Interreg CENTRAL EUROPE
European Union
European Regional Development Fund
TOGETHER

CE51 TOGETHER

TRAINING MATERIAL ON ENERGY EFFICIENCY IN PUBLIC BUILDINGS

Financial aspects

The training material, which is included in this publication, has been developed within the **TOGETHER** project (full name: **Towards a goal of efficiency through energy reduction**), co-funded by the Interreg CENTRAL EUROPE programme, which encourages cooperation on shared challenges in Central Europe. The project, implemented from June 2016 till May 2019, aims at promoting the concept of integrated energy management in public buildings through implementation of selected technical, DSM and financial measures in 85 pilot buildings from different EU countries. The training material focuses on financial aspects related to the overall topic of energy efficiency in public buildings. It is completed with 2 other publications - focusing respectively on technical and DSM issues.

Deliverable no: D.T1.2.2

Deliverable name: Training material on economy and finance of EE and RES

Author: Province of Treviso

Editing: Association of Municipalities Polish Network "Energie Cités"

March 2017

INTRODUCTION

This publication contains the training material on the economics and financing of energy efficiency in public buildings developed within the TOGETHER project, co-funded from the Interreg CENTRAL EUROPE programme. The project supports implementation of the concept of **integrated energy management** in public buildings through implementation of selected technical, DSM and financial measures in 85 pilot buildings from different EU countries.The measures implemented will lead to significant reduction of energy consumption and change of behaviour of building users.

An important part of the project was focused on the development of a comprehensive, transnational training model and material that could be used to increase knowledge, capacities and skills of building owners, managers and decisions makers, enabling them to successfully implement sustainable energy measures in their buildings and to engage users in this process.

The training material prepared by the consortium discusses wide variety of topics, which fall under three main categories: technical aspects, financial aspects and DSM aspects, where DSM stands for "demand side management" and concerns users' behaviours and energy management practices. This publication contains the training material focusing on **economics and financing of energy efficiency measures and solutions** implemented in public buildings. It is complemented by two other publications - one concentrating on technical aspects of the process (such us an energy audit, thermal retrofitting of the envelope, modernisation of internal installations, installation of RES, choosing optimal EE improvement scenario) and the other one - on DSM aspects (changing users' behaviours and application of ICT technologies for optimisation of energy consumption).

The **financial training material** aims at increasing trainees' knowledge, skills and capacities regarding financial aspects related to EE in public buildings, with the specific focus on the selection of most proper financing schemes, development of good quality project documentation and selection and monitoring of proper economic/financial indicators. The material has been divided into 8 training modules presented in the table below:

Module no	Module topic
Module 1	EU, national and regional financing schemes
Module 2	Alternative financing methods
Module 3	Economic and financial assessment of the investment
Module 4	Development of the financial documentation of the project
Module 5	Ensuring project bankbility, viability and profitability
Module 6	Attracting & cooperation with potential investors
Module 7	Choosing optimal funding for EE projects
Module 8	Tendering procedures and green public procurement

For each module there is a comprehensive theoretical introduction accompanied by at least one exercise and a set of guiding questions allowing the trainees to test new knowledge gained. In order to support the trainers in the preparation of respective training sessions there are also included further suggestions concerning e.g.:

- list of reference material that can be consulted to elaborate specific topics in more detail;
- other relevant issues that could be raised and discussed with the trainees
- suggestions for further exercises and practical application of new knowledge and skills.

The publication is also accompanied by **model PPT slides** that may be used by trainers during their work.

What is very important about the TOGETHER training material, is that it not only provides knowledge but also addresses practical aspects related with financing EE investments and ensuring their economic viability and profitability. For those, who would like to learn more about the issues raised here, the TOGETHER consortium developed special on-line library, which is a repository of existing materials and tools on energy use and energy efficiency in public buildings, including related economics. It can be accessed from the project website: http://www.interreg-central.eu/Content.Node/TOGETHER.html

LIST OF CONTENT

PART 1:
TRAINING MODULES

MODULE 1: EU, NATIONAL AND REGIONAL FINANCING SCHEMES

EUROPEAN FUNDS AND PROGRAMMES

EU budget is closely linked to the five priorities of the EU 2020 strategy: employment; research and development; climate/energy; education; social inclusion and poverty reduction. The most important funding instruments that finance sustainable energy investments (hard measures) are the European **Structural** and **Investment Funds** that are co-managed by the European Commission and Member States. The **European Investment Bank** is also becoming more and more active in financing local energy transition and climate projects. This funding could give a significant boost to local energy transition.

The EU budget is limited and will never be sufficient if disbursed in the form of grants. The objective is to progressively move from grants to revolving financing instruments such as loans, guarantees and innovative financial instruments, in particular for projects that are viable on the current market. Public budget will be used as a seed money to trigger much bigger private investments.
Source: Infinites European funds and sources - http://www.energy-cities.eu/European-funds-and-programmes

European Structural and Investment Funds 2014-2020, are a package of funds delivered through Operational Programmes (OP) negotiated by regional authorities with the European Commission.

Each OP defines strategic goals and investment priorities for each region and country involved.

The OPs are managed by authorities at national or regional level in the partnership with the European Commission.

Within the European Structural and Investment Funds the **ERDF** and **Cohesion funds** are the instruments that generally provide major funding for EE Energy Efficiency measures:

- **European Regional Development Fund (ERDF)** aims to strengthen economic and social cohesion in the European Union by correcting imbalances between its regions -> one of the major funding instruments are the European Territorial Cooperation Programmes (INTERREG)
  http://ec.europa.eu/regional_policy/en/funding/erdf/

- **Cohesion Fund (CF)** is aimed at Member States whose Gross National Income (GNI) per inhabitant is less than 90 % of the EU average. It aims to reduce economic and social disparities and to promote sustainable development. The Cohesion Fund can also support projects related to energy or transport, as long as they clearly benefit the environment in terms of energy efficiency, use of renewable energy, developing rail transport, supporting intermodality, strengthening public transport, etc.

  For the 2014-2020 period, the Cohesion Fund concerns Bulgaria, Croatia, Cyprus, the Czech Republic, Estonia, Greece, Hungary, Latvia, Lithuania, Malta, Poland, Portugal, Romania, Slovakia and Slovenia.
  http://ec.europa.eu/regional_policy/en/funding/cohesion-fund/

Before proceeding, a brief set of definitions regarding the most common types of capital should be presented for a better comprehension of the various types of investment funds that shall follow:

- **grant:** funds provided by regions, countries, foundations etc which need not be repayable;
- **equity:** own capital provided directly by the contractor for the realization of the measures;
- **debt:** capital lent from others in the form of loans, obligations etc senior debts must be repaid first while subordinated debts rank after other debts and bonds in the hierarchy of creditors;
- **mezzanine debt capital** generally refers to that layer of financing between a company's senior debt and equity, filling the gap between the two. Structurally, it is subordinate in priority of payment to senior debt, but senior in rank to common stock or equity (for more information: http://pages.stern.nyu.edu/~igiddy/articles/Mezzanine_Finance_Explained.pdf - Mezzanine Finance - NYU Stern School of Business)

EUROPEAN INVESTMENT FUNDS

European Energy Efficiency Fund (eeef)

The European Energy Efficiency Fund (eeef) targets investments in the member states of the European Union. The final beneficiaries of **eeef** are municipal, local and regional authorities as well as public and private entities acting on behalf of those authorities such as utilities, public transportation providers, social housing associations, energy service companies etc. Investments can be made in Euro, or local currencies, however the latter is restricted to a certain percentage.

To reach its final beneficiaries, eeef can pursue two types of investments:

- **Direct Investments**

  These comprise projects from project developers, energy service companies (ESCOs), small scale renewable energy and energy efficiency service and supply companies that serve energy efficiency and renewable energy markets in the target countries.

  Investments in energy efficiency and renewable energy projects in the range of €5m to €25m.

  Investment instruments include senior debt, mezzanine instruments, leasing structures and forfeiting loans (in cooperation with industry partners).
  Also possible are equity (co-)investments for renewable energy over the lifetime of projects or equity participation in special purpose vehicles, both in cooperation directly with municipalities, or with public and private entities acting on behalf of those authorities.
  Debt investments can have a maturity of up to 15 years, equity investments can be adapted to the needs of various project phases
  The Fund can (co-)invest as part of a consortium and participate through risk sharing with a local bank

- **Investments into Financial Institutions**

  These include investments in local commercial banks, leasing companies and other selected financial institutions that either finance or are committed to financing projects of the Final Beneficiaries meeting the eligibility criteria of eeef.
  Selected partner financial institutions will receive debt instruments with a maturity of up to 15 years.

These instruments include:

- senior debt
- subordinated debt
- guarantess

Specifications:

- No equity investments in financial institutions.
- Financial institutions onlend to the beneficiaries of the Fund meeting the eligibility criteria to finance energy efficiency and/or renewable energy projects

Source: eeef European Energy Efficiency Fund - http://www.eeef.lu/eligible-investments.html

European Fund for Strategic Investments (EFSI)

EFSI is an initiative launched jointly by the **EIB** Group - **European Investment Bank** and **European Investment Fund** - and the European Commission to help overcome the current investment gap in the EU by mobilising private financing for strategic investments.

With **EFSI** support, the EIB Group will provide funding for economically viable projects where it adds value, including projects with a higher risk profile than ordinary EIB activities. It will focus on sectors of key importance where the EIB Group has proven expertise and the capacity to deliver a positive impact on the European economy, including:

- Strategic infrastructure including digital, transport and energy
- Education, research, development and innovation
- Expansion of renewable energy and resource efficiency
- Support for smaller businesses and midcap companies

For information on how to apply for a loan under EFSI see

http://www.eib.org/efsi/how-does-a-project-get-efsi-financing/index.htm

Private Finance for Energy Efficiency (PF4EE)

Private Finance for Energy Efficiency (PF4EE) instrument is a joint agreement between the EIB (European Investment Bank) and the European Commission which aims to address the limited access to adequate and affordable commercial financing for energy efficiency investments.

The instrument targets projects which support the implementation of National Energy Efficiency Action Plans or other energy efficiency programmes of EU Member States.

The PF4EE instrument’s two core objectives are:

- to make energy efficiency lending a more sustainable activity within European financial institutions, considering the energy efficiency sector as a distinct market segment;
- to increase the availability of debt financing to eligible energy efficiency investments.

The instrument is managed by the EIB and funded by the Programme for the Environment and Climate Action (LIFE programme).

The PF4EE instrument will provide long-term financing from the EIB (EIB Loan for Energy Efficiency) and expert support services for the Financial Intermediaries (Expert Support Facility).

Source: http://www.eib.org/products/blending/pf4ee/index.htm

Technical Assistance For Project Development

Project realisation may be fostered with lighter instruments such as **grants for technical assistance**, in this case the funding is related to feasibility and market studies, programme structuring, business plans, energy audits and financial structuring. In other words, no money for project activities but only (a minor fraction) for a sound project development through a preliminary study.

ELENA - supporting investments in energy efficiency and sustainable transport

ELENA is a joint initiative by the EIB and the European Commission under the Horizon 2020 programme and provides grants for technical assistance focused on the implementation of energy efficiency, distributed renewable energy and urban transport projects and programmes.
The grant can be used to finance costs related to feasibility and market studies, programme structuring, business plans, energy audits and financial structuring, as well as to the preparation of tendering procedures, contractual arrangements and project implementation units.

Typically, ELENA supports programmes above EUR 30 million over a period of around 2-4 years, and can cover up to 90% of technical assistance/project development costs. Smaller projects can be supported when they are integrated into larger investment programmes. The annual grant budget is currently around EUR 20 million. Projects are evaluated and grants allocated on a first-come-first-served basis.

ELENA may co-finance the following investments field of Energy efficiency and distributed renewable energy:

- public and private buildings (including social housing), commercial and logistic properties and sites, and street and traffic lighting to support increased energy efficiency
- integration of renewable energy sources (RES) into the built environment – e.g. solar photovoltaic (PV) on roof tops, solar thermal collectors and biomass
- investments into renovating, extending or building new district heating/cooling networks, including networks based on combined heat and power (CHP), decentralised CHP systems
- local infrastructure including smart grids, information and communication technology
- infrastructure for energy efficiency, energy-efficient urban equipment and link with transport

source: http://www.bei.org/products/advising/elena/index.htm

Horizon 2020 (Call EE-22-2016-2017 _ Project Development Assistance

Horizon 2020 is the biggest EU Research and Innovation programme ever with nearly €80 billion of funding available over 7 years (2014 to 2020). The project development assistance call may be summarized as follows.

Target group:

public and private project promoters (e.g. public authorities or their groupings, public/private infrastructure operators and bodies, energy service companies (ESCOs), retail chains, estate managers and services/industry).

Aim:

Launch of concrete sustainable energy investment projects¤ and innovative financing solution schemes (focus: capturing untapped high energy efficiency potentials) Building technical, economic and legal expertise.

Proposals should:

- Lead to investments launched before end of the action, i.e. signed contracts (or launched tendering procedures as appropriate) Every million Euro of H2020 support should trigger investments worth at least EUR 15 million (1:15). Have an exemplary/showcase dimension in their ambition¤ (i.e. reduced energy consumption and/or investment size)
- Deliver organisational innovation in financial engineering¤ (e.g. on-bill financing schemes, guarantee funds, factoring funds) and/or mobilisation of investment programme (e.g. bundling, pooling)
- Demonstrate high degree of replicability and include clear action plan to communicate across EU towards potential replicators

Source: National Contact Points: http://ec.europa.eu/research/participants/portal/desktop/en/support/national_contact_points.html

There are many types of programmes with various measures, identifying the most appropriate funding opportunity is difficult, especially for non professionals, the method proposed by the **INFINITE Solutions project** supported by the Intelligent Energy Europe programme is very helpful because it focuses on the kind of activity are you searching funding for providing a set of funds/programmes for each activity.

The process is based on four types of activities:

1. **Soft activities**
2. **Human resource skills**
3. **Project development assistance**
4. **4Investments**

Soft activities

Exchange of experience, transfer of knowledge, peer learning, networking, organisation of events, preparation of energy and climate strategies & actions plans, research & studies, implementation of pilot and demonstration projects, development of innovative products, services, initiatives, business models and financing schemes, communication campaigns and involvement of stakeholders, etc.

Human resource skills

Trainings and education, reskilling qualified workforce, up-scaling skills, recruitment of experts, development of training programmes, etc.

Project development assistance

Preparation of investments, recruitment of new staff and experts, market studies, feasibility studies, energy audits, preparation of tendering procedures and contractual arrangements, structuring of business plans, etc. Hardware costs are excluded.

Investments

Hard measures such as retrofitting of buildings, new buildings, public lighting, production of renewable energy, district heating and cooling, cogeneration, etc

For details go to

http://www.energy-cities.eu/European-funds-and-programmes

Reminder

Proposals require time, effort and money, average success rates of proposals are low, preparing a good proposal is vital, no matter what your commitment level is (major project developer or partner).

What helps project proposals approval:

- clear assessment of the programme/call objectives
- development of successful ideas
- good partnerships and networking
- knowledge of PCM Project Cycle Management (programming, identification, formulation, implementation) technique

CHECK LIST

- read the programme documentation (not just the call documentation);
- make sure that the project idea concretely matches the requirements and objects of the call;
- check that the proposal is aligned with evaluation criteria (ask yourself what evaluators check);
- verify the project network and evaluate each partner's role carefully;
- when a proposal matches the call's requirements then descriptions are concise and precise;
- control overall coherence of project objectives, indicators and deliverables;
- review the work programme (Work Packages and Gannt);
- verify that the budget is coherent with the work programme;
- do not underestimate general project management and reporting;
- verify that project cash flows and final balance are financially sustainable

FURTHER SUGGESTIONS FOR TRAINERS

Focus on what kind of funding is desired, generally the most wanted type of funding is:

- grants (a)
- then -> funding through debt (borrowing) (b)
- least interesting -> grants limited to the technical assistance (c) that should trigger further investments

For example, in Horizon a 1 million grant for technical assistance is inspected to mobilise investments for at least EUR 15 million (1:15) which is very different from receiving a grant covering 85% for all project costs.

MODULE 2: ALTERNATIVE FINANCING METHODS

No matter where the funding comes from or what kind of scheme is used, when it comes to energy efficiency measures in buildings, you always have to start from an **energy usage baseline** and need a **projection of savings**.

DEFINITIONS AND FINANCING OPTIONS

Baselining

A sound energy usage baseline is the starting point for accurate projection of potential energy savings as well as for measurement after retrofits and/or retro-commissioning. A baseline should indicate how much fuel and electricity a building can be expected to use in a day given heating and cooling conditions and occupancy of the building (and potentially other influential factors).

Savings Projections

Savings calculations for projects of significant scale must be based on a calibrated building simulation model that meets the per-defined procedural requirements. Once the simulation model is established and calibrated, iterative runs are conducted for individual measures. The total package of all measures must be run together for the final projection of package energy reductions.

Once baselining and savings projections have been accomplished, the next step is the evaluation process of possible financing methods.

As in all investments, the starting question is: “have we got the money?”

Financing energy efficiency measures in buildings generally leads to three major available options:

1. **Self-financing**
2. **Dept-financing**
3. **EPC Energy Performance Contracting**

Self-financing

This case is becoming rare in many EU countries where budget constraints on public spending have consistently reduced the capacity of public bodies to carry out investments directly with their own budget. Nonetheless, when possible, 100% self-financing enables the public contractor (municipality, school etc) to avoid debt maintaining positive cash flows from the savings from each energy efficiency project.

Savings can be put into a revolving fund in order to finance other renovations or energy efficiency measures.

The revolving fund mechanism focuses generally on low-cost, high-impact projects such as exterior and interior lighting retrofits, PC energy management, window film, heating, ventilation, and air conditioning (HVAC) control upgrades etc.

The idea of a revolving fund has been extensively developed by the Municipality of Stuttgart through an internal Contracting scheme within the INFINITE Solutions project co-financed by the European Commission within the framework of the IEE Programme

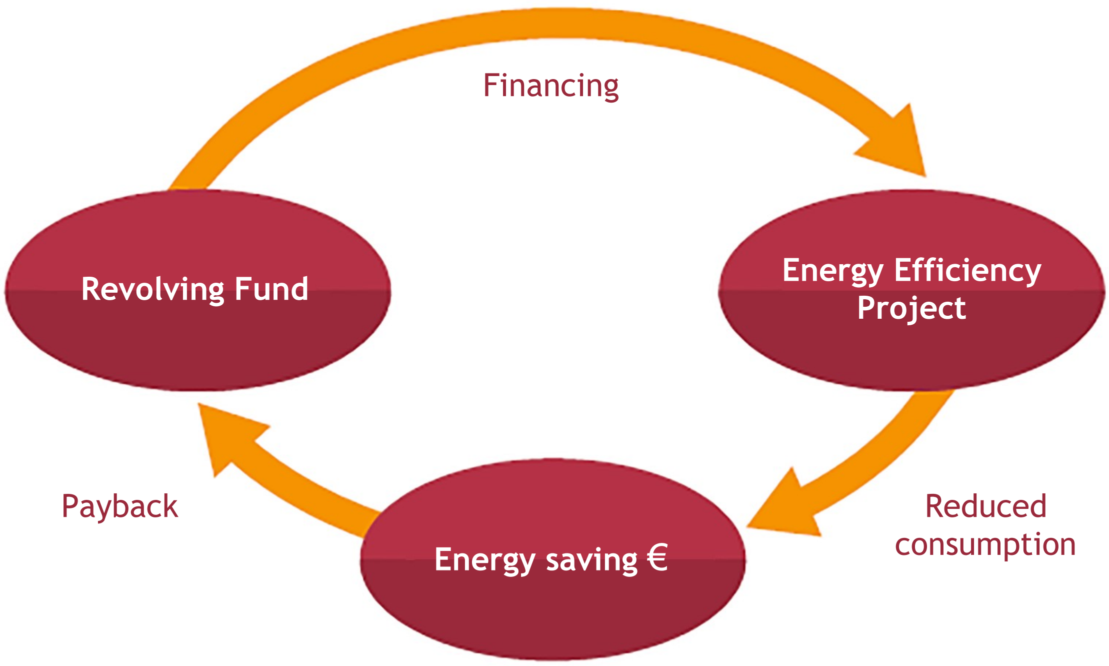
Source.: http://www.energy-cities.eu/spip.php?page=infinitesolutions_en

The idea of **Internal Contracting**, often called **Intracting** (municipal internal performance contracting scheme), is to enable the municipality to finance multiple investments for energy savings without being tied to an external contractor. This requires that a revolving fund be setup.

A revolving fund is a self replenishing pool of capital, which only needs to be supplied once. Its name derives from the revolving aspect of its investments and repayments: the central fund is replenished by income from its investments, creating the opportunity to continuously finance new investments from year to year. Its funds are intended to remain available with no fiscal year limitation.

Adapted for the specific purpose of realising energy savings, the revolving fund as a financial buffer is incorporated into a simple cycle of financing energy saving measures and paying back the cost of these investments through reduced energy costs.

This is the core of Internal Contracting, which is shown in the figure that follows



Source. n.1: Infinite Solutions Guidebook Financing the energy renovation of public buildings through Internal Contracting - http://www.energy-cities.eu/spip.php?page=infinitesolutions_en

Dept-financing

Dept financing of EE (Energy Efficiency) projects has become increasingly difficult in many EU countries due to budget constraints, nowadays public building owners mainly concentrate on off balance operations. Nonetheless, in cases where dept financing is possible, financing sources (banks, investors etc) require confidence on the project performance through the entire life cycle (confidence therefore on savings and cash flows over the years). A sound and complete technical/financial plan with a clear definition of the complete process necessary to ensure performance from initial audit through ongoing commissioning and M&V (Measurement & Verification) will be needed for the bankability of the EE project.

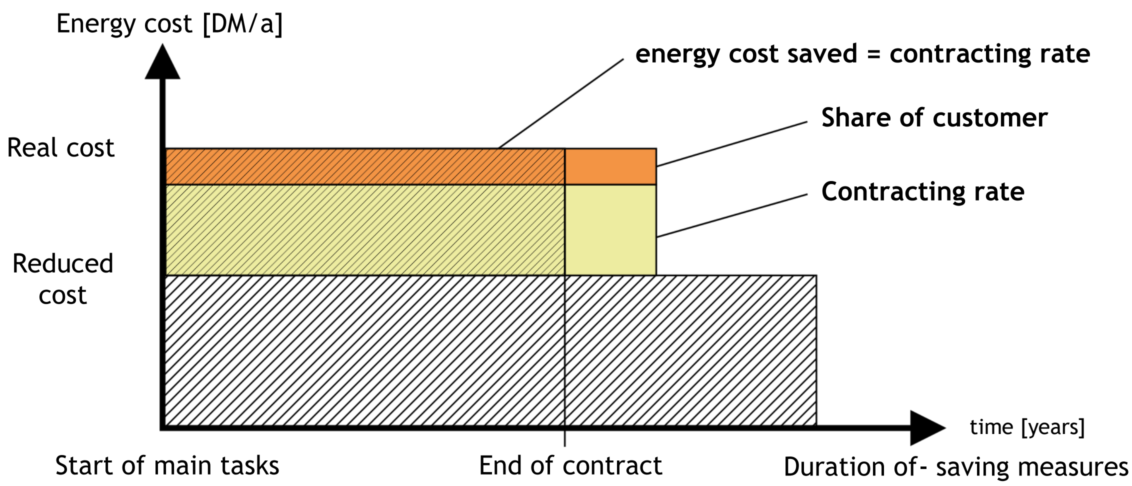
From a technical point of view, the most common debt based financing instruments are:

- loans from banks that come in a large variety of types and always imply debt and interest rates;
- bond issuing, which in general terms, is a debt instrument issued by the public body in order to to raise money. The issuer must pay a fixed amount each year until the certificate of debt reaches its predetermined maturity date;
- leasing, in most cases, in effect, is a hire-purchase agreement without the requirement of an initial deposit.

EPC Energy Performance Contracting

Under an EPC arrangement an external organisation (ESCO) implements a project to deliver energy efficiency, or a renewable energy project, and uses the stream of income from the cost savings, or the renewable energy produced, to repay the costs of the project, including the costs of the investment. Essentially the ESCO will not receive its payment unless the project delivers energy savings as expected.

The approach is based on the transfer of technical risks from the client to the ESCO based on performance guarantees given by the ESCO. In EPC, ESCO remuneration is based on demonstrated performance; a measure of performance is the level of energy savings or energy service. EPC is a means to deliver infrastructure improvements to facilities that lack energy engineering skills, manpower or management time, capital funding, understanding of risk, or technology information. Cash-poor, yet creditworthy customers are therefore good potential clients for EPC.



Source.: Berliner Energieagentur GmbH

There are numerous ways to structure an EPC contract, a brief description of the four major schemes follows:

- **guaranteed savings contract_** the **ESCO** takes over the **entire performance and design risk**; for this reason it is unlikely to be willing or able to further assume credit risk. The customers are financed directly by banks or by a financing agency; an advantages of this model is that finance institutions are better equipped to assess and handle customer's credit risk than ESCOs'. The customer repays the loan and assumes the investment repayment risk. If the savings are not enough to cover debt service, then the ESCO has to cover the difference. If savings exceed the guaranteed level, then the customer pays an agreed upon percentage of the savings to the ESCO. In this case there's a debt financing for the customer;
- **shared savings contract_** the **client** takes over **some performance risk**, hence it will try to avoid assuming any credit risk. The **ESCO** assumes **both performance** and the underlying customer **credit risk**, if the customer goes out of business, the revenue stream from the project will stop, putting the ESCO at risk. In addition such contractual arrangement may give raise to leveraging problems for ESCOs, because ESCOs become too indebted and at some point financial institutions may refuse lending to an ESCO due to high debt ratio. In effect the ESCO collateralizes the loan with anticipated savings payments from the customer, based on a share of the energy cost savings. The financing in this case goes off the customer's balance sheet;
- **chauffage contract** where an ESCO takes over complete responsibility for the provision to the client of an agreed set of energy services (e.g. space heat, lighting, motive power, etc.). This arrangement is an extreme form of energy management outsourcing. Where the energy supply market is competitive, the ESCO in a chauffage arrangement also takes over full responsibility for fuel/ electricity purchasing. The fee paid by the client under a chauffage arrangement is calculated on the basis of its existing energy bill minus a percentage saving (often in the range of 5-10 %). Thus the client is guaranteed an immediate saving relative to its current bill. The ESCO takes on the responsibility for providing the agreed level of energy service for lower than the current bill or for providing improved level of service for the same bill. The more efficiently and cheaply it can do this, the greater its earnings: chauffage contracts give the strongest incentive to ESCOs to provide services in an efficient way;
- **BOOT (Build-Own-Operate-Transfer)** model may involve an ESCO designing, building, financing, owning and operating the equipment for a defined period of time and then transferring this ownership across to the client. This model resembles a special purpose enterprise created for a particular project. Clients enter into long term supply contracts with the BOOT operator and are charged accordingly for the service delivered; the service charge includes capital and operating cost recovery and project profit. BOOT schemes are becoming an increasingly popular means of financing CHP projects in Europe.

Source: JRC Joint Research Centre

http://iet.jrc.ec.europa.eu/energyefficiency/european-energy-service-companies/energy-performance-contracting

Guaranteed VS shared savings reference table

Guaranteed savings	Shared savings
Performance related to level of energy saved Value of energy saved is guaranteed to meet debt service obligations down to a floor price ESCO carries performance risk Energy-user/customer carries credit risk If the energy-user/customer borrows, then debt appears on its balance sheet Requires creditworthy customer Extensive M&V ESCO can do more projects without getting highly leveraged More comprehensive	Performance related to cost of energy saved; the ESCO bills upon actual results Value of payments to ESCO is linked to energy price; betting on price of energy can be risky ESCO carries performance and credit risk as it typically carries out the financing Usually off the balance sheet of energy-user/customer Can serve customers that do not have access to financing Equipment may be leased Favours large ESCOs; small ESCOs become too leveraged to do more projects Favours projects with short payback ('cream skimming') How to share the 'excess' savings

Source: Dreessen 2003, Hansen 2003 and 2004, Poole and Stoner 2003

When **off balance EPCs** have to be applied to public buildings, the main components are:

- public private cooperation between a public building owner and an ESCO, which is usually operating as a commercial entity even if owned by e.g. a public utility;
- ESCOs perform as general contractors providing all services and goods from one single source;
- ESCOs and public building owners define the baseline energy consumption of the building(s) under specific conditions, as well as on the method of evaluation and verification of these energy savings taking into account variations e.g. in weather conditions and building use in a systematic, transparent, and verifiable way;
- ESCOs guarantee at their own risk the achievement of the agreed energy saving objectives and bear accountability for all investment costs;
- public building owners guarantee the payment of agreed EPC services depending on the achievement of agreed energy services

The most common EPC business model aims at the facilitation of investments in technical energy conservation measures (ECM) and is financed, usually in whole, from guaranteed energy savings over a contracting period of typically 5-15 years. In line with the definition of the European Energy Service Initiative (EESI), this standard model is called “EPC basic” . The EESI defines two additional business models: EPC light: Improvements of EE are mainly achieved by means of energy management measures with little or no¤ investment in technical facilities. EPC plus: Services of the ESCO are extended to comprehensive structural measures on the building shell like insulation or window replacement, but also necessary constructional measures without energy saving potentials.

Source: EnPC-INTRANS Capacity Building on Energy Performance Contracting in European Markets in Transition (GA N°649639)

http://www.enpc-intrans.eu/wp-content/uploads/2015/07/EnPC-INTRANS-D4-4-Manual-EN-final.pdf

CHECK LIST

- identify a complete range of technical interventions that may improve the EE of the building
- determine the energy savings for each type of intervention
- identify all feasible financial instruments which may be used
- is the operation ON or OFF balance
- how is the risk (performance, design and credit) allocated between the operators involved (e.g. Building owner, ESCO, bank)

FURTHER SUGGESTIONS FOR TRAINERS

Once the energy efficiency measures are defined together with the usage baseline and the projection of savings, **focus** on **where** the **money** comes from, funding generally comes in three major options:

- **Self-financing**
- **Dept-financing (borrowing from banks or other financial institutions)**
- **EPC Energy Performance Contracting**

MODULE 3: ECONOMIC AND FINANCIAL ASSESSMENT OF THE INVESTMENT

Once we've worked out the figures of the projected savings stemming from the investment in EE Energy Efficiency measures, benefits in the form of avoided costs from reductions in energy bills together with the ones related to the investment, debt service and life long maintenance an **economic & financial assessment** of the investment should be carried out.

The economic & financial assessment of a project goes beyond understanding whether an investment is convenient or not, it also provides a method to understand how to select the best investment in the case of different projects and different financing schemes, and is always a fundamental support for the general understanding the project.

The most common assessment methods (indicators) used are:

- NPV Net Present Value
- IRR Internal Rate of Return
- Simple payback period
- Discounted payback period

NPV (NET PRESENT VALUE)

It all starts from the **time value of money** .... instinctively we know that 1000€ received today are not equal to the same amount (1000€) to be received in 5 years, in other words it is better to have 1000€ cash today than, for example, a bond that assures the right to receive 1.000€ in 5 years from now.

There are three reasons why a euro tomorrow is worth less than a euro today:

- individuals prefer present consumption to future consumption
- when there is money inflation, the value of currency decreases over time
- if there is any uncertainty (risk) associated with the cash flow in the future, the less that cash flow will be valued

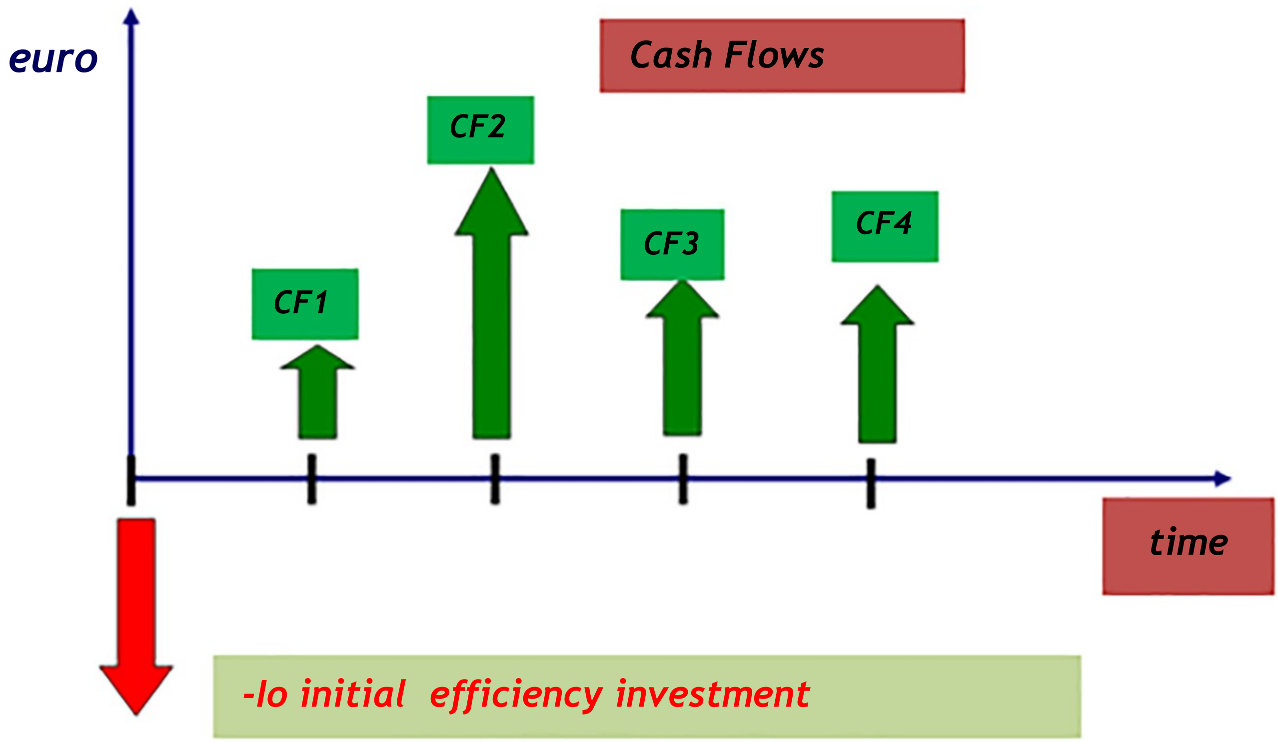
source: Aswath Damodaran:The time value of money, New York University

The time value of money means that the same amount of money has a different value over time which leads to the general concept on interest rate… e.i. renouncing to 1.000€ cash today, buying a bond that will payback 1.100 after a year: 1.000 (capital) + 100 (10% interest rate in 1 year on 1.000€) means that the **"price"** to renounce to 1.000€ cash for 1 year is 100€ or 10% **interest rate**.

The interest rate is therefore the means by which the equivalence of the value of money in time is realized.

Consider an energy efficiency investment **(-Io)** that yields 4 positive cash flows **(CFi)** for the next 4 years:

Earning = (CF1 +CF2 + CF3 + CF4) - Io = $\sum_{j=1,4}(FC_j)$ **- Io**

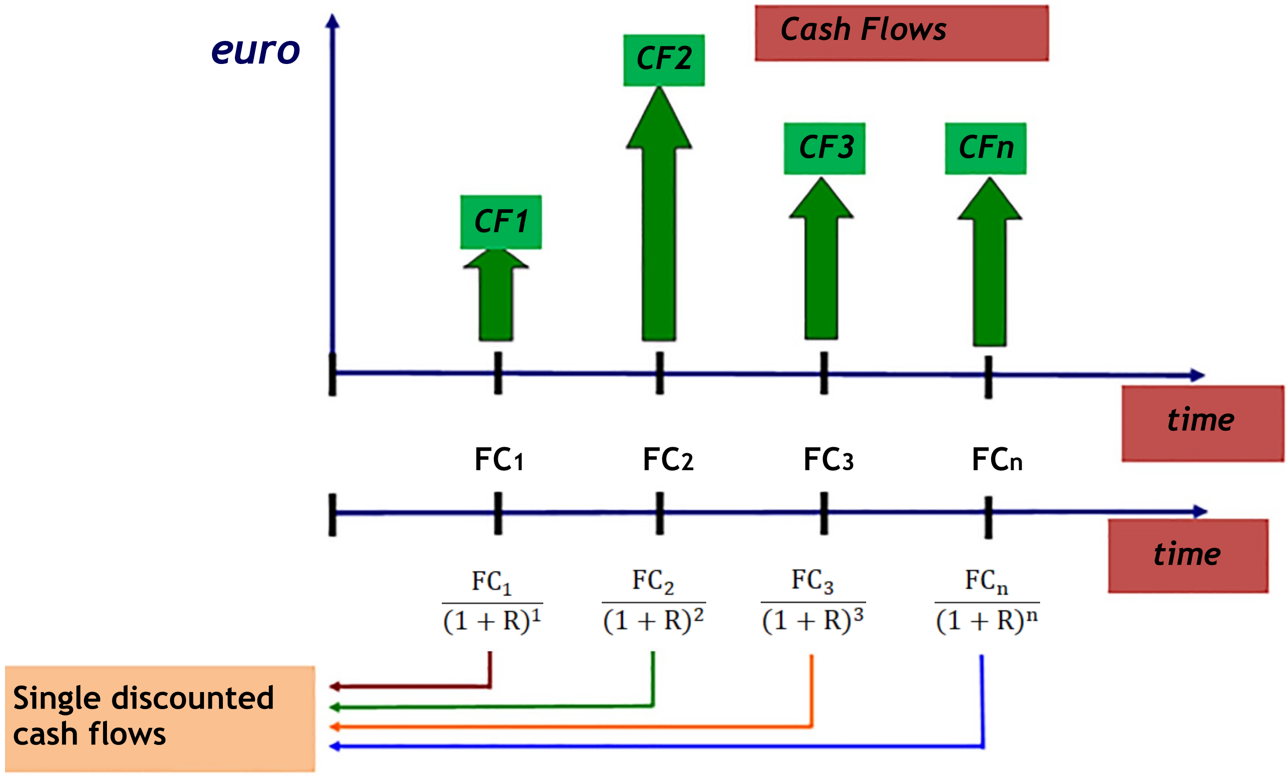


If the value of money were zero then interest rates would be zero and consequently this is the only condition when the formulae above is correct, otherwise in order to proceed correctly cash flows should be discounted. The time value of money leads to **compounding** and **discounting**.

Compounding and Discounting

The **PV Present Value** of a certain cash flow at a certain period (t) is = **CFt / (1+r)**^{t} this means discounting with “r” interest rate, at a “t” cash flow period, e.g. with r =5% interest rate per year and t = 4 years **PV equals** $CF_4/(1+5\%)^4$.

With more cash flows, the PV Present Value is the sum of all the discounted cash flows:



$$\text{Present Value PV} = \sum_{j=1}^{n} \frac{CFj}{(1+R)^n} \quad \dashrightarrow \quad NPV = \sum_{j=1}^{n} \frac{CFj}{(1+R)^n} - Io\ \text{(Initial Investment)}$$

The NPV Net Present Value is equal to PV - Io: the sum of all the discounted positive cash flows generated by the investment **MINUS** the initial investment **(-Io).**

NPV metric is an absolute measure expressed in € and is best used when comparing the profitability between projects of a similar scale for a straightforward comparison.

If **NPV >=0** _accept because the sum of all the discounted positive cash flows generated by the investment project cover the initial investment (-Io)

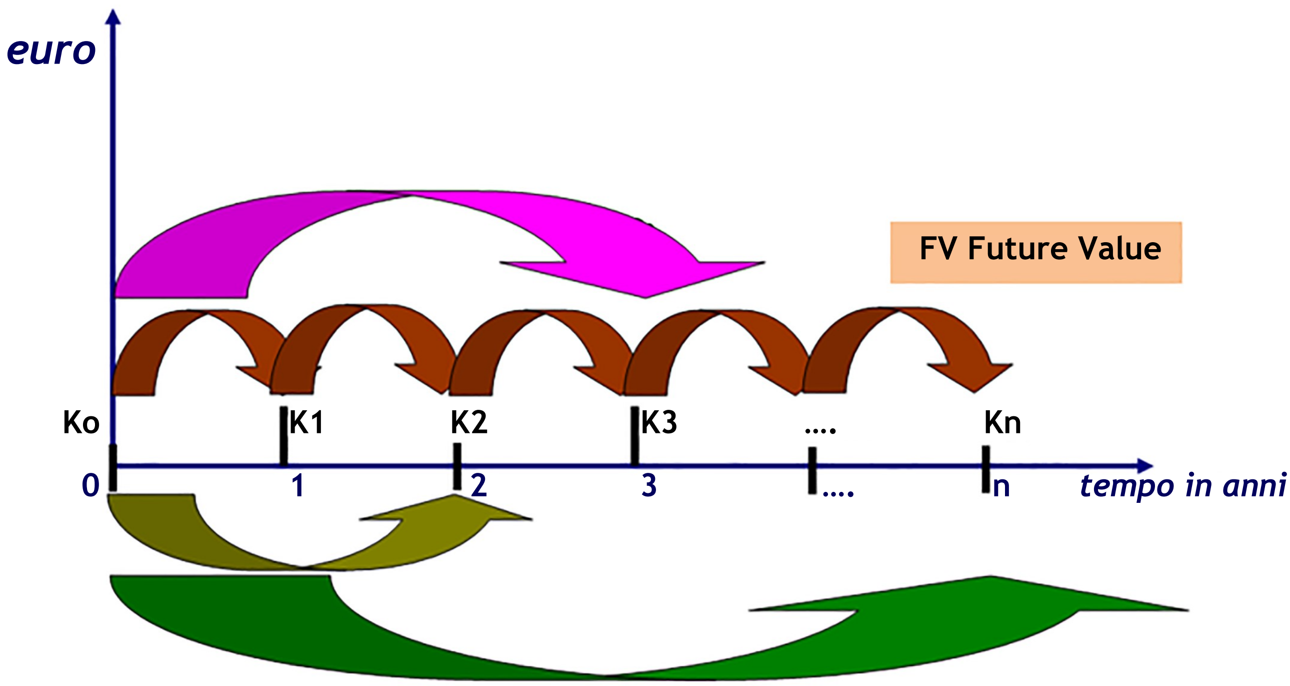
If **NPV<0** _refuse because the sum of all the discounted positive cash flows generated by the investment project do NOT cover the initial investment(-Io)

Profitability index = present value of future cash flows / initial investment, other index commonly used to directly compare the NPV of one project to the NPV of another to find the project that offers the best rate of return:

$$\text{Profitability index} = \text{Present Value PV/Io} = \left(\sum_{j=1}^{n} \frac{CFj}{(1+R)^n}\right) / \text{Io Initial investment}$$

The **FV Future Value** of an initial cash flow at starting point (0) **CF0** is = **CF0 x (1+ r)t** (compounding with r interest rate, t cash flow period).

With more cash flows, the FV Future Value at the n period is the sum of all the compounded cash flows:



$$FV = \sum_{j=1}^{n} CFj(1+R)^{j}$$

IRR (INTERNAL RATE OF RETURN)

The IRR method of DCF (Discounted Cash Flows) involves finding the percentage rate R which, when used to discount the cash flows expected from an investment, will produce an NPV of zero (where the total PV Present Value of the sequence of cash inflows is equal to the present value of the cash amount invested).

Source: student accountant, http://www.accaglobal.com-

The IRR therefore is that particular value of R that makes a NPV equal to zero

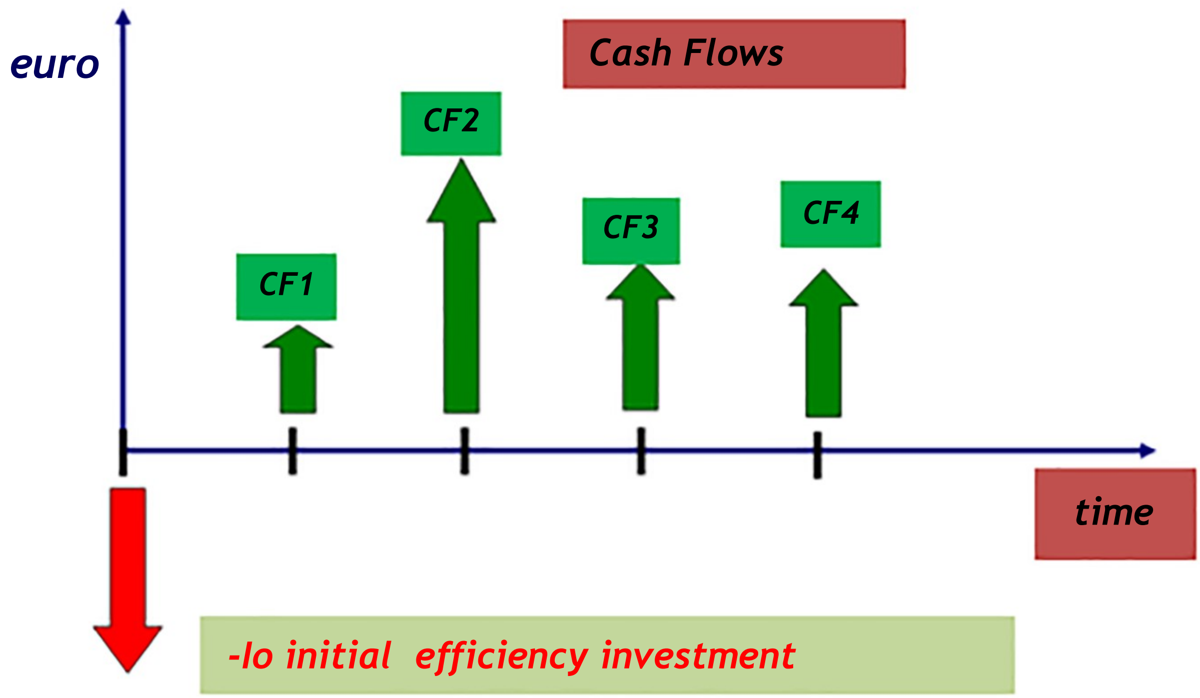
$$NPV = \sum_{j=1}^{n} \frac{CF}{(1+R)^{n}} - Io\ (\text{Initial Investment}) = 0, \text{ when } R = IRR$$

Once all the cash flows related to an energy efficiency investment project have been assessed, if we **define the interest rate R that is deemed appropriate for the project** (considering risk, alternative investments, cost of borrowing etc) the **NPV Net Present Value** can be calculated and it gives us the total discounted value of the investment calculated with at a certain "R" interest rate. In other words, the rate is fixed, and the NPV is then calculated.

The opposite approach is calculating the specific **"R"** (defined as an Internal Interest Rate) that makes the NPV equal to zero given the specific cash flows related to an energy efficiency investment project.

IRR should be coherent with the risk level of the project, cover the cost of borrowing, and provide a net remuneration deemed suitable for the efforts and characteristics of the project.

Given certain project cash flows ->



Calculating NPV and IRR provide two options:

Option 1: DEFINE THE INTEREST RATE "R" THAT THE PROJECT SHOULD YIELD -> CALCULATE **NPV**

Option 2: CALCULATE THE **IRR** INTERNAL RATE OF INTEREST THAT MAKES NPV ZERO.

The two options are related, making and example with building envelopes, when setting the amount of energy that the envelope should save (like defining the R that the project should yield) -> then the thickness insulation material follows as a consequence (like the **NPV**, dependent variable)

OR

alternatively, with a certain thickness of the envelope insulation material (like the defined project cash flows) -> the amount of energy saved follows as a consequence (like the **IRR**, dependent variable).

SIMPLE PAYBACK PERIOD

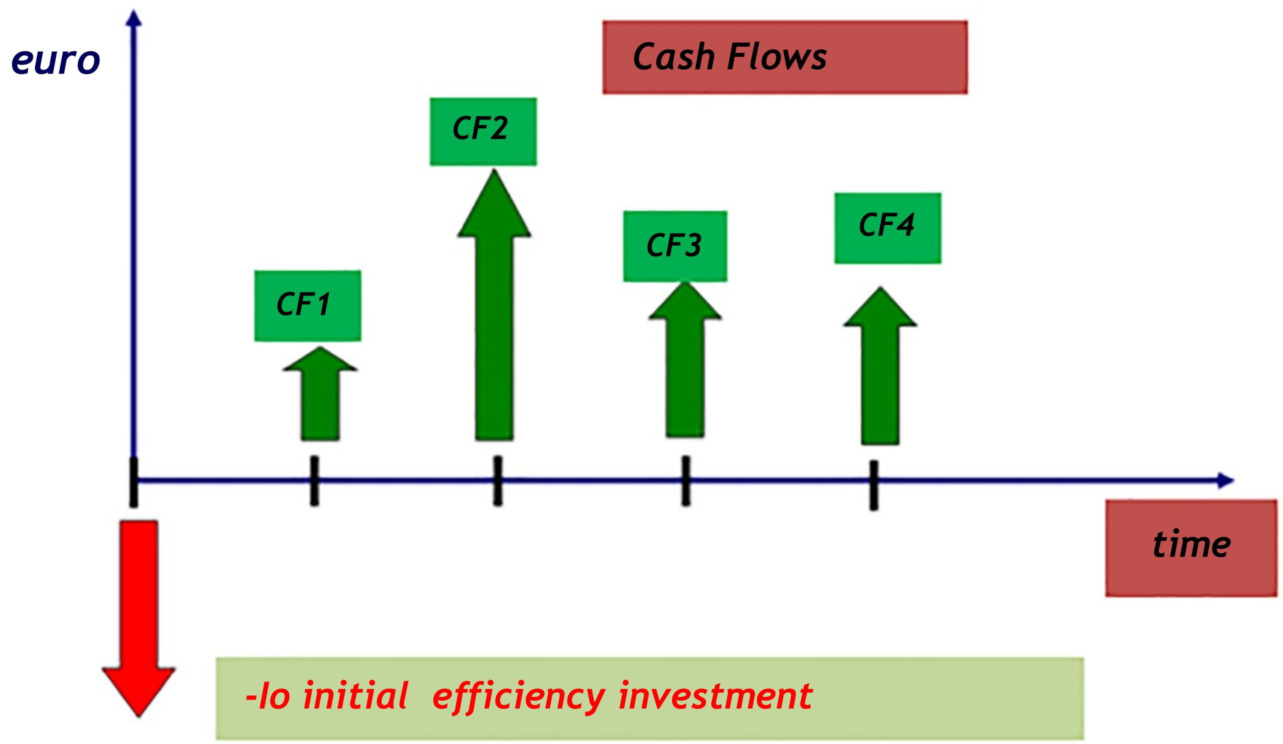
Simple payback period – defined as the number of years it would take to recover a project's costs – is a metric commonly used to evaluate energy efficiency and sustainability investments. While quick and intuitive, simple payback can lead to sub-optimal decision-making. By not incorporating important aspects such as the time value of money, cash flows after the payback period, and how a property's lease allocates the costs and benefits of an efficiency project, simple payback provides an incomplete view of an investment's financial return.

When it comes to deciding which investments get funded, the first question most managers ask is, "What's the simple payback period?" A quick calculation – dividing the initial costs of a project by the annual expected savings – simple payback period is the most widely used metric in capital budgeting.

Determining the simple payback period can be useful if the main goal is quickly recapturing funds, or as a screening exercise to compare competing projects. However, placing too much emphasis on simple payback gives a limited view of a project's economics and can result in missed opportunities.

Source: BETTERBRICKS http://www.betterbricks.com

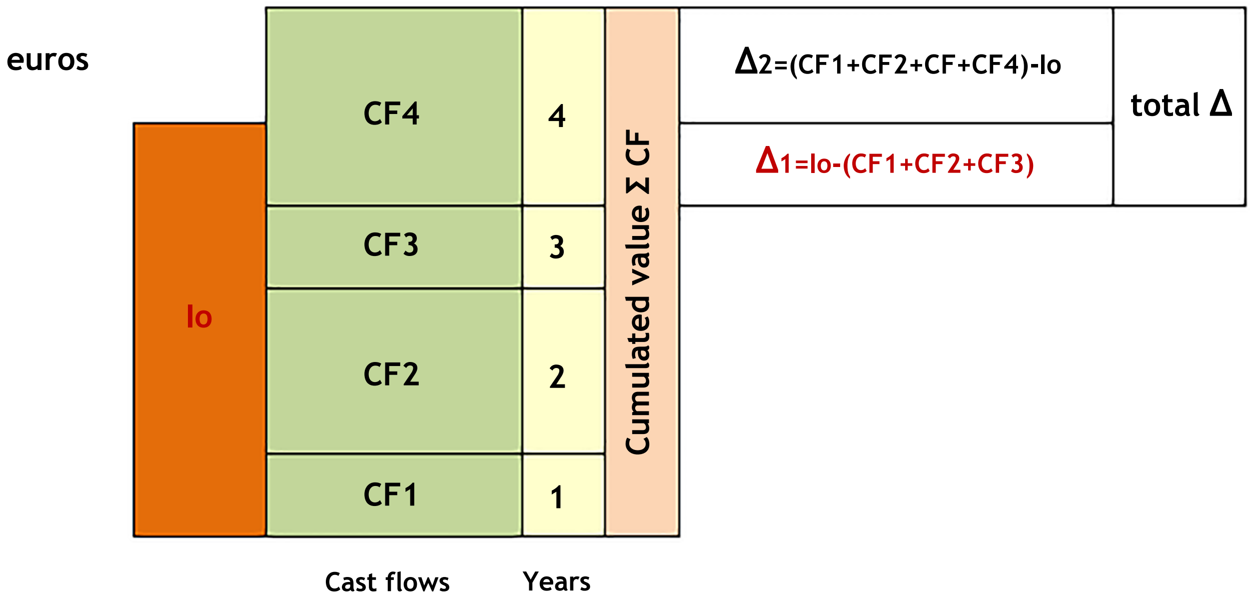
When expected savings/cash flows are NOT constant in time, then the simple payback period cannot be calculated anymore by simply dividing the initial investment cost of a project by the annual expected savings, in this case, the number of cash flows – per period- sufficient to recover the initial investment cost define simple payback period.



If CF1=CF2=CF3=CFi then **the Simple Payback** period is **Io/CFi**

e.i. Io=120.000€, CFi=30.000€/year, Simple Payback = 120.000/30.000=4 years

If Cash flows differ CF1 ≠CF2 ≠ CF3 ≠ CF4 then the **Simple Payback** period is **3 years** + **(Δ1/ total Δ) =**
3 years +[Io - (CF1+CF2+CF3)]/CF4.
Please refer to cumulative CF table that follows:

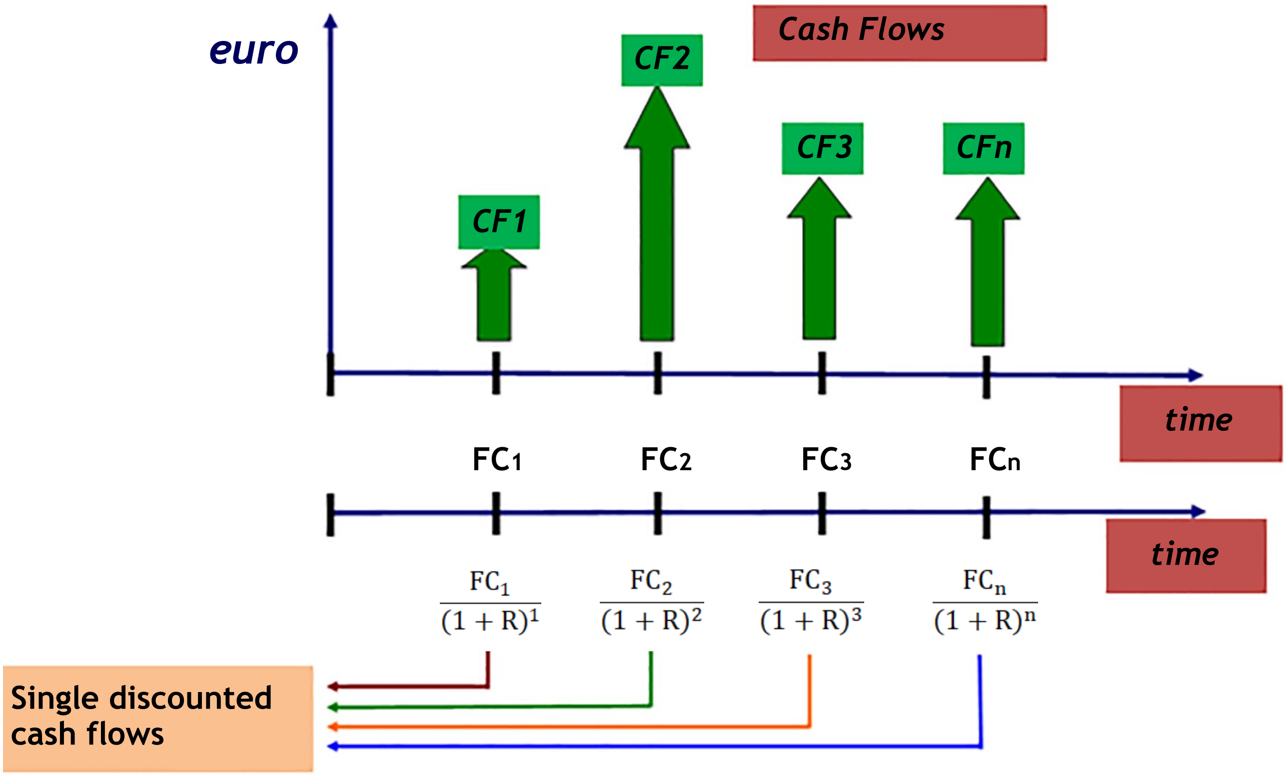


DISCOUNTED PAYBACK PERIOD

The discounted payback period is the amount of time (n years) needed so that the PV Present Value of n discounted cash flows (€/year) is equal to the initial project investment cost.

In this case the time value of money is taken into consideration, therefore this method is used with long payback periods and/or high interest rates (e.i. high inflation in the case of energy supplies).

If a project provides a certain number of CFj Cash Flows, single discounted cash flows are to be summed, the cumulative CF values work as in the table above with the only distinction that cash flows are discounted in this case.



The number of years to recover the initial investment shall be between n and n+1.
Formally:

$$\text{Present Value PV(n)} = \sum_{j=1}^{n} \frac{CFj}{(1+R)^{n}} < \text{Io (Initial Investment)} < PV(n+1) = \sum_{j=1}^{n+1} \frac{CFj}{(1+R)^{n+1}}$$

CHECK LIST

- when assessing the financial performance of a proposed project identify which financial indicators are important to the investors
- define and double check: implementation costs, estimated savings, available incentives, effective useful life, escalation rates, interest rates, discount rates, cost of capital, lease terms, and other appropriate financial inputs
- select the appropriate discount rate which will be critical to the financial analysis that always has to consider the project's cash flow structure, duration, risk, alternative investments, cost of borrowing etc
- verify formulae and data entry in you spread sheet

FURTHER SUGGESTIONS FOR TRAINERS

The process is: **Baseling** -> **savings** -> **cash** flows once this is done, what really becomes critical is defining an appropriate interest rate **R** for the project, this aspect is critical since the project's NPV Net Present Value depends on **R**.

An appropriate R always considers:

- **risk**
- **alternative investments**
- **cost of borrowing**

MODULE 4: DEVELOPMENT OF THE FINANCIAL DOCUMENTATION OF THE PROJECT

The **ICP Investor Confidence Protocol** is supported by the ***Horizon 2020 European Research and Innovation Programme*** and by the ***Stiftung Family Foundation*** and aims to establish itself as an EU-wide, open access system, to provide more stable, predictable, and reliable savings outcomes and to enable greater private investment through a more efficient transparent marketplace.

The 2010 Energy Performance of Buildings Directive and the 2012 Energy Efficiency Directive are the EU's main legislation related to reducing the energy consumption of buildings. All methodologies and procedures across all ICP protocols have taken into consideration the requirements of these key laws.

At the core of the system are ICP Europe protocols which provide comprehensive and robust guidance for project development at a European level, allowing market entities to dramatically streamline project underwriting processes related to project performance.

Private financing sources (banks, ESCO's investors etc) require confidence on the project performance on the entire life cycle (confidence therefore on savings and cash flows over the years).

The Investor Confidence Project (ICP) Europe, is an Energy Efficiency (EE) initiative addressing investment market barriers, which have been repeatedly identified as the main impediments to mass scaling of EE investments in Europe, by the International Energy Agency, the Buildings Performance Institute Europe, the Energy Efficiency Financial Institutions Group, as well as other relevant EE stakeholders in Europe.

The ICP Investor Confidence Protocol enables a clear definition of the complete process necessary to ensure performance from initial audit through ongoing commissioning and M&V (Measurement & Verification).

This ICP Investor Confidence Protocol represents a comprehensive resource designed for project developers, third-party quality assurance providers, and investors to ensure that projects are developed in full compliance with the ICP Protocols.

The Energy Efficiency Project (EEP) Framework is divided into five categories that represent the entire lifecycle of a well-conceived and well-executed energy efficiency project:

1. **Baselining**
   a. Core Requirements
   b. Rate Analysis, Demand, Load Profile, Interval Data
2. **Savings Calculations**
3. Design, Construction, and Verification

4. Operations, Maintenance, and Monitoring
5. Measurement and Verification (M&V)

It is important that project development activities are performed at specific points in the development of an energy efficiency project, schematically:

Key process in the development of financial documentation:

Proper **baselining** and **savings calculation** -> lead to reliable project cash flow figures -> on which the project financial assessment and documentation is built.

BASELINING

A technically sound energy consumption baseline provides a critical starting point for accurate projection of potential energy savings, and is also critical for measurement and verification upon completion of a retrofit and/or retro-commissioning. These are required for Large and Standard projects.

The building baseline must establish how much energy a building can be expected to use over a representative 12 month period, as a minimum.

The baseline needs to cover all energy sources and account for:

- Total electricity purchased
- Purchased or delivered steam, hot water, or chilled water
- Natural gas
- Fuel oil
- Coal
- Propane
- Biomass
- Any other resources consumed as fuel and any electricity generated on site from alternative energy systems
- Any renewable energy generated and used on site

It must also factor in the impact of independent variables such as weather, occupancy, and operating hours on the building's energy consumption.

There are currently a number of baselining and benchmarking tools and software applications that are commercially available. While not required, these tools can dramatically reduce costs compared with more ad hoc methods. These energy management software tools store, analyse, and display energy consumption or building systems data, and can be used to automate the processes involved in the baselining component of energy efficiency (EE) project development.

Building energy consumption metrics should be developed using the baseline historical utility data. This should include kWh/yr, and kWh/(m^2.yr). Heating values of fuels reported on utility bills are typically adjusted for delivered heat content, elevation, and temperature. Additional corrections are typically not needed. If fuel content values are not available from the local utility, they should be estimated, using recognised calculation methods, and documented. If the building is located at higher elevations, gas heating values should be adjusted for elevation according to best practices and in consultation with the gas supplier.

Normalisation is used to analyse, predict and compare energy performance under equivalent conditions. Regression-based energy modelling is a specific type of normalisation, and involves the development of an energy consumption equation, which relates the dependent variable (total site energy consumption, including electricity and on-site fuel or district energy) to independent variables known to significantly impact the building's energy consumption. Independent variables typically include weather (heating and cooling degree days), and may include other variables such as operating hours, occupancy or vacancy rates, and number of occupants.

The energy consumption equation can be determined using a regression analysis – the process of identifying the straight line of 'best fit' between the building's energy consumption (usually on a monthly basis) and one or more independent variables. An example of this is shown below:

Energy consumption (kWh) = m1X1 + m2X2 + C

Where

C = energy baseload in kWh (determined from regression analysis)

m1,2,etc = energy consumption in kWh per unit e.g. energy consumption per degree days kWh/°C (determined from regression analysis)

X1,2,etc = number of units e.g. number of degree days in °C

Further variables can also be included – this is known as multiple-linear regression. More complex regression techniques may also be employed – where these are required, the reasoning and calculation details must be provided.

For projects following the Standard protocols, where it is deemed that the independent variables do not have a significant effect on the baseline, then normalisation and development of the energy consumption equation is not required. However, clear justification for this approach should be provided, including an estimate of the impact on energy savings.

The regression-based energy model and the energy consumption equation should result in adjusted R2 values of at least 0.75 and a CV[RMSE] less than 0.2. Every attempt should be made to develop a model that falls within these accepted parameters. If these criteria cannot be met due to bad or inconsistent data, or other extenuating circumstances, the reasons for this discrepancy must be noted. In this case, it is recommended that the impact (uncertainty) that these discrepancies may have on the project's outcome be quantified.

SAVINGS CALCULATIONS

Savings calculations can be performed using detailed energy modelling, spreadsheet calculations, or other methods, depending on the requirements of the project and protocol. Regardless of the method employed, the procedure should be transparent and well documented. Calculation methods must be based on sound engineering methods, and be consistent with the IPMVP (International Performance Measurement & Verification Protocol) approach. Assumptions must be based on observations, field measurements, monitored data, or documented resources. In all cases, these assumptions should be conservative, transparent, and documented.

ECM (Energy Conservation Measure) descriptions should be thorough, documenting existing conditions, the proposed retrofit, and potential interactive effects. The descriptions should provide enough detail so that they can be used to develop accurate scopes of work and informed cost estimates.

For Large and Standard projects, the results of the savings calculations must be calibrated to estimated or known end-use energy consumption.

ECM (Energy Conservation Measure)

The results of the energy audit provide a list of ECMs that can include low-cost and no-cost measures, operations and maintenance (O&M) improvements, **and capital cost items**. Estimates of annual energy savings and implementation costs are key components of the **financial evaluation of an EE project** and therefore detailed descriptions of the measures must be developed so that these estimates can be accurately developed.

As a minimum, documentation for each recommended measure should include the following information:

- The present condition of the system or equipment
- Recommended action or improvement

A best practice approach would also include:

- Risk of equipment failure
- Schedule for implementation
- Summary of specific maintenance requirements or considerations associated with the ECMs, particularly any impacts on maintenance costs
- Interaction with other end uses and ECMs (see section 6.2.5)
- Potential issues which may prevent successful completion
- Organisations and individuals involved in implementing this action or improvement, and their responsibilities
- Staff effort required

Dynamic energy modelling is best suited to projects **with a large number of potentially interactive ECMs** being considered, and where there is a higher level of performance risk associated with the project. Development of an accurate energy model, calibrated to historical utility bills, is critical for the accurate estimation of energy savings associated with the ECMs. The energy model used should be developed using public domain or commercially available software that meets the current nationally or internationally recognised specifications for 8760 hour annual simulation of building energy consumption.

The modelling process starts with complete descriptions of the facility, building envelope, mechanical systems, service water heating, and electrical systems, and also includes climate data and utility rate information. The following are specific components that need to be input into the energy model:

- Building location and orientation
- Descriptions of all building envelope assemblies, including exterior walls, windows, doors, roofs, underground walls and floors, as well as component dimensions and orientations
- Space use classifications that best match the uses within the building or individual spaces, as well as space sizes (volume). These classifications determine default occupant density, plug loads, service water heating, minimum outdoor ventilation air, operating schedule, and lighting assumptions when this information is unknown
- Internal loads associated with each space, including occupant density, plug loads, process loads, infiltration, thermal mass, refrigeration equipment, cooking equipment, miscellaneous equipment, elevators and escalators, and lighting, as well as associated schedules and controls
- Zones representing areas of the building served by a single thermostat. Zones may be combined to simplify the energy model, assuming these zones are served by the same HVAC system or system type, have similar conditioning requirements, similar minimum airflows, and similar loads
- Information on all HVAC systems and equipment, including which systems serve which zones. All information regarding the system type, efficiency, performance curves and operation needs to be inputted into the model. This includes setpoints, control strategies, ventilation, and schedules
- Domestic hot water systems and associated schedules or controls
- Exterior lighting and associated schedules or controls
- Swimming pools and other miscellaneous gas or electricity using equipment
- Climate data
- Utility rate information

When developing an energy model, it is often necessary to make assumptions about how the building is being operated, or about the loads or schedules pertaining to the building. Reliance on assumptions should be minimised, but may be necessary due to lack of resources or available information.

Assumptions should always be conservative and clearly documented.

Development of the financial documentation of the project-methodology:

Baselining

↓

Energy savings

↓

Net cash flows per year

↓

Financial indicators

Once **baselining** and **energy savings** have been determined, **net cash flows** over the project's life cycle can be calculated.

CASH FLOWS

Estimates of **annual energy savings** and **implementation costs** are key components of the **financial evaluation** of an EE project so cash flow figures and be inserted in the financial documentation of the project.

Cash flow assumptions for calculation of financial indicators of the project:

- the initial investment year is year 0;
- costs and credits are given in year 0 terms, thus the inflation rate (or the escalation rate) is applied from year 1 onwards;
- timing of cash flows occurs at the end of the year

FINANCIAL INDICATORS

The financial evaluation of the project may carried on the basis of the project's life cycle net cash flows, as previously presented in Module:3, the following financial shall be calculated:

- NPV Net Present Value
- IRR Internal Rate of Return
- Simple payback period
- Discounted payback period

Net present value (NPV)

The net present value NPV of a project is the value of all future cash flows, discounted at the discount rate, in today's currency. It is calculated by discounting all cash flows as given in the following formula:

$$NPV = \sum_{j=1}^{n} \frac{CFj}{(1+R)^{n}} - Io\,(\text{Initial Investment})$$

IRR Internal Rate of Return

The internal rate of return IRR is the discount rate that causes the Net Present Value (NPV) of the project to be zero. It is calculated by solving the following formula for IRR:

$$NPV = \sum_{j=1}^{n} \frac{CF}{(1+IRR)^{n}} - Io\,(\text{Initial Investment}) = 0$$

Simple payback period

The simple payback SP is the number of years it takes for the cash flow to equal the total investment.

If CF Cash Flows are all the same CF1= CF2 …= CFi then the formulae is: **n of years = Io/CFi**

Discounted payback period

The simple payback SP is the number of years it takes for the discounted cash flows to equal the total investment.

The number of years to recover the initial investment shall be between n and n+1.

Formally:

$$\text{Present Value PV(n)} = \sum_{j=1}^{n} \frac{CFj}{(1+R)^{n}} < \text{Io (Initial Investment)} < PV(n+1) = \sum_{j=1}^{n+1} \frac{CFj}{(1+R)^{n+1}}$$

Compare financial indicators to possible EPC or PF proposals

When off balance operations are proposed by ESCOs or other companies through EPCs (Energy Performance Contracts) or via PF (Project Finance) to municipalities and/or public bodies that own the building a separate financial assessment of the project should be carried out by the owner in order to clarify if the project has sense and how much money the proposers are reasonably going to make. This sort of reverse financial engineering is very useful for a negotiating fair financial conditions with the proposers.

This document is based on:

ICP Investor Confidence Project_Energy Performance Protocol_Project Development Specification

http://europe.eeperformance.org/

CHECK LIST

- Perform a review of collected data to ensure that a minimum of 12 months of contiguous data have been collected
- Ensure that the collected data does not include any periods involving major renovations
- Review the regression-based energy model and the energy consumption equation form
- Review the report (or report sections) illustrating baseline development and energy consumption results
- Review modelling inputs, to ensure that they correspond to field data collected during the audit.
- Check that the proper energy cost rate schedule(s) have been used in the energy model
- Review model errors or warnings, and make corrections/amendments to the model where necessary.
- Review output reports, and compare metrics to typical comparable metrics (such as Energy Consumption Intensity in kWh.m^2.year, ventilation rates, load densities, etc.)
- Review calibration methods to ensure that adjustments to the model are reasonable.
- Check ECM modelling parameters and programming logic, as well as assumptions used, to ensure that they are conservative and documented

FURTHER SUGGESTIONS FOR TRAINERS

Again, the process as usual is: **Baseling** -> **savings** -> **cash flows**.

Critical points are:

- **Baselining**
- **Savings**
- **cash flow determination**
- **and then** -> the definition of an appropriate **interest rate "R"** for the calculation for calculation the project project's **NPV** (Net Present Value).

MODULE 5: ENSURING PROJECT BANKABILITY, VIABILITY AND PROFITABILITY

Good financial indicators are not enough to make EE (Energy Efficiency) upgrades and ECMs (Energy Conservation Measure) projects **bankable**, ready to be funded with debt or equity.

As pointed out in module n. 4, a well conceived and well executed energy efficiency project requires a framework structured on five steps covering its entire lifecycle:

1. Baselining
2. Savings calculations
3. Design, construction and verification
4. Operations, Maintenance and Monitoring
5. Measurement and Verification (M&V)

Preparation of sound and reliable financial documentation for the project evaluation is based on the first two steps, but only a correct overall management of the project can make the savings projections happen, which is what the investors want to be assured of. Energy efficiency projects are often complex and many aspects need to taken into consideration (technologies, financial instruments, contracts, tendering procedures, data management etc) this makes these kind of investments hard to standardise and difficult to understand for financial institutions, hence the need for an **ICP Investor Confidence Protocol** that defines a general project framework addressing all the major project issues over its entire life cycle.

Proper operation, maintenance practices, and monitoring are tasks critical to the ongoing energy-efficient performance of the building's systems. Measurement and Verification involve reliably **quantifying the savings** from energy conservation projects (or individual ECMs) by comparing the established baseline with the post-installation energy performance and use, normalised to reflect the same set of conditions.

Private financing sources (banks, ESCO's investors etc) require **confidence** on the project performance on the entire life cycle, confidence therefore on **savings** and **cash flows** over the years to be assured within an ICP (Investor Confidence Protocol) framework.

In order to complete our presentation of the ICP framework we need to pass on to the remaining three steps listed above.

DESIGN, CONSTRUCTION AND VERIFICATION

This part of the process focuses on the engineering, implementation and operational performance verification phase of the project. The key objectives here are to ensure that the project is designed and implemented as intended by providing oversight to the design as well as general oversight during construction. The submission of designs, equipment, performance specifications and installation plans should all be carefully reviewed to ensure compliance with the proposed project and the stakeholder's requirements.

OPV Operational Performance Verification

The term **"operational performance verification" (OPV)** is used specifically for retrofit or energy efficiency upgrade projects to distinguish the activity from "comprehensive" commissioning. OPV focuses on the commissioning activities specific to the EE upgrades and ECMs, rather than involving the commissioning of all building systems and components.

An important part of the OPV process is ensuring that roles, responsibilities, expectations, timelines, communication and site access requirements have been established. Furthermore, it should be confirmed that arrangements have been made regarding inspections, operational performance verification activities, testing, balancing, training, acceptance criteria, operations, maintenance and monitoring requirements, and that M&V guidelines are being met.

A qualified OPV Specialist should be appointed to manage the process, either under an in house role or using a third party. Although there are advantages to appointing an in house representative, the use of a third party is recommended to avoid conflicts of interest and to take advantage of specialised skills.

For large and standard projects, the OPV effort begins with the development of an **OPV plan** – the submission of a formally developed plan is optional for Targeted projects. The plan should be developed pre-construction, and should describe the verification activities, target energy budgets and key performance indicators associated with the project and the individual ECM (Energy Conservation Maesure). Performance indicators should be used to identify underperformance.

The plan should also describe the data logging, control system trending (analysis of historical data and using it to predict future performance, usually using the BMS (Building Management System), functional performance tests, spot measurements, or observations that will be used to establish both baseline operation as well as post-construction operation, to demonstrate that operations and performance have improved and have the ability to perform over time.

The OPV process itself, led by the OPV Specialist, should include consultation with the energy audit team, monitoring of designs, submittals and project changes, and inspections of the implemented changes. It also includes the responsibility for and means of reporting deviations from design and projected energy savings to the project owner in an issue log. If the collected post-installation data, testing results, or other observations indicate underperformance or a lack of potential continued performance, the OPV Specialist needs to:

- Help the customer / project development team fully install the measure properly and then re-verify its performance; or
- Work with the project development team to revise the ECM savings estimates using the actual post-installation data and associated inputs.

Successful OPV is achieved by applying traditional commissioning methods to the measures and affected systems involved in the project, and supplementing these methods with more data-driven activities, such as data logging, trending, and functional performance testing, as appropriate.

The level of effort required to verify proposed ECMs will vary. Measures that are well-known or have relatively low expected savings, and measures whose savings are considerably certain may only warrant installation verification. That is, visual inspection to ensure that the measures have been implemented properly – for example, wall insulation and windows. Measures with greater savings at risk or greater uncertainty will require a greater depth of OPV, such as sample spot measurements (for example, lighting fixtures and lamps, pumps), short term performance testing (for example, fans fitted with variable speed drives), and the collection and analysis of post-installation performance data (for example, more complex projects with multiple ECMs).

Typical OPV activities include:

- **Visual inspection -** verify the physical installation of the ECM; applied when ECM operation is well understood and uncertainty or anticipated relative savings are low.
- **Spot measurements -** measure key energy consumption parameters for ECMs or a sample of ECMs; applied when ECM performance may vary from published data based on installation details or load, or anticipated relative savings are low.
- **Functional performance testing -** test functionality and proper control; applied when ECM performance may vary depending on load, controls, or interoperability of other systems or components, and savings or uncertainty are high.
- **Trending and data logging -** set up BMS (Building Management System) trending or install data logging equipment and analyse data, and/or review control logic; applied when ECM performance may vary depending on controls or loads, and savings or uncertainty are high.

Concise documentation should be provided that details activities completed as part of the OPV process and significant findings from those activities – this is the OPV report, and is required for all projects. This documentation should be continuously updated during the course of a project.

Training of the facility staff and building operators may be one of the most important factors in determining the operational performance and persistence of energy savings. Without proper understanding of the new systems, the skills to operate the systems correctly, and a plan regarding how to resolve or report issues, it will be impossible for an energy efficiency project to succeed and perform optimally over time.

The building operating staff should be involved with all OPV activities, from planning through to implementation. Assisting with the OPV process provides critical on-the-job training, and ensures familiarity with the new systems and installed ECMs.

A well-developed training plan should be created, supported by comprehensive and useful building documentation. The training sessions should cover the changes arising from the energy efficiency project and the implemented ECMs. They should be developed/contributed to and performed by the consultants, vendors, and contractors.

OPERATIONS, MAINTENANCE AND MONITORING (OM&M)

Operations, Maintenance & Monitoring (OM&M) and building performance tracking is a process of continuous improvement, and involves tracking, analysing, diagnosing and resolving issues involving building HVAC (Heating, ventilation and air conditioning), lighting or other energy-consuming systems.

While the focus from an energy efficiency project perspective is on building system energy performance, it is important to consider and efficiently maintain the building occupants' needs, including comfortable temperatures and humidity levels, ventilation requirements, and lighting requirements.

Development of specific OM&M procedures can provide more clear direction to the facility's operations and maintenance staff, empowering them and providing specific methods for identifying, analysing, and resolving issues over time.

The overall OM&M process should involve the following key components:

1. Data collection and performance tracking - HVAC, lighting, and other energy-consuming equipment performance data is tracked along with energy consumption data. Various tools are available to support this process, and typically multiple tools are employed as part of the overall management strategy.
2. Detection of performance issues - use of automated tools to perform real-time analysis and identification of issues (fault detection and diagnostics), or the use of tools to present information in a way that facilitates identification of problems manually.
3. Diagnosing issues and identifying solutions - while automated tools can help facilitate issue diagnostics and the development of solutions, the skill, knowledge and training of building operators, supplemented by the assistance of service contractors or consultants, are critical components in diagnosing issues successfully and identifying appropriate solutions.
4. Resolve issues and verify results - issues should be resolved in a manner that addresses indoor conditions and occupant comfort, and also considers and optimises energy performance.

A strong OM&M management framework needs to clearly set out how automated or manual tools or processes are to be used, and provide the guidance, training and support necessary to extract, interpret and act on the data and analysis results. This management framework should dedicate resources to the OM&M effort by establishing roles and responsibilities and assigning them to the appropriate team member. The framework must set quantifiable performance goals, determine accountability, and define the performance tracking methods and metrics (the performance indicators).

Identifying energy performance indicators will depend on the ECMs proposed, and the associated energy consumption characteristics, and the factors affecting this. They can be applied at an equipment, system or whole building level, and are usually directly measured (e.g. kWh), calculated using a ratio of measured values (e.g. efficiency), or a calculated or modelled relationship between energy consumption and relevant variables (e.g. linear regression modelling to determine kWh/degree day). A performance indicator for a lighting system could be energy consumption kWh/occupant-hour and peak power draw in kW.

Automated energy management systems (EMS) can be incorporated into the OM&M management regime, and provide a method for tracking, analysing, and assessing energy performance against savings projections and benchmarks. These tools can be used at the project development and implementation stages to support the Baselining and M&V activities.

Data collection systems are used to collect energy data and transmit this data to the EMS. This data is typically collected in intervals of between one minute and one hour, and can track either whole-building energy consumption, or the energy consumption of specific systems or end-uses. The EMS aggregates this data, identifies errors, analyses the data, and provides graphical representations of the data or reports used to assess the energy performance of the building in real time.

Trended metrics can be plotted and reviewed on a regular basis to identify abnormal changes in values that might indicate problems. Long term patterns, averages, and minimum or maximum values can also be used to identify issues and track energy efficiency and system performance. Performance metrics typically include zone temperatures, equipment efficiencies, system efficiencies, and ventilation rates.

Tenant behaviour can be critical to the success of the ECM project. Ensuring tenants understand the impact of their behaviour on building energy consumption and, particularly, the new ECMs is integral to this. Energy awareness may take the form of poster campaigns, flyer distribution, or training sessions for building occupants. Consideration should also be given to involving tenants in design of the ECMs, if this is deemed appropriate.

MEASUREMENT AND VERIFICATION (M&V)

All Measurement & Verification (M&V) efforts involve reliably quantifying the savings from energy conservation projects (or individual ECMs) by comparing the established baseline with the post-installation energy performance and use, normalised to reflect the same set of conditions

For most M&V efforts, non-routine adjustments need to be made to the baseline to reflect unanticipated changes in the building’s energy use after the retrofits have been completed, such as increased occupancy, new internal loads, added floor area, etc. These items affect heating and cooling loads, and other building energy uses, and need to be calculated and subtracted from or added to the baseline, so that it can be accurately compared to the post-retrofit energy use. Calculation of the effects of these adjustments on the building’s energy use can be challenging, especially adjustments that affect the loads in the building, and have potentially complex interactive effects with the building’s HVAC systems. The calibrated energy model can subsequently be used to estimate these effects on energy use, in a more comprehensive and accurate manner than spreadsheet calculations or other methods.

M&V plan and implementation

The M&V process can be simply broken down into the following fundamental activities:

1. Document baseline energy
2. Plan and coordinate M&V activities (M&V Plan)
3. Verify operations
4. Gather data
5. Verify savings
6. Report results

The **first step** in the M&V process, has already been addressed in module n.4. The level of uncertainty should be quantified as part of this process. This can be performed by using the energy consumption equation and actual weather data (not averaged weather data) to determine the monthly baseline energy consumption, and comparing the results to the actual historical energy consumption associated with the baseline period. The difference, or error, in the calculated baseline can then be combined with the standard deviation and the confidence/precision levels to develop the uncertainty in the energy consumption equation.

The **second step** in the process involves planning and coordinating the M&V activities, the foundation of which is formed by the development of the M&V Plan.

M&V plan and implementation

The M&V Plan should be developed shortly after the energy efficiency project has been defined. Early development of the plan will ensure that all data needed for the savings calculations during the baseline period will be collected and available. This is particularly important when pre-retrofit data is needed to establish the baseline operation of systems affected by the proposed ECMs. Early development of the M&V Plan will also allow for coordination with Operational Performance Verification activities.

The M&V Plan itself should be adherent to the IPMVP (International Performance Measurement and Verification Protocol), which defines in detail the components the Plan needs to contain and consider.

In summary, the M&V Plan should address the following topics:

- Descriptions of the ECMs and operational performance verification procedures
- Definition of the measurement boundary, and discussion of potential interactive effects
- Documentation of the baseline period, energy use, and conditions; include descriptions of independent variable data coinciding with the energy data, and static factors coinciding with the energy data (the routine and non-routine adjustments)
- Definition of the reporting period (typically the length of time required to recover the investment costs associated with the energy efficiency project)
- Descriptions of the basis for adjustments (routine and non-routine – see later in this section)
- Description of the analysis procedures, including algorithms and assumptions to be used for savings verification
- Definition of energy prices used to value the energy-cost savings, and future adjustments to energy prices
- Description of the proposed metering plan and meter specifications, including methods for handling the data, and responsibilities for reporting and recording the data
- Qualitative (and, if feasible, quantitative) descriptions of expected accuracy
- Definition of the budget and resources required for the M&V process (initial and ongoing) Description of the M&V reporting format and schedule

The **third step** in the M&V process involves operational performance verification, which provides a means for realising savings potential. The **fourth step** involves data collection, which must be performed both before and after the planned retrofit.

The **fifth step** involves determination of verified energy savings. Savings may be determined for the entire facility or for portions of it. In all cases, the determination of verified savings involves consideration of the measurement boundaries, interactive effects, selection of appropriate measurement periods, and basis for adjustments.

Verified energy savings including the entire building. The measurement periods should adhere to the guidance set out in IPMVP Volume I (2012) section 4.5.2, and must include at a minimum a representative 12 month period for both pre- and post-retrofit utility data.

Adjustments to the baseline must be well defined and applied conservatively. The “adjustments” term is commonly used to restate the baseline energy consumption in terms of the reporting-period conditions.

The verified savings equation expressed in the IPMVP is defined as:

Savings = (Baseline Energy +/- Routine Adjustments to reporting-period conditions +/- Non-Routine Adjustments to reporting-period conditions) - Reporting-Period Energy

Routine adjustments (most commonly weather) which are expected to change routinely can be accounted for through regressions or other techniques to adjust both the baseline and reporting periods to the same set of conditions. This allows for accurate comparison between the two measurement periods.

Non-routine adjustments include factors which affect energy consumption that were not expected to change such as facility size, operation of installed equipment, conditioning of previously unconditioned spaces, number of occupants, or load changes. The first step is to identify these changes in the reporting period, but specifically, to pinpoint those adjustments that present a reasonable effect on energy consumption. This can be accomplished through interviews with the building owner and facility personnel, periodic site visits, observation of unexpected energy consumption patterns, or other methods.

Accurate and conservative calculation of the effects these non-routine adjustments have on energy consumption is critical. Sometimes these effects can be estimated within the energy-modelling software that was used to calculate the energy savings for the project. In other cases side calculation methods need to be employed, in which case applying the appropriate level of rigour and sound engineering principles is key. This includes accurately determining any assumptions used in these calculations.

In all cases, the application of adjustments needs to be handled with care. Only adjustments that are expected to have a relatively significant impact on energy consumption should be considered. And assumptions used within the adjustments need to be conservative and based on actual measurements, field observations, or well vetted and documented sources.

Verified Energy Savings

Requirements

Verified energy savings on specific equipment or systems affected by the ECMs, in this case the measurement boundary must be considered and defined and drawn around the equipment or systems affected by the ECMs. All significant energy requirements of the equipment within the boundary should be determined. Determination of the energy performance of the equipment can be accomplished by direct measurement of the energy flow, or through direct measurement of proxies of energy consumption that provide an indication of energy consumption.

All energy effects of the ECMs should be considered and measured if possible. In particular, interactive effects of the measures beyond the measurement boundary should be evaluated to determine if their effects warrant quantification, or if these effects can be reasonably ignored. The M&V Plan should still include a discussion of each effect, and its likely magnitude.

Both the baseline period and the post-retrofit (reporting) period need to be determined early on in the project development so that appropriate and adequate baseline data can be captured. The measurement periods need to collect data that reflect equipment operation through its full operating cycle (maximum energy consumption to minimum). The data should represent all operating conditions, and the baseline period should ideally coincide with the period immediately before commitment to undertake the retrofit.

This document is based on:

ICP Investor Confidence Project_Energy Performance Protocol_Project Development Specification
http://europe.eeperformance.org/

CHECK LIST

- Review OPV plan (where required) to ensure that it describes the OPV activities, target energy budgets and key performance indicators associated with the project and the individual ECMs
- Review OPV report, including results of any analysis and tests carried out, and the issues log, and ensure that appropriate actions are being taken to resolve issues or revise savings estimates
- Review training plan to ensure that key items listed above have been addressed
- Interview building operators to ensure that training efforts met their needs, that they understand the ECMs installed and how to operate and diagnose their operation, and that roles and responsibilities and the associated response network are defined and understood

FURTHER SUGGESTIONS FOR TRAINERS

Why are the remaining three ICP steps:

- Design, Construction
- Verification
- Operations, Maintenance and Monitoring and Measurement and Verification (M&V)

are so important?

Because they make the project work and enable the stakeholders to verify that the projected savings effectively been realized.

Checking is fundamental:

- correct savings projections -> **imply that**
- expected cash flows are being generated -> **thus**
- investors are satisfied (loans are being paid regularly) and the ECMs (Energy Conservation Measures) foreseen in the project are working.

MODULE 6: ATTRACTING AND COOPERATION WITH POTENTIAL INVESTORS

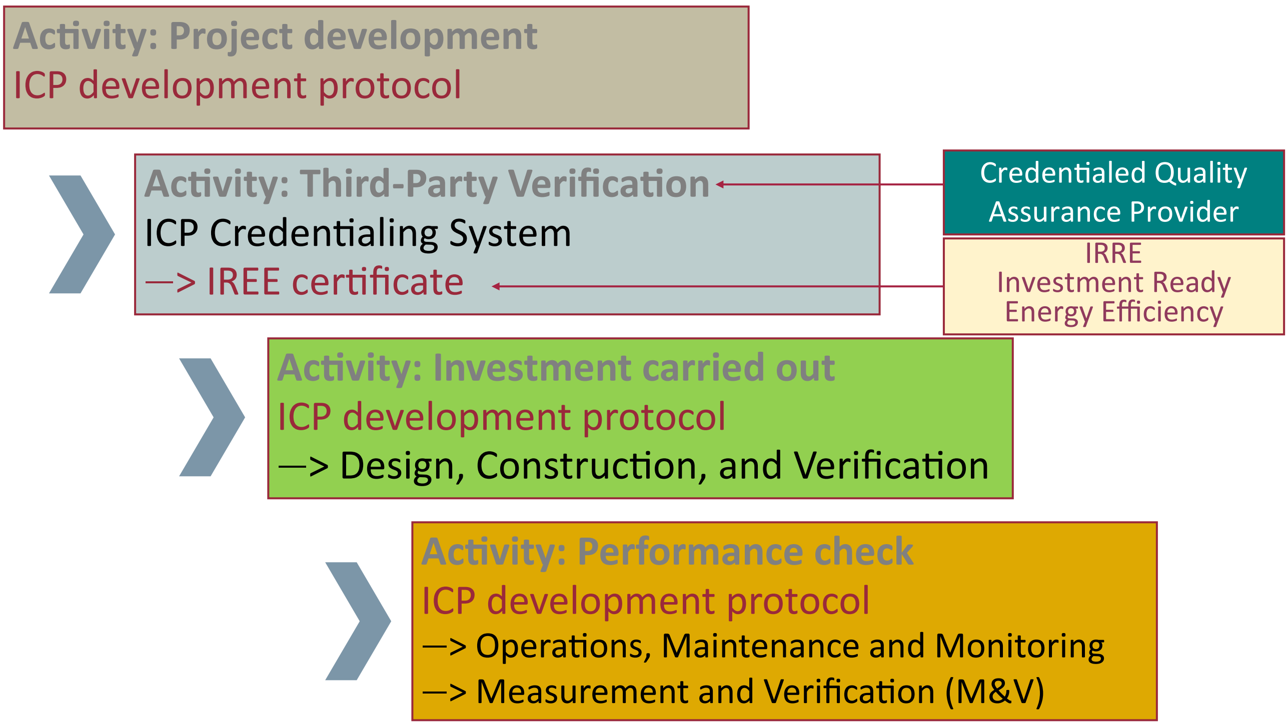
In general, projects become **attractive to investors** when they are confident that they comply and satisfy the requirements of an energy efficiency project development protocol, in our case ICP.

The **Investor Confidence Project (ICP)** provides a framework for energy efficiency project development, which standardises projects into verifiable project classes/steps in order to reduce transaction costs associated with technical underwriting and increase reliability and consistency of energy savings -> **cash flows.**

The **ICP Energy Performance Protocols** and **ICP Credentialing System** provide a comprehensive framework of elements that is flexible enough to accommodate the wide range of methods and resources required by projects.

In the previous modules we've examined the **ICP Energy Performance Protocol framework** regarding the project development, in the case of Energy efficiency investors which can include building owners, energy service companies, finance firms, insurance providers etc what is needed is an **independent** and **documented verification** of project compliance with ICP performance protocol in the form of a certification that makes the project **ready for investment.**

A review of the phases leading to the investment and project realisation follows



ENERGY EFFICIENCY PERFORMANCE - QA (QUALITY ASSURANCE) SPECIFICATION

Projects that successfully comply with the ICP protocols and the **Project Development and Quality Assurance Specifications** are eligible to be **certified** by an ICP Credentialed Quality Assurance Provider as an **ICP Investor Ready Energy Efficiency TM project**.

This certification ensures that a project conforms to the ICP Energy Performance Protocols and standardised documentation requirements which **assures investors** that a project has been engineered to consistent industry best practices.

The QA process as described by ICP addresses the primary responsibilities of the QA Provider, which include:

- Ensuring that the project was developed in accordance with the most appropriate ICP Energy Performance Protocol as specified by the ICP Project Development Specification
- Validating that all necessary documentation is provided and complete
- Checking that methodologies, assumptions, and results follow best practices and are reasonable based on the reviewer's professional experience, available guidelines, or data-driven thresholds
- Completing the ICP QA Checklist which lists all the required elements for ICP compliance.

A signature provided by an **ICP Credentialed Quality Assurance Provider** certifies that the project is ICP compliant and satisfies the requirements of an **ICP Investor Ready Energy Efficiency TM project** making it ready for funding thus **attractive to potential investors**.

PROJECT DEVELOPMENT AND QUALITY ASSURANCE

Energy efficiency investors, which can include building owners, energy service companies, finance firms, insurance providers, and utility programs, are exposed to performance risk but often do not have the expertise necessary to evaluate the complex technical details associated with an energy efficiency project. Regardless of the expertise and skills of the investors, transaction costs mount when multiple investors separately evaluate a project with expensive and time consuming technical due diligence processes.

For this reason, it is important that the project investor select a project development team with established experience and skills in energy efficiency project development. Furthermore, in order to protect their own best interests, it is highly recommended that project investors hire an independent consultant (or consultants) to provide technical oversight and quality assurance services, as described in this specification.

The Credentialed Project Development team is responsible for developing a project based on sound engineering principles and accepted industry best practices as specified by the ICP Protocols and Project Development Specification.

The Project Development Specification describes accepted approaches, recommended best practices, and resources that project development teams should utilize in order to adhere to these industry standards and protocols and achieve ICP compliance.

The **Credentialed Quality Assurance Provider** is required to be **independent** of the Project Development team and is responsible for reviewing the project components and associated documentation to ensure that the project is compliant with the ICP Protocols.

The Project Development Specification serves as a reference for the QA Provider to review and verify that the approaches used by the Project Developer meet industry standards and ICP requirements. The ICP QA Checklist provides a step by step format for the review process and also serves as the instrument for recording the verification by the QA provider.

A single firm or individual can be both a Credentialed QA Provider and a Credentialed Project Developer, but **cannot serve both functions** for an individual project.

QUALITY ASSURANCE AND THE EEP ENERGY EFFICIENCY PROJECT FRAMEWORK

As previously presented, the Energy Efficiency Project (EEP) Framework is divided into five categories that represent the entire lifecycle of a well-conceived and well-executed energy efficiency project:

1. Baselining
    a. Core Requirements
    b. Rate Analysis, Demand, Load Profile, Interval Data
2. Savings Calculations
3. Design, Construction, and Verification
4. Operations, Maintenance, and Monitoring
5. Measurement and Verification (M&V)

ICP strongly recommends and expects that the QA Quality Assurance provider be involved in the process early on during project development, so that issues can be identified and addressed as the project progresses, rather than at the end of a project when necessary information may be difficult to capture or when changes may have far reaching (and serious financial) implications. The QA provider should refer to the best practices and QA tasks listed in each section of the Project Development Specification to help guide the process of evaluating projects and to ultimately certify project compliance with the ICP Energy Performance Protocols.

Similarly, it is important that project development and associated quality assurance activities are performed at specific points in the development of an energy efficiency project, since the development of preceding components of a project may create a domino effect interfering with subsequent project components and results.

For example, the baseline and end-use energy consumption estimates are used in the calibration of an energy model or bounding of energy savings predictions, as well as in the M&V efforts. Inaccuracies in the development of these key baseline components can affect the subsequent accuracy of the energy model, possibly resulting in over-prediction of energy savings estimates and/or an inaccurate assessment of verified energy savings.

QA (QUALITY ASSURANCE) PROCESS

ICP Checklist and Investment Package

The ICP QA process requires the completion of the ICP Checklist to ensure that all necessary documentation, as described in the ICP protocols, has been properly developed and is available. These documents represent the Investment Package and serve as the foundation of an energy efficiency project.

It is the responsibility of the Project Development team to develop and assemble the required documentation and to make appropriate portions of this information available to team members, subcontractors, the QA provider, and stakeholders. The documentation should be clearly identified and organized so that recovery of and access to information is easily facilitated by team members and stakeholders.

During the QA process, the QA Provider is responsible for verifying that the Project Developer has adequately developed, organized, and supplied the required documentation.

Quality Assurance Review

The review of the methodologies, assumptions, and results for reasonableness represents an integral part of the QA Provider's role. The Project Development Specification presents specific QA tasks to be applied to each component of an energy efficiency project. Within each section of the Project Development Specification, a list of specific QA tasks are detailed to help guide the review process.

These QA tasks are listed within the Project Development Specification so that:

- The Project Development team can review these QA tasks and understand the expectations and activities that may be involved with the QA review process
- The direct relationship between the project best practices and QA tasks can be established

It is not feasible or necessary for the QA provider to recreate the entire project development process, and not all projects will require the application of all of the review tasks presented in the Project Development Specification. For this reason, it is important to determine the relative uncertainty and risk associated with each project component or measure and apply the appropriate level of review.

Third-Party

By definition, a third-party is someone who may be indirectly involved with, but is not a principal party to, an arrangement, contract, deal, or transaction. Any third-parties involved with an energy efficiency project should be contracted by the investors (building owner, etc), and not the project development team. Their responsibility is to represent the interests of the investors.

While various components of an energy efficiency project may involve the use of a **third-party**, within the context of ICP, there are two specific components of an energy efficiency project that require third-party involvement:

- the **first** component involves measurement and verification (M&V) efforts. ICP requires that the M&Vefforts be **performed by a third-party** M&V agent, or that the M&V efforts are overseen by a third-party. The third-party requirement ensures impartial development and/or oversight of verification of the energy savings achieved by the project.

- the **second** component involves the **QA Provider**. As with M&V, the **third-party QA Provider** needs to provide impartial technical oversight as described in this specification for determination of ICP compliance. These efforts ensure that the consistency and integrity of the ICP process are being maintained which translates to protecting the best interests of investors, including building owners.

Communication

While the QA Provider is third-party to the transaction, clear communication between the QA Provider and Project Developer is strongly encouraged. The QA provider is urged to take a collaborative approach with the Project Development team to resolve issues in order to develop a financially sound project built upon strong engineering and conservative assumptions. It is acceptable and appropriate to ask for clarification and to communicate with the Project Development team as necessary during the QA process, so long as the review process maintains a professional perspective and independence in their role as a third-party.

Project Acceptance

If the QA Provider finds that the project does not comply with the ICP Protocols, the reviewer shall provide a specific description of each deficiency to the Project Developer to assist in any necessary re-working of the project. As necessary, the QA Provider may include additional findings highlighting any other areas that were causes for concern. The QA Provider will use the guidelines set forth in the Project Development Specification and associated resources, as well as their professional experience and opinion, to determine for each item what constitutes substantial and reasonable compliance.

While many aspects of a project will be well defined and substantiated, there will always be assumptions used in the project development process. The Project Development Specification provides guidance regarding the use and development of assumptions and inputs. Nevertheless, the reasonableness of these items may be brought into question and determining whether they are appropriate will rely heavily on the experience of both the Project Development team and the QA Provider.

As such, the Project Development team and QA Provider may not always agree on what is reasonable. Items brought into question should be discussed and the reasons for their selection justified to the extent possible by the Project Development team. However, if any issues cannot be resolved it is the responsibility of the QA Provider to document these items in the investment package including how they were resolved, or why they have been left open. This procedure will allow a project to continue moving forward despite irreconcilable differences of opinion between the Project Development team and the QA Provider. Once the review has been successfully completed, the Quality Assurance Provider will complete and sign the QA Checklist to certify that the requirements of the ICP have been met based on the reviewer’s professional experience, available guidelines, and the ICP Project Development Specification.

A signed and completed QA checklist makes the project eligible to be certified as an ICP Investor Ready Energy Efficiency TM project. By signing this ICP QA checklist, the ICP Quality Assurance Provider attests to having reviewed the project development documentation and certifies that the project substantially follows the ICP Energy Performance Protocols and the ICP Project Development Specification. This Quality Assurance review and signature does not constitute a guarantee of energy savings performance, nor does it signify that the reviewer is taking professional responsibility for the required documents and engineering produced by the credentialed Project Developer.

Performance Period

The Investment Package should consist of all of the documentation required by the ICP Protocols that has been reviewed by the QA Provider and would typically be available at the point in time where investor due diligence would occur. It contains all of the information pertaining to the baseline and savings calculations, as well as the operational performance verification (OPV) plan, an ongoing management regime, and the measurement and verification (M&V) plan.

While the project may be certified as an Investor Ready Energy Efficiency TM project at this stage in the project's lifecycle, there are important tasks that still need to be accomplished as required by the ICP Protocols both during and after construction. These tasks and documentation requirements are specified in the protocols and detailed further in the Project Development Specification.

These tasks vary by protocol, but generally include:

- Implementation of the OPV plan, and development of an OPV report or statement
- Training of the facility personnel
- Updates to the Systems Manual and Operator's Manual (or creation of these manuals if they do not exist)
- Implementation of the ongoing management regime (periodic inspection, BAS review, recommissioning, fault detection and diagnostics, etc.)
- Measurement and verification efforts and reporting

Since these tasks typically occur during the performance period of the project, after the project has received its Investor Ready Energy Efficiency TM designation, there is the potential to place less importance on these activities or eliminate them altogether. However, persistence of energy savings and M&V are critical foundational elements to the overall ICP framework and project performance.

It is recommended that the contracting documentation specify how and when these construction and post-construction tasks will occur in order to ensure that they are carried out by the Project Development Team or responsible parties as laid out in required plans.

Similarly, the QA process should also apply to all of these construction and post-construction elements as well. The QA Provider should be retained and included in all of these activities, providing the same level of ICP compliance and technical review as is involved with the development of the Investment Package. The QA Provider will subsequently help ensure that these items are paid the proper attention by the Project Development Team.

This document is based on:

ICP Investor Confidence Project_Energy Performance Protocol_Project Development Specification
http://europe.eeperformance.org/

CHECK LIST

ICP Quality Assurance Checklist v1.0

Client:
Project:
Project Developer:
QA Provider:

INVESTOR CONFIDENCE PROJECT

Energy Performance Protocol
Large Apartment Blocks v1.0

BASELINING CORE REQUIREMETS

- ☐ 12-36 months utility data
- ☐ Utility baseline period
- ☐ Energy end-use estimates
- ☐ Weather data - related baseline
- ☐ 12 mos occupancy - related baseline
- ☐ Building asset data
- ☐ Baseline operational/performance data
- ☐ Normalised/regression-based baseline
- ☐ Utility rate structure

(if Demand Charges or Time of Use apply)

- ☐ Annual load profile
- ☐ Average daily load profiles
- ☐ Peak usage
- ☐ TOU summary by month *(if applicable)*

SAVINGS CALCULATIONS

- ☐ Software type
- ☐ Modeller credentials
- ☐ Weather file
- ☐ Model input files
- ☐ Model output files
- ☐ Model calibration
- ☐ Model process description
- ☐ Energy Efficiency Report

Energy Conservation Measures (ECMs)

- ☐ Investment criteria
- ☐ ECM model variables
- ☐ ECM results, and package results
- ☐ Cost estimates
- ☐ Quality assurance statement

DESIGN, CONSTRUCTION, AND VERIFICATION

- ☐ Operational Performance Verification plan
- ☐ OPV authority credentials

MEASUREMENT AND VERIFICATION

- ☐ Measurement and Verification plan
- ☐ M&V agent credentials

OPERATIONS, MAINTENANCE, AND MONITORING

- ☐ Ongoing management regime

- ☐ Project Developer Credential

QA Firm:
Reviewer*:
Date:
Signature:

** Reviewer must be qualifying individual per ICP QA Application*

Quality Assurance
INVESTOR CONFIDENCE PROJECT

By signing this ICP QA checklist, the ICP Quality Assurance Provider attests to having reviewed the project development documentation and certifies that the project substantially follows the ICP Energy Performance Protocols and the ICP Project Development Specification. This Quality Assurance review and signature does not constitute a guarantee of energy savings performance, nor does it signify that the reviewer is taking professional responsibility for the required documents and engineering produced by the Credentialed Project Developer.

FURTHER SUGGESTIONS FOR TRAINERS

The question is: what do investors want most of all? They want to be as sure as possible that they will realise the earnings foreseen in the project.

Investors are satisfied when loans are being paid regularly and this happens when all the **five steps** of the **ICP Investor Confidence** Protocol are being implemented well:

- ECMs (Energy Conservation Measures)foreseen in the project are working ->
- savings projections **are correct**->
- expected cash flows are being generated

Before proceeding with the investment, investors need to be assured that the project has undergone an **independent** and **documented** **verification** of its compliance with the **ICP performance protocol** -> in the form of a certification issued by a **Quality Assurance Provider** (independent third party) that makes the project ready for investment-> **IREE** Investment Ready Energy Efficiency.

MODULE 7: CHOOSING OPTIMAL FUNDING FOR EE PROJECTS

Alternative investments are becoming more mainstream also in the field of EE Energy Efficency investments in public buildings. As presented in Module 1, financing schemes come in a variety of packages/solutions with different operational characteristics and structures.

Choosing between different options is complex, therefore a method should be developed in order to support this fundamental decision that will have an impact on the entire project duration.

A complete assessment of the financial options should also take into consideration:

- **Risks**
- **Man days calculation according to the chosen scheme for project documentation and management**

RISK ASSESSMENT

Uncertainty and risk in Energy Conservation Measures

The estimated energy cost savings and implementation costs associated with the ECMs (Energy Conservation Measures) and package of measures are critical values for investors considering EE Energy Efficiency projects. Unfortunately, savings estimates and implementation costs are typically calculated as a single number and do not indicate a probable range or an estimated uncertainty. Failure to provide information about uncertainty leaves the financial analyst with no means to price the appropriate rate of return. This causes the financial analyst to increase the required rate of return or to de-rate the savings before applying the financial model. This practice undermines the viability of energy projects (Mills et al. 2003).

Uncertainty can occur from a variety of sources, including:

- Instrumentation equipment errors
- Modelling errors
- Statistical sampling
- Interactive effects
- Inaccuracy of assumptions (estimations)

Each of these sources of error can be minimised by using more sophisticated analysis methods, measurement equipment, sample sizes, and accurate assumptions. However, it must also be recognised that more certain savings estimates can come at an increased cost, with diminishing returns.

While it is important to a financial investor to understand the uncertainty involved in an EE project, in many cases resources and time may not be available to fully quantify the uncertainty associated with a proposed project. A **cost-effective alternative to quantifying uncertainty** is to **reduce risk**.

This is accomplished by:

- Reducing the number of assumptions used in the savings calculation and cost estimation efforts.
- Utilising conservative assumptions when these inputs are necessary.
- Reducing random errors by increasing sample sizes, using more efficient sample design, or applying sophisticated measurement techniques.
- Applying best practices to all components of project development.
- Properly applying design, delivery, and operational processes.
- Training facility staff adequately.
- Performing operational performance verification.
- Providing systems and methods to monitor and track performance on an ongoing basis, and providing an adequate managerial and recognition / response plan.
- Performing a comprehensive quality assurance process on all components of the project development, avoiding bias at all costs.

Recognising that quantifying uncertainty is not always possible, reducing risk provides a cost-effective means for providing increased investor confidence. For this reason, it is recommended that these risk reduction activities be performed for every project.

Risk transfer and quantification

In conventional procurements the public building owner/contractor controls each phase of the project development process: design, construction, finance, operations and maintenance accepting all risks. EE financial projects within European programmes can provide funding for the development of a conventional procurement or more commonly foresee **P3 (Public Private Partnerships), EPC (Energy Performance Contracts)** other innovative financing schemes as a means of project realisation, especially when projects need to be off balance. What is important in this case is accessing new financing sources/schemes and **transferring certain project risks**.

Cash flows stemming from savings calculations determined with an ICP protocol reduce uncertainty and risk in Energy Conservation Measures as presented in the previous paragraph, when it comes to choosing the optimal project scheme among several funding options extra information on the general risk assessment is fundamental.

VfM (Value for Money)

The **VfM analysis process** is utilised on a case-by-case basis to **compare** the aggregate benefits and the aggregate costs of alternative financing schemes against those of the conventional public alternative.

A key component of P3 (Public Private Partnerships) or other private procurement involves the **transfer** of **certain risks** from the public owner/contractor procuring the project to the private sector partner. The concept of “transferring risk” requires that the private partner will be responsible for cost overruns or expenses associated with the occurrence of that risk.

The application of risk management techniques can make enormous contributions to the cost effectiveness of a project. They also make VfM easier to conduct and a more reliable decision tool. Risk management begins with identifying the risks in a structured way, including looking at similar projects, using standard risk checklists, interviewing the various stakeholders and end users, and brainstorming or workshop sessions.

In P3 projects, a risk register is often prepared in advance, with public officials choosing among four options for each risk element:

- Retain certain risks;
- Insure against them;
- Transfer risk to the private sector partner; or
- Attempt to mitigate or share the risks.

The risk register will usually comprise the following components:

- Risk Category – type of risk;
- Risk Topic – identifying the specific risk;
- Risk Description – including a summary of the potential loss if the risk event occurs;
- Risk Probability – the likelihood of a risk occurring (e.g., high, moderate, low);
- Potential Consequence – impact of the risk, should it occur;
- Allocation of Risk –whether the risk will be transferred, shared or retained; and
- Treatment Options –actions that can reduce the likelihood or consequences of a particular risk (i.e., risk mitigation).

Risks need to be valued and expressed in €, here comes the tough part, once the type of risk has been identified the followings steps are defining the probability of occurrence of that specific risk and the economic value of the damage it causes. For some risks historical data is more easily available than for others, working on statistical data the impact of risk (in €) and its probability are determinable thus the risk value formulae:

Risk Value(€) = probability of occurrence($0 \leq \pi \leq 1$) x risk impact(€)

Creating a Benchmark: The Public Sector Comparator

The **PSC (Public Sector Comparator)** is expressed in Net Present Value (NPV) terms and is based on the actual public sector method of procuring the project in question. This means that if the public sector would procure the project as a design-build then the design-build method is the procuring option to be considered in the PSC. The PSC also includes any reasonably foreseeable efficiency which the public sector could achieve and takes full account of the risks which would be encountered by that style of procurement.

During the development of a PSC, several assumptions are made, including the assumption that the public sector can complete the project to the same quality and standards anticipated by private sector delivery. As the PSC presents a baseline cost of whole-life project delivery for the government, it can also be a useful tool that assists governments in forecasting the full costs associated with conventional procurements.

As stated above, the **VfM (Value for Money) analysis process** is utilised on a case-by-case basis to **compare** the aggregate benefits and the aggregate costs of alternative financing schemes against those of the conventional public alternative.

VfM analysts use a **Public Sector Comparator (PSC)** which is developed as a **baseline** against which any P3 (Public Private Partnerships) project, either hypothetical or as proposed by a private bidder, will be compared. A favorable comparison, in which the P3 achieves the same outcome for lower overall costs than the PSC, shows the P3's ability to generate **Value for Money (VfM)**.

An unfavorable comparison is evidence that the P3, as imagined or proposed, is unwarranted. An unfavorable comparison may also be taken to suggest that there is a better way of structuring a transaction and a better way of allocating risks between the parties. This can therefore help to inform the decision-making process with regard to the optimum type of transaction. The process of performing the VfM analysis should help the public contractor to focus on the key risks and opportunities and decide whether to look again at the project scope and key risk allocations before starting a procurement.

The **PSC (Public Sector Comparator)** estimates the hypothetical **risk-adjusted cost** if a project were to be financed, owned and implemented by the public sector. It is generally divided into five elements:

- raw PSC
- financing costs
- retained risk [Risk Value(€) = probability of occurrence(0≤π≤1) x risk impact(€)]
- transferable risk [Risk Value(€) = probability of occurrence(0≤π≤1) x risk impact(€)]
- competitive neutrality

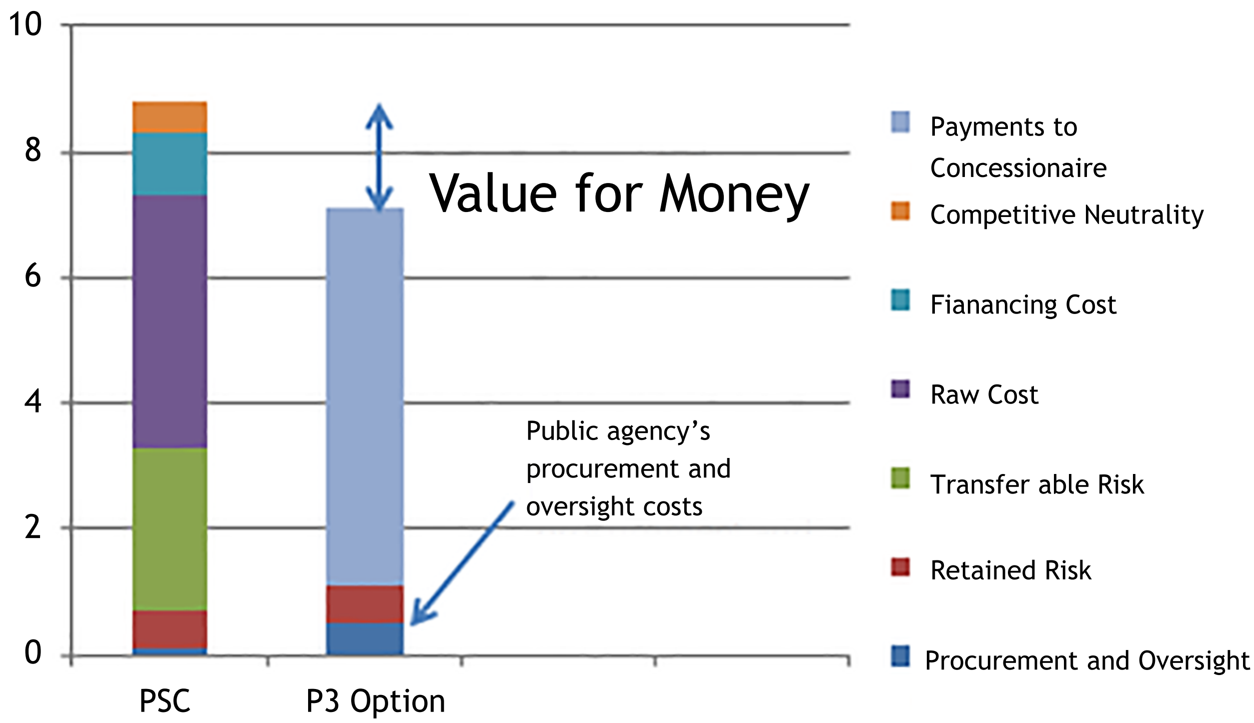
Raw PSC accounts for all life-cycle costs including public procurement costs, public oversight costs, and both capital and operating costs associated with building and maintaining the project and delivering the service over the pre-determined time. Construction or capital expenditures (design, procurement, construction) + all costs associated with operations and maintenance (even heavy maintenance) + overhead costs (administrative, employees, supplies, etc) for the next 30 years.

Financing costs are the costs associated with arranging financing for a project, generally with bonds for a conventional procurement.

Retained risk refers to the value of any risk that is not transferable to the bidder, e.g., the risk of delay in gaining project approvals.

Transferable risk refers to the value of any risk that is transferable to the bidder. Some risks may be shared, i.e., borne partly by the public contractor and partly by the private entity equally or in some other proportion, e.g., earthquake risk. (If the facility were to be damaged by an earthquake, the private sector may be only partially responsible for repairing the asset, depending on the extent of damage.)

Competitive neutrality adjusts the PSC for any competitive advantages or disadvantages that accrue to a public sector contractor by virtue of its public ownership. Competitive neutrality components will usually represent cost adjustments to the PSC, they will be discounted to a NPV just like other components i.e. taxation is the most obvious differential treatment. Taxes are costs to a private partner that ultimately result in revenues to the public sector. Public sector authorities are usually not subject to the same sales, payroll or property taxes that a P3 contractor would face. These differentials would require an increase to the PSC to represent a true "apples-to-apples" comparison.



Source: US Department of Transportation_Value for Money Assessment for Public-Private Partnerships: A Primer_ https://www.fhwa.dot.gov/ipd/pdfs/p3/p3_value_for_money_primer_122612.pdf

This could be a typical case where a specific **3P** (Public Private Partnerships) project for an **ECM Energy Conservation Measure project** is based on a payments (annuities) to a concessionaire usually covered by the new energy efficiency project savings versus a project financed, owned and implemented by a public contractor.

Both options (PSC and P3) are NPV (Net Present Values), risk values have been calculated *[Risk Value (€) = probability of occurrence(0≤π≤1) x risk impact(€)]* and competitive neutrality has also been taken into consideration. The **Value for Money** is equal to **PSC** (Public Sector Comparator) option MINUS P3 option which is the amount of money saved by using the P3 option: **VfM = PSC - P3 or other option**.

How does this apply to our work and how does this help us?

Suppose we can use the following EU programmes ELENA, HORIZON; and an INTERREG for an EE Energy Efficiency project on public buildings, underlying technical interventions are the same for all projects.

Different programmes foresee different financial schemes (with different levels/use of debt, grants, equity etc) and can be 3Ps, EPCs or other innovative financial scheme. They all use an ICP protocol.

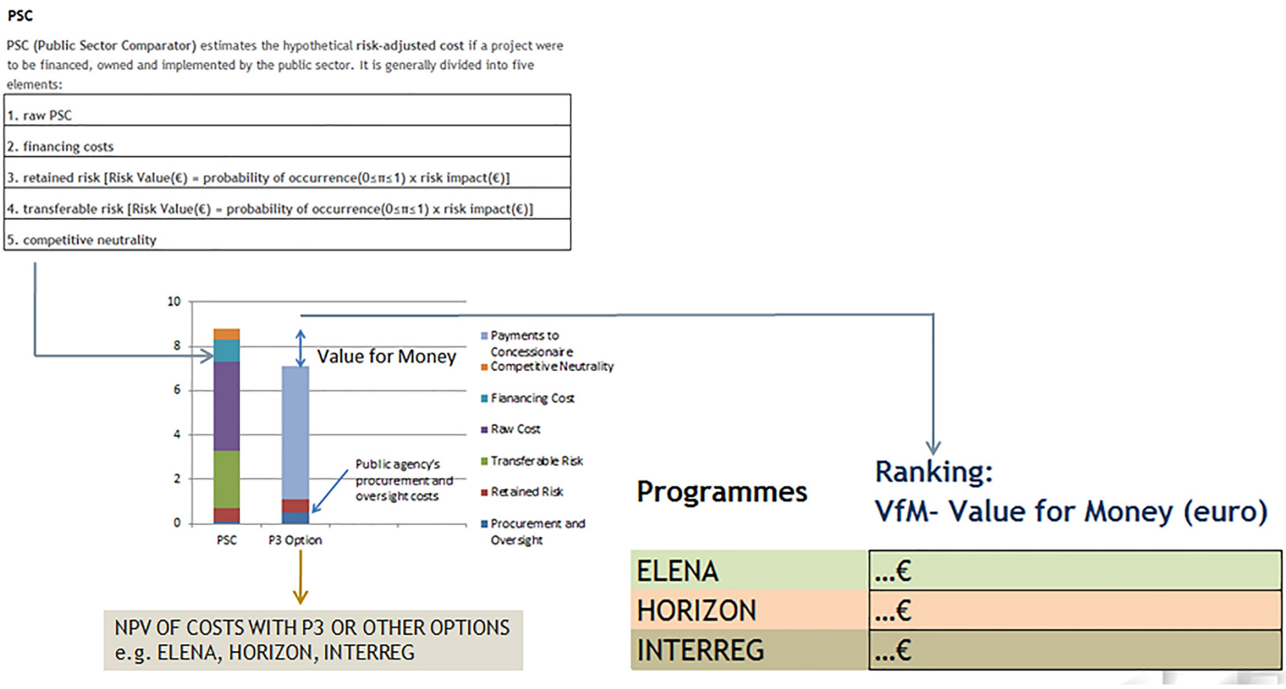
How are going to proceed ?

Step n.1_go through each programme and determine annual net cash flows (over the same period for all options)

Step n.2 _ calculate **PSC (Public Sector Comparator)** and then **VfM (Value for Money)** for each option in order to verify that these options are really convenient Versus a project financed, owned and implemented by the public contractor. If each option generates a positive VfM then the project with the highest one is the optimum funding scheme. In the case of a contractor who has to work "off balance" due to budget constraints, the choice will only focus on the best of the EU available programmes while PSC works only as a pure comparator/benchmark.

Step n.3 _ General commitment and man days calculation for tender documentation preparation and overall project management. These costs can differ a lot according to programmes and depending on whether the project is financed, owned and implemented by the public contractor (in this case there's no special funding for project management while some projects only fund technical assistance and project developing). Step n.3 can also be included in raw costs but it is an important aspect also because it provides public bodies with a clear evaluation of the commitment each type of project requires.

The project that ranks higher represents the optimum to be used for funding, **VfM** considers **Net Present values**, the sensitive aspect here is defining an appropriate discount rate.



This document is based on:
ICP Investor Confidence Project_Energy Performance Protocol_Project Development Specification
http://europe.eeperformance.org/

US Department of Transportation_Value for Money Assessment for Public-Private Partnerships: A Primer_
https://www.fhwa.dot.gov/ipd/pdfs/p3/p3_value_for_money_primer_122612.pdf

CHECK LIST

- Review OPV plan (where required) to ensure that it describes the OPV activities, target energy budgets and key performance indicators associated with the project and the individual ECMs
- Review raw PSC costs and financing costs
- Check retained risk [Risk Value(€) = probability of occurrence($0 \leq \pi \leq 1$) x risk impact(€)]
- Verify transferable risk [Risk Value(€) = probability of occurrence($0 \leq \pi \leq 1$) x risk impact(€)]
- Review competitive neutrality

FURTHER SUGGESTIONS FOR TRAINERS

Why do we need all this? Wouldn’t calculating the NPV of every project be enough?

Supposing there’s only one available project, the **first** thing we need to know is:

- Is this project **convenient** compared to the option where the whole intervention is financed, owned and implemented by the public sector

The **second** point, that applies always, is:

- adjust costs to risks, go national statistical data on the costs and realisation periods of different types of public works and other sources that provide evidence of the major risks (designing, construction, operations etc) incurred.
- Costs grow when adding risks, compare projects always **after** risk adjustment.

MODULE 8: TENDERING PROCEDURES AND GREEN PUBLIC PROCUREMENT

Each partner country has its own specific national legislation. From a technical/financial point of view the process of realising EE (Energy Efficiency) and ECM (Energy Conservation Measures) projects instead is common to all partners.

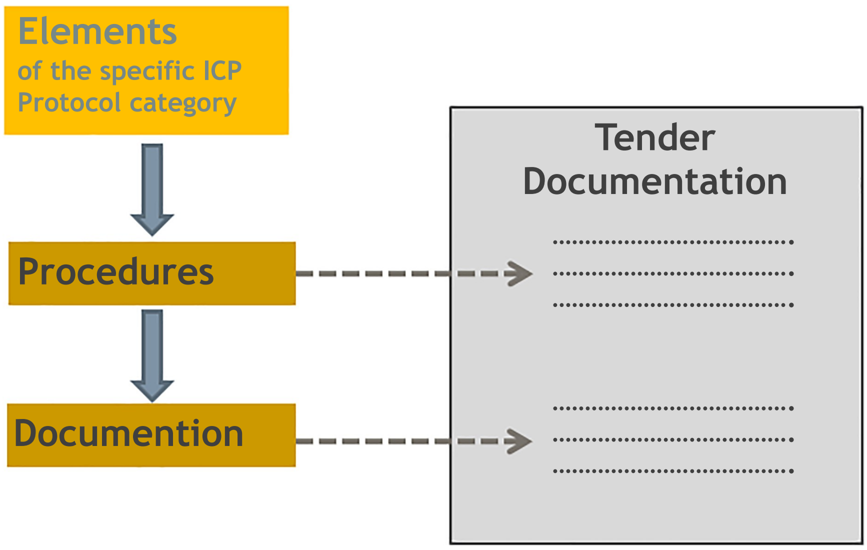
In order to ensure proper EE interventions, an adequate general project management and the realisation of the foreseen savings=>cash flows over the project's entire life cycle, sound and well detailed technical requirements must be part of the **technical requirements of the tender**.

The recommendations that follow apply to whole building retrofits and large apartment blocks.

As already pointed out before, the ICP protocol framework is divided into following five categories, which together are designed to represent the entire lifecycle of a well-conceived and well-executed energy efficiency project:

1. Baselining
2. Savings Calculations
3. **Design, Construction, and Verification**
4. **O&M (Operations, Maintenance, and Monitoring)**
5. **M&V (Measurement and Verification)**

Once points n.1 &2 have been defined the following 3 ICP categories need to be well defined, implemented and executed, they should therefore **be part of the technical requirements of the tender** according to the scheme that follows:



DESIGN, CONSTRUCTION AND VERIFICATION

The design and construction team must commit to realising the intent of the energy audit recommendations – that is, the ECMs - accepted by the Project Owner. As part of this effort, the design and construction team is required to perform operational performance verification on the measures implemented as part of the project.

Unlike a full commissioning effort, this process does not involve assessment of all of the systems and controls. Instead, it is targeted at ensuring that the implemented ECMs have the ability to achieve the predicted energy savings, and involves verification that the measures were implemented properly and have the capability to perform.

The operational performance verification process involves visual inspection of the installed systems and control sequences to ensure that they were implemented as intended, as well as targeted functional performance testing, spot measurements or short term monitoring.

Elements to be considered:

- **Operational Performance Verification Specialist:** Appointment of a qualified Operational Performance Verification Specialist as manager of the performance verification process is required.
- **Operational Performance Verification Plan:** Development of an Operational Performance Verification plan (pre-construction) that describes the verification activities, target energy budgets and key performance indicators.
- **Design and Construction:** The Specialist must ensure that the ECMs have been implemented as designed and can be expected to perform as conceived and projected by the energy audit. This will include consultation with the energy audit team, monitoring of designs, submittals, project changes, and inspections of the implemented changes. The Specialist must have the responsibility and means of reporting deviations from design and projected energy savings to the Project Owner.
- **Training:** Training of building operators in operation of the new systems/equipment, including their energy performance targets and key performance indicators.
- **Operational Performance Verification Report:** Concise documentation shall be provided that details activities completed as part of the operational performance verification process and significant findings from those activities, which is continuously updated during the course of a project.

Procedures (part of the technical requirements of the tender)

1. Appoint a qualified Operational Performance Verification Specialist (the 'Specialist') with at least five years of demonstrated operational performance verification experience, documented in the form of a CV outlining relevant project experience.
2. Develop an Operational Performance Verification plan (pre-construction) that describes the verification activities, target energy budgets and key performance indicators.
3. Consult with the energy audit team, monitor designs, submittals and project changes, and visual inspection of the implemented changes.
4. The Specialist should perform operational performance verification activities, and document operational performance verification results as part of the building's permanent documentation.
5. Train operators in the correct operation of all new systems and equipment, including meeting energy performance targets.

Documentation (part of the technical requirements of the tender)

- Qualifications of the Specialist.
- A concise Operational Performance Verification Plan specified for all new systems and/or major pieces of equipment in the project. The Plan will define all of the procedures and tests to be performed and a performance checklist.
- System and equipment test requirements must include specific tests and documentation that relate to the energy performance of the new and modified systems and/or equipment, conducted over a suitable range of operating (or simulated operating) conditions, and time period.
- A concise Operational Performance Verification Report, which is a record of operational performance verification results. The report should include photographs, screen captures of the Building Automation System (BAS), copies of invoices, testing and data analysis results as appropriate.
- Statements by the Specialist that the project, first as designed and, subsequently, as built conforms with the intent and scope of the energy audit and has the ability to achieve predicted energy savings.
- Training materials and record of training.
- Full documentation of all new and modified systems and equipment in the form of Systems Manuals, to be prepared following the guidance set out in EN 13460:2009 Maintenance – Documents for maintenance.
- Documentation must include (monthly where possible) target energy budgets and other key performance indicators for the modified building as a whole and down to the level of systems and major equipment where required.

O&M OPERATIONS, MAINTENANCE AND MONITORING

Operations, Maintenance, and Monitoring is the practice of systematic monitoring of energy system performance and implementing corrective actions to ensure “in specification” energy performance. (Often referred to as Ongoing Commissioning, Monitoring-based Commissioning, Performance-based Monitoring, and Building Re-tuning).

Elements to be considered:

- **Performance Indicators:** Establishment of key performance indicators at component and/or system level - the performance bands outside which corrective communication/response will be taken – consistent with achieving close to desired building level energy performance defined in the Operator’s manual (see section 6.3). Key performance indicators must be measurable.
- **Monitoring:** Identification of points, interval and duration to be monitored by the building management system.
- **Operation:** Assignment of responsibilities for communication of performance issues and implementation of corrective actions. Development of a concise, targeted Operator’s Manual discussing the new ECMs or systems, including assignment of responsibilities for communication of performance issues and implementation of corrective actions.
- **Training:** Training of building operators in proper maintenance best-practices for the new and modified systems/equipment.

- **Outreach:** Notifying building tenants of the improvements performed in the building as part of the project, and descriptions of any behaviour modifications or best practices recommended as part of the energy efficiency efforts.

Procedures (part of the technical requirements of the tender):

1. Select ongoing management regime, either Building Management System (BMS) report review by staff, software-based monitoring and fault detection, whole-building monitoring, periodic recommissioning, or a combination of these
2. Train facility staff and service providers on new equipment, management and monitoring software and reporting regime. Training must incorporate understanding, skills, and procedures necessary to support the operations, maintenance, and monitoring program.
3. Chart the data points to be monitored and their relationship to the performance of the new installations and modified equipment/systems.
4. Install and test fault detection functions for system malfunctions or substantial deviations.
5. Compare actual performance with savings projections for the same period given adjustment factors on a (minimum) monthly basis.
6. Collate periodic performance reports covering all monitored points including all observed deviations from projected operation, analysis of cause, and corrective actions taken or recommended.
7. Development of a concise Operator's Manual targeting the new systems and their operation, including assignment of responsibilities for communication of performance issues and implementation of corrective action. In many cases, the Operator's Manual and Systems Manual can be combined into one document to be used by the operations and maintenance personnel
8. Train operators in proper maintenance best-practices for all new systems and equipment - refer to EN 15331:2011 Criteria for design, management and control of maintenance services for buildings [6a] for guidance).
9. Notify building tenants of the improvements performed in the building as part of the project, and descriptions of any behaviour modifications or best practices recommended as part of the energy efficiency efforts.

Documentation (part of the technical requirements of the tender):

- Points list of key variables to be trended in the BAS (building Automation System).
- Plan for fault detection and remediation - may be fully automated, a combination of automation and active response by commissioning and building personnel, or periodic recommissioning. The plan should indicate the intervals for measurements and the duration within which performance will be measured, or a schedule and plan for periodic recommissioning.
- Organisational chart establishing contact information for all personnel involved in ongoing commissioning process and clear internal responsibility for the monitoring and response activities. If ongoing commissioning is outsourced to a third-party provider, the chart must clarify its relationship to the property's operating staff and senior management personnel, reporting processes and responsibilities for corrective action.

- Operator's Manual describing the new systems and their proper operational performance, as well as an organisational chart establishing contact information for all personnel involved in ongoing system operation and responsibilities for corrective action.
- Maintenance plans and service response log, including warranties for any new equipment.
- Training curriculum.

M&V (MEASUREMENT AND VERIFICATION)

The following overarching principles should govern any Measurement and Verification (M&V) Plan:

- **Transparency:** all input data, baseline calculations, and variable derivations must be made available to all parties and any authorised reviewers.
- **Reproducibility:** given the same source data and a description of the adjustment methodology, any competent practitioner must be able to produce identical or nearly identical results.
- **Fairness:** baseline adjustments must show no meaningful statistical bias toward a positive or negative outcome.

Standard M&V Method

Quantifying the savings reliably from energy conservation projects requires the comparison of established baseline and post-installation energy use normalised to reflect the same set of conditions. For purposes of this protocol, the pre-retrofit energy usage baseline that was developed in the Baselining section of this protocol is the starting point for measurement and verification. The standard method is to utilise the original regression-driven baseline model, applying it to post-installation conditions to represent what the baseline energy use would have been in the absence of an energy conservation program in the building.

Savings are determined by comparison to the established baseline energy and post-installation energy use, adjusted to the same set of conditions. The approach requires adjustments to baseline energy use as follows:

1. **Routine adjustments:** Account for expected changes in energy use.
2. **Non-routine adjustments:** Account for unexpected changes in energy use not due to installed ECMs.

Routine adjustments typically include those for changes in weather. **Non-routine** adjustments typically include changes in occupancy (vacancy rates), type of space use, equipment, operating hours, service levels (e.g. a new tenant requires colder air), and utility rates (where the difference in cost and not usage is the desired outcome).

The equation for an adjustment takes the general form:

$$\textbf{EnergyUsage}_{New} = \textbf{EnergyUsage}_{Baseline} \; \textbf{+/- Adjustments}$$

For example, an engineer may estimate the impact of a change in occupancy on the overall energy usage in a building. The adjustment factor to be applied may come from a whole building simulation that estimates the impact based upon the existing systems and their ability to modulate to respond to higher or lower occupancy, or a spreadsheet calculation method. Alternatively it might be derived from a comparison of actual usage data for periods of lower or higher occupancy.

Elements to be considered:

- Appointment of a third-party measurement and verification professional with Certified Measurement & Verification Professional (CMVP) certification or at least five years of demonstrated M&V experience, documented in the form of a CV outlining relevant project experience, to provide M&V services, or to provide oversight to the M&V process.
- M&V plan adhering to the IPMVP (International Performance Measurement and Verification Protocol). This is the foundation of the M&V activities, and should be developed as early as possible in the project.
- Definition of the baseline period.
- All baseline energy use and cost parameters (the dependent variables in an adjustment calculation).
- Definition of the baseline values of routine adjustment parameters (the independent variables, such as external temperature).
- Utility rates applicable to the baseline values.
- List and describe all methods for routine adjustments.
- List and describe all known or expected non-routine adjustments.
- Provide all adjustment parameters and formulae for routine and known or expected non-routine adjustments.
- Define the principles upon which any unknown non-routine adjustments will be based.
- Input data sets, assumptions and calculations to be made available to all parties in an efficiency project and any commissioned or independent reviewers.
- Whole-building energy data recorded from building energy meters, recorded as monthly kWh consumption (minimum 12 months), or short time intervals (typically 15-minute).
- Concurrent period hourly ambient temperatures and other independent variable data identified as a significant energy use driver for subject building. Building operation schedules.
- A regression-based energy model built from the collected baseline data. Model types may be averages, simple linear, multiple regressions, change-point, or polynomial model.

Procedures (part of the technical requirements of the tender)

This involves planning and coordinating M&V activities. Comply with applicable sections of IPMVP (International Performance Measurement and Verification Protocol) - Option C.

1. Develop an IPMVP (International Performance Measurement and Verification Protocol)-adherent M&V plan. This should be developed pre-construction.
2. Gather necessary data – before and after the planned retrofit.
3. Verify savings for the entire facility. This involves consideration of the measurement boundaries, interactive effects, selection of appropriate measurement periods, and basis for adjustments.

The following should be taken into account during the reporting period:

- **Routine Adjustments:**

  See IPMVP Option C

- **Non-Routine Adjustment Procedures:**

To the extent possible, ongoing commissioning processes should be used to reduce/eliminate the need for non-routine adjustments. Equipment failures and other anomalies should be identified and addressed before non-routine adjustments must be applied. Nevertheless, during the post-installation period, unexpected changes may take place in buildings. For a 'like for like' comparison with the baseline, the impact of these unexpected changes must be quantified and adjusted for.

- **Constant Load:**

Identify the source of the additional (or removed) load and use a measurement instrument to measure the amount of power consumed. Identify the duration of the increased load and quantify the total additional energy consumed.

Install a monitoring device to continuously monitor the additional power. Quantify the additional energy used during the reporting period.

- **Uncertainty:**

while uncertainty does not necessarily need to be quantified, quality assurance activities should be employed to minimise uncertainty and risk throughout the energy efficiency project development process.

4. Report results.

Documentation (part of the technical requirements of the tender):

- **Measurement and Verification plan.**
- **Data collected and used in analysis.**
- **Description of model type and how it was developed**

  Regression model or simulation model.

  Description of routine adjustments of baseline energy use.

- **Non-routine adjustments**

  Description of cause or source of unexpected changes.

  Impact

  - ☐ Temporary or permanent.
  - ☐ Constant or variable impact.
  - ☐ Amount of energy affected.

  Measurements made to quantify non-routine adjustments.

  Description of baseline adjustment procedure.

This document is based on:
ICP Investor Confidence Project_ Large Apartment Block Protocol
http://europe.eeperformance.org/

CHECK LIST

Tender requirements in the case of large apartment blocks should address each ICP Project category as specified in the checklist that follows.

BASELINING CORE REQUIREMETS

- ☐ 12-36 months utility data
- ☐ Utility baseline period
- ☐ Energy end-use estimates
- ☐ Weather data - related baseline
- ☐ 12 mos occupancy - related baseline
- ☐ Building asset data
- ☐ Baseline operational/performance data
- ☐ Normalised/regression-based baseline
- ☐ Utility rate structure

(if Demand Charges or Time of Use apply)

- ☐ Annual load profile
- ☐ Average daily load profiles
- ☐ Peak usage
- ☐ TOU summary by month *(if applicable)*

SAVINGS CALCULATIONS

- ☐ Software type
- ☐ Modeller credentials
- ☐ Weather file
- ☐ Model input files
- ☐ Model output files
- ☐ Model calibration
- ☐ Model process description
- ☐ Energy Efficiency Report

Energy Conservation Measures (ECMs)

- ☐ Investment criteria
- ☐ ECM model variables
- ☐ ECM results, and package results
- ☐ Cost estimates
- ☐ Quality assurance statement

DESIGN, CONSTRUCTION, AND VERIFICATION

- ☐ Operational Performance Verification plan
- ☐ OPV authority credentials

MEASUREMENT AND VERIFICATION

- ☐ Measurement and Verification plan
- ☐ M&V agent credentials

OPERATIONS, MAINTENANCE, AND MONITORING

- ☐ Ongoing management regime

- ☐ Project Developer Credential

FURTHER SUGGESTIONS FOR TRAINERS

Specific national legislation on tenders varies from country to country, what stays the same is the need to get the technical work done well and check that savings are real.

Thus, ICP (Investor Confidence Protocol) **procedures** and **documentation on**

- Design, Construction, and Verification
- O&M (Operations, Maintenance, and Monitoring)
- M&V (Measurement and Verification)

should be of be part of the technical requirements of the tender.

PART 2:
EXERCISES

EXERCISE 1: EU, NATIONAL AND REGIONAL FINANCING SCHEMES

Suppose a public authority is considering the possibility to carry out sound ECMs (Energy Conservation Measures) for its headquarters and other buildings it owns, it therefore wishes to have an overview on the major EU programmes for energy efficiency measures.

How should the person appointed for this task proceed? What are the principal programmes to be considered? Where can further information and details be found. Finally, how could the information gathered be presented synthetically to the public authority board?

Please refer to this document and the table that follows to complete the exercise.

The excel file **Module N.1-Exercise** contains the table below and is attached to this handbook.

Topic/ objective	Programme/tool	Fore details	More information
a) Direct funding for the beneficiary generally through grants	European Regional Development Fund (ERDF)	http://ec.europa.eu/regional_policy/en/funding/erdf/	Major funding instruments: INTERREG programmes
	Cohesion Fund (CF)	http://ec.europa.eu/regional_policy/en/funding/cohesion-fund/	aimed at Member States whose Gross National Income (GNI) per inhabitant is less than 90 % of the EU average
b) European Investment Funds through fuding to beneficiares through debt	European Energy Efficiency Fund (eeef)	http://www.eeef.lu/eligible-investments.html	Direct investments OR investments to financial institutions who finance projects of the Final Beneficiaries
	European Fund for Strategic Investments (EFSI)	http://www.eib.org/efsi/how-does-a-project-get-efsi-financing/index.htm	Mobilises private financing for strategic investments providing funding for economically viable projects where it adds value, including projects with a higher risk profile than ordinary EIB activities
	Private Finance for Energy Efficiency (PF4EE)	http://www.eib.org/products/blending/pf4ee/index.htm	Addres the limited access to adequate and affordable commercial financing for efficiency investments
c) Grants for technical assistance. No money for project activities but only for project development	ELENA - supporting investments in efficiency and sustainable transport	source: http://www.bei.org/products/advising/elena/index.htm	In this case the funding is related to feasibility and market studies, programme structuring, business plans, audits and financial structuring. In other words, no money for project activities but only (a minor fraction) for a sound project development through a preliminary study
	Horizon 2020 (Call EE-22-2016-2017_Project Development Assistance	http://ec.europa.eu/research/participants/portal/deskop/en/support/national_contact_points.htm	

EXERCISE 2:
ALTERNTIVE FINANCING METHODS

Consider a specific project (existing or invented) and fill in the yellow cells, this is a starting exercise that provides a first assessment of the project's general funding structure.

Go to http://www.energy-cities.eu/Innovative-financing-schemes or to the TOGETHER library (http://www.interreg-central.eu/Content.Node/TOGETHER.html) and check the document "Financing schemes increasing energy efficiency and renewable energy use in public and private buildings". Select one the projects and try to insert the data in the excel Module N.2-Excercise that is attached to this handbook. Please refer to the table that follows.

Module N.2_Alternative Financinf methods
Excercise: Project funding assessment
(fill in the cels in yellow)

ECMs (Energy Conservation Measure)		Notes
Envelope	Yes/No	
Winows	Yes/No	
HVAC equipment	Yes/No	
Boiler system	Yes/No	
Lighting	Yes/No	
…………	Yes/No	

Financial data		Notes
Investment value	I0	
Savings per year	I0	
Contracting rate (annuity) paid to ESCO	Yes	
Inflation adjustments	Yes	
Extensive M&V Measurement and Verification system	Yes	

Funding structure				Notes
Grant - Technical assistance			0%	
Grant - Project activities			0%	
Other financing methods				
Direct Funding	30%	Self	10%	
		Debt	20%	
EPC			70%	
		Tot.	**100%**	

If EPC is used then define:	ESCO	Beneficiary	Notes
Design risk	100%	0%	
Construction & Performance risk	100%	0%	
Credit risk	100%	0%	
Equipment owning	100%	0%	
Equipment operation	100%	0%	
Fuel/electricity purchasing	100%	0%	

EXERCISE 3: ECONOMIC AND FINANCIAL ASSESSMENT OF THE INVESTMENT

This basic exercise regards the thermal isolation of a small public building (used as an office) where an envelope of 10 cm of EPS was realised as ECM Energy Conservation Measure, savings were calculated together with the effect of inflation and final net cash flows for a 20 year period (which is the estimated duration period of the envelope).

The basic information defined in the **State of the art, Financial data and Energy Conservation Measures** tables will enable us to calculate the four financial indicators defined in this module. The excel file of the exercise will also be available to trainers so that they may gain further acquaintance with the use of the formulae on the spread sheet.

The scope of this exercise is to focus on the calculation methods.

Sate of the art		
Small public building on two floors	160	m^2
Traditional (non condensing) gas boiler for heating		
NO thermal envelope on walls		
Gas consumption for heating	2.800	[sm^3/anno]
Annual gas costs	2.240	[€/anno]

Financial data		
Cost of gas per standard cubic metre	0,80	[€/sm^3]
Discount rate deemed suitable	4%	
Average inflation rate on gas	2%	

Energy Conservation Measure: 10 cms of EPS (Expanded Polystyrene) external enevolpe on walls		
EPS surface	162	[m^2]
EPS thickness	10	[cm]
Cost of thermal envelope per square metre	60	[€/m^2]
Gas consumption for heating (after the intervention)	1.840	[sm^3/anno]

Calculation of savings:

Energy Conservation Measure:
10 cms of EPS (Expanded Polystyrene) external enevolpe on walls

Total cost of the measure	€ 9.720 **[€]**
Gas consumption - after intervention	1.840 **[smc/year]**
Cost of gas per standard cubic metre	1.472 **[€/year]**
Savings	**768 [€/year]**

Calculation of the financial indicators:

Energy Conservation Measure:10 cms of EPS (Expanded Polystyrene) external enevolpe on walls

EPS 10 CM - INVESTMENT (Io)	-9.720
SAVINGS	€ 768

	1	2	3	4	5	6	7	8	9	10
SAVINGS	768	768	768	768	768	768	768	768	768	768
SAVINGS + INFLATION	768	783	799	815	831	848	865	882	900	918
CF = CASH FLOWS	-8.952	783	799	815	831	848	865	882	900	918
CUMULATIVE CASH FLOWS	-8.952	-8.169	-7.370	-6.555	-5.723	-4.875	-4.010	-3.128	-2.228	-1.311

	11	12	13	14	15	16	17	18	19	20
SAVINGS	768	768	768	768	768	768	768	768	768	768
SAVINGS + INFLATION	936	955	974	993	1.013	1.034	1.054	1.075	1.097	1.119
CF = CASH FLOWS	936	955	974	993	1.013	1.034	1.054	1.075	1.097	1.119
CUMULATIVE CASH FLOWS	-374	580	1.554	2.548	3.561	4.595	5.649	6.725	7.822	8.940

NPV NET PRESENT VALUE € 3.012 €

$$NPV = \sum_{j=1}^{n} \frac{CF}{(1+R)^n} - Io \ (\text{Initial Investment})$$

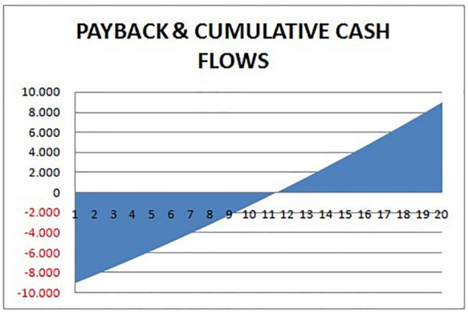
PROFITABILITY INDEX 0,31

$$\text{Profitability index} = \text{Present Value PV/Io} = \left(\sum_{j=1}^{n} \frac{CFj}{(1+R)^n}\right) / \text{Io Initial investment}$$

IRR INTERNAL RATE RETURN 7,56%

$$NPV = \sum_{j=1}^{n} \frac{CF}{(1+IRR)^n} - Io \ (\text{Initial Investment}) = 0$$

PAYBACK 11<PYBK<12 YEARS



Please refer to the excel **Module N.2-Excercise** that is attached to this handbook.

EXERCISE 4:
DEVELOPMENT OF THE FINANCIAL DOCUMENTATION OF THE PROJECT

This module really focuses on **baselining** and **savings projections** since cash flows depend on **savings** (see previous exercise in module n.1) and revolves around getting the first two categories of the ICP system done correctly.

Baselining provides a critical starting point for an accurate projection of potential energy savings.

It must also consider the impact of independent variables such as weather, occupancy, and operating hours on the building's energy consumption.

Building energy consumption metrics should be developed using the baseline historical utility data. This should include kWh/yr, and kWh/(m2.yr). Heating values of fuels reported on utility bills are typically adjusted for delivered heat content, elevation, and temperature.

Normalisation is used to analyse, predict and compare energy performance under equivalent conditions. Regression-based energy modelling is a specific type of normalisation, and involves the development of an energy **consumption equation**, which relates the dependent variable (total site energy consumption) to independent variables known to significantly impact the building's energy consumption.

Independent variables typically include weather Heating degree day (HDD) and may include other variables such as operating hours, occupancy or vacancy rates, and number of occupants.

The energy consumption equation can be determined using a regression analysis – the process of identifying the straight line of 'best fit' between the building's energy consumption (usually on a monthly basis) and one or more independent variables.

An example of this is shown below for a primary school, the **energy consumption (kWh) = m1X1 + m2X2 + m3X3 + C** where, e.g. **X1 can be** Heating Degree Days (HDD), **X2** occupancy and **X3** number of occupants.

If after the ECM (Energy Conservation Measure) has been completed there's a warm winter, are savings due to the ECM or to the higher average temperature? This is what energy consumption equations are for. First, knowing the independent variables of the period (HDD, Occupancy etc) through the equation we can calculate what the consumption level **would have been before the ECM**, then measuring the effective energy consumption of the period (even with bills) we can calculate the correct **SAVINGS** (difference between the two, Adjusted Baseline Computations).

The excel file **Exercise-Module N.4** is attacged to this handbook. Fill in cells in yellow with data from another building and go through the formulae on the spread sheet.

Primary School

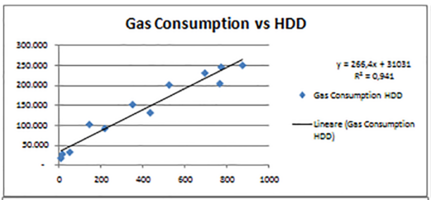
Period	Baseline data			
	Y	x1	x2	x3
	Gas Consumption	HDD	ccupancy Da	Occupant number
Jan	250.310	876	15	750
Feb	230.672	696,8	20	748
Mar	200.568	526,7	20	753
Apr	130.120	436,3	15	756
May	100.698	148	17	745
Jun	30.357	54,2	5	754
Jul	25.367	19	5	253
Aug	15.003	13	0	100
Sep	90.534	220,9	10	350
Oct	150.687	353,4	20	759
Nov	203.975	767,5	20	740
Dec	245.682	773,7	15	733
Mean	139.498			
Sum	1.673.973	4.885,20	162	

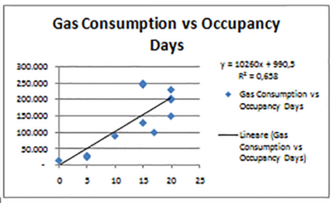
*Hot sanitary water consuptions included

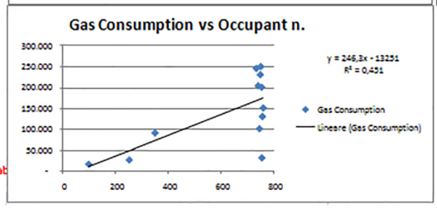
Gas consumption data come from the utility bill meter.

HDD data come from local ARPA measurements.

Occupancy days and Occupant numbeer come from the school facility management staff.







Given the correlation level (R2) between Gas Consumptions and the three considered indipendent variab the only relevant indipendent variable is "HDD".

Therefore the equation used for the energy consumption m

Gradient	266,4370866
Intercept	31031,21205
R2	0,94183599

y = 266,44*x1 + 31031

	x1	intercept			
	266,4370866	31031,212	#N/D	#N/D	#N/D
SE equation terms	20,93795228	10654,5416	#N/D	#N/D	#N/D
R2, SE energy moc	0,94183599	22144,0922	#N/D	#N/D	#N/D
	161,927623	10	#N/D	#N/D	#N/D
	79402961692	4903608180	#N/D	#N/D	#N/D
	#N/D	#N/D	#N/D	#N/D	#N/D
	#N/D	#N/D	#N/D	#N/D	#N/D
	#N/D	#N/D	#N/D	#N/D	#N/D
	#N/D	#N/D	#N/D	#N/D	#N/D

Indipendent variables sensitivity

t student test t>2 o t<-2	12,72507851	2,91248683

Energy Equation 1 – ONLY HDD

y = 266,44*x1 + 31031

Energy Equation 1 – ONLY HDD

Period	Y Gas Consumption*	Check		
Jan	250.310	264.430		
Feb	230.672	216.685		
Mar	200.568	171.364		
Apr	130.120	147.278		
May	100.698	70.357		
Jun	30.357	45.472		
Jul	25.367	36.200		
Aug	15.003	34.415		
Sep	90.534	89.887		
Oct	150.687	125.190		
Nov	203.975	235.522		
Dec	245.682	237.174		
Sum	1.673.973	1.673.973	-	OK
Mean	139.498	139.498	-	OK

The Excel file **Exercise module N.4** is attached to this handbook. Fill in the yellow cells with the independent variables.

Furthermore the pdf file **Exercise module N.4** is a good example of a Savings Calculation Method. This material was contributed for EVO (Efficiency Valuation Organization) subscribers to see how others are addressing these issue.

EXERCISE 5:
ENSURING PROJECT BANKABILITY, VIABILITY AND PROFITABILITY

This exercise comes from the contribution to EVO (Efficiency Valuation Organization) by subscribers in order to provide a practical methodology integrated with real data on how others are addressing the topic of the M&V (Measurement & Verification) Plan.

The pdf file of the exercise that is presented below is attached to the handbook, please refer to the file **Exercise module N.5**.

Appendix C. Example M&V Plan – Biosciences Building

The following is an example M&V Plan for EBCx measures anticipated in a biosciences building on a university campus in Northern California. It follows the recommended M&V Plan content found in the IPMVP, 2007, Chapter 5.

C.1 Building Description

The Biosciences Building has a floor area of approximately 180,000 square feet. It has a lower level, a ground level, and four floors of research lab space. On each floor there are four laboratory suites. Each suite consists of two separate laboratory rooms. A typical floor plan is shown in Figure C-1. The building is made of steel and masonry, with recessed windows on each floor.

The well-known utility provides electricity to the entire campus through a master meter. The Biosciences Building receives electric power through three connections to the campus' distribution network. Each connection has its own sub meter. Electric power and energy data from each sub meter is collected and displayed on the campus's online energy monitoring system. The recording interval is 15 minutes.

The campus operates a cogeneration facility that supplies steam to each building. The Biosciences Building receives steam from the main steam distribution loop. Steam flow rate and total pounds, as well as steam pressure are monitored by the campus's online energy monitoring system. The recording interval is 15 minutes.

An M&V Plan should provide a basic building or facility description. Such descriptions are also required in RCx planning reports or investigation reports, and to save time, the M&V plan can refer to other documents where this information is contained.

EXERCISE 7: CHOOSING OPTIMAL FUNDING FOR EE PROJECTS

As pointed out in **Module N.2**, under an EPC Energy Performance Contract arrangement an external organisation (ESCO) implements a project to deliver energy efficiency and uses the stream of income from the cost savings to repay the costs of the project, including the costs of the investment.

Essentially the ESCO will not receive its payment unless the project delivers energy savings as expected.

The principal structures an EPC contract, were also described in **Module N.2.** Suppose two different projects present different types of EPCs for the same energy efficiency measures and have the same NPV Net Present Value which one is more convenient ?

In this case we'll have to consider risk, the EPC with the lowest risk is the one to choose, implicitly, it shall bare the lower overall investment costs adjusted to risks.

ANNEXES

Annex 1: Module no 1 exercise

Annex 2: Module no 2 exercise

Annex 3: Module no 3 exercise

Annex 4: Module no 4 exercise

Annex 5: Module no 5 exercise

Annex 6: Module no 6 exercise