RENONBILL

OVERVIEW OF ON-BILL BUILDINGS ENERGY RENOVATION SCHEMES

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1 EXECUTIVE SUMMARY

The objective of the Horizon 2020 RenOnBill project is to scale up investments towards deep energy renovations of residential buildings, by promoting the development and implementation of on-bill schemes, based on the cooperation between energy utilities and financial institutions.

On-bill schemes are a method of financing energy renovation investments in buildings that draws on utility bills as repayment vehicle.

This document aims at introducing on-bill schemes as a powerful tool for financing energy efficiency in the residential sector, setting the initial background for the development of the work foreseen in the rest of the RenOnBill project.

In Chapter 2, the fundamentals of on-bill schemes, as well as those of other relevant energy financing mechanisms, are reviewed and analysed, demonstrating the suitability of on-bill schemes for large scale replication of small investments in residential buildings. The main issues related to energy efficiency financing mechanisms, with particular emphasis on on-bill schemes, are discussed and compared in order to highlight the corresponding positive and negative aspects. **The conclusion is that, in general, on-bill schemes and PACE are the most suitable mechanisms for the implementation of large-scale programs**.

In Chapter 3, we present a detailed overview of several on-bill schemes that successfully supported energy renovations in the North American residential building sector, as well other relevant on-bill initiatives carried out in Europe and in developing countries. **The analysis demonstrates that these mechanisms are rather flexible and they can be implemented for a multitude of purposes ranging from enhancing electricity system adequacy to ensuring customers retention.**

Finally, Chapter 4 provides for a comparative analysis of all the on-bill schemes discussed in the document and outlines the **key issues** that need **to be addressed in order to ensure the replicability and scaling up of these schemes in Europe**. The analysis highlights **customers' very low default rates in paying utility bills repaying the investments**. This issue is **crucial for the replication of on-bill schemes in Europe**, since it is fundamental to assess if this is a peculiarity of North American markets or can be transposed in other contexts.

2 FINANCING ENERGY EFFICIENCY

2.1 Introduction

In the European Union (EU), **buildings are responsible for about 40% of energy consumption and 36% of carbon emissions**. As highlighted by the European Commission (EC), a large majority of the building stock, approximately 75%, is energy inefficient and the yearly renovation rate is limited to 0.4% - 1.2% depending on the EU country [1].

This situation highlights a relevant potential to implement energy efficiency measures which can lead to a relevant decrease in energy consumption and carbon emissions in the building sector.

The implementation of energy efficiency measures also brings environmental, social and economic benefits. Environmental benefits are attributable to the reduction of carbon and pollutant emissions deriving from lower energy consumption. Social benefits are determined by the higher comfort that energy efficient buildings can provide to the occupants. Economic advantages result from the investments that the implementation of energy efficiency measures may generate with the corresponding increase of direct and indirect workplaces.

In order to successfully exploit the energy efficiency potential of the building sector, different actions can be implemented to stimulate investments. When it comes to residential buildings, the main barrier that hinders investments in energy efficiency is represented by the **high initial investment costs**, even though, in many cases, the investment can be profitable. This has prevented the implementation of substantial interventions in the residential sector.

To counteract this, governments at central or local level, can promote specific supporting policies (e.g. direct contributions, fiscal incentives, etc.) for energy efficiency investments, but this implies the mobilisation of public resources, which can cover only a limited amount of the total investments.

In light of this, to obtain substantial results, it seems necessary to **involve the private sector in the financing of energy efficiency interventions**. In this context, it would appear "natural" to involve financial institutions, as they are main actors of the capital market. However, they encountered numerous problems in entering the energy efficiency market [2]. Specifically, a relevant issue is represented by the unfamiliarity of financers with energy efficiency investments. Financial institutions experience different issues in approaching the energy efficiency market; the most relevant are:

- Small size and fragmentation of the investments in comparison to other projects;
- Lack of project standardisation;
- Difficulties in evaluating the projects which results in the assignment of a higher risk profile to energy efficiency investments.

2.2 On-Bill Schemes

A scheme which is successfully implemented in the USA is represented by "on-bill energy efficiency", which is a method of financing energy efficiency improvements that uses the utility bill as the repayment vehicle [3]. This method has been in place in the USA for more than 30 years by financing over USD 2 bill, of which 60% went to residential buildings. On-bill schemes help to solve some of the common issues encountered in developing energy efficiency projects in residential buildings, namely:

- High upfront investment costs;
- Increase of the debt level for families;
- Relationship with financial institutions for loans or other forms of financing;
- Possible solution of the owner-tenant dilemma.

On-bill programmes can have very different structures, which can be categorised under different dimensions [3]. This means that there is not a common definition of on-bill schemes and, often, on-bill financing is considered to be an umbrella term, even though it refers to a specific type of on-bill mechanism. In the following sections some specific definitions are introduced.

A general classification of on-bill schemes can be determined according to three criteria: source of financing, association with property's meter and underwriting methodologies.

2.2.1 Source of financing

Taking into account the source of financing, two main variants of on-bill mechanisms exist.

On-bill financing (OBF)

In this programme **the utility is the investor**, hence the **capital for upfront costs is provided by the utility**, which finances the energy efficiency interventions with own funds (e.g. utility shareholder capital, money from bill-payers, etc.), or targeted public funds. Usually in these programmes, specific energy efficiency interventions are allowed after an energy saving assessment is developed by the utility itself. The end user repays the cost associated with the renovation through the utility bill in a number of years according to the programme rules.

On-bill repayment (OBR)

In these programmes **the lender is a private third party and the utility acts as repayment intermediary**, meaning that the capital is provided by a third party, but utility bills are used to remit loan repayments by building occupants. OBR can be divided in three different sub-mechanisms [4], as shown in Figures 1 and 2:

- **The programme administrator acts as a warehousing entity**. The programme administrator (PA), e.g. the utility, initially uses the utility's own funds to finance the specific interventions. In a second phase these credits are aggregated and sold to financial institutions under specific agreements. Financial institutions can sell these utility credits (or clients' debts) on the financial markets by developing specific products or by adding them to existing investments instruments. This scheme allows financing OBR programmes to enter financial markets. Finally, the OBR repayments

are collected by the utilities and transferred to the investors. A general model of how the scheme works is presented in Figure 1(a).

- **The programme administrator raises private capital upfront**. In these mechanisms the PA, e.g. the utility, immediately involves the financial market, without using own funds. The PA bundles the final users' request for OBR schemes, e.g. by issuing a bond, and investors provide the capital to implement the measures by buying the bonds. Then, OBR repayments are collected by the utilities and given back to the investors. The utility plays the role of a demand aggregator and of an intermediary between final users and financial institutions, see Fig. 1(b).

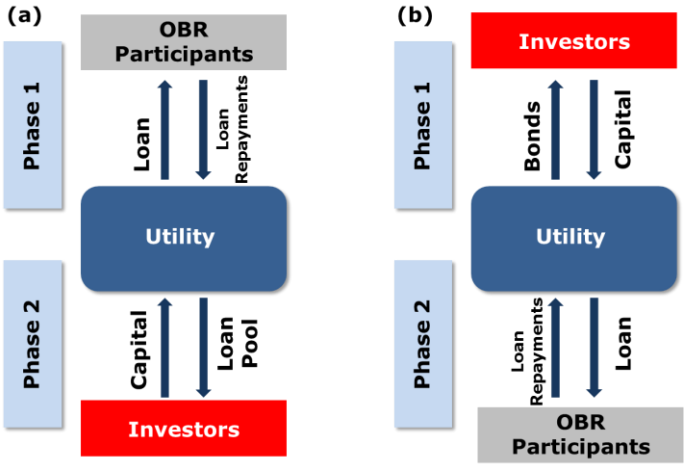

Figure 2.1 – Model of on-bill repayments (OBR) schemes where a utility is the programme administrator: (a) programme administrator acts as warehousing entity; (b) programme administrator raises private capital upfront

- **Open market**. In this model, financial institutions directly interact with the final clients and use utility bills as a system for repayments of individual loans. This mechanism, shown in Figure 2, requires the existence of an additional agent to coordinate the process (e.g. a Master Servicer).

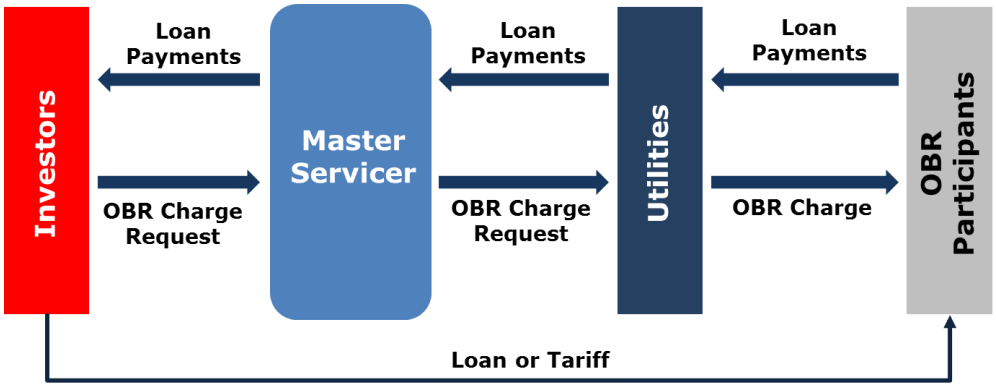

Figure 2.2 - Model of an OBR scheme with Open Market approach

2.2.2 Meter attachment and user disconnection

Additional consideration to be taken into account include whether the scheme is associated with the property's meter and whether in case of no payments the utility service can be disconnected. From this, three types of schemes applicable to both OBF and OBR, can be identified as shown in Table 1.

Scheme	Meter attached	Disconnection allowed	Description
Tariffed on bill	Yes	Yes	In this scheme, **energy efficiency measures** are **paid by the utility** and the **final user pays an additional tariff on-bill** for this service. The **tariff** is **associated with the meter** at the address where upgrades have been implemented, rather than with the specific end-user. This way, the on-bill scheme can be easily transferred to another user if the dwelling is sold or there is a change in tenants. This charge is treated as any other utility charge and the disconnection in case of non- payment is possible.
On-bill loan	No	Yes	In this model, the **loans** are **treated as debt of the end-user**. A broad range of financial products (e.g. unsecured loans, leases) may be re-paid on the end-user's bill and the **disconnection right** of the utility acts **as a motivation for the end-user to repay the loan**. In case of default, utilities act according to their usual collection protocols for bill delinquency.
Line item billing	No	No	The **utility bill** is **simply used as a tool for participating consumers to make payments**. In the event that a participant fails to make principal and interest payments, financing charges are typically written off or removed from the utility bill. Then financial institutions or the utility are free to recoup the losses on the basis of their contract with the end-user.

Table 2.1 - Schemes for the association to the meter and disconnection for payment default

On the basis of stakeholder interviews performed during the initial research of RenOnBill, it became apparent that the *"meter attached"* option versus the traditional *"tied to user"* option can present positive and negative aspects. Subject to feasibility, the **meter attachment can offer a form of collateralisation and a certain degree of flexibility**, since the payment can be transferred among the property owners or tenants. Specifically, for rental properties, the perceived risk level for investors may be lower in "tied to meter" settings, if the owner was to step in in case of payment default by the tenant.

However, **the meter attachment only works in contexts where vacancy is unlikely and could entail a lower default risk**. Furthermore, *"meter attached"* schemes may give

financial institutions or utilities a say in the choice of the next occupant – probably undesirable for homeowners but also for financial agents (e.g. due to high administrative costs for new contract set up, check of the new occupant's creditworthiness, etc.).

The *"tied to user"* structure is more familiar and standardised: the contract and the risk is linked to a specific person (i.e. user), similar to a bank's credit lending system, which is also conceptualised with reference to a natural person. On the other hand, **this solution has lower degrees of flexibility and may be hindered by the owner-tenant dilemma**[1].

2.2.3 Further categorisation aspects

Further categorisation can be made based on the underwriting and risk assessment approaches used and the type of eligible energy renovation measures that can be chosen [4].

Underwriting represents the process that financial institutions implement in order to assess the solidity of the counterparty or the suitability of a property to be granted a financial product. Different approaches can be used in this phase and they have a direct impact on the on-bill programme transactions costs and approval and default rates. Four kinds of underwriting methodologies can be identified [4]:

- **Traditional underwriting standard:** traditional metrics, such as credit score and debt to income ratio are used to evaluate the counterpart.
- **Expanded underwriting standard: t**raditional metrics are employed, but the acceptability limits might be relaxed according to specific criteria set by the programme administrator, for example to enlarge the number of target customers.
- **Alternative underwriting standard:** metrics different from the traditional ones are taken into account, such as the historical rate of default in paying bills. This approach helps to reduce the transaction costs and to increase the number of target customers.
- **Hybrid underwriting standard:** this approach is represented by a mix of traditional and alternative metrics employed to evaluate the access to on-bill programmes of the target customers.

In terms of eligible renovation measures, on-bill programmes can be grouped in two categories: single measure and comprehensive retrofit. In the first case, only single specific measures are eligible, whereas the second option allows for the implementation of more sophisticated retrofits. In some cases, measures other than energy efficiency, e.g. improvement in health and safety of dwellings, might be offered to increase the impact of the programme.

2.2.4 The Golden Rule: bill neutrality

In principle, **on-bill programmes can be structured to ensure "bill neutrality"**, also known as the "Golden Rule" [5], **which means that the projected energy savings offset the fixed**

[1] The owner/tenant dilemma occurs when a landlord and a tenant have difficulties in agreeing upon a common strategy for energy-efficiency improvement of a property.

monthly loan or tariff instalment. In this way, **the final user does not pay higher bills than before the interventions** and, once the pay-back period of the utility is reached, the final user will experience real on-bill financial savings. Usually, the mechanism is linked to the installed meter; therefore, it can be transferred in case the tenant or owner changes.

On the other hand, bill neutrality determines an increase of the pay-back period for the utilities which may prevent important renovation measures by limiting the loan amount and, with that, the potential of energy efficiency interventions. Most of the programmes are not based on the bill neutrality concept [4].

According to stakeholder interviews, offering bill neutrality may pose risks, since it is difficult to have a clear view of energy prices in the long term and because energy savings may be difficult to estimate due to user behaviour uncertainties (e.g. rebound effects). Furthermore, in a scenario of low energy prices, achieving bill neutrality may be difficult.

2.3 Design of On-Bill Schemes

On-bill programmes may result attractive for financial institutions willing to invest in energy efficiency, since the counterparty and/or the intermediary is represented by a utility, which can **bundle a significant number of energy efficiency investments**. In such a way, the relationship for financial institutions is of "B2B" nature, without the issue to manage many counterparties, which are managed by the utilities in the framework of their usual core business. On the other hand, final users, depending on the structure of the on-bill programme, can pay for the service without acquiring debt, which may influence their access to credit for other needs [5]. Figure 2.3 provides an overview of the main issues to take into account for the definition of an on-bill scheme.

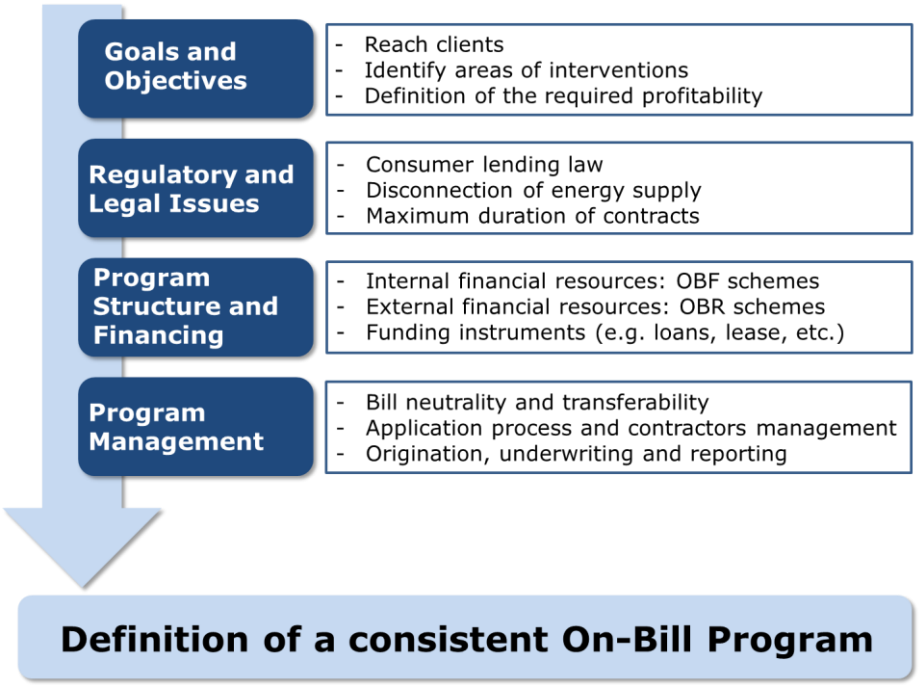

Figure 2.3 - Key-points for designing an "on-bill" programme

It can be said that properly designed on-bill programmes have the potential to attract investments in highly energy efficient technologies in the residential sector, but, at the same time, **these mechanisms challenge the traditional core business of utilities** [5]; the commercialisation of energy. However, it is to be noticed that in the last years many changes occurred in the energy sector and the business models of energy utilities are undergoing radical changes [6]; therefore, the implementation of innovative market-based mechanisms to support the implementation of energy efficiency interventions may also be seen as an opportunity for innovative energy utilities.

Furthermore, the implementation of energy efficiency actions is an irreversible trend in place all over the world. Therefore, from a strategic point of view, it is more convenient for the utilities to lead this energy efficiency transition in order to try to extract some value from it, rather than to undergo this transformation passively.

2.3.1 On-bill financing vs. on-bill repayment

On-bill financing (OBF) and on-bill repayment (OBR) present different features which, depending on specific contexts, may result convenient for the utilities and other parties involved in the on-bill scheme design offer.

At first glance, OBF mechanisms are the optimal scheme for energy utilities, as this was also confirmed by stakeholder interviews developed during the initial research phase of the RenOnBill project. In particular, **OBF allows to extract the maximum value from the projects, since, generally, no financial intermediaries are present, and the value chain is shorter**.

On the contrary, this solution may be complicated to implement, especially for small-medium sized utilities, with limited own resources. In such cases, only niche programmes can be proposed, namely those targeting a well selected segment of the customer basis. Moreover, partnering with a bank could offer options for risk-sharing.

Large utilities can more easily promote significant OBF programmes, both in size and in scope, but they need to carefully evaluate the trade-offs of investing own resources in such programmes (e.g. opportunity costs, need for additional expertise and employees, etc.). Furthermore, the default risk of the clients is completely taken by the utility, even though utilities already deal with large default risks in their energy supply service.

Because of this, partnering with a financial institution could be considered, as in that case utilities would be able to use their resources for other purposes, small utilities could launch more extensive programmes and the default risk could be at least shared with financial institutions participating in the programme.

Finally, it is important to mention that OBF programmes may be in conflict with national loan regulations, which is usually an exclusive service of financial institutions. Therefore, it is possible that utilities must have to register or create companies registered as financial institutions if they want to launch OBF programmes. For this purpose, a cooperation with a bank could be considered. Furthermore, engaging in commercial lending activities may entail complying with financial liquidity regulations (e.g. blocking a sum of equity capital).

Depending on how an OBR programme is structured, other relevant disadvantages for utilities can exist. For example, if financial institutions directly finance the utility and not the final users, **the debtor position of the utility can worsen substantially**, depending on the dimension of the programme.

Mixed models between OBF and OBR could also be an option, since they may smooth the concerns connected with these two models. Against that background, a mixture of third-party capital, own capital and public subsidies could be considered.

2.4 Other Energy Efficiency Financing Schemes

Energy efficiency projects may be supported with instruments other than on-bill schemes and in the following four examples are analysed; **Energy Performance Contracts** (EPC), **Energy Service Agreements** (ESA), **Managed Energy Service Agreements** (MESA) and **Property Assessed Clean Energy** (PACE).

EPC, ESA and MESA are usually implemented with the support of an ESCO or another project developer (e.g. engineering company, construction company, financial institution, etc.), whereas PACE is developed in cooperation with local public administrations.

Model	Source of financing	Provider	Technical risk	Financial risk	Default risk
OBF	Utility equity/ targeted public funds	Utility	Final user	Utility	Utility
OBR	Financial institutions	Utility	Final user	Financial institutions	Utility/ financial institutions
EPC	Loan/ owner's equity	ESCO	ESCO	Final user	Financial institutions
ESA	Financial institutions	Developer (e.g. ESCO or others)	ESCO	SPV	Financial institutions
MESA	Financial institutions	Developer (e.g. ESCO or others)	ESCO	SPV	Financial institutions
PACE	Financial institutions	Public administration	Building owner	Public administration	Financial institutions

Table 2.2 - Main features of the analysed energy efficiency financing mechanisms

These schemes can be considered alternatives to on-bill schemes, but they **are more tailored for single larger real estate assets** and their **application on massive scale may result complicated**. Only PACE is suitable for application on large scale being an "on-tax" mechanism, but it could result financially unsustainable for public administrations, which needs relevant resources to manage the programme.

Table 2.3 outlines pros and cons of the reviewed energy financing schemes, in order to furnish a complete overview before providing a detailed description of these mechanisms.

The analysis of the financing schemes highlights that, in contrast to on-bill schemes, **only PACE is suitable for supporting energy efficiency investments in the residential sector**. EPC, ESA and MESA are more related to large properties due to their complexity and volume of investments required to justify the high transaction costs.

Model	Pros	Cons
OBF	• Implementation of a large number of interventions • Possibility to finance a large range of interventions, e.g. from lamps substitution to envelope insulation • Utilities as unique interface with final users	• Possible impact on the utility debt position • Necessary to implement substantial organisational procedures for the management of the programme
OBR	• Massive involvement of financial institutions in the energy efficiency market with substantial mobilisation of private capital • Implementation of a large number and range of interventions (i.e. like in OBF)	• Longer value chain and lower margin for utilities with respect to OBF • Possibility to have multiple interfaces with final users • Collateralisation as a relevant issue for financial institutions (e.g. financial vs. industrial approach)
EPC	• All the process managed/ supervised by one entity, usually an ESCO • Possibility to complement it with financial instruments such as energy efficiency insurance • Suitable to mobilise private capital from financial institutions in the energy efficiency market	• Instrument only limited to large investments in large properties (e.g. commercial buildings, hospitals, etc.) • Possibility to have complex contractual arrangements depending on the size of the investment
ESA	• Project revenues directly linked to the energy savings • Very high commitment from ESCOs in guaranteeing energy savings • Attraction of private capital in the energy efficiency market	• Applicability limited to large properties • Complex organisational structure and corresponding higher transaction costs • Relationship with more entities (e.g. ESCO and utilities) for final users
MESA	• Turn-key agreement for energy services • All the process managed by only one entity • Win-win agreement for the client, since, in the worst case, energy bills remain unchanged	• Applicability limited to large properties • High transaction costs justified only by large investments • ESCO not in involved in the negotiations with energy suppliers
PACE	• Linked to the property rather than to a person • Possibility to target a large range of properties (e.g. residential and commercial) • Effective instrument to support the implementation of local energy plans	• Relevant resources to invest from municipalities • Possible necessity to develop complex financial products to finance PACE programmes • Possible difficulties for the implementation in small municipalities • Owner-tenant dilemma not addressed

Table 2.3 - Comparative analysis of the analysed energy efficiency financing mechanisms

On-bill schemes do not necessarily include the intervention of public funds or the public sector, whereas PACE is completely based on public interventions and therefore not based on market principles.

An application of EPC to the residential sector is under development in Latvia through the Sunshine project discussed in the following sections. However, it is a very specific case due to the characteristics of the building stock (i.e. very large post-Soviet buildings) and property management criteria.

The only large-scale application of EPC, ESA and MESA could be foreseen in the social housing sector, where, usually, there is a company managing a significant amount of buildings; therefore, there is a critical mass of resources to mobilise.

2.4.1 Energy Performance Contracts

An Energy Performance Contract (EPC), also referred to as an Energy Performance Service Contract (ESPC), **is a contractual framework between the beneficiary and the provider of an energy efficiency service**. Usually the provider is an Energy Service Company (ESCO), which implements, verifies and monitors the energy efficiency implementations, in order to certify the achieved level of energy efficiency [12]. Alternatively, the EPC providers can be represented by equipment vendors, facility management companies, construction companies, etc. [2].

Energy savings are stipulated in the EPC and guaranteed by the ESCO company, that, in case of failure, has to refund the beneficiary. The EPC can also be guaranteed through an energy efficiency insurance agreement, that is, the ESCO can protect its margin by subscribing to such an insurance. The insurance covers the ESCO in the case that promised energy savings are not achieved (Technical Risk Insurance) or the credit risk of the final customers by ensuring that repayments to the ESCOs are guaranteed in the case of customer default [20].

The financing for the investment can be provided directly by the ESCO or obtained through financial institutions, e.g. by means of a loan. However, in general, all the procedure is managed by the ESCO, which guarantees that energy savings are sufficient to pay back the debt within a certain amount of time. The guaranteed savings are the crucial element to induce the financial institutions to provide a loan for a given investment [21].

The main advantage of EPCs is that the performance risk is moved away from final users and mainly concentrated on ESCOs. Basically, final users only need to interact with the ESCO, which manages the entire project from the financing to the implementation and then monitors it in order to certify the savings.

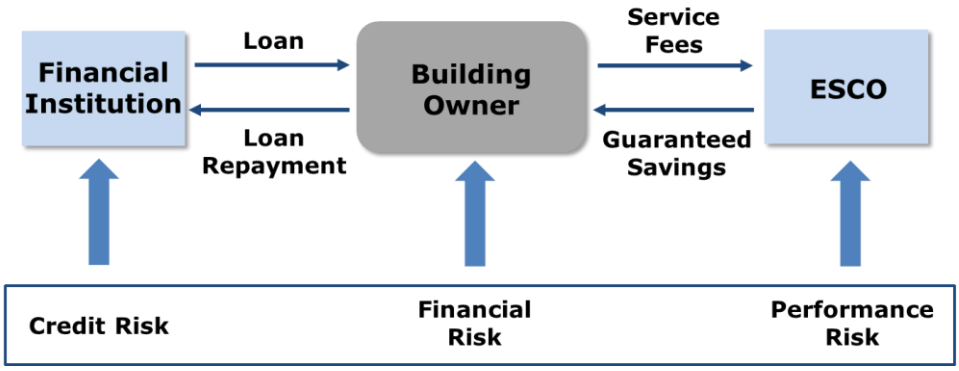

Figure 2.4 – EPC outline and corresponding risk shares

EPCs can be complemented with other instruments in order to secure the cash flow linked to energy savings. Innovative instruments are represented by energy saving (or efficiency) insurances[2] which can protect the EPC from risks associated with damages of the equipment or from under-performance of the project, i.e. the financial risk of not obtaining the necessary cash flow.

An example of EPC applied to the residential sector is represented by the Sunshine programme active in Latvia and analysed in section 2.2.2.

2.4.2 Energy Service Agreements

An Energy Service Agreement (ESA) is a specific framework where a developer **designs, finances and implements energy efficiency measures** in a facility; the client pays the developer, which is often an ESCO, through the achieved savings, or a fee based on the level of achieved savings. This kind of contractual arrangement builds on Purchase Power Agreements (PPAs), which are very common in the project financing of thermal and renewable power plants [22].

Usually, a Special Purpose Vehicle (SPV) is created to collect capital to finance ESAs and the ESCOs cooperate with the SPV, which evaluates and decides to finance the submitted projects.

The level of achieved savings is measured and monitored, possibly adjusted for variable climatic conditions and energy prices. **The ESA beneficiary pays the fee specified in the agreement to the ESCO and continues to pay the utility bills**. There is no commitment or interface between the ESCO and utilities providing the energy supply (e.g. electricity, natural gas, heat, etc.). Instead, the ESCO is committed to reimburse the financing received by the SPV.

Usually, these agreements last 10-15 years and after this period the client can benefit from all the energy savings while the ESCO has satisfied its profitability targets. The main risk is connected to the fact that if the intervention fails in achieving the estimated energy savings the savings share paid to the ESCO will not be sufficient to refund the SPV. On the other

[2] https://www.climatefinancelab.org/project/insurance-for-energy-savings/

hand, as discussed in the previous section, in principle it is possible to hedge this risk with an energy saving insurance, although currently, this product represents a niche market.

The main limitation to the ESA model is represented by the higher transaction costs due to the amount of third parties involved. Therefore, this framework is suitable only in presence of relevant investment volumes. This requires motivation of financial institutions and building owners. **Usually, ESAs are implemented to support the refurbishment of large commercial properties, as they guarantee a "substantial critical mass"**, which makes the establishment of the necessary service infrastructures convenient.

This model is generally not appropriate for small investments such as private residential buildings. On the contrary, another interesting field of application might be represented by social housing, which are often owned and managed by a central authority. Often, refurbishment of social housing assets is necessary**.** However, it is also difficult to obtain the corresponding financial resources. **ESAs schemes could be considered in such cases, as the volume of investment is relevant, and the refurbishment can be self-financed by means of savings on energy bills**.

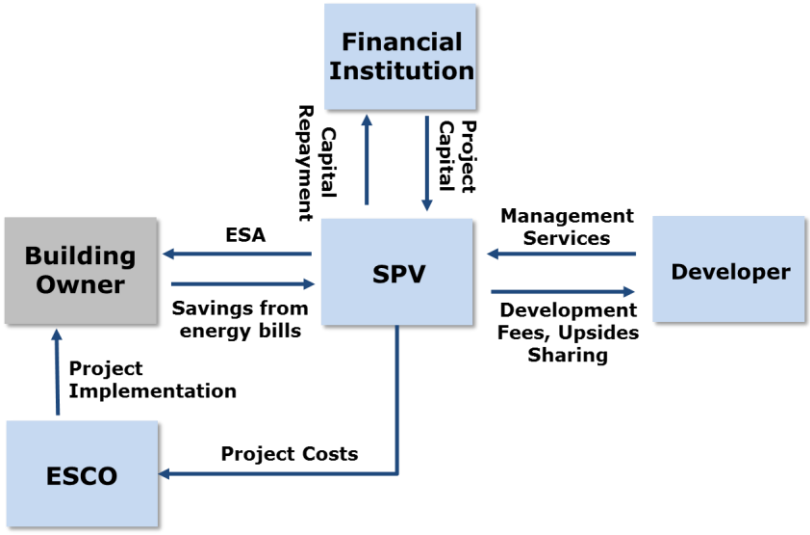

Figure 2.5 - General model of a possible ESA arrangement [12]

2.4.3 Managed Energy Service Agreements

In a **Managed Energy Service Agreement (MESA),** the developer offers **a full service and also pays the bill to the utilities.** The client buys an "all inclusive" service and pays to the developer, typically an ESCO, an amount equal to the historical level of energy consumption, adjusted for climatic conditions, building occupancy rate and escalation of energy prices.

The MESA developer is usually not involved in the procurement of energy supply, as it could incur in conflict of interest, since it has no interest in providing the supply with the most competitive prices. Therefore, the supply is negotiated and chosen by the clients and the developer pays the energy bills. The agreement has an established duration, as it is the case for ESA. At the end of this period the clients may exploit the savings and the ESCO has fulfilled its revenue requirements.

Such projects are quite attractive for managers of large properties, since they are only in contact with one developer, the ESCO, which manages all the aspects related to the project and assumes the performance risk.

For the client this is a good agreement as in the worst case they continue paying the previous cost level of bills, but if some savings are achieved, they have been obtained at no cost (or at a very low cost). Therefore, MESA can represent a "win-win" agreement.

MESAs, as is the case of ESAs, are contractual agreements which are usually implemented for large properties due to high transaction costs. On the other hand, some simplified schemes similar to MESAs could be defined with application to smaller investments.

Furthermore, as already pointed out for ESAs, MESAs might be an interesting instrument to support the modernisation of buildings belonging to social housing buildings, where the volume of investments are relevant, and they are usually managed by dedicated companies. Therefore, there would be a "B2B" relationship between the developer and the client.

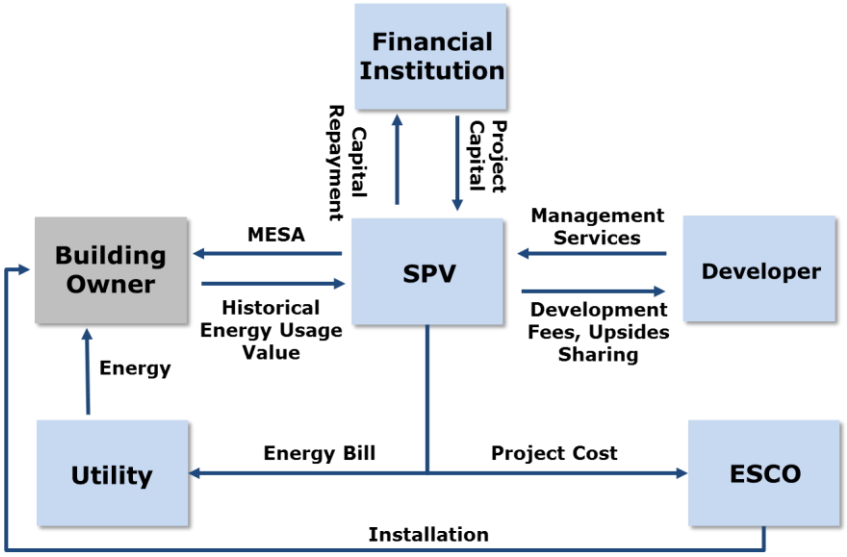

Figure 2.6 - Model of a possible MESA arrangement [12]

2.4.4 Property Assessed Clean Energy

The property assessed clean energy (PACE) is an innovative mechanism introduced in the USA to support the implementation of energy efficiency measures or renewable energy (RES) technologies. The mechanism is innovative since it is linked to the specific property rather than to a person. It is available for both commercial and residential properties. If the latter is the case it is referred to as "R-PACE" (Residential-PACE).

The PACE mechanism supports building owners in facing the up-front cost connected with the energy refurbishment or the installation of RES technologies. Usually, the high amount of necessary CAPEX represents the first barrier to the investment in energy efficiency technologies [23]. In the PACE framework, the investment costs are provided by local administrations and paid back by the owners through a dedicated tax linked to the

property for a period of 20 years. The resources to support the investment are raised by local administrations by issuing bonds to support investment in the field of clean energy [24]. This allows for the mobilisation of private capital to support clean investments.

Differently from a standard loan, PACE is linked to the property rather than to a private individual. Therefore, if the property is sold before the end of the repayment period, the new owner takes the commitment to pay the remaining special tax instalments [24]. This special feature and the long repayment period, if compared to other mechanisms, allows property owners to implement a deeper energy renovation of the building. The transferability is seen as a high level of flexibility for building owners, as they do not pay for an investment that they may not exploit completely.

The eligible energy efficiency measures or renewable technologies are established by the local governments implementing the PACE and they can vary according to different parameters, e.g. the local climatic conditions or the status of conservation of the building stock.

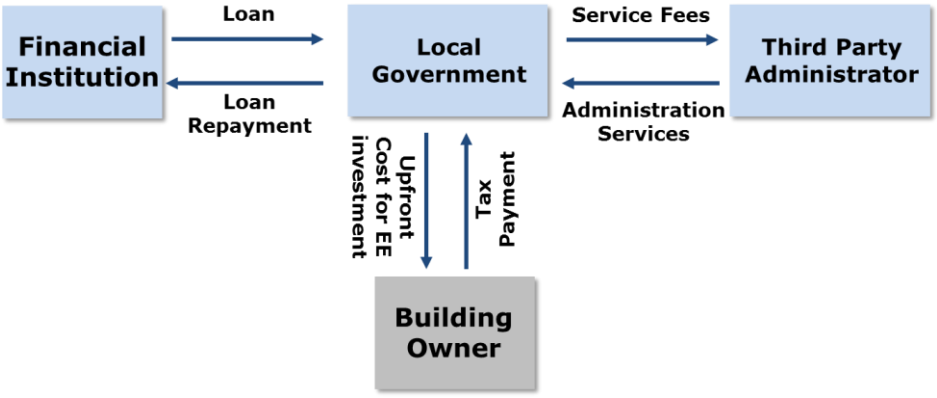

Figure 2.7 - Model of a possible PACE scheme [24]

As of the beginning of 2019, PACE funded more than USD 6 billion in projects, including 220,000 homes– making it a relatively successful form of financing for energy efficiency interventions. However, the payment structure, attached to the property tax, poses unique regulatory challenges in the EU. Nonetheless, pilot projects are underway, such as the one promoted by the EUROPACE Horizon 2020 initiative in the city of Olot in Spain [25].

3 OVERVIEW OF EXISTING ON-BILL SCHEMES

3.1 The North American Context

On-bill programmes have been active in the United States since 1978, when Energy Right Solutions launched a programme dedicated to residential homeowners [4].

After this pioneering initiative, many other programmes were launched in the 2000s, both in the US and Canada. Many of these schemes are based on the **Pay As You Save (PAYS) framework** introduced in 1998 by the Energy Efficiency Institute (EEI) [7]. According to PAYS owners or tenants were allowed to install energy efficient technologies without incurring in upfront costs and with no debt obligations, since the amount due on the bill is a cost, rather than a debt, worsening the overall debt position of a family [5].

Since then the mechanism attracted the attention of many operators in the USA and other countries, who implemented and modified it according to their local strategic and market needs.

In the next sections, each of the programmes presented in Table 3.1 is thoroughly analysed by illustrating its main features and rules, as well as by formulating a synthetic strengths and weaknesses analysis.

Name of the programme	Location	Programme administrator	Year in force	Current status
Help my House	South Carolina – USA	Central Electric Power Cooperative (CEPC)	2011	Ended in 2013
How$mart	Kansas - USA	Midwest Energy	2007	Active
EPIC	Colorado - USA	Fort Collins Utilities	2013	Active
HES Payment Plan	Connecticut - USA	Capital for Change	n.a.	Active
Upgrade to $ave	North Carolina – USA	Roanoke Electric Cooperative	2014	Active
Energy Efficiency Loan Programme	Oregon – USA	Eugene Water & Electric Board (EWEB)	1995	Active
Energy-Efficiency Loans	Florida - USA	City of Tallahassee	1983	Active
Home Energy Lending Programme (HELP)	Arkansas – USA	Ouachita Electric Cooperative	2013	Active
HowSmartKY	Kentucky – USA	MACED	2010	Active
Holland on-bill Loan Programme	Michighan - USA	Holland Energy Fund	November 2016	Active
Manitoba Hydro Power Smart Residential Loan Programme	Canada	Manitoba Hydro (MH) and Province of Manitoba	2001	Active
Nelson Hydro - EcoSave	Canada	Nelson Hydro (a City of Nelson owned and operated utility)	2012	Active
Home Energy Loan Programme (HELP)	Canada	City of Penticton and City of Penticton owned utility company	n.a.	Active until 2022

Table 3.1 - Examples of on-bill programmes active in USA and Canada

3.1.1 "Help My House" mechanism

Location	South Carolina – USA
Brief description	The Help My House pilot programme was led by Central Electric Power Cooperative (CEPC), and The Electric Cooperatives of South Carolina (ECSC), a trade organisation representing the cooperatives. The individually participating cooperatives identified and screened participants, choosing single-family homes with high annual electricity use, implemented an energy audit and supervised the refurbishment works.
Year in force	2011
Current status	Ended in 2013
Project size	Pilot of 125 homes
Supported interventions	• Insulation • Sealing air leaks • Upgrading heating and cooling system
Possible beneficiaries	Rural single-family buildings.
On-bill scheme	• On-bill financing scheme with disconnection allowed for non-payment and "meter attached" (i.e. the financing can be passed to the next homeowner or tenant) • Programme financed with low-cost loans for energy efficiency improvements funded by the US Department of Agriculture • Financing approved for households based on one year of good bill payment history rather than credit scores, addressing a common limiting factor for low-income households • 10-year financing given with 2.5% interest
Strategic analysis	**S**trengths: • Support to low income rural communities • Process completely governed by utilities through the auditors • Easy accessibility to the programme **W**eaknesses: • Pilot programme with a limited number of interventions • The lack of assistance at the end of the programme may vanish the achieved results (e.g. lack of maintenance)
Source	https://www.epa.gov/sites/production/files/2017-06/documents/help_my_house_profile_6-1-16_508.pdf

3.1.2 "How$mart" mechanism

Location	Kansas – USA
Brief description	Participating customers must start with an energy audit to determine potential savings. Midwest Energy will develop a conservation plan with recommended improvements. Customers may choose the contractor to complete the work. Contractors must sign a Contractor Master Agreement. Landlords and tenants must be in agreement to participate in the How$mart programme.
Year in force	2007
Current status	Active
Project size	1,327 buildings improved up until 2015
Supported interventions	• Insulation and air sealing • Heating and cooling systems • Commercial lightening • RES technologies
Possible beneficiaries	Programme available to Midwest Energy customers (e.g. Homeowners, tenants, landlords, and commercial businesses) in good standing and current on utility payments.
On-bill scheme	• On-bill financing scheme based on a "meter attached" (i.e. the repayment can be passed to the next owner or tenant) tariff with allowed disconnection for non- payment • 15-year duration (or ¾ of the operating life of the interventions) with 5% fee on the project investment. • Monthly tariff to repay the upfront cost not exceeding 90% of the energy savings • Low cost capital provided to the utility by state and federal funds, i.e. public funds.
Strategic analysis	**S**trengths: • Simplicity of the programme • Availability of an appropriate range of interventions • The utility governs all the process **W**eaknesses: • Long duration (up to 15 years) • Uncertainty regarding the customer's flexibility when selecting measures suggested in the energy audit • All the risk is taken by the utility (e.g. the contractor does not take any risk).
Sources	http://www.mwenergy.com/environmental/energy-efficiency/howsmart

3.1.3 "EPIC financing" mechanism

Location	Colorado – USA
Brief description	EPIC financing programme helps rental and owner-occupied property owners invest in energy efficiency improvements through an easy, streamlined "assessment-to-upgrade" process. This includes flexible term loans and low-interest rates. EPIC loans are repaid on the owner's Fort Collins Utilities monthly service bill.
Year in force	2013
Current status	Active
Project size	64 houses participate in the first pilot
Supported interventions	• Furnace • Air conditioner • Whole house fan and water heater • Insulation and air sealing • Windows • Water service line repair and/or replacement
Possible beneficiaries	Residential single-family homes, including duplexes and attached town homes in Fort Collins (rental properties are eligible; condo units in multi-storey buildings are not) can apply to the programme. The contractor must be current Utilities electric customer to apply for energy efficiency, solar and water conservation loans.
On-bill scheme	• On-bill repayment scheme with allowed disconnection for non-payment • Loan duration between 3 and 20 years, with an amount between USD 1,000 and USD 25,000 and interest rate between 3.49% and 4.49% depending of the duration of the loan • Partnership between Fort Collins Utilities and Impact Development Fund Colorado • Loan awarded on the basis of bill payment and financial score
Strategic analysis	**S**trengths: • High loans amount (up to USD 25,000) and possibility to cover 100% of the qualifying project cost • Availability of an appropriate range of interventions • Simple application (e.g. online form to fill to start the process) **W**eaknesses: • Very long duration for the highest amount of financing
References	https://www.fcgov.com/utilities/residential/conserve/financing/rental-property-single-family https://www.toolsofchange.com/en/case-studies/detail/707/

3.1.4 "HES Payment Plan (Micro Loan)" mechanism

Location	Connecticut – USA
Brief description	The HES Payment Plan Loan provides low-cost financing for energy efficiency improvements. The objective is to reduce household energy costs while maintaining healthy, efficient, and comfortable homes.
Year in force	n.a.
Current status	Active
Project size	n.a.
Supported interventions	• Air / Duct Sealing • Ductless Heat Pumps • Electric Heat Pump Water Heaters • Insulation • Natural Gas Hot Water Heaters
Possible beneficiaries	Residential (applicants must own a single or 2-4 family-house) customers in the State of Connecticut. Customers of the utilities Eversource and United Illuminating Company are qualified to apply.
On-bill scheme	• On-bill repayment of an "unsecured" loan • Loans between USD 1,000 and USD 3,000 to be repaid in 3 years with a 0% interest rate • Only selected measures to choose • Loan awarded on the basis of the utility bills payment history
Strategic analysis	**S**trengths: • Very attractive financial conditions for the customers, i.e. 0% interest rate on the loan • No fees or prepayment penalties are applied **W**eaknesses: • The maximum amount of the loan is limited, and it prevents the implementation of a radical refurbishment • All the risk (e.g. default of the customer) is taken by the utility
Source	https://www.capitalforchange.org/homeowners/energy-efficiency-programs/hes-plan

3.1.5 "Upgrade to $ave" mechanism

Location	North Carolina – USA
Brief description	Upgrade to Save allows Roanoke Electric Cooperative members to realise energy efficiency improvements to their home, such as weatherisation or more efficient heating and cooling systems, with no upfront costs. The resident then repays the cost of the improvements to the cooperative through a new charge on their bill, which is more than offset by the amount they save because of the improvements.
Year in force	2014
Current status	Active
Project size	So far, through Upgrade to $ave, the co-op has invested approximately USD 2.9 million into energy-efficient upgrades for member-owners. As January 2019, the co-op still has nearly USD 3.1 million left in federal financing to invest in the programme. Over 425 member-owners have already benefited from this high-impact programme.
Supported interventions	• Air/duct sealing • Heat pump upgrades • Insulation • LED lighting • Water heater wraps
Possible beneficiaries	All the Roanoke Electric Cooperative member-owners.
On-bill scheme	• On-bill financing programme based on an on-bill tariff structure "meter attached" (i.e. it can be transferred to the next owner or tenant). Amount of the tariff lower than energy savings • Capital to invest obtained from federal funds • Average loan duration between 2-12 years with an average amount of USD 7,000
Strategic analysis	**S**trengths: • Support to low income rural communities • Process completely governed by the utility • Easy accessibility to the programme • Programme based on the Golden Rule **W**eaknesses: • The lack of assistance at the end of the programme may vanish the achieved results (e.g. lack of maintenance)
Source	https://www.roanokeelectric.com/content/wanted-more-member-owners-'upgrade-and-save'

3.1.6 "Energy Efficiency Loan Programme" mechanism

Location	Oregon – USA
Brief description	EWEB, a municipal utility, offers a wide range of loan programmes for residential or business customers. The first pilot programme was launched in 1990 to test costumers' interests, in 1992 a residential programme was initiated and in 1995 the programme was fully approved and expanded to business customers and residential multi-family buildings. Currently the company offers zero interest loans up to USD 20,000 for residential users and interesting bearing loans, with 4% interest, for business customers.
Year in force	1995
Current status	Active
Project size	From 1995 to 2010,1,156 loans were financed
Supported interventions	• Heat pumps • Heat pump water heater • Insulation • LEDs installation • Programmable digital thermostats installation • Window replacements
Possible beneficiaries	All the EWEB customers, residential and business buildings. Generally, eligible homes must have permanently installed electric heat as their primary heating source.
On-bill scheme	• On-bill financing programme financed with company funds • Revolving fund now established • Disconnection in case of non-payment allowed • 0% loan up to USD 20,000 and unsecured loan up to USD 5,000. If necessary, standard loans security mechanisms considered • Four to five years of payback term on-bill • Depending on the amount, loan awarded on the basis of utility bills payment history and credit check
Strategic analysis	**S**trengths: • High loans amount (up to USD 20,000) for residential and no fixed cap for businesses • 0% interest rate for residential customers and 4% for business • Process completely governed by the utility • Wide range of possible improvements **W**eaknesses: • Limitations in the utilisation of the programme more than once • Administrative complications if the loan is over USD 5,000
Source	https://www.eesi.org/files/Mark_Freeman_100815.pdf https://www.eesi.org/files/OBFprimer.pdf

3.1.7 "Energy Efficiency Loan Programme" of the City of Tallahassee

Location	Florida – USA
Brief description	City of Tallahassee Utility (Florida) has been running a successful on-bill financing programme since 1983. The programme has enabled the municipal utility's customers to perform energy efficiency retrofits and other energy projects to their homes with no up-front costs.
Year in force	1983
Current status	Active
Project size	• 17,000 retrofits from 1983 up to 2017 and USD 130 million invested • 18% participation among 97,000 utility customers (2017 data) • Default rate <1% (2017 data)
Supported interventions	• HVAC replacement • Appliances: air conditioning units, clothes washers, etc. • Electric vehicle home charging stations • Pool pumps • Water source heat pumps • Weatherisation measures
Possible beneficiaries	Residential and small commercial customers.
On-bill scheme	• On-bill financing mechanism with on-bill loan structure (disconnection for non-payment allowed) • Loans for municipality utility's customers, who are homeowners, up to USD 20,000 • Repayment within a period of 5-10 years with a 5% interest • Loans are secured with a property lien • No formal credit check required to access the programme. One year of good bill payment history necessary to participate
Strategic analysis	**S**trengths: • High loans amount (up to USD 20,000) • Simplicity of the programme • Participation of trained contractors and installers **W**eaknesses: • Loans are not transferable • Duration can be long for high amount of financing • Higher interest rates than other OBF programmes (4-6%)
Source	https://www.talgov.com/you/you-products-home-loans.aspx https://www.michigan.gov/documents/mpsc/April_2017_On-bill-primer_for_Michigan_Utilities_560204_7.pdf https://www.eesi.org/files/OBFprimer.pdf

3.1.8 "Home Energy Lending Programme (HELP)" mechanism

Location	Arkansas - USA
Brief description	Ouachita Electric Cooperative, an electric cooperative in southern Arkansas, launched its Home Energy Lending Programme (HELP) in late 2013, with the objective of removing the upfront cost barrier of implementing residential energy efficiency measures by offering a low-interest energy efficiency finance programme. HELP was set up initially as an on-bill loan programme and in 2016 transformed into a tariff on-bill structure.
Year in force	2013
Current status	Replaced in 2016 by an opt-in tariff programme.
Project size	Ouachita Electric's on-bill loan programme helped improve 350 homes up until December 2015, with zero loan defaults over the first year of the programme.
Supported interventions	• Air/duct Sealing, attic Insulation • Heat pump, HVAC • LED light bulbs • Solar PV panels
Possible beneficiaries	All Ouachita Electric Cooperative customers (residential and commercial).
On-bill scheme	• On-bill repayment programme with on-bill tariff structure whose amount has a maximum value equal to 80% of the estimated energy savings • Disconnection for non-payment allowed and possibility to transfer the tariff to the next owner and/or tenant • Programme financed by the National Rural Utilities Cooperative Finance Corporation, which is a financial cooperative engaged in financing the member energy cooperatives • Possible renovation investments in the range of USD 1,000 to USD 25,000 with a cost recovery period up to 12 years • Bill payments history used to check the eligibility
Strategic analysis	**S**trength: • High loan amount (up to USD 25,000) • Long repayment timing • Based on the Golden Rule • Availability of an appropriate range of interventions (including installation of solar PV panels for residential houses) **W**eakness: • Complex technical estimations of the savings are necessary
Source	https://www.oecc.com/pdfs/Ouachita%20Electric%20HELP%20PAYS%20Program%20-%20First%204%20Months%20of%20Activity-1.pdf https://www.eesi.org/obf/coops/casestudies

3.1.9 "How$martKY Energy Efficiency for Everyone" mechanism

Location	Kentucky - USA
Brief description	In 2010, the Mountain Association for Community Economic Development (MACED) launched a pilot financing programme for EE: How$martKY, available for members of four electric cooperatives in Kentucky. The programme was made permanent in 2013. It was inspired by the Kansas How$mart programme. Like the Kansas scheme, it is an on-bill tariff programme that is tied to a customer's meter.
Year in force	Pilot in 2010, made permanent in 2013
Current status	Active
Project size	• Total projects: 166 completed projects with an average cost of USD 8,000 per retrofit • Total amount financed: USD 1.2 million had been financed as of September 2014
Supported interventions	• Air/duct sealing • Heat pump • Insulation
Possible beneficiaries	Residents, small businesses, local governments, communities, and non-profits of Kentucky
On-bill scheme	• On-bill financing scheme developed on the basis of a tariffed on-bill option (i.e. disconnection for non-payments allowed and with possibility to transfer the tariff to the next customer) • Mountain Association Community Economic Development (MACED) is the loan originator which lends the loan capital to each participating energy cooperative (four cooperatives involved, namely Big Sandy RECC, Fleming-Mason RECC, Grayson RECC, and Jackson Energy) • Maximum amount of the interventions is USD 25.000 to be repaid in 15 years with a 3% interest plus a fee equal to the 5% of the project cost included in the tariff • Bills payments history utilised as underwriting criteria; no credit ratings considered
Strategic analysis	**S**trength: • High loan amount (up to USD 25,000) • Adequate type of supported investments • Cooperation among the utilities of the territory **W**eakness: • Long duration for the highest amount of financing • A fee of 5% of the project cost is rolled into the loan
Sources	http://www.howsmartky.com/Default.aspx https://www.eesi.org/obf/coops/casestudies

3.1.10 "Holland Energy Fund" mechanism

Location	Michigan (City of Holland), USA
Brief description	The goal of the Holland Energy Fund's on-bill loan programme is to strengthen communities and neighbourhoods by encouraging deep energy savings, increasing access to efficiency measures and administratively operating in a cost-effective manner. The target is to refurbish a significant share of the 7,400 single houses in Holland. An energy audit is performed before the investment and installation is developed by qualified contractors.
Year in force	November 2016
Current status	Active
Project size	In 2016, 55 on-bill loans were provided Up to 2019, more than 250 homes joined the programme
Supported interventions	Interventions included in the Michigan Energy Measures Database, such as: • Lamps substitution • Heat pumps, efficient boilers and solar thermal panels installation • Wall Insulation
Possible beneficiaries	Owners of residential buildings (four units or less) within the City of Holland are eligible for participating in the programme
On-bill scheme	• OBF scheme launched by Holland Board of Public Works • Holland Energy Fund, a non-profit corporation supporting the City of Holland, finances the energy efficiency programme • Loan between USD 5,000 – 30,000 to be repaid in a maximum of 15 years with an interest less than 6.99%. No penalties for pre-payment • Loan associated to the meter and transferable to the next customer (i.e. meter attached) • Disconnection for non-payment is allowed • Underwriting criteria mainly based on twelve months on time Holland Board of Public Works bill payment history
Strategic analysis	**S**trengths • Broad range of efficiency measures to choose • Appropriate loan amount to implement relevant renovations • Transferability to the next customer (i.e. owner) • Simply underwriting criteria **W**eaknesses • Tenants excluded from the programme
Source	https://hollandenergyfund.com/on-bill-loan-programme/ https://www.michigan.gov/documents/mpsc/April_2017_On-bill-primer_for_Michigan_Utilities_560204_7.pdf https://mibiz.com/sections/energy/holland-leads-with-energy-financing-programme-but-work-remains

3.1.11 Manitoba Hydro Power Smart Residential Loan Programme

Location	Canada – Manitoba Province
Brief description	Manitoba Hydro offers its residential customers Pay-as-You-Save (PAYS) financing for eligible energy efficiency upgrades, notably space heating, insulation, and water heating equipment. Monthly payments are added to the utility bill and are transferable to the next homeowner.
Year in force	2001
Current status	Active
Project size and results	• Around 5,000 participants per year, with approximately USD 6,000 of investment • In 13 years, it reached 15% of the target market • Loan default rates equal 0.48% • On average, one project saves 825 kWh/year, or 7.5% of energy used
Supported interventions	• Residential space heating equipment • Insulation • Residential water heating and conservation: – Drain water heat recovery systems; – Water efficient toilets
Possible beneficiaries	Residential customers of the Manitoba Hydro, with homes where energy improvements are made and have an active Manitoba Hydro account in good standing.
On-bill scheme	• Capital for the Manitoba programme comes from public money that are generated internally by the Manitoba government and lent to Manitoba Hydro at low cost. The Manitoba government does not back any of the loans • The maximum term depends on the upgrade, but the most common terms go up to 20 - 25 years • When the loan programme was launched, the interest rate charged by Manitoba Hydro was set at over 6%, but this has changed over the years and currently sits at 4.8%
Strategic analysis	**S**trengths: • Relaxed underwriting criteria resulting in rejection rate of 5% • Interest rates are kept relatively low • A quick turnaround time for approval of around 48 hours **W**eaknesses: • Limited range of supported interventions
Source	https://www.hydro.mb.ca/your_home/pays/

3.1.12 Nelson Hydro - EcoSave

Location	Canada - Nelson
Brief description	The EcoSave Energy Retrofits Programme has been established as one of the key strategies for the City of Nelsons Low Carbon Path to 2040. The EcoSave programme has been designed for Nelson Hydro (a City of Nelson owned and operated utility) customers, who are homeowners, to have a home energy evaluation to determine what energy efficiency upgrades (retrofits) can be done, and to access current rebate offers complete with an on-bill financing option.
Year in force	2012
Current status	Active
Project size and results	• Statistics for the first two years of the programme show that there is an average of less than 0.02% loans that defaulted
Supported interventions	• Water conservation toilets • Other interventions that provide energy or water reduction may be considered eligible after being analysed by the EcoSave coordinator
Possible beneficiaries	• Nelson Hydro customer • Owner(s) of the residential home, including the land • City of Nelson resident
On-bill scheme	• Maximum loan amount is USD 16,000 • Choice of 5-year or 10-year term • 3.5 % fixed interest rate (possible change once per year) • Approval was based on the 24 months payment history of the Nelson Hydro utility bill, i.e. without using credit information. • The bylaw for the on-bill financing was created to protect the City of Nelson from defaults. In case of a default, standard utility collection procedures will apply including service disconnects and transfers of the amounts due to property tax • If the house sells before the on-bill financing loan is paid off, the loan will need to be paid in full prior to the sale of the house
Strategic analysis	**S**trengths: • Approval is based on the payment history and without using credit information • Default protection comes from service disconnects and transfers of the amounts due to property tax **W**eaknesses: • The scheme establishes that the loan must be repaid in full prior to the sale of the house
Source	https://www.nelson.ca/742/Energy-Retrofits-Programs https://www.nelson.ca/faq.aspx?qid=92

3.1.13 Home Energy Loan Programme (HELP)

Location	Canada - Penticton
Brief description	The Home Energy Loan Programme (HELP) is a loan service available through the City of Penticton for eligible energy efficiency upgrades made by City of Penticton residents that own and occupy their own homes. HELP is repaid by the customer through monthly payments on their City of Penticton utility bill.
Year in force	n.a.
Current status	Active until 2022
Project size and results	n.a.
Supported interventions	Eligible upgrades include (but are not limited to): • Insulation and air leakages reduction • Installing more efficient space and water heating systems
Possible beneficiaries	• City of Penticton Residential Electric Utility Customer; • Registered owner of the property and hold the utilities account in the registered owner names
On-bill scheme	• The maximum loan amount is CAD 10,000 with 10-year amortisation • The interest rate is fixed at the prime rate (between 3% and 4%) + 0.5% (interest rate is set at the time the loan is granted) • Monthly loan payments are made through City Utility bills. Loans can be repaid in full, or in part, at any time without penalty • Approvals are based on a credit check based on Utility bill payments for previous 12 months with 9 months of credit history. Alternatively, on a letter from the previous electrical utility indicating the "good standing" of the customer • If the home is sold before the amortisation period is over, the loan will need to be paid in full upon the sale of the house • In case of a default, the normal utility collection procedures including service disconnection and addition of outstanding amounts to property tax apply
Strategic analysis	**S**trengths: • Approvals are based on utility bill payment checks and/or a letter from the previous utility indicating the customer's "good standing". • In case of default, a normal utility collection procedure starts and relies on service disconnection and debt transfer to the property tax **W**eaknesses: • If the home is sold before the amortisation period is over, the loan will need to be paid in full upon the sale of the house
Source	https://www.penticton.ca/EN/main/departments/electricity/energy-retrofits.html https://www.ratehub.ca/prime-rate

3.2 The European Context

In recent years, increasing attention has been devoted to the implementation of energy efficiency measures in the European building sector. To this aim, different regulations have emanated to support this energy policy, namely the Energy Performance of Buildings Directive, first launched in 2010, then revised in 2012 and later reviewed in 2018 [8]. The common aim of these regulations is to support and accelerate the renovation of the existing building stock in Europe in order to reduce primary energy consumption. In order to launch such ambitious renovation programmes, it is necessary to address the corresponding financing issues [9].

Different types of programmes have been launched all around Europe to scale up energy efficiency investments, but on-bill programmes had a limited diffusion, despite the large success and efficacy they had in the USA. In this section, two programmes are analysed; the on-bill programme Green Deal in UK and the energy performance contract Sunshine in Latvia.

The main difference between the European and the American programmes is the very active role taken by the central government in European programmes. Both Green Deal and Sunshine were started due to relevant state intervention and support.

In particular, the **Green Deal** was born under a state design in order to migrate "to the market" after the start-up, but it failed due to a set of complexities that affected the programme since its beginning, as explained below.

As for **Sunshine**, it is a relatively new mechanism conceived to support the necessary massive refurbishment of the Latvian building stock, which was mostly built during the Soviet period with poor energy standards. The programme is run on the basis of a cooperation between an ESCO and a fund which finances the interventions. The fund is represented by ERDF, an institutional EU fund, therefore the public intervention assumes relevant importance. The interventions have the aim to reduce the residential energy consumption, but also to improve the home comfort for the people, therefore it also addresses "non-energy benefits" connected with energy refurbishment interventions. This aspect is less emphasised on the North American on-bill programmes.

Up until now, the Latvian programme resulted to be successful and effective in addressing its scopes. It is to be said that the programme might be replicated in similar contexts (e.g. other Baltic countries), but, on the other hand, the majority of EU countries (e.g. Italy, Spain, Germany, France, etc.) have a very different market context and building stock. Therefore, it is fundamental to analyse the most appropriate configuration for possible on-bill programmes. Probably, solutions closer to those adopted in the USA may be more appropriate for EU countries with more dynamic economic and energy contexts.

3.2.1 United Kingdom - Green Deal

In 2009 the Green Deal was the first on-bill programme introduced in Europe. After a testing phase which lasted from November 2009 to July 2011, the mechanism was officially launched on the market in 2013 [10, 5]. The Green Deal programme was launched to address three main issues [5]:

- To reduce the relevant waste of energy in British households due to poorly insulated houses and inefficient equipment;
- To achieve the national target to cut carbon emissions by 80% within 2050 with respect to 1990 levels;
- To minimise fuel poverty in the country.

The Green Deal programme was based on the Pay as You Save (PAYS) mechanism, but with a number of differences, in particular related to the application of the Golden Rule, which does not allow that repayments are greater than the savings. The structure of the Green Deal is that of an OBR programme, where funding is obtained by third parties (e.g. financial institutions) and utility bills are used to collect the repayments.

The mechanism is founded on the idea of linking loans from an accredited "Green Deal Provider" for refurbishment of a building directly to the property, i.e. specifically to the connected electric meter [10]. The loan is repaid through a surcharge on the electric bill, which is collected by the supplying utility and paid to the Green Deal provider, which is the programme administrator in charge of developing all the technical and financial aspects of the projects. Different typologies of companies can be "Green Deal Providers", e.g. finance companies, installers, etc.[3] The mechanism can be classified as "tariffed on bill" with meter attachment and possible disconnection for non-payment [5, 10].

During the testing phase of the mechanism the Golden Rule was not included, therefore if the value of energy saved exceeded the monthly surcharge, the occupant obtained a "premium", if the opposite was verified the occupants were to pay the surcharge with own financial resources, as the bill saving is not sufficient to repay. In the final implementation of the Green Deal, the Golden Rule was included [5]. On the other hand, the clients were also given the option to implement efficiency measures which were unluckily to repay with energy savings, provided that they self-financed the non-repayable part [10].

The UK government hypothesised that the main barrier which hampered the implementation of energy efficiency measures in the residential sector was the lack of capital. Therefore, if upfront cost was provided, a relevant number of citizens would have been stimulated to act by refurbishing their dwellings. Unluckily, this did not happen, and the government decided to stop funding the programme in 2015.

The Green Deal was subject to a strong criticism for a number of reasons and it is indicated as an example of failure in energy policy. In fact, in 2011 the UK Department of Energy and Climate Change (DECC) estimated that by 2020 the Green Deal would have supported the refurbishment of 14 million homes. Unfortunately, the reality was quite different as only 14.000 homes were retrofitted by the end of March 2016 since the full launch of the programme in January 2013 [11].

The causes of this failure can be found in four main issues, namely limited financial appeal (a), a poor policy design (b), low level of engagement with consumers (c) [11] **and complex bureaucratic procedures (d)** [12].

[3] https://www.gdfc.co.uk/business/current-green-deal-providers/

a) **Limited financial appeal.** The interest rate provided by Green Deal resulted higher with respect to high street secured loans (e.g. rates higher than 7% for the green deal vs. market values of 3.5% for secured loans and of 6%-7% for unsecured loans [10]), which are a usual benchmark for consumers. This was due to the choice of the government to avoid any public subsidy to the programme. It is supposed that interest rates of 2%-3% would have been more appropriate and attractive, as demonstrated by the German KfW programme [10].
b) **Poor policy design**. The Green Deal was conceived as a PAYS mechanism based on the Golden Rule. On the other hand, the high interest rates allowed the full funding of only very convenient energy efficiency measures. Therefore, the typologies of measures to implement resulted to be very limited and this prevented final users to join the programme.
c) **Low level of engagement with consumers.** The Green Deal was prevalently proposed to the consumers as a merely financial mechanism and only the support for the upfront investment was emphasised. Certainly, the financial support is important, but it does not represent the only motivation to invest from the consumer point of view. Also, other elements could influence *the willingness to invest* of the consumers, such as to improve the comfort of their homes, to live in healthy houses, etc. These dimensions were not emphasised during the Green Deal marketing, but they have been proven to be fundamental [13].
d) **Complex bureaucratic procedures**. The procedure to join the Green Deal resulted to be quite complex and involved a number of third parties, namely assessors (energy advisers), providers (i.e. supervisors of the renovation projects, including the financial aspects) and installers. This complicated the take on of the programme, since many subjects, not necessarily well coordinated among them, needed to cooperate on the technical and administrative sides. This discouraged the consumers to engage with the Green Deal. Furthermore, it can be added that for many of the involved companies Green Deal represented only a minor activity [9], therefore their attention to this initiative was quite limited.

3.2.2 Latvia - Sunshine

In most of the Post-Soviet and Post-Socialist countries there are relevant issues with the status of conservation of a large share of the building stock. In the Eastern and Central European countries and the Baltic states, the building stock presents similar features and the construction techniques were the same during the period 1950-1980.

The huge amount of buildings in these countries requires renovations to reduce energy consumption and prevent energy waste. For this reason, it is necessary to set up mechanisms which support the technical and financial feasibility of energy efficiency investments.

To address this problem**, the Latvian Government initiated a programme of renovation based on the Energy Performance Contract model** (EPC) [14.

This is not, indeed, an example of an on-bill scheme. Final users pay the same bill as before the renovation works to a House Management Company (HMC), which is in charge of the overall operation and maintenance of the building. The HMC pays a reduced fee to

the energy providers (e.g. electricity utility, heat supply operator, etc.) due to the implemented energy efficiency measures and the obtained bill savings are used to pay the ESCO.

In this model the **ESCO has the role of an aggregator, similar to that of utilities in common on-bill schemes**, but, due to the peculiarity of the Latvian building stock, e.g. Soviet buildings which need an overall refurbishment, it is mandatory to find an agreement at whole building level (i.e. not at single owner level). In this context, ESCOs can appropriately work, since they can focus on a small number of large projects.

The focus of the investments is the renovation of the building envelope, insulation of heat distribution pipes, installation of control systems, etc. in residential buildings. At moment, a pilot phase of the project has been implemented with the refurbishment of 15 typical multifamily buildings of the Soviet period in the last 5 years.

The projects are financed up to 40% with funds from the European Regional Development Fund (ERDF) and the remaining part is obtained from the savings on the energy bill [14]. All the projects are managed and implemented by an Energy Service Company (ESCO) called RenEsco and ESCs are the contractual arrangement used to regulate the agreement between homeowners and the ESCO. The ESCO guarantees a determined level of energy savings and obtains the funds from ERDF plus the energy saved on the monthly bill, through on-bill financing, for the first 20 years. Therefore, the homeowners will continue to pay the same energy bill for the first 20 years, but the renovations have an average operating life of 30 years. Also, there is an immediate increase of the dwelling value of 20%-30% and an increase of the comfort. The default rates of the programme are very low, with 97% of the payments being on time [14].

With the increasing success of the programme, the situation is getting complicated for the ESCO cash flow, since the company needs to provide immediately the resources to sustain the CAPEX and the return will be obtained only during many years. To deal with this unbalanced situation a forfaiting fund, the Latvian Building Energy Efficiency Fund (LABEEF), was created in order to buy the receivables of the ESCO, which can be converted in financial products to be sold on secondary financial markets. The receivables are typically bought by LABEEF after 1-2 years from the energy investment implementation, in order to have a clear track-record of the real amount of energy saved. When LABEEF buys the receivables, the ESCO improves its financial position and can obtain access to new loans to implement new investments.

Up to now the programme results to be successful in the Latvian context, therefore it is reasonable to use it as a model for countries with similar contexts. On the other hand, the mechanism put in place in Latvia is quite sophisticated and well organised, therefore the same level of accuracy and precision is required for a possible replication[4].

[4] https://fineergodom.eu/about-us/

3.3 On-Bill Programmes in Developing Countries

On-bill schemes are active also in developing countries, but often with aims and scope which are different to those in developed countries. In particular, on-bill schemes are considered effective mechanism for implementing **Demand Side Management (DSM) policies**, which support the management of complex energy systems.

In many developing countries there are imbalances between power demand and generation during peak hours (e.g. morning peak or night peak). This happens because the power network and available capacity are limited. Yet, interventions on these infrastructures result complicated and expensive for developing countries. In order to guarantee appropriate working conditions for the power system, **one solution is the decrease of demand by implementing simple energy efficiency measures**.

However, the average financial conditions of the population do often not allow sustaining investments, even with limited upfront costs. Thus, on-bill schemes are seen as a solution. For example, India and Sri Lanka implemented an on-bill scheme for the replacement of low efficiency lamps with highly efficient ones in order to reduce the night demand peak and ensure the equilibrium between demand and supply.

A similar programme is available in Mexico for the implementation of efficient air conditioning systems, which contribute to reduce the morning power peak.

In other developing countries, e.g. Tunisia, an on-bill scheme has been implemented to promote large scale utilisation of renewables in the residential sector. The aim of the programme was to support the utilisation of local resources (e.g. solar energy) against to imported energy sources (e.g. natural gas). The programme had a twofold scope, namely, to increase the security of energy supply and to reduce the environmental impact of domestic hot water generation.

In the following sections, four on-bill schemes are briefly described by summarising their main features and results.

3.3.1 Mexico - "Cambia tu viejo por uno nuevo"

The programme "*Cambia tu viejo por uno nuevo*" (Replace your old one for a new one) was initiated in Mexico, with the aim to promote the upgrade from old inefficient electrical equipment to new efficient ones [15]. In particular, the target is to substitute old refrigerators and air conditioning systems with more efficient devices. The programme was introduced by the Ministry of Energy and implemented by local financial institutions, namely the Trust for Saving Electricity and the National Developing Bank [15].

The funds to support the programme were obtained from World Bank and the Inter-American Development Bank. Provided that they have no debt for default of utility bill payments, final users can benefit of the programme through an on-bill scheme, accessing the funds for substituting their devices and then repay them through their bills.

This programme allowed to substitute 1.7 million residential refrigerators and 200.000 air conditioning systems and achieving a carbon emissions reduction of 550 kt/year and electricity savings of 823 GWh/year [15].

3.3.2 Sri Lanka – "On-bill Demand Side Management"

In order to address a power crisis in the 1990's, CEB, the vertically integrated public utility of Sri Lanka, initiated a DSM programme for reducing energy demand and improving the system adequacy [16]. Sri Lanka, as many other developing countries, has a load profile characterised by a sharp evening peak due to electric lighting, often obtained with inefficient lighting systems. In a power system with scarce generating capacity, adjusting demand by, for example, using energy efficient lamps is fundamental [16].

On the basis of this premise, CEB introduced a programme for substitution of lamps of its customers with energy-efficient Compact Fluorescent Lamps (CFLs). CEB developed a list of suitable lamp models and dealers and stipulated agreements with them in order to establish a network of verified suppliers. Final users could obtain lamps from one of the certified suppliers of their choice (maximum four lamps per user) and pay in 12 instalments directly charged on their electricity bill. On the contrary, the supplier was paid directly by CEB [16].

In this way, the main barrier to lamp substitution, namely the coverage of initial upfront cost, was overcome. It is important to highlight that the utility cannot disconnect the user for non-payment of the lamps, since this is forbidden by the law. The disconnection is possible only if the user does not pay the part of the bill related to the electricity supply. Therefore, customers need to sign a separate agreement with CEB for entering the DSM programme and make the payments on the bill. Therefore, the bill is only used as a vehicle to collect the re-payments [16].

3.3.3 India - "DELP Programme"

The DELP programme was launched by electricity distribution company in the area of New Delhi and Rajasthan [17]. It is an initiative aiming at supporting the substitution of low efficiency lamps with high efficiency LED lamps. Financial support to residential customers to overcome the barrier related to upfront costs is provided by the company, which gets reimbursed on-bill by the final users.

The financial resources for the implementation of the programme are provided by Energy Efficiency Services Limited (EESL), which is a governmental company providing energy efficiency services [17]. Power utilities only act as reimbursement vehicle by collecting payments on the bill.

The initiatives allowed to install more than 20 million efficient LED lamps [18].

3.3.4 Tunisia - "PROSOL Programme"

The aim of the PROSOL programme is to develop a durable label which could group all the incentives for the implementation of thermal solar energy systems. For such a reason the PROSOL label was created and launched in 2005 for the residential sector and later in 2009 and 2010 enlarged to the tertiary and industrial sector respectively [19].

The programme is implemented through a cooperation between the Tunisian Electricity and Natural Gas Company (STEG) and Attijari Bank, one of the most important banks of the

country. The bank guaranteed the financing for PROSOL of EUR 64 million in the period 2007-2012 and invested other 60 M€ in 2016. The interest rates were always lower than 7% [19].

The residential mechanism is structured as an on-bill scheme. In particular, an on-bill repayment system is implemented where the Attijari Bank finances the investments which are first evaluated by external suppliers (about 50 suppliers are present in the country) and then validated by STEG [19]. Data related to adhesion to PROSOL are also submitted to the National Agency for Energy Management (ANME). Once all the validations are completed, the interventions are implemented, and the supplier is paid by the bank. Then the final users start to pay back the investment through the bills emitted by STEG which in turn collects the repayments for Attijari Bank.

The programme allowed to install a surface of ~70.000-80.000 m^2 of solar thermal power per year in the period 2008-2013 [19].

4 ANALYSIS AND CONCLUSIONS

4.1 Comparative Analysis

Name of the programme	On-bill scheme		Programme administrator			Structure	
	OBF	OBR	Utility	ESCO	Other	Disconnection possible	Meter attached
Help my House	✓		✓			Yes	Yes
How$mart	✓		✓			Yes	Yes
EPIC		✓	✓			Yes	No
HES Payment Plan		✓	✓			n.a.	No
Upgrade to $ave	✓		✓			Yes	Yes
Energy Efficiency Loan Programme (Oregon)	✓		✓			Yes	No
Energy-Efficiency Loans (Tallahassee)	✓		✓			Yes	No
Home Energy Lending Programme (HELP)		✓	✓			Yes	Yes
HowSmartKY	✓				✓	Yes	Yes
Holland Energy Fund	✓				✓	Yes	Yes
Manitoba Hydro Power Smart Residential Loan Programme	✓		✓			n.a.	No
Nelson Hydro - EcoSave	✓		✓			Yes	n.a.
Home Energy Loan Programme (HELP)	✓		✓			Yes	n.a.
Green Deal		✓			✓	Yes	Yes
Cambia tu Viejo por uno Nuevo		✓	✓			n.a.	n.a.
On-bill Demand Side Management - Sri Lanka	✓		✓			No	n.a.
DELP Programme		✓	✓			n.a.	n.a.
PROSOL		✓	✓			Yes	No

Table 4.1 - Synthetic comparison of the analysed On-bill Programmes

The overview of different on-bill programmes active in the US and other markets highlighted that a variety of schemes has been employed. This can be attributed to the diversity of the

programme managers, the differences in the operating contexts and the variability of regional/state regulatory frameworks. It can be said that this flexibility in the designing of on-bill programmes represents an advantage for programme administrators (e.g. utilities), as it proves that the mechanisms are adaptable and customisable according to specific needs.

Therefore, the detailed analysis of the most popular mechanisms represents an interesting starting point for determining a possible replication potential.

In terms of supported investments, it can be said that all the programmes listed in Table 4.1 promote an adequate number and typology of interventions. On the other hand, some of them, e.g. MACED, are specifically targeted to energy efficiency interventions, others, e.g. HELP and How$mart, also support renewable energy generation.

As synthesised in Table 4.1, **most programmes** are **managed by an energy utility**. This may represent a key-point for the success, since **utilities, together with final users**, are the **most affected stakeholders of an on-bill programme**. On-bill programmes affect the core business of a utility, namely the selling of energy, therefore if such companies are not involved directly, it is very difficult to run these programmes, with serious possibilities to fail, as happened for the case of the "Green Deal" in the United Kingdom.

Name of the programme	Default rate	Source
Help my House	<1%	https://www.eesi.org/obf/munis/faq
How$mart	<1%	https://www.eesi.org/obf/coops/casestudies
Upgrade to $ave	0.3%	Case study: Upgrade to save programme, Amir Chireh Mehr Eva Wang 2017
Energy Efficiency Loan Programme	0.5%	https://www.eesi.org/files/Mark_Freeman_100815.pdf
Energy-Efficiency Loans	1%	https://www.epa.gov/sites/production/files/2018-12/documents/usepa_on_billprograms.pdf
Home Energy Lending Programme (HELP)	<1%	https://www.oecc.com/pdfs/HELP_PAYS_Report_2016-Ouachita_Electric_20170612V1.pdf
HowSmartKY	<2%	http://www.meeaconference.org/sites/meeaconference.org/files/NORTONMEEAConference2018.pdf
Manitoba Hydro Power Smart Residential Loan Programme	0.48%	https://www.hydro.mb.ca/your_home/pays/
Nelson Hydro - EcoSave	0.02%	https://www.nelson.ca/742/Energy-Retrofits-Programs https://www.nelson.ca/faq.aspx?qid=92

Table 4.2 - Default rate of the analysed on-bill programmes

If utilities play the key role, they will take an active part in identifying targeted clients to be involved in the programme. This will help to minimise the default rate and to increase the

success of the programme. In fact, Table 4.2 illustrates that **default rates are very limited** in on-bill programmes.

Furthermore, another critical aspect for the realisation of on-bill programmes is represented by its simplicity for the end users [15]. If the process to join the programme is complex, users are discouraged to apply, as demonstrated by the negative experience of the "Green Deal", where complex administrative procedures prevented users' enrolment in the programme.

The promotion of on-bill programmes may result in business origination activities for the utilities, especially now that the business models of traditional utilities are changing and moving towards the concept of "energy service provider", as highlighted in [6].

The success of a certain business model also depends on the context of operation of the programme and on the typology of the management company. For example, utilities managed and owned by municipalities have as "core business" the optimal satisfaction of the energy needs of a community, therefore their main mission is not to generate business for the shareholders, but to provide services for the citizens.

Therefore, **municipal utilities in the structuring of on-bill programmes may take into account also the advantages obtained from the reduction of externalities for the municipality and its citizens deriving from the implementation of energy efficiency interventions**.

4.2 Opportunities and Threats Analysis

In Section 2, a detailed Strengths and Weaknesses analysis has been developed for each of the analysed on-bill schemes. This allowed to highlight the peculiarities of each scheme and to appreciate the specific differences.

A general analysis of Opportunities and Threats is instead presented in this section, since in terms of external factors, similar aspects can be identified for all the considered mechanisms. The analysis, illustrated in Table 4.3, highlights the main features of on-bill schemes and their possible impacts on the utility business.

It can be concluded that **there is a multitude of opportunities to enlarge and increase the current business of energy utilities** by offering new services connected with energy efficiency and financed via on-bill schemes.

Opportunities	Threats
• To consider the broadening of energy services offered through on-bill schemes, such as by including renewables, energy storage services, e-mobility, etc. • **Possible integration with other programmes** (e.g. energy efficiency insurance) and public incentives • **Creation of a large network of partners** (e.g. contractors, financial institutions, etc.) • **Increasing customers' loyalty** and **new business origination** by developing long term maintenance programmes • Stimulus to implement energy efficiency **interventions on a massive scale** • **Electricity companies can promote a fuel switching,** e.g. from natural gas to electricity for buildings heating by using heat pumps	• Mass market extension of on-bill schemes may determine a high incidence of programme management costs • **Relevant complexity in contractor's management** • Increase of the financial risk if many customers apply for the programme • **Cannibalisation of the margin from energy selling**, especially fuel for heating (e.g. natural gas) or heating services (e.g. district heating)

Table 4.3 - Opportunities and Threats for on-bill schemes

On the other hand, **the main threat is the careful evaluation of the trade-offs between possible new businesses and the cannibalisation of the margin of the traditional utility business**, namely the selling of energy.

4.3 Next Steps: Replicability Analysis

This document presents an overview of on-bill schemes available in North America, and also discusses some relevant initiatives in Europe and in developing countries. Furthermore, other relevant energy financing mechanisms are reviewed and analysed.

On-bill schemes demonstrated to be a successful tool for supporting energy efficiency measures in the North American residential sector. On the other hand, it is necessary to verify if North American market conditions are comparable to European ones. For example, there could be concerns regarding the social acceptance of some clauses of on-bill contracts, such as the disconnection in case of non-payment.

In order to establish if on-bill schemes can be successfully implemented in the European context, it is necessary to develop a detailed replicability analysis with the involvement of all the relevant stakeholders, namely utilities, financial institutions and public authorities. It is of fundamental importance to understand which aspects of North American programmes can be replicated, and which need to be radically changed in order to design successful schemes for the European context.

Building upon these assumptions, the next steps to develop a replicability analysis can be summarised as follows:

- To analyse the barriers hampering energy efficiency investments in the European residential sector, with focus on the four countries addressed by RenOnBill;
- To open a dialogue with the relevant stakeholders in order to assess the replicability of on-bill schemes in EU;
- To design effective business models which can overcome the identified barriers and propose suitable on-bill schemes for the European context.

The upcoming RenOnBill publications will address the above-mentioned issues.

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