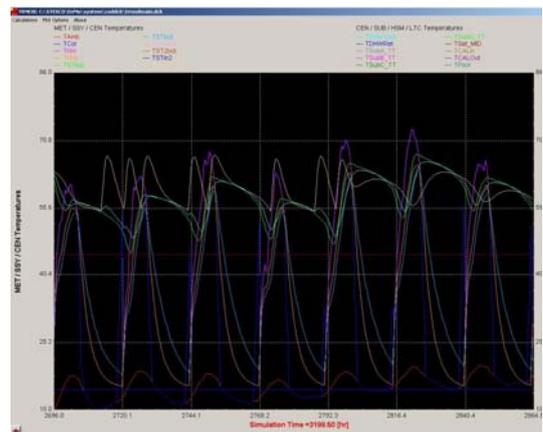


STESCO SOFTWARE TOOL

Project examples





C/ Roger de Llúria, 39 3º 2ª.
E-08009 BARCELONA

Tel.: (+34) 93 342 47 55
Fax.: (+34) 93 342 47 56

E-Mail: infoaiguasol@aiguasol.com
URL: <http://www.aiguasol.com>

STESCO SOFTWARE TOOL

Project examples

1	INTRODUCTION	4
2	ENERGY MODULE	5
3	ECONOMICAL MODULE	6
3.1	EXAMPLE 1: SIMULATED PROJECT	7
3.2	EXAMPLE 3.2: CALCULATED PROJECT	14

1 INTRODUCTION

The STESCO is a software tool developed in the framework of the ST-ESCo project, financed by the EU.

The tool it's been developed with two objectives:

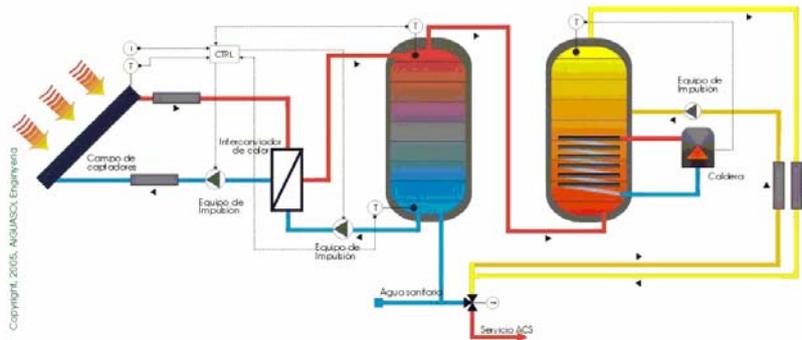
1. Develop and distribute an easy and friendly, but also precise, tool for the prediction of the energy output of solar thermal plants
2. Use the output of the previous objective to evaluate the economical viability of solar thermal projects for Energy service companies (ESCo).

So, the tool is structured in two main modules, one for the simulation of the thermal solar systems (Energy module) and another for the economical evaluation of the systems (Economical module). In the next points, both are described and some examples are given.

Both modules are available in English, Spanish, Catalan, Italian and German. This option can be selected from the "File/Language" option of the main menu of the program, and also from both modules if it hasn't been previously selected.

2 ENERGY MODULE

The first step for the evaluation of a solar thermal system in the ESCo format is a precise evaluation of the energy output of the solar system planned. To do this, a Trnsys based simulation tool is included in the software; it simulates the configuration of the image below:



To open the application, select “System simulation” from the main menu. A new window is opened with the graphical interface for the data introduction of the system; it is structured in seven tabs:

1. Main
2. Loads
3. Solar field
4. Production
5. Control
6. Simulation parameters
7. Project data

Each tab has several fields that the user has to fill with the technical information concerning its system. On the help, the user can find detailed information about each field.

Once the system and the meteorological data are defined, the user has to update the project and save it in a user created folder with the same name as the project, located at

C:\STESCO\EnMo

before running the simulation.

3 ECONOMICAL MODULE

Once the simulation is finished, the user may want to evaluate the economical benefits of the system through the economical module. This is done through the STESCO main menu, choosing from the “File/Economical analysis” option.

This will open a new dialog box; there, from the “File/New” option, the user can select his already simulated system or any other just typing the name of the project. There is also the option of introducing the energy delivered by the system if it's been calculated by any other method selecting the “Annual mean” radio button.

There are three different dialog boxes for data introduction:

1. Project data: General information about the project
2. Model input data: Data relating investment costs, operation and maintenance costs of the system, consumption and conventional energy system
3. Contract data: Billing method implemented in the contract

Once all the data are filled, the user can select from Economical module main menu the “Financial calculations option”. There, the economical balance of the project can be visualized in graphical and table form.

There is also the possibility for the user to study different billing methods and make simplified sensibility studies; just changing the economical parameters of the project and calculating, the results of this change in the economical balance can be seen immediately, since it is actualized with the changes and graphically compared to the system initially defined both for the ESCo and the final user of the plant. If a new situation more interesting is found, it can be saved and go on with the optimization, taking this new situation as the reference balance.

In the following, some examples of this process are given.

3.1 EXAMPLE 1: SIMULATED PROJECT

Previously to any economical analysis, the energy balance of the system has to be evaluated. STESCo includes a simulation tool to help in this process and also allows the introduction by the user of the data. In this example, a solar thermal system for a hotel sited in Barcelona will be followed. We will make the following assumptions:

- The hotel as an occupation near to full all the year
- The daily and monthly profile are known



The screenshot shows two input sections for water load profiles:

Monthly Profile

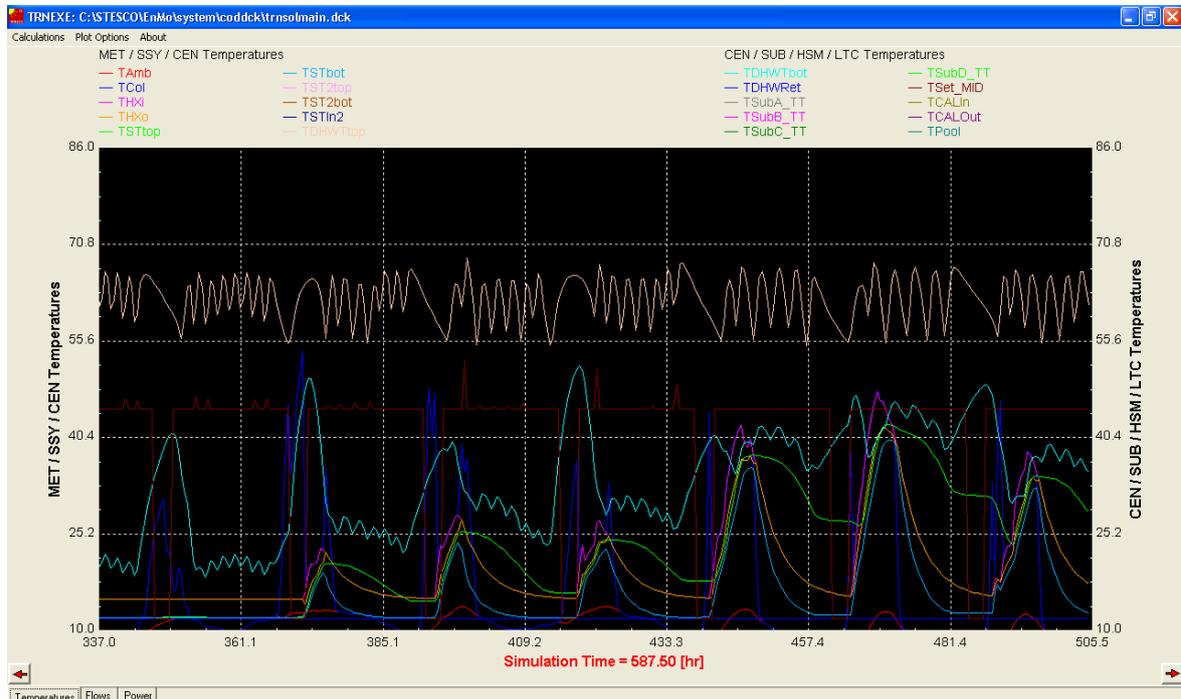
January	0,800	May	1,000	September	1,100
February	0,800	June	1,100	October	1,000
March	0,800	July	1,200	November	0,800
April	1,000	August	1,200	December	0,800

Perfil diari

0-1	0,100	6-7	0,500	12-13	0,900	18-19	1,000
1-2	0,000	7-8	1,000	13-14	0,900	19-20	1,000
2-3	0,000	8-9	1,500	14-15	0,900	20-21	1,000
3-4	0,000	9-10	1,000	15-16	0,900	21-22	1,000
4-5	0,000	10-11	0,900	16-17	0,900	22-23	0,100
5-6	0,200	11-12	0,900	17-18	1,000	23-24	0,100

- The mean daily load is 14000 l. at 45°C
- The data of the collector model is left as default
- The collector field parameters modified are:
 1. Number of collectors:45
 2. Collector field flow rate: 65 kg/h·m². This parameter sets the number of collectors connected in series as 2.
- The solar storage is set as 6 m³, and the auxiliary storage as 2 m³
- The other parameters are left as default.

Once all the data has been introduced, we update the project, choose “Save as...” *Hotel_BCN* (as the name of our project), we select from the menu “Project/Calculate” and the simulation proceeds. A screen as follows can be seen:



Here, the values of the selected variables can be followed through the year. For a detailed description of these variables look at the help file.

In a few minutes, the simulation has finished. Now, from "Simulation/Results/Excel sheet" the energy balance for the defined system can be evaluated. This option generates a printable 5 pages report in excel format that includes a brief description of the parameters of the system, the solar system energy balance in a monthly basis (radiation, production, thermal losses, solar energy delivered to consumption, auxiliary energy delivered and consumed, etc). With this, a technical analysis of the system can be done and further improvements in the system description can be implemented and simulated. To generate this report, the Microsoft Excel software must be installed in the computer, and the security level for macros must be set as medium.

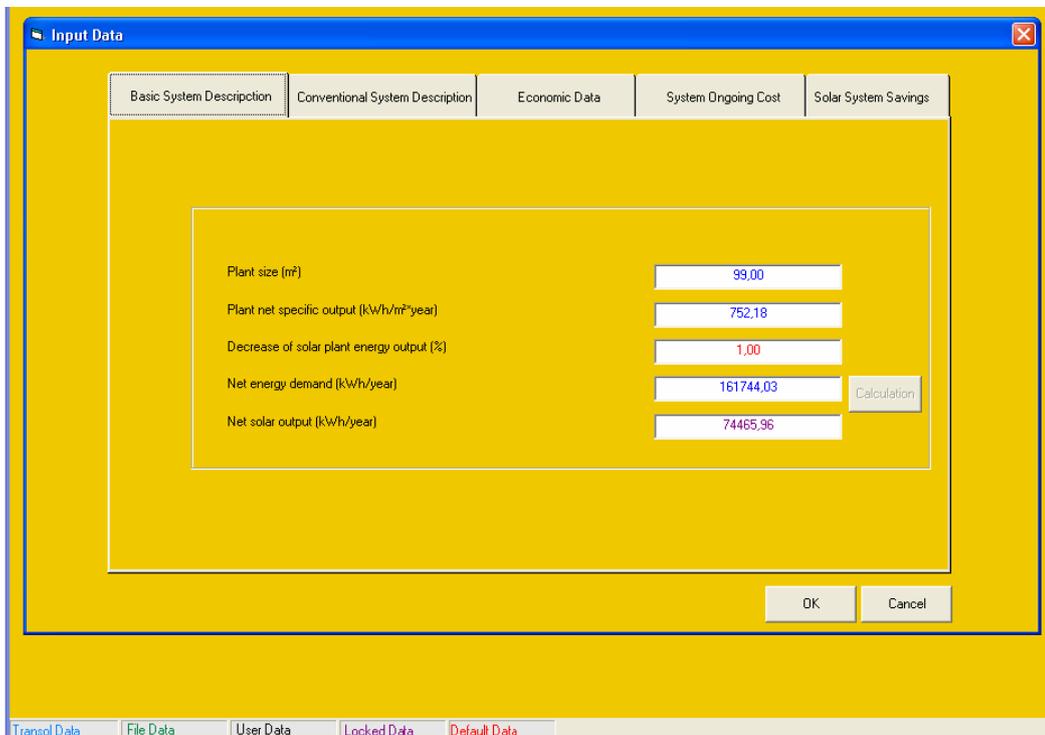
Once we are satisfied with system production, we can go to the next step, the economical analysis of the system. From the STESCO main menu select the "File/Economical analysis" option and a new window is opened. There, choose "File/New". This will open the "New economical analysis" dialog box.

Here, we select the default option "Transol". This means that we are going to use the results of a system simulation as an input for our economical analysis. The other option (Annual mean) is used in the case that we want to use as energy inputs user introduced data. This case will be explained in the next example. Now, back to the simulated example, we have to type the name of the transol file we saved the project, *Hotel_BCN*. We can also introduce here the name of the project, for instance *Hotel_v1*.

Now, click the OK button and a new dialog box opens, the Economy project window. It's upper menu has four fields:

1. File: for common window commands
2. Data: for the introduction of project parameters
3. Interactive Financial Calculations: for results and economic optimization
4. Report: commands for generating a simple report in excel format

The first one is complete the data of the project. For this purpose, a colour code for the numbers of the interface has been created. Select the "Model input data" from the data menu:



Field	Value
Plant size (m ²)	99,00
Plant net specific output (kWh/m ² /year)	752,18
Decrease of solar plant energy output (%)	1,00
Net energy demand (kWh/year)	161744,03
Net solar output (kWh/year)	74465,96

The first tab of this window is the basic system description. Each value has different colours, depending on its origin.

- Blue: data from transol simulation
- Green: data read from any other file
- Black: User introduced data
- Purple: Locked data, calculated from other data on the interface
- Red: default data

Given that we have simulated this project before with TRANSOL, some values have been loaded from the simulation:

- The plant size
- Plant net specific output
- Net energy demand

We can follow with the description of the system moving through the tabs on the interface. In the “Conventional System Description” tab, we will update:

1. System efficiency = 85%

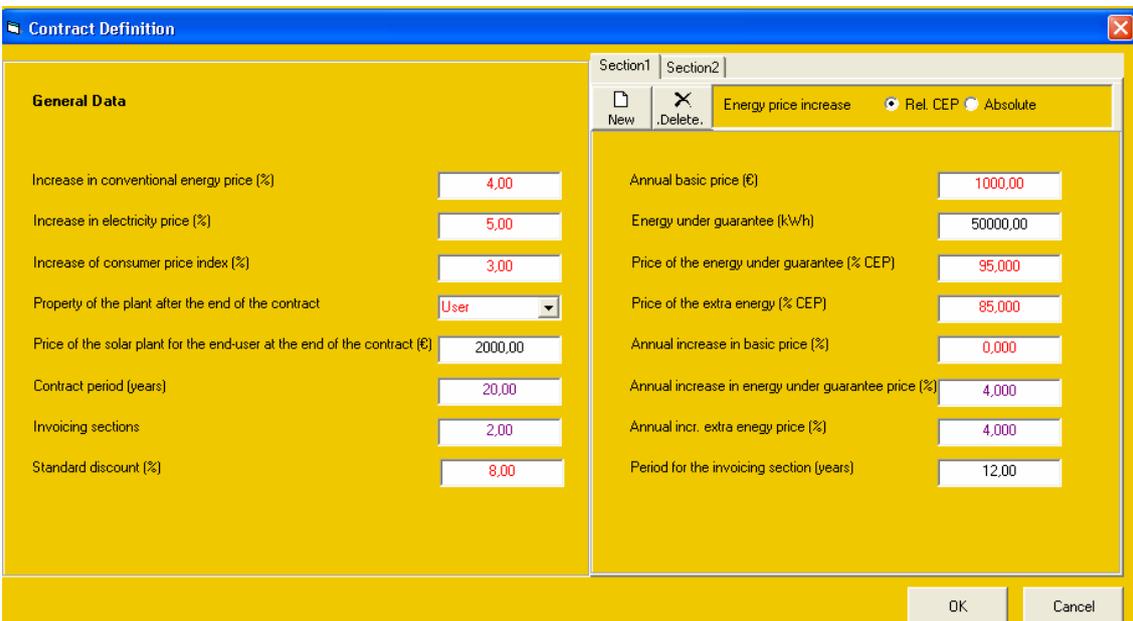
In the following tab, “Economic Data”, we set

1. Specific investment costs: 580 €/m² (note that the “Total investment is updated consequently)
2. User contribution to investment: 10000€
3. Direct subsidies: 20000€

Finally, in the “System ongoing costs” tab we set

1. Monitoring costs: 500 €/year
2. Service and maintenance: 600 €/year
3. Insurance: 600 €/year
4. The electricity consumed by the system is paid by the user

Now, with this hypothesis introduced we proceed to define the billing format for the solar energy produced by the installation. Select “Data/Contract data”:



The screenshot shows the 'Contract Definition' window with two sections: 'General Data' and 'Section2'.

General Data:

Increase in conventional energy price (%)	4,00
Increase in electricity price (%)	5,00
Increase of consumer price index (%)	3,00
Property of the plant after the end of the contract	User
Price of the solar plant for the end-user at the end of the contract (€)	2000,00
Contract period (years)	20,00
Invoicing sections	2,00
Standard discount (%)	8,00

Section2:

Energy price increase: Rel. CEP Absolute

Annual basic price (€)	1000,00
Energy under guarantee (kWh)	50000,00
Price of the energy under guarantee (% CEP)	95,000
Price of the extra energy (% CEP)	85,000
Annual increase in basic price (%)	0,000
Annual increase in energy under guarantee price (%)	4,000
Annual incr. extra energy price (%)	4,000
Period for the invoicing section (years)	12,00

Buttons: New, .Delete., OK, Cancel

In this dialog box, the left side is devoted to general economic data. We simply change the final price of the solar plant to 2000€. The contract studied in this example, we suppose a contract with two invoicing sections:

1. An initial invoicing section, for the whole length of the credit assumed by the ESCO (12 years) with higher billing for the user.
2. A second section, from the end of the previous and during 8 years, in which the user's bill is a slightly reduced.

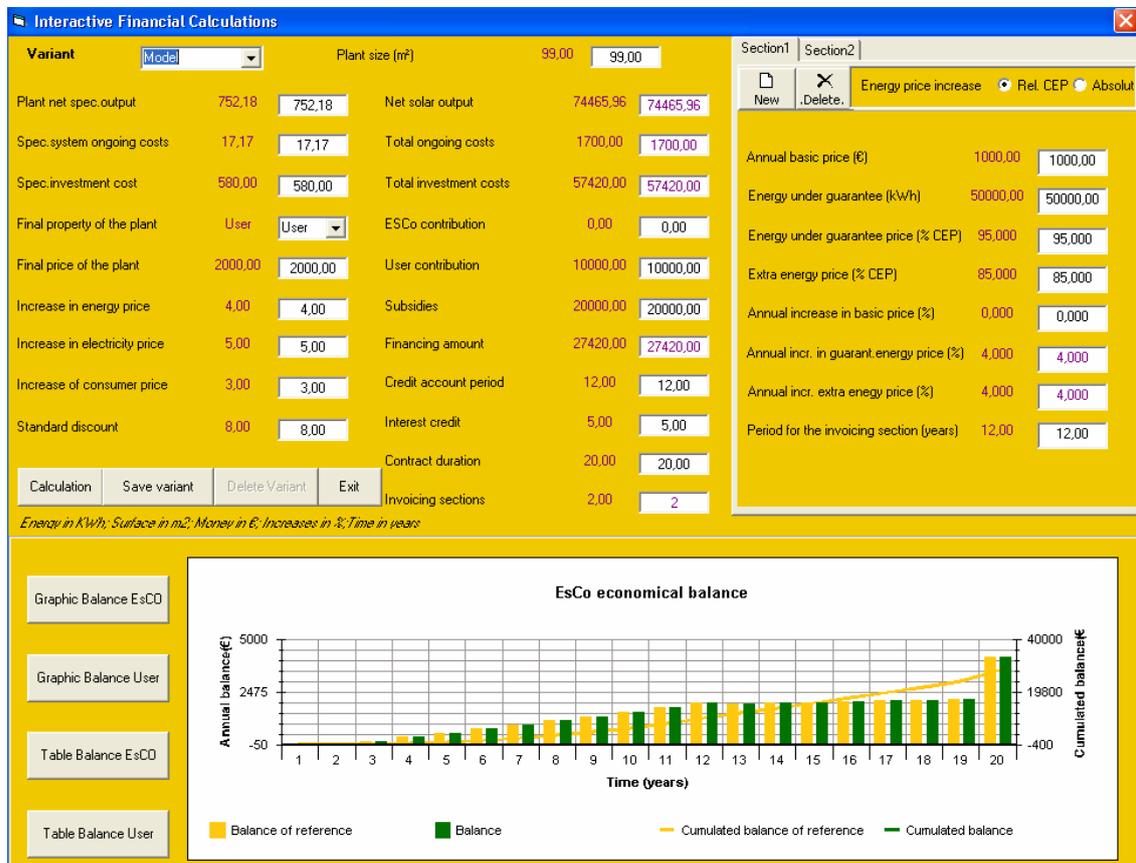
In both cases, we will set the price of the solar energy as a percentage of the Conventional Energy Price (CEP). This is indicated selecting the "Rel. CEP" radio button on the upper right side of the screen; the other option "Absolute" is used when the billing is set as an absolute value (€/kWh). In this example, we use for first section of the contract:

- Energy under guarantee: 50000 kWh
- Annual basic price: 1000 €
- Price of the energy under guarantee: 95 %
- Price of the extra energy: 85 %
- Period of the invoicing section: 12 years

And for the second section:

- Energy under guarantee: 45000 kWh
- Annual basic price: 900 €
- Price of the energy under guarantee: 90 %
- Price of the extra energy: 80 %
- Period of the invoicing section: 8 years
-

Now, we have introduced all the data needed and the results can be visualized. To do it, select "Financial calculations". Given the small solar field considered, the economic balance can't be very fruitful. The result should be as the image:



Here we can see all the parameters that can be modified in this dialog box, mainly economical parameters, and the lower part of the window is dedicated to the results visualization. We have four possibilities, see the results in graphic form (both for the ESCo and the user) or in table form (also for the ESCo and the user).

Note that the graphs have bars, related to the left axis and a line, the cumulated balance, related to the right axis, and that there are two series, the balance and the balance of reference. Now, since we have defined just one scenario, both series coincide in all the points. To understand the significance of this two series, suppose that we want to study the effect that could have for the ESCo reduce the period for returning the credit to 8 years, without modifying the billing periods included in the contract definition. We introduce in the "Credit account period" the new value and click the "Calculation" button. As expected, we can see that through the years 9 to 12 the annual balance is quite higher in this case, and the balance from the first to the eighth year is a bit worse. The global result, at least the accumulated balance of the contract, is a little better in this case, but the time distribution of the income for selling the solar energy is slightly delayed. Depending on the cash availability of the ESCo and other factors, the most interesting situation can be selected.

For example, imagine that the ESCo is able to make an initial contribution in order to reduce the credit amount, and finally, the financial costs of the operation. We suppose that the ESCo makes an initial contribution of 6000€. We introduce the value and click again on the calculation button. The results should look like the image below



Note that the reference values are kept in purple at the left of the field of the corresponding values. From the results in table form we see that the final balance is a bit higher in this case, although the distribution of the income is less favourable. We find that this case is a better starting point for the optimization of the economical results and we want to save it as the reference scenario for further analysis. This is done simply by clicking the “Save variant” button. A new menu asks us the name of the saved variant; we type, for example, “reference”. Now, both series coincide again, since the new scenario has overwritten the previous reference scenario.

If desired, is possible to turn back to the previous reference scenario just selecting the desired one from the drop down menu “Variant”.

Once a good solution has been developed, we can save it and generate the economic excel report; we close the window and click on “Report”, and for instance, ESCo report. The tool asks if we have Microsoft Excel installed in our computer, and then, the name of the variant to be used to generate the report. In a few seconds, the report is created, and we can print all the economic data of the scenario calculated.

3.2 EXAMPLE 3.2: CALCULATED PROJECT

In this second example, we will discuss an estimated example. With this, we mean that the net energy output is only estimated. So, in this case, we select in the “Project data” dialog box the “Annual mean” radio button, type the name of the project as *Hospital_v1* and click OK.

In this situation, the first we should do is calculating the energy demand of the system, what can be done with the help of the “Calculation” button in the “Basic system description” tab. We set a daily consumption of 32000 litres, a set point temperature of 45°C and a cold water temperature of 12°C. Note that in this case we don't consider any monthly or daily profiles and the cold water temperature are left constant through all the year.

In this example, we will set the following values for the parameters:

- Basic system description
 - Plant size: 300 m²
 - Plant net specific output: 730 kWh/ m²
- Conventional system description
 - System efficiency: 90 %
- Economic data
 - User contribution to investment: 20,000 €
 - Subsidies: 50,000 €
 - Credit account years: 8 years
 - Specific investment costs: 560 €/ m²
- System ongoing costs
 - Monitoring costs: 800 €/year
 - Maintenance: 1500 €/year
 - Other costs: 1200 €/year

For the contract definition we also introduce two different periods, with the following characteristics:

- First invoicing section:
 - Basic price: 2200 €/year
 - Energy under guarantee: 150000 kWh
 - Price for energy under guarantee: 0,055 €/kWh
 - Price of extra energy: 0,048 €/year

- Annual increase in energy price (granted and extra): 3 %
- Second invoicing section:
 - Basic price: 1200 €/year
 - Energy under guarantee: 120000 kWh
 - Price for energy under guarantee: 0,055 €/kWh
 - Price of extra energy: 0,042 €/year
 - Annual increase in energy price (granted and extra): 3 %

The duration of both years is set equal to 10 years, for total contract duration of 20 years.

With this values introduced, now we can go to the financial calculations to see the economic results of this situation. Looks like the image below.



The economic balance is not very favourable to the ESCo, in special in the first years. To improve its results, we change the energy under guarantee for the first period of the contract to 200,000 kWh and click the calculation button. We can see that the effect is very small, and the user balance doesn't left too much space to be reduced if its investment has to be maintained. In this case, probably a bigger subsidy should be found if the operation have to be viable, or the investment costs reduced.