ENERGY FINANCING MIX

Catalogue of evaluation mechanisms for investments in energy efficiency (D2.1)

April 2019

This project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement No 785081. Disclaimer: The content of this material does not reflect the official opinion of the European Union. Responsibility for the information and views expressed lies entirely with the author(s).

Before we get started – what this catalogue is (… and what it is not)

This catalogue is …

- an energy technology-specific **compilation of evaluation and feasibility criteria** for energy investments
- a tool to enable **standardised and systematic evaluation** of potential energy projects
- able to **consider territorial differences** in investment cost, energy prices, capital cost and influence on financing options
- hands-on and suitable for **capacity-building** initiatives

This catalogue is not …

- an **exhaustive and complete** list including all existing evaluation methods
- a **scientific study** comparing different evaluation methods and proposing "one best" criterion
- **applicable to all countries** without reflection of local framework conditions
- a **blueprint** for analysing EE projects

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The following section presents an overview of some evaluation mechanisms

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All stakeholders benefit from a correct and structured EE project evaluation

Stakeholder	Correct EE project evaluation helps …
Investing businesses	▪ **assess** value creation potential of investment in EE project and prioritize versus other investment opportunities requiring capital ▪ **determine** effect of EE project on credit line and creditworthiness ▪ **improve** understanding of maximum feasible investment cost ▪ **optimize** benefits from investment by improving configuration ▪ better **understand** sensitivities and manage risks ▪ **provide** benchmark for post-investment performance reviews
Financing institutions	▪ **evaluate** quality and creditworthiness of EE project to be financed
Equipment providers / suppliers	▪ **identify** equipment needed to maximize value creation for investing company and financing institutions
General public	▪ **assess** EE project potential for reduction of emission and energy consumption

To achieve all this, it is important to use appropriate evaluation mechanisms!

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SOURCES: www.energy-efficiency.gov.uk

FIX ENERGY FINANCING MIX

The following section presents an overview of some evaluation mechanisms

- **1** Introduction: why need for evaluation of EE investments?
- **2** Setting the baseline: prerequisites for correct evaluation of EE investments
- **3** Overview of different types of evaluation mechanisms and criteria
  - **3A** Deep-dive 1: Payback period
  - **3B** Deep-dive 2: NPV
  - **3C** Deep-dive 3: IRR
  - **3D** Deep-dive 4: Emission reduction
  - **3E** Deep-dive 5: LCOE
- **4** Country-specific differences and particularities
- **5** Real-life computation examples
- **6** Helpful resources
  - **6A** Project benchmarks

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Garbage in, garbage out – a correct evaluation of EE investments requires certain prerequisites

	Prerequisites
Data	▪ Availability of the detailed feasibility study, including information on CAPEX, O&M expenses, savings, life-time of the projects, financial information (capital structure, cost and maturity of lending) ▪ Availability of environmental and social impact analysis if required by legislation ▪ Availability of reliable financing information ▪ Availability of correct, detailed and reliable energy price forecasts ▪ Availability of complete summarized technical-legislation conditions ▪ Availability of complete data on parameters of consumption (amount, development/shape)
Processes	▪ Availability of analysis of alternative technologies (comparison of different accesses, technologies, financing solutions) ▪ Establishment of transparent and standardized evaluation process and methodology
Supporting resources and factors	▪ Availability of experienced staff for the successful execution of the project and its evaluation ▪ Predictability of stable regulatory environment

These factors need to be in place to allow correct use of evaluation methods described

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SOURCES: Questionnaires received from PP countries

Several points need to be considered when evaluating EE projects

NOT EXHAUSTIVE

- **Interaction effects:** Some EE improvement measures interact with other EE projects and can lead to a multiplication of the effect and make it difficult to attribute benefits to a specific project
- **Project lifetime:** Assumed lifetime has a large effect on most evaluation mechanisms; there are different approaches (economic life, physical life, technological life)
- **Additional benefits:** In addition to energy savings, new EE technology often also leads to savings in maintenance etc., which need to be accounted for
- **Rebound effects:** some of the energy savings resulting from energy efficient technologies is offset by behaviors.
- **Lifecycle cost:** Includes environmental impact of measure "from cradle to grave" and allows for full assessment

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EE investment projects can be evaluated from many different perspectives

NOT EXHAUSTIVE

Evaluation criteria for EE projects

Types of criteria for EE investments		Relevant stakeholder
Financial	Investment cost / CAPEX Payback period NPV[1] IRR[2] Avoidance cost …	• Financial investors • Credit line providers • Leasing companies • Executing business • …
Environmental / Social	Energy savings Emission reductions …	• Executing business • General public • NGOs • Governments • …
Technical	Technical maturity Reliability and durability …	• Executing business • Leasing companies • Equipment providers • …

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SOURCES: Demirtas (2013)

[1] Net Present Value [2] Internal Rate of Return

3A

Payback period is a simple and easy-to-understand evaluation method

Description

- The most simple way to evaluate EE investment projects
- Considers capital cost and (average) annual savings, but no interest rate and time effects

Assessment

- \+ **Simple** to compute and understand
- \+ Expressed in **tangible** terms (years)+
- \+ Does not require **assumptions** about project life cycle and interest rates

- \- Does not consider **savings after payback** period and residual value
- \- Does not consider **time value** of money

Computation

$$payback(years) = \frac{capital\ cost}{annual\ savings}$$

Example

- **Project data:** investment cost = EUR 1,000; annual savings = EUR 500
- **Payback period:** 1000 / 500 = 2 years

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NPV of EE projects shows how much economic value they create

Description

- Discount rate is the cost of financing
- If positive, EE project creates value
- For selection between different EE projects, choose project with highest NPV

Computation

$$NPV = yr_0\, cashflow + \frac{yr_1\, cashflow}{(1+r)^1} + \frac{yr_2\, cashflow}{(1+r)^2} + \cdots \frac{yr_n\, cashflow}{(1+r)^n}$$

Assessment

+ Considers **time value** of money
+ Allows to **disaggregate** and optimize value drivers
+ **Widely used** measure by financial decision makers

- Difficult to anticipate long-term **lifetime** of EE improvement asset
- Requires **assumptions** about long-term financing costs etc.

Example

- **Project data:** capital expenditure = EUR 1,000; annual savings = EUR 500; cost of capital = 10%; lifetime = 3 years
- Computation: NPV = -1000 + 500 * 1.1^{-1} + 500 * 1.1^{-2} + 500 * 1.1^{-3} = 243

SOURCES: www.energy-efficiency.gov.uk

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IRR

Description

- Interest rate that equates the NPV of expected future cash flows to the initial cost of the project present value
- Often used in conjunction with the NPV
- Computer software or financial calculators are recommended

Computation

Set NPV (in NPV equation) to 0 and solve for r.

$$0 = yr_0\ cashflow + \frac{yr_1\ cashflow}{(1+r)^1} + \frac{yr_2\ cashflow}{(1+r)^2} + \cdots \frac{yr_n\ cashflow}{(1+r)^n}$$

Assessment

Similar pros and cons to NPV since equation is derived from NPV but…

+ **Provides direct comparison** to leaving money in the bank and collecting compound interest, or alternative means of financing (different costs of capital)
+ IRR can be used to indicate a **"go" or "no go"**

- Does not account for the **relative size** of savings
- **Cannot** be used to compare or **prioritize** options (can lead to minimizing upfront costs regardless of long term savings)

Example

- **Project data:** capital expenditure = EUR 1,000; annual savings = EUR 500; cost of capital = 10%; lifetime = 3 years

$$0 = -1000 + \frac{500}{(1+r)^1} + \frac{500}{(1+r)^2} + \frac{500}{(1+r)^3}$$

$$IRR = 23.375\% \quad Note: IRR > cost\ of\ capital$$

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SOURCES: www.energy-efficiency.gov.uk

Emission reduction is a non-financial indicator for the environmental value of an EE project

Description

- Non-financial indicator of environmental impact of EE measure
- Describes emissions saved or energy consumption reduced over time or per year by EE measure

Assessment

+ Often used to qualify initiative for **government support**
+ Can be used for **marketing purposes**
+ **Complements** financial evaluation perspective

- Often **difficult to anticipate** energy savings or emission reductions ex-ante

Example

Efficient refrigeration project in Georgia

- EE initiatives: efficient refrigerating equipment, thermal insulation
- Investment cost: USD 394,000
- Effect: 85% of current energy consumption saved; 600t of CO_2 saved per year

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SOURCES: http://seff.ebrd.com/cs/Satellite?c=Content&cid=1395250750611&pagename=SEFF%2FContent%2FSEFF_Content

Levelized Cost of Energy LCOE

Description

- Estimates the average lifetime cost of power production per energy unit
- A simple LCOE will consider investment costs, fuel costs and maintenance costs, while a more **complex one will also consider environmental externalities, system costs and heat revenue**

Assessment

\+ Can reflect socioeconomic costs (**not purely financial**).

\+ Allows **comparison of different technologies** with different characteristics (life spans, project size, cost of capital, etc.) and **detailed** country-specific analysis

\- Considers a relatively high number of full load hours, constant over lifetime

\- Only considers costs, not revenues

\- Needs more complex inputs than financial calculations

Computation (simple – undiscounted LCOE)

$$\frac{sum\ of\ costs\ -\ incentives}{yearly\ energy\ output\ *\ lifetime}$$

Note: Several, more complex, LCOE (country-specific) calculating tools are available online

Example

Project data: capital expenditure = EUR 100,000; yearly maintenance costs = EUR 2,500; yearly interest payment = 800; tax incentive = 17,000; energy production = 62,500 kWh / Year; Lifetime = 20 years

$$LCOE = \frac{(100{,}000 + 20 * (2{,}500 + 800) - 17{,}000\ EUR}{20 * 62{,}500\ kWh}$$ = 0.1192 EUR/kWH

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SOURCES: https://ens.dk/sites/ens.dk/files/contents/material/file/vejledning_lcoe_calculator.pdf and https://www.energy.gov/sites/prod/files/2015/08/f25/LCOE.pdf

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Countries vary greatly regarding their EE investment framework conditions

	AM	AT	CZ (1 CZK=0.039 EUR)	GE (1 GEL=0.033 EUR)	PL (1 PLN=0.023 EUR)	HR
Average electricity cost for households [per kWh, in euro] Exchange rate 25.02.2019	0.081 EUR (day) 0.063 EUR (night)	0.2 EUR	0.16 EUR	in Tbilisi: • up to 101 kWh/month - 0.048 EUR • from 101-301 kWh - 0.061 EUR • 301 kWh/month and above - 0.076 EUR In country, except Tbilisi: • up to 101 kWh/month - 0.047 EUR • from 101-301 kWh - 0.06 EUR	0.13 EUR	0.12 EUR (day) 0.07 EUR (night)
Development of electricity cost for households over next years [in % p.a.]	3%	2-3% (but much higher in last years)	5%	NA	about 10%	5%
Average electricity cost for industry [per kWh, in euro] Exchange rate 25.02.2019	0.076 EUR 0.058 EUR	0.107 EUR	0.058-0.18 EUR	in Tbilisi • up to 220/380 volt - 0.07 EUR • from 3.3-6-10 kV - 0.056 EUR • 35-110 kV - 0.053 EUR In country, except Tbilisi • 0.4 kV - 0.07 EUR • from 3.3-6-10 kV - 0.054 EUR • 35-110 kV - 0.049 EUR	0.12-0.14 EUR	0.14 EUR (day) 0.08 EUR (night)
Development of electricity cost for industry over next years [in % p.a.]	3%	2-3% (but much higher in last years)	3-4%	NA	Up to 30-70%	5%

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SOURCES: Questionnaires provided by PP countries. Answers including local currencies are in the Appendix

Countries vary greatly regarding their EE investment framework conditions

	AM	AT	CZ (1 CZK=0.039 EUR)	GE (1 GEL=0.033 EUR)	PL (1 PLN=0.023 EUR)	HR
Inflation rate [in %]	3-4%	2%	2.2% (growing)	NA	1.80%	2-3%
Interest rate used to discount future financial flows [in %]	8.5-9.5% in USD	NA	3.5% (growing)	NA	Varies	5-7%
Fuel prices for gasoline [per kWh, in euro] Exchange rate 25.02.2019	0.87 EUR	1.3 EUR	1.31 EUR	0.83 EUR	1.17 EUR	1.3 EUR
Heating costs for households [per kWh, in euro] Exchange rate 25.02.2019	0.045 EUR	0.065 EUR (natural gas)	0.055– 0.11 EUR	NA	• 0.039 EUR (coal) • 0.046 EUR (gas) • 0.13 EUR (electricity)	• 0.065 EUR (VAT excl.) for district heating • 0.05 EUR (VAT excl.) for gas boilers • 0.06 EUR (VAT excl.) for fuel oil
Heating costs for industry [per kWh, in euro] Exchange rate 25.02.2019	0.018 EUR	0.035 EUR (natural gas)	0.041 – 0.086 EUR	NA	Varies	• 0.12 EUR (VAT excl.) for district heating • 0.06 EUR (VAT excl.) for gas boilers • 0.06 (VAT excl.) for fuel oil

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Depending on country characteristics, different evaluation mechanisms are relevant

	Evaluation mechanism	Description	Relevance AM	AT	CZ	PL	HR	GE (leasing)	GE
Financial	CAPEX (investment cost)	Initial cost to deploy an EE project	5	5	5	5	5	5	5
	Payback period (years	Investment cost divided by the difference between annual savings minus annual running cost	5	5	5	4	4	1	3
	NPV (net present value)	The discounted future annual savings minus the investment cost	4	4	3	4	4	1	4
	IRR (internal rate of return	Similar to NPV. The IRR is the discount rate when the NPV is zero	4	4	4	4	4	1	4
	Avoidance cost	Average cost of each kWh energy saved over the lifetime of the projected measure	4	2	2	2	4	1	3
	Qualification for financial support	Does the project qualify for preferential credit lines etc.?	4	NA	3	4	5	4	4
	Source of funding	Is the project financed through equity, loan, subsidies, cash-flows, etc.?	4	5	5	5	4	4	4
	Type of energy supplier concerned	Which type of energy supplier does the EE project affect (e.g. district heating provider, wholesale electricity utility)?	2	5	2	2	2	1	3
	Terms of the loan	Cost and maturity of debt	5	3	3	NA	5	NA	NA
	Total amount saved	How much can be saved during the lifetime of the measure	NA	2	4	NA	NA	NA	NA
	Interest	Cost of money from external sources	NA	5	5	NA	NA	NA	NA
	Rate of potential subsidies	Ease of obtaining and size of subsides	NA	3	5	NA	NA	NA	NA
	Collateral required by financing institution	Amount of collateral required	NA	3	3	2	NA	NA	NA

Low relevance

High relevance

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Depending on country characteristics, different evaluation mechanisms are relevant

	Evaluation mechanism	Description	AM	AT	CZ	PL	HR	GE (leasing)	GE
Environmental/Social	Primary energy savings	Amount of kWh energy saved over the lifetime of the projected measure	5	3	5	3	5	1	3
	Emission reductions	CO2 emissions saved over the lifetime of the projected measure	1	2	3	2	4	1	2
	Creation of new work places	Work places created by the project	NA	1	1	3	NA	NA	NA
	Reduction of air pollution	Reduction of PM2.5 and PM1 emission levels	NA	3	3	4	NA	NA	NA
Technical	Maturity of technology	Qualitative assessment of how mature the technology is	4	4	4	3	4	5	5
	Reliability and durability of technology	Qualitative assessment of how reliable the technology is	4	3	4	4	4	5	5
	Regulatory feasibility	Assessment of whether the EE project will likely fulfill regulatory requirements	4	2	3	4	NA	1	3
	Degree of self-sufficiency	Assessment of the share of won energy demand produced on site	4	3	2	3	4	1	4

Low relevance

High relevance

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Computational Examples – Undiscounted Methods

Using a case study from the EBRD for the Russian shipbuilding company

"The investment of €620,000 allowed the company to reduce its energy consumption by 900 MWh per year, resulting in the cost savings of €155,000 per year."

What would be the household's payback period (in years)?

$$\text{Payback Period} = \frac{620{,}000}{155{,}000}$$

$$\text{Payback Period} = 4 \text{ years}$$

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SOURCES: https://seff.ebrd.com

Computational Examples – Discounted Methods

Using a case study from the EBRD for Outstanding electricity savings in Georgian deep freeze production for inspiration.

"A $394,000 investment allowed to decrease the company's existing electricity consumption by 85%, leading to $116,000 cost savings each year…" "A successful Georgian refrigeration company constructed a cold storage facility in 2012. To further boost the own performance, the company planned a new deep freeze facility and addressed Energocredit for a loan".

Assuming the new deep freeze facility will last for 10 years and you must pay a 13% interest on the loan. **What is the NPV?**

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Computational Examples – Discounted Methods

First step: Map the cash flows

Year	Capital expenditure	Savings	Cashflow	Cumulative Cashflow
0	-394,000		-394,000	-394,000
1		116,000	116,000	-278,000
2		116,000	116,000	-162,000
3		116,000	116,000	-46,000
4		116,000	116,000	70,000
5		116,000	116,000	186,000
6		116,000	116,000	302,000
7		116,000	116,000	418,000
8		116,000	116,000	534,000
9		116,000	116,000	650,000
10		116,000	116,000	766,000

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Computational Examples – Discounted Methods

Remember: NPV is the sum of the **discounted cash flows.** We can now use the 13% interest of the loan as a discount factor.

Year	Capital expenditure	Savings	Cashflow	PV of discounted Cashflows	Cumulative Cashflow at PV
0	-394,000		-394,000	-394,000	-394,000
1		116,000	116,000	102,655	-291,345
2		116,000	116,000	90,845	-200,500
3		116,000	116,000	80,394	-120,106
4		116,000	116,000	71,145	-48,961
5		116,000	116,000	62,960	13,999
6		116,000	116,000	55,717	69,716
7		116,000	116,000	49,307	119,023
8		116,000	116,000	43,635	162,657
9		116,000	116,000	38,615	201,272
10		116,000	116,000	34,172	235,444

NPV = $235 444

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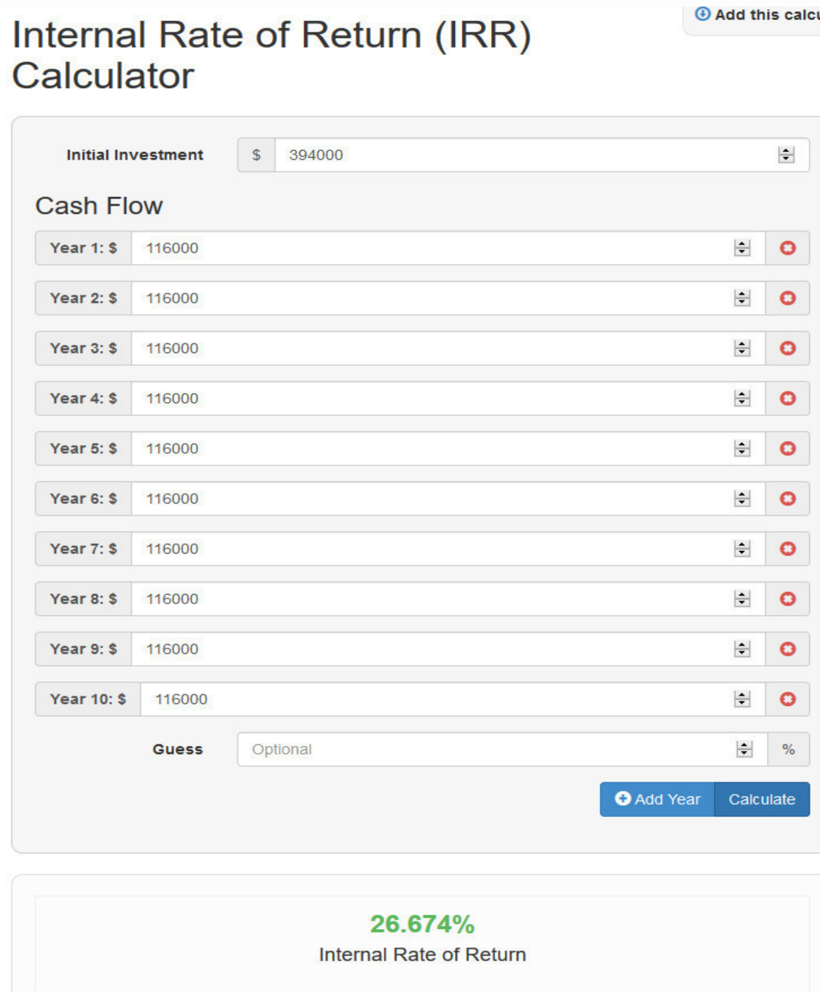
Computational Examples – Discounted Methods

What is the IRR?

Using an online calculator, we obtain the IRR

IRR = 26.67%



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SOURCES: https://www.calculatestuff.com/financial/irr-calculator

Computational Examples – Discounted Methods

To compare projects→ Let's assume same company has the opportunity to change to more efficient lighting and better insulation.

This new project requires an initial investment of $230,000 investment and allows to decrease the company's existing electricity consumption by $76,000 each year. Assuming the project will last for 15 years and you must pay 15% discount rate.

What is the NPV? What is the IRR ?

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Computational Examples – Discounted Methods

Note: this project also has period and a different discount factor

Year	Capital expenditure	Savings	Cash flow	PV of discounted Cash flows	Cumulative Cash flow at PV
0	-230,000		-230,000	-230,000	-230,000
1		76,000	76,000	66,087	-163,913
2		76,000	76,000	57,467	-106,446
3		76,000	76,000	49,971	-56,475
4		76,000	76,000	43,453	-13,022
5		76,000	76,000	37,785	24,764
6		76,000	76,000	32,857	57,621
7		76,000	76,000	28,571	86,192
8		76,000	76,000	24,845	111,036
9		76,000	76,000	21,604	132,640
10		76,000	76,000	18,786	151,426
11		76,000	76,000	16,336	167,762
12		76,000	76,000	14,205	181,967
13		76,000	76,000	12,352	194,319
14		76,000	76,000	10,741	205,060
15		76,000	76,000	9,340	214,400

NPV = $214,400

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Computational Examples – Discounted Methods

Comparing the financial indicators

	IRR	NPV
Refrigeration	26.67	235,444
Insulation and Lighting	32.56	214,400

Prioritize the project with **higher NPV**

Note: the "Refrigeration" project has a **higher NPV,** but **lower IRR** than the "Insulation and Lighting" project. When comparing between projects you must look at the NPV. The IRR can be compared to the discount factors. Both projects have a higher Internal Rate of Return than their discount factor (cost of the loan). These means both projects are a "GO".

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Computational Examples – Discounted Methods

You can also include more factors into your NPV calculation. Some of these can be maintenance costs or inflation costs. Below is an example including an increasing maintenance cost.

Adding maintenance costs to the calculation. Let's assume the anticipated maintenance for the first project is anticipated to a flat $450 per year, and you anticipate it to increase at 3% each year.

How does the NPV look like now?

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Computational Examples – Discounted Methods

Year	Capital expenditure	Savings	Maintenance cost	Cash flow	PV of discounted Cash flows	Cumulative Cash flow at PV
0	-394,000			-394,000	-394,000	-394,000
1		116,000	-450	115,550	102,257	-291,743
2		116,000	-464	115,537	90,482	-201,261
3		116,000	-477	115,523	80,063	-121,198
4		116,000	-492	115,508	70,843	-50,355
5		116,000	-506	115,494	62,685	12,330
6		116,000	-522	115,478	55,466	67,797
7		116,000	-537	115,463	49,079	116,875
8		116,000	-553	115,447	43,426	160,302
9		116,000	-570	115,430	38,425	198,727
10		116,000	-587	115,413	33,999	232,726

NPV = $232 726

As you can see, the NPV dropped from $235 444 to $232 726

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The following section presents an overview of some evaluation mechanisms

1	Introduction: why need for evaluation of EE investments?
2	Setting the baseline: prerequisites for correct evaluation of EE investments
3	Overview of different types of evaluation mechanisms and criteria
3A	Deep-dive 1: Payback period
3B	Deep-dive 2: NPV
3C	Deep-dive 3: IRR
3D	Deep-dive 4: Emission reduction
3E	Deep-dive 5: LCOE
4	Country-specific differences and particularities
5	Real-life computation examples
6	Helpful resources
6A	**Project benchmarks**

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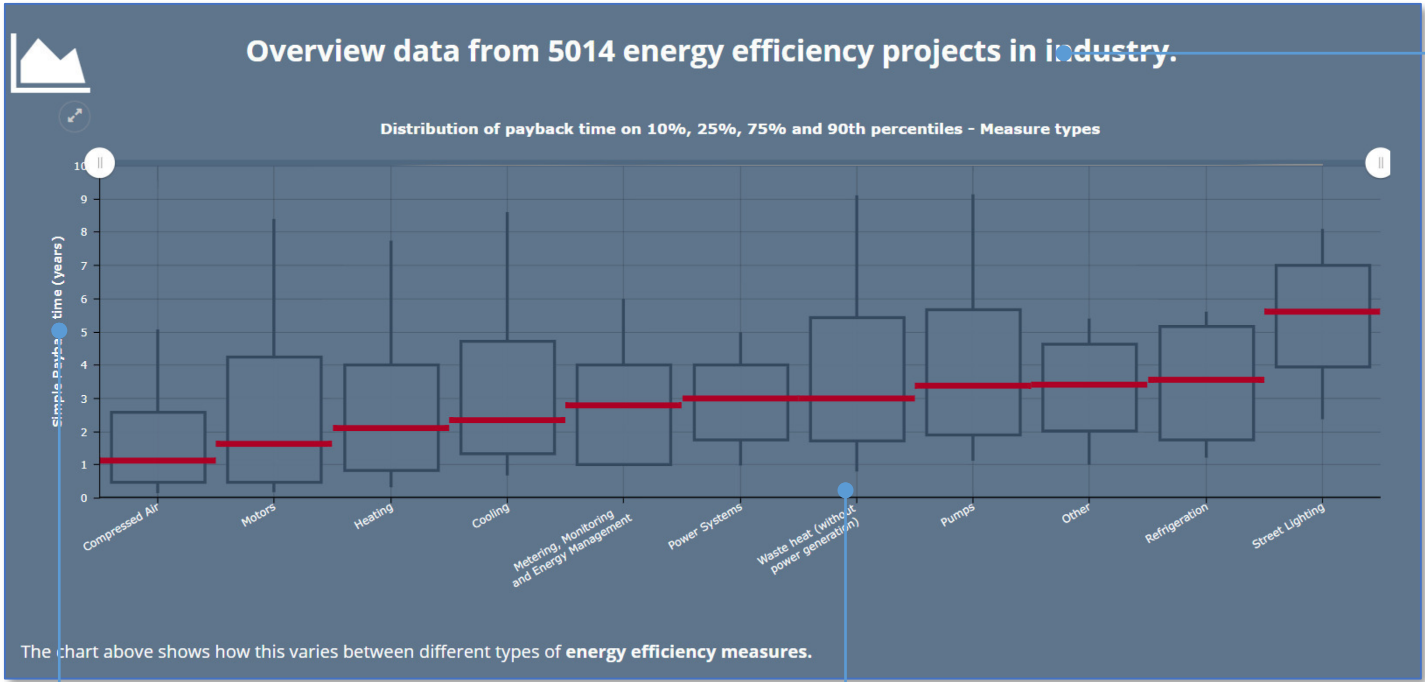
The DEEP ("De-risk Energy Efficiency Platform") allows to benchmark EE projects



- Contains data from 5014 EE projects in **industry** and 5152 EE projects in **building** *(as of 10/2018)*

- Allows to statistically analyse EE projects by **payback period** and **avoidance cost**

- **Segments** projects into HVAC, lighting, building fabric, integrated renovation (for **buildings**) and compressed air, motors, heating, cooling, energy management, power systems, waste heat, pumps, refrigeration, street lighting (for **industry**)

Also offers a tool specifically for benchmarking own energy efficiency projects *(https://deep.eefig.eu/benchmark/)*

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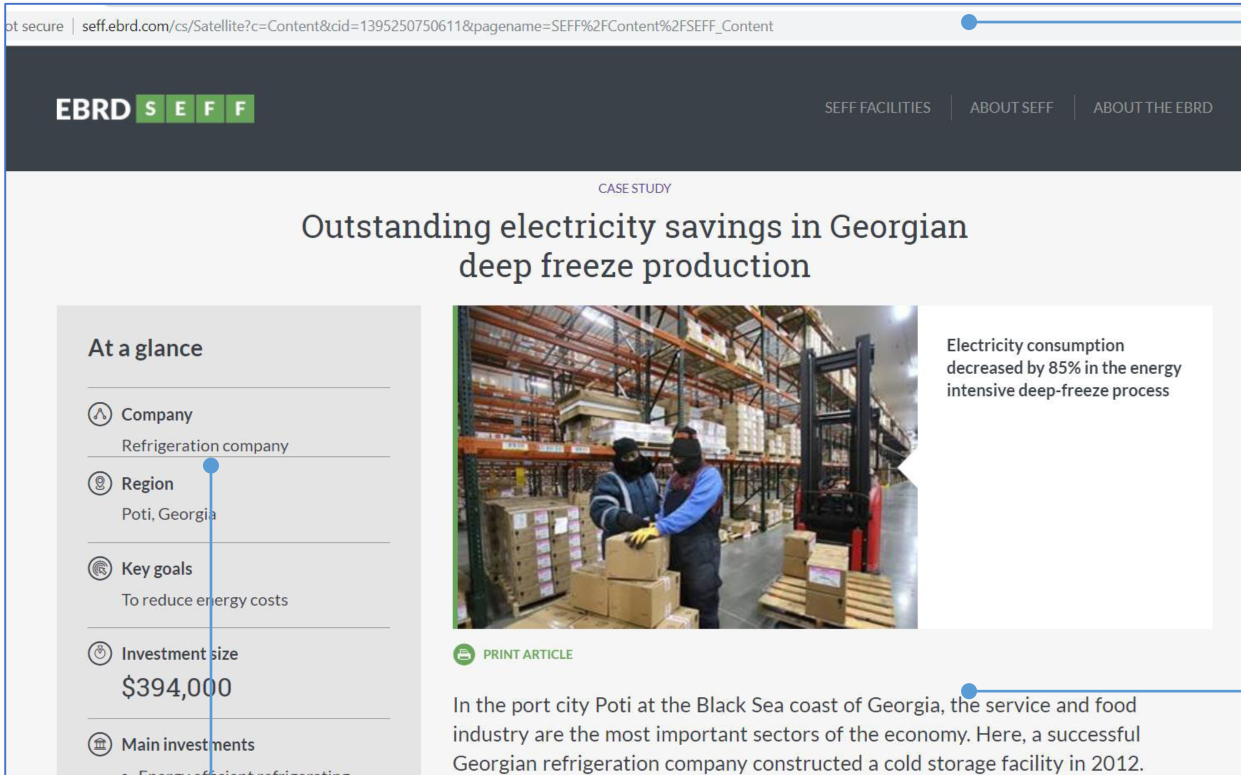
SOURCES: https://deep.eefig.eu

6A

For most project partner countries, EBRD shows criteria of real projects



- Contains data **from project in all major EBRD project countries** (e.g. Georgia, Armenia, Croatia)
- Provides short project summaries outlining **how they were financed** (including credit lines etc.)
- Lists for each project **important evaluation criteria** (e.g., payback period, energy savings, cost savings, emission reductions, investment size)

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SOURCES: https://seff.ebrd.com

6A

Example benchmarks for EE improvement projects

NOT EXHAUSTIVE

Measure	Typical energy savings [%]	Typical payback time [years]
• Automatic lighting controls	20-50	2-10
• Task lighting	30-70	4-8
• Time controls on office equipment	20-60	0.5-3
• High-efficiency motors	3-6	0.5-3
• High-efficiency boilers	5-7	2-3
• Building energy management system	5-10	3-6
• External insulation	10-20	25-35
• High-efficiency refrigeration	~85	4
• Energy-efficient production equipment (textiles)	~72	6

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SOURCES: www.energy-efficiency.gov.uk; www.seff.ebrd.com

BACK-UP

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Countries vary greatly regarding their EE investment framework conditions

		AM	AT	CZ	GE	PL	HR
Average electricity cost for households	[per kWh, in local currency]	44.98 AMD (day) 34.98 AMD (night)	0.2 EUR	4.1 CZK	in Tbilisi up to 101 kWh/month – 0.1454 GEL from 101-301 kWh/month – 0.1855GEL 301 kWh/month and above – 0.2304 GEL In country, except Tbilisi up to 101 kWh/month – 0.1423 GEL from 101-301 kWh/month – 0.1821GEL	0.55 PLN	0.12 EUR (day) 0.07 EUR (night)
Development of electricity cost for households over next years	[in % p.a.]	3%	2-3% (but much higher in last years)	5%	NA	about 10%	5%
Average electricity cost for industry	[per kWh, in local currency]	41.98 AMD (day) 31.98 AMD (night)	0.107 EUR	1.5-4.5 CZK	in Tbilisi 220/380 volt – 0.2131 GEL 3.3-6-10 kV – 0.1688 GEL 35-110 kV – 0.1611 GEL In country, except Tbilisi 0.4 kV – 0.2108 GEL 3.3-6-10 kV – 0.1625 GEL 35-110 kV – 0.1486 GEL	0.5-0.6 PLN (depending on size and type of company)	0.14 EUR (day) 0.08 EUR (night)
Development of electricity cost for industry over next years	[in % p.a.]	3%	2-3% (but much higher in last years)	3-4%	NA	Up to 30-70%	5%
Inflation rate	[in %]	3-4%	2%	2.2% (growing)	NA	1.8%	2-3%
Interest rate used to discount future financial flows	[in %]	8.5-9.5% in USD; 10-11% in local currency	NA	3.5% (growing)	NA	Varies	5-7%
Fuel prices for gasoline	[per liter, in local currency]	480 AMD	1.3 EUR	33.5 CZK	2.5 GEL	5.06 PLN	1.3 EUR
Heating costs for households	[per kWh, in local currency]	25 AMD (VAT included) - NG based individual boilers	0.065 EUR (natural gas)	1.4-2.95 CZK	NA	0.17 PLN (coal); 0.20 PLN (gas); 0.57 PLN (electricity)	0.065 EUR (VAT incl.) for district heating; 0.05 EUR (VAT incl.) for gas boilers; 0.06 EUR (VAT incl.) for fuel oil
Heating costs for industry	[per kWh, in local currency]	10 AMD (net of VAT) - NG based individual boilers	0.035 EUR (natural gas)	1.05-2.2 CZK (without VAT 21%)	NA	Varies	0.12 EUR (VAT excl.) for district heating; 0.06 EUR (VAT excl.) for gas boilers; 0.06 EUR (VAT excl.) for fuel oil

SOURCES: Questionnaires provided by PP countries

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	AM	AT	CZ .039 exchange rate	GE 0.33	PL 0.23	HR
Average electricity cost for households [per kWh, in local currency]	44.98 AMD (day) 34.98 AMD (night)	0.2 EUR	4.1 CZK	in Tbilisi: • up to 101 kWh/month - 0.1454 GEL • from 101-301 kWh - 0.1855 GEL • 301 kWh/month and above - 0.2304 GEL In country, except Tbilisi: • up to 101 kWh/month - 0.1423 GEL • from 101-301 kWh - 0.1821 GEL	0.55 PLN	0.12 (day) 0.07 (night)
Average electricity cost for households [per kWh, in euro] Exchange rate 25.02.2019	0.081 EUR (day) 0.063 EUR (night)	0.2 EUR	0.16 EUR	in Tbilisi: • up to 101 kWh/month - 0.048 EUR • from 101-301 kWh - 0.061 EUR • 301 kWh/month and above - 0.076 EUR In country, except Tbilisi: • up to 101 kWh/month - 0.047 EUR • from 101-301 kWh - 0.06 EUR	0.13 EUR	0.12 EUR (day) 0.07 EUR (night)
Development of electricity cost for households over next years [in % p.a.]	3%	2-3% (but much higher in last years)	5%	NA	about 10%	5%
Average electricity cost for industry [per kWh, in local currency]	41.98 AMD (day) 31.98 AMD (night)	0.107 EUR	1.5-4.5 CZK	in Tbilisi • up to 220/380 volt - 0.2131 GEL • from 3.3-6-10 kV - 0.1688 GEL • 35-110 kV - 0.1611 GEL In country, except Tbilisi • 0.4 kV - 0.2108 GEL • from 3.3-6-10 kV - 0.1625 GEL • 35-110 kV - 0.1486 GEL	0.5-0.6 PLN (depending on size and type of company	0.14 EUR (day) 0.08 EUR (night)
Average electricity cost for industry [per kWh, in euro] Exchange rate 25.02.2019	0.076 0.058	0.107 EUR	0.058-0.18 EUR	in Tbilisi • up to 220/380 volt - 0.07 EUR • from 3.3-6-10 kV - 0.056 EUR • 35-110 kV - 0.053 EUR In country, except Tbilisi • 0.4 kV - 0.07 EUR • from 3.3-6-10 kV - 0.054 EUR • 35-110 kV - 0.049 EUR	0.12-0.14 EUR	0.14 EUR (day) 0.08 EUR (night)
Development of electricity cost for industry over next years [in % p.a.]	3%	2-3% (but much higher in last years)	3-4%	NA	Up to 30-70%	5%
Inflation rate [in %]	3-4%	2%	2.2% (growing)	NA	1.80%	2-3%
Interest rate used to discount future financial flows [in %]	8.5-9.5% in USD	NA	3.5% (growing)	NA	Varies	5-7%
Fuel prices for gasoline [per liter, in local currency]	480 AMD	1.3 EUR	33.5 CZK	2.5 GEL	5.06 PLN	1.3 EUR
Fuel prices for gasoline [per kWh, in euro] Exchange rate 25.02.2019	0.87 EUR	1.3 EUR	1.31 EUR	0.83 EUR	1.17 EUR	1.3 EUR
Heating costs for households [per kWh, in local currency]	25 AMD (VAT included) - NG based individual boilers	0.065 EUR (natural gas)	1.4 - 2.95 CZK	NA	0.17 PLN (coal); 0.20 PLN (gas); 0.57 PLN (electricity)	0.065 EUR (VAT excl.) for district heating; 0.05 EUR (VAT excl.) for gas boilers; 0.06 EUR (VAT excl.) for fuel oil
Heating costs for households [per kWh, in euro] Exchange rate 25.02.2019	0.045 EUR	0.065 EUR (natural gas)	0.055– 0.11 EUR	NA	0.039 EUR (coal) 0.046 EUR (gas) 0.13 EUR (electricity)	0.065 EUR (VAT excl.) for district heating 0.05 EUR (VAT excl.) for gas boilers 0.06 EUR (VAT excl.) for fuel oil
Heating costs for industry [per kWh, in local currency]	10 AMD (VAT included) - NG based individual boilers	0.035 EUR (natural gas)	1.05 - 2.2 CZK (without VAT 21%)	NA	Varies	0.12 EUR (VAT excl.) for district heating; 0.06 EUR (VAT excl.) for gas boilers; 0.06 EUR (VAT excl.) for fuel oil
Heating costs for industry [per kWh, in euro] Exchange rate 25.02.2019	0.018 EUR	0.035 EUR (natural gas)	0.041 – 0.086 EUR	NA	Varies	

ENERGY FINANCING MIX

Catalogue of evaluation mechanisms for investments in energy efficiency (D2.1)

Guide

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Before we get started – what this catalogue is (… and what it is not)

This catalogue is …

- an energy technology-specific **compilation of evaluation and feasibility criteria** for energy investments
- a tool to enable **standardised and systematic evaluation** of potential energy projects
- able to **consider territorial differences** in investment cost, energy prices, capital cost and influence on financing options
- hands-on and suitable for **capacity-building** initiatives

This catalogue is not …

- an **exhaustive and complete** list including all existing evaluation methods
- a **scientific study** comparing different evaluation methods and proposing "one best" criterion
- **applicable to all countries** without reflection of local framework conditions
- a **blueprint** for analysing EE projects

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ENERGY FINANCING MIX

Why?

Stakeholder	Correct EE project evaluation helps …
Investing businesses	▪ **assess** value creation potential of investment in EE project and prioritize versus other investment opportunities requiring capital ▪ **determine** effect of EE project on credit line and creditworthiness ▪ **improve** understanding of maximum feasible investment cost ▪ **optimize** benefits from investment by improving configuration ▪ better **understand** sensitivities and manage risks ▪ **provide** benchmark for post-investment performance reviews
Financing institutions	▪ **evaluate** quality and creditworthiness of EE project to be financed
Equipment providers / suppliers	▪ **identify** equipment needed to maximize value creation for investing company and financing institutions
General public	▪ **assess** EE project potential for reduction of emission and energy consumption

To achieve all this, it is important to use appropriate evaluation mechanisms!

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SOURCES: www.energy-efficiency.gov.uk

Prerequisites

Prerequisites

Data	▪ Availability of the detailed feasibility study, including information on CAPEX, O&M expenses, savings, life-time of the projects, financial information (capital structure, cost and maturity of lending) ▪ Availability of environmental and social impact analysis if required by legislation ▪ Availability of reliable financing information ▪ Availability of correct, detailed and reliable energy price forecasts ▪ Availability of complete summarized technical-legislation conditions ▪ Availability of complete data on parameters of consumption (amount, development/shape)
Processes	▪ Availability of analysis of alternative technologies (comparison of different accesses, technologies, financing solutions) ▪ Establishment of transparent and standardized evaluation process and methodology
Supporting resources and factors	▪ Availability of experienced staff for the successful execution of the project and its evaluation ▪ Predictability of stable regulatory environment

These factors need to be in place to allow correct use of evaluation methods described

SOURCES: Questionnaires received from PP countries

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Several points need to be considered when evaluating EE projects

NOT EXHAUSTIVE

- **Interaction effects:** Some EE improvement measures interact with other EE projects and can lead to a multiplication of the effect and make it difficult to attribute benefits to a specific project
  - For example: installation of a more efficient insulation can influence the heating requirements. Installing a new boiler and insulation at the same time can result in significant interactions
  - For the best results, in general the energy requirements (load) should be decreased first and afterwards the delivery can be optimized.

SOURCES: www.energy-efficiency.gov.uk

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Several points need to be considered when evaluating EE projects

NOT EXHAUSTIVE

- **Project lifetime:** Assumed lifetime has a large effect on most evaluation mechanisms (particularly with discounted methods)
  - Economic life: how long will it provide economic benefits?
  - Physical life: how long until it becomes unusable?
  - Technological life: How long until the technology is considered not up to standards? technologically obsolete? or even illegal?

For a conservative estimate, take the shortest one!

SOURCES: www.energy-efficiency.gov.uk

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Several points need to be considered when evaluating EE projects

NOT EXHAUSTIVE

- **Additional benefits:** In addition to energy savings, new EE technology often also leads to savings in maintenance etc., which need to be accounted
  - Cheaper maintenance/more infrequent maintenance
  - Cost of audits
  - Operational costs (less staff)
  - Cheaper replacement parts
  - Legal costs

SOURCES: www.energy-efficiency.gov.uk

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Several points need to be considered when evaluating EE projects

NOT EXHAUSTIVE

- **Rebound effect (take-back effect):** Happens when some of the energy savings resulting from energy efficient technologies is offset by behaviors.
  - Adding more assets (even if energy efficient) lead to de-facto higher energy consumption
  - Energy efficient technologies kept in standby increase energy consumption
  - Savings stemming from energy efficiency can allow the asset to be used for longer or carelessly
  - Energy efficiency savings can be spent on non-energy efficient assets afterwards

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SOURCES: www.energy-efficiency.gov.uk and https://ac.els-cdn.com/S0301421500000215/1-s2.0-S0301421500000215-main.pdf?_tid=3b8f4c3b-0681-4e73-b7a3-20169192c7c9&acdnat=1551795584_9be91059fdc0c1209cfc3280c37a9343

Several points need to be considered when evaluating EE projects

NOT EXHAUSTIVE

- **Lifecycle cost:** Includes environmental impact of measure “from cradle to grave” and allows for full assessment
  - **Why?** Because environmental costs start prior to the use/installation of the product and continue afterwards.
  - Life cycle analysis (LCA) considers the production, packaging and distribution of the technology as well as the disposal
  - What to measure? Raw materials, Energy consumed, Emissions, Waste

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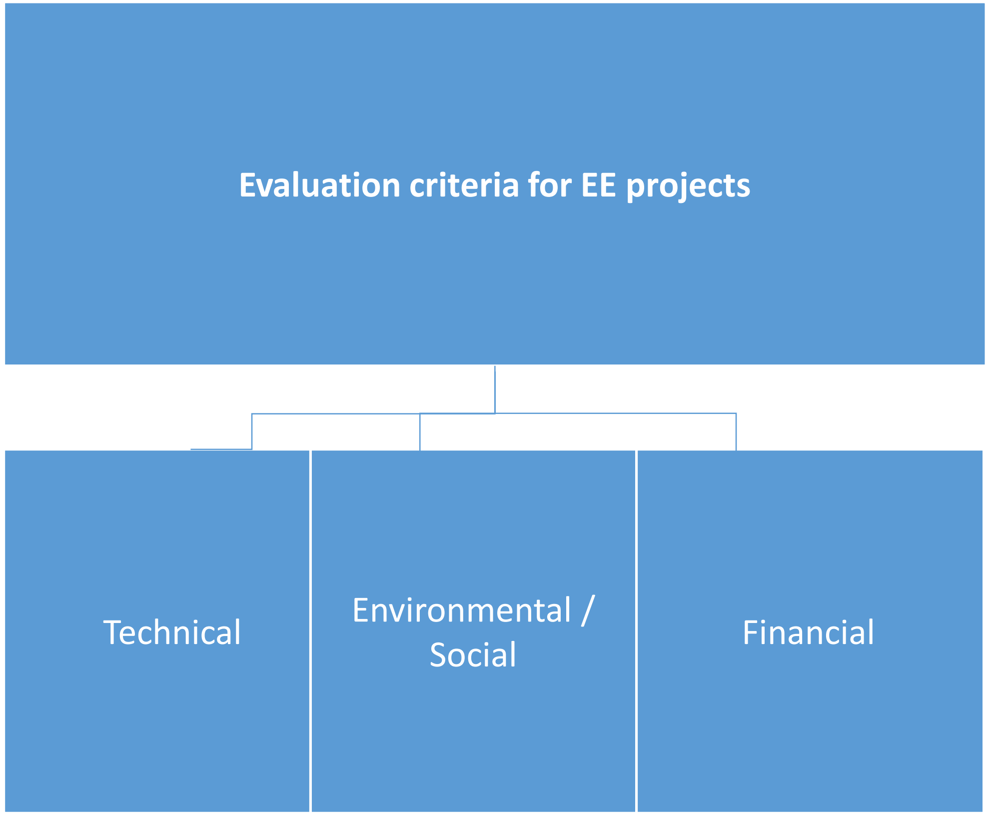
SOURCES: www.energy-efficiency.gov.uk

EE investment projects can be evaluated from many different perspectives

NOT EXHAUSTIVE



Energy Efficiency projects often involve more than one relevant stakeholder. Therefore, these perspectives are not entirely independent.

A good evaluation will give picture of the whole system (how each part interact with the other and what are the trade-offs) and must consider long term implications.

For example, a government might fund an EE project achieve emission reductions using primarily an environmental perspective, but the technology must be safe and reliable.

Similarly, the motivation of a financial investor can be purely financial, but it still has to respect environmental laws and targets.

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SOURCES: Demirtas (2013)
[1] Net Present Value [2] Internal Rate of Return

Undiscounted Methods: Payback Period

NOT EXHAUSTIVE

It is the simplest measure because it does not consider interest rates or the effects of time.

Both, the **advantages** and the **disadvantages** of this method rest on its **simplicity**

	Project A	Project B
Investment cost	2000 EUR	2000 EUR
Yearly return	500 EUR	400 EUR
Project life	10 years	14 years
Residual value	500 EUR	1200 EUR

Easy to calculate, easy to understand and uses no assumptions.

- Rather than a decision making method, payback period can be considered a measure of financial risk (how long will my capital be tied up?) This might be more relevant for individuals or small firms without access to financing opportunities

Similarly, does not consider relevant factors (benefits after payback), time value of money

- Can lead to ignoring the project life or residual value of the asset

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Discounted Methods: What is discounting?

- **What does this even mean?**

Time Value of Money = a Euro today is better than a Euro tomorrow

Why? We can earn **interest** (maybe very little) on investments.
For example: What is the value of a € 100 investment at 5% p.a. interest in 2 years?

This is an example of **compounding**:

$$PV * (1 + r)^n = FV$$

$$100 * 1.05^2 = 100 * 1.05 * 1.05 = 110.25$$

PV = Present Value
r = Interest rate p.a.
n = Number of years
FV = Future Value

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Discounted Methods: What is discounting?

NOT EXHAUSTIVE

- If we turn the idea of compounding around, we can compute what 110.25 Euros in 2 years are worth today at 5% p.a. interest.

$$110.25 * \frac{1}{1.05^2} = 100$$

$$PV = FV * \frac{1}{(1+r)^n}$$

- Discount factors tell us how much we have to **correct future returns** to account for the time value of money.

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Discounted Methods: NPV

- It is a widely used financial tool. It allows the user to make an 'apples-to-apples' comparison

- The net present value (NPV) of an investment is: what you can sell it for, corrected for interest you could have earned (r) (or will have to pay for a loan) for the years you hold the investment, minus the initial investment (C0) which is usually a cash-outflow.

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Discounted Methods: NPV

NOT EXHAUSTIVE

- Difficulties lie on the **assumptions** (prediction of cashflows and long term financing costs). It is rather simple to estimate the first couple of cashflows, but long term estimations are difficult

$$NPV = yr_0\ cashflow + \frac{yr_1\ cashflow}{(1+r)^1} + \frac{yr_2\ cashflow}{(1+r)^2} + \cdots \frac{yr_n\ cashflow}{(1+r)^n}$$

  - Example: Capital expenditure = EUR 1,000; annual savings = EUR 500; cost of capital = 10%; lifetime = 3 years

$$PV = -1000 + \frac{500}{(1+.10)^1} + \frac{500}{(1+.10)^2} + \frac{500}{(1+.10)^3}$$

Note: You cannot borrow money for free. The **cost of capital** refers to the **interest** which has to be paid on acquiring the capital to invest in the project.

SOURCES: www.energy-efficiency.gov.uk

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3B

Discounted Methods: NPV

NOT EXHAUSTIVE

Year	Capital expenditure	Savings	Cashflow	PV of discounted Cashflows	Cumulative Cashflow at PV
0	-394,000		-394,000	-394,000	-394,000
1		116,000	116,000	102,655	-291,345
2		116,000	116,000	90,845	-200,500
3		116,000	116,000	80,394	-120,106
4		116,000	116,000	71,145	-48,961
5		116,000	116,000	62,960	13,999
6		116,000	116,000	55,717	69,716
7		116,000	116,000	49,307	119,023
8		116,000	116,000	43,635	162,657
9		116,000	116,000	38,615	201,272
10		116,000	116,000	34,172	235,444

Example of 116,000 discounted at 13%

Note the values of cashflows after year 0

SOURCES: www.energy-efficiency.gov.uk

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Discounted Methods: NPV

NOT EXHAUSTIVE

- What is the correct “interest rate”?

1. Interest on savings? Mostly, the alternative to an investment is not only putting the money in a savings account.
2. Interest on loans? The price for a loan will be driven by all investments of a company, not a particular investment.
3. The **better option** is to find alternative investment with equal risk and take its expected return

$$expected\ return = \frac{expected\ profit}{investment}$$

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SOURCES: www.energy-efficiency.gov.uk

Discounted Methods: IRR

NOT EXHAUSTIVE

- The internal rate of return is the discount rate which reduces the NPV to 0
- The **higher** the IRR the **better**
- It can be used to compare to an **internal hurdle rate** ("We only consider projects with returns higher than 10%") or to the **cost of capital** ("Similar projects were funded using a 10% discount rate)

- Challenges:
  - long term cashflow assumptions
  - does not account for relative size or project life (is it better to get 20% return over one year or 13% return over 10 years?)

SOURCES: www.energy-efficiency.gov.uk

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Undiscounted Methods

1. No specific method (opportunistic/eye-balling it)
2. Undiscounted methods
3. Discounting methods using the organization's specified discount rates.
4. Full discounting methods using internal rate of return and ranking priority projects as part of an ongoing investment strategy using the NPV.

Complexity + richness of information increases

SOURCES: www.energy-efficiency.gov.uk

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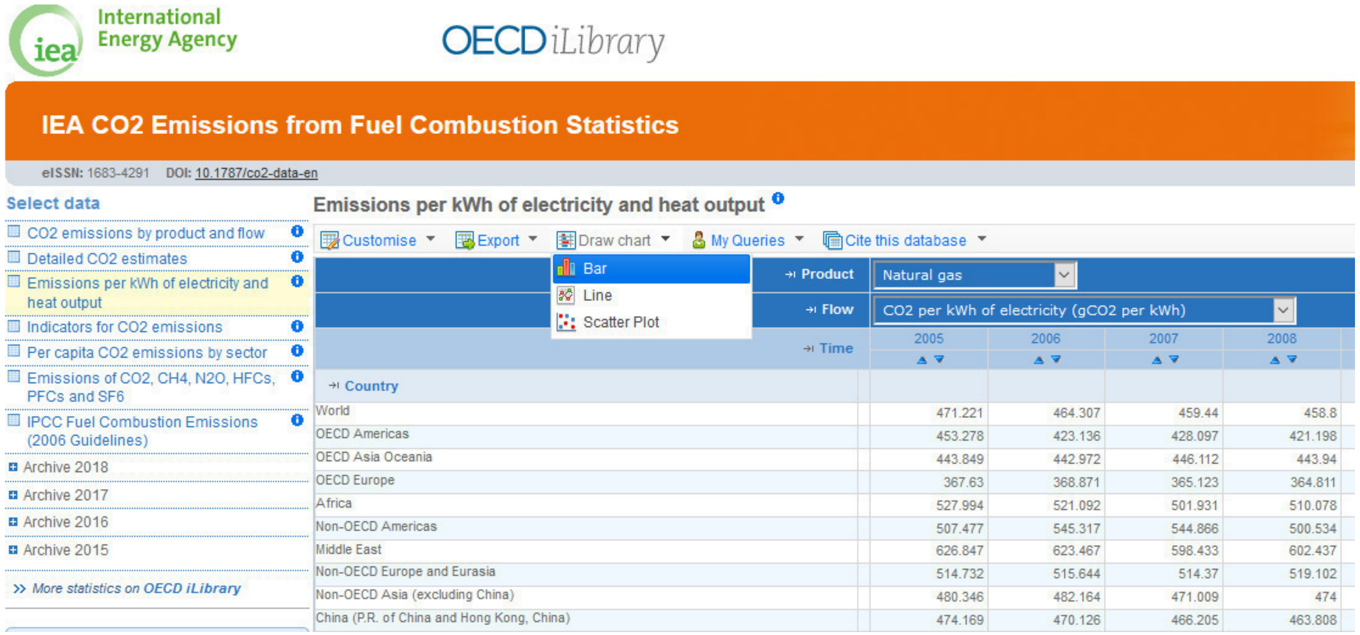
Emission Reductions

NOT EXHAUSTIVE

- Often used to qualify for government support
- The most common measure is CO_2 equivalents (Energy efficiency does not need to target CO_2 explicitly)
- Can be difficult for non-technicians to grasp



Country / Time	2005	2006	2007	2008
World	471.221	464.307	459.44	458.8
OECD Americas	453.278	423.136	428.097	421.198
OECD Asia Oceania	443.849	442.972	446.112	443.94
OECD Europe	367.63	368.871	365.123	364.811
Africa	527.994	521.092	501.931	510.078
Non-OECD Americas	507.477	545.317	544.866	500.534
Middle East	626.847	623.467	598.433	602.437
Non-OECD Europe and Eurasia	514.732	515.644	514.37	519.102
Non-OECD Asia (excluding China)	480.346	482.164	471.009	474
China (P.R. of China and Hong Kong, China)	474.169	470.126	466.205	463.808

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SOURCES: https://stats.oecd.org/BrandedView.aspx?oecd_bv_id=co2-data-en&doi=data-00432-en

LCOE

NOT EXHAUSTIVE

- Estimates the average lifetime cost of power production per energy unit
- A **simple LCOE will consider investment costs, fuel costs and maintenance costs**, while a more complex one will also consider environmental externalities, system costs and heat revenue
  - Complex LCO calculations will depend on technology choices and country. Available tools

Project data: capital expenditure = EUR 100,000; yearly maintenance costs = EUR 2,500; yearly interest payment = 800; tax incentive = 17,000; energy production = 62,500 kWh / Year; Lifetime = 20 years

$$LCOE = \frac{(100{,}000 + 20 * (2{,}500 + 800) - 17{,}000\ EUR}{20 * 62{,}500\ kWh}$$ = 0.1192 EUR/kWH

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SOURCES:
https://ens.dk/sites/ens.dk/files/contents/material/file/vejledning_lcoe_calculator.pdf

Countries vary greatly regarding their EE investment framework conditions

As illustrated by the tables in Section 4, **Countries vary greatly in their conditions.** For this reason it is important to understand the specific country characteristics.

For more information regarding the Financial and Policy Baselines of the partner countries refer to the prior more detailed reports that can be found at (http://energyfinancing.eu/en/f-a-q-en/reports/40-first-d-1-1-d1-2-country-reports)

Conditions vary, so what?

From a financial perspective: this can mean that the exact same type of project can be profitable in a country but not viable in another

- A different discount rate or energy inflation cost can change the NPV from a project form positive to negative

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Using this case study from the EBRD: Calculate the payback period

The company is a small barbershop famous for its services in the far east city of Blagoveshchensk, Russia. The business was facing the problem of continuously increasing energy bill, especially during the winter period.

To stay competitive in a saturated market, the company decided to invest into modernization of its building and contacted its servicing bank. It turned to be the RuSEFF participating bank.

The RuSEFF team supported the company with assessment of the energy balance of the production facilities. The RuSEFF team defined that energy losses were mainly caused by the poor envelope insulation and old windows.

The suggested project comprised replacement of old windows with the energy efficient ones, thermal insulation of walls and modernization of the heating system.

The €17,200 investment allows the company to reduce its energy consumption by 176 MWh per year, leading to annual €4,650 cost savings. This means the investment will be repaid from energy savings only in less than four years, turning the future cash-flows into company's income for many more years to come. The company will benefit from these measures immediately with the decreased energy bill and improved comfort. The latter is likely to attract more clients and increase the company’s turnover.

This project demonstrates that energy efficiency investments are possible and profitable even in small service enterprises. Therefore, it is worth checking the energy saving potential of possible investment measures to choose the most profitable and attractive investment.

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Using some examples: Choose the right discount rate and compute the NPV (using the formula) for both

You are looking to improve lighting efficiency in a building.

You have 2 primary options: One is to install occupancy sensors and the other one is to install a central time clock. The two projects have different initial costs and also will generate different savings, but they both have a 5 year life. Moreover, based on your prior experience of similar projects your company will only accept projects with at least a 20% return (this means you have a 20% hurdle rate). To execute this project, you can get at a 13% interest rate. As an alternative to the project, you can also put the money in a savings account and earn 4% interest p.a. yearly.

	Occupancy Sensors	Central Timeclock
Capital Expenditure	17,000 EUR	4,500 EUR
Yearly savings	6,100 EUR	1,750 EUR
Project life	5 yr	5 yr
Discount rate	??%	??%

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Discount rate	??%	??%

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Using some examples: Choose the right discount rate and compute the NPV (using a spreadsheet/table) for both

Using the formula can get quite tedious. It is easier to use a spreadsheet to make NPV calculations. For this you will have to map the cashflows in a table, discount them, and then sum them up.

Discount Rate	0.20

Year	Yearly Cashflow	PV of discounted cashflows
0	-17000	-17000.00
1	6100	5083.33
2	6100	4236.11
3	6100	3530.09
4	6100	2941.74
5	6100	2451.45
Total		**1242.73**

Discount Rate	0.20

Year	Yearly Cashflow	PV of discounted cashflows
0	-17000	=E5/(1+$E$2)^$D5
1	6100	5083.33
2	6100	4236.11
3	6100	3530.09
4	6100	2941.74
5	6100	2451.45
Total		**1242.73**

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Using some examples: Using Excel for the IRR

Calculating the IRR is very simple on Excel if you have already mapped your cashflows

Discount Rate	0.20	
Year	**Yearly Cashflow**	**PV of discounted cashflows**
0	-17000	-17000.00
1	6100	5083.33
2	6100	4236.11
3	6100	3530.09
4	6100	2941.74
5	6100	2451.45
Total		**1242.73**
IRR	=IRR(E5:E10)	

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Using some examples: Compute the NPV using Excel

	Occupancy Sensors	Central Time clock
Capital Expenditure	17,000 EUR	4,500 EUR
Yearly savings	6,100 EUR	1,750 EUR
Project life	5 yr	5 yr
Discount rate	20%	20%
IRR	?	?
NPV	?	?

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Using some examples: Compute the NPV using Excel

	Occupancy Sensors	Central Time clock
Capital Expenditure	17,000 EUR	4,500 EUR
Yearly savings	6,100 EUR	1,750 EUR
Project life	5 yr	5 yr
Discount rate	20%	20%
IRR	23%	27%
NPV	1242.73	733.57

Choose the project with the higher NPV, even if it has a lower IRR!

But this calculations were made using very simple assumptions…

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Adding costs to your NPV calculation: Maintenance costs

The Occupancy Sensors will require battery replacements on Yr 2 costing 800 EUR and cleaning on Yr 3 costing 300 EUR
While the Time Clock will require yearly maintenance that costs 2% of the Capital Expenditure.

Update the table!

	Occupancy Sensors	Central Time clock
Capital Expenditure	17,000 EUR	4,500 EUR
Yearly savings	6,100 EUR	1,750 EUR
Project life	5 yr	5 yr
Discount rate	20%	20%
IRR	??%	??
NPV	??	??

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Update the table!

	Occupancy Sensors	Central Time clock
Capital Expenditure	17,000 EUR	4,500 EUR
Yearly savings	6,100 EUR	1,750 EUR
Project life	5 yr	5 yr
Discount rate	20%	20%
IRR	??%	??
NPV	??	??

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Adding costs to your NPV calculation: Maintenance costs

You can easily do this by adding the costs while paying attention to the correct years!

Discount Rate	0.20

Year	Savings	Maintenance Costs	Yearly Cashflow	PV of discounted cashflows
0	-17000		-17000.00	-17000.00
1	6100		6100.00	5083.33
2	6100	-800.00	5300.00	3680.56
3	6100	-300.00	5800.00	3356.48
4	6100		6100.00	2941.74
5	6100		6100.00	2451.45
Total				**513.57**
IRR			21%	

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Adding costs to your NPV calculation: Inflation

What about inflation?

To include inflation in your calculations, you need to use a nominal discount rate. This means you have to modify your existing discount rate.

Nominal discount rate = (1 + real discount rate) * (1 + inflation rate) – 1

What happens to the prior estimates if you include inflation at 1.5%?

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EFIX ENERGY FINANCING MIX

Adding costs to your NPV calculation: Inflation

Real Discount Rate	0.20	Inflation Rate		0.015
Nominal Discount Rate	0.218			

Year	Savings	Maintenance Costs	Yearly Cashflow	PV of discounted cashflows
0	-17000		-17000.00	-17000.00
1	6100		6100.00	5008.21
2	6100	-800.00	5300.00	3572.57
3	6100	-300.00	5800.00	3209.86
4	6100		6100.00	2771.66
5	6100		6100.00	2275.59
Total				**-162.10**

The NPV is now negative!!

The point of these examples is to show how leaving out assumptions can lead to a misleading NPV

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The right discount rate

The discount rate can also change which option you should prioritize. It is important to be very careful.

Project A will pay 20,000 euros after 5 years (all at once). Find the NPVs assuming different discount rates.

	10%	15%	20%
A			

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Using this case study from the EBRD: The right discount rate

At a discount rate of 10% you should accept Project A, but at a discount rate of 20% you should not

	10%	15%	20%
A	EUR 3,418	EUR 944	EUR -962

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NPV Formula on Microsoft Excel

You can use the NPV formula on excel, but you need to be careful. Remember to subtract the initial cost!!

=NPV(discount_rate , cashflow yr1 : cashflow yr n) – cashflow yr 0

		10%	15%
Yr1	0	=NPV(0.1, $B$9:$B$13)-9000	
Yr2	0		
Yr3	0		
Yr4	0		
Yr5	20000		

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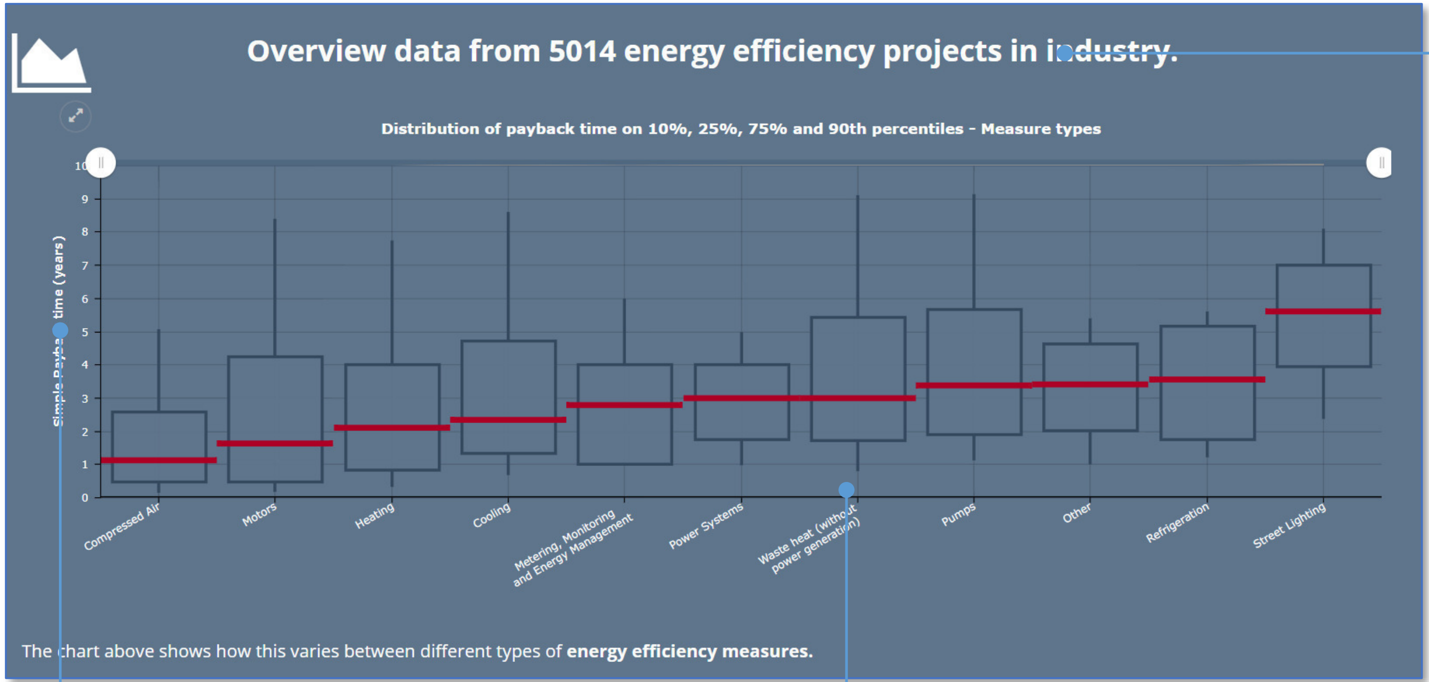
The DEEP ("De-risk Energy Efficiency Platform") allows to benchmark EE projects



- Contains data from 5014 EE projects in **industry** and 5152 EE projects in **building** *(as of 10/2018)*

- Allows to statistically analyse EE projects by **payback period** and **avoidance cost**

- **Segments** projects into HVAC, lighting, building fabric, integrated renovation (for **buildings**) and compressed air, motors, heating, cooling, energy management, power systems, waste heat, pumps, refrigeration, street lighting (for **industry**)

Also offers a tool specifically for benchmarking own energy efficiency projects *(https://deep.eefig.eu/benchmark/)*

SOURCES: https://deep.eefig.eu

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6A

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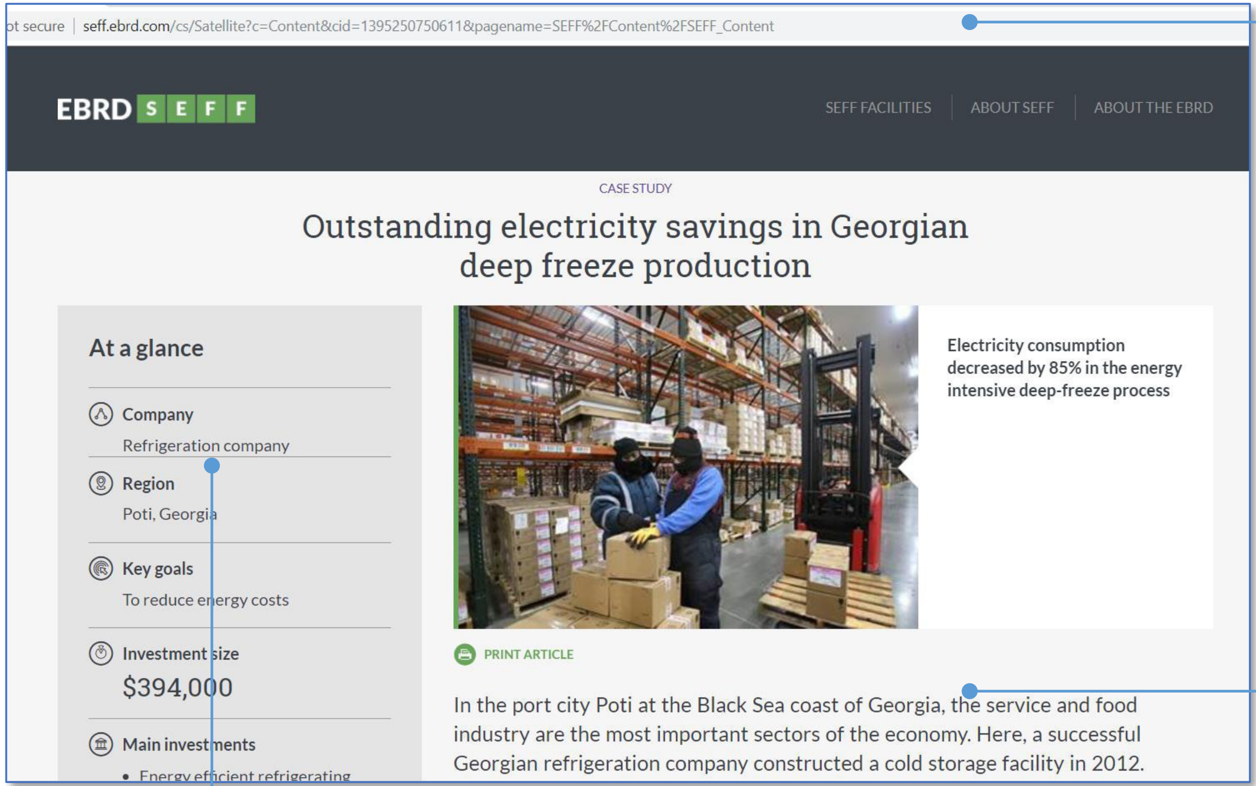
For most project partner countries, EBRD shows criteria of real projects



- Contains data **from project in all major EBRD project countries** (e.g. Georgia, Armenia, Croatia)
- Provides short project summaries outlining **how they were financed** (including credit lines etc.)
- Lists for each project **important evaluation criteria** (e.g., payback period, energy savings, cost savings, emission reductions, investment size)

SOURCES: https://seff.ebrd.com

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6A

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Example benchmarks for EE improvement projects

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Measure	Typical energy savings [%]	Typical payback time [years]
• Automatic lighting controls	20-50	2-10
• Task lighting	30-70	4-8
• Time controls on office equipment	20-60	0.5-3
• High-efficiency motors	3-6	0.5-3
• High-efficiency boilers	5-7	2-3
• Building energy management system	5-10	3-6
• External insulation	10-20	25-35
• High-efficiency refrigeration	~85	4
• Energy-efficient production equipment (textiles)	~72	6

SOURCES: www.energy-efficiency.gov.uk; www.seff.ebrd.com

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