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BESS - Benchmarking and Energy management Schemes in SMEs

Description of the Adjustment Factors used within the BESS Web based monitoring and benchmarking

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Adjustment factors

The application has options for four different kinds of adjustment; system efficiency factor, climate, production utilization and production mix. The use of adjustment factors improves the comparability of your benchmark results, since it enables to exclude several influences on energy use that are outside control of the company. The users of the international web benchmarking have the possibility to choose, whether or not to use adjustment factors. Below you find a description of the methodology for the different adjustments.

Climate

Though the influence of the climate to the energy efficiency of many production sites is only modest a refinement can be made by adjusting the energy consumption with the need for heating (and cooling) in different climatic zones, in order to get a more justifiable indicator. It is desired to be able to adjust the energy consumption with the need for heating (and cooling) in different climatic zones, in order to get a more justifiable indicator. In order to manage the energy used in heating, it is needed to take account of the weather. Degree-days figures provide a simple and convenient way to do this by reducing the local weather to a single number representing how cold it was. *Table 1* indicate average heating degree-days (HDD) for most of the participating countries within the BESS-project.

Table 1*: Average heating degree-days (HDD) for some European counties. Source: Odyssee-Mure database.*

Country	HDD
Portugal	1 278
Greece	1 461
Italia	2 085
Spain	2 152
Ireland	2 343
Bulgaria	2 680
Belgium	3 015
Netherlands	3 043
Slovenia	3 044
Austria	3 126
Romania	3 132
Slovakia	3 440
Czech Republic	3 559
Poland	3 605
Sweden	3 637
Lithuania	4 071
Latvia	4 243
Norway	4 362
Finland	4 878

There are various methods of calculating degree-day values, but all refer to a “base temperature”. For heating this is the outside air temperature at which no artificial heat is required to keep the building comfortable. The heating degree-days of a year are obtained by subtracting the average temperature of a day by the “base temperature” and accumulate this for all the days during the year. In this project we use 18°C as the “base temperature”.

$$\text{Heating degree-days, HDD} = 18 - T_{mean}$$

added up for all days in a year.

Cooling degree-days can be calculated in a similar way, but there is no officially designed base temperature and CDD are not so far implemented within the BESS-application.

The most accurate way of adjusting for climate is to use the heating degree-days in the actual year of the localization of the plant. If this isn't available, the heating degrees of the country may be used (preferable of the actual year). The climate of Brussels is used as the "normal climate".

In production industries, only a part of the energy consumption is depending on the climate. This part differs from industry to industry, and is difficult to generalize. If you want to do adjustment for climate you have to report the average share of thermal energy that is depended of the climate in your company.

The climate dependent share of the thermal energy consumption will then be divided by the heating degree-days of the company/country and multiplied with the heating degree-days of Brussels.

Example 1:
Climate corrected thermal energy consumption = thermal energy * ((1-heating dependent share) + heating dependent share * heating degree-days (Brussels) / heating degree-days (Country A))

$$E\ (\text{thermal})_{c.c.} = 30\,000\ \text{GJ/year} * ((1-0.2) + 0.2 * 3015/1500) = 36\,060\ \text{GJ/year}$$

If this company were located in Brussels instead of in the south of Europe, the company would have used 20% more thermal energy due to the climate differences.

If you need more information how to calculate the degree-days on the location of your production site over a specific period please contact an energy consultant or institute in your country.

System efficiency factor

The application has an option to use a system efficiency factor related to the different energy sources. These system efficiency factors will differ depending upon where the system boundary is set, and this is not necessarily the same for all sectors/benchmark-classes. Separate documents on the benchmark methodology in different sectors/benchmark-classes give a description of the system boundary.

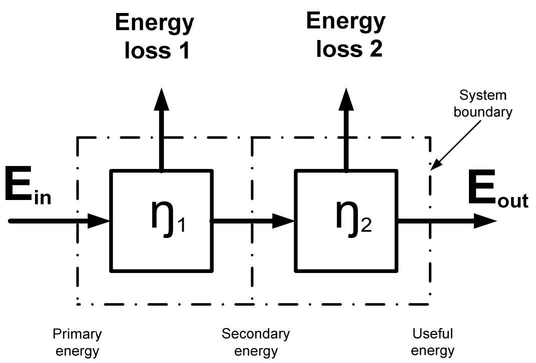
It is possible to set a default value on the system efficiency factor into the application, but this can be changed by the user when entering company data. It can be useful to be aware of the following definition of primary, secondary and final energy:

Primary energy is the energy contained in raw fuels (i.e. natural resources prior to any processing), including combustible wastes and other forms of energy received by a system as input to the system. The concept is used especially in energy statistics in the course of the compilation of energy balances.

Primary energies are transformed in energy conversion processes to more convenient forms of energy, such as electrical energy, steam and cleaner fuels. These subsequent forms of energy are called secondary energy. Final energy is the energy as it is received by the user (useful energy purchased), and may be both the primary and secondary energies (e.g. natural gas as primary energy and electricity as the secondary energy used in an installation).

For comparable reason electricity has to be reported either as primary energy or secondary energy. The same approach has to be used for all companies within the same sector/benchmark-class. Separate documents on the benchmark methodology in different sectors/benchmark-classes give a description of the used approach.

Energy reported into a system can be adjusted by the system efficiency factor. For this purpose benchmarking can be done both with and without use of the system efficiency factor. The system efficiency factor can also include the total of several efficiency factors within the system boundary as illustrated in the figure below.



$$\eta_{sys} = \frac{E_{out}}{E_{in}}$$

Example: Boiler efficiency

The energy reported from the companies is normally the actual use of energy (purchased), but in addition they can also report the annual boiler efficiency for all energy sources used in boilers. By doing this, it is possible to compare the net energy used in the production site, excluding differences of energy in the boiler house.

Example 2:

Net energy consumption = energy source A * boiler efficiency A + energy source B * boiler efficiency B….

E net = 10 000 GJ/year * 1 + 30 000 GJ/year * 80/100 = 34 000 GJ/year

Capacity utilization

Specific energy consumption often increases when the production capacity isn't fully used because of basic energy use are being spread over less units of production than at full production rate. The objective to adjust for reduced production capacity utilization is to separate the effect of a production rate change from other variables and energy efficiency changes. Adjustment should only be used for external factors (beyond the influence of the company itself).

When adjusting for capacity utilization, the basic energy consumption is reduced in the case of lower production utilization to match the share of basic energy consumption at full capacity utilization. If e.g. the basic energy consumption at full capacity utilization is 30%, it might increase to 35% at the level of 80% production utilization. The basic energy consumption then represents a too large part of the total energy consumption that ought to be reduced to the same level as in the case of full production capacity utilization, see figure 1 and example 3.

Example 3:
A company produces 10 000 tons at full capacity using 10 GWh and the SEC is then 1 kWh/kg. At 80% capacity utilization it produces 8 000 tons using 8.6 GWh and the SEC is then 1.08 kWh/kg. 35% of this energy use goes to non-product depending uses (like space heating, washing, lighting etc). This amount could then be adjusted, since it becomes unfairly big when the capacity utilization goes down. The adjusted energy consumption then becomes:

$$8.6 * 0.35*0.8 + 8.6 * (1-0.35) = 8.0 \text{ GWh}$$

where the non-product dependent share of the energy use is adjusted by the production capacity utilization of 80%. The adjusted SEC then is 1.0 kWh/kg, i.e. the same as at full capacity. In this case it is only the production capacity utilization that has changed, other factors may influence the total energy consumption, but here they are not present, showing just how to handle different production rates.

Production capacity utilization may be defined as the production capacity the plant is designed for, at normal working hours. A practical way of calculating the production capacity utilization may be the actual raw material input divided by the designed input. For dairies this would then be treated raw milk, for bakeries consumption of flour and for the meat processing industry the received tons of meat.

A way of calculating the non-production dependent share is to plot the energy consumption against productions using data that have been collected at regular intervals (daily, weekly, monthly…). Most processes will exhibit a pattern through which a straight line (best fit line) can be drawn. This line indicates the relationship between energy consumption and its driver (in this case, production). The intercept with the y-axis shows the non-production dependent energy use in absolute figures, see figure 2.

To calculate the share of non-productive energy consumption at the actual production rate, the basic energy consumption is divided by the actual energy use at the actual production capacity utilization level. Of course this share shouldn't be too high, since the whole methodology depends on that the energy consumption is dependent on the production volumes. If not, another method has to be chosen (e.g. energy consumption per m² heated area).

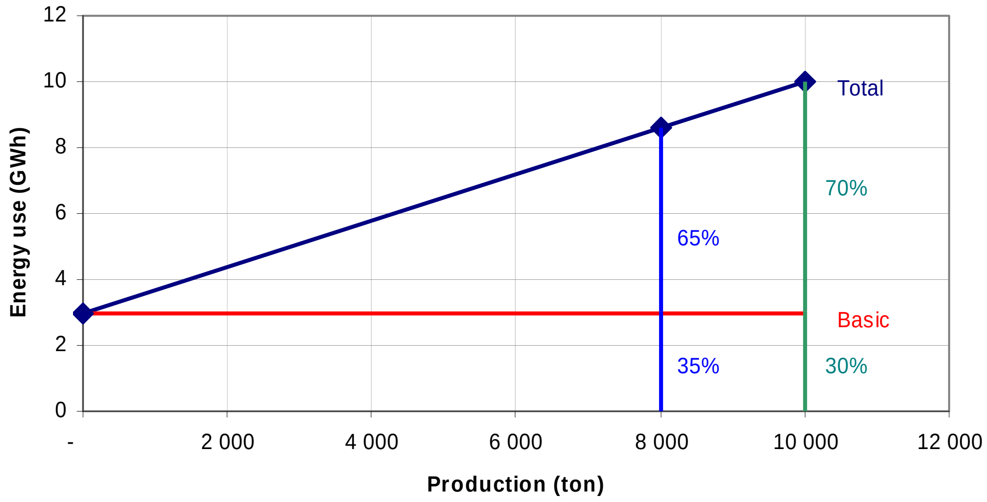


Figure 1: The share the basic energy consumption represents increases when the production utilization decreases

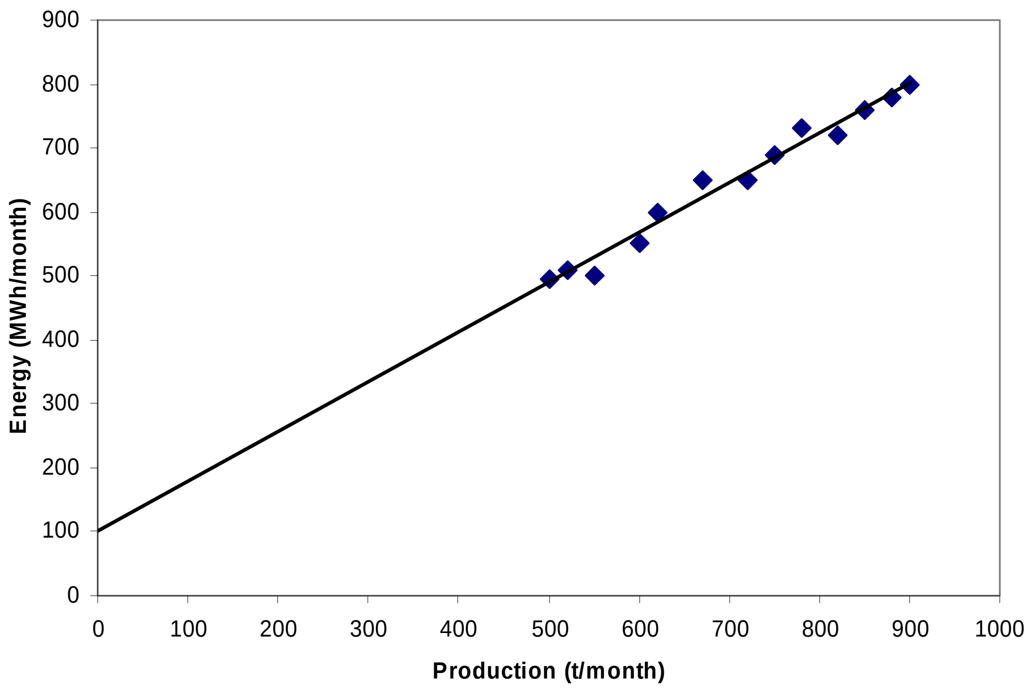


Figure 2: Monthly energy consumption vs. production volume. The intercept with the y-axis gives the basic energy consumption.

Production mix

In some industrial branches, the diversity for products is quite large and the energy consumption for each product may vary a lot. The best way to compare companies is to have homogenous groups with companies producing the same products, with the same type of equipment and with similar production volumes. But often this isn't possible to achieve, and then a sort of normalization of different products as regards the energy intensity of each product, is a way to adjust for different production mix.

You find a description of the methodology used for adjustment regard production mix as a separate document for each sector/benchmark-classes.