

Key number	Unit
Steam use/kg product 1	MJ/kg
Steam use/kg product 2	MJ/kg
Electricity use/kg product 1	kWh/kg
Electricity use /kg product 2	kWh/kg
Use of energy resources/kg product 1	MJ/kg
Allocation, use of hydrogen* <ul style="list-style-type: none"> - Process raw material - Energy raw material - Not utilized 	%

Steam use is the single most important factor for the energy efficiency of this production process, followed by electricity use. These were the reasons for the key numbers proposed above. Since it is impossible to make a direct comparison between steam use and electricity use, these parameters were recalculated as use of energy resources. Hydrogen is generated from the electrolysis process and is used primarily as a process raw material. Some of the hydrogen is used as energy resource in the steam boiler. The remaining part is not being utilized, why not utilized hydrogen constitutes an interesting key number to study.

It is important to notice that some of the proposed key numbers may be contradictory. Measures leading to a total decrease of energy use may for example lead to an increase of energy use in a specific process. Better monitoring methods may also lead to changes of certain key numbers, while the reality situation has in fact not changed. Accordingly, it is not beneficial for the business to set goals which in the end will prevent improvements to be carried out.

Different kinds of energy production give rise to different kinds of environmental impacts. Consequently, it is important to bear in mind the use of resources which is the result of energy use from a wider perspective. In this context, hydrogen should be regarded as a very cheap energy source from an environmental point of view. Hydrogen is generated as a by-product in this process. Combustion gives rise to water only. Under these circumstances, hydrogen has no environmental impacts during its life-cycle. Oil on the other hand requires energy for extraction, refinement and further processing. These

processes burden the environment with different kinds of emissions. When oil is combusted, pollutants like fossil carbon dioxide, sulphur dioxide and nitrogen oxides are formed. Electricity is a cleaner energy source at the location where it is used. However, electricity generation gives rise to different kinds of environmental impacts at the place of production, depending on the type of energy resource and the type of production technology.

The following generic data can be used to compare the environmental impact from the different types of energy used in this process. The total life-cycles of the energy types have been accounted for.

Type of energy	CO ₂ emissions [g/MJ]	NO _x emissions [g/MJ]	SO ₂ emissions [g/MJ]
Hydrogen	0	0	0
WRD oil	80	0,1	0,05
Electricity	7	0,03	0,02

Electricity produced in Sweden gives rise to environmental impact in the form of radioactive waste from nuclear power, of which the potential hazards are very difficult to survey. When regarding other types of environmental impacts, oil comes out as the least favorable alternative. From all aspects, hydrogen is by far the cleanest energy source to use for energy production in this particular process.