SWH technology rose dramatically under Prosol compared with previous initiatives. Addressing and appropriately mitigating credit risk proved to be the key factor in engaging local financial institutions: the near-zero realized loan default rates allowed banks to preserve their profitability while offering very affordable credit to households (at rates roughly half of the prevailing market ones). Notably, thanks to the public utility involvement as debt servicer, repayment enforcer, and debt guarantor, the perceived credit risk was mitigated in a straightforward, effective, and low-cost manner.

Finally, when drawing lessons on the scalability and replicability of the Program, the crucial need for a supportive institutional framework tackling audience- and technology-specific challenges cannot be overstated. In particular, the issues of awareness, technology, and credit risk mitigation, as well as competitiveness in the face of fossil-fuel subsidization, are important to address.

Nevertheless, we emphasize that it is still too early to declare that Prosol is a complete success. During the time frame of our analysis, the initiative has certainly managed to support, to a very great extent, the deployment of solar water heaters through an effective combination of public and private resources. More importantly, the initiative has demonstrated that public support for renewable energy can add value to the public budget by shifting demand away from heavily subsidized fossil fuels, resulting in a net gain for public resources.

The design of the financial mechanism and effective risk-allocation arrangements has allowed a significant leverage of private resources while preserving banks' profitability and credit affordability for households.

At the same time, required technology standards and a well-run suppliers' certification process managed by ANME has contributed to improve the quality and reliability of the technology among households, stimulating demand and supporting the development of a skilled local supply chain.

It is a fair question to ask whether a Prosol-type program would achieve sustainable outcomes in the long run. In particular, we ask what would happen to the SWH market if the Tunisian Government withdrew its financial support, particularly given an uncertain political and fiscal environment. This question is best answered by looking in parallel at what could happen to the subsidies of fossil fuels. Our analysis has shown that, in a 'free-market' scenario, without any subsidies for fossil or for renewable energy, SWHs would be a 'first-best' investment option offering financial returns superior to fossil fueled alternatives. **Given the context in which the Program has been developed and the impact of the solar subsidies on the public budget, support to SWHs still appears as a 'second-best solution' for the economy as a whole.** Hence, a complete removal of public support would make its survival difficult in such a distorted market, without a comparable reduction of fossil fuel subsidies.

The fate of the SWH market in Tunisia will for some time continue to rest with the Tunisian Government. A rational step would be to advance reform of environmentally-harmful fossil fuel subsidies in a clear and predictable manner, ensuring that the poorest are protected from rapid price rises. Given the ability of the current Program to essentially self-finance itself – through the displacement of LPG subsidies – we see a strong argument in favor of the Government's continue support for the current approach, while also looking at how to phase out the LPG subsidies in the same period, which offers not only environmental benefits, but real cost savings and the opportunity to reshape the country's future energy security.

Index of acronyms

AFDB	African Development Bank
ANME	National Agency for Energy Conservation (Agence Nationale pour la Maîtrise de l'Energie)
BAU	Business as Usual
CBT	Central Bank of Tunisia
CDM	Clean Development Mechanism
CER	Certified Emission Reduction
CPA	CDM Programme Activity
CPI	Climate Policy Initiative
CSNER	Chambre Syndicale Nationale des Energies Renouvelables
EE	Energy Efficiency
EPA	Energy Purchase Agreements
ERPA	Emission Reduction Purchase Agreement
ESCO	Energy Services Company
FNME	Tunisian National Energy Conservation Fund
GEF	Global Environmental Facility
GHG	Green House Gases
GIZ	Deutsche Gesellschaft für Internationale Zusammenarbeit
GOT	Government of Tunisia
GOI	Government of Italy
IEA	International Energy Agency
INS	Institut National de la Statistique
IMF	International Monetary Fund
LCOE	Levelized Cost of Energy
LPG	Liquefied Petroleum Gas
MATTM	Italian Ministry for the Environment for Protection of Land and Sea
MEDREC	Mediterranean Renewable Energy Centre
MEDREP	Mediterranean Renewable Energy Program
MENA	Middle East and North Africa Region
MIEPME	Tunisian Ministry of Industry, Energy and Small and Middle Size Enterprises
NPL	Non Performing Loans
POA	Programme of Activities
RES	Renewable Energies
RCREEE	Regional Center for Renewable Energy and Energy
OECD	Organization of Economic Co-operation and Development
OGRT	Official Gazette of the Tunisian Republic
PPA	Power Purchase Agreement
PROSOL	Programme Solaire
STB	Tunisian National Bank (Société Tunisienne de Banque)
STEG	Tunisian Company of Electricity and Gas (Tunisian Société Tunisienne d'Electricite et du Gaz)
SWH	Solar Water Heater
TDN	Tunisian Dinars
TOE	Tonne of Oil Equivalent
UBCI	Union Bancaire pour le Commerce et l'Industrie
UNEP–DTIE	United Nations Environment Programme - Division of Technology, Industry, and Economics
UNFCCC	United Nations Framework Convention on Climate Change

References

Adriatic Fair. 2011. "Montesol - Solar Water Heating Project in Montenegro", Adriatic Fair. http://www.adriafair.co.me/Press/990/MONTESOL+-+solar+water+heating+project+in+Montenegro.shtml.

AfDB, OECD, UNDP, UNECA. 2011. "African Economic Outlook – Tunisia Country note 2011". African Economic Outlook. http://www.africaneconomicoutlook.org/fileadmin/uploads/aeo/Country_Notes/2011/Full/Tunisia.pdf.

African Development Bank (AfDB). 2010. "The Middle of the Pyramid: Dynamics of the Middle Class in Africa - Market Brief 20 April 2011." African Development Bank. http://www.afdb.org/fileadmin/uploads/afdb/Documents/Publications/The%20Middle%20of%20the%20Pyramid_The%20Middle%20of%20the%20Pyramid.pdf.

Agence Française de Développement (AFD). 2008. «Tunisie: Financer la Maîtrise de l'Energie». Paris, France. http://www.afd.fr/webdav/site/afd/shared/PUBLICATIONS/RECHERCHE/Archives/Notes-et-documents/44-notes-documents.pdf.

Allali, B. et al. 2011. "PROMASOL: Democratizing Access to Solar Water-Heaters. Growing Inclusive Market". http://solarthermalworld.org/files/Morocco_Promasol_2011.pdf?download.

Amen Bank. 2011. "Bilan Arrêté au 31.12.2010". Conseil du Marché Financier. http://www.cmf.org.tn/pdf/informations_ste/EF/AMEN_BANK_EFD311210.pdf.

Amen Bank. 2012. Personal Communication, March 19, 2012.

ANME. 2011a. "Guide Pratique de Gestion e l'Energie pour Responsable-Energie". Agence Nationale pour la Maîtrise de l'Energie. http://www.anme.nat.tn/.

ANME. 2012a. Data provided via personal communication with UNEP, February 24, 2012

ANME. 2012b. Data and information provided via personal communication between February and March 2012.

ANME. 2007a. "Program de Promotion de l'Utilisation du Chauffe-eau Solaire en Tunisie. Systemes Solaires Destinés Aux Etablissements Privés. Cahier Des Charges Concernant l'Eligibilité des Prescripteurs & Controleurs Techniques." Agence Nationale pour la Maîtrise de l'Energie. http://www.anme.nat.tn.

ANME. 2007b. "Prosol Tertiare Présentation du Mécanisme et Modalités d'Accès aux Avantages". Agence Nationale pour la Maîtrise de l'Energie. http://www.anme.nat.tn/.

ANME. 2010b. "Projet Prosol Elec". http://www.minambiente.it/export/sites/default/archivio/allegati/vari/projet_prosol_elec_2010.pdf.

ANME. 2011a. "Clean Development Mechanism Small-Scale Program Of Activities Design Document Form, CDM-SSC-PoA-DD, Version 01". UNFCCC, http://cdm.unfccc.int/.

ANME. 2011b. "Small-Scale CDM Program of Activities Design Document Form – Prosol Tertiary". UNFCCC, http://cdm.unfccc.int/.

APIE. 2006-2011. "Couts des facteurs de production – Tunisie". Agence de Promotion de l'Investissement Extérieur. http://www.investintunisia.tn/.

Archibat. 2009. "De nouvelles dispositions législatives en matière de maîtrise de l'énergie". Architecture, Bâtiment, Communication. http://www.archibat.info/news.php?artid=153.

Attijari Bank. 2011. "Rapport Annuel 2010". Attijari Bank. http://www.attijaribank.com.tn/attijari/site/RA2010FR.pdf.

Baccouche. 2011. "Tunisia Solar Thermal Program - Residential, Industrial and Hotels Sector". http://www.solar-process-heat.eu/fileadmin/redakteure/WSED/2011/download_presentations/Baccouche.pdf.

Bahri. 2011. "Energy cooperation and sustainable development of the South Mediterranean Region". Presented at: ICS UNIDO Expert Group Meeting (EGM) on Instruments and Potential for the Use of Renewable Energies for Regional Development. Trieste, 2010.

Central Bank of Tunisia (CBT). 2006-2011. "Rapport Annuel de la Banque Centrale de Tunisie" from 2005 to 2010. Central Bank of Tunisia. http://www.bct.gov.tn/bct/siteprod/francais/publications/hist_publication.jsp.

Central Bank of Tunisia (CBT). 2012. "Main interest rates", Central Bank of Tunisia. http://www.bct.gov.tn/bct/siteprod/english/indicateurs/interet.jsp.

Centre Scientifique et Technique du Bâtiment. 2012. "SOLO model". Available online at: http://www.tecsol.fr/st_uk/default-uk.htm.

Chaibi, T.M. 2010. "Programs for Scaling up Renewable Energies in Africa. Pan African University. http://energycenter.knust.edu.gh/downloads/7/71691.pdf.

Chebbi, L. 2011. "STEG Energies Renouvelables Tunisia". Presentation at: Desert Energy Conference. Cairo, 2011. http://www.dii-eumena.com/fileadmin/Daten/AC_2011/Presentations/3a%20Markets/Dii_Cairo%202011_Chebbi_How%20to%20integrate%20RE%20into%20the%20markets.pdf.

Conseil du Marché Financier (CMF). 2005-2010. "Annual Reports for Amen Bank, Attijari Bank and UBCI from 2005 to 2010. Consultation des états financiers des sociétés faisant APE". Conseuil du Marché Financier. http://www.cmf.org.tn/htm/informations_ste/ef_search.php.

Consortium MVVdecon/ENEA/RTE-I/Sonelgaz/Terna. 2011. "Paving the Way for the Mediterranean Solar Plan. 2011 - Benchmarking of existing practice against EU norms - Country Report Tunisia." Paving the Way for the Mediterranean Solar Plan. http://www.pavingtheway-msp.eu/fileadmin/paving-the-way/Tunisa.pdf.

Consortium MVVdecon/ENEA/RTE-I/Sonelgaz/Terna. 2011. "Paving the Way for the Mediterranean Solar Plan. 2011 - Benchmarking of existing practice against EU norms - Country Report Palestine. http://www.pavingtheway-msp.eu/fileadmin/paving-the-way/Palestine.pdf.

Damodaran. 2012. "Country Default Spreads and Risk Premiums". New York University. http://pages.stern.nyu.edu/~adamodar/.

Eco-Ser. 2012. Personal communication, March 19, 2012.

Ernez. 2008. "Promotion Program of Solar Water Heating in Tunisia - PROSOL II." Presented at: Seminar on Energy Efficiency, Demand-side Management, and Renewable Energy, organised by INOGATE Technical Secretariat. Brussels, 2008. http://www1.inogate.org/inogate_Program/inogate_events/training-courses/seminar-energy-efficiency-demand-side-management/presentations/Prosol_II__Mr._Ernez.ppt.

G-20 Leaders Statement: The Pittsburgh Summit, September 24-25, 2009, Pittsburgh, http://www.g20.utoronto.ca/2009/2009communique0925.html

GIZ. 2009. "Solar Thermal Application in Egypt, Jordan, Lebanon, Palestinian Territories, Syria and Tunisia: Technical Aspects, Framework Conditions and Private Sector Needs". http://www.solarthermalworld.org/files/Solar%20Thermal%20Application%20in%20Arab%20Countries.pdf.

Global Solar Thermal Energy Council (GSTEC). 2008. "Morocco: The national market offers huge, but insufficiently exploited potential". http://www.solarthermalworld.org/node/2849.

Global Solar Thermal Energy Council (GSTEC). 2008. "Tunisian Market Growing Rapidly". Global Solar Thermal Energy Council. http://www.solarthermalworld.org/node/166.

Gorina, N. 2009. "Carbon Prices: pre and post 2012, Essent Trading." Presented at: Expert meeting on trade and climate change: trade and investment opportunities and challenges under the CDM organized by UNCTAD. Geneva, 2009. http://archive.unctad.org/sections/wcmu/docs/c1em1p08_en.pdf.

Government of Tunisia / Agence de Promotion de l'Industrie et de l'Innovation. 1993. "Code d'Incitations aux Investissements". République Tunisienne Ministère de l'Industrie et du Commerce. http://www.tunisieindustrie.nat.tn/fr/download/CFGA/Code.pdf.

Green Budget Germany (GBE). 2012. Personal communication on February 3, 2012.

GTZ. 2006. "International Experiences with the Promotion of Solar Water Heaters at Household-Level". Deutsche Gesellschaft für Technische Zusammenarbeit – GTZ, Mexico, October 2006. http://www.solarthermalworld.org/files/Promoting-Solar-Water_Heaters.pdf?download.

GTZ. 2008. "CDM/JI Initiative Country Study, Tunisia Stock-Taking Report and Assessment of the CDM Progress Status in Tunisia". http://www.jiko-bmu.de/files/basisinformationen/application/pdf/cdm_market_overview_tunesien.pdf.

Haselip, J., Nygaard, I., Hansen, U., Ackom, E., eds. 2011. "Diffusion of Renewable Energy Technologies: Case Studies of Enabling Frameworks in Developing Countries. Technology Transfer Perspectives Series".

ICIS Heren. 2011. "CER prices crash towards primary market costs". http://www.icis.com/heren/articles/2011/08/01/9481559/cer-prices-crash-towards-primary-market-costs.html.

Institute National de Statistique (INS). 2010. "Annuaire Statistique de la Tunisie – 2009". Institute National de Statistique. http://www.ins.nat.tn/publication/Anunaire_2009.pdf.

Institute National de Statistique (INS). 2012. "Importation par Produits en Valeurs and (en kg) - 271113 – Butanes. Institute National de Statistique. http://www.ins.nat.tn/fr/comex_nsh6_serie.php?chaptr=271113&b=v&b1=i&c=d.

Intergovernmental Panel on Climate Change (IPCC). 2006. "2006 IPCC Guidelines for National GHG Inventories". http://www.ipcc-nggip.iges.or.jp/public/2006gl/index.html.

International Energy Agency. 2011. "World Energy Outlook 2011". OECD/IEA, Paris.

International Monetary Fund (IMF). 2008. "Tunisia: 2008 Article IV Consultation—Staff Report; Public Information Notice on the Executive Board Discussion; and Statement by the Executive Director for Tunisia". International Monetary Fund, Washington, DC, http://www.imf.org/external/pubs/ft/scr/2008/cr08345.pdf.

International Monetary Fund (IMF). 2011. "World Economic Outlook" International Monetary Fund. http://www.imf.org/external/pubs/ft/weo/2011/01/weodata/download.aspx.

International Monetary Fund (IMF)/World Bank. 2006. Tunisia. Financial Sector Assessment. Washington DC: IMF. http://www.imf.org/external/pubs/ft/scr/2006/cr06448.pdf.

Kamberi, Z. 2011. "Global Solar Water Heating Market Transformation and Strengthening Initiative: Albania Country Program". http://www.ccalb.org/editor-files/file/Raportimet%20e%20Eksperteve/Experts%20report/Zija/Draft_final_report_SWH_project_022520112.pdf.

Koplow, D. 2009. "Measuring Energy Subsidies Using the Price-Gap Approach". International Institute for Sustainable Development (IISD), Winnipeg, Manitoba, Canada.http://www.iisd.org/pdf/2009/bali_2_copenhagen_ff_subsidies_pricegap.pdf.

Lang, K. (ed.), IISD, GSI. 2010. "GSI-UNEP Conference Report Increasing the Momentum of Fossil-Fuel Subsidy Reform: Developments and Opportunities". International Institute for Sustainable Development. http://www.iisd.org/gsi/sites/default/files/ffs_conference.pdf.

Marrouki. 2009. "Creating a Credit Market for Solar Water Heater". Presented at: Sustainability Week Conference. Beirut, 2009. http://www.lebanon-gbc.org/Content/News/SamiMarrouki.pdf.

MATTM. 2009a. "Cooperation for Environment Protection between Italian Ministry of Environment and Albania". Italian Ministry for Environment, Land and Sea. http://www.ccalb.org/editor-files/file/Presentation%20PDF/Valerio%20Boccone_Italian%20Ministry%20of%20Environment.pdf.

MATTM. 2009b. "Prosol Tunisie – Meccanismo di Incentivazione per la Diffusione del Solare Termico in Tunisia", Italian Ministry for Environment, Land and Sea. http://www.minambiente.it/export/sites/default/archivio/allegati/vari/PROSOL.pdf.

MATTM. 2011. Personal communication on December, 14 2011.

Maxula Bourse. 2010. "Revue Bancaire 2010". Maxula Bourse. http://www.maxulabourse.com.tn/publications/revues/Revue%20Bancaire%202010.pdf.

Maxula Bourse. 2011. "Revue Bancaire 2011". Maxula Bourse. http://www.maxulabourse.com.tn/publications/revues/Revue%20Bancaire.pdf.

MED-EMIP. 2010. "Support for the Enhanced Integration and the Improved Security of the Euro-Mediterranean Energy Market (MED-EMIP) - MED-EMIP: Development of a Budget Allocation Efficiency Chart for Public and Private Sector Spending - Country Report: Tunisia". Euro-Mediterranean Energy Market Integration Project, European Commission. http://www.medemip.eu/CMS/ODArchive/MedEmipReports/E04-004-F-BAC_Report-Tunisia.pdf.

MEDREC. 2008. "Prosol Tunisia 2007". MEDREC. http://www.medrec.org/en/download/PROSOL%20TUNISIA%202007.PDF.

MEDREC. 2011. Personal communication on December 14, 2011.

Menichetti E., and M., Thouami. 2007. "Creating a credit market for solar thermal: the PROSOL project in Tunisia." Presented at: Third European Solar Thermal Energy Conference. Freiburg, 2007. http://www.medrec.org/en/download/estec2007_Conference_PROSOL.pdf.

MERCADOS, 2010. "Development of An Area Based Energy Service Company (ESCO) Model for Solar Water Heating in India. Final Report". http://www.undp.org/content/dam/india/docs/development_of_an_area_based_energy_service_company_ (esco)_model_for_solar_water_heating_in_india.pdf.

Ministry of Industry and Technology (MIEPME). 2010. "The Tunisian Solar Plan", Republic of Tunisia.

Ministry of Industry and Technology. 2009. "Ajustement des prix des hydrocarbures". Ministry of Industry and Technology. http://www.industrie.gov.tn/fr/directdoc.asp?docid=299.

Ministry of Industry, Energy and Small and Medium-Sized Enterprises (MIEPME). 2012. Personal communication on March 19, 2012

Ministry of New and Renewable Energy (MNRE) and Renewable Energy and Energy Efficiency Partnership (REEEP), South Asia Secretariat. 2010. Solar Water Heating Systems A Review of Global Experiences. http://www.aeinetwork.org/reeep/doc/DIREC_Background.pdf.

Missaoui, R. 2007. "Chauffe-eau Solaires en Tunisie: le Program PROSOL". In Énergies renouvelables, développement et environnement discours, réalités et perspectives, InstItut de l'énergle et de l'environnement de la francophonie. IEPF, Québec, Canada. http://www.global-chance.org/IMG/pdf/GC23p67-74.pdf.

Missaoui, R., and S. Marrouki. 2009a. "Etude sur les prix des CES en Tunisie: Rapport Définitive". Alcor – GTZ/ANME, Tunis, Tunisia.

Missaoui, R., and S. Marrouki. 2009b. "Conception et Mise en place d'un Mecanisme de Maintenance des CES Individuels dans le Cadre du Program Prosol". Eco.Ser / Alcor, Tunis, Tunisia.

Observatoire Méditerranéen de l'Energie. 2007. "Renewable Energy In The Southern And Eastern Mediterranean Countries". http://www.abhatoo.net.ma/index.php/fre/content/download/9756/148197/file/renewable_energy_southern.pdf.

OECD. 2011a. "Towards Green Growth". http://www.oecd.org/document/10/0,3746,en_2649_37465_47983690_1_1_1_37465,00.html.

OECD. 2011b. "Towards a Policy Framework for Low-Carbon, Climate-Resilient Infrastructure Investment - Staff consultation draft, revised 1 December, 2011". http://www.oecd.org/dataoecd/53/42/49184842.pdf.

OECD. 2012a. Scholz., W., C Tébar Less "Proposal of Tunisia to Adhere to The OECD Declaration on International Investment and Multinational Enterprises. Working Party of the Investment Committee. Directorate for Financial and Enterprise Affairs Investment Committee". Organisation for Economic Co-operation and Development. DAF/INV/WP(2012)1.

OECD. 2012b. Corfee-Morlot, J., V. Marchal, C. Kauffmann, C. Tebar Less, F. Stewart, C. Kennedy and C. Kaminke. "Towards A Green Investment Policy Framework. The Case of Low-Carbon, Resilient Infrastructure" - Staff consultation draft, 24 April 2012. Organisation for Economic Co-operation and Development – OCED (forthcoming).

Orbeo. 2010. "Orbeo Overview". http://www.chaireeconomieduclimat.org/wp-content/uploads/2010/12/ORBEO-marketoverview-2010-FI-NAL.pdf.

PKF. 2011. "Tunisia Tax Guide 2011". PKF International Limited. at: http://www.pkf.com/media/387233/pkf%20tunisia%20tax%20guide%202011.pdf.

PlanBleu. 2011. "Energie, Changement Climatique et Bâtiment en Méditerranée: Perspectives Régionales", Plan Bleu Centre d'Activités Régionales PNUE/PAM. http://www.planbleu.org/publications/energie_cc_batimentFR.pdf.

RCREEE. 2010. "Appui Technique/Prestations De Services Pour L'évaluation de L'impact Economique, Technologique et Environnemental de La Réglementation Nationale et Des Incitations Relatives Aux Energies Renouvelables et L'efficacité Energétique". RCREEE. http://www.rcreee.org/Studies/Danida_Country_Studies/Tunisia_FR.pdf.

REN21. 2011. "Renewables 2011 Global Status Report". REN21 Secretariat, Paris, France. http://www.ren21.net/Portals/97/documents/GSR/REN21_GSR2011.pdf.

Republic of Tunisia. 2005. "Law n. 2005-82 du 16 Aout 2005, Portant Création d'un Système de Maîtrise de L'énergie", in Journal Officiel de la République Tunisienne. http://www.iort.gov.tn.

Republic of Tunisia. 2009. "Décret n° 2009-362 du 9 Février 2009, modifiant le Décret n° 2005-2234 du 22 août 2005, Fixant les Taux et les Montants des Primes Relatives aux Actions Concernées par le Régime Pour la Maîtrise de L'énergie Ainsi que les Conditions et les Modalités de leur Octro »i. Ministry of Industry Energy and Small and Medium-Sized Enterprises. In Journal Officiel de la République Tunisienne. http://www.iort.gov.tn.

Ressources Naturelles Canada. 2005. "RETscreen - Solar Water Heating Project Model" Ressources Naturelles Canada. www.retscreen.net/download.php/ang/470/0/SWH3.pdf.

Roulleau T., C.R., Lloyd. 2008. "International Policy Issues Regarding Solar Water Heating, with a Focus on New Zealand". Energy Policy 36: 1843–1857.

Saidane. 2010. "Banking Services in Africa: the Regulatory and Institutional dimension?". Presented at: UNCTAD Multi-Year Expert Meeting on Services, Development and Trade: the Regulatory and Institutional dimension. Geneva, 2010.

Senit, C.-A. 2008. "L'efficacité Énergétique Dans le Secteur Résidentiel: une Analyse des Politiques des Pays du Sud et de l'est de la Méditerranée" - Ilddri, Idées pour le débat N° 14/2008. Paris : Institut du Développement Durable et des Relations Internationales. http://dspace.cigilibrary.org/jspui/bitstream/123456789/26239/1/Idea%200814.pdf?1.

STEG. 2010. "6ème me Enquête Résidentielle". Tunis: Direction des études et de la planification.STEG. 2012. Personal communication on 19-3-2012. UNEP. 2012a. Personal Communication on 13-1-2012

Sustainable Energy Africa - SEA. 2007. "How to Implement Renewable Energy and Energy Efficiency Options Support for South African Local Government". http://www.energycommunity.org/documents/SEA1.Success%20through%20sustainability%20.pdf.

Tampier, M., and J-P. Beaulieu. 2006. "Renewable Energy Financing Case Studies: Lessons to be Learned from Successful Initiatives". Commission for Environmental Cooperation, Montreal. http://www.cec.org/Storage/60/5266_RE%20Financing%20Case%20Studies_en.pdf.

Touhami, M., 2011. "Prosol - Financing Solar Water Heating in Tunisia". Presented at: Inaugural Meeting of the San Giorgio Group: Expanding Green, Low-Emissions Finance. Island of San Giorgio Maggiore, Venice, Italy, October 16-17, 2011.

Tunisie Valeurs. 2005. Tunis. https://www.tunisievaleurs.com.tn/indexang.asp.

Tunisie Valeurs. 2011. "Semi Annual Report". Tunisie Valeurs, Tunis. https://www.tunisievaleurs.com.tn/indexang.asp.

TÜV SÜD Industrie Service GmbH. 2011. "Validation Report - Validation of the CDM Program of Activities: Solar Water Heater Program in Tunisia". REPORT NO. 600500202, March 2011. Munich – Germany. http://cdm.unfccc.int/filestorage/E/7/L/E7LT9YICARBGP46SQVW0ZNOF1HU3JK/Validation%20Report%20PoA.pdf?t=aUF8bTF0cWVnfDCKaQz_Yt7XzoB57H8Ht8zp.

UBCI. 2011a. "UBCI Etats Financiers au 31 Decembre 2010". http://www.cmf.org.tn/pdf/informations_ste/EF/UBCI_EFD311210.pdf.

UBCI. 2011b. "Rapport Annuel 2010". UBCI. http://media-cms.bnpparibas.com/file/48/2/ra_ubci_2010_definitif.18482.pdf.

UNEP. 2012b. Personal Communication, February 21, 2012.

United Nations Environment Programme (UNEP). 2008. "Investing in a Climate for Change. Engaging the Finance Sector". UNEP, Paris, France. Available online at: http://www.unep.fr/shared/publications/pdf/WEBx0140xPA-InvestClimateChange.pdf.

United Nations Environment Programme (UNEP). 2008. "Programme de Développement du Marché Marocain des Chauffe-eau Solaires PROMASOL". http://www.pnud.org.ma/pdf/P4_promasol.pdf.

United Nations Environment Programme (UNEP). 2009. "MEDREP Evaluation Report - Project Supervision Review".

United Nations Environment Programme Division of Technology, Industry and Economics (UNEP-DTIE). 2010. The Balkan Renewable Energy Programme (BALREP).

United Nations Development Programme (UNDP). 2010. "Human Development Index 2010". http://hdr.undp.org/en/media/Lets-Talk-HD-HDI_2010.pdf.

United Nations Development Programme Global Environment Facility. 2011. "Final Evaluation. Caribbean Renewable Energy Development Programme (CREDP)." UNDP. http://erc.undp.org/evaluationadmin/downloaddocument.html%3Fdocid%3D5151.

Van den Akker, J. 2011. "Final Evaluation. Caribbean Renewable Energy Development Program (CREDP)", United Nations Development Programme, Global Environment Facility.

Varadarajan, U., D. Nelson, M. Hervé-Mignucci, and B. Pierpoint. 2011. "The Impacts of Policy on the Financing of Renewable Projects: A Case Study Analysis". Climate Policy Initiative, San Francisco, United States. http://climatepolicyinitiative.org/publication/the-impacts-of-policy-on-the-financing-of-renewable-projects-a-case-study-analysis/.

Weiss, W. and F. Mauthner. 2011. "Solar Heat Worldwide 2011. Markets and Contribution to the Energy Supply 2009". IEA Solar Heating and Cooling Program (SHC), Austria. http://www.iea-shc.org/publications/downloads/Solar_Heat_Worldwide-2011.pdf.

World Bank. 2004. Implementation Completion Report (TF-25141 TF-28666) on a Grant in the Amount of USD 7.4 Million to The Republic of Tunisia for a Solar Water Heating Project, Report No: 30910.

World Energy Council (WEC) - ADEME. 2007. "Policy Measures to Support Solar Water Heating: Information, Incentives and Regulations. ADEME, World Energy Council". http://www.worldenergy.org/documents/solar_synthesis.pdf.

Websites

Africatime.com: http://www.africatime.com/

Agence de Promotion de l'Investissement Extérieur (APIE) : http://www.investintunisia.tn Babnet Tunisie: http://www.babnet.net

Agence Nationale pour la Maîtrise de l'Energie (ANME): http://www.anme.nat.tn/index.php?id=3.

Business News: http://www.businessnews.com.tn/

Institut National De La Statistique – Tunisie: http://www.ins.nat.tn.

(IEA)/IRENA Global Renewable Energy Policies and Measures Database: http://www.iea.org/textbase/pm/?mode=re.

Italian Ministry for Environment, Land and Territory and Sea (MATT): http://www.minambiente.it/home_it/index.html?lang=it.

Mediterranean Renewable Energy Center (MEDREC): http://www.medrec.org/en/index.php.

Ministry of Economy, Republic of Montenegro: www.mek.gov.me.

Ministry of Industry, Energy and Small and Medium-Sized Enterprises (MIEPME); Ministry of Industry and Technology, Republic of Tunisia: http://www.tunisianindustry.nat.tn/en/doc.asp?docid=685&mcat=4&mrub=83.

Oanda. 2012 - Historical Exchange Rates: http://www.oanda.com/lang/it/currency/historical-rates/.

Official Printing Office of the Republic of Tunisia: http://www.iort.gov.tn/WD120AWP/WD120Awp.exe/CONNECT/SITEIORT.

Portail de l'Industrie & de la Technologie : http://www.industrie.gov.tn

REEGLE Policy Database: http://www.reegle.info/policy-and-regulatory-overviews/TN.

Renewable Energy World: http://www.renewableenergyworld.com.

Société Tunisienne d'Electricité et du Gaz (STEG): http://www.steg.com.tn/fr/index.html.

The World Bank 2011, Open Data: http://data.worldbank.org/.

Tunisia Today: http://www.tunisia-today.com

TuniZien.net: http://www.tunizien.net

United Nations Environment Programme Division of Technology, Industry and Economics (UNEP-DTIE): http://www.unep.org/dtie/.

Appendix A - Methodologies

A1. Investment's cash flow modeling

We use a cash flow model to examine the impact of Prosol support measures on key financial metrics such as payback of investment and Levelized Cost of Energy (LCOE) from a private investor's perspective.

The model evaluates purchase alternatives and the performances of the SWHs during the 15 years of lifetime of the SWH.

Model inputs

- Total cost: investment, financing, operations and maintenance;
- Technical features: SWH energy productivity, average efficiency, calorific value;
- Fuel and electricity prices.

Model assumptions

- Households evaluate the investment against high-efficient available alternatives. Upfront costs, operational costs and energy bills attributable to the alternative water heaters are all accounted as **potential cost savings** (revenues);
- Households opt for the **highest credit lines** made available by the banks;
- **No system defaults** occur over the 15 years lifetime as constant maintenance is assumed; **Installation and administrative fees** (e.g., STEG registration fee for the SWH) **are included in the price of the water heaters**;

Model outputs

- **LCOE**: the cost of energy to the final user calculated by dividing actualized negative cash flows by the discounted generation, the resulting figure is weighted according to the existing market structure of SWHs (200 and 300 liters) and system-specific productivity;
- **Payback period**: the time needed by the investor to recover negative cash flows with the cost savings originated by the investment.

A2. Thermal energy production and GHG savings

Total energy savings: estimates are based on the yearly market deployment and average energy productivity of the SWH considering the substitution of the main water heating conventional alternatives (LPG; electricity and natural gas-fired water heaters). Figures are weighted by the generation mix to reflect the evolution of the market structure over the considered timeframe, and net of an estimated BAU baseline accounting for the purchases that would have occurred in the absence of Prosol.

GHGs avoided (CO_2): estimated avoided emissions are calculated multiplying energy savings by an emission factor that quantifies the CO_2 released by the specific energy source used by the water heater.

LPG Subsidy (IEA Approach)

The level of LPG subsidy granted to end-users is estimated using the IEA's price-gap approach[75]. This methodology compares the reference price of LPG, which correspond to the full cost for imports and supply – to the end-user price set by the Tunisian Government for the 13 kg LPG bottle, the most widely used in the residential sector for water heating (STEG, 2010; ANME, 2010a).

According to this approach the level of LPG subsidy is expressed as:

LPG Subsidy = (LPG Reference Price) – (LPG End-user Price)

Model inputs

- Import price of butane at the nearest international hub i.e. Algeria[76];
- Average supply costs including transport, internal distribution and marketing operations;
- Value-added tax (10-12%);
- End-user price of the 13 kg LPG bottle.

Model outputs

The amount of LPG subsidies avoided is calculated as the product of the energy savings obtained through the substitution of LPG-fired water heaters and the estimated level of subsidization.

75 For addition information see IEA website, http://www.iea.org/weo/methodology_sub.asp.

76 Butane is largely used in Tunisia for the 13 kg bottles. Given that the country imports over the 70% of its LPG consumption needs, we considered import prices from Algeria where the largest share of butane is imported from.

Appendix A.3 – Model Inputs Table

The following table includes all input data used for quantitative analysis in this paper. When possible, data, modeling assumptions and results were tested with experts and stakeholders involved in the Program. Where a particular modeling input was not available a reasonable proxy was defined, based on available market information and existing regulation (i.e. conventional water heaters maintenance costs).

Input	Description	Source
Prosol Program		
TIME FRAME	2005-2010	
EXCHANGE RATES	Average TND/USD 2005-2010 exchange rate: **0.7534** Average EUR/USD 2005-2010 exchange rate: **1.344**	Oanda (2012)
CAPITAL COST SUBSIDY	For 2005-2008: **20%** of the cost of SWH with a cap of **USD 75/m^2 (TND 100/m^2)**. For 2009-2010: **USD 150/m^2 (TND 200)** for SWH with collector area between 1-3 m^2 **USD 300/m^2 (TND 400)** for SWH with a collector area between 3-7 m^2 Since SWH of 200 litres and 300 litres capacity measure on average 2 and 4 m^2 respectively, we assume that the contribution corresponds to around USD **75/m^2 (TND 100 /m^2)**	Republic of Tunisia (2009); ANME (2007a). Decree n° 2009-362
INTEREST RATE SUBSIDY	The interest rate subsidy served by MATTM through UNEP applied for the 5 years of the loans contracted during the first 18th months of Prosol I, until exhaustion of the granted fund. **= 7%** for 12 months; reduced to **4%** in the following 6 months.	Haselip et al. (2011)
PROSOL DEBT INTEREST RATE	The interest rates requested by the banks every year correspond to: 7% for Prosol I; TMM+1 for Prosol II in 2007 and TMM+1.2 in 2008-2010. For each specific loan vintage, Interest Rates are assumed fixed during the five years of debt repayment: **7.0%** (2005-2006); **6.26%** (2007); **6.40%** (2008); **6.37%** (2009); **5.49%** (2010); 6.00% (2011)	Central Bank of Tunisia (2012); GTZ (2006); Missaoui (2007)
DEBT DEFAULT RATES	Prosol (Residental) loan default rate: **1%**	ANME (2012b)
CREDIT LINES CONTRACTED WITHIN PROSOL (USD)	Loans contracted in 2005-2006 are estimated assuming **50%** access to credit and **70%** average debt coverage for the purchase of SWHs. For the 2007-2011 actual amount of credit lines contracted by households are provided by STEG (2012): **USD 5,396,981** (2007); **16,935,453** (2008); **18,029,088** (2009); **19,963,179** (2010).	STEG (2012); Touhami (2011), Energie del Sole (2012)
Water Heaters Market Data		
SWH DEPLOYMENT DATA	Number of SWH systems units and m^2 installed every year. Installation: **7,093** (2005)**; 10,843** (2006)**; 19,100** (2007)**; 27,500** (2008)**; 27,000** (2009)**; 27,500** (2010)**.** Collector surface area (m^2): **22,312** (2005)**; 34,730** (2006)**; 55,308** (2007)**; 80,000** (2008)**; 82,000** (2009)**; 81,000** (2010)**.**	MATTM (2009a), Bahri (2011)

Input	Description	Source
SWH BAU DEPLOYMENT TRENDS	SWHs units installed in 2004: **2,500** This figure marks the lowest point for SWHs, in terms of market deployment. It can be considered a conservative figure because: (1) SWH technology improvements and rising energy prices may have made SWH more attractive to households, even in a BAU scenario where SWH lacks the support of a subsidy scheme; (2) Policy expectations over the setting up of a financing Program on SWH may have postponed households' purchasing decisions from 2004 to the following years.	MATTM (2009a), Bahri (2011)
WATER HEATERS MARKET STRUCTURE	Market shares in 2004: LPG (72%), Electricity (11%), Natural Gas (14%), SWH (3%) Market shares in 2009: **LPG (67%), Electricity (7%), Natural Gas (19%), SWH (7%)** This data is used to estimate SWH substitutions in the residential market. Intermediate data is estimated through a trend.	STEG (2010)
SWH PRICES (USD/M²)	**USD 371 (2005); 382 (2006); 371 (2007); 374 (2008); 390 (2009); 422 (2010); 454 (2011).** Weighted average of price per square meter of SWHs in Tunisia based on market shares of 200 l and 300 l SWHs	Missaoui and Marrouki (2009a) MATTM (2009a) ANME (2012a)
CONVENTIONAL WATER HEATER PRICES (USD)	LPG and Natural Gas-fired WH (10 l): **USD 120** (TND 160) LPG and Natural Gas-fired WH (13 l): **USD 150** (TND 200) Electric WH (200 l): **USD 166** (TND 220) Electric WH (300 l): **USD 234** (TND 300)	ANME (2010a)
	SWH TECHNICAL DATA	
EXPECTED LIFE-CYCLE	15 years	ANME (2010a), TÜV SÜD (2011)
USAGE RATE (RESIDENTIAL SECTOR)	99% Rate measured based on the average number of days spent outside home by Tunisian residents, as reported in UNFCCC (2011a). According to UNFCCC (2011a) this is a conservative value.	ANME (2010a)
AVERAGE ENERGY PRODUCTIVITY	**SWH 200 litres**: **1,148 kWh/year** **SWH 300 litres**: **2,506 kWh/year** Average annual energy output for SWHs estimated through the SOLO model developed by the Centre Scientifique et Technique du Bâtiment, assuming daily consumption matching tank capacity and average irradiation in Tunisia. SWH Models: SOFTEN (Giordano) simulations with model **C8/8 S.U, H.S.U C8/12 S.U, H.S.U**; and **C8/8 S HI C8/8 H.S HI, C8/12 S HI C8/12 H.S HI**. Insulation type Polyurethane (3 cm thickness). SOFTEN is the largest distributor of SWHs in Tunisia. Storage tank outside: 200 liters (300 liters) Location: we used a city located in the mid-Tunisia Sfax as a representative of the average insulation Consumption: 200 l/day (300 l/day for 300 l SWH) Collector: with 45° slant and orientation towards south. Coefficients: β = 0.75; k = 4	Centre Scientifique et Technique du Bâtiment (2012).

Input	Description	Source
SYSTEM DEFAULT RISK "NO ACTION" SCENARIO	The theoretical cumulated default probability risk of a SWH, due to the absence of maintenance, tends to grow exponentially with time from 11% at its second year of operation – being the first covered by full guarantee – to 81% at its 15th year, the end of its expected life-time.	CPI elaboration based on Mirrouki and Missaoui and Marrouki (2009b)
MAINTENANCE COSTS	**SWH 200 l** = **USD 30/year** (TND 40) **SWH 300 l** = **USD 45/year** (TND 60)	Missaoui and Marrouki (2009b)
CONVENTIONAL WATER HEATERS TECHNICAL DATA		
LPG: AVERAGE WEIGHT OF BOTTLES	Residential sector: **13 kg** Hotel sector: **25 kg**	STEG (2010), ANME (2011a), other sources.
AVERAGE EFFICIENCY PER ENERGY SOURCE	High-efficiency water heaters: **Electricity: 94%; LPG: 86% Natural Gas 86%** Conventional water heaters (low-medium efficiency): **Electricity: 88%; LPG: 55%; Natural Gas: 55%**	Ressource naturelles Canada (2005) ANME (2011a)
NET CALORIFIC VALUE	**LPG: 11,060 (kcal/kg); Natural Gas 9 (Th/Nm^3)**	ANME (2011a)
GHG EMISSIONS FACTORS (TCO_2/MWH)	LPG: 0.227, Electricity: 0.550, Natural Gas: 0.202	IPCC (2006). ANME (2011a)
MAINTENANCE COSTS	LPG WH: USD 38/year (TND 50) Natural Gas WH: USD 38/year (TND 50) Electric WH: USD 15/year (TND 20)	CPI's assumption based on communication with stakeholders'
ENERGY MARKET DATA		
LPG IMPORT PRICE AND VOLUME	Import price of butane from Algeria up to 2010. We used butane as a proxy for LPG contained in the 13 kg bottles used in the Tunisian residential sector. Price estimates for 2011-2025 are derived from annual growth rates of crude oil real prices grossed-up with annual forecasted inflation rates for Tunisia.	INS (2012) INS (2012) IEA (2011) IMF (2011)
ESTIMATED LPG AVERAGE SUPPLY COSTS AND VAT (USD/T)	Approximately USD/t **287** It refers to transport, distribution and marketing costs and VAT Due to the lack of data availability we estimated supply costs based on the average difference between observed reference prices and butane import prices from Algeria during the period 2005-2010.	Calculation based on various sources, including local news websites, APIE reports, INS (2012a), INS (2012b).
LPG END-USER PRICES	Residential sector: figures on LPG end-use prices in the residential sector are sourced from the National Statistics office for the years up to 2009, from governmental communications for the years 2010-2011. Prices refer to 13 kg bottles. Price estimates for 2011-2025 are derived from a linear growth trend. This reflects the trend observed in annual average end-user LPG prices since Prosol inception. Tertiary sector: figures on LPG end-use prices for the tertiary sector are sourced from governmental communications up to 2011. Prices refer to 25 kg bottles. All prices include VAT.	INS (2010); Various sources, including local news websites, APIE reports

Input	Description	Source
ELECTRICITY PRICES	Prices for the residential sector refer to the 12 months average of all tranches (low and normal) for low tension electricity rates. Prices for the tertiary sector refer to the same tranches excluding rates reserved to the residential sector only. Price estimates for 2011-2025 are derived from a linear growth trend. All prices are grossed-up with VAT.	APIE reports
NATURAL GAS PRICES	Prices for the residential sector refer to the 12 months average of low pressure natural gas rates for tranche 1. Prices for the tertiary sector refer to the 12 months average for tranche 2. Price estimates for 2011-2025 are derived from a linear growth trend. All prices are grossed-up with VAT.	APIE reports
FINANCIAL DATA		
DISCOUNT RATE FOR HOUSEHOLDS AND TUNISIAN GOVERNMENT	Tunisian Government Bonds with maturities of 4 and 6 years: **5.44%** Given the 5 years loan commitment, for households the most suitable discount rate is represented by the average interest rate of Tunisian treasury bonds with analogous maturity, considering these as a low-risk investment alternative to the SWH. The same discount rate is used to indicate inter-temporal preferences for the Tunisian Government as the commitment of public resources extends on a similar time-frame.	Central Bank of Tunisia (2012)
DISCOUNT RATE FOR THE TERTIARY SECTOR	The discount rate is derived from a simplified CAPM applied to the overall Tunisian equity market. Cost of equity = (risk free rate) + (market risk premium): **11.86%** = 4.75% + 7.11% The risk free rate is calculated as the average TMM rate for the period 2005-2011. The market risk premium for Tunisia is estimated based on the model developed by Professor Damodaran (New York University), linking equity market risk premia to government bond ratings and country default spread.	Central Bank of Tunisia (2012), Damodaran (2012)
INFLATION RATES	2005-2010 average compounded inflation rate (end-of-period consumer prices): **3.68%** 2011-2025 average compounded inflation rate (end-of-period consumer prices): **3.08%**	IMF (2011)
BANKING DATA		
PRE-PROSOL DEBT INTEREST RATE	Consumer loan interest rate: **13%**	Touhami (2011)
DEFAULT RATES	Estimated from the average level of NPL over total loans in banks' balance sheets: **15%**	Central Bank of Tunisia (2006-2011)
BANKS COST OF RESOURCES	2005-2010 average bank funding rate: **3.5%**	Central Bank of Tunisia (2006-2011)

Appendix B - Prosol Residential Risks Management

Risk assessment

1. SWHs failure risks and associated impacts on the profitability of the "green" investment

Table 1 presents the results of a sensitivity test we run on the SWH's payback and on the amount of energy bills saved by households starting from an 'ideal' 0% rate (however, very closed to the realized one in the Program) to an arbitrary fixed annual default rate of 3% per annum, and a variable one, exponentially growing over time, estimated from a 'no-maintenance' scenario (Missaoui and Marrouki, 2009b).[77]

Table 1. Impact of default rates on SWHs profitability

	SWH FAILURE RATES		
	Base Case (no default risk)	3% p.a.	No Maintenance
PAYBACK	10	11.5	20
ENERGY BILL SAVINGS	100%	82%	68%

Source: CPI elaboration based on various sources (see Reference section).

2. Debt-default and associated benefits risks

The impact associated to debt-default risk was estimated by applying different rates of default to a Prosol loan's cash flow stream, starting from the 1% rate realized in the Program to an estimated average market rate of 15%, deducted from the non-performing loans share of bank's portfolios. As per business practice, a recovery rate of 0%[78] was also assumed. Table 2 highlights the impacts resulting on banks' IRR and their expected cash flows recovery.[79]

Table 2. Impact of debt defaults on banks' returns

	LOAN DEFAULT RATES		
	Base Case (Prosol II)	5%	15%
IRR	5.8%	3.1%	-4.1%
LOAN REPAYMENTS + INTEREST RATES	100%	92.6%	76.5%

Source: CPI elaboration based on various sources (see Reference section).

3. Program failure and associated benefits risks

To test the potential impact of different SWH uptake on the Tunisian Government expected returns we stressed the number of actual installations by a factor of +/-10 and +/-20%.

Table 3. Impact of different installation rates on Prosol's returns.

	TOTAL DEPLOYMENT				
	Δ -20%	Δ -10%	Base Case	Δ +20%	Δ +20%
LPG SUBSIDIES SAVINGS (USD MLN)	-24	-12	101	10	23
GHG EMISSIONS (KTCO2)	-165	-82	715	82	165
ENERGY SAVINGS (KTOE)	-58	-29	251	29	57

Source: CPI elaboration based on various sources (see Reference section).

77 The Table reflects payback changes occurring when SWH are supported by the measure introduced under Prosol I..

78 Consumer loans are generally without collateral, hence banks' recovery rate are typically negligible.

79 Estimated at current Prosol interest rates (6%) and cost of capital (3.1% at bank funding rates).

Table 4. Risk matrix - Prosol I (2005-2006).

Phase	Risk	MATTM	UNEP	GoT	ANME	STEG	Technology Suppliers	2 Commercial Banks	Households	Treatment/Mitigation Measures
DEVELOPMENT	**Program design and planning risk** • Risk of planning faults causing drawbacks and/or impacts on stakeholders • Capacity building related risks: missing target scale and measures efficacy	Program design and promotion		Program design and financing						• Lessons from previous programs • UNEP expertise in similar programs
	Procurement and Equipment • SWH inadequate technology • Inexperienced installers				Certification of SWH and suppliers quality		ANME's standards compliance		Technological failure and missing expected energy delivery	• Certifications of SWH models, and suppliers and quality requirements • Training activities
	Construction and O&M costs • Failure of individual SWH installed					Loans recovery system	5-yr warranty		Technological failure risk at guartee expiry	• Proven technology • Long lifetime expectancy (15 yrs) • Monitoring and maintenance
OPERATIONS	**Capex** • Failure in securing the capital	Effective		Finance 20% of total cost and manages resources				Finance 70% of total cost		• ANME-MATTM provide 20% capital cost subsidies complemented by MATTM/UNEP • Capital sourcing shared by 2 banks
	Interest Rate Risk • Impacts from interest rate floatations	allocation of resources						5-yr fixed interest rate loans		• Fixed interests reset every year to Tunisian Money Market rates plus spread
	Credit Default risk • Failure in meeting loan commitments						Credit Guarantee	Residual to two other risk bearers	Loss of electricity service	• Consider alternative credit guarantor • Debt interest offset by energy savings • Low-cost and enforceable credit collection system
OUTCOME	**Energy and Environmental Policy Targets** • Missing energy and mitigation targets	Responsibility for creating local value chain		Responsibility for meeting set targets						• Mature and reliable technology • Proven results in the country and elsewhere • Awareness campaigns to promote uptake
	Socio-economic & Industrial Policy Targets • Missing socio-economic and industrial targets	Responsibility for meeting stated objectives		Responsibility for creating local value chain						• Accreditation requirements and incentive measures aimed to favor local industry growth

Relative amount of risk taken on by stakeholders: Low — High

Source: CPI elaboration based on various sources (see Reference section).

Table 5. Risk matrix - Prosol II (2007-2010).

	Risk	MATTM	UNEP	GoT	ANME	STEG	Technology Suppliers	Attijari Bank	Households	Orbeo	Treatment/Mitigation Measures
DEVELOPMENT	**Program design and planning risk** • Risk of planning faults causing drawbacks and/or impacts on stakeholders • Capacity building related risks: missing target scale and measures efficacy			Program design and financing							• Lessons from previous programs • Learning from Prosol I
	Procurement and Equipment • SWH inadequate technology • Inexperienced installers				Certification of SWH and suppliers quality		ANME's standards compliance		Technological failure and missing expected energy delivery		• Certifications of SWH models, and suppliers and quality requirements • Training activities
	Construction and O&M costs • Failure of individual SWH installed					Loans recovery system	5-yr warranty		Technological failure risk at guarantee expiry		• Proven technology • Long lifetime expectancy (15 yrs) • Monitoring and maintenance
OPERATIONS	**Capex** • Failure in securing the capital			Finance 20% of total cost and manages resources				Finance 70% of total cost			• ANME-MATTM provide 20% capital cost subsidies complemented by MATTM/UNEP • Capital sourcing shared by 2 banks
	Interest Rate Risk • Impacts from interest rate floatations							5-yr fixed interest rate loans			• Fixed interests reset every year to Tunisian Money Market rates plus spread
	Credit Default risk • Failure in meeting loan commitments					Credit Guarantee		Residual to two other risk bearers	Loss of electricity service		• Consider alternative credit guarantor • Debt interest offset by energy savings • Low-cost and enforceable credit collection system
	Carbon Finance • Failure and delays in obtaining CERs and CERs pricing risk			CERs Delivery*						CERs Pricing Risk*	• PDD consultancy by EcoSecurities • ERPA arrangements with Orbeo • Technical support by GIZ
OUTCOME	**Energy and Environmental Policy Targets** • Missing energy and mitigation targets			Responsibility for meeting set targets							• Mature and reliable technology • Proven results in the country and elsewhere • Awareness campaigns to promote uptake
	Socio-economic & Industrial Policy Targets • Missing socio-economic and industrial targets			Responsibility for creating local value chain							• Accreditation requirements and incentive measures aimed to favor local industry growth

Relative amount of risk taken on by stakeholders: Low → High

Source: CPI elaboration based on various sources (see Reference section).

*CER-related risks, which are supposedly managed through an ERPA with the CER buyer, ORBEO. Confidentiality issues prevent us from properly characterizing and allocating such risks.

Appendix C - Other SWH Incentive Programs

Table 6. Examples of SWH support Programs in the MENA and Balkan Region.

Country	Mechanism	Time frame	Target audience and objectives	Financial Support Measures	Demand-side finance actors	Accompanying Measures	Financing Entity	Investment (USD mln)	Achievements
MOROCCO	PROMASOL	I 2002-2008 II 2012-	1. Institutional customers 2. Industry and private businesses 3. Residential obj. 100,000 m²	1. Agreements 2. Leasing 3. Currently under discussion within PROMASOL II (2012-onwards) **Solar Industry Accompaniment** (SIA): to covers 20% of all expenses related to the purchase and installation of the SWH **Commercial Partnership Insurance**' (CPI): to insure up to to 80% of the commercial risks incurred by the parties e.g. late payment or non-payment	• Leasing companies • FOGEER Guarantee Fund: to guarantee up to 70% of the credit granted and a bonus of 1.5% point	• Product quality certification • Installers quality certification • Awareness raising and capacity building • VAT Reduction, from 20% to 14%	Funded by: • FGEF • CDER - Center for Development of Renewable Energies • UNDP • GoM • Government of Andalusia • ONE - National Electricity Office	43.3*	• SWH Deployment: +140,000 m² (obj. reached) • Value chain: + 25 manufacturing companies • CO_2 avoided: 1.3 million tons (2002-2008)
	PROSOL Loan and Leasing Facility	2005-2008	Tertiary: Hotels -> obj.: 80	• Temporary **interest rate subsidy**	• Local Commercial Banks • ONE collecting agent and guarantor de facto	• Product quality certification performance guarantee • CDM	• MATTM • UNEP • ONE - National Office of Electricity	1.2	17 hotels
EGYPT	Egysol Leasing and Loan Guarantee Mechanism	March 2010-	Tertiary: Hotels (mainly) -> obj. 100	• **Capital cost subsidy**: 25% up to 250 m² • **Maintenance cost subsidy**: USD 4/m2/year for the first 2 years of operation and USD 3/m2/year for the remaining two • **Leasing meachanism**: Traget: hotels in operation and with no credit problems The facility will provide a subsidy of 15%, to reducee the total down payment (to 20%) • **Loan Guarantee Mechanism** Target: hotels with facilities under contraction and/or with financing problems Hotels can get a loan guarantee as well as partial interest rate subsidy (6% vs. 13%) for the cost of the SWH. The loan contracts would have a term of 5 years and the down payment will be negotiable.	• Local Commercial Banks	• Awareness raising and communication campaing • Capacity building • Accreditation and quality control standards for SWH suppliers (50% of certification costs borne by UNEP)	• MATTM • UNEP • NREA - New and Renewable Energy Authority of Egypt	0.5	12 hotels or 2000 m² of solar collectors
MONTENEGRO	Montesol	2011-	Residential: Households -> obj. 3,500 to 4,000 m²	• **Interest rate subsidy** Concessional line of credit to be paid out to the bank in monthly interest-free annuities over 3, 5 or 7 years duration	• 2 Local banks: NL Bank and HypoAlpeAdria Bank	• Awareness raising and communication campaigns • Capacity building • Accreditation of suppliers • Warranty period of at least 5 year • CDM	• MATTM • UNEP • GoMo - Ministry of the Economy of Montenegro	1	several households (?)
MACEDONIA	MACESOL Still in assessment phase	2011-	na	Under development in partnership with local stakeholders	na	• Awareness raising and communication campaigns • Capacity building	• MATTM • UNEP • GoMa	na	na

Source: CPI elaboration based on various sources (see Reference section).