Federal Ministry
for Economic Cooperation
and Development

Investment Grade Calculation, Forecasting & Analysis of ESCo-Projects

Manual for Excel-Calculation-Tool

Published by

Deutsche Gesellschaft
für Internationale
Zusammenarbeit (GIZ) GmbH

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Contents

1 Introduction

The present guideline gives further information on the Excel-Tool for Investment Grade, Calculation, Forecasting and Analysis of ESCo-Projects. It is used during the training workshops on the tool given by GIZ and Energetic Solutions. Hence, the targets are the participants of these workshops, which can use the manual as a reference work. This manual is not to be considered as a standalone document. To be able to fully understand the usage and functionality of the tool, participation in the workshops is crucial. The reader shall be reminded that it is prohibited to spread the calculation tool. Usage is only allowed within the own company.

Every description is composed of three subsections. Firstly, in *Goals and Functionalities* the purpose of each sheet is discussed briefly. Then an overview over the *Input and Output* Data is given. For more complex sheets the section *Further Comments and Explanations* discusses inputs and outputs which are not self-explanatory and explains some of the calculations' principles. Every other page *Space for Own Notes* is given, where participants can take own notes during the workshop.

1.1 General Information and operating guidelines

1. The password to open the tool is "GIZ".
2. Cells for entering required data are marked in yellow. Optional cells are in bright green. Some of the optional cells contain standard input values. If you want to change but keep the standard value, it is possible to multiply the entire formula by 0 and add the new value. Every spreadsheet contains some unlocked cells for own calculations, marked in green at the bottom of the page.
3. All remaining cells are locked.
4. Comments are given in blue fonts.
5. The structure of each sheet allows data input at the top, followed by a display of the calculated output data. In the output area, some cells allow a modification of the calculated data. These cells have a bright green background color. The consecutive composition of input and output areas facilitates the verification of the input data and the computed results.
6. It is recommended to enter the formulas used for own calculations in the cells (use cells as your calculator instead of separate calculations) or in a comment. This increases the traceability of the calculation.
7. All calculations have to be either performed with or without taxes.
8. It is recommended to perform calculations without taxes since they are raised based on the success of the whole company and not just single projects.
9. Unless further noted, start dates always correspond to the first day of the month, end dates to the last day. E.g. for a project that runs from 01/2015 to 12/2017 the exact dates are 01/01/2015 to 12/31/2017.
10. The purpose of the tool is to calculate and analyze the economic characteristics of an Energy Supply or Energy Performance Project. The technical feasibility is not validated. It is the user's responsibility to check whether the project's components are able to fulfill the requirements.

1.2. Disclaimer

Neither the developers of the tool nor the trainers at the workshop assume liability for the correctness of the calculations. It is in the responsibility of the user to cross check the results before actually implementing an energy contracting project. The user is strongly advised to constantly confirm plausibility of the inputs and outputs.

Usage is only permitted within the own company. Hence, it is not allowed to share the tool or the present manual.

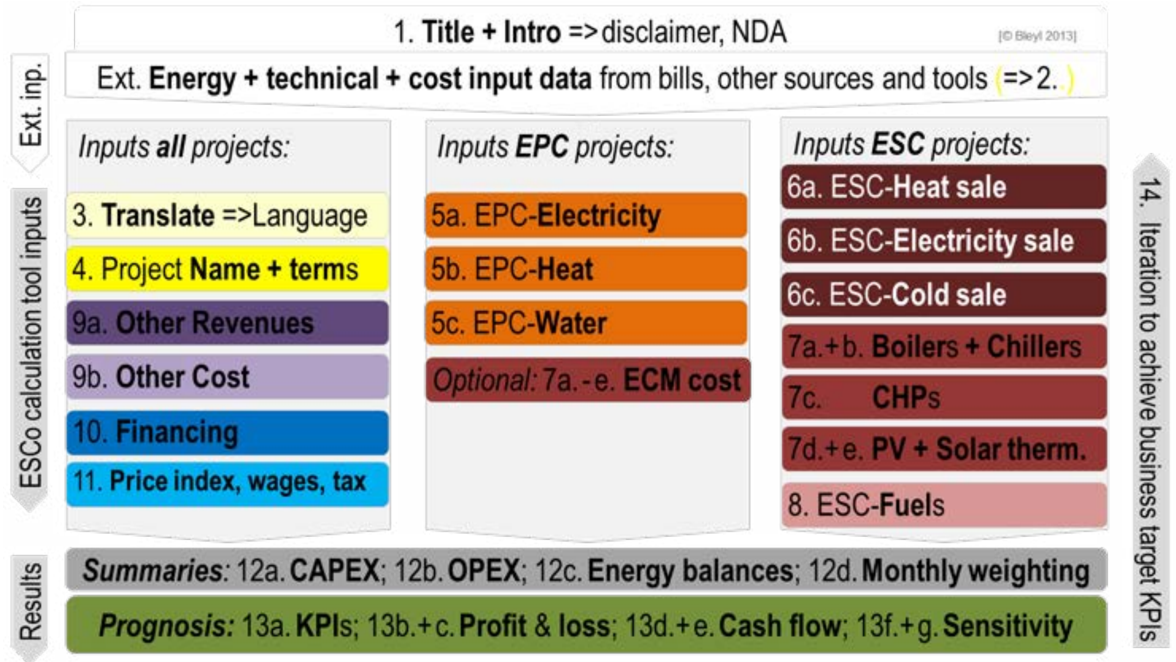
1.3. Further information

Basic knowledge of the conceivable business models of ESCo as well as the foundations of investment budgeting are prerequisites for the application of the calculation tool. If you have no experience in the assessment of investments, it is recommended to read some articles on Investopedia (http://www.investopedia.com/). To get a basic understanding of ESCos read the guideline Assessing Framework Conditions for Energy Service Companies, published by GIZ.

2 Description of the Spreadsheets

The Excel-Calculation-Tool consists of a variety of spreadsheets. For all projects it is required to enter the input data in spreadsheets 4, 9, 10 and 11. For calculating the economic data for EPC projects, further information has to be entered into spreadsheet 5. If an ESC project is calculated, spreadsheets 6, 7 and 8 have to be filled out.

After all the required data is entered, the summary and a forecast are calculated and given in sheets 12 and 13. If the calculated KPIs don't fit the target KPIs further iteration steps have to be performed.



2.1 Description of:

2a. Quickcalc

Goals and Functionalities

Simple Energy Performance Contracting projects can be calculated using this sheet. To keep it simple, input is limited to projects with only one customer. The baseline of this customer consists of the average energy price, a price for power demand and a miscellaneous cost component. For all these baseline cost components a price increase factor can be entered.

Concerning the saving measures, their reduction relating to the baseline expenses, the start date of the savings and the share of the savings disbursed to the ESCo have to be provided.

CAPEX and OPEX should reflect all costs related to the implementation of the measures. Some typically occurring cost components are given as a guideline. It is not distinguished between internal and external costs.

In general, input and calculation procedure concerning the baseline, savings and costs is equivalent to *6a. ESC-Heat sale*. For more information the reader is advised to read this chapter. The input of financing conditions is equivalent to *10. Financing*.

Input	Output
• Project name • Date of project commencement and termination • Baseline expenses for procurement of energy including a yearly price increase factor • CAPEX, OPEX and saving success of implemented measures • Miscellaneous costs and revenues • Financing conditions	• Financial key figures of the project • Cash-Flow figure including annual and cumulative cash-flow and the annual profit • Figure of debt services, the cash flow available for debt service and the debt service cover ratio

2.2 Description of:

3. Translate

Goals and Functionalities

The only functionality of this sheet is the localization of the calculation tool. In the current version supported languages are Chinese, Croatian, English, French and German. The currencies of countries, in which GIZ and energetic solutions have already conducted the workshop can be selected. Once you set up the language and currency according to your country, there is no need to open this sheet again.

Input	Output
• Language of the tool • Currency	• None

Notes:

2.3 Description of:

4. Name + term

Goals and functionalities

This sheet provides the possibility to enter project start and end dates. These will be used for further calculation and project name, which will be printed on the headline of each spreadsheet. If the project investments should be depreciated before project termination, an optional input for the last month of depreciation period can be made. Unless further noted, depreciation of each component starts at its commissioning.

Input	Output
• Project name • Project start and end date • Depreciation end date	• Project duration • Operating months in the first year

Notes:

2.4 Description of:

5a. EPC-Electricity

Goals and Functionalities

In this sheet, the user can enter the electricity cost baseline and electricity saving measures for up to ten individual customers or areas within one facility. Time series of baseline, savings and revenues are calculated and plotted in a graph to facilitate verification. Additionally, specific costs and revenues for each saved MWh are given.

Input	Output
• Names of customers or areas • All electrical energy and power related costs for each customer or area • Electricity saving measures with achieved savings and date of implementation • CAPEX and OPEX for saving measures[1] • Time series of utilization factors • Time series of ESCo revenue share	• Baseline and savings: Sums and time series • Time series for baseline electricity expenses, customer and ESCo-revenues • Time series of total electricity savings and specific costs and ESCo-revenues for saved electricity • Chart of baseline, ESCo and customer revenues and remaining expenses • Chart of specific costs and revenues • Chart of baseline and new cost structure

[1] CAPEX – capital expenditures, OPEX – operational expenditures

Further Comments and Explanation

Energy cost baseline

It is either possible to enter an average energy price and total consumption of energy or to enter high, middle and low tariffs with the respective consumption. Furthermore expenses for power demand, reactive electricity, measuring costs and lump sums can be entered.

Please mind that consumption and prices have to be related to full years. If commencement of savings or termination of the projects occurs during a year, percentages are calculated automatically.

Savings entry

For each customer up to three measures can be entered. It is possible to enter reduction percentages regarding the baseline consumption. Calculation assumes all measures act cumulatively. E.g. if measure 1 reduces the consumption by 50%, measure 2 by 10%, total reduction is 60% (red box in *Screenshot 1*). In case the price changes due to the reduced consumption, this can be entered as well. The total savings S are calculated via

$$S = \sum_{customers} \sum_{\substack{cost \\ components}} C_{old} \cdot P_{old} - C_{old} \cdot (1 - SP_1 - SP_2 - SP_3) \cdot P_{new}$$

where C_{old} is the old consumption, P the prices and SP the saving percentages.

Savings do not necessarily have to start at project commencement, e.g. due to construction phases. The date of savings commencement can be entered in a column on the far right (blue box in *Screenshot 1*).

	sum of savings	average costs for energy or high tariff for electric energy		low tariff for electric energy		commencement of savings (main service phase)	
	EUR/a	MWh/a	EUR/a	MWh/a	EUR/a		
sum of all measures	98,400.0	600.0	69,000.0	300.0	29,400.0		
measures	EUR/a	%	EUR/MWh	%	EUR/MWh	year	month
customer (or area) 1	98,400.0	60.0%	115.00	60.0%	98.00	2015	1
measure 1, e.g. lighting	-	50.0%	-	50.0%	-	-	-
measure 2, e.g. fans	-	10.0%	-	10.0%	-	-	-
measure 3, e.g. user motivation	-		-		-	-	-

Screenshot 1: Electricity savings entry (incomplete picture)

Costs for the investment and operation phases

For each measure specific investment costs (CAPEX), internal and external operation expenses (OPEX) can be entered. The top column shows the entry units. It is absolutely crucial to stick to the given units. Investment, planning & commissioning, management and external operation costs are entered in total sums. For project development, construction management, technical operations and measurement & verification the billed working hours have to be entered. Costs are calculated with the hourly wages from *11. Price Indexes*, that are also shown in the unit row.

In *Screenshot 2* the investment costs for the EPC Project: Re-Lighting are entered. The investment for the purchasing of equipment is 190,000 €. Additionally 8,500 € are needed for planning and commissioning and 80 hours of internal staff costs for project development and construction management have to be charged. Hence, the total investments including staff costs are:

$$190{,}000€ + 8{,}500€ + 50h \cdot \frac{75€}{h} + 30h \cdot \frac{75€}{h} = 204{,}500€$$

	sum of investments incl. staff cost	investment 2015	investment 2016	planning + commissioning	project development staff	construction management staff
	EUR	EUR	EUR	EUR	h	h
sum of all measures	204,500	190,000	0	8,500	50	30
measures	EUR	EUR	EUR	EUR	75 EUR/h	75 EUR/h
customer (or area) 1	204,500	190,000	0	8,500	50	30
measure 1, e.g. lighting	204,500	190,000		8,500	50	30
measure 2, e.g. fans	0					
measure 3, e.g. user motivation	0					

Screenshot 2: Input of EPC investment costs

	staff costs in operation (internal)				operating costs (external)			
	management costs in 1st year EUR/a	management costs next years EUR/a	technical operations in year 1 h/a	technical operations next years h/a	operating sum (external) EUR/a	management EUR/a	maintenance + repair EUR/a	insurance policies EUR/a
sum of all measures	0	0	10	10	2,850	0	2,850	0
measures	EUR/a	EUR/a	75 EUR/h	75 EUR/h	EUR/a	EUR/a	EUR/a	EUR/a
customer (or area) 1	0	0	10	10	2,850	0	2,850	0
measure 1, e.g. lighting			*10*	*10*	*2,850*		*2,850*	
measure 2, e.g. fans					*0*			
measure 3, e.g. user motivation					*0*			

Screenshot 3: Input of EPC operation costs. Internal M&V costs are not shown.

Concerning operation costs, internal and external costs are distinguished. Internal management costs are charged with total sums, internal costs for technical operation and M&V (not shown in *Screenshot 3*) are entered with the billed working hours. Wages can be entered in *11. Price Indexes*. In the first year of operation, the workload might be higher. Therefore it is possible to enter different operation costs in the first year of the project. Please consider that "first" and "next years" refer to the year of project start and not to the year of implementation of the measure. Furthermore it is assumed that the entered operation costs refer to a full year of operation. Fractions are calculated automatically.

External operation costs have to be entered with absolute values.

Baseline and ESCo revenue development

In the first of these two tables it is possible to enter utilization factors for all customers or areas and ESCo revenue shares. Due to changed usage the utilization can be higher or lower compared to the base year. For every year the utilization factor can be entered in percentages of the base year. The baseline time series takes into account changes in utilization factor and the price development for baseline electricity costs (*11. Price Indexes*).

For every customer and year the ESCo share of the revenue can be entered. The remains are the customers' gains. ESCo revenues are calculated according to the formula:

$$\text{ESCo revenue}_{year\ y} = \text{baseline} \times \text{utilization factor}_{year\ y} \times \text{ESCo savings share}_{year\ y}$$

Specific production costs

Specific production costs denote the ESCo's expenditures to save one MWh of electricity. It is distinguished between specific capital expenditures (CAPEX) and specific operation expenditures (OPEX). Calculation of the capital expenditures $CAPEX_{el,y}$ in year y is performed by the following formula:

$$CAPEX_{el,y} = D_{ELSM,y} - D_{S,ELSM,y}$$

where D_{ELSM} is the depreciation of electricity saving measures in year y and $D_{S,ELSM}$ is the depreciation of the subsidies and construction grants disbursed for electricity saving measures. The specific CAPEX is the quotient between the $CAPEX_{el,y}$ and the achieved electricity savings in MWh.

The specific OPEX is simply the quotient between the operation costs entered previously in this sheet and the achieved savings.

One condition for a profitable project is that the sum of specific CAPEX and OPEX need to be higher than the specific revenues. This can easily be verified by checking the figure containing this data.

Notes:

2.5 Description of:

5b. EPC-Heat

Goals and Functionalities

Design and calculation principles of this sheet are equivalent to *5a. EPC-Electricity*. Hence only a brief description is given here. For further information the reader is advised to read the preceding chapter. As the title suggests, in this sheet all expenses, measures and savings regarding thermal energy can be entered.

Input	Output
• Names of customers or areas • All thermal energy and power related costs for each customer or area • Heat saving measures with achieved savings and date of implementation • CAPEX and OPEX for saving measures • Time series of utilization factors • Time series of ESCo revenue share	• Baseline and savings: Sums and time series • Time series for baseline heat expenses, customer and ESCo-revenues • Time series of total heat savings and specific costs and ESCo-revenues for saved heat • Chart of baseline, ESCo and customer revenues and remaining expenses • Chart of specific costs and revenues • Chart of baseline and new cost structure

2.6 Description of:

5c. EPC-Water

Goals and Functionalities

Design and calculation principles of this sheet are equivalent to *5a. EPC-Electricity*. Hence only a brief description is given here. For further information the reader is advised to read that chapter. As the title suggests, in this sheet all expenses, measures and savings regarding water consumption can be entered.

Input	Output
• Names of customers or areas • All water related costs for each customer or area • Water measures with achieved savings and date of implementation • CAPEX and OPEX for saving measures • Time series of utilization factors • Time series of ESCo revenue share	• Baseline and savings: Sums and time series • Time series for baseline water expenses, customer and ESCo-revenues • Time series of total water savings and specific costs and ESCo-revenues for saved water • Chart of baseline, ESCo and customer revenues and remaining expenses • Chart of specific costs and revenues • Chart of baseline and new cost structure

2.7 Description of:

6a. ESC-Heat sale

Goals and Functionalities

For energy supply contracting projects this sheet provides an input possibility for the data of heat customers. It is possible to enter power load, energy consumption and the commencement and termination of supply for up to ten customers. For each customer individual prices for useful heat, hot water, service and measuring can be specified along with the corresponding price adjustment formulas.

Input	Output
• Names of customers • Power demand and heat consumption of each customer • Utilization factor time series for connected load and energy demand of each customer • Prices for service, heat and measuring • Commencement and termination of supply • Price adjustment factors	• Time series of connected load and heat sale • Time series of price development for each customer • Time series of revenues from each customer • Chart of revenue development from heat sale • Chart of specific heat generation and selling price development

Further Comments and Explanation

Heating demand

The amount of heat sold to the customers has to be entered for a full year of supply. If supply periods (e.g. in the first or last year of supply) do not concur with full years, fractions of useful heat are calculated according to the data in *12c. Energy balances*. It is assumed that the demand for hot water remains constant throughout the year, hence fractions of hot water demand are calculated according to the number of supply months. For energy and power demand time series of utilization factors can be entered. This is useful if you expect a non-constant demand of the customers.

			price adjustment percentages						
useful heat	unit	price in 2015	fixed	natural gas	biomass	electricity	district heating	add. Factor	sum
customer 1	*EUR/MWh*	*100.00*	*20%*	*70%*	*0%*	*10%*	*0%*	*0%*	*100%*
customer 2	*EUR/MWh*	*95.00*	*10%*	*80%*	*0%*	*0%*	*0%*	*10%*	*100%*
customer 3	*EUR/MWh*		*0%*	*70%*	*0%*	*10%*	*0%*	*0%*	*80%*

Screenshot 4: Useful heat price and price adjustment entry

Price and price adjustment entry

In the first input column you can enter the service price and energy prices for useful heat and hot water in the year of project commencement. For each customer specific price adjustment factors can be entered to reflect the price increases. Prices in future years are calculated according to the following formula:

$$P_y = P_{start} \cdot (PAP_{fixed} + \sum_{i = \substack{price \\ components}} PAP_i \cdot PI_i)$$

P_y is the price in year y, P_{start} the price in the year of project commencement, PAP_i are the price adjustment percentages and PI_i the price indexes from sheet *11. Price Indexes*.

Consequently the sum of the price adjustment percentages has to be 100%. If it is not, the sum cell will be marked red.

These price adjustment factors are used to reflect the price variations of the single cost components. It is common to enter factors that reflect the cost structure well. E.g. if 70% of the generation costs are caused by purchasing natural gas, this adjustment factor should be set to 70%. If this is done, price increase of natural gas won't influence the project's profitability.

In standard settings the two fuels used in boilers and CHPs are natural gas and biomass. By modifying the data in *ESC-Fuels+DH* it is possible to change them.

Specific cost and revenue development

This figure is a powerful way to gain an overview on the cost structure of the heat generation in energy supply projects. The influence of price increase, change in the amounts of sold heat and commissioning and decommissioning of equipment can easily be verified. Because the generation of heat, electricity and cold is highly interlinked, a methodology to allocate costs between these energies has to be applied. *Figure 1* explains this methodology:

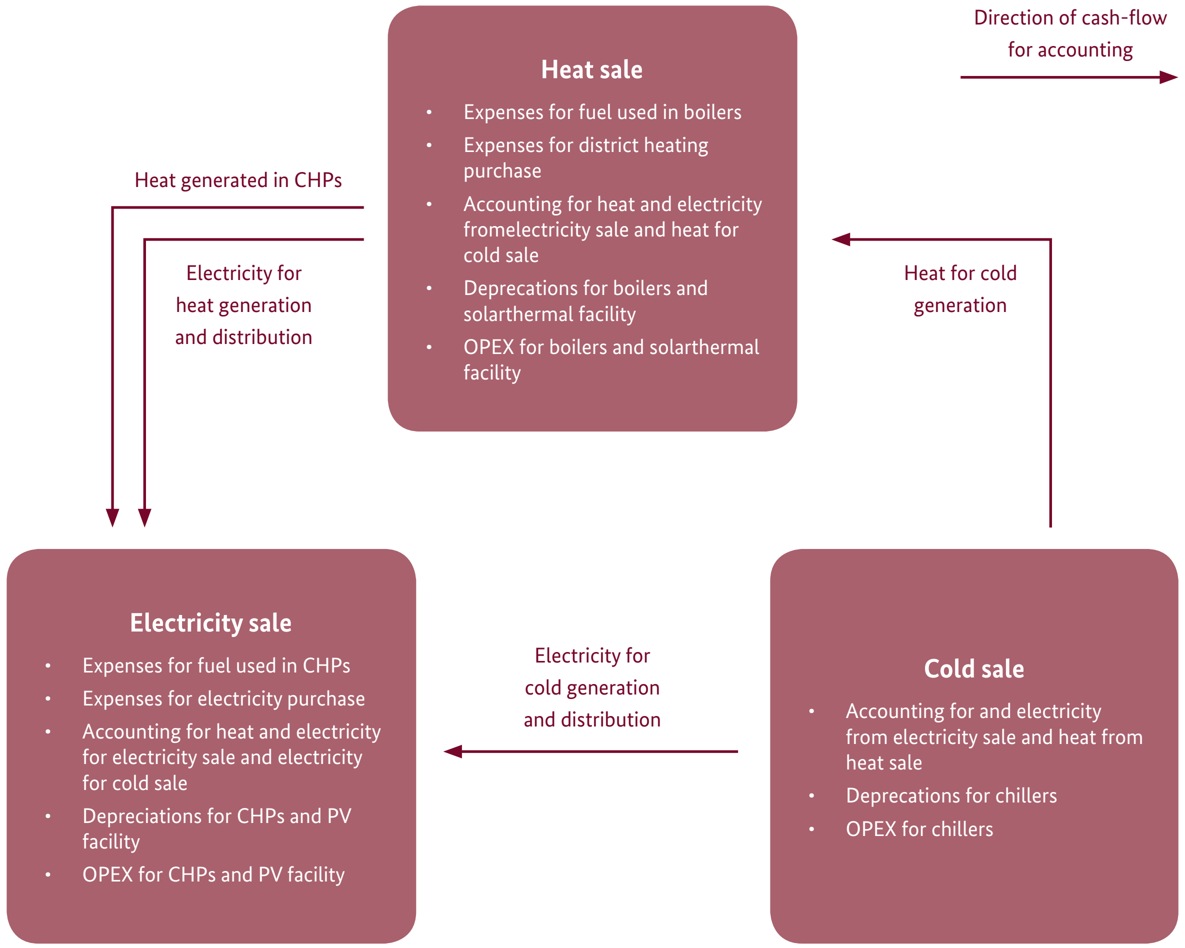


Figure 1: Allocation of costs between heat, electricity and cold sale. Electricity is accounted with the average purchasing price from the utility and heat with the average fuel costs for generation in boilers

In general, electricity generation and purchasing expenses are accounted for in *6b. ESC-Electricity sale*. To account for electricity consumption of heat generation and distribution a cash-flow from heat sale to electricity sale is assumed. The electrical MWh used for heat generation are multiplied by the average electricity purchasing prices[2] . This amount is added to the fuel costs for heat generation in *6a. ESC-Heat sale* and subtracted from the fuel costs for electricity generation in *6b. ESC-Electricity sale*.

The amount of heat generated in CHPs and sold to customers is accounted with the average fuel costs for heat generation in boilers. Equivalently to the accounting of electricity for heat generation, a cash flow is added to the fuel costs for heat generation in *6a. ESC-Heat sale* and subtracted from the fuel costs for electricity generation in *6b. ESC-Electricity sale*.

The specific fuel costs for heat generation are calculated according to the following formula

$$SFC_{HG} = \frac{FFE_{boilers} + BME_{boilers} + DHE + AC_{6b} - AC_{6c}}{HS}$$

Notes:

with SFC_{HG} the specific fuel costs for heat generation, $FFE_{boilers}$ the fossil fuel expenses for use in boilers, $BME_{boilers}$ the biomass expenses for use in boilers, *DHE* the expenses for purchasing district heating, AC_{6b} the accounting cash-flow with sheet *6b. ESC-Electricity sale*, AC_{6c} the accounting cash-flow with sheet *6c. ESC-Cold sale* and HS the MWh of heat sold to customers.

Specific CAPEX and OPEX for each year are calculated by dividing the depreciations and OPEX of boilers and the solar thermal facility with the MWh of heat sold to customers.

To compute the specific revenues, the time series of the heat sale revenue components are divided by the amount of MWh heat sold to the customers.

[2] If no electricity is purchased, the average selling prices to customers are used

2.8 Description of:

6b. ESC-Electricity sale

Goals and Functionalities

Similar to *6a. ESC-Heat sale*, this sheet has the functionality to input the data of electricity customers. Moreover feed-in tariffs for electricity generated in PV and CHP systems can be entered here. Differently from *6a. ESC-Heat sale* no price adjustment factors are entered because this approach is not common with electricity supply contracts.

Input	Output
• Names of customers • Power demand and electricity consumption of each customer • Utilization factor time series for connected load and energy demand of each customer • Energy price, capacity charge and base price per customer • Commencement and termination of supply • Feed-in tariffs for CHP and PV generation	• Time series of electricity sale and feed-in • Time series of electricity price development • Time series of electricity sale revenues • Chart of revenue development from heat sale • Chart of specific heat generation and selling price development

Further Comments and Explanation

Electricity demand

Input into the first table is similar to *6a. ESC-Heat sale*. Hence, the reader is redirected to the previous chapter for more detailed explanation. The only difference is the distinction between high and low tariff instead of useful heat and hot water.

Prices

There are no price increase formulas in this sheet. All prices are entered for the year of project start and increase according to the electricity sales price index in *11. Price Indexes*.

Some countries have a dedicated feed-in scheme for electricity generated in CHP where they distinguish between summer and winter and high and low tariffs. The tool provides a possibility to specify the shares of feed-in electricity at the specific tariffs[3]. For PV there is usually a single feed-in tariff.

	energy price		capacity charge	service price
sale to electricity customer	high tariff EUR/MWh	low tariff EUR/MWh	EUR/kW	EUR/a
customer 1	180.00	150.00	30.00	100.00
customer 2	190.00	160.00	40.00	300.00
customer 3				

		summer		winter	
CHP feed-in tariff	unit	high tariff	low tariff	high tariff	low tariff
energy price	EUR/MWh	250.00		200.00	
percentage	-	30%			70%
PV electricity feed-in					
PV electricity	EUR/MWh	150.00			

Screenshot 5: Electricity sale price entry

[3] Percentages refer to the share of electricity generated in CHPs and fed into the grid. See *12c. Energy balances* for further information.

Specific cost and revenue development

The methodology for accounting of electricity and heat generated in CHPs and PV systems that are used for heat or cold generation is explained in *6a. ESC-Heat sale* and shown in *Figure 1*. For a more detailed explanation the reader is redirected to the previous chapter.

The specific fuel costs for electricity generation are calculated according to the following formula

$$SFC_{EG} = \frac{FFE_{CHPs} + BME_{CHPs} + EE - AC_{6a} - AC_{6c}}{EG}$$

with SFC_{EG} the specific fuel costs for electricity generation, FFE_{CHPs} the fossil fuel expenses for use in CHPs, BME_{CHPs} the biomass expenses for use in CHPs, EE the expenses for purchasing of electricity from a utility, AC_{6a} the accounting cash-flow with sheet *6a. ESC-Heat sale*, AC_{6c} the accounting cash-flow with sheet *6c. ESC-Cold sale* and EG the MWh of electricity generated in CHPs and PV systems.

Specific CAPEX and OPEX for each year are calculated by dividing the depreciations and OPEX of CHPs and PV systems by the MWh of electricity generation.

To compute the specific revenues, the revenue components from electricity sale to customers are divided by the amount of MWh electricity sold to the customers. Hence the time series of specific revenues does not take the fed-in electricity into account.

Notes:

2.9 Description of:

6c. ESC-Cold sale

Goals and Functionalities

This sheet is nearly identical to *6a. ESC-Heat sale*. In comparison its usage is simpler, since there is no distinction between different kinds of cold. The reader is redirected to the two previous chapters for a detailed explanation of input and calculation procedures.

Input	Output
• Names of customers • Power demand and cold consumption of each customer • Utilization factor time series for connected load and energy demand of each customer • Prices for service, heat and measuring • Commencement and termination of supply • Price adjustment factors	• Time series of connected load and cold sale • Time series of price development for cold customers • Time series of revenues from each customer • Chart of revenue development from cold sale • Chart of specific cold generation and selling price development

Notes:

2.10 Description of:

7a. Boilers

Goals and Functionalities

The calculation is able to take up to three boilers into account. Each boiler can have a specific annual efficiency and run either on a fossil fuel or biomass. This sheet provides input possibilities for all data related to the boilers. The data is used in further sheets for calculations. Hardly any calculations are performed here.

Input	Output
• Investment expenses for all three boilers (cumulated) • Annual efficiency of heat distribution (e.g. district heating grid) • Total internal electricity demand of boilers and heat distribution system • Power, annual efficiency, type of fuel and percentage of heating demand coverage for each boiler • Commissioning and decommissioning dates for boilers II and III • Operation expenses for all boilers cumulated	• Sums of total investment, operating costs and installed capacity

Further Comments and Explanation

Input of investment costs

Investment and operation expenses are not allocated to each boiler but entered cumulated for all (up to) three boilers. For investment, planning and commissioning the total sums have to be entered. Project development and construction management is charged by entering the necessary working hours. Wages for own staff are entered in sheet *11. Price Indexes*.

Input of technical data

A boiler can either run on a fossil fuel or biomass. The selection made in this sheet determines which fuel properties (price, heating value, etc.) from sheet *8. ESC-Fuels+DH* are used for further calculation. If the project makes use of two fossil fuels, one can be defined as biomass. Therefore you need to adopt the properties (price, heating value) of the biomass fuel in *8. ESC-Fuels+DH*.

Please mind that it is crucial to always enter annual efficiencies, which is the ratio between useful energy output and the primary energy input for a whole year. Since equipment usually does not operate at full load throughout the year, the annual efficiency can vary significantly from the efficiency at design load. Hence, simply entering efficiencies at design load can lead to substantial errors.

For boilers II and III the percentage of heating demand coverage has to be entered. Boiler I automatically covers the remaining demand. A simple calculation example: Total heat demand is 1,000 MWh/a. Boiler II covers 20%, hence 200 MWh, 500 MWh are covered by a CHP. The remaining 300 MWh are covered by Boiler I (more detailed explanation in *12c. Energy balances*).

entry of investment costs and staff expenditure for activation

		unit	2015	2016	2017	sum
investment		EUR	100,000			100,000
planning		EUR	4,000			4,000
approval		EUR				0
sum of investment, planning, approval		EUR	104,000	0	0	104,000
project development	hours	h	10			10
	costs	EUR	750	0	0	750
construction management	hours	h	5			5
	costs	EUR	375	0	0	375
grand total		EUR	105,125	0	0	105,125

Screenshot 6: Input of investment costs for boilers

Input of commissioning and decommissioning dates

Since boiler I automatically covers the remaining heat demand, its commissioning and decommissioning dates comply with the dates of project commencement and termination from *4. Name+term*.

Input of operation costs

The last rows provide an input opportunity for external operating costs like rent, insurance and maintenance. Again for operation costs by internal staff, the billed working hours have to be entered. The input possibility for wages is in sheet *11. Price Indexes*. During the first three years of operation, specific working hours can be entered. This might be useful if you expect a higher workload shortly after the installation of equipment.

External operation costs are entered in absolute sums or in percentages of the investment costs. It is possible to enter specific annual price increase factors for all these expenses. The standard value is an average price increase factor from *11. Price Indexes*: 60% of the general wages increase factor and 40% of the general maintenance increase factor.

operating cost entry

internal staff costs	unit	2015	2016	2017	following years
technical operations management	h/a	15	10	10	10
	EUR/a	1,125	765	780	796
M&V + invoicing	h/a	5	5	5	5
	EUR/a	375	383	390	398

operating costs (external)	% of investment	amount EUR/a	annually increase
maintenance + repair	1.00%	1,000	
technical operations management (external)	0.5%	500	2.0%
chimney sweeper	0.0%		2.0%
rent	0.0%		2.0%
insurance	0.0%		2.0%
telephone/modem	0.0%		2.0%
misc. operating costs (external)	0.0%		2.0%

Screenshot 7: Input of operation costs for boilers

2.11 Description of:

7b. Chillers

Goals and Functionalities

Technical and financial information of equipment for cold generation can be entered in this sheet. The general structure of investment and operating costs is equivalent to *7a. Boilers*. For a more detailed explanation read that chapter. As in *7a. Boilers* the annual efficiency and electricity consumption of cold distribution can be entered.

The calculation tool is able to deal with two kinds of chillers: absorption refrigerators and compression chillers. If you wish to use more than one machine of a kind, you need to enter the average coefficient of performance (COP).

The preset value for commissioning is the first date of cold supply to a customer, for decommissioning it is the last date of cold supply. It is possible to change the standard values. But obviously the chillers have to be operational during the whole supply period. If you enter a commissioning date after supply start or a decommissioning date before supply end, an error message will be displayed in this sheet and *6c. ESC-Cold sale*.

Input	Output
• Investment expenses for all chillers (cumulated) • Annual efficiency and electricity demand of cold distribution • Power, annual efficiency (COP) and percentage of cooling demand coverage for the absorption and compression refrigerators • Operation expenses for all chillers (cumulated) • Commissioning and decommissioning dates of all chillers	• Sums of total investment, operating costs and installed capacity

Notes:

2.12 Description of:

7c. CHPs

Goals and Functionalities

Due to their total high annual efficiencies combined heat and power units are often key elements of energy supply contracting projects. The data necessary for economic assessment can be entered in this sheet. In general, the structure is similar to *7a. Boilers* and *7b. Chillers*. But since CHP units are generally more complex than boilers or chillers, more information has to be provided.

The tool is able to calculate with data of up to three individual CHPs. If you want to calculate a project with more CHPs, you can merge several devices and enter the average values. The used fuels can be, as in *7a. Boilers*, one fossil fuel and one biomass fuel.

Input	Output
• Investment expenses for all CHPs (cumulated) • Electric power, annual electric and thermal efficiencies and type of fuel • Internal electricity demand • Commissioning and decommissioning dates of each CHP • Full load hours during startup phase and undisturbed operation • Operation and maintenance expenses	• Sums of total investment, operating costs and installed capacity • Electric and thermal energy generation

Further Comments and Explanation

Technical data entry

Connected load and fuel
The electric power output is the gross electricity generation. Internal electricity demand of the CHP unit is considered in the second to last row.

For biomass and fossil fuels the same holds true as for boilers, explained in *7a. Boilers*.

Efficiencies
It is necessary to enter annual electric and thermal efficiencies. The total efficiency is the sum of electric thermal efficiencies.

Please remember to enter efficiencies based on the lower heating value (LHV) (see *8. ESC-Fuels+DH* for a more detailed explanation).

	unit	CHP I	CHP II	CHP III	sum
connected load and fuels					
electric power output	kW	30.0			30.0
fuel ("fossil" or "biomass")	-	Fossil	Fossil	Biomass	
annual efficiency					
electric (based on lower heating value)	-	30%			
thermal (based on lower heating value)	-	56%			
total (based on lower heating value)	-	86.0%	-	-	
full load hours	h/a	6,500			
full load hour development					
first operating year	-	85%	100%	100%	
second operating year	-	90%	100%	100%	
third year of operation	-	95%	100%	100%	
electricity					
electricity generation	MWh/a	195	0	0	195
heat generation	MWh/a	364	0	0	364
internal electricity demand	MWh/a	4.9	0.0	0.0	
percentage of electricity feed-in for all CHPs	%				30.0%

Screenshot 8: CHP technical data entry

Full load hours
The number in row "full load hours" represents the full load hours if no unplanned shutdowns occur. To account for technical issues during project startup, it is possible to enter the fraction of full load hours during the first three operating years. After the third year of operation 100% full load hours are assumed (6,500 in the example above).

First operating year refers to the first 12 months of operation, not the year of commissioning.

NOTE:
The actual number of full load hours usually has a huge impact on the profitability of projects that include combined heat and power equipment. During planning full load hours are often assumed to be higher than in reality. Hence, it is recommended to examine this factor in detail before the profitability of a project is calculated.

Electricity
Electricity generation *EG* is calculated via:

$$EG = FLH \cdot EPO$$

with *FLH* full load hours and *EPO* electric power output.

For further calculation the primary energy demand *PE* according to the following formula is needed:

$$PE = EG/\eta_{el}$$

with η_{el} as the electric efficiency.

According to the previous formulas the cogenerated heat CH is

$$CH = PE \cdot \eta_{th} = FLH \cdot EPO \cdot \frac{\eta_{th}}{\eta_{el}}$$

with η_{th} as the thermal efficiency.

The standard value for internal electricity demand is 2.5% of the gross electricity generation. The provided values are reduced by the same factors for project startup mentioned above.

If more electricity is produced than sold to the ESC customers it has to be fed into the grid. Also in some countries, due to feed-in-tariffs or tax exemptions, it is more beneficial to sell electricity to the grid operator or the utility and buy it back. The share of fed-in electricity can be entered in the last row. Entry possibilities for feed-in conditions are provided in *6b. ESC-Electricity sale*.

Notes:

2.13 Description of:

7d. PV

Goals and Functionalities

If a project includes the installation of a PV-system, investment and operation expenses can be entered in this sheet. The structure and calculation principles are similar to the ones of the other *7x.-sheets*.

In case commissioning or decommissioning does not occur at the beginning or end of a full year, generated electricity in the incomplete years is calculated according to the data from *12d. Monthly weightings to account for fluctuating radiation throughout the year*.

Input	Output
• Investment expenses for all PV systems (cumulated) • Operation expenses for all PV systems (cumulated) • Peak power, annual generation per kWp, internal electricity demand and feed-in share	• Annual electricity generation from PV • Sums of total investment and operating costs

Further Comments and Explanation

Technical Data

Facility output
This is the nominal power at standard test conditions (cell temperature: 25° C, radiation intensity 1.000 W/m², airmass 1.5).

Annual electricity generation/kWp
The specific energy output per kWp installed can be entered here. It is a function of system quality, location and orientation.

Separate PV electricity feed-in
In some countries, due to high feed-in tariffs, it is favorable to feed 100% of the generated energy into the public grid. If this happens, choose yes. If some electricity is sold directly to customers or used by the ESCo itself (e.g. for cold generation), choose no.

A detailed explanation of the calculation procedure is given in chapter *12c. Energy balances.*

Percentage of fed-in electricity
If you chose no in the previous row, you can enter the percentage of generated electricity that is fed into the grid.

Please note that the percentage refers to the gross production (not taking own consumption into account).

electricity generation	unit	
facility output	kWp	100.0
annual electricity generation/kWp	kWh/kWp	900
annual electricity generation	MWh/year	90
internal electricity demand	MWh/year	2
separate PV electricity feed-in?	yes/no	no
if not: percentage of fed-in PV electricity?	%	30%

Screenshot 9: Technical Data of PV-systems

2.14 Description of:

7e. Solarthermal

Goals and Functionalities

Similar to the previous sheet *7d. PV*, this sheet provides an input possibility for investment and operation costs and heat generation of a solar thermal system. Investment and operating costs entry is equivalent to all the other *7-sheets* and input of the technical data should be self-explanatory.

Input	Output
• Investment expenses for all solar thermal systems (cumulated) • Operation expenses for all PV solar thermal (cumulated) • Absorbent surface, specific yield, internal electricity demand	• Annual heat generation in solar thermal equipment • Sums of total investment and operating costs

Notes:

2.15 Description of:

8. ESC-Fuels+DH

Goals and Functionalities

This sheet serves as a possibility to enter purchasing fuel prices and other expenses for procurement of energy and raw materials. If an EPC-project is calculated, it is not necessary to enter any data because only costs for procured energy from a utility are reflected here.

Input	Output
• Energy prices, capacity charges and service prices for one fossil and one biogenic fuel purchased • High and low energy tariffs, capacity charges and service prices of purchased electricity and district heating • Expenses for miscellaneous operating and raw materials	• Time series for all costs related to the procurement of energy • Figures for the absolute and specific price development of purchased energy

Notes:

Further Comments and Explanation

Fossil fuel data and cost entry

In the first table data for purchasing conditions of the fossil fuel can be entered.

Higher and lower heating values
Usually the utility will charge a customer for fuels with reference to the higher heating value (HHV). But efficiencies for boilers and CHPs often refer to the lower heating value (LHV). The data input into the calculation tool must follow this convention. Hence, a conversion factor between lower and higher heating values is needed. Please remember that the difference not only depends on the type of fuel but also on location, quality and mixture (e.g. the term natural gas refers to a gaseous mixture of methane with minor parts of ethane. The conversion factor depends on the mixture ratio). Using standard values is likely to cause errors in the calculation. Your energy supplier should be able to provide you the conversion factor.

Energy prices for boilers and CHP
In some countries, it is common that different prices exist depending on the usage of the fuel. E.g. on fuels used to fire CHPs might be a discount because the load throughout the year is more constant than for fuels used for heat generation. Therefore the calculation tool provides the possibility to enter two different energy prices and capacity charges for the energy carriers.

Capacity charge
Even though you enter the loads for boilers, CHPs, etc. in sheets 7a. to 7e., it is necessary to enter the values for the total connection load in this sheet because these values don't necessarily have to match.

fossil fuel data and cost entry

fuel *natural gas*

conversion factor HHV/LHV *1.108*

	energy price	capacity charge		measurement / service price
intended purpose	EUR/MWh (HHV)	kW	EUR/kW	EUR/a
natural gas for boilers	60.00	30	50.00	80.0
natural gas for CHPs	58.00	10	45.00	80.0

Screenshot 10: Fossil fuel purchasing conditions input

Biomass data and cost entry
In this table data of the biomass fuel can be entered equivalently to the previous table. If the equipment uses two different kinds of fossil fuels, it is possible to enter the data of the second one here and select the corresponding ones in sheets *7a. Boilers* and *7c. CHPs*. E.g. a CHP system might run with natural gas and a peak load boiler running on heating oil is installed for backup purposes. In this case it would be favorable to “define” the heating oil as biomass fuel.

Electricity cost entry
In addition to the input of purchasing conditions for fossil fuel and biomass, the table for electricity costs provides a possibility to enter high and low energy tariffs. Simply enter the share of electricity purchased at high tariff, the remaining demand is purchased at low tariff. In the time series below, the computed average energy price is given.

District heating cost entry
In this sheet you can enter the conditions for purchasing energy from a district heating network. This might be the case if the location is connected to a district heating network and own boilers/CHP do not generate sufficient heat. The percentage of remaining heat demand coverage refers to the gap between heat sale to customers and generation in CHPs, boiler II and III. See *12c. Energy balances* for a detailed explanation.

Notes:

2.16 Description of:

9a. Other revenues

Goals and Functionalities

Here the user can enter revenues that don’t fit into any of the previous categories. One example would be revenues that are created by the sale of components at the end of the project or from CO_2 certificates.

Input	Output
• Designation of revenues • Revenue time series	• None

Notes:

2.17 Description of:

9b. Other costs

Goals and Functionalities

This sheet provides an input possibility for costs that occur by purchasing or operation of components not mentioned before. For example the financial data of a heat distribution grid can be entered here. Also the user can enter a time series of miscellaneous costs. An example would be recapitalizations during the project term or major, infrequent inspections not covered by the OPEX of the previous sheets.

The design of this sheet is similar to the sheets *7a.-7e.*, hence the reader is directed to these chapters for further information.

Input	Output
• Investment expenditures of miscellaneous equipment • Operation expenditures of miscellaneous equipment • Commissioning and Decommissioning of miscellaneous equipment • Time series of miscellaneous costs	• Sums of total investment and operating costs for other equipment

Notes:

2.18 Description of:

10. Financing

Goals and Functionalities

Information about loans, subsidies and equity can be entered in this sheet. It calculates the debt service cash flow and the composite interest rate which is needed for calculating the projects net present value in *13d. Cash-Flow*. Borrowed capital can be entered as two mortgages with fixed repayment rate and declining interests and one annuity loan. Interest rates are fixed.

Input	Output
• Subsidies for the respective investments • Shares' interest rates and repayment conditions of the loans • Equity interest rate • Composite interest rate (optional)	• Debt service cash flow • Composite interest rate • Figure with debt service cash flow, cash flow available for debt service (CFADS) and debt service cover ratio (DSCR)

Notes:

Further Comments and Explanation

Investment and subsidies

The total investment sum is adopted from previous calculations. The user has to enter the absolute amounts of subsidies paid in the first three years for the particular measures. Please consider that guaranteed feed-in tariffs are not treated as a subsidy in this sheet. They have to be entered in *6b. ESC-Electricity sale*.

Loans

Borrowed capital
The first two loans have fixed repayments and declining interests. Fixed-rate mortgages can be entered in the annuity loan row.

Financing share
In this column the share, the loan contributes to the sum of investment, planning and commissioning has to be entered. Please mind that banks usually don't disburse credits for financing of planning and commissioning costs.

Disagio
It is the percentage of the loan, which is not paid out. E.g. in the example above the disagio is 1% of 100,000 €. Hence, the bank only disburses 99,000 €. 1,000 € are kept as a fee.

Number of yearly repayments
Since repayments are calculated to be made at the end of whole months, possible values are 1, 2, 3, 4, 6 and 12.

Date of borrowing
The loan is paid out at the first day of the month. Standard value is the month of project commencement.

borrowed capital		financing share	annual interest rate	disagio	effective interest rate	repayments per year	date of borrowing *year*	*month*
loan I	*100,000*	*50.0%*	*5.0%*	*1.20%*	*5.38%*	*4*	*2015*	*1*
loan II	*0*			*0.00%*	*0.00%*	*4*	*2015*	*1*
annuity loan	*30,000*	*15.0%*	*8.0%*	*0.00%*	*8.30%*	*12*	*2015*	*1*
loan sum	130,000	65.0%						

borrowed capital	first payment *year*	*month*	last payment *year*	*month*	duration *months*	number of repayments	rate of payment *EUR*
loan I	*2016*	*3*	*2023*	*6*	*102*	*30*	*3,333*
loan II	*2015*	*3*	*2023*	*6*	*102*	*34*	*0*
annuity loan	*2015*	*1*	*2015*	*12*	*12*	*12*	*2,610*

Screenshot 11: Loan condition entry

First payment
Between the date of borrowing and the first payment the loan is deferred. During that period only interests have to be paid. Because the payment of the interests is due in the same intervals as the actual repayment, not all values can be entered. Repayments are executed at the last day of the repayment period.

Example: Repayment of loan 1 is on a quarterly basis. Because the date of borrowing is the 01/01/15 repayment can start only at the ends of months 3, 6, 9 or 12. In the given example, the first repayment is made on 03/31/16; hence, the last "interest-only-payment" is due on 12/31/15.

Standard value is the end of the first repayment period (as in the annuity loan above).

Notes:

Last payment
The date of the last payment of the loan. Equivalent to first payment not all months are valid inputs.

Repayment cash flow is calculated, to have zero debt at the last day of the last payments' month.

Standard value is the closest possible repayment month (see first payment above) to project termination.

2.19 Description of:

11. Price Indexes

Goals and functionalities

Project lifetimes in energy contracting can be long. To reflect changes in wages, fuel prices, feed-in tariffs, etc. in this sheet price indexes can be entered.

Input	Output
• Increase factors and relative price levels for: » General wages » Operation and maintenance costs » Energy purchasing and selling prices » Wages for own staff • Absolute prices for wages of own staff	• Time series of price indexes and absolute prices

Further Comments and Explanations

The price index is automatically set to 100 in the year of project commencement. If you enter an increase factor, the price index will increase yearly by that factor. Additionally for the wages of own staff it is essential to enter the absolute values in the year of project commencement[4] .

If you expect a non-linear yearly increase (e.g. increase in wages by 5% every 3 years), you can edit the time series of the price indexes directly.

All projects

General wages and maintenance
These price increase factors reflect the general inflation rate in the area of project operation. They influence external operation costs like technical operations management or external maintenance costs.

Wages of own staff
Absolute values and price increase in these rows are used to calculate the expenses for own staff during project development, construction and operation. It is necessary to enter the value of the base year and a price increase factor/index time series.

[4] All further prices in the year of project commencement can be entered in the respective calculation sheets (e.g. fuel purchasing prices in *8. ESC-Fuels+DH*)

Energy Performance Projects

Baseline Performance Contracting
The price indexes from these rows are used to calculate the price development of energy performance contracting. Hence, they influence the baseline calculation, the savings for the customer and the revenues of the ESCo. They don't have any influence energy purchasing or selling prices of ESC projects.

Energy Savings Projects

Fossil and biomass fuels, district heating
For the fossil and biomass fuel and for district heating supply two price increase factors exist. The first one influences the energy price (MWh), the second one all remaining price components like the capacity charge (kW) and measuring or base prices.

These factors only influence the purchasing prices directly. Selling prices of heat, cold or electricity might be influenced indirectly via the price adjustment percentages. See *6a. ESC-Heat sale* for a more detailed explanation on price adjustment percentages.

Electricity

Notes:

Concerning electricity in ESC projects, four price indexes exist. The purchasing index influences all price components (energy, capacity and base price) of electricity purchasing by the ESCo. The selling price index influences the prices at which electricity is sold to the customers. Usually electricity selling prices in contracting projects are tied to nationwide electricity price indexes. Hence, the price development time series of purchasing and selling prices are likely to be identical.

In some countries specific feed-in tariffs for electricity generated in CHPs or PV-systems exist. The actual feed-in tariffs can be defined in *6b. ESC-Electricity sale*. Here, only the price index referring to the absolute prices are entered.

Additional price adjustment factors
If the cost structure of heat and cold selling prices or CHP maintenance requirements cannot be represented by the already existing price adjustment factors, it is possible to use these additional price adjustment factors. See *6a. ESC-Heat sale* for a more detailed explanation on price adjustment factors.

2.20 Description of:

12a. CAPEX summary

Goals and Functionalities

Depreciation of investments and internally produced assets has an important influence on the calculation of profits and losses. Hence, this sheet calculates the time series of linear depreciation. Furthermore costs for loans and equity are calculated.

Input	Output
• None	• Monthly depreciation rates • Time series of depreciation • Borrowed capital and equity costs

Further Comments and Explanation

Investments and monthly depreciation rates

Within this calculation tool, investments can only be made during the first three years of project operation.

All project investments and capitalized internally produced assets are summarized in the first table. In the next step, these investments are used to calculate monthly depreciation rates. The monthly depreciation rate in one column refers to the investment made in this specific year. For calculating the total depreciation in one given year the monthly depreciation rates up to that year are summed up and multiplied by the depreciation months[5] of that year. E.g. the total depreciation in 2018 is:

$$\text{depreciation}_{2018} = \text{depreciation months}_{2018} * (\text{rate}_{2015} + \text{rate}_{2016} + \text{rate}_{2017})$$

measures	commissioning year	commissioning month	sum of depreciation months	sum of investment, planning, approval 2015	2016	2017	sum	monthly depreciation rate for investment, planning + approval 2015	2016	2017
			months	EUR	EUR	EUR	EUR	EUR	EUR	EUR
electricity saving measures	2016	2	89	8,500	190,000	0	198,500	0	2,230	0
heat use saving measures	2015	1	102	101,000	0	0	101,000	990	0	0
water saving measures	2015	1	102	0	0	0	0	0	0	0
heat generation from boiler	2015	1	102	0	0	0	0	0	0	0

measures	capitalized internally produced assets 2015	2016	2017	sum	monthly depreciation rate for internally produced and capitalized assests 2015	2016	2017
	EUR	EUR	EUR	EUR	EUR	EUR	EUR
electricity saving measures	5,700	0	0	5,700	0	89	0
heat use saving measures	3,400	0	0	3,400	33	0	0
water saving measures	0	0	0	0	0	0	0
heat generation from boiler	0	0	0	0	0	0	0

Screenshot 12: Investment and monthly depreciation rates. Depreciation starts at commissioning and ends at project termination in 06/2023

Depreciation period

Standard value for the end of depreciation is the project termination. If the total investments shall be depreciated before project termination, *4. Name+term* provides an opportunity to enter the end of depreciation of all investments. Nevertheless, if decommissioning of equipment (e.g. a CHP device) happens before the global end of depreciation, the period will be shortened.

Notes:

[5] Calculated in the following table (not explained in this guideline)

Measure/Equipment	Start of depreciation	End of depreciation (whichever comes first)
Electricity saving measures	Implementation of measures at first customer	• Project termination • End of depreciation
Heat use saving measures	Implementation of measures at first customer	• Project termination • End of depreciation
Water saving measures	Implementation of measures at first customer	• Project termination • End of depreciation
Heat generation from boiler	Project start	• Project termination
CHP	Commissioning of first CHP	• Project termination • End of depreciation • Decommissioning of first CHP
PV facility	Commissioning	• Project termination • End of depreciation • Decommissioning
Solar thermal facility	Commissioning	• Project termination • End of depreciation • Decommissioning
Cooling generation	Commissioning	• Project termination • End of depreciation • Decommissioning
Misc. facility	Commissioning	• Project termination • End of depreciation • Decommissioning

2.21 Description of:

12b. OPEX summary

Goals and Functionalities

This sheet acts as a summary for operation expenses. The majority of the sheet should be self-explanatory since data from previous sheets is simply collected and adopted to reflect price increase from sheet *11. Price Indexes.* An exception is made for maintenance and repair. Usually maintenance expenses rise during the operation period due to wear. To account for that, during the first third of operation only 50% of the annual expenses are billed. This increases to 100% in the second third and 150% in the last third. If annual maintenance costs are 1,000 € with no price increase and the total operation period is 6 years, the time series for maintenance expenses is:

Year	1	2	3	4	5	6
Maintenance expenses	500 €	500 €	1,000€	1,000 €	1,500 €	1,500 €

Input	Output
• None	• Time series of operation expenses for all measures/equipment » Internal staff » Technical operations management » Measurement and verification » Misc. operating costs

2.22 Description of:

12c. Energy balances

Goals and Functionalities

The calculation tool consists of several input sheets for energy sales, generation, own usage and purchasing data. *12c. Energy balances* is used by the tool to summarize all this data inputs, to calculate energy balances for each energy carrier and determine the amount of heat/electricity purchased from a utility.

Input	Output
• None	• Time series of energy (heat, cold, electricity) sold to customers • Time series of energy generation by sources • Time series of primary energy carrier purchases

Notes:

Further Comments and Explanation

Electricity balances

This table calculates the electricity purchased from the utility. Calculation procedure is as shown in Figure 2. The total electricity demand is the sum of electricity sale and internal demand of the equipment. From this demand, the not fed-in share of electricity generation in CHP-units and PV-systems is subtracted. If this value is negative (CHP or PV produce more electricity than needed), it is assumed that the excess electricity is sold to the utility at purchasing conditions. This is comparable to a net-metering scheme.

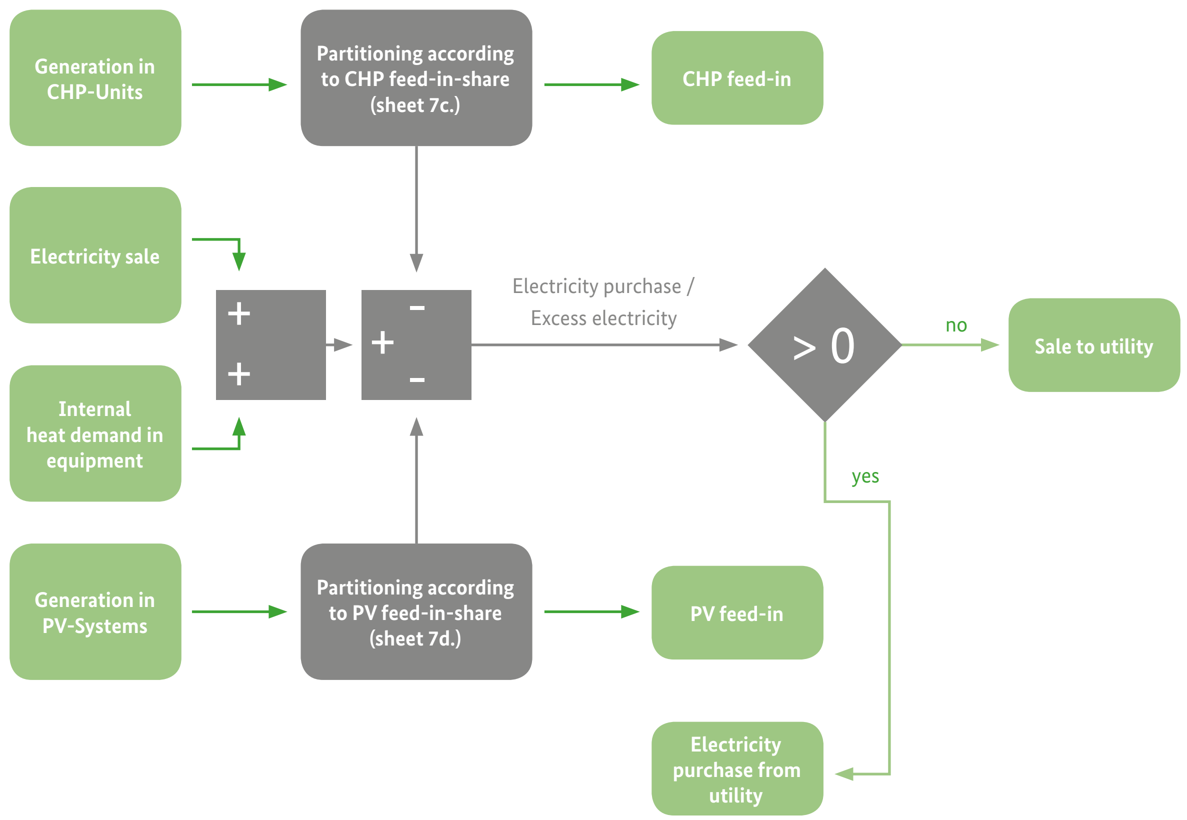


Figure 2: Explanation of electricity balance calculation

Heating balances

In table *Heating balances* the load for boiler 1 or the waste heat to environment is calculated. Figure 3 explains the calculation scheme. Total heat demand is the sum of heat sale to customers, heat demand for absorption refrigerators and distribution losses. From total demand, heat generated in boilers II & III, CHPs I to III and the solar thermal system is subtracted. The remaining heat demand can be covered partly or entirely by district heating supply. The percentage of remaining heat demand coverage by district heating is entered in *8. ESC-Fuels+DH*. The part not covered by district heating is automatically generated in boiler I.

If CHPs, boilers II & III and the solar thermal system generate more heat than needed, the excess heat is wasted in a heat exchanger and given off to the environment. This might be the case if CHPs are run electricity regulated and there are not sufficient heat customers.

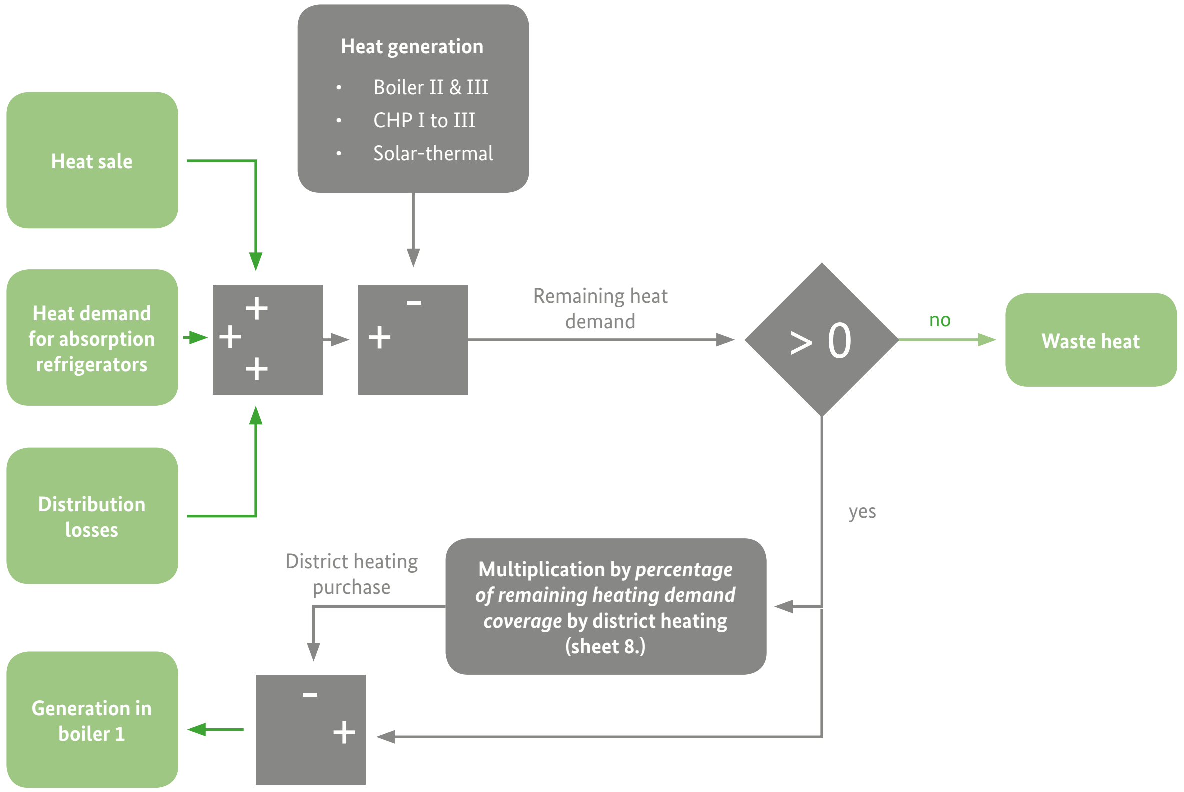


Figure 3: Explanation of heat balance calculation

Cooling balances

Compared to the electricity and heating balances, calculation of cooling balances is much simpler. Figure 4 explains the procedure. The total cooling demand is the sum of sales and distribution losses. The coverage share between compression and absorption chillers is set in *7b. Chillers*.

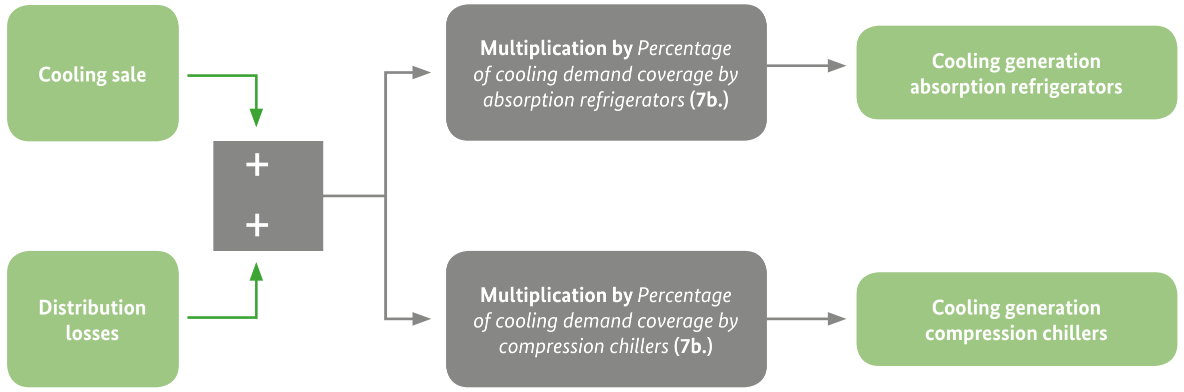


Figure 4: Explanation of cooling balance calculation

Notes:

2.23 Description of:

12d. Monthly weightings

Goals and Functionalities

Heating and cooling as well as solar radiation is usually not constant throughout the year. If the supply period for individual customers or the operation period of solar systems does not concur with full years, this sheet provides an input possibility for the monthly distribution.

To facilitate the verification of input data, a figure is given. It shows the share of demand/radiation in each month.

Input	Output
• Heating degree days per month • Heating demand per month • Solar radiation per month • Cooling degree days per month	• Yearly distribution of demand/radiation • Cumulative percentages of demand/radiation • Figure of yearly distribution

Notes:

Further Comments and Explanation

Weighting of heating/cooling demand

One can distinguish three usage types of heating and cooling supply:

1. Heating/cooling supply is mainly used for room climatization. In this case heating/cooling degree days are an appropriate measure for describing the fluctuation of demand throughout the year.

2. If the project is used for supplying process heat/cold, the demand is more or less constant throughout the year.

3. A mixture of the first two cases. A base load of process heat/cold demand is overlapped by fluctuating demand for room climatization.

To ensure a correct weighting in the latter two cases, it is possible to enter the heating/cooling demand percentage per month directly. For the first case, simply enter the heating/cooling degree days.

Please note that this weighting only matters in the first or last year of supply. During full years, the amounts entered in *6a. ESC-Heat sale* and *6c. ESC-Cold sale* are sold and heating/cooling degree days are not taken into account.

Weighting of solar radiation

Similar to the weighting of heating/cooling demand is the weighting of solar radiation implemented. The user has to enter the horizontally irradiated energy per square meter for each month, which is a function of the location. This information is used for the calculation of produced energy in the year of commissioning and decommissioning of PV or solar thermal systems. Once again, during full years of operation the data entered has no implications.

Notes:

2.24 Description of:

13a. Key figures

Goals and Functionalities

This sheet gives a summary of the income statement and the cash-flow time series. Besides that, key figures of the project are presented. Examples are the return on investment, net present values and the loan life cover ratio.

Input	Output
• None	• Summary of income statement and cash-flow time series • Key figures from income statement (e.g. profit-turnover ratio) • Key figures from cash-flow (e.g. net present value)

Further Comments and Explanation

Key figures from cash flow

The calculation procedure of the key figures from cash flow is explained in detail in the chapter *13d. Cash-Flow*.

Key figures from income statement

From the data in *13b. P&L* the profit-turnover ratio and the return on investment are calculated:

The profit-turnover ratio is calculated by the following formula:

Profit-turnover-ratio = (revenues-expenditures) / revenues

In *13b. P&L* the values are given for each year of project operation. Here only the value for the whole project and an annual average are presented. Please mind that these two values are identical.

To obtain the return on investment, the following formula has to be applied:

Return on investment =
(earning + interests on borrowed capital) / total investment

Since the base for calculation of the annual average and the absolute value for the project is the total investment the two values are not identical.

2.25 Description of:

13b. P&L

Goals and Functionalities

In *13b. P&L* information on expenditures and revenues from previous sheets are collected and evaluated. It shows time series of investments, revenues, expenditures, the yearly result and key figures.

The yearly result before taxes is solely the difference between revenues and expenditures. Revenues and expenditures in each year are the sums of the data mentioned in the table input and output data above.

If the user wishes to take taxes into account, it is possible to enter tax rates and calculate the tax amounts here. Since the tax base is usually a whole company and no single investments, tax calculation in the present tool is provisionary. In standard settings corporate and commercial taxes are not taken into account.

Input	Output
• Optionally: » Corporate and commercial tax rates	• Time series of investments • Time series of revenues, consisting of: » Sales revenues from savings » Sales revenues from energy sales » Misc. revenues (*9a. Other revenues*) » Capitalized internally produced assets » Activated construction grants • Time series of expenditures, consisting of: » Purchasing of final energy and misc. materials » Operating costs » Misc. costs (*9b. Other costs*) » Internal staff costs » Depreciation » Interest costs • Time series of yearly results and key figures

2.26 Description of:

13d. Cash-Flow

Goals and Functionalities

Unlike *13b. P&L* this sheet is a balance where actual cash flows are accounted in their year of occurrence. For calculating the profit and losses in each year depreciations of investments act as expenditures that reduce the profit. In reality liquidity is needed when investments are being made. A positive cash flow achieved during the subsequent years is used for loan repayments and to increase the invested equity.

This sheet collects data from previous sheets and calculates two cash flows: the project cash flow and the equity cash flow. These cash flows are discounted to calculate the net present values (NPV). Furthermore the internal rate of return (IRR) of each cash flow is calculated along with payback periods.

Input	Output
• None	• Summary of investments, loan repayments, revenues and costs • Project and equity cash flow • Cash flow available for debt service • Net present values, internal rates of return, payback periods

Further Comments and Explanation

Explanation of project and equity cash flow

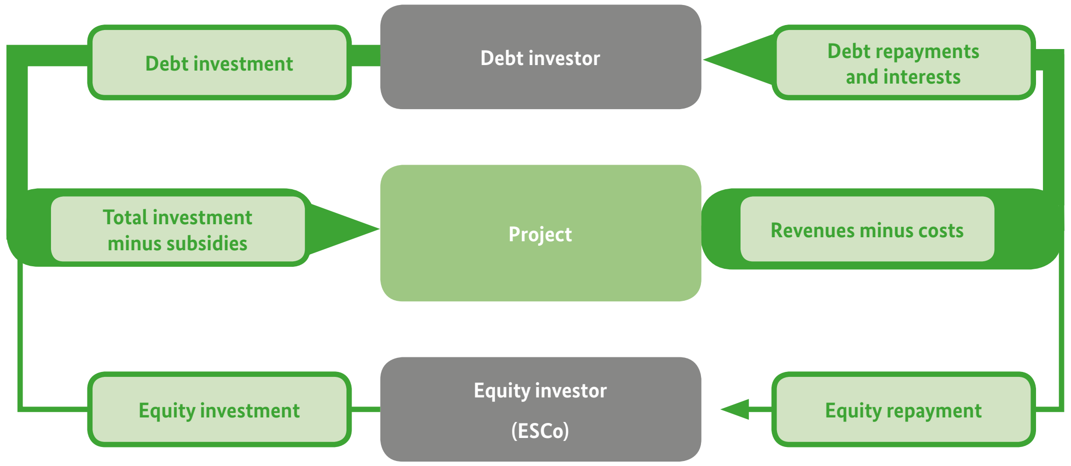


Figure 5: Cash flow scheme

Figure 5 explains the calculation scheme for the project and the equity cash flow. The big arrows entering and leaving the project box represent the project cash flow. It is calculated by the following formula:

$$PCF_y = -I_y + S_y + R_y - C_y$$

where PCF_y is the project cash flow, I_y the investments, S_y the disbursed subsidies and C_y the costs, each in year y.

Usually a project is partly financed by debt. Thus the cash flow share of the equity investor (in energy contracting projects the ESCo) is smaller than the project cash flow. In Figure 5 it is represented by the lower circle. The formula for calculation is:

$$ECF_y = PCF_y + DL_y - IDP_y$$

where ECF_y is the equity cash flow, DL_y the disbursed loans and IDP_y the interest and debt payments, each in year y. Hence:

$$ECF_y = -I_y + DL_y + S_y + R_y - C_y - IDP_y$$

Discounting of cash flows

These two cash flows can be discounted with various interest rates. According to the combination, one obtains the following net present values:

1. **Project net present value without borrowed capital**
   If a project is completely financed by equity, project and equity cash flows are identical. In Figure 5 the upper circle disappears.

   By discounting the cash flow with the equity interest rate, the net present value of a project in case of equity-only financing is obtained.

2. **Project net present value with borrowed capital**
   Typically equity interest rates are higher than debt interest rates. Therefore it is reasonable to take out a loan for financing of an investment. As indicated in Figure 5, the project cash flow remains unaltered.

   Discounting the project cash flow with the composite interest rate yields the project net present value with borrowed capital. For an assessment of the economic feasibility this is the most important indicator.

3. **Equity net present value**
   The equity cash flow can be discounted with the equity interest rate to obtain the equity net present value. It is the value added to the ESCos equity if the investment is being made.

For a positive investment decision the latter two NPVs have to be positive. In Screenshot 13 an example for such a case is given

Internal rates of return

For both cash flows the internal rates of return (IRRs) can be calculated. Besides the NPVs they are important key figures for investment decision making. One can issue the following statements:

Condition	Consequence	Feasibility
$IRR_{project}$ > Equity interest rate	Project net present value without borrowed capital positive	Feasible
$IRR_{project}$ < Equity interest rate	Project net present value without borrowed capital negative	No decision possible. Debt financing recommended
$IRR_{project}$ > Composite interest rate	Project net present value with borrowed capital positive	Feasible
$IRR_{project}$ < Composite interest rate	Project net present value with borrowed capital negative	No

The project of Screenshot 13 has a project internal rate of return lower than the equity interest rate. Consequently the project net present value without debt capital is negative (see green box). Without debt financing this project would not be feasible. If a credit of 98,000 € is raised at 4.5% interests, the weighted average cost of capital becomes 5.9%, which is lower than the projects internal rate of return. As a consequence the projects net present value becomes positive and the project profitable (see blue box). This is an example of a project that becomes profitable by raising of a credit.

		project cash-flow		equity cash-flow
		without debt capital	with debt capital	with debt capital
invested equity	EUR	140,000	42,000	42,000
invested debt capital	EUR	0	98,000	98,000
interest rate for discounting	%	9% (equity interest rate)	5.9% (WACC)	9% (equity interest rate)
net present value	EUR	-7,071	2,383	1,399
internal rate of return	%	6.6%		12.0%

Screenshot 13: Cash-Flow statement of a project that becomes feasible by raising of a borrowing

2.27 Description of:

13f. Sensitivity

Goals and Functionalities

During the planning of energy contracting projects several uncertainties arise. For example there are predictions for the development of future energy prices but no one knows how accurate they are. The price development can have a major impact on the profitability of energy contracting projects.

For a successful project development it is crucial to know which parameters have a major impact on the financial performance of a project. These parameters should be closely monitored and optimized. For example in energy performance contracting the investment costs typically have the highest impact on the profitability. Therefore optimization of investment costs is much more sensible than for example of operating costs in this case.

A powerful sensitivity analysis has to accomplish these two tasks. Firstly assess the uncertainties of future developments and secondly identify the key factors for project success.

Furthermore project planning is an iterative process. Once you calculated a project which is economically not feasible, you can use the sensitivity analysis to determine target figures (e.g. for investment costs, electricity selling prices, etc.) to make it profitable. These target figures can be used as inputs for the next iteration step.

Please mind that the sensitivity analysis just varies one factor at a time and does not take interdependencies into account. This can lead to numbers, which are not actually achievable. If for example the heat sales volume is increased, the technical parameters of the boilers and CHPs are kept constant. An increase of sales volume by 30% might lead to a situation where – in reality – the boilers and CHPs cannot ensure sufficient heat supply.

Calculation of the sensitivity analysis data tables is quite complex and computing power intensive. Thus in standard settings automatic recalculation is disabled. Once you made changes in the input data and want to recalculate the data tables you have to press the F9 key on your keyboard (On Mac: cmd + =).

It is possible to change the standard settings by clicking on *File – Options – Formula* and changing the parameter *Workbook calculation*. For using the calculation tool it is recommended to choose *Automatic except for data tables*.

Input	Output
• Variation interval • Selection of data for figures	• Variation of the absolute values • Net present values and internal rate of returns when key factors of the project are varied • Figures of the results of the sensitivity analysis (selection of data for figures possible)

Further Comments and Explanation

The not-varied factor is always 100%. Within the columns left and right of 100%, you can see the financial indicators, with a decreased or increased factor. E.g. if the total investment entered in the previous sheets is 140,000€, the column 90% shows you the NPV and IRR the project would achieve, if the investment was only 126,000€. You can change the bandwidth of variation by modifying the interval cell. 15% will give you 55% to 145%. The absolute values of the factors of purchasing or selling prices and amounts refer to the yearly average during the whole project. For some factors the calculation of absolute values is not feasible, e.g. it is not possible to calculate an average selling price because thermal and electrical MWh would have to be mixed.

If you put an x into the columns *figure 1* or *figure 2*, the data will appear in the respective figure below the tables. In the figures horizontal lines indicate the NPV and IRR, if no variations occur. In the IRR figures, also the equity interest rate and the weighted average cost of capital are shown as horizontal lines.

Some factors have subfactors, you can access them by clicking at the plus on their left. For example in the data table selling prices all selling prices are changed by the same factor. The row electricity selling prices indicates the effect of changed prices for electricity while the prices for heat and cold stay constant.

The following table shows what is actually varied within the calculations and what would be cause for such a variation in reality. Subfactors are not listed since the calculation procedure and the reasons for a change are identical to their superior factors.

interval 5% Automatic calculation disabled! For recalculation press 'F9' (Mac: cmd + =)

sensitivity analysis - general factors

	figure 1	figure 2	unit	change per 5 % interval	change in comparison to the initial value and influences on IRR and NPV				
investment costs (CAPEX)	x	x	EUR	7,000	126,000	133,000	140,000	147,000	154,000
change in comparison to the initial value			%	5%	90%	95%	100%	105%	110%
internal rate of return project cash flow			%	-1.9%	14.1%	11.9%	10.0%	8.2%	6.6%
net present value project cash flow without debt capital			EUR	-7,000	30,996	23,996	16,996	9,996	2,996
net present value equity cash flow			EUR	-6,393	28,633	22,240	15,846	9,453	3,059
subsidies/construct cost grants	x		EUR	1,050	18,900	19,950	21,000	22,050	23,100
change in comparison to the initial value			%	5%	90%	95%	100%	105%	110%
internal rate of return project cash flow			%	0.3%	9.5%	9.7%	10.0%	10.2%	10.5%
net present value project cash flow without debt capital			EUR	992	15,013	16,004	16,996	17,987	18,979
net present value equity cash flow			EUR	963	13,920	14,883	15,846	16,809	17,773

Screenshot 14: Sensitivity analysis of EPC-Lighting example

Name	What is varied	Actual representation (examples)
Investment costs	All investments from sheets *5.*, *6.* and *9b.*including planning and commissioning, excluding internally produced assets.	• Use of higher quality equipment↑ • More cost efficient construction↓
Subsidies/ construction grants	Construction grants from sheet *10.* Feed-in tariffs are kept constant.	• Higher grants paid by the government or another institution↑
Interest on borrowed capital	The interest rates on loans in sheet *10.* Equity interest rate is kept constant.	• Better financing conditions from banks↓ • More collaterals provided by ESCo↓ • Higher investment risk↑
Operating Costs	All operation costs of ESC equipment and EPC measures (technical operations management, measurement and verification, maintenance, etc.).	• Higher maintenance costs due to increased wear↑ • More efficient management↓
Project duration	Project termination in sheet *4*.	• Shorter contracting period – EPC-customer pays contracting rate for a shorter time↓ • Longer supply period – more time for depreciation of equipment↑
Saving revenues	The revenues generated by EPC projects.	• Higher baseline energy prices – 130% represents an increase of energy prices by 30% during the whole project (see blue line in Figure 6)↑ • Higher utilization factor↑ • Lower ESCo-revenue share↓
Price increase factor baseline	Price increase factors for the calculation of the baseline sum of EPC projects. If the baseline increase factor is set to 2%, the values in column 115% represent the results with an increase factor of 2.3%.	• More dynamic energy price increase than expected↑

Name	What is varied	Actual representation (examples)
Selling prices	The selling prices in ESC projects. Comparable to saving revenues, 130% represents selling prices that are constantly 30% higher than the ones entered in sheets *6* throughout the project. Service, power, energy and measuring prices are varied simultaneously by the same factor.	• Lower selling prices by ESCo↓
Sales volume	The amounts of energy sold to the customers. Please mind that the generation infrastructure will not be changed. Energy generation by source will be changed according to the figures in chapter *12c*.	• More customers↑ • Decreased consumption of the customers due to implementation of efficiency measures↓
Purchasing prices final energy carriers	Absolute purchasing prices of final energy carriers are varied. This does not influence the price increase during the project (see blue line in Figure 6).	• Lower purchasing prices for ESCo due to better delivery contracts↓
Price increase factor energy carriers	This varies only the increase factor of purchasing prices of ESC projects. EPC projects are not influenced (see green line in Figure 6). Via price adjustment factors (see sheets *6*) selling prices can also be influenced indirectly.	• More dynamic energy price increase than expected↑

Figure 6 explains the difference between variation of the price increase factor and the energy price. In the not varied case, energy prices rise by 5% per year. The green line shows the price index development if the price increase factor is 30% higher (5% -> 6.5%). If the absolute values of prices are increased by 30%, the light green line is derived. Its inclination is identical to the not varied price.

Comparison of energy price variation

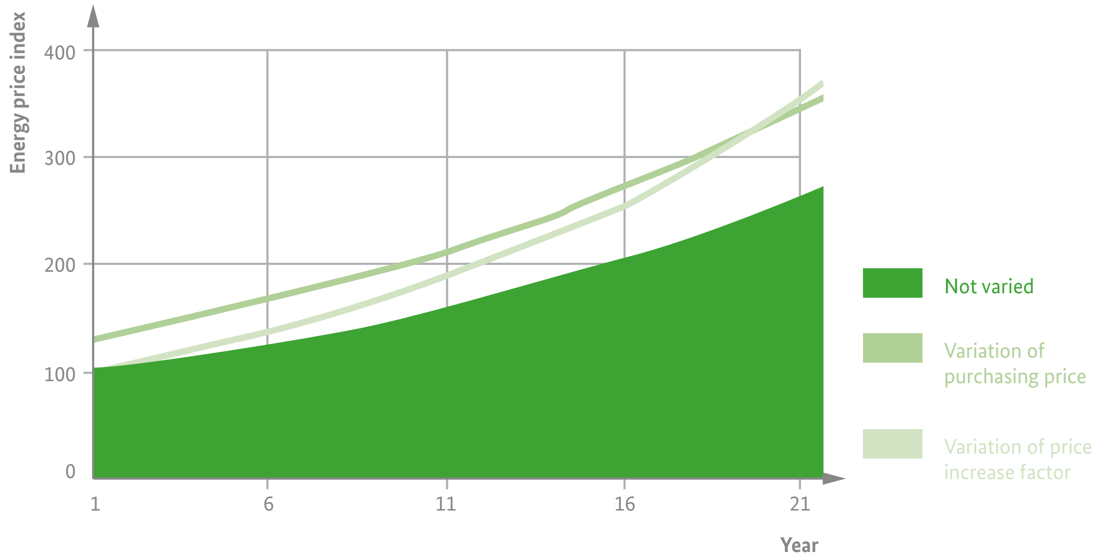


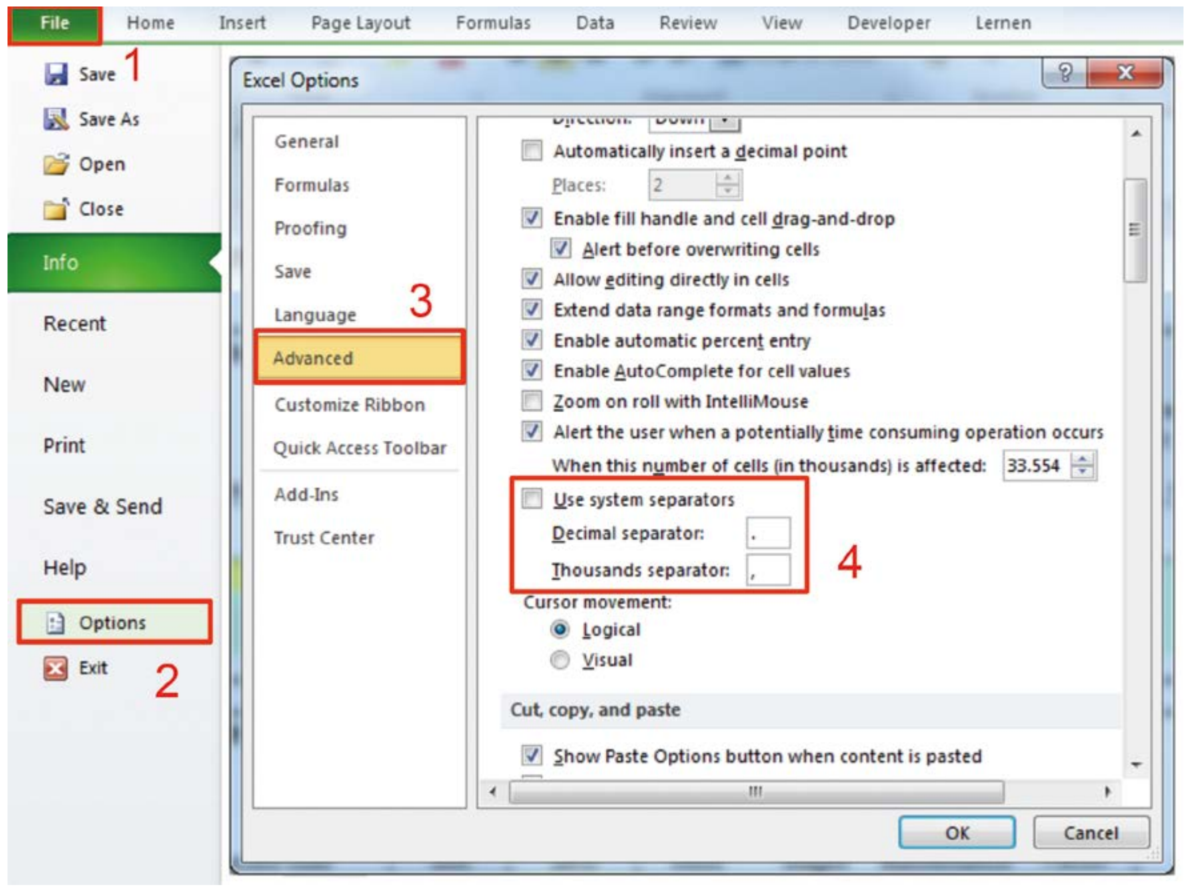
Figure 6: Explanation of variation factors. Price increase 5% p.a., variation +30%

Notes:

3 Excel Know-How

3.1 Change decimal and thousands separator

Usually Excel adopts the system settings for decimal and thousands separator. If you want to change the separator standards (e.g. , instead of . for thousands separator), choose *File* (1 in Screenshot 15) – *Options* (2) – *Advanced* (3). In this menu unselect the checkbox *Use system separators* and enter your desired separators in the respective fields.

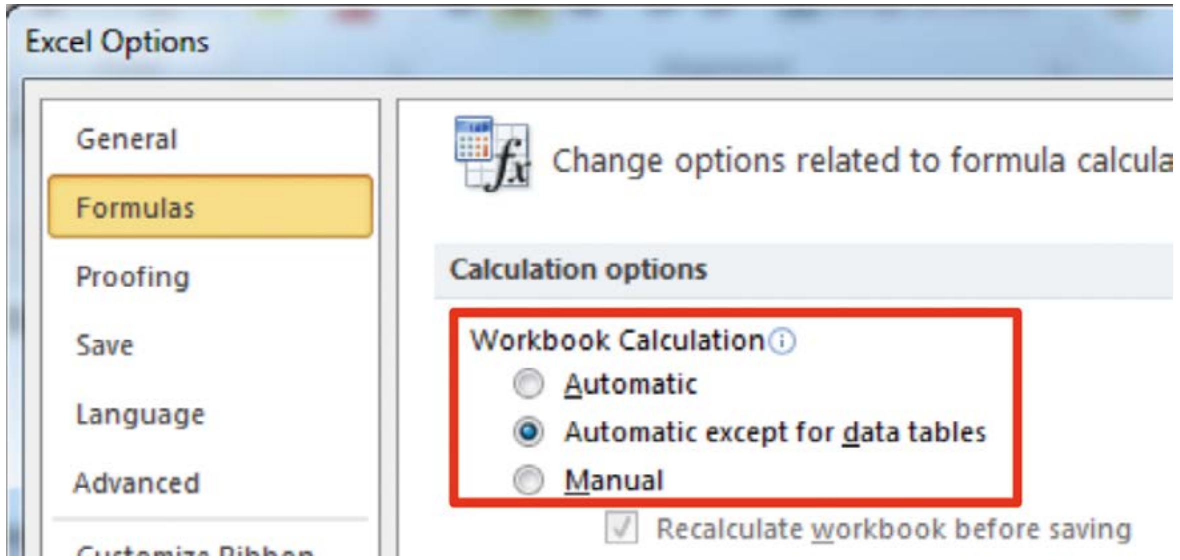


Screenshot 15: Changing of the separator settings in Excel 2010

3.2 Change the workbook calculation settings

The calculation tool contains a powerful sensitivity analysis[6], which makes extensive use of the data table functionality. However, this slows calculations down, if data tables are recalculated after every modification of the input parameters. To avoid this, automatic calculation of data tables should be disabled.

If you changed the settings and calculation performance becomes poor, you can reset by accessing *File – Options – Formulas*. In that window, select the option *Automatic except for data tables* (red box in Screenshot 16). If this option is selected, data tables are calculated by pressing F9 (*cmd* + = on Mac).



Screenshot 16: Change calculation settings for data tables

[6] See *13f. Sensitivity* for explanation

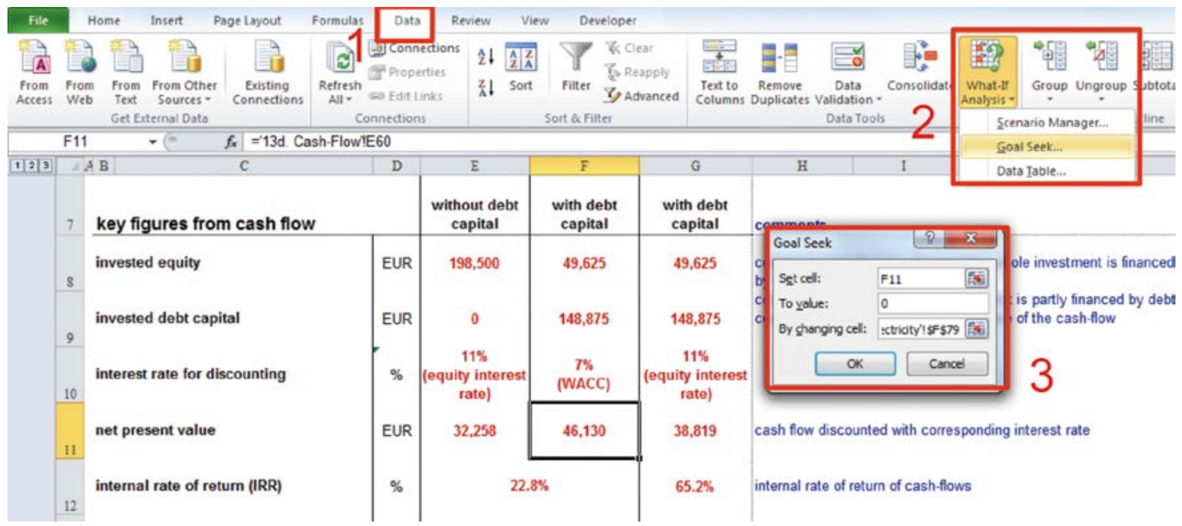
3.3 Goal Seek

The built-in Excel-functionality Goal Seek can be a powerful tool for determining critical values. As an example consider an EPC-project where the most critical value for project success is the investment costs. By using the goal seek function you can easily determine the investment costs that must not be exceeded, to keep the project profitable without using the trial-and-error technique.

To access goal seek, select the ribbon Data (1 in Screenshot 17) and choose *What-If Analysis – Goal Seek* (2). In the *Goal Seek* window (3), you can enter the necessary inputs for performing the analysis. Excel will change the cell selected in *By changing cell* in such a way that the cell selected in *Set cell* will have the value entered in To *value*.

If you want to determine the critical investment costs that must not be exceeded, you need to calculate the value that will turn the NPV of the project cash flow with debt capital to zero (see explanation in *13d. Cash-Flow*). To perform this calculation with Goal Seek, you need to select the NPV-cell in *Set cell* and enter 0 into *To value*. Now select the cell where you enter the investment costs in *By changing cell* and press OK. Excel should start iterating and find a value that will cause the desired target value. In the EPC Project: Re-Lighting example project, the critical investment costs are 242,870 € (instead of 190,000 € before goal seek) if the other parameters stay unaltered and construction costs will still be 20% of the investment.

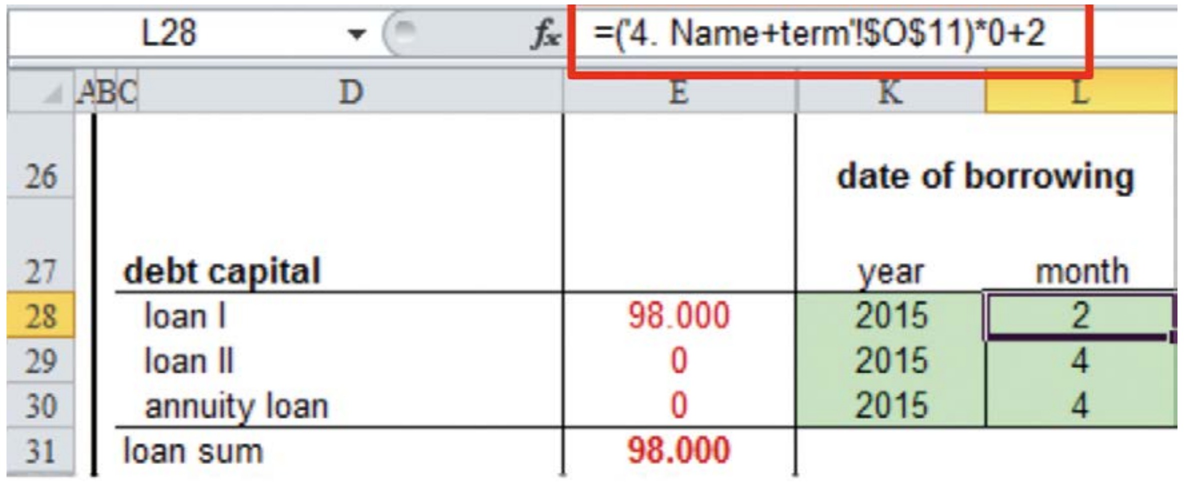
Please mind that the cell Excel shall change cannot contain a formula. It is necessary to enter an absolute value. For more information on Goal Seek watch this tutorial video: http://www.youtube.com/watch?v=G-pzq41GJWE



Screenshot 17: Access of the goal seek function

3.4 Keeping the standard values

Some cells contain standard values or predefined formulas that can be modified. If you want to keep the original values you can embrace them, multiply by zero and add the value you want to enter. See Screenshot 18 for an example.



L28 =('4. Name+term'!O11)*0+2

	D	E	K	L
26			date of borrowing	
27	debt capital		year	month
28	loan I	98.000	2015	2
29	loan II	0	2015	4
30	annuity loan	0	2015	4
31	loan sum	98.000		

Screenshot 18: Example on how to overwrite the standard value without deleting it

Notes:

4 Example Projects

To practice the usage of the tool an EPC and an ESC project can be calculated. Necessary input data and the calculated key figures can be found in the project descriptions below. A complete description of the input procedure to calculate the example projects is not given. It is recommended to save and keep the examples calculated during the training course for further references.

4.1 EPC Project: Re-Lighting

In an industrial production site metal halide lamps are replaced by modern, more efficient LED fixtures. The project is implemented by an energy service company. Calculate the key economic parameters of the project.

Project Outline

Schedule	Start: 01/2015; contract term: 4,5 years, construction: 1 month
Light before	348 x 500 W metal halide fixtures
ECM measure	Replace by 500 x 100 W LED fixtures
Operating hours	5,400 hours/year (flat rate, except first year: 4,500 h)

Electricity and operating cost, price increase and wages

Energy	High tariff: 115 EUR/MWh (35%), Low tariff: 85EUR/MWh
Power	28,50 EUR/MWh
O&M	Annually 1,5% of investment(external) + 10 h/a personal(in-house)
Price increase	Electricity: 2,5% per year, others: 2% per year
Wages	For all internal staff: 75 EUR/h in base year

Investment, financing and revenue sharing

Investment	380 EUR/fixture + 8,500 EUR for planning + 80 h in-house
Subsidies	20% of investment (without planning) in second year
Equity share	25% of investment including planning at 11% interest
Borrowed capital	5,5 % interest, 4 repayments per year
Savings share ESCo	year 1: 100%, year 2: 90%, year 3 et sq.: 80%

Project key figures

key figures from cash flow		project cash-flow: without borrowed capital	project cash-flow: with borrowed capital	equity cash-flow: with borrowed capital
invested equity	EUR	198,500	49,625	49,625
invested borrowed capital	EUR	0	148,875	148,875
interest rate for discount	-	11% (equity interest rate)	7% (composite interest rate)	11% (equity interest rate)
net present value	EUR	32,258	46,130	38,819
internal rate of return (IRR)	-	22.8%		65.2%
payback period (incl. subsidies, dynamic)	years	3.1		1.8
payback period (incl. subsidies, static)	years	3.1		0.8
Loan Life Cover Ratio	-	-	1.38	-

cash flow		total over project duration	annual averages
cumulative project cash-flow	EUR	75,333	16,741
cumulative equity cash-flow	EUR	55,886	12,419

revenues and expenditure from income statement		total over project duration	annual averages
investments	EUR	198,500	-
revenues	EUR	302,447	67,210
expenditure	EUR	246,561	54,791
earnings (EBT) (before taxes, accounting)	EUR	55,886	12,419

key figures from P&L		total over project	annual averages
profit-turnover ratio (before taxes, static)	-	18.5%	18.5%
return on investment (ROI) (before taxes, static)	-	36.8%	8.2%

Screenshot 19: Key figures from example EPC project: Re-Lighting

4.2 ESC Project: Agricultural ESC

In this project a tomato grower and a flower wholesale shall be supplied with heat and electricity. Before implementation of the measures, electricity supply is directed from the utility and heat supply is ensured by an old 3 MW heating oil boiler. Both, electricity and heat supply will be taken over by an Energy Service Company. To increase the energy efficiency a micro-CHP and a modern condensing boiler – both running on natural gas – will be installed. The old heating oil boiler will be kept as a backup for demand peaks.

Before installment of the new equipment, the tomato grower buys bottles of liquid CO_2 to stimulate tomato growth. Since the exhaust gases of the new equipment are almost pure CO_2 and steam, they can be used to increase the CO_2-concentration within the greenhouses. Even though this generates an additional benefit to the customer because no CO_2-bottles have to be purchased, it is not considered in the calculation.

The task is to determine prices that will ensure a profitable project.

General information

Project start	April 2015
Project end	July 2023
Construction period	3 months
Price increase	Generally: 2% Except: natural gas and heating oil: 3%

- All calculations are performed without taxes
- Price adjustment factors should be determined to reflect the cost structure

Customers

	Tomato Grower	Flower wholesale
Thermal power	1,100 kW	630 kW
Thermal energy	1,713 MWh	1,127 MWh
Electric energy	60 MWh	137 MWh
Thermal and electric energy purchasing prices	To be determined	

Equipment

	Micro CHP	Condensing Boiler	Old heating oil boiler
Power	30 kW_{el} and 56 kW_{th}	460 kW_{th}	3 MW_{th}
Annual efficiency	Electric: 31%, Thermal: 58%	95% for boiler, 98% for heat distribution	80 %
Internal electricity demand	3% of electricity generation	0,5% of thermal energy generation	0,5% of thermal energy generation
Full load hours / Heating demand coverage	5.500 h	70 %	Remaining heating demand
Investment including planning	90,000 €	50,000 €	/
Subsidies	15% of investments disbursed in second year of operation		/
Maintenance	1,5 ct./kWh	2% of investments	/

Financing

	Equity	Debt
Percentage of investment	30 %	70 %
Interests	9 %	4,5 %
Repayments per year	/	2

Fuels

These are the purchasing conditions for the ESCo at the utility and heating oil supplier.

	Gas	Heating Oil	Electricity
Energy price	58 €/MWh	78 €/MWh	234 €/MWh
Base price	160 €/year	/	84€/year
Higher to lower heating value (HHV / LHV)	1,11	1,07	/

Project key figures

A big variety of price structure is conceivable. Hence, it is not possible to provide a “correct solution”. In the following a possible approach is presented for determining the selling prices and adjustment factors.

1. To encourage customers to purchase electricity from an ESCo, the prices need to be lower than the best available alternative. Therefore the prices for electricity supply are often tied to an electricity price index. For the calculation of the project it is assumed that customers pay 95% of the utility electricity price while the selling price increase factor is identical to the purchase price increase factor. Hence, the customers are charged 222.30 €/MWh in 2015 with a 2% annual price increase

2. For heat supply we ask for the average generation price. The base year does not consist of a full year of supply. Therefore the average price is calculated for 2016 and discounted by the average price increase to determine the heat selling price of the base year. The selling price in 2016 is calculated by using the following formula:

$$P_{2016} = \frac{EPE_{2016} - RES_{2016}}{HS_{2016}}$$

   Where *P* is the heat selling price, *EPE* the expenditures for purchasing energy carriers, *RES* the revenues from electricity sale to customers and *HS* the amount of heat sold to customers. After discounting with the price increase factor for natural gas/heating oil, the heat selling price for 2015 is calculated to be 69.95 €/MWh

3. In the next step, price adjustment factors for the heat selling price have to be determined. To keep the calculation simple, simply the cost structure for purchasing of final energy carriers from *13b. P&L* is reflected. Again, this is done for the first full year of operation. Purchasing of natural gas accounts in 2016 for 71% of final energy purchasing costs, heating oil for 24% and electricity for 5%. These factors are entered into the price adjustment percentages table in *6a. ESC-Heat sale*.

4. Now we have to determine the price adjustment factors for the service price. Again we want to keep it simple and only consider capital and maintenance costs. According to the following formula, maintenance costs account for roughly 15% in 2016

$$PAP_{maintenance} = \frac{E_{maintenance}}{E_{depreciation} - R_{misc.operational\ yields} + E_{interests} + E_{maintenance}}$$

   where $PAP_{maintenance}$ is the maintenance price adjustment percentage of the service price, E are the expenditures from sheet *13b. P&L* and $R_{misc.\ operational\ yields}$ are the revenues generated by construction grants and subsidies. Consequently the fixed price adjustment percentage for the heat service price is 85%.

5. In the last step, we have to determine a service price to make the project profitable. By using the goal seek function, we obtain 14.82 €/kW if we want to achieve a project IRR of 10%.

Please consider that the aforementioned steps are only one possibility to determine a cost structure for a profitable project. Many more are conceivable. If you enter the values from above into the calculation tool, you should obtain the key figures from Screenshot 20.

key figures from cash flow		project cash-flow		equity cash-flow
		without borrowed capital	with borrowed capital	with borrowed capital
invested equity	EUR	140,000	42,000	42,000
invested borrowed capital	EUR	0	98,000	98,000
interest rate for discount	-	9% (equity interest rate)	5,9% (WACC)	9% (equity interest rate)
net present value	EUR	3,715	16,996	15,846
internal rate of return (IRR)	-	10.0%		26.6%
payback period (incl. subsidies, dynamic)	years	5.6		3.1
payback period (incl. subsidies, static)	years	5.9		3.4
Loan Life Cover Ratio	-	-	1.38	-

cash flow		total over project duration	annual averages
cumulative project cash-flow	EUR	49,716	5,966
cumulative equity cash-flow	EUR	30,974	3,717

revenues and expenditure from income statement		total over project duration	annual averages
investments	EUR	140,000	-
revenues	EUR	2,411,079	289,329
expenditure	EUR	2,380,105	285,613
earnings (EBT) (before taxes, accounting)	EUR	30,974	3,717

key figures from P&L		total over project	annual averages
profit-turnover ratio (before taxes, static)	-	1.3%	1.3%
return on investment (ROI) (before taxes, static)	-	35.5%	4.3%

Screenshot 20: Key figures from the example ESC Project: Agricultural ESC if the proposed price structure is applied

Notes:

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