

VALUATION OF ENERGY EFFICIENCY MEASURES FOR ON-BILL SCHEMES



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POLICY FACTSHEET

Energy efficiency measures and their financial performance

Residential buildings use about 25%¹ of final energy consumption in the EU and existing buildings are one of the sectors with the highest potential for implementing energy efficiency measures. Proper exploitation of such large potential requires an accurate valuation of energy efficiency projects.

On-bill schemes as a way of financing energy renovation of buildings

On-bill schemes are innovative approaches to financing energy renovation of buildings relying on the utility bill as the repayment vehicle. On-bill investments can involve different project participants – utilities, governments, banks and homeowners – and combine their individual interests. In each on-bill investment, a utility company holds the central position of demand aggregator and, in some cases, of the investor. More about on-bill schemes can be found in the RenOnBill policy briefing '[On-bill schemes to deliver the Renovation Wave and economic recovery](#)' and in the RenOnBill paper '[Supporting energy efficiency measures in the residential sector](#)'.

Due to a long list of project participants, as well as the costs and benefits they perceive, valuation of on-bill schemes deserves special attention. To select the most appropriate and feasible investment, the valuation of a single on-bill project has to consider and combine its technical and financial aspects simultaneously.

Financial decisions differ significantly from decisions related to technical issues. While technical decisions rely mostly on time-independent and well-known inputs, such as physical properties of materials, financial decisions are not that straightforward. Financial valuation usually requires forecasts of different inputs, such as energy prices, that are never completely accurate. In addition, complexity is increased by the fact that common financial analysis tends to neglect project results that are not obvious and easily monetised.

¹ BPIE (2011). Buildings Performance Institute Europe. Europe's buildings under the microscope

Investment analysis is especially important in the light of the Renovation Wave and Recovery and Resilience Facility funds. Proper valuation of on-bill schemes may be crucial for an effective use of these funds and significantly support implementation of the national recovery and resilience plans, and especially of their green transition components.

Purpose of the paper



This paper will explain the financial valuation of on-bill investments and introduce some of the most important underlying topics. Special focus will be on the practical implementation of valuation steps and different perceptions project participants may have when analysing an on-bill investment. A chapter is devoted to the monetisation of non-energy benefits and their inclusion into project valuation.

Although potentially relevant for representatives of homeowners, the paper presents concepts that will most likely be used by governments, financial institutions and utility companies. In addition, the last chapter explains how governments can adopt these techniques effectively, but also how they can promote financial valuation among homeowners, financial institutions and utility companies.

FINANCIAL ANALYSIS

The financial analysis of on-bill investments is typically based on two distinctive steps:

1. Determining project cash flows, and
2. Discounting them. This approach results in a set of financial indicators used for the project valuation, such as net present value (NPV) and internal rate of return (IRR). A few underlying concepts of financial analysis, as well as NPV, IRR and their importance, are explained in the following chapters.

Project perception

Different project participants – governments, banks, utilities and homeowners – will perceive a single project in different ways and evaluate it using different valuation inputs and financial indicators. This is mostly because fundraising and project expectations are not the same for all project participants who may count on different cash inflows or outflows or use different rates when discounting them. Project perception can range from highly individual, in the case of a homeowner interested in home-related benefits, to a regional or even national view, as in the case of governments investing in national on-bill schemes.

Incremental approach

The financial analysis of energy renovation investments compares an investment scenario in which an investment is made and the project is executed, against a business-as-usual scenario without the project.² As a result of such a comparison, the investment valuation is based only on the incremental cash flows, i.e., the difference between cash flows generated by these two scenarios.

Cash flows

For a homeowner, typical cash inflows are savings on the energy bill from reduced energy consumption and/or switching to a cheaper energy source. Any inflow from energy efficiency improvements, such as a reduction in property taxes due to increased energy class,³ should be taken into account as well. Major cash outflows for the homeowner are repayments of debt and interest but may also include costs related to the maintenance of the implemented energy efficiency measures, such as a newly installed heating system.

For a utility company or financial institution, cash outflows will consist mostly of disbursed loans covering a part of or the complete initial investment, and cash inflows will include related collected debt and interest. While main cash outflows for governments may be on-bill related subsidies, guarantee fund contributions or even trainings provided to utilities or construction companies, inflows are much more difficult to identify. For this purpose, focusing on inflows from non-energy benefits, and especially on the benefits beyond an increased collection of value-added or profit taxes, may be crucial.

Initial investment is a form of cash outflow, usually distributed among several of the project participants, that includes all costs necessary to implement the project. Energy renovation will typically deal with replacement costs needed to replace existing with new machinery/equipment, where special care should be paid to possible cash inflow from replaced equipment's residual value.

Financial analysis should cover the complete project lifetime and is usually performed on an annual basis. Typical cashflow structures of investment projects imply high initial outflow through investment costs, and a series of annual net cash flows equal to cash inflows minus cash outflows. The frequency of cash flows deserves special attention – it can be annual in the case of energy savings or biennial in the case of maintenance costs.

Discount rates

As a general rule, a discount rate is the required rate of return on an investment, and as such will significantly depend on the market where the investment is evaluated. The discount rate could also be perceived as the interest rate an investor – a firm or an individual – can earn by investing somewhere else at a similar risk level; this introduces the issue of project opportunity costs.⁴

2 The business-as-usual scenario may include maintenance investments needed to keep the building at its pre-investment performance level.

3 As in the case of [reduction of property tax for energy-efficient buildings in Flanders, Belgium](#)

4 Opportunity cost is usually defined as the potential gain from the best alternative forgone.

Since different project participants may have different interests in the same project, they may use different discount rates for discounting their cash flows. For instance, a utility contributing to an on-bill project may be interested in how it performs against a non-energy-efficiency investment such as government bonds,⁵ and may therefore use the interest rate on the bonds as its discounting factor. A financier providing a loan may compare the internal rate of return of energy savings with the loan interest rate to confirm the project's financial risk. The same approach to risk assessment could be used by a government when considering the set-up of an on-bill guarantee fund⁶ to support an on-bill investment scheme.

Financial indicators

Net present value, or NPV, is the sum of the initial investment (INV) and discounted future cash flows (DCF) occurring during the operating life of the energy efficiency project. The NPV is calculated as:

$$NPV = -INV + DCF, \text{ and}$$

$$DCF = \sum_{i=1}^n \frac{CF_i}{(1+r)^i},$$

where n is the number of years in a project's operating life, CF_i cash flow in year i , and r the discount rate.

The NPV represents the value of the savings beyond the amount of the initial investment, implying that if its value is greater than zero, then the investment is profitable. The NPV provides a monetary amount and is affected by the size of the initial amount invested, i.e., larger investments lead to larger NPV. Projects should be undertaken starting from the one with the highest NPV, down to the lowest.

On the other hand, the internal rate of return (IRR) is the discount rate that would make the NPV equal to zero. Starting from the NPV definition, the IRR is the value of r satisfying the following equation:

$$\sum_{i=1}^n \frac{CF_i}{(1+r)^i} = INV.$$

The IRR represents a relative measure of profitability showing the percentage return per unit of invested capital, allowing comparison of different investments independently from their size. The decision rule here would be to accept all the investments that have an IRR higher than the required rate of return.

⁵ Government bonds are usually used as benchmarks since they are typically considered risk-free investments.

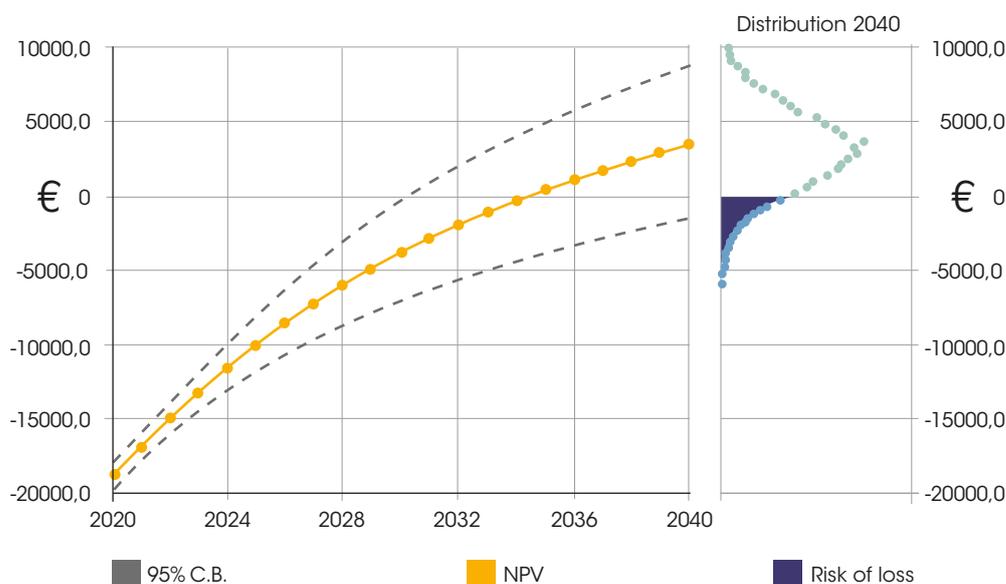
⁶ Used to cover complete or partial loss financiers may face when homeowners fail on debt servicing.

From a financial point of view, NPV is suggested as the main method of choice among different projects, while IRR can be used to complement the NPV analysis. The IRR would support the selection of projects with similar NPV and similar invested capital or could be used to indicate the safety margin of the project by comparing the difference between the IRR and the minimum required return.

Probabilistic approach

A financial analysis is usually based on inputs that cannot be taken as certain, such as cost of electricity, labour costs or weather conditions. In the case of on-bill and other energy efficiency investments this uncertainty is only increased by an extensive project lifetime.⁷ Another set of important inputs bringing uncertainty are the geometric and thermal properties of the targeted building stock and the efficiency or quality of the energy systems; these are usually represented by average values.

A possible solution to the uncertainty is the use of computer simulations designed to analyse and test solutions to investment decisions. One of the most frequently used simulation techniques is a Monte Carlo analysis that starts from a set of possible values for valuation inputs and results in a set of possible values for financial indicators, where each of these values is linked with its respective likelihood of materialising.



An example of applying the Monte Carlo technique to a project's NPV is presented in the graph above, showing how NPV values change with forecasted project life. The graph also explains that a 20-year project starting in 2020 has a 10% of chance of negative NPV, represented by the red area under the NPV frequency distribution (bell-shaped curve), implying 10% risk of loss.

⁷ Useful life of an on-bill investment may be over 20 years.

Inclusion of non-energy benefits

Besides energy bill cost savings, on-bill investments result in other important benefits for project participants and for society. Although their market value is usually unavailable, once included in valuation of on-bill investments these benefits may have a significant impact on valuation results.

Examples of non-energy benefits from on-bill investments range from comfortable homes with better indoor air quality or with higher market value, achievable at a local scale, to global benefits of reduced air pollution and reduced CO₂ emissions. Comfortable homes will help homeowners to have lower risk of respiratory illnesses or other chronic conditions and improve their quality of life, while reduced air pollution may prevent loss of crops and have a positive effect on ecosystems and human health in general.

Although non-energy benefits of on-bill investments may be easily identified, their monetisation can be a challenge. However, a recent increase in the importance of non-energy benefits has resulted in numerous studies⁸ providing reference unit costs and making their monetisation possible. A way of monetising non-energy benefits is by multiplying such unit costs with incremental non-energy effects. Taking CO₂ emissions as an example, this would mean multiplying the reduction in CO₂ emissions coming from an on-bill investment with the unit cost of damage associated with CO₂ emissions, as shown in **Table 1**.

Table 1: Monetised damage of carbon emissions (€/t CO₂e)

	2020	2030	2040	2050
High	69	96	146	231
Mid	40	54	79	121

Source: [European Investment Bank \(2013\)](#)

Another example of monetised non-energy benefits is the estimated reduction in government spending on public health due to reduced air pollution. In cases where on-bill interventions reduce energy consumption from fossil fuels, an assessment including energy generation technology, average weather conditions and conversion factors from Table 2 could determine the resulting reduction in hospital admissions due to respiratory infections. After considering an average cost per hospital admission, the reduction in government spending for public health systems could be determined.

⁸ Such as [ExternE project results](#)

Table 2: Exposure-response factors due to incremental air pollution

	Low	Mid	High
Change in annual hospital admissions for respiratory infections per 10,000 people, per change in annual PM ₁₀ concentration in [$\mu\text{g}/\text{m}^3$]	0.124	0.187	0.251
Change in annual symptom days, per 1000 people, per change in annual PM ₁₀ concentration in [$\mu\text{g}/\text{m}^3$]	221.9	465.0	686.9

Source: European Commission (1995). Externalities of Energy Vol. 4: Oil and Gas.

Since hospital admissions and symptom days may vary significantly, **Table 2** provides a range of potential values to be used. Mid values are those that can be expected in most cases, while low and high values are extreme values still possible but with a lower probability of occurrence.

RELEVANCE FOR GOVERNMENTS

Homeowners may be the least skilled when it comes to the evaluation of renovation projects. The majority of personal investments, including home renovations, are usually done without considering all project results, and without paying much attention to financial indicators. On the other hand, financial institutions and utilities may be proficient in financial analysis. However, peculiarities of on-bill investments, such as the complexity of inputs, may make their financial evaluation techniques incomplete. Finally, due to their primary focus on public finance, governments may not have sufficient capacities for the financial evaluation of investment schemes, which is especially true in the case of on-bill schemes where societal benefits may be significant.



To support proper evaluation of on-bill schemes, and to ensure adequate allocation of available funds, the RenOnBill project proposes governments undertake the following actions when setting up an on-bill renovation programme.



Developing their own on-bill project evaluation techniques

Although governments may contract external expertise for the evaluation of on-bill investments, such as when deciding on the level of subsidies, it is very important that governments themselves have certain level of skills for the same task. As a minimum, governments should be able to understand the underlying evaluation methodology and to critically review the analysis performed on their behalf.

To do so, governments could introduce policies and evaluation standards to be applied whenever considering their participation in an on-bill or energy efficiency programme, such as through subsidies or guarantee funds. Based on on-bill scheme features and the potential role of the government, such evaluation should ensure that all possible cash flows to and from government budgets are taken into account. Since government investments may affect a wide group of stakeholders, from local communities to whole industries, identification of relevant cash flows may require special attention.

Governments should carefully consider all non-energy costs and benefits of the on-bill investments. Firstly, a government could adopt some of the existing approaches and research results, such as those explained above, when monetising non-energy benefits and include them in project evaluation. In addition, governments could establish dedicated monitoring of non-energy benefits achieved over time and make their own, local market adapted estimates of non-energy benefits. Such an approach could include, for instance, monitoring of increases in property values or reduction in energy poverty. Eventually, and where possible, this could replace third-party estimates of non-energy benefits and significantly improve the accuracy of project valuation.

Preparing and promoting clear on-bill project evaluation guidelines

National governments could prepare clear and tailor-made on-bill project evaluation guidelines for different on-bill investment participants – banks, utilities and homeowners. Once prepared, such guidelines should be distributed to promote and further explain the on-bill evaluation approach presented in this paper.

Starting from the discounted cash flow (DCF) as a proposed project evaluation methodology, and from the specifics of the on-bill investments, a customised guideline should pay significant attention to project participants' level of expertise and different perceptions they may have on a single on-bill investment.

Regarding the on-bill investment details, the guideline should be able to clearly define all potential cash inflows and outflows a project participant may experience throughout the project life. Attention should be paid to cases where a cash inflow for one participant is equal to a cash outflow for the other, as in the case of reduced property taxes resulting in cash inflow for homeowners and cash outflow for government. Also, although more relevant for governments, cash flows linked to non-energy benefits should be considered by all project participants. An example could be improved health condition and quality of life for homeowners due to reduced energy poverty and increased indoor air quality.

Another point to consider is the proficiency in project analysis of different participants. While the guidelines for financial institutions and utilities may be highly technical and for example provide only references to relevant laws, guidelines for homeowners should be as clear as possible and based on simple and non-technical language. For instance, rather than their theoretical background, practical implications of different legal and technical aspects, such as details of potential reduction in property taxes due to improved

building performance, should be clearly explained to homeowners. However, no matter how different approaches to explaining the on-bill evaluation are, the guidelines must contain all relevant information without neglecting complex and difficult-to-explain topics.

GLOSSARY

Cash flow	Net amount of cash and cash equivalents being transferred to and from a non-energy company/individual. Cash received represents inflows, while money spent represents outflows.
Discount rate	The interest rate used in discounted cash flow (DCF) analysis to determine the present value of future cash flows.
IRR	The internal rate of return (IRR) is a metric used in financial analysis to estimate the profitability of potential investments. The IRR is a discount rate that makes the NPV of all cash flows equal to zero in a discounted cash flow analysis.
Non-energy benefits	Different benefits originating from energy efficiency investments in addition to the energy savings. These may include reduced energy poverty, increase in employment rates, or reduced air pollution.
NPV	The net present value (NPV) equals the difference between the present value of cash inflows and outflows over a period of time and is used in investment planning to analyse its profitability.
On-bill scheme	A method of financing energy efficiency improvements using the utility bill as the repayment vehicle.
Recovery and Resilience Facility	A temporary European Commission instrument to raise funds and help repair the economic and social damage from the coronavirus pandemic.
Recovery and Resilience Plans	Plans prepared by the Member States to explain how they would benefit from the Facility. A plan should explain reforms and investments to be implemented by end of 2026.
Utility company	A company which supplies utilities, such as gas, electricity, water, phones and similar.



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