

Appendix 2 Energy requirements for paper and pulp production

Energy calculation guidelines

Use of energy in the form of fuel and electricity is subject to requirements. Through information on the actual energy consumption during production in relation to set reference values, an energy point is calculated.

The energy calculation covers the entire paper product; both the paper production and the pulps used. Fillers in paper and transport of raw materials as well as within the factory area shall not be included in the energy calculation.

Non-integrated pulp mill

Electricity

The calculations must include both purchased and on-site produced electricity.

Electricity = on-site produced electricity + purchased electricity - sold electricity.

The calculation of electricity consumption must be based on invoices and readings from electricity meters. On-site produced electricity is documented using readings from electricity meters. The requirement covers all processes from debarking to drying the pulp. An exemption applies to electricity for offices or lighting in the factory area. The average electricity consumption can be used for all pulps if the pulp mill only produces pulps of equivalent quality using the same type of process.

Fuel

The calculation must include both purchased fuel and fuel produced at the plant, divided into renewable and fossil fuels. The pulp producer must report the fuel used for on-site generated electricity and should deduct the fuel for electricity before reporting it to the paper manufacturer. The paper manufacturer deducts the fuel consumption from internally produced electricity using a factor of 1.25 in its own energy calculation.

Fuel pulp = fuel produced at the plant + purchased fuel - sold fuel* (sold fuel and/or heat/0,8)

The amount of fuel purchased must be adjusted to the quantities at the start and end of the current year. Consumption of internally produced fuel from bark, shavings and other wood residues is calculated using the thermal values for the fuels used or measured.

* *Excess energy*

Excess energy sold in the form of electricity, steam or heat is subtracted from the total consumption. The amount of fuel used to produce electricity or heat is calculated by dividing the sold electricity or heat by 0.8. This is equivalent to an average efficiency for the total production of electricity and heat.

Alternatively, the actual efficiency of the plant in the conversion of fuel to heat energy can be used.

Verification

An overview of the factory's energy supply system showing the number of boilers, with information about the boiler effect and which fuel is used.

Report on the amount of purchased, on-site produced, and sold electricity.

Report on the amount of purchased, on-site produced, and sold fuel/heat.

Conversion factors and efficiency must be stated if thermal energy has been re-calculated to fuel.

The calculation sheet produced by Nordic Ecolabelling can be used.

Non-integrated paper mill

Electricity

The calculations must include both purchased and on-site produced electricity.

Electricity = on-site produced electricity + purchased electricity - sold electricity.

The calculation of electricity consumption must be based on invoices and readings from electricity meters. On-site produced electricity is documented using readings from electricity meters. The requirement covers all processes from pulping to drying the base paper. An exemption applies to electricity for offices or lighting in the factory area. The average electricity consumption can be used for all paper if the paper mill only produces paper of equivalent quality using the same type of process.

Fuel

All purchased fuel must be included in the calculations, divided into fossil and renewable fuels.

Fuel paper = purchased fuel - sold heat converted to excess energy*

The amount of purchased fuel must be adjusted to the quantities at the start and end of the current year.

* *Excess energy*

Excess energy sold in the form of electricity, steam or heat is subtracted from the total consumption. The amount of fuel used to generate electricity or heat that is sold off is calculated by dividing the sold electricity or heat by 0.8. The coefficient of 0.8 is equivalent to the average energy efficiency for total heat and electricity production. Alternatively, the actual energy efficiency of the plant in the conversion of fuel to heat energy can be used.

Verification

An overview of the paper machinery's energy supply system showing the number of boilers, with information about the boiler effect and which fuel is used.

Report on the amount of purchased, on-site produced, and sold electricity.

Report on the amount of purchased, on-site produced and sold fuel/heat.

Conversion factors and efficiency must be stated if thermal energy has been re-calculated to fuel.

The calculation sheet produced by Nordic Ecolabelling can be used.

Steam

If excess steam from another production process is used (e.g., from another industry), the energy content of the steam must be included in the calculation. In this case, Table 1, the steam table should be used. If steam from electric boilers is used, the energy content must be converted to fuel in the same way, but the energy content must be multiplied by 1.25.

Energy calculation, paper production*Energy score for paper production*

Energy scores for $P_{\text{paper(electricity)}}$ and $P_{\text{paper(fuel)}}$ for paper production are calculated using the following formulas:

$$P_{\text{paper_electricity}} = \frac{\text{Electricity}_{\text{consumed}}}{\text{Electricity}_{\text{reference}}}$$

$$P_{\text{paper_fuel}} = \frac{\text{Fuel}_{\text{consumed}} - 1.25 \cdot \text{in-house generated electricity}}{\text{Fuel}_{\text{reference}}}$$

The following reference values for kraft paper must be used:

$$\text{Electricity}_{\text{reference}} = 1600 \text{ kWh/ADt}$$

$$\text{Fuel}_{\text{reference}} = 2100 \text{ kWh/ADt}$$

Verification

Calculation of energy score. The calculation sheet produced by Nordic Ecolabelling can be used.

Energy score when a mixture of different pulp types are used

The following formulas are used to calculate the energy score when a mixture of different pulp types is used:

$$P_{pulp_electricity} = \sum_{i=1}^n P_{pulp_electricity_i} \cdot pulp_i$$

$$P_{pulp_fuel} = \sum_{i=1}^n P_{pulp_fuel_i} \cdot pulp_i$$

$Pulp_i$ is the percentage of the individual pulp relative to the total pulp mixture. Due to wastage and differences in water content, the sum total of the pulp may be greater than 1. $P_{pulp(electricity)_i}$ is the energy score for electricity for pulp i . $P_{pulp(fuel)_i}$ is the energy score for fuel for pulp i .

Verification

Calculation of energy score. The calculation sheet produced by Nordic Ecolabelling can be used.

Total energy score for paper and pulp production

The total energy score for both electricity and fuel consumption for the paper production, including pulp production, is calculated using the formulas below:

$$P_{electricity} = P_{electricity_pulp} + P_{electricity_paper}$$

$$P_{fuel} = P_{fuel_pulp} + P_{fuel_paper}$$

The amount of fuel used to produce electricity in the pulp mill must be deducted by the paper manufacturer from the values received from the pulp producer using a factor of 1.25.

Worst case calculations must be included to show that each pulp recipe meets the requirements if no specific calculations are reported for each pulp mixture.

Verification

The documentation must include calculations with sub-totals. The base values used for consumed fuel and electricity must be stated. Worst case calculations must be included to show that each pulp recipe meets the requirements if no specific pulp-mixture calculations are reported for each pulp mixture present. The calculation sheet produced by Nordic Ecolabelling can be used.

Energy score for pulp production

Energy scores for $P_{pulp(electricity)}$ and $P_{pulp(fuel)}$ for paper production are calculated using the following formulas:

$$P_{pulp_electricity_i} = \frac{Electricity_{consumed}}{Electricity_{reference}}$$

$$P_{pulp_fuel_i} = \frac{Fuel_{consumed} - 1.25 \cdot in - house\ generated\ electricity}{Fuel_{reference}}$$

The table below shows the reference values for electricity and fuel:

Table 1 Reference values pulp

Process	Fuel kWh/t, Ref. value	Electricity kWh/t, Ref. value
Bleached chemical pulp	3600	650
Dried, bleached chemical pulp	4600	700
Unbleached chemical pulp	3200	550
Dried, bleached chemical pulp	4200	600
NSSC	3200	700
Dried NCCS	4100	750
CTMP	N/A	1500
Dried CTMP	900	1500
DIP	300	450
Dried DIP	1200	500
TMP	N/A	2200
Dried TMP	900	2250
Slip	N/A	2000
Dried slip	900	2050

Verification

Calculation of energy score. The calculation sheet produced by Nordic Ecolabelling can be used.

Table 2 Steam table

Enthalpy in gauged steam, h'' , as a function of absolute pressure, p or temperature, t . Enthalpy is divided by an efficiency of 0.9 and added to the heat consumption.

p Bar	t 0C	h'' KJ/kg	p bar	t 0C	h'' KJ/kg
0.50	81.3	2646.0	16.0	201.4	2791.7
0.60	86.0	2653.6	17.0	204.3	2793.4
0.80	93.5	2665.8	18.0	207.1	2794.8
1.00	99.6	2675.4	19.0	209.8	2796.1
1.20	104.8	2683.4	20.0	212.4	2797.2
1.40	109.3	2690.3	22.0	217.2	2799.1
1.60	113.3	2696.2	24.0	221.8	2800.4
1.80	116.9	2701.5	26.0	226.0	2801.4
2.00	120.2	2706.3	28.0	230.1	2802.0
2.50	127.4	2716.4	30.0	233.0	2802.3
3.00	133.5	2724.7	32.0	237.5	2802.3
3.50	138.9	2731.6	34.0	240.9	2802.1
4.00	143.6	2737.6	36.0	244.1	2801.7
4.50	147.9	2742.9	38.0	247.3	2801.1
5.00	151.8	2747.5	40.0	250.3	2800.3
6.00	158.8	2755.5	45.0	257.4	2797.7
7.00	165.0	2762.0	50.0	263.9	2794.2
8.00	170.4	2767.5	55.0	269.9	2789.9
9.00	175.4	2772.1	60.0	275.6	2785.0
10.00	179.9	2776.2	65.0	280.8	2779.5
11.00	184.0	2779.7	70.0	285.8	2773.5
12.00	188.0	2782.7	80.0	295.0	2759.9
13.00	191.6	2785.4	90.0	303.3	2744.6
14.00	195.0	2787.8	100.0	311.0	2727.7
15.00	198.3	2789.9	110.0	318.1	2709.3

Source: Thermal Engineering Data, which refers to Schmidt, E.: Properties of water and Steam in SI.Units, 1969. Springer-Verlag and R. Oldenbourg 1969.