# D.T2.2.3
# Methodology to test the tool to assess public investments for industry's low carbon transition

## WP T2: Activity 2.2 Methodology and local specification to assess public investment to industry

The report provides the methodology of the assessment tool developed (O.T1.4) with local specification from stakeholders' feedbacks, local legislation, existing instruments, practices, etc. The methodology will be used during realisation of the pilot actions.

| | |
|---|---|
| Prepared by | ENVIROS, s.r.o.<br>Pavel Ruzicka, Katerina Maneva Mitrovikj |
| Project number and acronym | CE 1131 FIRECE |
| Lead partner | Chamber of Commerce of Venice Rovigo Delta-Lagunare |
| Address | Dykova 53/10, Praha, Czech Republic |
| Email | pavel.ruzicka@enviros.cz |
| Date, venue | 15th November 2019, Prague |

# List of Contents

# Introduction

The FIRECE project aims to contribute to the implementation of the Regional Energy Plans to achieve the targets on energy efficiency and renewable energy sources planned at EU and national level with particular attention to industry.

This report provides the methodology how to apply and use the Tool to assess public investments to support industry's low-carbon transition (O.T1.4). The overall Tool is split into two separate tools:

1. **Programme level tool**

   The Programme level tool can be used to assess potential impacts of a new public funding/financing programme, which aim is to support industry's low-carbon transition (i.e. support of investment into energy saving and renewable energy measures).

   The instrument allows the user to calculate the expected use of budget allocation, expected investment generated, expected energy savings, and expected decrease of emissions.

2. **Project level tool**

   The Project level tool main focus is to evaluate economic parameters of a particular project (e.g. NPV – net present values, CF – cash flow, etc.) as well as its environmental benefits in terms of decreased carbon emissions.

   With reference to funding/financial support, the user is able to simulate how different types of instruments (subsidies, loans) and different shares of financial support affect economic parameters of the project and so its financial viability.

# 1 Energy saving measures

The following twenty groups of energy saving measures relevant for the industry are considered in both tools:

1. Buildings insulation
2. Change of technological processes
3. Control of circulation pumps
4. Decrease of losses in heat distribution
5. Energy management
6. Installation of cogeneration units
7. Installation of flue gas pre-heaters to boilers
8. Installation of frequency inventors
9. Installation of heat pumps
10. Installation of photovoltaic systems (for electricity generation)
11. Installation of solar thermal systems (for heat generation)
12. Installation/replacement of compressors
13. Replacement of coal boiler with biomass boiler
14. Replacement of coal boiler with gas boiler
15. Replacement of coal boiler with new coal boiler
16. Replacement of existing lighting with LED80
17. Replacement of lighting LED80 with LED110
18. Thermal insulation of technologies
19. Transformers replacement
20. Waste heat utilisation

## Building insulation

The building insulation measure refers to implement additional thermal insulation of existing structures, mainly perimeter walls, roof, ground floor, ceiling or basement, and replacement of apertures.

In general, it can be stated that 60% of the original consumption can be saved from a standard overall reconstruction, including insulation of external walls, the roof, the basement ceiling and the replacement of the openings.

It is possible to save about 40% when refurbishing only the perimeter walls with window replacement. Up to 90% with passive house or nearly zero energy building renovation.

The amount of savings depends on the technical condition of the building and the reconstruction project. Since other additional costs are attached to the renovation of the building, which improve the appearance of the building or contribute to the improvement of comfort or safety, but do not contribute to energy saving, the payback time is estimated in range of 12 to 50 years. The service life depends on the quality of the design, the materials used and the behavior of the users. On average, it is up to 20 years.

### Change of technological processes

This saving measure refers to the wide range of possible changes to be made in technological processes of industries' production. Their cost of implementation as their payback and effectiveness may be highly variable.

Frequently, important changes in terms of energy saving cannot be performed as they present adverse impact on the production quality. For this main barrier, the potential of the measure must be reduced.

### Control of circulation pumps

The measure temporarily controls the circulation of hot water in plants where it is technically possible. These are one- or two-shift operations where the hot water circulation pump is in operation, including weekends when the plant is out of service.

### Decrease of losses in heat distribution

The losses reduction in heat distribution can be mainly achieved by insulating steam and condensed pipes, changing heat transfer medium (steam – hot water or steam – hot water) and replacing four-pipes design for two-pipes. Industrial companies and district heating systems are mainly involved in losses reduction. Given the current situation in the liberalised energy market, measures are applied to heat sources burning all fuels (coal, biomass, natural gas, heating oils, etc.). In the case of fuel cost savings only, the payback time ranges from 20 years. If

maintenance costs are also achieved, which are reflected in the price of heat, the payback period can be reduced to 15 years.

## Energy management

The energy management system consists of a wide range of processes designed to achieve and maintain both short and long term energy economy optimisation from the perspective of the owner or operator.

From these activities, we can appoint, the principles of energy policy set, optimisation of energy purchase, maintenance of best operation practices, application of procedures for continuous improvement, integration of energy management in the process of investment decision-making, monitoring, analysis and reporting of results in the field of the energy management efficiency, the systems of functionality's control and regulation, etc.

The operating costs are mainly influenced by the working cost of the person responsible for maintaining the energy consumption data collection and processing system.

## Installation of cogeneration units

The measure consists in the installation of cogeneration units based on a gas engine. CHP plants producing heat and electricity are designed and dimensioned predominantly on electric power, so that the electricity produced covers its own consumption. The heat produced by the cogeneration unit is used in technological processes, for heating or hot water preparation. The economics of the measure is significantly influenced by the price decision of the Energy Regulatory Office with operational support for electricity generation on cogeneration plants, as many applications are based on a long payback period or are irreversible without support.

There are no final energy savings at the CHP unit's installation site, as the consumption of natural gas will increase by the equivalent of power produced in the cogeneration unit. This amount of power produced will be less to be bought from the grid by the electric power plant. In terms of primary energy, savings are achieved as the cogeneration unit produces power in the combined cycle with heat, and the overall efficiency of the primary fuel utilization is then over 85%. On the other hand, energy collected from the grid is mostly produced by condensing power plants with an efficiency of only about 35%, as a result of the condensed heat channeling through the towers to the surroundings without being used.

## Installation of flue gas pre-heaters to boilers

An economizer (flue gas / water heat exchanger) is installed behind the boiler to cool down the flue gas by heating the feed water, thereby increasing the efficiency of heat generation on the boiler. The economizer is usually designed as a counter current.

The installation of Economizer is recommended mainly for gas boilers, whose flue gases have a low dew point, so even with a more pronounced cooling of the flue gases there is no risk of condensation of water vapour from flue gas would result in the corrosion of the chimney.

Additional cooling of flue gases in economizer, for example by about 70 °C, increase the boiler efficiency by about 5%.[1]

## Installation of frequency inventors

Frequency converter control is today's most discussed way of controlling electric drives. The most cost-effective measures are in the regulation of compressors with frequency converters, which increase or decrease the speed of the compressors depending on the amount of compressed air to be produced.

Significant savings (depending on operation) are achieved by the installation of frequency inverters in water pumping, especially in power pumps or circulating pumps.

Other energy-saving measures with the installation of frequency inverters are implemented in the area of air handling unit fan control, flue gas fans, air fans and electrical equipment technology drives.

## Installation of heat pumps

The implementation of heat pumps is an extensive range of austerity measures in the area of hot water preparation, heating and cooling.

The most widespread compressor heat pumps are operationally limited by a low-potential source temperature of -10 ° C to 25 ° C and a heating circuit temperature of approximately 55 ° C (one-stage) to 70 ° C (two-stage).

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[1] In Czech Republic, for a gas boiler of 3 MW capacity and approximate annual use of 1,500 h/y, it results in savings of 225 MWh/y (810 GJ/y). With a natural gas's unit cost of € 11 / GJ, it represents a financial savings of € 8,867 / year. The corresponding economizer output for a 3 MW boiler is 150 kW, with a specific cost of the economizer including installation of about € 78 / kW, the simple payback period on this measure is 1.3 years.

Therefore, in terms of heat source, a distinction must be made:

1. Waste heat is available at a temperature level up to approx. 25 ° C (higher temperatures cannot be processed by the heat pump);
2. Waste heat is not available - it is necessary to use the surrounding environment as the source of low potential heat, mostly air, eventually ground water or ground well.

In the first case, a constant source temperature and a relatively high heating factor are preferred. However, it should be noted that the heating factor is lower for the two-stage heat pump.

Therefore, it is most advantageous to install the heat pump in an industrial plant with a year-round occurrence of waste heat up to 25 ° C (preferably on water or other liquid) and a year-round requirement for heating another medium from a temperature below 40 ° C. In such a case, the economy of the heat pump operation is very good due to the relatively high heating factor (about 4-6) and the year-round operating time.

If waste heat is not available, air / water heat pumps are most often used for hot water and heating, with an average annual heating factor of about 2.6 and heating of about 2.8.[2]

## Installation of photovoltaic systems (for electricity generation)

This measure aims to develop the implementation of photovoltaic systems for self-consumption of power energy.

## Installation of solar thermal systems (for heat generation)

This measure aims to develop the implementation of solar thermal systems for self-consumption of generated heat.

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[2] For illustration on the Czech market, the installation of a heat pump in an industrial plant with total operating time of 5 000 h/y, a heating factor of 4 (waste heat), a unit cost for natural gas saved of € 31 / MWh and a unit cost of electricity for powering the heat pump of € 86 / MWh, will have a simple payback period of 3.5 year. Final energy savings of the plant reaches 65%, while only 15% of primary energy savings is achieved, due the poor efficiency of electricity production in the system (power stations reaches 35%).

## Installation/replacement of compressors

Compressed air is usually one of the most expensive energy carriers and is an integral part of the technological equipment of a wide range of businesses. In most cases, compressed air is produced by means of volumetric compressors, such as reciprocating or rotary, where the most prominent representatives are screw compressors. In addition to these, they can be found mainly in plants with high consumption of compressed air and the application of speed compressors especially turbocompressors.

Significant energy savings in this area can be achieved when monitoring compressed air production by replacing compressors with more modern screw compressors, which are used in most cases. However, correct operation of compressors is a condition for energy saving, as no significant savings will be reached with improper operation of modern compressors.

The savings amount can be monitored by measuring electricity consumption and compressed air production. Their mutual ratio (electricity consumption by compressed air production) is called the specific intensity of compressed air production kWh.m-3. This value, in addition to the compressor type, depends primarily on the output air pressure. In the industry (for typical systems with a 0.6 MPa air pressure), this value ranges from 0.11 – 0.13 kWh.m-3. Modern screw compressors achieve specific intensity values even below 0.1 kWh.m-3 and can results in savings up to 20% of consumed power. Another significant savings can be performed by regulated compressors, equipped with frequency converters and waste heat recovery equipment.

For older screw compressors and turbo compressors, a portion of compressed air (approx. 15%) is used to regenerate the air dryer filling, other losses are caused by switching on and off the compressors without regulation of different power according to the immediate consumption, excess air produced is discharged to the atmosphere – loss of about 5-10%. These losses can be eliminated by installing an adsorption dryer recovering heat from compressed air and regulating the compressor drive by instantaneous extraction. The reduction in power consumption in this case reaches up to 30% and the simple payback ranges from about 5 to 7 years.

## Replacement of coal boiler with gas boiler

Gas atmospheric boiler shows higher efficiency on average range of 10 - 20% compared to coal-fired boiler, depending on the physical condition of the coal-fired boiler (leakage, high chimney loss). However, the fuel saving in the gas boiler is

negated by a higher fuel price and the cost of building a gas connection. Nevertheless, the removal of a coal-fired boiler with higher output eliminates the wage costs of continuous boiler operation and the cost of storing cinder and fly ash.

The whole operating costs after the exchange of a coal-fired boiler for gas will be slightly higher (neglected payment for emissions); this replacement is therefore not relevant in economics terms. With greater coal-fired boiler performance, this conclusion will be even more striking. Consequently, replacement can only be recommended in the case of a physically old coal-fired boiler.

## Replacement of coal boiler with new coal boiler

The new coal boilers show a higher efficiency in the range of approximately 5-10%, depending on the physical condition of the old boiler (leakage, high chimney loss). The higher efficiency of new coal boilers is also the consequence of better regulation and higher cooling performance of combustion gases, but this is limited by the sulphur content of burnt coal and thus the dew point of flue gas.[3]

## Replacement of existing lighting with LED80

Complete replacement of existing lighting with 80 lm/W LED luminaires (short for LED80): the technical potential of this measure is determined by the difference of consumption between the existing lighting and 100% LED80 lighting.

By 2030, the existing lighting (ordinary light bulbs, halogen bulbs, compact and linear fluorescent lamps) will significantly be replaced by LED light sources. LED light sources are getting constantly more available and can be used to replace any current light source without any further modifications from the light-technical point of view (distribution of luminous flux by the luminaire).

## Replacement of lighting LED80 with LED110

The measure is described as follows: replacement of 80 lm/W LED light sources by technologically advanced LEDS with a 110 lm/W output (abbreviated LED110): The

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[3] As an example, for the Czech market, in the heat production of the heating plant (1 500 h/y use of installed capacity), the boiler's heat production with an installed capacity of 5 MW, will be 7,500 MWh/y (27,000 GJ/y). With a brown coal's unit cost of € 4 /GJ and the efficiency of the new boiler increased by 8%, the new boiler will save € 8405 / year of fuel expenditure. With a specific investment cost of 1MWt boiler replacement of about € 58,000 /year, the payback period will be 35 years.

technical potential of the measure is determined by the difference between the LED80's lighting consumption and LED110.

The measure is considered as an additional measure to the "Replacement of existing lighting with LED80"; its application assumes an earlier application of the first measure.

### Thermal insulation of technologies

The measure consists in insulating technological processes such as dryer, heat furnaces, production lines, where there are a numerous fittings and pipes that are uninsulated and generating significant heat losses. Depending on the state of thermal insulation prior to renovation, energy savings of up to 70% of the original heat loss can be achieved. However, the achieved savings are typically about 40%.

### Transformers replacement

Transformers are used in industrial and commercial buildings for the supply of electrical power to individual circuits. As many transformers are exposed to high operating temperatures and dust, over time they face problems such as deterioration of winding insulation, clogged inlets, clogged cooling ducts, etc. Operating in such conditions can lead to a reduction in their capacity.

This measure consists in replacing of existing transformers with new low loss transformers or optimizing their operation.

### Waste heat utilisation

In a wide range of industrial technological processes, waste heat produced is discharged into the outside environment, thereby undermining the energy entering the processes.

One of the most relevant waste heat use can be managed at compressors, where it is possible to reach a heat output of approx. 60 – 70% of the compressor's power consumption. Waste heat is used here for the preparation of hot water or the return system pre-heating.

Another option is the use of waste heat in refrigeration equipment's capacitors.

In cases of low potential of waste heat, measures are proposed, focusing on the use of heat recovery for air-conditioning and, therefore, for hot-water heating. Heat pumps are suggested for the use of low potential heat to a higher temperature level, for the preparation of hot water or heating. However, these are separated measures.

High-temperature waste heat (steam waste, flue gas) is utilized by heat exchangers with heat supply for heating and hot water preparation. In certain cases, for heat recovery in technology.

The payback on investment of the use of waste heat is influenced, firstly, by the difference of temperature between the waste and the heated media and, but mostly, the heating type and the heated media. In the case of heating water with waste steam, the transfer factor is several orders higher than heating air or heating any medium with flue gas. This corresponds to the very different size of the heat transfer surface and thus to the size and price of the exchanger.

# 2 Programme level tool

The Programme level tool can be used to assess potential impacts of a new public funding/financing programme, which aim is to support industry's low-carbon transition (i.e. support of investment into energy saving and renewable energy measures).

The instrument allows the user to calculate the expected use of budget allocation, expected investment generated, expected energy savings, and expected decrease of emissions.

**The Programme level tool can be used in the Pilot action 1** addressed to public authorities "Ex-ante assessment analysis finalisation and implementation of FI/IFI".

## 2.1 Principle of the tool

The tool is developed in the form of an excel worksheet with input data into specific cells. The User Guide presents the tool in several paragraphs as follows:

1. A Quick presentation of the method: this short paragraph explains by example how will be used the excel calculation. It details the input needed and the input resulting.

2. An explanation of calculations behind: this more detailed paragraph aims to make understandable how are used the inputs, and what initial data are required to get the output.

3. Data to be implemented: this paragraph is important as it presents which data are specific to each country and are required to the proper functioning of the calculation. Partners are asked to fulfil it as much as possible.

4. Saving measures description: in order to assist the data implementation described in the previous paragraph, each measure was described to a proper understanding.

This User Guide might be incomplete; therefore, we kindly ask you to share with us questions and feedbacks regarding the tool and the Guide.

### 2.1.1 Quick presentation of the method

The first input data to start the assessment is the "Expected allocation of the policy (program)". As it is stated, it represents the budget in € which is granted to the programme:

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| Title of the new policy (programme) | |
| --- | --- |
| Tolerance | 10% |
| Expected allocation of the policy (programme) | €   2,000,000.00 |

[ START NEW ]  [ ADD MEASURE ]  [ RELOAD GRAPH ]

The allocation is granted for the programme, which can be divided in different measures. The user then inserts for each measure their share of the program's allocated budget. If the sum of the share is not equal to 100%, the calculation will notify it. The last input for this part of the calculation is the share of subsidy, loan and own resources on the total investment cost:

**Policy Program**                                    ✕

Saving measure

[                                                  ▼ ]

Share on the policy (programme allocation)

[                                                    ]

Share of subsidy on the total investment costs

[                                                    ]

[ Next measure ]   [ Done ]   [ Cancel ]

Too low share of subsidy in the total investment cost results in a non-implementation of the measure, represented as the absence of outputs in the forecasted cells. If the subsidy is not sufficient enough, the main beneficiary of the measure will not invest, as the payback time for it will be too long. In the opposite, too large share of subsidy would increase the expect allocation utilisation by the programme and overdraw the budget.

The tool helps you estimate what share on the total investment cost your allocated budget should represents, and the resulting potential savings in energy and pollutant emissions reduction.

| Saving Measure 6 | Energy Management | | |
|---|---|---|---|
| Total saving potential of the measure | | 969 TJ | |
| Savings realised without any subsidies | | 533 TJ | |
| Share on the policy (programme allocation) | | 3% | |
| | € | 15,000 | |
| Share of subsidy on the total investment costs | | 46% | |
| Expected allocation utilisation | € | 11,823 | Allocation will be likely not exhausted |
| Investment costs at the expected utilisation of the allocation | € | 31,527 | |
| Expected energy savings | | 282 TJ | Outputs:¶ |
| Expected drop of $CO_2$ emissions | | 30,930 t | • → Total·expected·investment·cost¶ |
| Expected drop of $CH_4$ emissions | | 1,207 kg | • → Expected·energy·savings¶ <br> • → Expected·drop·of·pollutant·emissions¶ |
| Expected drop of $N_2O$ emissions | | 416 kg | • → Expected·Cash·Flow¶ |
| Expected drop of $CO_{2eq}$ emissions | | 31,084 t | |
| Expected Cash Flow | | 3,941 €/y | |

## 2.1.2    Calculations explanations

The study quantifies the technical potential for energy savings (energy that can be saved under existing technical possibilities) and the economic potential for final energy savings (the amount of energy saved by the respective measure for the benefit of the implementing entity) for 2020 – 2030 for 37 energy efficiency measures covering all sectors of the national economy – agriculture, industry, services, public sector, households and transport.

*NB: The technical and economic parameters of energy efficiency measures were obtained from projects implemented in operational programs and projects and experiences with 500 measures designed in 110 energy audits and assessments prepared by ENVIROS during 2015 – 2017.*

*The calculation of the potential for energy savings is based on the official final energy balance in the Eurostat methodology to the last available year 2015 when the final energy consumption in the Czech Republic was 1009 PJ.*

### 2.1.2.1 Definition of energy saving potentials

The technical potential is the amount of saved final energy by measures, which are technically feasible until 2030.

The economic potential represents the amount of energy saved by measures, which have a simple return period shorter than their expected technical lifespan.

- Potential not requiring support (self-realizable potential): The simple return period of the measure is shorter than the required free period of return of the measure in the sector.

- Potential requiring support: The simple recovery period is longer than the required free period of return of the measure.
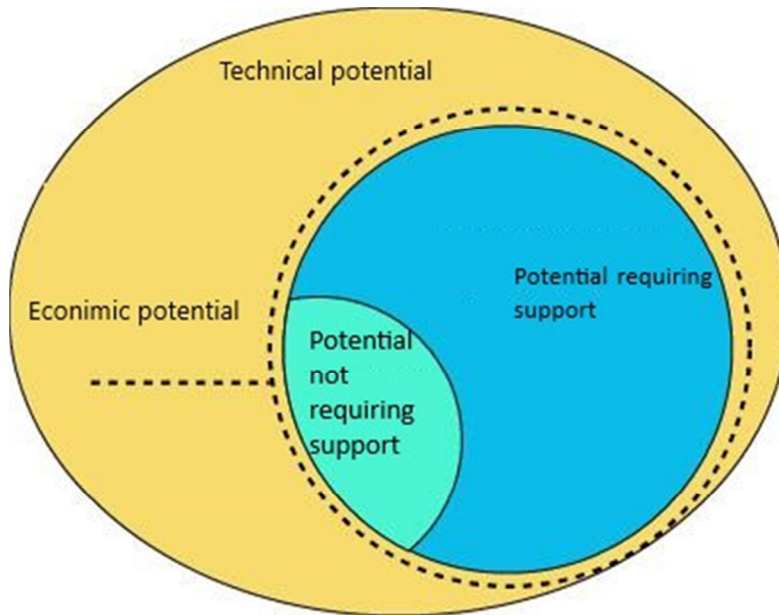
In the calculation, for each data from each measure are 3 categories:

- MIN: The lowest investment cost

- TYP: The typical investment cost (average)

- MAX: The highest investment cost

As stated before, different projects were conducted in each measure category and lead to a collection of data. This collection of data served to estimate tendency about investment, share of subsidy needed, energy saving, economical potential and pollutant emission reduction. The 3 categories are detailed in the following:

| Category | Description |
|---|---|
| The lowest investment cost – MIN | The lowest investment cost refers to the project with the smallest amount of budget needed, with low energy potential savings, but with the best price per energy saved. In general, they do not need large subsidy as their simple payback without it is short enough to motivate private investment. |
| The typical investment cost - TYP | The typical investment cost is the average of all the executed project related to the measure. Depending on the amount of project assessed and their prices for energy saved, the share of subsidy needed will be rather low or significantly high. |

| | |
|---|---|
| The highest investment cost - MAX | The highest investment cost refers to the project with the biggest amount of budget needed, resulting in high energy potential saving, but a rather poor rate of price per energy saved. Therefore, those projects need a sufficient share of subsidy in the total investment cost, as their payback period is not profitable for investors. |

In the calculation, depending on the share of subsidy in the total investment, the expected allocation utilisation will vary. A minimum share of subsidy is needed to "trigger" the low cost projects. If we take our previous example of Building insulation, for each category (MIN, TYP, MAX), collection of data from implemented project were provided to the tool:

- Price per GJ for each category (Ni – unit investment) ①

- Subsidy share needed for the implementation of the project ②

- Subsidy amount ③

- Total investment cost ④

- Energy savings potential ⑤

- Potential of pollutant emission reduction ⑥

| Title of the new policy (programme) | | | |
|---|---|---|---|
| Tolerance | | 10% | |
| **Expected allocation of the policy (programme)** | € | 500,000.00 | |

| START NEW | ADD MEASURE | RELOAD GRAPH | |
|---|---|---|---|

| **Saving Measure 6** | | Energy Management | |
|---|---|---|---|
| Total saving potential of the measure | | 969 TJ | |
| Savings realised without any subsidies | | 533 TJ | |
| Share on the policy (programme allocation) | | 3% | |
| | € | 15,000 | |
| Share of subsidy on the total investment costs | | 46% | |
| Expected allocation utilisation | € | 11,823 | Allocation will be likely not exhausted |
| Investment costs at the expected utilisation of the allocation | € | 31,527 | |
| Expected energy savings | | 282 TJ | |
| Expected drop of $CO_2$ emissions | | 30,930 t | |
| Expected drop of $CH_4$ emissions | | 1,207 kg | |
| Expected drop of $N_2O$ emissions | | 416 kg | |
| Expected drop of $CO_{2eq}$ emissions | | 31,084 t | |
| Expected Cash Flow | | 3,941 €/y | |

| | MIN | TYP | MAX | | MIN | TYP | MAX | Total |
|---|---|---|---|---|---|---|---|---|
| (1) Ni | 175 | 250 | 391 | coefficient | 98.33% | 15.00% | 0.00% | |
| (2) subsidy share | 58.33% | 75.00% | 87.50% | | | | | |
| (3) subsidy | 220,779,551 | 812,317,031 | 741,026,910 | subsidy | 217,099,891 | 121,847,555 | 0 | 338,947,446 |
| investment costs | 378,479,229 | 1,083,089,375 | 846,887,897 | investment costs | 372,171,242 | 162,463,406 | 0 | 534,634,649 |
| potential | 2,167 | 4,334 | 2,167 | potential | 2,131 | 650 | 0 | 2,781 |
| (6) CO2 | 143,664 | 287,328 | 143,664 | CO2 | 141,270 | 43,099 | 0 | 184,369 |
| CH4 | 10,439 | 20,879 | 10,439 | CH4 | 10,265 | 3,132 | 0 | 13,397 |
| N2O | 1,831 | 3,662 | 1,831 | N2O | 1,801 | 549 | 0 | 2,350 |
| CO2eq | 144,471 | 288,942 | 144,471 | CO2eq | 142,063 | 43,341 | 0 | 185,404 |

As we observe for this measure, a minimum subsidy shares of 58.33% (2.a) is needed for implementing the low cost project (MIN). A tolerance (T) is set due to the inaccuracy of the method. In our case, the tolerance is set to 10%. It is verified in the TYP calculated column (2.b), even if the 75% rate (2.), is not reached by the subsidy shares set (S) in the saving measure calculation.

| Title of the new policy (programme) | |
|---|---|
| Tolerance | 10% |
| Expected allocation of the policy (programme) | € 3,500,000.00 |

START NEW    ADD MEASURE    RELOAD GRAPH

| Saving Measure 3 | Buildings Insulation |
|---|---|
| Total saving potential of the measure | 8,668 TJ |
| Savings realised without any subsidies | 0 TJ |
| Share on the policy (programme allocation) | 12% |
| | € 420,000 |
| Share of subsidy on the total investment costs | 68% |
| Expected allocation utilisation | € 338,947   Allocation will be likely not exhausted |
| Investment costs at the expected utilisation of the allocation | € 534,635 |
| Expected energy savings | 1,947 TJ |
| Expected drop of $CO_2$ emissions | 129,058 t |
| Expected drop of $CH_4$ emissions | 9,378 kg |
| Expected drop of $N_2O$ emissions | 1,645 kg |
| Expected drop of $CO_{2eq}$ emissions | 129,783 t |
| Expected Cash Flow | 39,137 €/y |

| | MIN | TYP | MAX | | MIN | TYP | MAX | Total |
|---|---|---|---|---|---|---|---|---|
| Ni | 175 | 250 | 391 | coefficient | 98.33% | (2.b*) 15.00% | 0.00% | |
| subsidy share | (2.a) 58.33% | (2.b) 75.00% | 87.50% | | | | | |
| subsidy | 220,779,551 | 812,317,031 | 741,026,910 | subsidy | 217,099,891 | 121,847,555 | 0 | 338,947,446 |
| investment costs | 378,479,229 | 1,083,089,375 | 846,887,897 | investment costs | 372,171,242 | 162,463,406 | 0 | 534,634,649 |
| potential | 2,167 | 4,334 | 2,167 | potential | 2,131 | 650 | 0 | 2,781 |
| CO2 | 143,664 | 287,328 | 143,664 | CO2 | 141,270 | 43,099 | 0 | 184,369 |
| CH4 | 10,439 | 20,879 | 10,439 | CH4 | 10,265 | 3,132 | 0 | 13,397 |
| N2O | 1,831 | 3,662 | 1,831 | N2O | 1,801 | 549 | 0 | 2,350 |
| CO2eq | 144,471 | 288,942 | 144,471 | CO2eq | 142,063 | 43,341 | 0 | 185,404 |

The estimated implementation rates ②* are calculated as follow:

- If the selected subsidy shares Ⓢ < collected subsidy share ② - Tolerance ; Then Category estimated implementation rates ②* = 0%

- If the selected subsidy shares Ⓢ > collected subsidy share ② + Tolerance ; Then Category estimated implementation rates ②* = 100%

- Else Category estimated implementation rates ②* = (Ⓢ - (② - T)) / 2xT

| Title of the new policy (programme) | | |
|---|---|---|
| Tolerance | | 10% |
| Expected allocation of the policy (programme) | € | 3,500,000.00 |

**START NEW**    **ADD MEASURE**    **RELOAD GRAPH**

| Saving Measure 3 | | Buildings Insulation |
|---|---|---|
| Total saving potential of the measure | | 8,668 TJ |
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| Expected drop of $CO_{2eq}$ emissions | | 129,783 t |
| Expected Cash Flow | | 39,137 €/y |

| | MIN | TYP | MAX | | | MIN | TYP | MAX | Total |
|---|---|---|---|---|---|---|---|---|---|
| Ni | 175 | 250 | 391 | ②*⟩ coefficient | | 98.33% | 15.00% | 0.00% | |
| ②¹⟩ subsidy share | 58.33% | 75.00% | 87.50% | | | | | | |
| ③¹⟩ subsidy | 220,779,551 | 812,317,031 | 741,026,910 | ③*⟩ subsidy | | 217,099,891 | 121,847,555 | 0 | 338,947,446 |
| | | | | | | | | | |
| investment costs | 378,479,229 | 1,083,089,375 | 846,887,897 | investment costs | | 372,171,242 | 162,463,406 | 0 | 534,634,649 |
| potential | 2,167 | 4,334 | 2,167 | potential | | 2,131 | 650 | 0 | 2,781 |
| CO2 | 143,664 | 287,328 | 143,664 | CO2 | | 141,270 | 43,099 | 0 | 184,369 |
| CH4 | 10,439 | 20,879 | 10,439 | CH4 | | 10,265 | 3,132 | 0 | 13,397 |
| N2O | 1,831 | 3,662 | 1,831 | N2O | | 1,801 | 549 | 0 | 2,350 |
| CO2eq | 144,471 | 288,942 | 144,471 | CO2eq | | 142,063 | 43,341 | 0 | 185,404 |

The expected allocation utilisation Ⓐ is then resulting sum of the 3 category subsidies (÷1000), which are equal to the estimated implementation rates times the subsidy from collected data (③*=②*x③). The calculation is then similar for each following row (× 0.7 for energy savings and drop of pollutant emissions).

### 2.1.3    Data implementation

For each measure, there are two important data to be implemented in the Saving_measures sheet:

- Unit investments [€/GJ]:  It is the price per GJ for each type of investment cost. It is important for calculating the investment cost

- Energy saving potential [TJ]: It is the total potential savings for each type of investment cost of the measure, not the average from the projects. It the second important data to calculate the investment cost.

| Measure | Cost type | Measure detail | Unit investments [€/GJ] | Subsidy share [%] | Payback period w/o subsidy [y] | Energy saving potential [TJ] |
|---|---|---|---|---|---|---|
| Buildings insulation | MAX | Buildings insulation#MAX | 390.8 | 88% | 40 | 2,167 |
| Buildings insulation | MIN | Buildings insulation#MIN | 174.7 | 58% | 12 | 2,167 |
| Buildings insulation | TYP | Buildings insulation#TYP | 249.9 | 75% | 20 | 4,334 |

Subsidy share can be kept as it is or change in the case of more relevant data. Data must be implemented for each cost type (MAX, MIN, TYP) with MAX the high investment cost project, MIN the low investment, and TYP the average. The energy saving potential is the total potential for the measure, not only for one project. Data must be introduced for those all the measures listed in the chapter 1.

## 2.2    User guide

The tool is developed in the form of an Excel worksheet with data to input in specific cells. In the User's Guide Manual will be presented how to use the tool, and the principle behind it. This tool is the programme level tool, used to assess public investment supporting industry's low-carbon transition. The instrument allows the user to calculate the expected use of allocation, expected investment, expected energy savings, and expected decrease of emissions.

### 2.2.1    New Programme

To start a new programme assessment, press the Start New button:

| |
|---|
| START NEW |
| ADD MEASURE |
| RELOAD GRAPH |
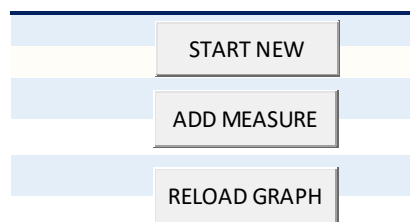
A popup window will ask you with you want to proceed. All the data previously entered will be erased, it is recommended to save a copy of the program you are going to erase.
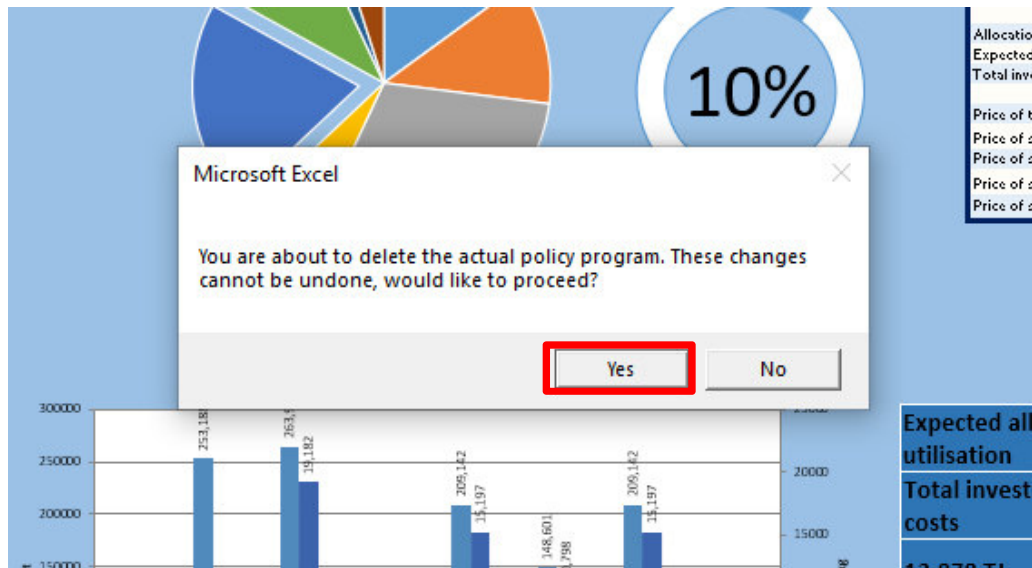
Once you have validated the erasure of the data, you can check that all previous measures are not in the tool anymore and the charts are now empty. The input of data to the instrument is basic. These inputs are required:

- Saving measure: you will have to choose one over 37 energy efficiency measure covering all sectors – agriculture, industry, services, public sector, households and transport.

- Share on the policy (program allocation): this share represents the amount from the total budget of the program that will be dedicated to this measure

- Share of subsidy on the total investment costs: this share represents the allocated budget from the policy program in the total cost of the measure implementation.

- Share of loan on the total investment costs: this share represents the investment share covered by a loan with interest

- Share of own resources on the total investment costs: this share represents the investment from the company.

*NB: The shares inputs are in percentage format (35). If you use decimal, be aware to use your system decimal separator. ("." Or ",")*

Here is the view of the popup window for the data input:





Fill in the cell the first measure. Once the cells are filled, simply press "Next measure" button. If each data is on the right format, the instrument will indicate that the measure is now in the program.

Once you have added your first measure, you can now proceed with the rest of the measure the same way. If you have made a mistake in the input, you can delete the last entered measure by pressing the "Cancel" button.
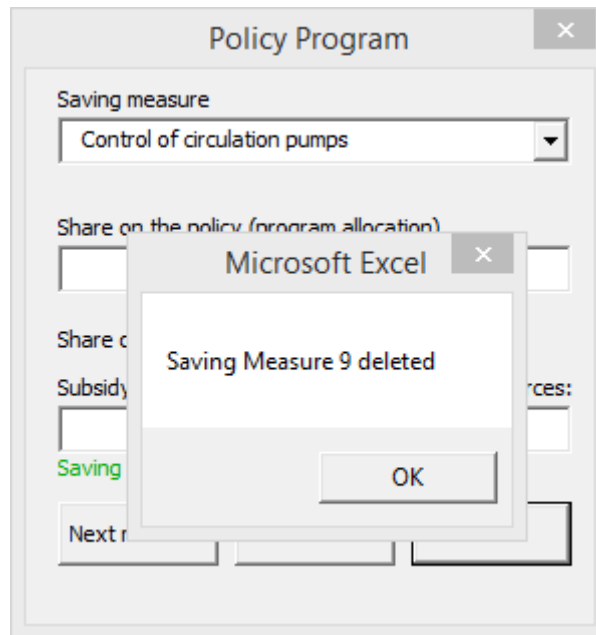
*NB: if you try to put more than 100% of the budget, the tool will warn you and notify how much is there left to be allocated:*
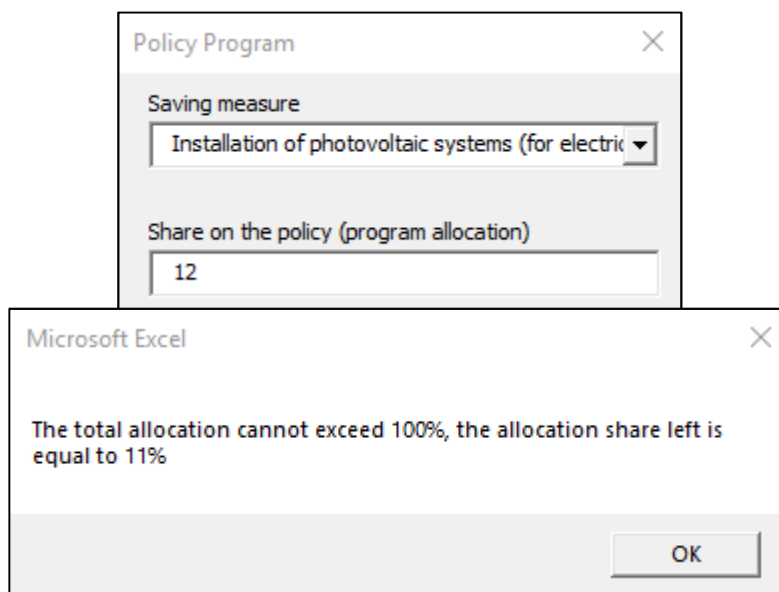


Finally, once you have input every measure, you can press the "Done" button to get to the dashboard with all the display ready.

In the case you are not reaching 100% of the budget or you want to modify the policy program, you can still come back to the data input window without deleting all the data by pressing the "ADD MEASURE" button in the dashboard. You will be back where you left the measure registration.
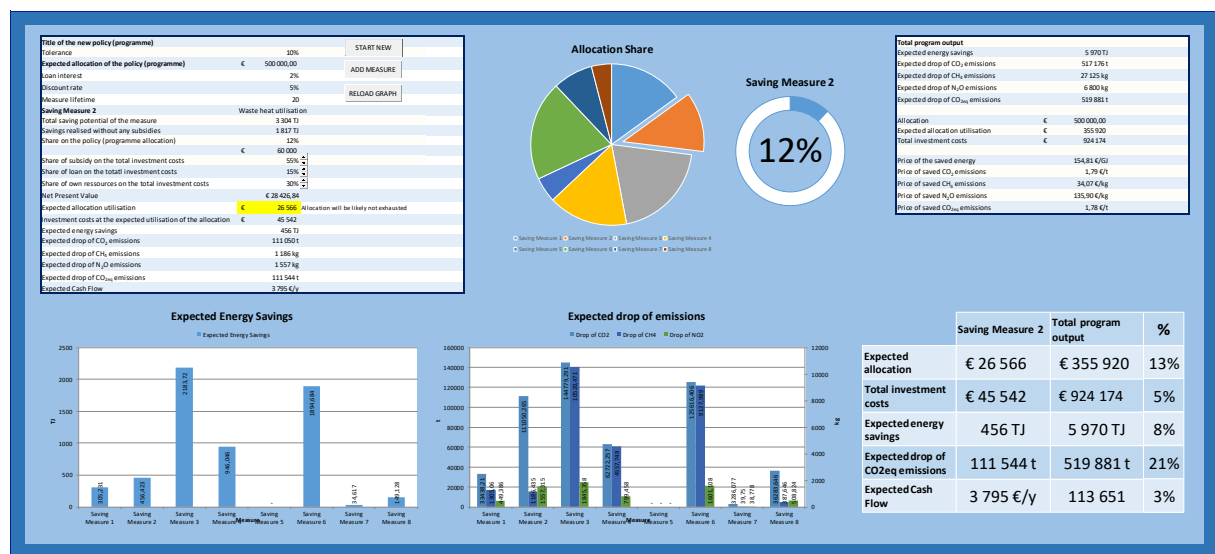
## 2.2.2 Dashboards

### 2.2.2.1 General overview

The first dashboard represents the general overview of the input and output data for each measure and the total program. The main purpose is to observe the general result and the weight of each project on it.

Here is an example of Policy Program dashboard:



In the first table, you can add the total budget of the program, and its tittle. You can set the tolerance relative to the inaccuracy of the method, generally set equal to 10%.

The second table gather input and output data for each measure. You can navigate from one measure to another thanks to the drop down list, automatically updating the values according the selected measure.

| Saving Measure 2 | ste heat utilisation | |
|---|---|---|
| | 3 304 TJ | |
| | 1 817 TJ | |
| | 12% | |
| | 60 000 | |
| | 55% | |
| Share of loan on the totatl investment costs | 15% | |
| Share of own ressources on the total investment costs | 30% | |
| Net Present Value | € 28 426,84 | |
| Expected allocation utilisation | € 26 566 | Allocation will be likely not exhausted |
| Investment costs at the expected utilisation of the allocation | € 45 542 | |
| Expected energy savings | 456 TJ | |
| Expected drop of $CO_2$ emissions | 111 050 t | |
| Expected drop of $CH_4$ emissions | 1 186 kg | |
| Expected drop of $N_2O$ emissions | 1 557 kg | |
| Expected drop of $CO_{2eq}$ emissions | 111 544 t | |
| Expected Cash Flow | 3 795 €/y | |

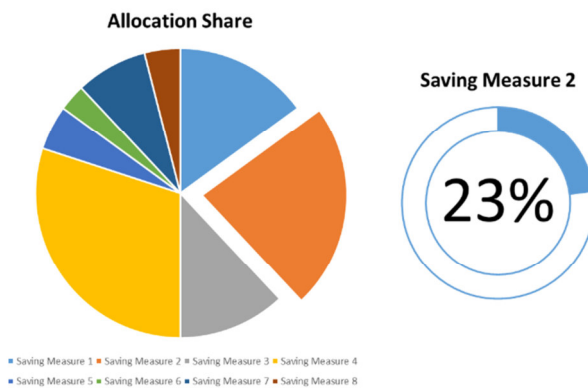The last table display the total output for the whole policy program:

| Total program output | | |
|---|---|---|
| Expected energy savings | | 9,305 TJ |
| Expected drop of $CO_2$ emissions | | 871,303 t |
| Expected drop of $CH_4$ emissions | | 41,642 kg |
| Expected drop of $N_2O$ emissions | | 11,552 kg |
| Expected drop of $CO_{2eq}$ emissions | | 875,786 t |
| | | |
| Allocation | € | 500,000.00 |
| Expected allocation utilisation | € | 671,851 |
| Total investment costs | € | 1,435,518 |
| | | |
| Price of the saved energy | | 154.27 €/GJ |
| Price of saved $CO_2$ emissions | | 1.65 €/t |
| Price of saved $CH_4$ emissions | | 34.47 €/kg |
| Price of saved $N_2O$ emissions | | 124.26 €/kg |
| Price of saved $CO_{2eq}$ emissions | | 1.64 €/t |

You can select the measure you want to analyze. The expected output are highlighted and weighted against the total program ouptut:
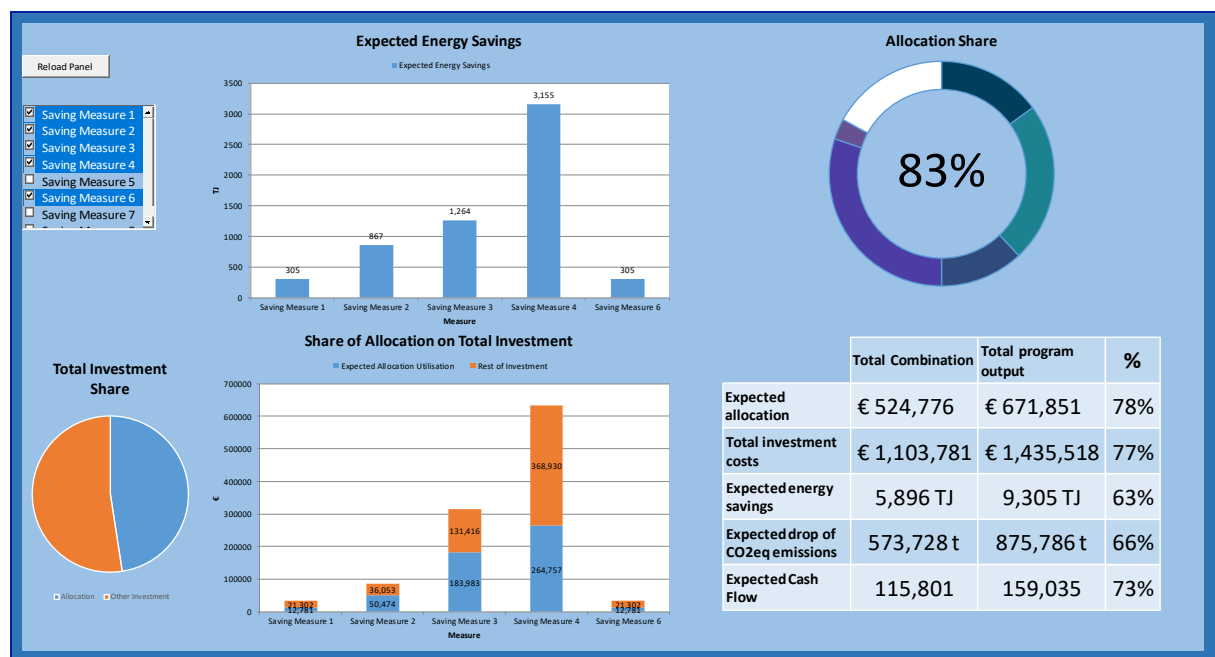
| | Saving Measure 2 | Total program output | % |
|---|---|---|---|
| Expected allocation | € 50,474 | € 671,851 | 8% |
| Total investment costs | € 86,527 | € 1,435,518 | 6% |
| Expected energy savings | 867 TJ | 9,305 TJ | 9% |
| Expected drop of CO2eq emissions | 211,928 t | 875,786 t | 24% |
| Expected Cash Flow | 7,211 €/y | 159,035 | 5% |

And the pie charts are also showing the planned allocated share of budget for the selected measure:
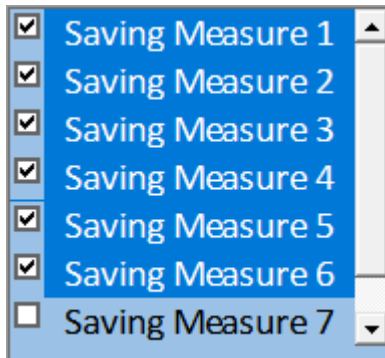


## 2.2.2.2 Efficiency measure combination panel



| | Total Combination | Total program output | % |
|---|---|---|---|
| Expected allocation | € 524,776 | € 671,851 | 78% |
| Total investment costs | € 1,103,781 | € 1,435,518 | 77% |
| Expected energy savings | 5,896 TJ | 9,305 TJ | 63% |
| Expected drop of CO2eq emissions | 573,728 t | 875,786 t | 66% |
| Expected Cash Flow | 115,801 | 159,035 | 73% |

Interreg
CENTRAL EUROPE
European Union
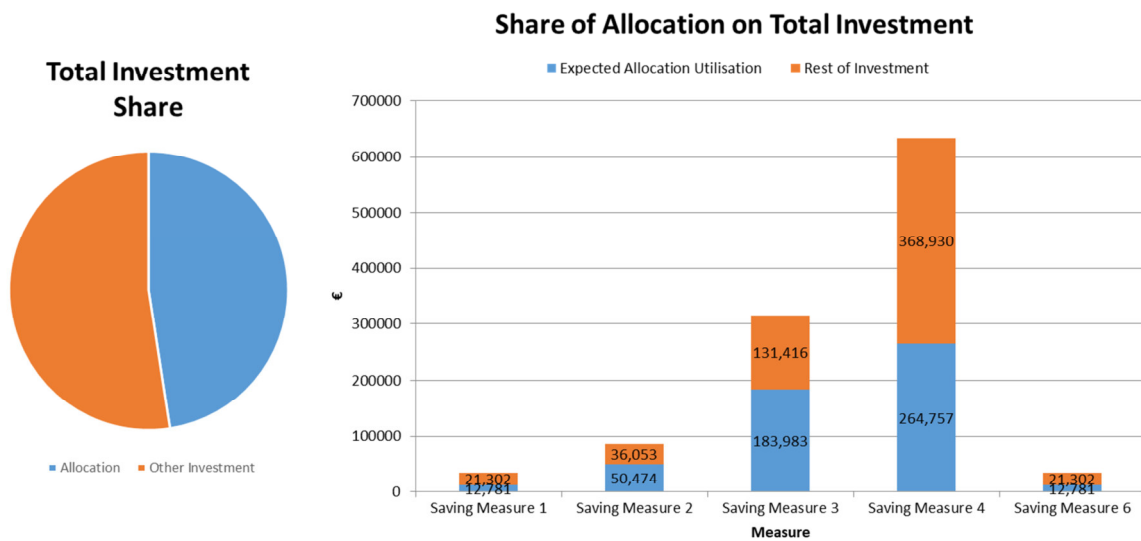European Regional
Development Fund
FIRECE

The tool enables you to combine your input measures and observe their weight on the total policy program, without creating a file for each combination. To do so, use the worksheet "Control_Panel". There, you should find a list box with every measure registered in your policy program: Simply select the measures you need to combine, and the instrument will automatically update the display.

☑ Saving Measure 1
☑ Saving Measure 2
☑ Saving Measure 3
☑ Saving Measure 4
☑ Saving Measure 5
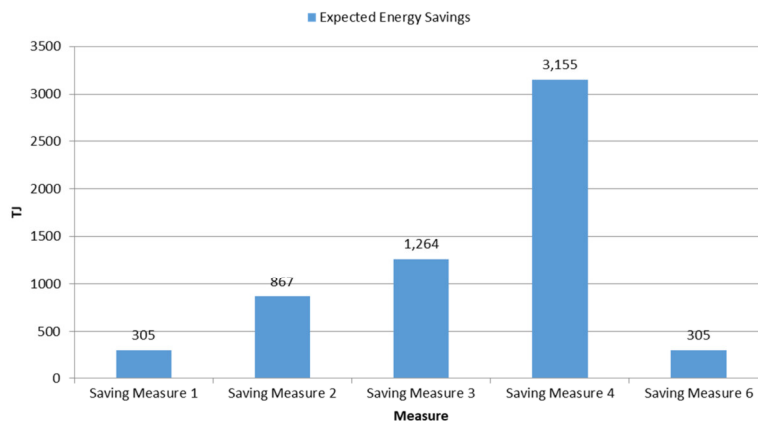☑ Saving Measure 6
☐ Saving Measure 7

Regarding the chart output, you will find the energy savings chart, the combination allocated budget share on the total budget, and the share of allocated policy budget on the total cost of the measures:
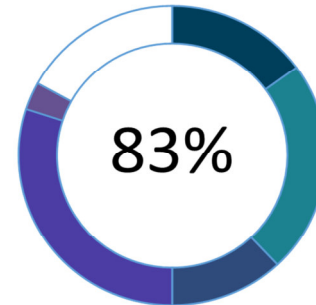


**Total Investment Share**

- Allocation
- Other Investment

**Share of Allocation on Total Investment**

- Expected Allocation Utilisation
- Rest of Investment

| Measure | Expected Allocation Utilisation | Rest of Investment |
|---|---|---|
| Saving Measure 1 | 12,781 | 21,302 |
| Saving Measure 2 | 50,474 | 36,053 |
| Saving Measure 3 | 183,983 | 131,416 |
| Saving Measure 4 | 264,757 | 368,930 |
| Saving Measure 6 | 12,781 | 21,302 |

**Expected Energy Savings**



**Allocation Share**

83%

The last table, as the one in the general overview, is showing the weight of the measure combination on the total program output, for each output:

|  | Total Combination | Total program output | % |
|---|---|---|---|
| **Expected allocation** | € 524,776 | € 671,851 | 78% |
| **Total investment costs** | € 1,103,781 | € 1,435,518 | 77% |
| **Expected energy savings** | 5,896 TJ | 9,305 TJ | 63% |
| **Expected drop of CO2eq emissions** | 573,728 t | 875,786 t | 66% |
| **Expected Cash Flow** | 115,801 | 159,035 | 73% |

You can therefore observe which combination give the best result in the case not all of the measure can be applied.

# 3 Project level tool

The Project level tool main focus is to evaluate economic parameters of a particular project (e.g. NPV – net present values, CF – cash flow, etc.) as well as its environmental benefits in terms of decreased carbon emissions.

With reference to funding/financial support, the user is able to simulate how different types of instruments (subsidies, loans) and different shares of financial support affect economic parameters of the project and so its financial viability.

**The Project level tool can be used in the Pilot action 2** addressed to SMEs "Improving energy efficiency in Industry Sector".

## 3.1 Principle of the tool

### 3.1.1 Inputs and outputs

The Project level tool requires to introduce two types of inputs (investment/funding related inputs, energy savings related inputs), and provide outputs in a form of energy and environmental benefits and economic indicators.

In detail, they are described in the User Guide (chapter 3.2).

### 3.1.2 Calculation model

**3.1.2.1 Net Present Value – project financing**

The Net Present Value (NPV) is calculated for different data input.

The first calculation will take as parameter the project financing mechanism (Loan, Subsidy, Own resources). The NPV is calculated according the following formula:

$$NPV = -\,Investment \times Equity\;Share + \sum_{h=1}^{lifetime} \frac{Cash\;Flow - Loan\;payment}{(1 + Discount\;factor)^h}$$

The Total *Investment* times the *Equity Share* results in the amount of self-owned investment of the company in the project. The *Cash Flow* is calculated based on your "Expected energy savings & cost of energy" inputs. The *lifetime* considered is the lifetime of the implemented project. The project is expected to be worthless at this end of the lifetime period. The *Discount factor* is the discount factor chosen for the project. The *Loan payment* is a standard loan payment calculated as follow:

$$Loan\ payment = \frac{Interest \times Investment \times Loan\ Share}{1 - (1 + Interest)^{-period}}$$

The *Loan Share* is the weight of the Loan on the total *Investment*. The *Interest* is the loan's interest to be repaid over the specific *period*.

The calculations time bases (annually, monthly, etc.) are not define, therefore it is up to the user to decide on which the calculation should be done. Particular attention should be paid on the unit of each input, to not mix different period rate or income which would result in wrong calculation.

*NB: It is advised to use the tool on an annual base, since the project lifetime tends to be long.*

### 3.1.2.2 Net Present Value – 100% loan

The NPV for a financing only supported by a loan is calculated according the same formulas, just the loan share is considered equal to 1 and the rest 0. This calculation is necessary to determine what should be the share of subsidy on the total investment to be as profitable, in terms of Net Present Value, as an investment only supported by a preferential loan. The calculation methodology will be described in the following section.

### 3.1.2.3 Own resources and Subsidy investment equivalent to a 100% preferential loan investment

To calculate what direct investment with subsidy is equivalent to 100% preferential loan investment, it is necessary to start from the NPV calculated previously in the section 2.3.2, and subtract to it the NPV calculate without loan payment:

$$Direct\ Investment = NPV_{100\%loan} - \sum_{h=1}^{lifetime} \frac{Cash\ Flow}{(1 + Discount\ factor)^h}$$

Therefore, the share of subsidy needed to support the investment without loan and being as profitable as an investment with 100% preferential loan financing is:

$$Subsidy\ Share = 1 - \frac{Investment}{Direct\ Investment}$$

## 3.2   User guide

The tool is developed on the form of a excel worksheet with data to input in specific cells. In the User's Guide Manual will be presented how to use the tool, and the principle behind it. The tool main focus is to evaluate the Net Present

Value (NPV) of a project, depending on several inputs. The advantage of the tool is to be able to compare a funding mix of loan, subsidy, and own to an equivalent mix of own resource/subsidy funding with the precise share of subsidy needed to find the same conditions as the loan with preferential interest.

## 3.2.1    Inputs

There are two types of inputs required to perform the financial evaluation of the project:

- Investment/Funding related inputs

- Energy savings related inputs

### 3.2.1.1 Investment/Funding related inputs

The funding related inputs are presented in the table below:

- The Total refers to the total investment in the project, including each funding share (Loan, Subsidy, Own resources).

- The Loan is the share of the loan funding on the total investment

- The Subsidy is the share of the subsidy funding on the total investment

- The Own resources is the share of owned funding by the project beneficiary on the total investment

- The Interest rate is the rate linked to the loan share

- The Repay is the period length to repay the loan

- The Discount rate refers to the rate used for the discount factor on cash flow, in order to estimate the NPV

- The Lifetime is the expected lifetime of the project

| INPUT | | |
|---|---|---|
| Investment | Total | € 1,500,000.00 |
| | Loan | 57% |
| | Equity | 22% |
| | Subsidy | 21% |
| Loan | Interest rate | 2% |
| | Repay | 20 years |
| Equity | Discount rate | 5% |
| Measure | Lifetime/expected payback period | 20 years |

*NB: The tool is programmed for keeping the sum of the shares to 100% to avoid miscalculations.*

### 3.2.1.2 Energy related inputs

The energy related inputs are presented in the table below.

For each type of energy, the expected energy savings in MJ are required, as the energy cost per unit. These inputs will be needed to calculate the cash flow related to the project.

| INPUT | | | |
|---|---|---|---|
| **Expected energy savings & cost of energy** | Electricity | 3 000 MJ | 0,026 €/MJ |
| | Natural Gas | 0 MJ | 0,012 €/MJ |
| | Coal | 0 MJ | 0,003 €/MJ |
| | Heat | 3 000 MJ | 0,020 €/MJ |
| | Solid biofuels | 0 MJ | 0,008 €/MJ |
| | Gaseous biofuels | 0 MJ | 0,000 €/MJ |
| | Other fuels | 0 MJ | 0,000 €/MJ |
| | Total | 6 000 MJ | 0,023 €/MJ |

*NB: The total cost of energy refers to the average cost of energy from the input data.*

## 3.2.2 Outputs

There are two types of outputs:

- Figures outputs
- Graphics outputs

### 3.2.2.1 Figure outputs

The figure outputs are presented on the following table:

| OUTPUT | | |
|---|---|---|
| Expected drop of $CO_2$ emissions | | 1,494 t |
| Expected drop of $CH_4$ emissions | | 109 kg |
| Expected drop of $N_2O$ emissions | | 30 kg |
| Expected drop of $CO_{2eq}$ emissions | | 1,505 t |
| Expected Cash Flow | | 254,875 €/year |
| NPV | € | 2,194,669.42 |
| Simple payback : | | 5.9 years |
| NPV equivalent direct investment: | € | 1,143,221.83 |
| Subsidy share: | | 24% |
| If loan = 100% | € | 2,033,084.03 |

The expected drop of CO2eq emissions is the sum of CO2, CH4 and N2O emissions

- The expected Cash Flow is calculated based on the energy savings and the energy cost inputs

- The NPV is the NPV calculated for the project funding mechanism

- The simple payback is the total investment divided by the Cash Flow

- The NPV equivalent direct investment is the calculated direct investment (own resources) needed to reach the same NPV as if loan = 100% of the investment. The investment with this direct investment is completed by the missing Subsidy share (in this case 24%)

The tool not only calculate the NPV regarding the investment mix provided (Loan, Subsidy, Own resources), and the other parameter, but also process the NPV for a loan investment only, and the equivalent investment mix with no loan. (This operation will be further explained through the graphic outputs.)
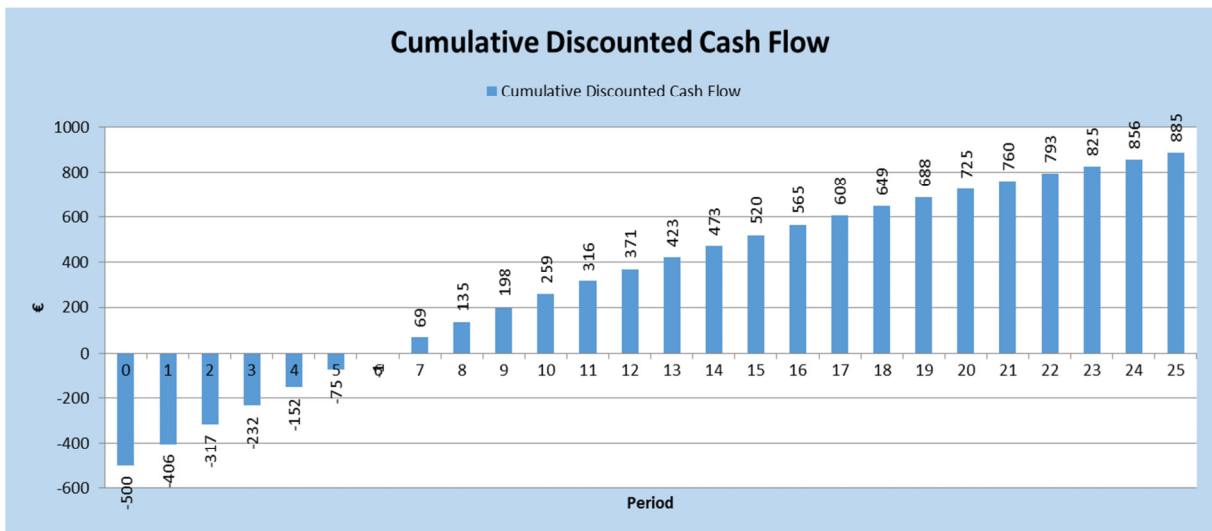
### 3.2.2.2 Graphic outputs

The first three graphics are only a recapitulation of the input data with

- Share on investment

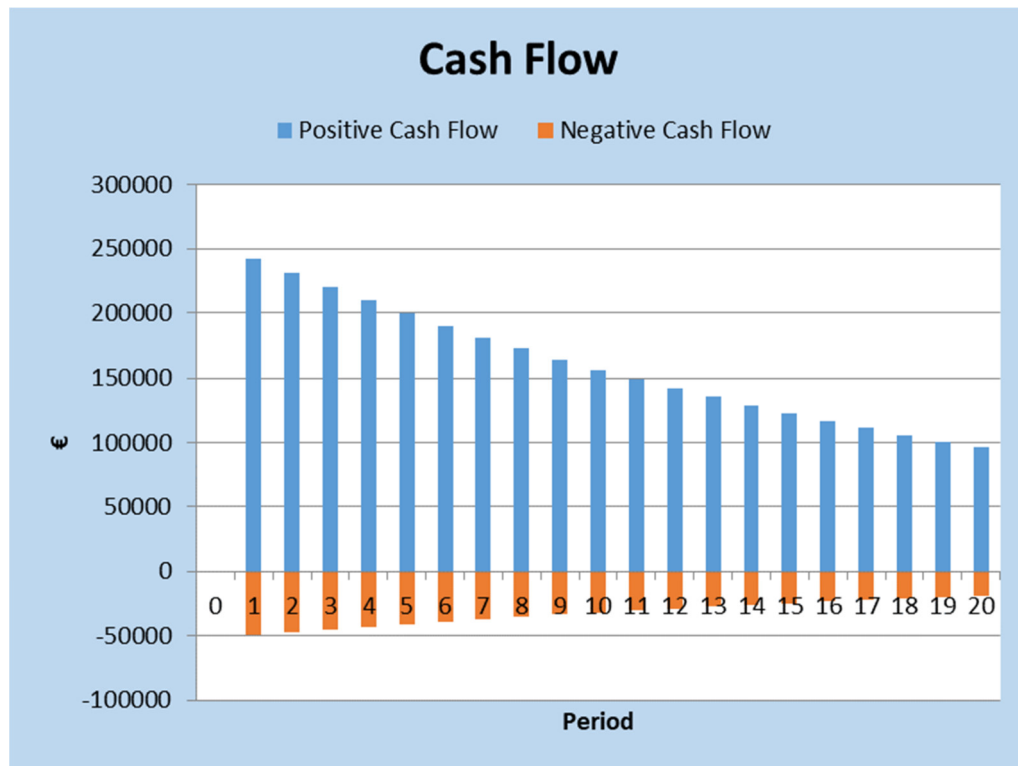- Energy savings

- Energy cost
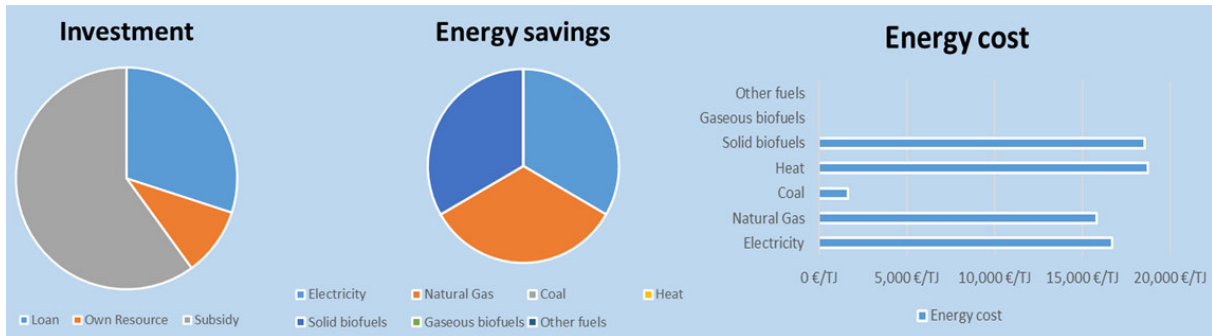
The fourth graphic represent the cumulative discounted cash flow over the input lifetime of the project. The last output point of the graphic represents the NPV.

The fifth graphic shows the cash flow evolution:



The **"Positive Cash Flow"** stands for the calculated cash flow from the energy savings. The **"Negative Cash Flow"** stands for the interest repaid for the loan.

The sixth graphic present the same NPV as the "Cumulative Discounted Cash Flow", only the investment mix to reach it differs. The previous graphic was showing the evolution according the input mix, and this one is showing the equivalent to this investment if there is no loan, but only own resources and subsidy.
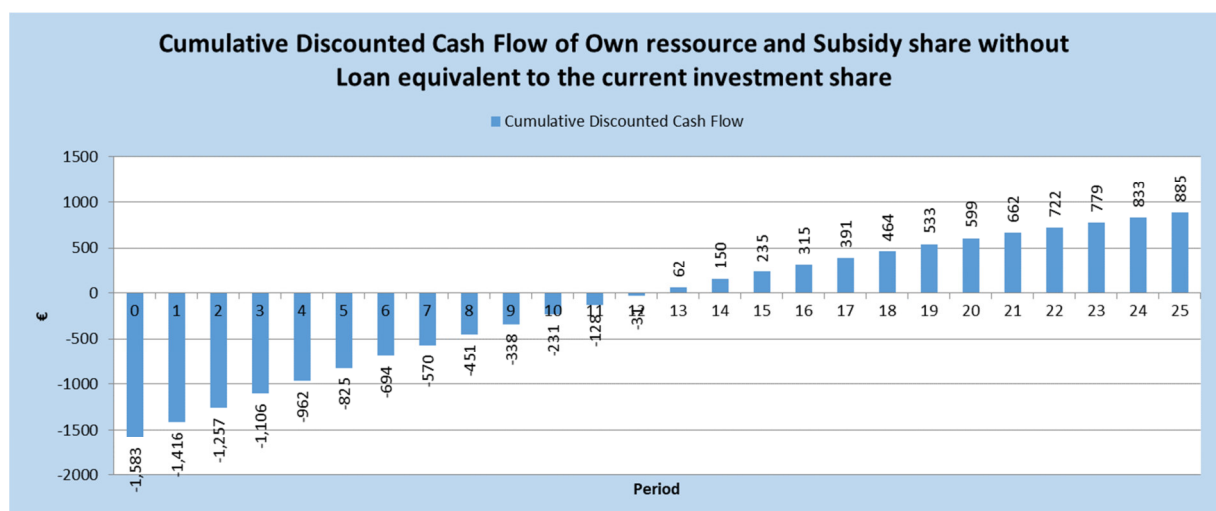
# Annexes

## Annex I – Programme level tool calculator

See the MS Excel file "D.T2.2.3-I Programme level tool.xlsx"

## Annex II – Project level tool calculator

See the MS Excel file "D.T2.2.3-II Project level tool.xlsx"