LCA Report for Environmental Product Declaration of Sodium Salts – Sodium Carbonate and Sodium Bicarbonate

Kazan Soda
Date
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Prepared by
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Contents

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1. GENERAL ASPECTS

1.1 General information about the applicant company and the product

Kazan Soda was established in Ankara in 2011 with the aim of extracting and operating the trona mineral reserves and bringing them into the economy. Kazan Soda is one of the facilities in Turkey of WE Soda Ltd., which is part of Ciner Group, and is the largest natural soda ash and sodium bicarbonate producer in Europe. Kazan Soda uses the solution mining technique, which is an environmentally friendly and innovative method for the extraction of trona ore.

Kazan Soda, which started its commercial operation in 2018, has become a facility that produces and sells ~3 million tons of soda ash and sodium bicarbonate. Kazan Soda, one of Turkey's largest chemical exporters, meets the needs of many industries, from glass production to baking powder; With its global integrated production and supply chain network, it exports its products all over the world, especially to Europe. The electricity and steam energy needed for production are produced in the natural gas cogeneration power plant within the factory, with the remaining 2.3 billion kWh of electricity being sent to the Ankara community every year.

1.2 Commissioner of the LCA study, internal or external practitioner of the LCA study

This LCA study is commissioned by Kazan Soda and prepared by Sustainability Consultant Mrs. Banu Kilic Acar of Semtrio Sustainability Consulting. This report has been carried out for sodium carbonate and sodium bicarbonate products.

1.3 Contact Details

This report was issued in February 2024. Participant details are present in the table below.

Table 1: Contact information for the participants

Company	Address	Participant	Contact
Kazan Soda	MülK Küme Evleri 1. Cadde No:122 Yenikent-Sincan/ANKARA	Esin Ozkasnakli	e.ozkasnakli@kazansoda.com
Semtrio	Budotek Teknopark Umraniye / Istanbul	Mrs. Banu Kilic Acar	banukilicacar@semtrio.com

1.4 Requirements and Standards

This study is conducted according to the guidelines of ISO 14040:2006, ISO 14044:2006, ISO 14025:2006, ISO 14020:2006 and the requirements given in the General Program Instructions; PCR 2021:03 Basic Chemicals version 1.1.1.

The inventory for the LCA study is based on the period of 1st January 2022 and 31st December 2022 production figures from Ankara manufacturing plant. This LCA was modelled with SimaPro LCA v9.5.0.2 software with Ecoinvent v3.9.1 database for secondary data.

2. GOAL OF THE STUDY

This LCA study aims to evaluate the environmental impacts of sodium carbonate and sodium bicarbonate products, cradle to gate (A1-3) with options approach to be awarded Environmental Product Declarations (EPDs) certified by The International EPD System through third-party verification. This LCA study aims to be used as business-to-business communication.

3. SCOPE OF THE STUDY

3.1 Specification of the Products

This LCA study evaluates the potential environmental impact of Soda Ash and Sodium Bicarbonate life cycle manufactured by Kazan Soda. The environmental impacts include Sodium Carbonate (Natural Soda Ash) and Sodium Bicarbonate production processes during their life cycle from raw material supply to transportation to distribution.

3.1.1 Sodium Carbonate (Dense Soda Ash)

Sodium Carbonate: Dense Soda Ash, Sodium Carbonate also known as Disodium Carbonate is a chemical substance, white in colour and its aqueous solution is clear and colorless (chemical formula Na_2CO_3). It is a simple, natural product used in products worldwide. Soda Ash is the 10th most consumed inorganic compound in the world, which has been used for over 5,000 years. It is a safe, simple compound and a key component in a variety of industrial processes . Over half of all Soda Ash production is used in glass manufacturing, but it is also used in a wide range of other products, such as powdered detergents and soaps and rechargeable batteries, as well as being used extensively in metallurgical processes, and across the food, cosmetic and pharmaceutical industries.

Areas of Usage

- Glass
- Chemical Industry
- Soap and Detergent Industry
- Paper
- Flue Gas Treatment
- Water and Wastewater Treatment

CAS No: 497-19-8 EINECS No: 207-838-8 Mol. Weight: 105,99

Sodium Carbonate is classified under CPC Group: 342 - Basic inorganic chemicals n.e.c., Class: 3424 - Phosphates of triammonium; salts and peroxysalts of inorganic acids and metals n.e.c., 34240 Sodium carbonate, neutral, crystallized or dehydrated.

Eco-labelling, e.g. ISO Type I is not available for the product.

3.1.2 Sodium Bicarbonate

Sodium Bicarbonate also known as Sodium Hydrogen Carbonate is a chemical substance white in colour and its aqueous solution is clear and colorless (chemical formula $NaHCO_3$). Like Soda Ash, Sodium Bicarbonate is a safe inorganic compound that is chemically closely related to Soda Ash. The main uses of Sodium Bicarbonate are as a raising agent in food manufacture, as an ingredient in pharmaceutical healthcare and animal feed products, and in waste water treatment. More recently, Sodium Bicarbonate is increasingly being used in new environmental applications, including the desulphurisation or “scrubbing” of flue gas emissions, particularly in the shipping industry.

Areas of Usage

Food Grade Sodium Bicarbonate:

- Baking powder
- Cake, donut, pancake and cookie additive
- Drinks
- Tooth paste

Feed Grade Sodium Bicarbonate:

- Dairy farming
- Poultry raising
- Pig farming

Technical Grade Sodium Bicarbonate:

- Chemical industry
- Cleaners
- Powder fire extinguishers
- Paper production
- Leather industry
- Waste gas desulphurization
- Textile industry
- Water and waste water treatment

CAS No: 144-55-8 EINECS No: 205-633-8 Mol. Weight: 84.01

Sodium Bicarbonate is classified under CPC Group: 342 - Basic inorganic chemicals n.e.c., Class: 3424 - Phosphates of triammonium; salts and peroxysalts of inorganic acids and metals n.e.c., 34240 Sodium bicarbonate.

Eco-labelling, e.g. ISO Type I is not available for the product.

3.2 Production Process

MINING

Kazan Soda produce sodium carbonate and sodium bicarbonate from naturally occurring underground ore, called trona which is more environmentally friendly because of less requirement of energy and water & less production of CO2 and solid waste.

As WE soda, which includes Eti Soda and Kazan Soda are the only soda ash producer in the world outside China to use innovative solution-extraction on a commercial scale.

In this patented production method, heated water is injected to the underground ore body, which then dissolves the trona for forming brine solution. The brine is then extracted to the surface, and pumped to a central processing facility.

PROCESS

Kazan Soda employs meticulous process for production of soda ash and sodium bicarbonate, involving several essential stages. The process initiates with brine pretreatment, aimed at filtering suspended solids from the initial raw brine. Following this, a dual-stage stripping and evaporation process transforms sodium bicarbonate into sodium carbonate via a heat-induced chemical reaction, crucial for maintaining product quality by optimizing sodium carbonate concentrations. The carbon dioxide produced as a by-product of this reaction is utilized in later stages of the production for the bicarbonate process. Subsequently, in the decahydrate crystallization unit, concentrating the brine leads to the formation of deca crystals, effectively decreasing impurities, particularly the high sodium chloride content, present in the solution. Moreover, the company utilizes the deca purge solution in caustic soda production where caustic soda is used to reduce the amount of bicarbonate in the brine before it progresses to the decahydrate unit. Then, the monohydrate crystallization phase refines deca crystals into a dense soda ash crystals slurry, which is then centrifuged and dried to yield the final dense soda ash product. For the production of sodium bicarbonate, a systematic approach akin to that employed in dense soda ash production is utilized. This systematic method involves the controlled introduction of recycled CO2 to generate sodium bicarbonate, along with bicarbonate crystallization achieved by cooling concentrated brine. Finally, sodium bicarbonate is produced using centrifugation and drying processes similar to those used in the dense soda ash production.

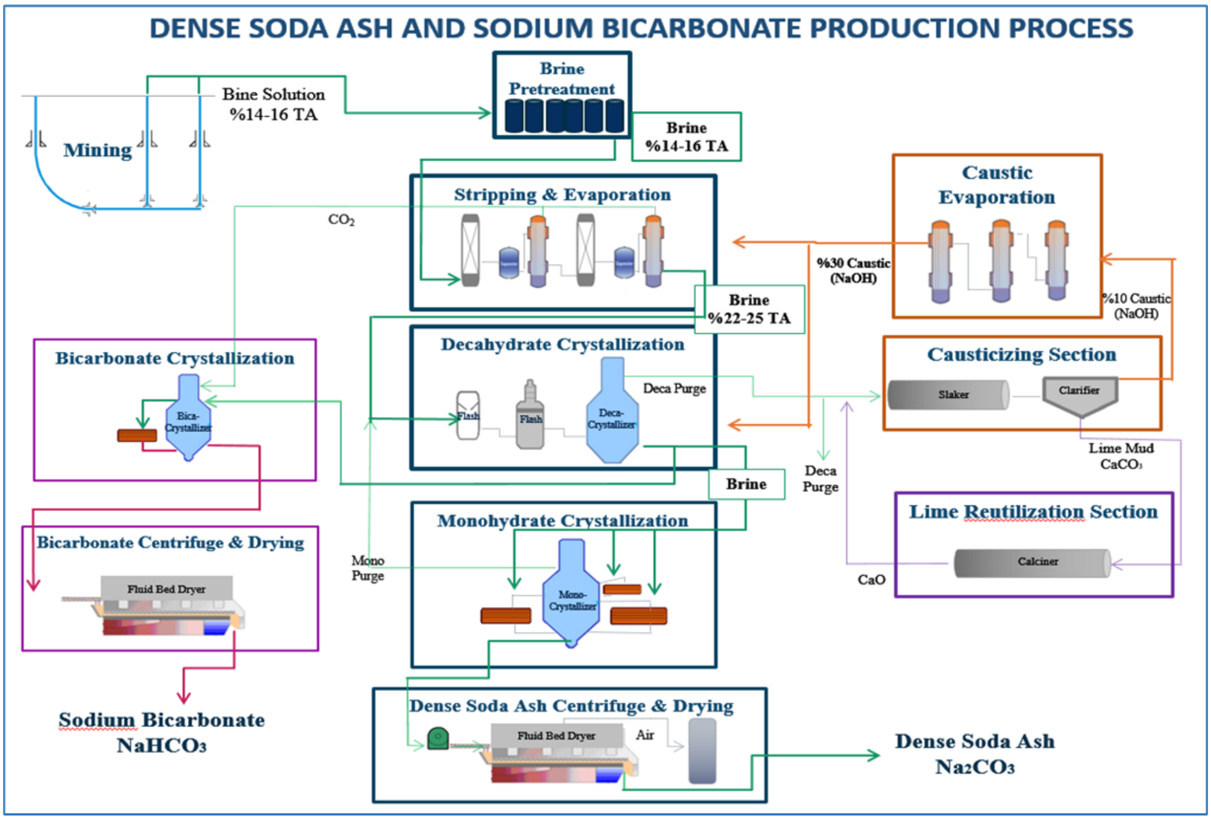

Figure 1: Natural Soda Ash and Sodium Bicarbonate production flow

COGENERATION

Kazan Soda includes a natural gas cogeneration power plant to provide steam for process. Excess electric power generated is utilized for contributing to the power distribution grid.

3.3 Declared Unit

The declared unit is 1 kg sodium carbonate and 1 kg sodium bicarbonate.

Distribution Packaging: packaging designed to contain one or more articles or packages, or bulk materials, for the purposes of transport, handling and/or distribution. No recycled content included in the packaging materials.

3.4 Content Declaration

Table 2: Content declaration of Sodium Carbonate

Product	Brine solution, weight-%	Quicklime, weight-%	Caustic, weight-%	Antifoam, weight-%
Sodium Carbonate	99%	0.3%	0.3%	< 0.3%

Table 3: Content declaration of packaging material, for Sodium Carbonate

Sodium Carbonate	Unit	Weight, %	Biogenic carbon, kg
Plastic Packaging-Bigbag (kg)	2.41E-04	-	-
Plastic Packaging-Smallbag (kg)	1.57E-05	-	-
Wooden Pallet (p)	2.0E-05	-	-

Table 4: Content declaration of Sodium Bicarbonate

Product	Brine solution, weight-%	Quicklime, weight-%	Caustic, weight-%	Antifoam, weight-%
Sodium Bicarbonate	99%	0.3%	0.3%	< 0.3%

Table 5: Content declaration of packaging material, for Sodium Bicarbonate

Sodium Bicarbonate	Unit	Weight, %	Biogenic carbon, kg
Plastic Packaging-Bigbag (kg)	1.55E-04	-	-
Plastic Packaging-Smallbag (kg)	3.85E-04	-	-
Wooden Pallet (p)	8.0E-05	-	-

Packaging Materials

Distribution Packaging; for the purposes of transport, handling and/or distribution.

The distribution packaging is:

• small bags (25kg) packaging

• bigbags (1250kg) packaging

• Wooden pallets for handling of packaged products.

For product packaging, end-of-life stage scenario has been created. The weights of bigbag, smallbag, and pallet products have been determined based on sales volume and the calculation has been made assuming that packaging products went to a 100 km disposal facility.

For bigbag and small bag products, EPA's "Plastic Containers and Packaging" material has been used and recycling, incineration and landfill rates have been calculated for the bigbag and small bag products.

It has been accepted that the pallet is 100% recyclable.

3.5 System Boundary

According to the PCR 2021:003 version 1.1.1, the system boundary of both products is shown in the figure below.

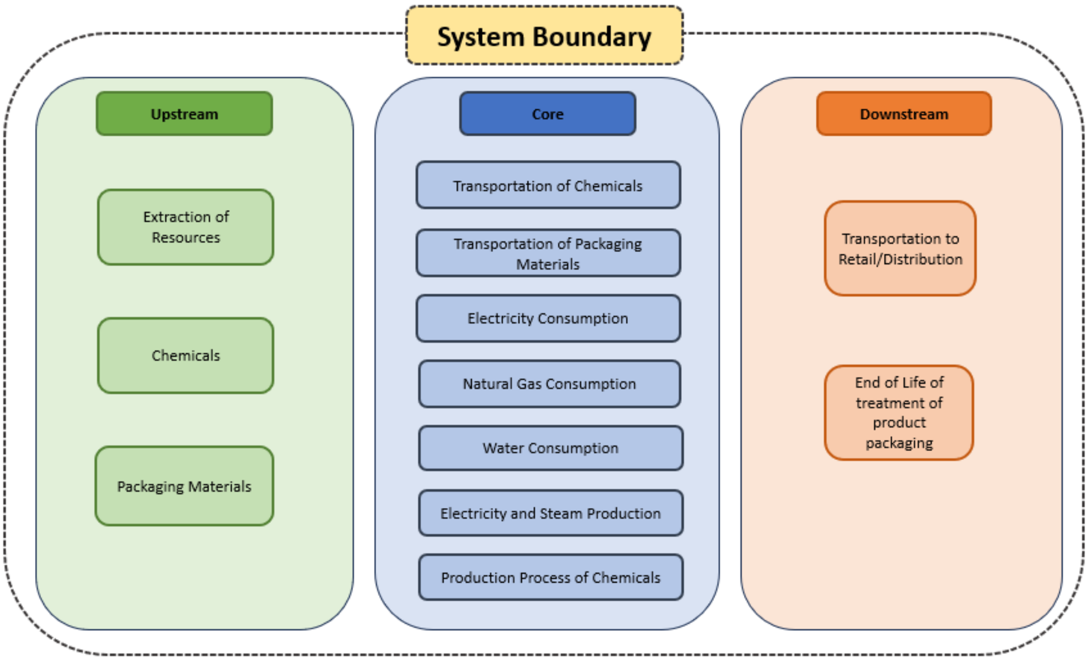

Figure 2: System boundary of the LCA study

3.5.1. Upstream Processes

The scope of the upstream processes is defined as production of the inputs to the core processes and activities which the manufacturing organization is not in control of over the supply chain.

The following attributional processes are part of the product system and classified as upstream processes:

- The manufacturing of the chemicals: quicklime, caustic and anti-foam
- The production processes of energy wares used in the extraction and refinement
- The manufacturing of the primary and secondary packaging

3.5.2 Core Processes

The scope of the core module is defined by the organizational boundaries and includes all activities which the manufacturing organization is in control of. In this LCA Study the core process includes, impacts generated by natural gas burned in the core process, impacts due to the electricity production according the country energy mix.

Production of trona solution also operated by Kazan Soda and considered under core processes. Energy consumption during the trona solution delivery to the manufacturing plant has been included into core processes.

The core processes include:

- Trona solution mining

- Manufacturing of the final product
- Impacts due to the consumption of electricity, natural gas and water
- Impacts due to the production of electricity and steam in the core module
- Transportation of chemicals and packaging materials

The core processes do not include:

- Manufacturing of production equipment, buildings, and other capital goods,
- Business travel of personnel,
- Travel to and from work by personnel,
- Research and development activities,
- Scraps coming from demolition of building or other infrastructures.

3.5.3 Downstream Processes

The transportation of the product to the customer has been calculated, taking into account the actual transportation distances and types. It has been calculated by including bulk, bigbag, and smallbag packaging.

End of life treatment of product packaging;

For product packaging, end-of-life stage scenario has been created. The weights of bigbag, smallbag, and pallet products have been determined based on sales volume and the calculation has been made assuming that packaging products went to a 100 km disposal facility.

For bigbag and small bag products, EPA's "Plastic Containers and Packaging" material has been used and recycling, incineration and landfill rates have been calculated for the bigbag and small bag products.

It has been accepted that the pallet is 100% recyclable.

Excluded Downstream Process:

End-of-life of the chemical product and use phase are excluded.

Sodium Carbonate (Natural Soda Ash) and Sodium Bicarbonate have many different applications and are often used as input materials to other production processes. It is difficult to allocate an environmental burden from the use phase to the chemical input.

Also, the end-of-life management depends on the application and location of the use and disposal of the chemical.

No relevant data is available for the use and end of life phases of the products manufactured by Kazan Soda.

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4 LIFE CYCLE INVENTORY ANALYSIS

4.1 Data Collection

Data collection for this LCA study has been carried out in accordance with data requirement stated in ISO 14040/44 standard and related PCR Basic Chemicals version 1.1.1.

There are two different data classifications has been used as primary and secondary data. All primary data has been collected from Kazan Soda production plant. For secondary data Ecoinvent v3.9.1 datasets have been adopted.

Upstream data, raw materials production, transportation, and electricity mix data have been obtained from Ecoinvent v3.9.1 as secondary data. All manufacturing data in core processes have been gathered from Kazan Soda production plant. The manufacturing data are monitored and recorded in Kazan Soda data collection system(SAP). The production data in this LCA study represents the period from 1st January 2022 to 31th December 2022. A third-party verification has been proceeded for all manufacturing data, electricity, water and natural gas consumption according to ISO 14064-1:2018.

Mileage and tonnage figures for transport data to the core processes were provided by Kazan Soda procurement department specifically per origin of departures, however, roadway and seaway data per ton per kilometres were taken from Ecoinvent v3.9.1.

All raw materials and packaging materials have been purchased from Turkiye.

Entire life cycle inventory data are presented in Appendix III.

4.2 Exclusion and Cut-off Rules

Life Cycle Inventory data for a minimum of 99 % of total inflows to the three life cycle stages have been included and a cut-off rule of 1% regarding energy, mass and environmental relevance was applied.

- Infrastructure and capital goods are excluded from the analysis, except in cases where inventory data provide this information as part of an aggregated dataset, e.g. Ecoinvent, market or production data as secondary database.
- Social and economic impacts are beyond the scope of this report and therefore excluded. However, differences do exist in human resource aspects (e.g., labour requirements) and cost between the different manual processes in garment manufacturing.
- Business travel of personnel.
- Travel to and from work by personnel.
- Research and development activities.
- Scraps coming from demolition of building or other infrastructures.

4.3 Allocation

During manufacturing, calcium carbonate, deka purge and salt are produced as by-product. Therefore, calcium carbonate, deka purge and salt have been excluded from system boundaries, and mass allocation is proceeded.

Manufacturing data, raw materials and energy consumption are allocated for two main products (Natural Soda Ash and sodium bicarbonate) and three by-product (calcium carbonate, deka purge and salt), by using mass allocation. It is not possible to exact divide the unit process into two or more sub-processes and collecting the environmental data related to Natural Soda Ash and sodium bicarbonate separately. That means mass allocation obtained for Natural Soda Ash and sodium bicarbonate. Kazan Soda cannot monitor and record raw material and energy consumptions for products and by products separately.

An allocation is also applied for emissions caused by cogeneration plant.

An Alternative Generation Method has been conducted for co-generation plant. At the cogeneration plant, natural gas is consumed; electricity and steam are produced. (Note: remaining electricity demand is purchased from the grid).

- Allocates GHG emissions according to the amount of fuel energy used to produce each final energy stream.
- Assumes that conversion of fuel energy to electricity energy is more efficient than converting fuel to steam. Thus, focuses on the initial fuel-to-steam conversion process.

During period of LCA study from 1st January to 31st December 2022, 524,448,549.00 sm^3 of natural gas was combusted at the cogeneration unit. According to the GHG study, the natural gas combusted caused 1,029,654.42 tonnes of CO2 eq. By using Alternative Generation Methodology, that amount of CO2 eq is allocated to per kWh electricity and per kWh heat.

Year:	2022									
	Step 1			Step 2		Step 3		Step 4		
	A	B	C	D	E	F	G	H	I	
Facility/source description	E_T Total direct emissions from CHP facility	H Steam output (district heat, process heat, other steam)	P Power output	e_H Assumed efficiency of typical steam production	e_P Assumed efficiency of typical power production	E_H Emissions share steam production	E_P Emissions share electricity production	Emissions factor - steam	Emissions factor - electricity	
						F = A * {(B / D) / [(B / D) + (C / E)]}	G = A - F	H = F / B	I = G / C	
	metric tons	kWh	(same unit as in column B)	(number between 0 and 1)	(number between 0 and 1)	metric tons	metric tons	Metric ton / unit of heat output	Metric ton / unit of electricity output	
CO2, ton	1,028,635.89	2,463,887,548.00	1,971,780,356.00	0.40	0.60	670,770.15	357,865.74	0.272241	0.1814937	kg
CH4, ton	18.45	2,463,887,548.00	1,971,780,356.00	0.40	0.60	12.03	6.42	0.000005	0.0000033	kg
N2O, ton	1.85	2,463,887,548.00	1,971,780,356.00	0.40	0.60	1.20	0.64	0.000000	0.0000003	kg
NG, m3	524,448,549.00	2,463,887,548.00	1,971,780,356.00	0.40	0.60	341,991,209.75	182,457,339.25	0.138801	0.0925343	m3
Water, m3	2,626,130.00	2,463,887,548.00	1,971,780,356.00	0.40	0.60	1,712,490.92	913,639.08	0.695036	0.463357	kg

Figure 3: Allocation results of carbon dioxide emissions caused by cogeneration plant for electricity

Year:	2018									
	Step 1			Step 2		Step 3		Step 4		
	A	B	C	D	E	F	G	H	I	
Facility/source description	E_T Total direct emissions from CHP facility	H Steam output (district heat, process heat, other steam)	P Power output	e_H Assumed efficiency of typical steam production	e_P Assumed efficiency of typical power production	E_H Emissions share steam production	E_P Emissions share electricity production	Emissions factor - steam	Emissions factor - electricity	
						F = A * {(B / D) / [(B / D) + (C / E)]}	G = A - F	H = F / B	I = G / C	
	metric tons	MJ	(same unit as in column B)	(number between 0 and 1)	(number between 0 and 1)	metric tons	metric tons	Metric ton / unit of heat output	Metric ton / unit of electricity output	
CO2, ton	1,028,635.89	8,869,995,171.76	7,098,409,281,600.00	0.40	0.60	1,924.43	1,026,711.46	0.0002170	0.0001446	kg
CH4, ton	18.45	8,869,995,171.76	7,098,409,281,600.00	0.40	0.60	0.03	18.42	3.89E-09	0.0000000	kg
N2O, ton	1.85	8,869,995,171.76	7,098,409,281,600.00	0.40	0.60	0.00	1.84	3.89E-10	0.0000000	kg
NG, m3	524,448,549.00	8,869,995,171.76	7,098,409,281,600.00	0.40	0.60	981,167.67	523,467,381.33	0.0001106	0.0000737	m3
Water, m3	2,626,130.00	8,869,995,171.76	7,098,409,281,600.00	0.40	0.60	4,913.11	2,621,216.89	0.0005539	0.000369	kg

Figure 4: Allocation results of carbon dioxide emissions caused by cogeneration plant for steam

The allocation method is based on the fact that benefits gained from improved fuel utilisation as well as the environmental impacts connected to combined heat and power generation, are distributed between the two products – electricity and heat – in the same proportion as the fuel needed for separate electricity and heat generation processes. The relationship of distribution is expressed as percentage of the fuel needed for each alternative process with respect to the total quantity needed.

4.4 Data Quality

Specific data (primary data) was used for the Core Module and was gathered from the Kazan Soda Manufacturing Plant. Primary data includes actual product weights, amounts of raw materials used, product content, energy consumption, transport figures, water consumption and amounts of wastes.

For upstream module, selected generic data (secondary data) was applied and was obtained from Ecoinvent v3.9.1.

Primary data used in this LCA study represent the production figures of 2022, less than 5 years old. Secondary data used in the study was obtained from Ecoinvent v3.9.1 which is less than 10 years old. Ecoinvent is a commercial life cycle data provider and meets all selected generic data quality requirements of the PCR.

Cut-off criteria for the upstream generic data is at least 99%, according to the relevant PCR in terms of the energy, the mass, and the overall environmental relevance of the flows. Inventory data covers all elementary flows and obtained from Ecoinvent v3.9.1. Technological and geographical references are presented in Appendix II.

Electricity data was taken from Ecoinvent v3.9.1 and here are the production mix figures;

Table 2: The electricity mix production figures for Turkey (Ecoinvent v3.9.1)

INPUT	Percentage
Electricity, medium voltage {TR}| electricity voltage transformation from high to medium voltage | Cut-off, U	99.42%
Electricity, medium voltage {TR}| market for electricity, medium voltage | Cut-off, U	%

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5 ENVIRONMENTAL PERFORMANCE RELATED INFORMATION

All resource use values are calculated from Cumulative Energy Demand; net use of fresh water has been calculated from SimaPro Inventory result outputs. Potential environmental impacts are calculated with EN 15804:2012+A2:2019 method.

5.1 LCA Results for 1 kg of Sodium Carbonate (Soda Ash) – Without Packaging[1]

Table 7: Potential environmental impact for 1 kg Sodium Carbonate (Soda Ash)-Without Packaging

Impact category	Unit	Upstream	Core		Total	Downstream	TOTAL
		Raw Materials Supply	Transport	Manufacturing		Transportation	
Climate change - fossil	kg CO2 eq	0.049	6.22E-08	0.208	0.26	3.71E-01	0.63
Climate change - biogenic	kg CO2 eq	2.19E-04	1.61E-10	2.57E-04	4.75E-04	1.79E-04	6.54E-04
Climate change - land use and land use change	kg CO2 eq	5.05E-05	3.02E-11	1.97E-04	2.48E-04	2.52E-04	5.00E-04
Climate change – total	kg CO2 eq	0.049	6.24E-08	0.21	0.26	3.71E-01	0.63
Ozone Depletion	kg CFC11 eq	1.45E-08	1.32E-15	4.69E-09	1.92E-08	6.30E-09	2.55E-08
Acidification	mol H+ eq	1.68E-04	1.33E-10	2.45E-04	4.13E-04	7.88E-03	8.29E-03
Eutrophication aquatic freshwater	kg P eq	1.47E-06	4.93E-13	2.22E-06	3.69E-06	1.91E-06	5.60E-06
Eutrophication aquatic marine	kg N eq	3.23E-05	3.26E-11	5.92E-05	9.16E-05	1.97E-03	2.06E-03
Eutrophication terrestrial	mol N eq	3.58E-04	3.40E-10	6.53E-04	1.01E-03	2.18E-02	2.28E-02
Photochemical ozone formation	kg NMVOC eq	1.17E-04	2.06E-10	3.17E-04	4.34E-04	6.12E-03	6.55E-03
Depletion of abiotic resources - minerals and metals	kg Sb eq	2.35E-07	1.98E-13	6.14E-08	2.96E-07	4.76E+00	4.76
Depletion of abiotic resources - fossil fuels	MJ, net calorific value	0.43	8.61E-07	1.97	2.4	4.76E+00	7.16
Water use	m3 world eq. deprived	0.024	3.60E-09	0.087	0.11	1.51E-02	0.13

[1] As the PCR requirement, the results of the packaging are separated from the product results

Table 8: Use of resources for 1 kg Sodium Carbonate (Soda Ash)-Without Packaging

Impact category	Unit	Upstream	Core		A1-3 Total	Downstream	TOTAL
		A1	A2	A3		Downstream Transportation	
		Raw Materials Supply	Transport	Manufacturing			
Use of renewable primary energy excluding renewable primary energy resources used as raw materials	MJ, net calorific value	0.045	1.35E-08	0.06	0.1	4.60E-02	0.15
Use of renewable primary energy resources used as raw materials	MJ, net calorific value	0	0	0	0.0	0	0
Total use of renewable primary energy resources (primary energy and primary energy resources used as raw materials)	MJ, net calorific value	0.045	1.35E-08	0.06	0.1	4.60E-02	0.15
Use of non-renewable primary energy excluding nonrenewable primary energy resources used as raw materials	MJ, net calorific value	0.46	9.15E-07	2.18	2.6	5.06	7.7
Use of non-renewable primary energy resources used as raw materials	MJ, net calorific value	0	0	0	0.0	0	0
Total use of non-renewable primary energy resources (primary energy and primary energy resources used as raw materials)	MJ, net calorific value	0.46	9.15E-07	2.18	2.6	5.06	7.7
Use of secondary material	kg	0	0	0	0.0	0	0
Use of renewable secondary fuels	MJ, net calorific value	0	0	0	0.0	0	0
Use of non-renewable secondary fuels	MJ, net calorific value	0	0	0	0.0	0	0
Net use of fresh water	m3	3.08E-03	7.77E-10	1.92E-02	2.23E-02	3.03E-03	2.53E-02

Table 9: Waste Production for 1 kg Sodium Carbonate (Soda Ash)-Without Packaging

Impact category	Unit	Upstream	Core		A1-3 Total	Downstream	TOTAL
		A1	A2	A3			

		Raw Materials Supply	Transport	Manufacturing		Downstream Transportation	
Hazardous waste disposed	kg	0	0	0	0	0.00	0
Non-hazardous waste disposed	kg	0	0	0	0	0.00	0
Radioactive waste disposed	kg	0	0	0	0	0.00	0

Table 10: Output Flows Production for 1 kg Sodium Carbonate (Soda Ash)-Without Packaging

Impact category	Unit	Upstream	Core		A1-3 Total	Downstream	**TOTAL**
		A1	A2	A3		Downstream Transportation	
		Raw Materials Supply	Transport	Manufacturing			
Components for re-use	kg	0	0	0	0	0.00	0
Materials for recycling	kg	0	0	0	0	0.00	0
Materials for energy recovery	kg	0	0	0	0	0.00	0
Exported energy - Electrical	MJ	0	0	0	0	0.00	0
Exported energy - Thermal	MJ	0	0	0	0	0.00	0

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5.2 LCA Results for 1 kg of Sodium Carbonate (Soda Ash) – Only Packaging Materials (Bigbag)

Table 11: Potential environmental impact for 1 kg Sodium Carbonate (Soda Ash)-Only Packaging Materials (Bigbag)

Impact category	Unit	Upstream	Core	Total	Downstream	TOTAL
					End of Life	
Climate change - fossil	kg CO2 eq	7.3E-04	2.68E-05	7.52E-04	2.48E-04	1.00E-03
Climate change - biogenic	kg CO2 eq	-8.7E-06	6.92E-08	-8.60E-06	8.01E-08	-8.52E-06
Climate change - land use and land use change	kg CO2 eq	6.4E-07	1.30E-08	6.58E-07	1.09E-08	6.69E-07
Climate change – total	kg CO2 eq	7.2E-04	2.68E-05	7.44E-04	1.08E-07	7.44E-04
Ozone Depletion	kg CFC11 eq	4.7E-12	5.68E-13	5.25E-12	2.13E-10	2.19E-10
Acidification	mol H+ eq	3.0E-06	5.70E-08	3.06E-06	4.95E-08	3.11E-06
Eutrophication aquatic freshwater	kg P eq	2.3E-08	2.12E-10	2.31E-08	4.48E-07	4.71E-07
Eutrophication aquatic marine	kg N eq	5.6E-07	1.40E-08	5.74E-07	1.54E-07	7.27E-07
Eutrophication terrestrial	mol N eq	6.2E-06	1.46E-07	6.35E-06	5.69E-13	6.35E-06
Photochemical ozone formation	kg NMVOC eq	3.0E-06	8.85E-08	3.08E-06	7.57E-11	3.08E-06
Depletion of abiotic resources - minerals and metals	kg Sb eq	2.5E-09	8.53E-11	2.60E-09	2.68E-04	2.68E-04
Depletion of abiotic resources - fossil fuels	MJ, net calorific value	2.0E-02	3.71E-04	2.07E-02	1.10E-05	2.07E-02
Water use	m3 world eq. deprived	2.9E-04	1.55E-06	2.88E-04	2.77E-04	5.65E-04

Table 12: Use of resources for 1 kg Sodium Carbonate (Soda Ash)- Only Packaging Materials (Bigbag)

Impact category	Unit	Upstream	Core	A1-3 Total	Downstream	TOTAL
					End of Life	
Use of renewable primary energy excluding renewable primary energy resources used as raw materials	MJ, net calorific value	8.82E-04	5.82E-06	8.88E-04	6.41E-06	8.94E-04
Use of renewable primary energy resources used as raw materials		0	0	0.0	0	0

Total use of renewable primary energy resources (primary energy and primary energy resources used as raw materials)		8.82E-04	5.82E-06	8.88E-04	6.41E-06	8.94E-04
Use of non-renewable primary energy excluding nonrenewable primary energy resources used as raw materials	MJ, net calorific value	2.18E-02	3.94E-04	2.22E-02	2.85E-04	2.25E-02
Use of non-renewable primary energy resources used as raw materials		0	0	0.0	0	0
Total use of non-renewable primary energy resources (primary energy and primary energy resources used as raw materials)		2.18E-02	3.94E-04	2.22E-02	2.85E-04	2.25E-02
Use of secondary material	kg	0	0	0.0	0	0
Use of renewable secondary fuels	MJ, net calorific value	0	0	0.0	0	0
Use of non-renewable secondary fuels		0	0	0.0	0	0
Net use of fresh water	m3	5.31E-05	3.35E-07	5.35E-05	7.46E-07	5.42E-05

Table 13: Waste Production for 1 kg Sodium Carbonate (Soda Ash)- Only Packaging Materials (Bigbag)

Impact category	Unit	Upstream	Core	A1-3 Total	Downstream	**TOTAL**
					End of Life	
Hazardous waste disposed	kg	0	0	0	0.00	0
Non-hazardous waste disposed	kg	0	0	0	1.67E-04	1.67E-04
Radioactive waste disposed	kg	0	0	0	0.00	0

Table 14: Output Flows Production for 1 kg Sodium Carbonate (Soda Ash)- Only Packaging Materials (Bigbag)

Impact category	Unit	Upstream	Core	A1-3 Total	Downstream	**TOTAL**
					End of Life	
Components for re-use	kg	0	0	0	0.00	0
Materials for recycling	kg	0	0	0	3.28E-05	3.28E-05
Materials for energy recovery	kg	0	0	0	4.08E-05	4.08E-05
Exported energy - Electrical	MJ	0	0	0	0.00	0
Exported energy - Thermal	MJ	0	0	0	0.00	0

5.3 LCA Results for 1 kg of Sodium Carbonate (Soda Ash)- Only Packaging Materials (Smallbag)

Table 15: Potential environmental impact for 1 kg Sodium Carbonate (Soda Ash)-Only Packaging Materials (Smallbag)

Impact category	Unit	Upstream	Core	A1-3 Total	Downstream	TOTAL
					End of Life	
Climate change - fossil	kg CO2 eq	4.82E-05	1.79E-08	4.82E-05	1.63E-05	6.45E-05
Climate change - biogenic	kg CO2 eq	-5.76E-07	4.62E-11	-5.76E-07	5.29E-09	-5.71E-07
Climate change - land use and land use change	kg CO2 eq	4.28E-08	8.67E-12	4.28E-08	7.22E-10	4.35E-08
Climate change – total	kg CO2 eq	4.76E-05	1.79E-08	4.76E-05	7.12E-09	4.76E-05
Ozone Depletion	kg CFC11 eq	3.11E-13	3.79E-16	3.11E-13	1.41E-11	1.44E-11
Acidification	mol H+ eq	2.00E-07	3.81E-11	2.00E-07	3.26E-09	2.03E-07
Eutrophication aquatic freshwater	kg P eq	1.52E-09	1.42E-13	1.52E-09	2.95E-08	3.10E-08
Eutrophication aquatic marine	kg N eq	3.71E-08	9.37E-12	3.72E-08	1.01E-08	4.73E-08
Eutrophication terrestrial	mol N eq	4.12E-07	9.76E-11	4.12E-07	3.76E-14	4.12E-07
Photochemical ozone formation	kg NMVOC eq	1.98E-07	5.91E-11	1.98E-07	5.01E-12	1.98E-07
Depletion of abiotic resources - minerals and metals	kg Sb eq	1.67E-10	5.69E-14	1.67E-10	1.77E-05	1.77E-05
Depletion of abiotic resources - fossil fuels	MJ, net calorific value	1.35E-03	2.47E-07	1.35E-03	7.22E-07	1.35E-03
Water use	m3 world eq. deprived	1.90E-05	1.03E-09	1.90E-05	1.83E-05	3.73E-05

Table 16: Use of resources for 1 kg Sodium Carbonate (Soda Ash)- Only Packaging Materials (Smallbag)

Impact category	Unit	Upstream	Core	A1-3 Total	Downstream	TOTAL
					End of Life	
Use of renewable primary energy excluding renewable primary energy resources used as raw materials	MJ, net calorific value	5.86E-05	3.89E-09	5.86E-05	4.24E-07	5.90E-05
Use of renewable primary energy resources used as raw materials		0	0	0.0	0	0

Total use of renewable primary energy resources (primary energy and primary energy resources used as raw materials)		5.86E-05	3.89E-09	5.86E-05	4.24E-07	5.90E-05
Use of non-renewable primary energy excluding nonrenewable primary energy resources used as raw materials	MJ, net calorific value	1.45E-03	2.63E-07	1.45E-03	1.89E-05	1.47E-03
Use of non-renewable primary energy resources used as raw materials		0	0	0.0	0	0
Total use of non-renewable primary energy resources (primary energy and primary energy resources used as raw materials)		1.45E-03	2.63E-07	1.45E-03	1.89E-05	1.47E-03
Use of secondary material	kg	0	0	0.0	0	0
Use of renewable secondary fuels	MJ, net calorific value	0	0	0.0	0	0
Use of non-renewable secondary fuels		0	0	0.0	0	0
Net use of fresh water	m3	3.53E-06	2.23E-10	3.53E-06	4.92E-08	3.58E-06

Table 17: Waste Production for 1 kg Sodium Carbonate (Soda Ash)- Only Packaging Materials (Smallbag)

Impact category	Unit	Upstream	Core	A1-3 Total	Downstream	**TOTAL**
					End of Life	
Hazardous waste disposed	kg	0	0	0	0.00	0
Non-hazardous waste disposed	kg	0	0	0	1.09E-05	1.09E-05
Radioactive waste disposed	kg	0	0	0	0.00	0

Table 18: Output Flows Production for 1 kg Sodium Carbonate (Soda Ash)- Only Packaging Materials (Smallbag)

Impact category	Unit	Upstream	Core	A1-3 Total	Downstream	**TOTAL**
					End of Life	
Components for re-use	kg	0	0	0	0.00	0
Materials for recycling	kg	0	0	0	5.24E-05	5.24E-05
Materials for energy recovery	kg	0	0	0	6.52E-05	6.52E-05
Exported energy - Electrical	MJ	0	0	0	0.00	0
Exported energy - Thermal	MJ	0	0	0	0.00	0

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5.4 LCA Results for 1 kg Sodium Carbonate (Soda Ash)-Only Packaging Materials (Pallet)

Table 19: Potential environmental impact for 1 kg Sodium Carbonate (Soda Ash)-Only Packaging Materials (Pallet)

Impact category	Unit	Upstream	Core	A1-3 Total	Downstream	TOTAL
					End of Life	
Climate change - fossil	kg CO2 eq	1.12E-04	3.13E-05	1.43E-04	2.24E-05	1.66E-04
Climate change - biogenic	kg CO2 eq	-8.86E-04	8.08E-08	-8.85E-04	7.36E-08	-8.85E-04
Climate change - land use and land use change	kg CO2 eq	6.84E-07	1.52E-08	6.99E-07	1.29E-08	7.12E-07
Climate change – total	kg CO2 eq	-7.73E-04	3.14E-05	-7.41E-04	4.65E-08	-7.41E-04
Ozone Depletion	kg CFC11 eq	2.87E-12	6.63E-13	3.53E-12	2.10E-10	2.14E-10
Acidification	mol H+ eq	6.28E-07	6.66E-08	6.95E-07	1.05E-08	7.05E-07
Eutrophication aquatic freshwater	kg P eq	1.16E-08	2.48E-10	1.19E-08	1.09E-07	1.21E-07
Eutrophication aquatic marine	kg N eq	1.88E-07	1.64E-08	2.04E-07	6.87E-08	2.73E-07
Eutrophication terrestrial	mol N eq	2.13E-06	1.71E-07	2.30E-06	4.76E-13	2.30E-06
Photochemical ozone formation	kg NMVOC eq	9.25E-07	1.03E-07	1.03E-06	9.53E-11	1.03E-06
Depletion of abiotic resources - minerals and metals	kg Sb eq	6.08E-10	9.96E-11	7.08E-10	3.07E-04	3.07E-04
Depletion of abiotic resources - fossil fuels	MJ, net calorific value	1.87E-03	4.33E-04	2.30E-03	1.29E-06	2.30E-03
Water use	m3 world eq. deprived	5.60E-05	1.81E-06	5.78E-05	3.17E-04	3.74E-04

Table 20: Use of resources for 1 kg Sodium Carbonate (Soda Ash)- Only Packaging Materials (Pallet)

Impact category	Unit	Upstream	Core	A1-3 Total	Downstream	TOTAL
					End of Life	
Use of renewable primary energy excluding renewable primary energy resources used as raw materials	MJ, net calorific value	1.08E-02	6.80E-06	1.08E-02	6.68E-06	1.08E-02
Use of renewable primary energy resources used as raw materials		0	0	0.0	0	0

Total use of renewable primary energy resources (primary energy and primary energy resources used as raw materials)		1.08E-02	6.80E-06	1.08E-02	6.68E-06	1.08E-02
Use of non-renewable primary energy excluding nonrenewable primary energy resources used as raw materials	MJ, net calorific value	2.01E-03	4.60E-04	2.47E-03	3.27E-04	2.79E-03
Use of non-renewable primary energy resources used as raw materials		0	0	0.0	0	0
Total use of non-renewable primary energy resources (primary energy and primary energy resources used as raw materials)		2.01E-03	4.60E-04	2.47E-03	3.27E-04	2.79E-03
Use of secondary material	kg	0	0	0.0	0	0
Use of renewable secondary fuels	MJ, net calorific value	0	0	0.0	0	0
Use of non-renewable secondary fuels		0	0	0.0	0	0
Net use of fresh water	m3	7.91E-06	3.91E-07	8.30E-06	3.25E-07	8.63E-06

Table 21: Waste Production for 1 kg Sodium Carbonate (Soda Ash)- Only Packaging Materials (Pallet)

Impact category	Unit	Upstream	Core	A1-3 Total	Downstream	**TOTAL**
					End of Life	
Hazardous waste disposed	kg	0	0	0	0	0
Non-hazardous waste disposed	kg	0	0	0	0	0.0
Radioactive waste disposed	kg	0	0	0	0	0

Table 22: Output Flows Production for 1 kg Sodium Carbonate (Soda Ash)- Only Packaging Materials (Pallet)

Impact category	Unit	Upstream	Core	A1-3 Total	Downstream	**TOTAL**
					End of Life	
Components for re-use	kg	0	0	0	0.00	0
Materials for recycling	kg	0	0	0	3.93E-04	3.93E-04
Materials for energy recovery	kg	0	0	0	0.00	0
Exported energy - Electrical	MJ	0	0	0	0.00	0
Exported energy - Thermal	MJ	0	0	0	0.00	0

5.5 LCA Results for 1 kg of Sodium Bicarbonate – Without Packaging[2]

Table 233: Potential environmental impact for 1 kg Sodium Bicarbonate -Without Packaging

Impact category	Unit	Upstream	Core		Total	Downstream	TOTAL
		Raw Materials Supply	Transport	Manufacturing		Transportation	
Climate change - fossil	kg CO2 eq	2.03E-03	2.17E-09	4.42E-02	0.05	2.72E-01	0.32
Climate change - biogenic	kg CO2 eq	8.85E-06	5.62E-12	6.51E-05	7.39E-05	1.85E-04	2.59E-04
Climate change - land use and land use change	kg CO2 eq	2.08E-06	1.05E-12	4.90E-05	5.11E-05	1.77E-04	2.28E-04
Climate change – total	kg CO2 eq	2.04E-03	2.18E-09	4.43E-02	4.63E-02	2.72E-01	0.32
Ozone Depletion	kg CFC11 eq	6.00E-10	4.61E-17	1.46E-09	2.06E-09	4.80E-09	6.86E-09
Acidification	mol H+ eq	6.93E-06	4.63E-12	6.91E-05	7.60E-05	5.08E-03	5.16E-03
Eutrophication aquatic freshwater	kg P eq	6.06E-08	1.72E-14	5.62E-07	6.23E-07	1.51E-06	2.13E-06
Eutrophication aquatic marine	kg N eq	1.33E-06	1.14E-12	1.75E-05	1.89E-05	1.27E-03	1.29E-03
Eutrophication terrestrial	mol N eq	1.48E-05	1.19E-11	1.93E-04	2.08E-04	1.40E-02	1.43E-02
Photochemical ozone formation	kg NMVOC eq	4.83E-06	7.19E-12	9.60E-05	1.01E-04	4.02E-03	4.12E-03
Depletion of abiotic resources - minerals and metals	kg Sb eq	9.62E-09	6.93E-15	1.81E-08	2.77E-08	3.6	3.56E+00
Depletion of abiotic resources - fossil fuels	MJ, net calorific value	1.75E-02	3.01E-08	6.07E-01	6.24E-01	3.6	4.18
Water use	m3 world eq. deprived	1.00E-03	1.26E-10	1.64E-02	1.74E-02	0.01	0.03

Table 24: Use of resources for 1 kg Sodium Bicarbonate-Without Packaging

Impact category	Unit	Upstream	Core		A1-3 Total	Downstream	TOTAL
		A1	A2	A3			
		Raw Materials Supply	Transport	Manufacturing		Downstream Transportation	
Use of renewable primary energy excluding renewable primary energy resources used as raw materials	MJ, net calorific value	1.83E-03	4.73E-10	1.47E-02	1.66E-02	3.71E-02	5.36E-02

[2] As the PCR requirement, the results of the packaging are separated from the product results

Use of renewable primary energy resources used as raw materials		0	0	0	0.0	0	0.0
Total use of renewable primary energy resources (primary energy and primary energy resources used as raw materials)		1.83E-03	4.73E-10	1.47E-02	1.66E-02	3.71E-02	5.36E-02
Use of non-renewable primary energy excluding nonrenewable primary energy resources used as raw materials	MJ, net calorific value	1.86E-02	3.20E-08	0.67	0.7	3.78	4.47
Use of non-renewable primary energy resources used as raw materials		0	0	0	0	0	0
Total use of non-renewable primary energy resources (primary energy and primary energy resources used as raw materials)		1.86E-02	3.20E-08	0.67	0.7	3.78	4.47E+00
Use of secondary material	kg	0	0	0	0	0	0
Use of renewable secondary fuels	MJ, net calorific value	0	0	0	0	0	0
Use of non-renewable secondary fuels		0	0	0	0	0	0
Net use of fresh water	m3	1.26E-04	2.72E-11	5.79E-03	5.91E-03	2.43E-03	8.34E-03

Table 25: Waste Production for 1 kg Sodium Bicarbonate-Without Packaging

Impact category	Unit	Upstream	Core		A1-3 Total	Downstream	TOTAL
		A1	A2	A3		Downstream Transportation	
		Raw Materials Supply	Transport	Manufacturing			
Hazardous waste disposed	kg	0	0	0	0	0.00	0
Non-hazardous waste disposed	kg	0	0	0	0	0.00	0
Radioactive waste disposed	kg	0	0	0	0	0.00	0

Table 26: Output Flows Production for 1 kg Sodium Bicarbonate-Without Packaging

Impact category	Unit	Upstream	Core		A1-3 Total	Downstream	TOTAL
		A1	A2	A3		Downstream Transportation	
		Raw Materials Supply	Transport	Manufacturing			
Components for re-use	kg	0	0	0	0	0.00	0
Materials for recycling	kg	0	0	0	0	0.00	0

Materials for energy recovery	kg	0	0	0	0	0.00	0
Exported energy - Electrical	MJ	0	0	0	0	0.00	0
Exported energy - Thermal	MJ	0	0	0	0	0.00	0

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5.6 LCA Results for 1 kg of Sodium Bicarbonate – Only Packaging Materials (Bigbag)

Table 27: Potential environmental impact for 1 kg Sodium Bicarbonate -Only Packaging Materials (bigbag)

Impact category	Unit	Upstream	Core	A1-3 Total	Downstream End of Life	TOTAL
Climate change - fossil	kg CO2 eq	4.66E-04	1.72E-05	4.83E-04	1.60E-04	6.44E-04
Climate change - biogenic	kg CO2 eq	-5.57E-06	4.45E-08	-5.53E-06	5.16E-08	-5.48E-06
Climate change - land use and land use change	kg CO2 eq	4.14E-07	8.35E-09	4.23E-07	7.02E-09	4.30E-07
Climate change – total	kg CO2 eq	4.61E-04	1.73E-05	4.78E-04	6.96E-08	4.78E-04
Ozone Depletion	kg CFC11 eq	3.01E-12	3.65E-13	3.37E-12	1.37E-10	1.41E-10
Acidification	mol H+ eq	1.93E-06	3.67E-08	1.97E-06	3.19E-08	2.00E-06
Eutrophication aquatic freshwater	kg P eq	1.47E-08	1.36E-10	1.48E-08	2.89E-07	3.04E-07
Eutrophication aquatic marine	kg N eq	3.60E-07	9.02E-09	3.69E-07	9.90E-08	4.68E-07
Eutrophication terrestrial	mol N eq	3.99E-06	9.40E-08	4.08E-06	3.66E-13	4.08E-06
Photochemical ozone formation	kg NMVOC eq	1.92E-06	5.69E-08	1.98E-06	4.87E-11	1.98E-06
Depletion of abiotic resources - minerals and metals	kg Sb eq	1.61E-09	5.48E-11	1.67E-09	1.72E-04	1.72E-04
Depletion of abiotic resources - fossil fuels	MJ, net calorific value	1.31E-02	2.38E-04	1.33E-02	7.08E-06	1.33E-02
Water use	m3 world eq. deprived	1.84E-04	9.96E-07	1.85E-04	1.78E-04	3.63E-04

Table 28: Use of resources for 1 kg Sodium Bicarbonate -Only Packaging Materials (bigbag)

Impact category	Unit	Upstream	Core	Total	Downstream End of Life	TOTAL
Use of renewable primary energy excluding renewable primary energy resources used as raw materials	MJ, net calorific value	5.67E-04	3.74E-06	5.71E-04	4.13E-06	5.75E-04
Use of renewable primary energy resources used as raw materials		0	0	0.0	0	0

Total use of renewable primary energy resources (primary energy and primary energy resources used as raw materials)		5.67E-04	3.74E-06	5.71E-04	4.13E-06	5.75E-04
Use of non-renewable primary energy excluding nonrenewable primary energy resources used as raw materials		1.40E-02	2.53E-04	1.43E-02	1.84E-04	1.45E-02
Use of non-renewable primary energy resources used as raw materials	MJ, net calorific value	0	0	0.0	0	0
Total use of non-renewable primary energy resources (primary energy and primary energy resources used as raw materials)		1.40E-02	2.53E-04	1.43E-02	1.84E-04	1.45E-02
Use of secondary material	kg	0	0	0.0	0	0
Use of renewable secondary fuels	MJ, net calorific value	0	0	0.0	0	0
Use of non-renewable secondary fuels		0	0	0.0	0	0
Net use of fresh water	m3	3.42E-05	2.15E-07	3.44E-05	4.81E-07	3.49E-05

Table 29: Waste Production for 1 kg Sodium Bicarbonate -Only Packaging Materials (bigbag)

Impact category	Unit	Upstream	Core	Total	Downstream	**TOTAL**
					End of Life	
Hazardous waste disposed	kg	0	0	0	0	0
Non-hazardous waste disposed	kg	0	0	0	1.08E-04	1.08E-04
Radioactive waste disposed	kg	0	0	0	0	0

Table 30: Output Flows Production for 1 kg Sodium Bicarbonate -Only Packaging Materials (bigbag)

Impact category	Unit	Upstream	Core	Total	Downstream	**TOTAL**
					End of Life	
Components for re-use	kg	0	0	0	0.00	0
Materials for recycling	kg	0	0	0	2.11E-05	2.11E-05
Materials for energy recovery	kg	0	0	0	2.62E-05	2.62E-05
Exported energy - Electrical	MJ	0	0	0	0.00	0
Exported energy - Thermal	MJ	0	0	0	0.00	0

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5.7 LCA Results for 1 kg of Sodium Bicarbonate – Only Packaging Materials (Smallbag)

Table 31. Potential environmental impact for 1 kg Sodium Bicarbonate -Only Packaging Materials (Smallbag)

Impact category	Unit	Upstream	Core	Total	Downstream	TOTAL
					End of Life	
Climate change - fossil	kg CO2 eq	1.16E-03	4.38E-07	1.16E-03	4.00E-04	1.56E-03
Climate change - biogenic	kg CO2 eq	-1.39E-05	1.13E-09	-1.39E-05	1.28E-07	-1.37E-05
Climate change - land use and land use change	kg CO2 eq	1.03E-06	2.12E-10	1.03E-06	1.73E-08	1.05E-06
Climate change – total	kg CO2 eq	1.15E-03	4.39E-07	1.15E-03	1.73E-07	1.15E-03
Ozone Depletion	kg CFC11 eq	7.47E-12	9.28E-15	7.48E-12	3.40E-10	3.47E-10
Acidification	mol H+ eq	4.80E-06	9.33E-10	4.80E-06	7.96E-08	4.88E-06
Eutrophication aquatic freshwater	kg P eq	3.65E-08	3.47E-12	3.65E-08	7.21E-07	7.57E-07
Eutrophication aquatic marine	kg N eq	8.94E-07	2.30E-10	8.94E-07	2.46E-07	1.14E-06
Eutrophication terrestrial	mol N eq	9.90E-06	2.39E-09	9.91E-06	9.07E-13	9.91E-06
Photochemical ozone formation	kg NMVOC eq	4.77E-06	1.45E-09	4.77E-06	1.20E-10	4.77E-06
Depletion of abiotic resources - minerals and metals	kg Sb eq	4.01E-09	1.39E-12	4.01E-09	4.25E-04	4.25E-04
Depletion of abiotic resources - fossil fuels	MJ, net calorific value	3.25E-02	6.06E-06	3.25E-02	1.77E-05	3.25E-02
Water use	m3 world eq. deprived	4.57E-04	2.53E-08	4.57E-04	4.40E-04	8.97E-04

Table 32: Use of resources for 1 kg Sodium Bicarbonate -Only Packaging Materials (Smallbag)

Impact category	Unit	Upstream	Core	A1-3 Total	Downstream	TOTAL
					End of Life	
Use of renewable primary energy excluding renewable primary energy resources used as raw materials	MJ, net calorific value	1.41E-03	9.53E-08	1.41E-03	1.02E-05	1.42E-03
Use of renewable primary energy resources used as raw materials	MJ, net calorific value	0	0	0	0	0

Total use of renewable primary energy resources (primary energy and primary energy resources used as raw materials)		1.41E-03	9.53E-08	1.41E-03	1.02E-05	1.42E-03
Use of non-renewable primary energy excluding nonrenewable primary energy resources used as raw materials		3.48E-02	6.44E-06	3.48E-02	4.53E-04	3.53E-02
Use of non-renewable primary energy resources used as raw materials	MJ, net calorific value	0	0	0	0	0
Total use of non-renewable primary energy resources (primary energy and primary energy resources used as raw materials)		3.48E-02	6.44E-06	3.48E-02	4.53E-04	3.53E-02
Use of secondary material	kg	0	0	0	0	0
Use of renewable secondary fuels	MJ, net calorific value	0	0	0	0	0
Use of non-renewable secondary fuels		0	0	0	0	0
Net use of fresh water	m3	8.49E-05	5.47E-09	8.49E-05	1.20E-06	8.61E-05

Table 33: Waste Production for 1 kg Sodium Bicarbonate -Only Packaging Materials (Smallbag)

Impact category	Unit	Upstream	Core	A1-3 Total	Downstream	**TOTAL**
					End of Life	
Hazardous waste disposed	kg	0	0	0	0	0
Non-hazardous waste disposed	kg	0	0	0	2.67E-04	2.67E-04
Radioactive waste disposed	kg	0	0	0	0	0

Table 34: Output Flows Production for 1 kg Sodium Bicarbonate -Only Packaging Materials (Smallbag)

Impact category	Unit	Upstream	Core	A1-3 Total	Downstream	**TOTAL**
					End of Life	
Components for re-use	kg	0	0	0	0.00	0
Materials for recycling	kg	0	0	0	5.24E-05	5.24E-05
Materials for energy recovery	kg	0	0	0	6.52E-05	6.52E-05
Exported energy - Electrical	MJ	0	0	0	0.00	0
Exported energy - Thermal	MJ	0	0	0	0.00	0

5.8 LCA Results for 1 kg of Sodium Bicarbonate – Only Packaging Materials (Pallet)

Table 35: Potential environmental impact for 1 kg Sodium Bicarbonate -Only Packaging Materials (pallet)

Impact category	Unit	Upstream	Core	A1-3 Total	Downstream End of Life	TOTAL
Climate change - fossil	kg CO2 eq	4.39E-04	1.76E-04	6.16E-04	1.27E-04	7.42E-04
Climate change - biogenic	kg CO2 eq	-3.47E-03	4.56E-07	-3.47E-03	4.15E-07	-3.47E-03
Climate change - land use and land use change	kg CO2 eq	2.68E-06	8.56E-08	2.76E-06	7.28E-08	2.84E-06
Climate change – total	kg CO2 eq	-3.03E-03	1.77E-04	-2.85E-03	2.62E-07	-2.85E-03
Ozone Depletion	kg CFC11 eq	1.12E-11	3.74E-12	1.50E-11	1.19E-09	1.20E-09
Acidification	mol H+ eq	2.46E-06	3.76E-07	2.84E-06	5.90E-08	2.90E-06
Eutrophication aquatic freshwater	kg P eq	4.55E-08	1.40E-09	4.69E-08	6.17E-07	6.64E-07
Eutrophication aquatic marine	kg N eq	7.37E-07	9.25E-08	8.29E-07	3.87E-07	1.22E-06
Eutrophication terrestrial	mol N eq	8.33E-06	9.64E-07	9.29E-06	2.68E-12	9.29E-06
Photochemical ozone formation	kg NMVOC eq	3.62E-06	5.84E-07	4.21E-06	5.37E-10	4.21E-06
Depletion of abiotic resources - minerals and metals	kg Sb eq	2.38E-09	5.62E-10	2.94E-09	1.73E-03	1.73E-03
Depletion of abiotic resources - fossil fuels	MJ, net calorific value	7.32E-03	2.44E-03	9.76E-03	7.27E-06	9.77E-03
Water use	m3 world eq. deprived	2.19E-04	1.02E-05	2.30E-04	1.79E-03	2.02E-03

Table 36: Use of resources for 1 kg Sodium Bicarbonate -Only Packaging Materials (pallet)

Impact category	Unit	Upstream	Core	A1-3 Total	Downstream End of Life	TOTAL
Use of renewable primary energy excluding renewable primary energy resources used as raw materials	MJ, net calorific value	4.21E-02	3.84E-05	4.22E-02	3.77E-05	4.22E-02
Use of renewable primary energy resources used as raw materials		0	0	0.0	0	0
Total use of renewable primary energy resources (primary energy and primary energy resources used as raw materials)		4.21E-02	3.84E-05	4.22E-02	3.77E-05	4.22E-02

Use of non-renewable primary energy excluding nonrenewable primary energy resources used as raw materials	MJ, net calorific value	7.85E-03	2.60E-03	1.05E-02	1.84E-03	1.23E-02
Use of non-renewable primary energy resources used as raw materials		0	0	0.0	0	0
Total use of non-renewable primary energy resources (primary energy and primary energy resources used as raw materials)		7.85E-03	2.60E-03	1.05E-02	1.84E-03	1.23E-02
Use of secondary material	kg	0	0	0.0	0	0
Use of renewable secondary fuels	MJ, net calorific value	0	0	0.0	0	0
Use of non-renewable secondary fuels		0	0	0.0	0	0
Net use of fresh water	m3	3.10E-05	2.20E-06	3.32E-05	1.83E-06	3.50E-05

Table 37: Waste Production for 1 kg Sodium Bicarbonate -Only Packaging Materials (pallet)

Impact category	Unit	Upstream	Core	A1-3 Total	Downstream	**TOTAL**
					End of Life	
Hazardous waste disposed	kg	0	0	0	0	0
Non-hazardous waste disposed	kg	0	0	0	0	0
Radioactive waste disposed	kg	0	0	0	0	0

Table 38: Output Flows Production for 1 kg Sodium Bicarbonate -Only Packaging Materials (pallet)

Impact category	Unit	Upstream	Core	A1-3 Total	Downstream	**TOTAL**
					End of Life	
Components for re-use	kg	0	0	0	0	0
Materials for recycling	kg	0	0	0	2.22E-03	2.22E-03
Materials for energy recovery	kg	0	0	0	0	0
Exported energy - Electrical	MJ	0	0	0	0	0
Exported energy - Thermal	MJ	0	0	0	0	0

6 ADDITIONAL INFORMATION

By-product has been generated by the production process.

During manufacturing, calcium carbonate, deka purge and salt are produced as by-product. Therefore, calcium carbonate, deka purge and salt have been excluded from system boundaries, and mass allocation is proceeded.

Manufacturing data, raw materials and energy consumption are allocated for two main products (Natural Soda Ash and sodium bicarbonate) and three by-product (calcium carbonate, deka purge and salt), by using mass allocation. It is not possible to exact divide the unit process into two or more sub-processes and collecting the environmental data related to Natural Soda Ash and sodium bicarbonate separately. That means mass allocation obtained for Natural Soda Ash and sodium bicarbonate. Kazan Soda cannot monitor and record raw material and energy consumptions for products and by products separately.

7 LIFE CYCLE INTERPRETATION

7.1 Sodium Carbonate (Soda Ash)-Without Packaging

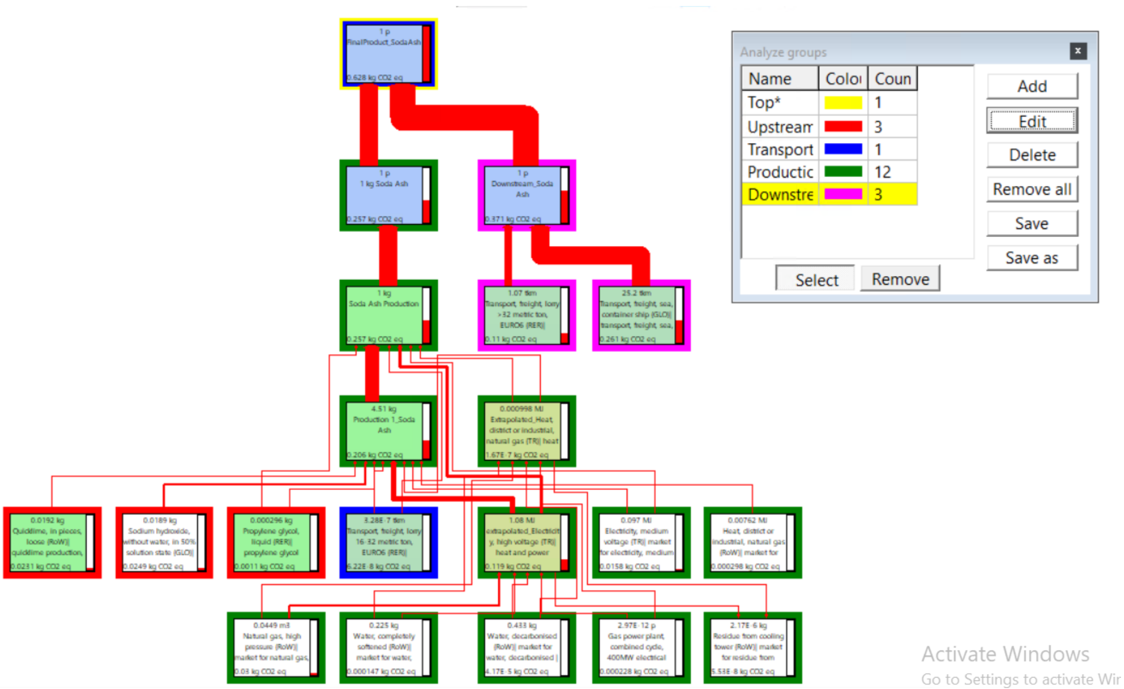

Figure 5: Global Warming Potential network flow for 1 kg of soda ash-without packaging

The relative impacts of all life cycle stages for 1 kg of Sodium Carbonate is presented in Figure 5 for each impact category. Electricity of the product life cycle appears as the highest impact contributor.

Long-term emissions (>100 years) are not taken into consideration in the impact estimate. In this interpretation section, SimaPro LCA model is presented for only considering Climate Change Fossil results as kg CO2 eq. All other LCIA results are also presented as bar charts in the Figure 5.

The climate change fossil value of the final Product is 0.628 kg CO_2 e.

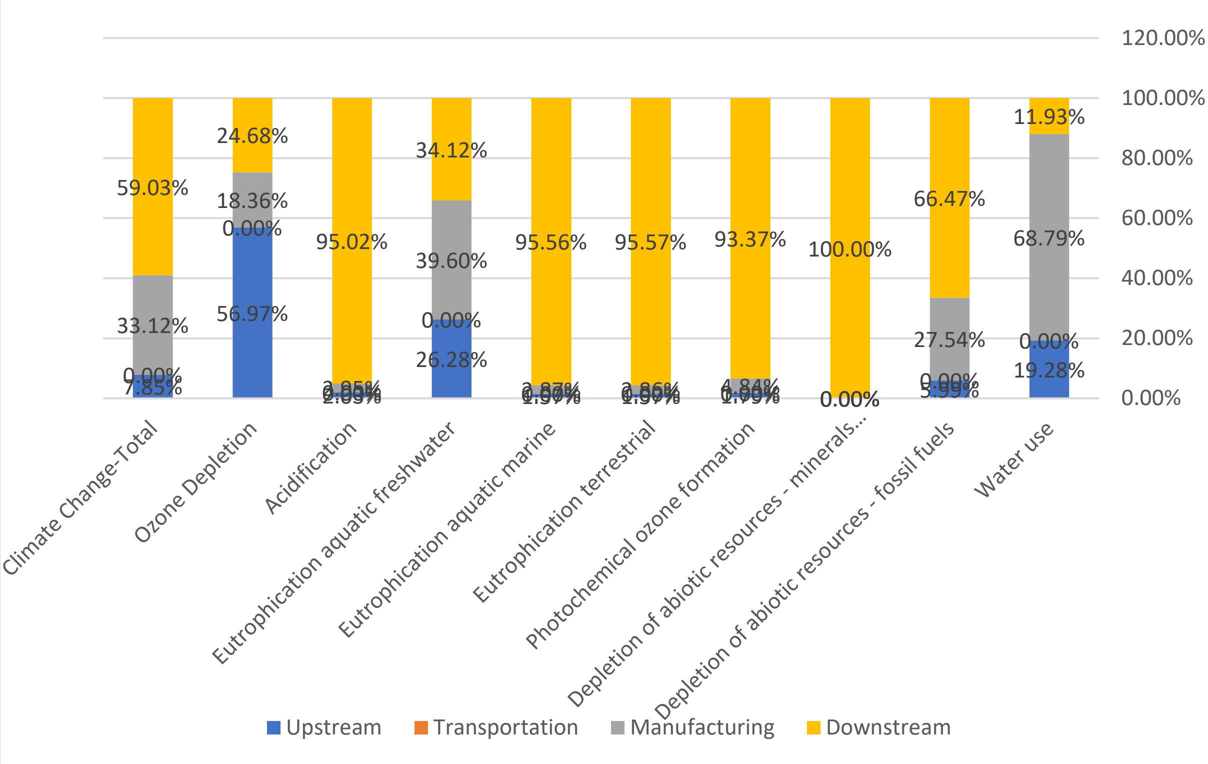

Figure 6: Potential environmental impact per module for 1 kg of soda ash-without packaging

Environmental indicators caused by per life cycle module 1 kg of Sodium Carbonate is presented in Figure 6. Environmental impacts caused by Core module is appeared to be dominant for climate change and it is the main hotspot in all environmental impact indicators.

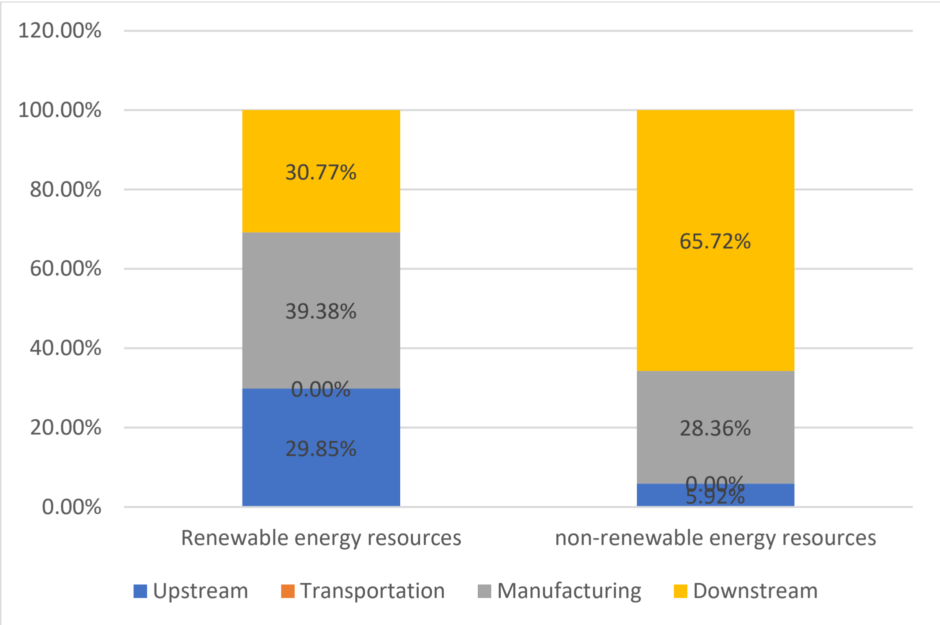

Figure 7: Energy consumption per module for 1 kg of soda ash-without packaging

Figure 7 shows the energy consumption at each module of the life cycle by source (renewable or non-renewable). Fossil energy sources are the most dominant at Core life cycle stage.

7.2 Sodium Carbonate (Soda Ash)-Only Packaging Materials (bigbag)

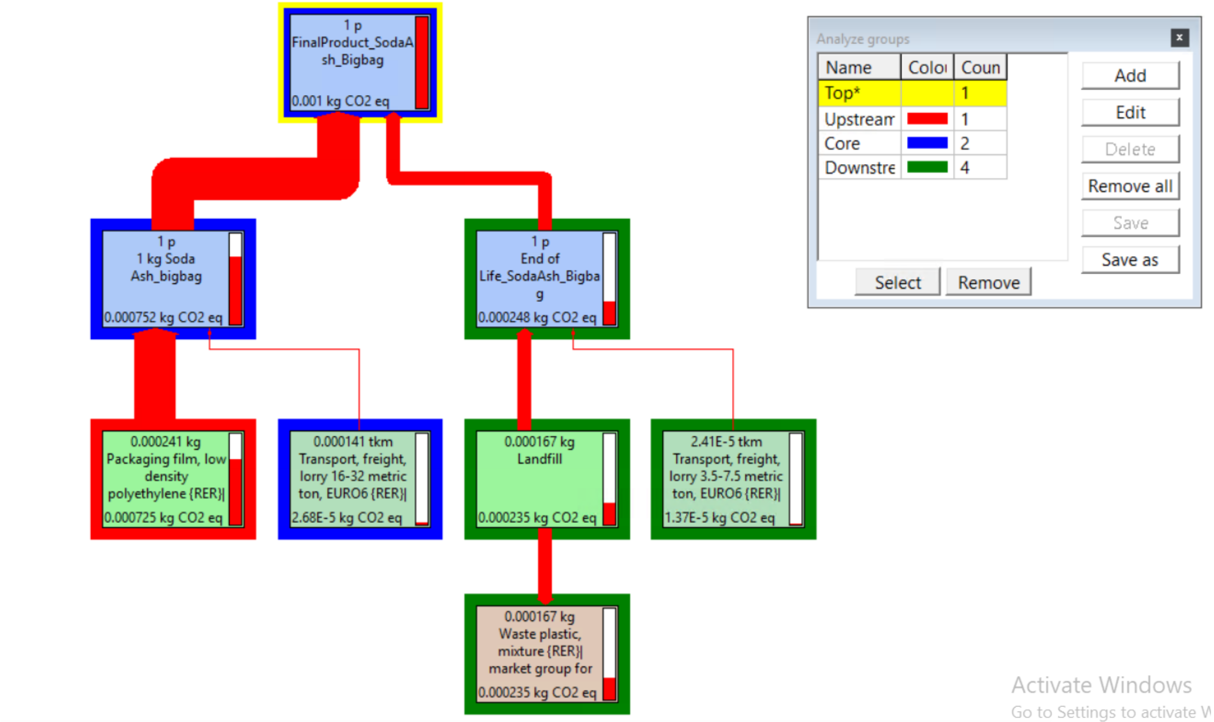

Figure 8: Global Warming Potential network flow for 1 kg of soda ash-bigbag

The relative impacts of all life cycle stages for 1 kg of Sodium Carbonate is presented in Figure 8 for each impact category. Electricity of the product life cycle appears as the highest impact contributor.

Long-term emissions (>100 years) are not taken into consideration in the impact estimate. In this interpretation section, SimaPro LCA model is presented for only considering Climate Change Fossil results as kg CO2 eq. All other LCIA results are also presented as bar charts in the Figure 8.

The climate change fossil value of the final Product is 0.001 kg CO_2 e.

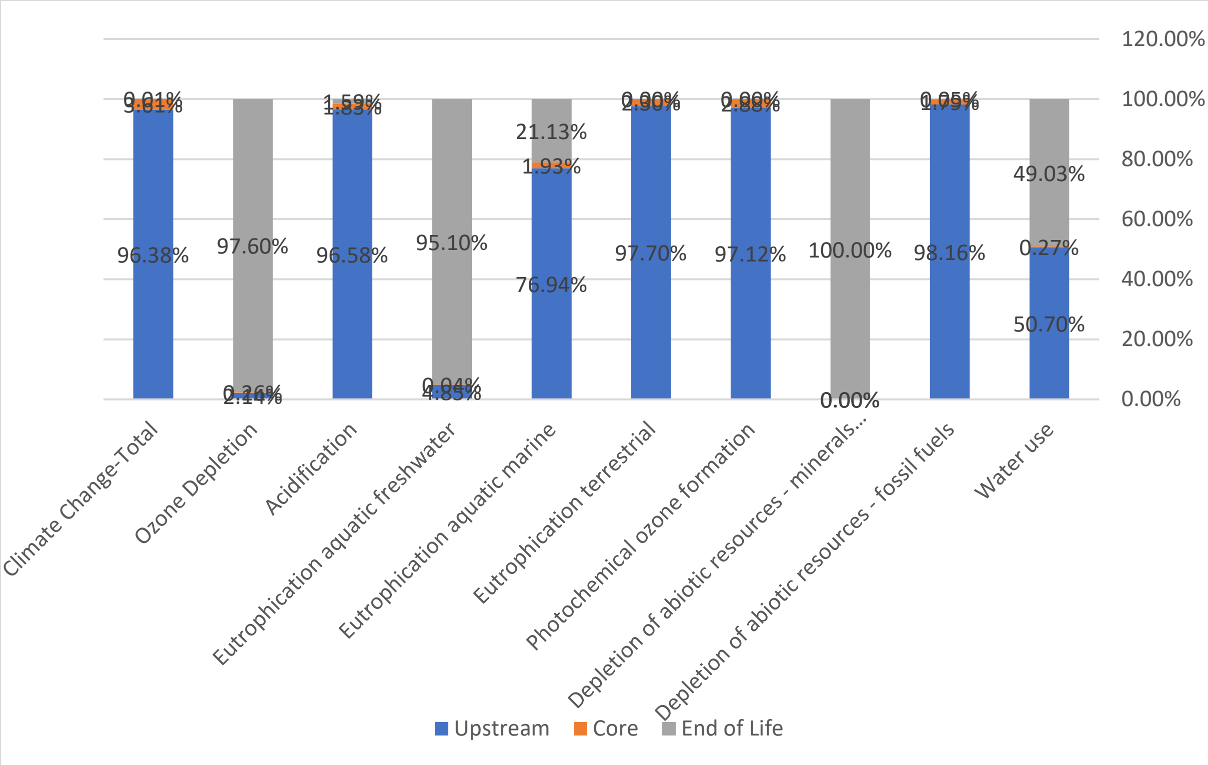

Figure 9: Potential environmental impact per module for 1 kg of soda ash-bigbag

Environmental indicators caused by per life cycle module 1 kg of Sodium Carbonate-bigbag is presented in Figure 9. Environmental impacts caused by Core module is appeared to be dominant for climate change and it is the main hotspot in all environmental impact indicators.

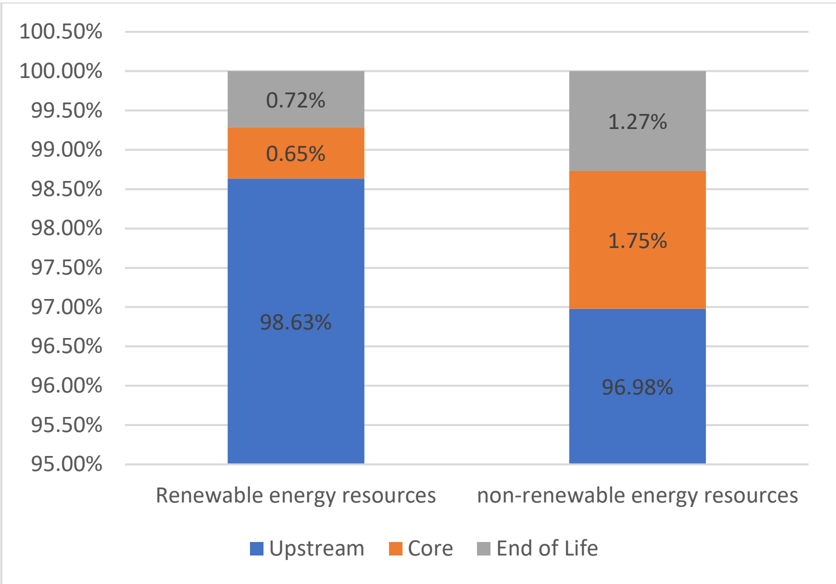

Figure 10: Energy consumption per module for 1 kg of soda ash-bigbag

Figure 10 shows the energy consumption at each module of the life cycle by source (renewable or non-renewable). Fossil energy sources are the most dominant at Core life cycle stage.

7.3 Sodium Carbonate (Soda Ash)-Only Packaging Materials (smallbag)

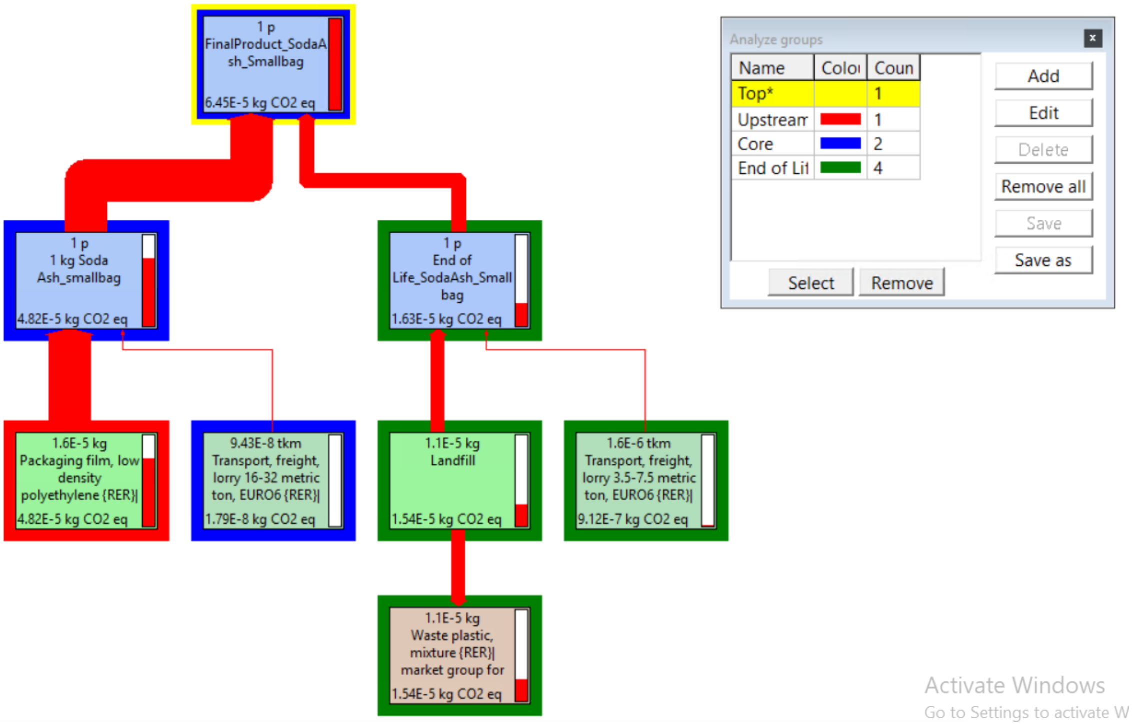

Figure 11: Global Warming Potential network flow for 1 kg of soda ash-small bag

The relative impacts of all life cycle stages for 1 kg of Sodium Carbonate is presented in Figure 11 for each impact category. Electricity of the product life cycle appears as the highest impact contributor.

Long-term emissions (>100 years) are not taken into consideration in the impact estimate. In this interpretation section, SimaPro LCA model is presented for only considering Climate Change Fossil results as kg CO2 eq. All other LCIA results are also presented as bar charts in the Figure 11.

The climate change fossil value of the final Product is 6.45E-5 kg CO_2 e.

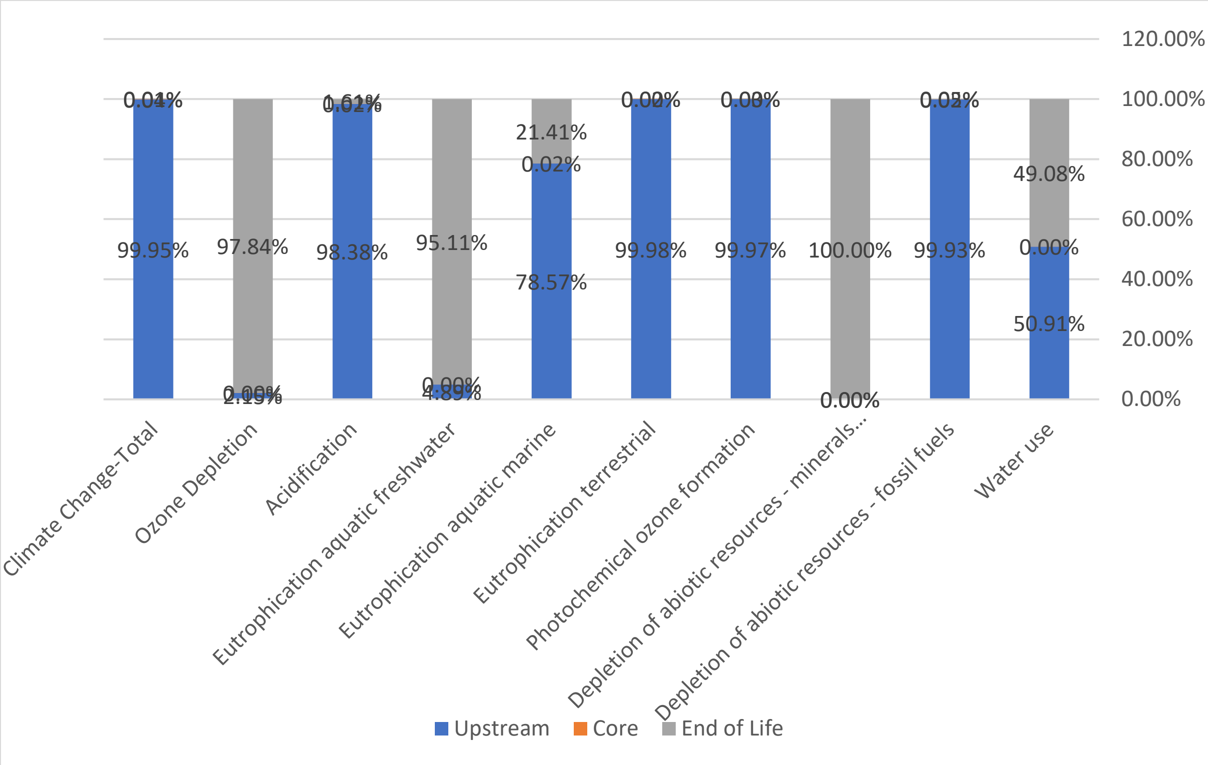

Figure 12: Potential environmental impact per module for 1 kg of soda ash-smallbag

Environmental indicators caused by per life cycle module 1 kg of Sodium Carbonate-smallbag is presented in Figure 12. Environmental impacts caused by Core module is appeared to be dominant for climate change and it is the main hotspot in all environmental impact indicators.

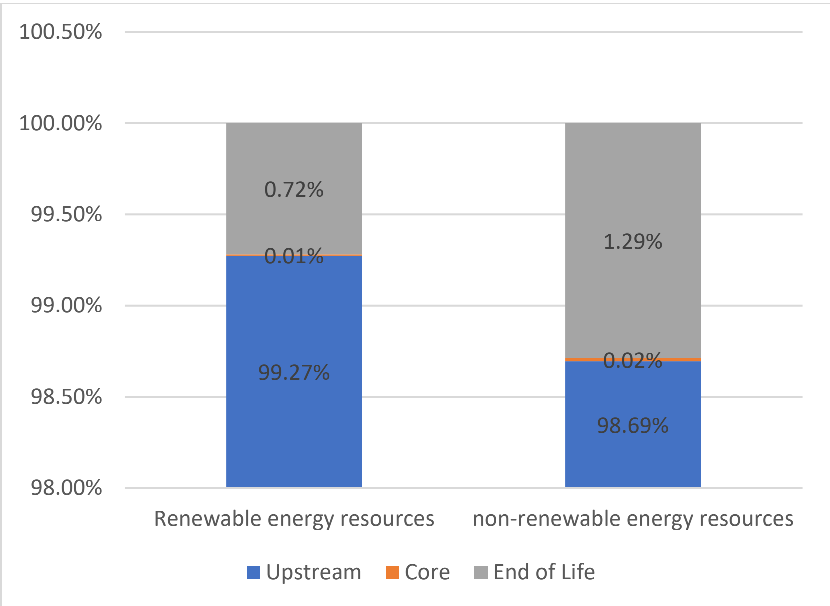

Figure 13: Energy consumption per module for 1 kg of soda ash-smallbag

Figure 13 shows the energy consumption at each module of the life cycle by source (renewable or non-renewable). Fossil energy sources are the most dominant at Core life cycle stage.

7.4 Sodium Carbonate (Soda Ash)-Only Packaging Materials (pallet)

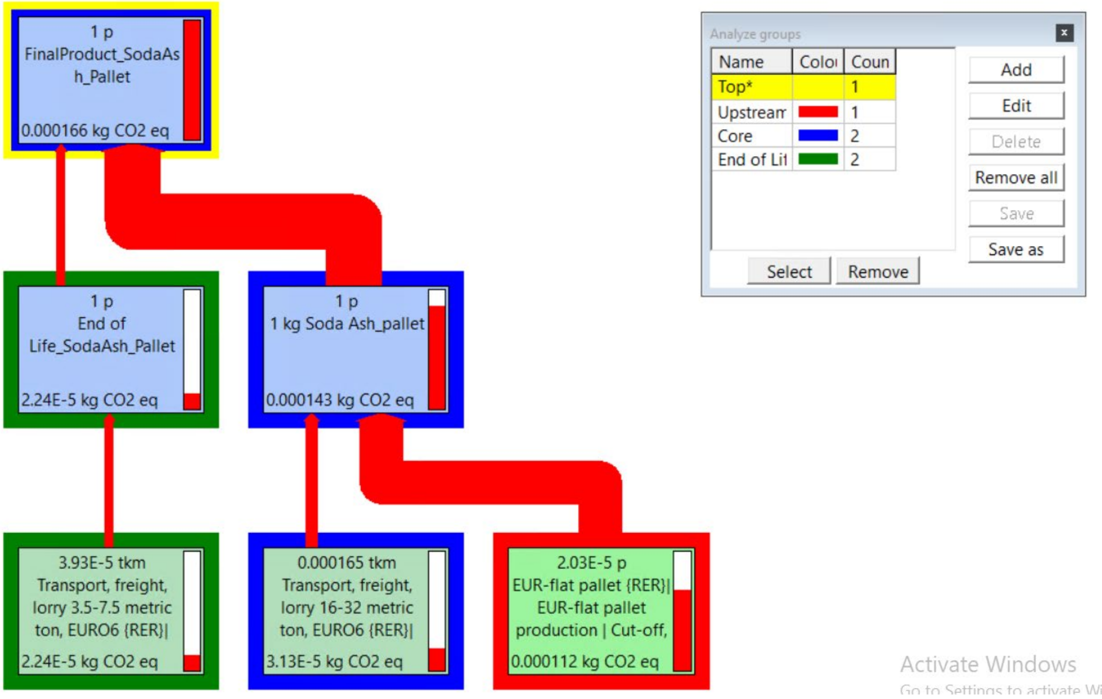

Figure 14: Global Warming Potential network flow for 1 kg of soda ash-pallet

The relative impacts of all life cycle stages for 1 kg of Sodium Carbonate is presented in Figure 14 for each impact category. Electricity of the product life cycle appears as the highest impact contributor.

Long-term emissions (>100 years) are not taken into consideration in the impact estimate. In this interpretation section, SimaPro LCA model is presented for only considering Climate Change Fossil results as kg CO2 eq. All other LCIA results are also presented as bar charts in the Figure 14.

The climate change fossil value of the final Product is 0.000166 kg CO_2 e.

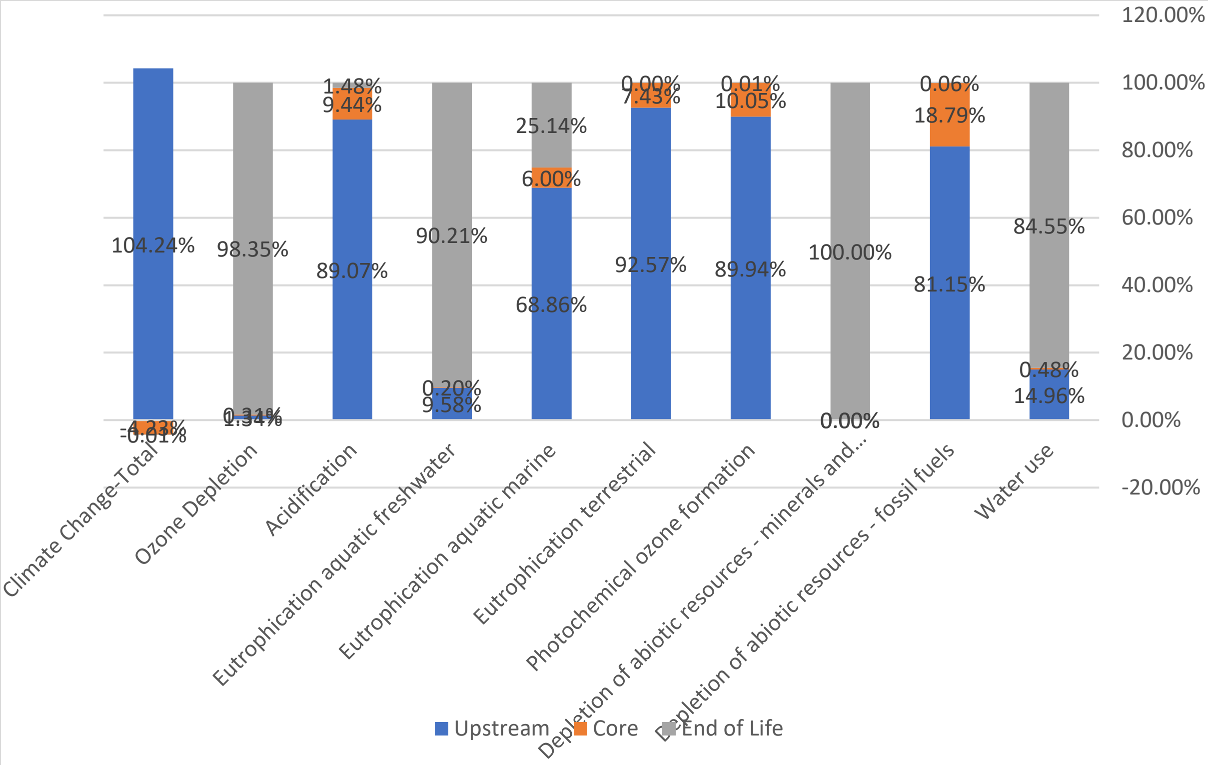

Figure 15: Potential environmental impact per module for 1 kg of soda ash-pallet

Environmental indicators caused by per life cycle module 1 kg of Sodium Carbonate-pallet is presented in Figure 15. Environmental impacts caused by Core module is appeared to be dominant for climate change and it is the main hotspot in all environmental impact indicators.

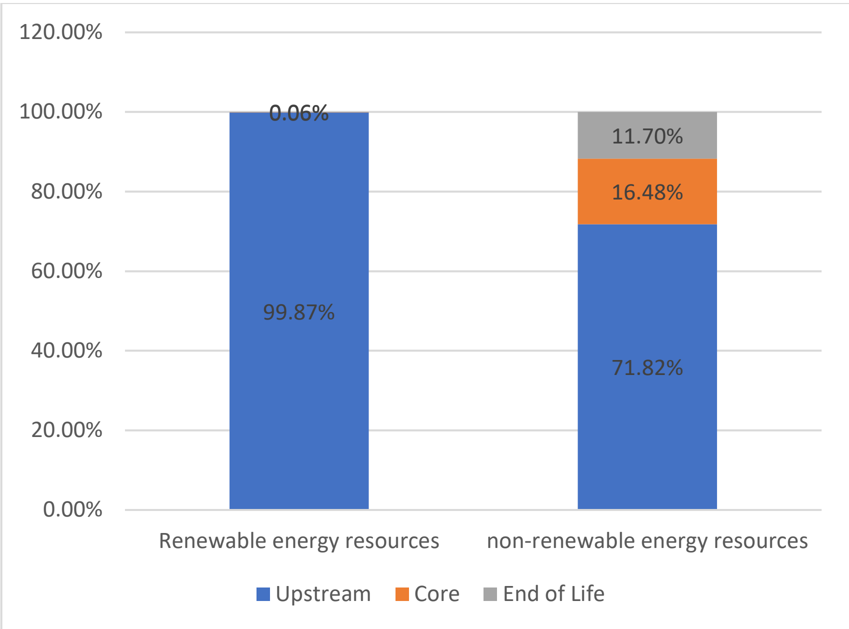

Figure 16: Energy consumption per module for 1 kg of soda ash-pallet

Figure 16 shows the energy consumption at each module of the life cycle by source (renewable or non-renewable). Fossil energy sources are the most dominant at Core life cycle stage.

7.5 Sodium Bicarbonate -Without Packaging

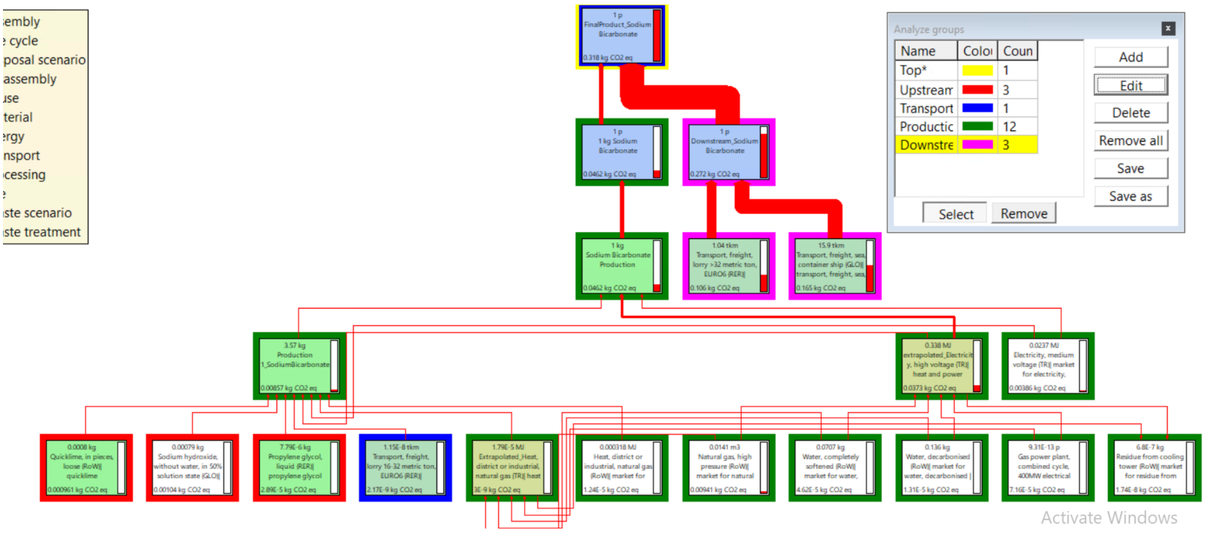

Figure 17: Global Warming Potential network flow for 1 kg of sodium bicarbonate-without packaging

The relative impacts of all life cycle stages for 1 kg of Sodium Bicarbonate is presented in Figure 17 for each impact category. Electricity of the product life cycle appears as the highest impact contributor.

Long-term emissions (>100 years) are not taken into consideration in the impact estimate. In this interpretation section, SimaPro LCA model is presented for only considering Climate Change Fossil results as kg CO2 eq. All other LCIA results are also presented as bar charts in the Figure 17.

The climate change fossil value of the final Product is 0.32 kg CO_2 e.

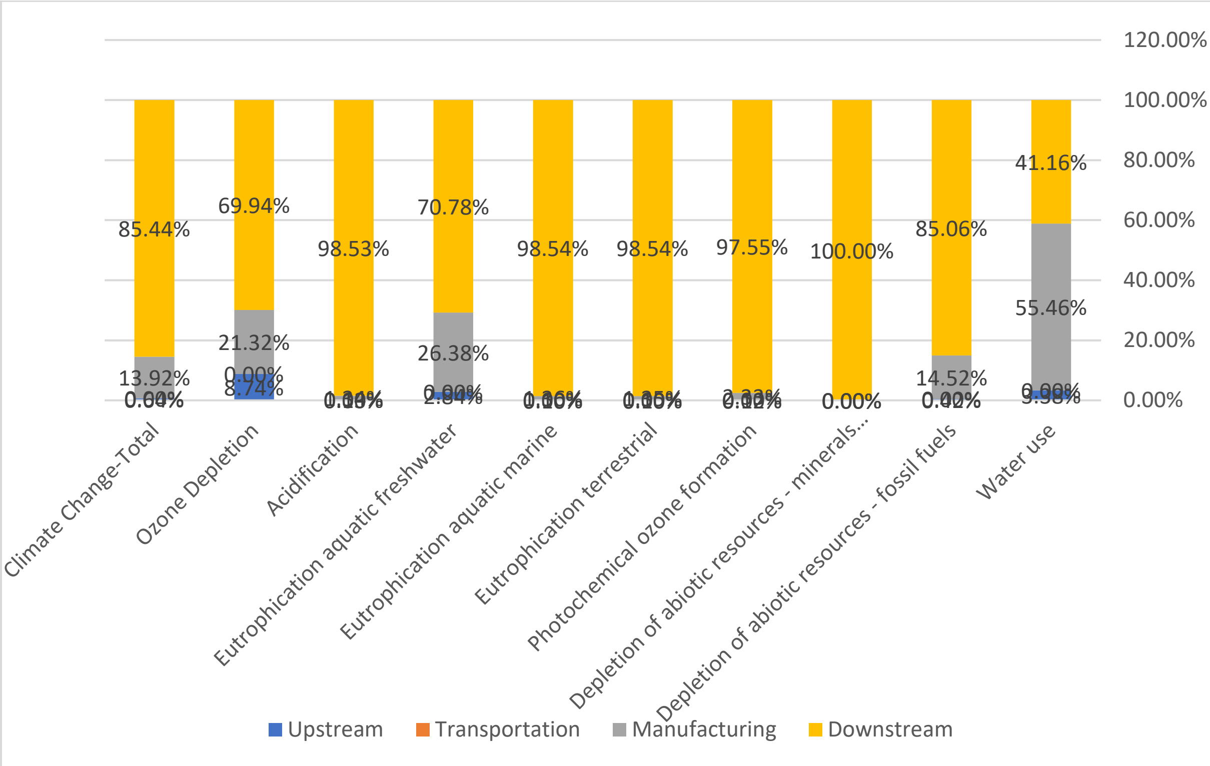

Figure 18: Potential environmental impact per module for 1 kg of sodium bicarbonate-without packaging

Environmental indicators caused by per life cycle module 1 kg of Sodium Bicarbonate is presented in Figure 18. Environmental impacts caused by Core module is appeared to be dominant for climate change and it is the main hotspot in all environmental impact indicators.

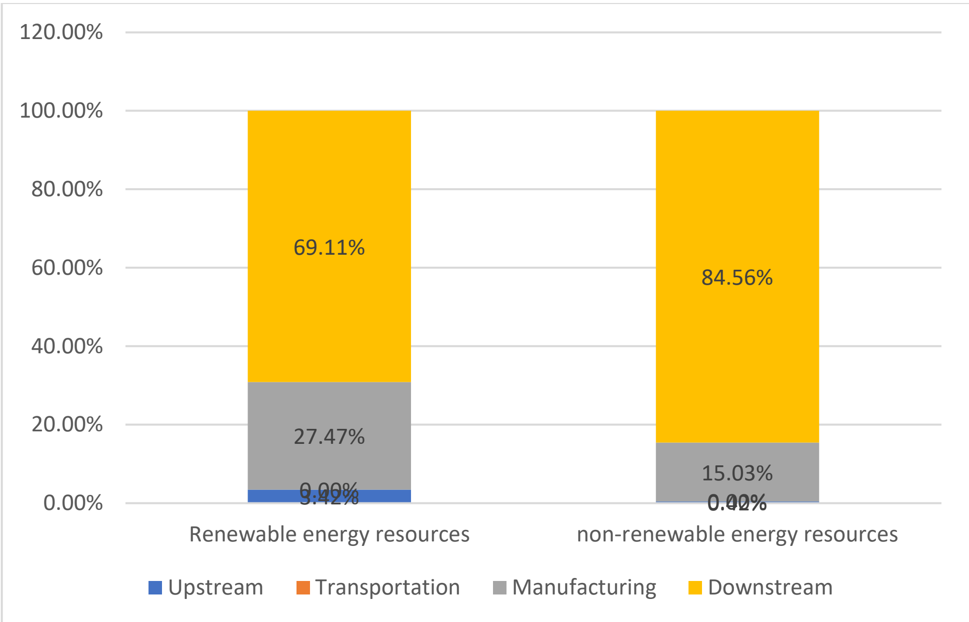

Figure 19: Energy consumption per module for 1 kg of sodium bicarbonate-without packaging

Figure 19 shows the energy consumption at each module of the life cycle by source (renewable or non-renewable). Fossil energy sources are the most dominant at Core life cycle stage.

7.6 Sodium Bicarbonate -Only Packaging Materials-Bigbag

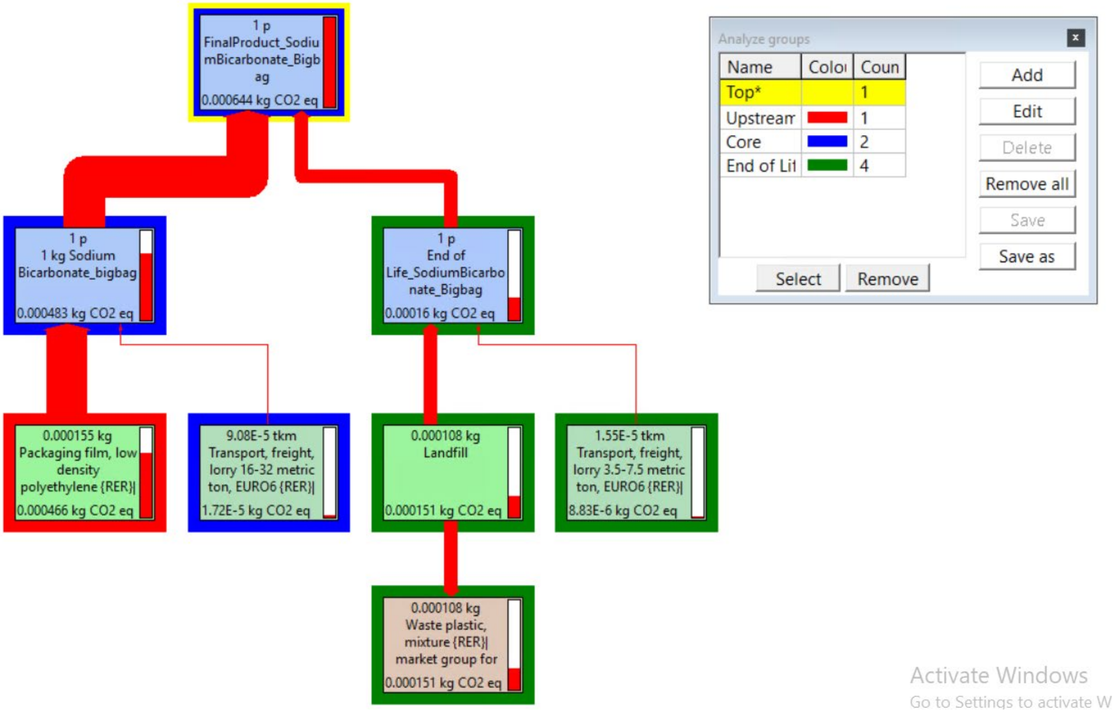

Figure 20: Global Warming Potential network flow for 1 kg of sodium bicarbonate-bigbag

The relative impacts of all life cycle stages for 1 kg of Sodium Bicarbonate is presented in Figure 20 for each impact category. Electricity of the product life cycle appears as the highest impact contributor.

Long-term emissions (>100 years) are not taken into consideration in the impact estimate. In this interpretation section, SimaPro LCA model is presented for only considering Climate Change Fossil results as kg CO2 eq. All other LCIA results are also presented as bar charts in the Figure 20.

The climate change fossil value of the final Product is 0.000644 kg CO_2 e.

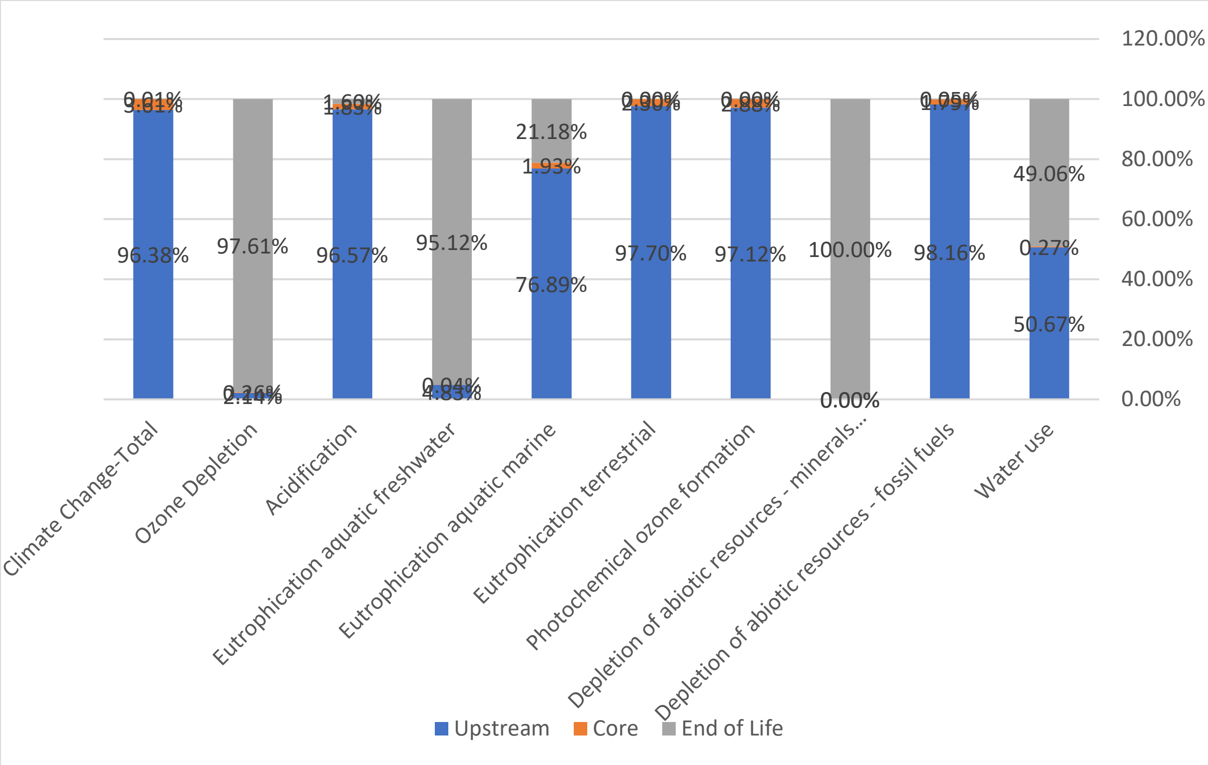

Figure 21: Potential environmental impact per module for 1 kg of sodium bicarbonate-bigbag

Environmental indicators caused by per life cycle module 1 kg of Sodium Bicarbonate is presented in Figure 21. Environmental impacts caused by Core module is appeared to be dominant for climate change and it is the main hotspot in all environmental impact indicators.

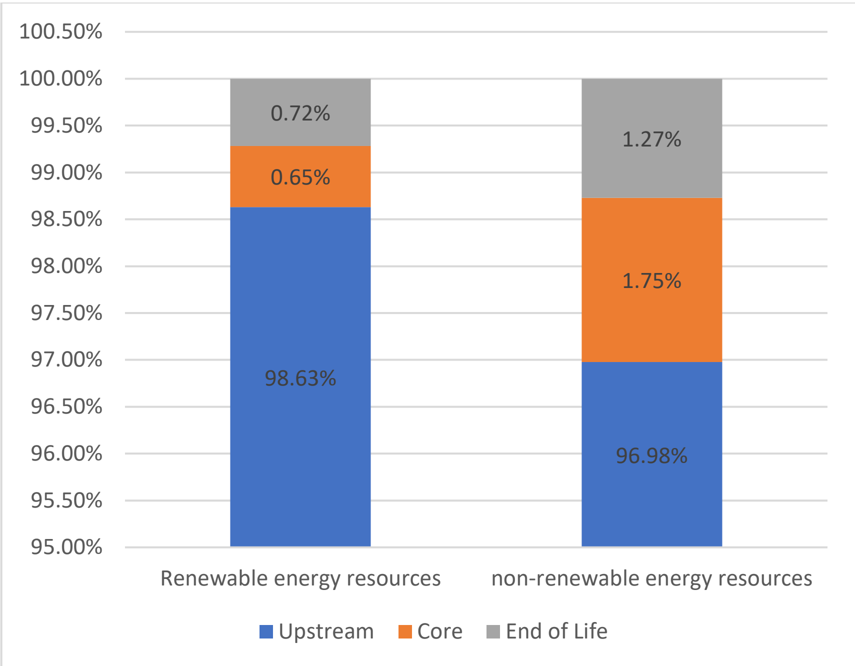

Figure 22: Energy consumption per module for 1 kg of sodium bicarbonate-bigbag

Figure 22 shows the energy consumption at each module of the life cycle by source (renewable or non-renewable). Fossil energy sources are the most dominant at Core life cycle stage.

7.7 Sodium Bicarbonate -Only Packaging Materials-Smallbag

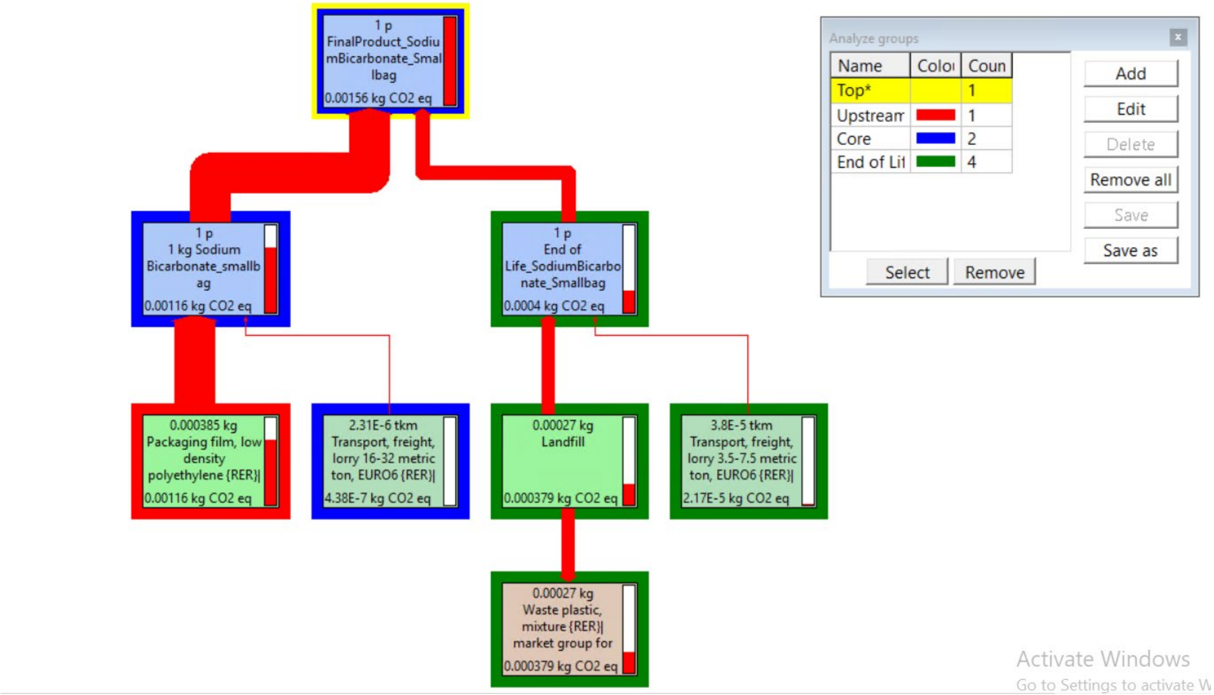

Figure 23: Global Warming Potential network flow for 1 kg of sodium bicarbonate-smallbag

The relative impacts of all life cycle stages for 1 kg of Sodium Bicarbonate is presented in Figure 23 for each impact category. Electricity of the product life cycle appears as the highest impact contributor.

Long-term emissions (>100 years) are not taken into consideration in the impact estimate. In this interpretation section, SimaPro LCA model is presented for only considering Climate Change Fossil results as kg CO2 eq. All other LCIA results are also presented as bar charts in the Figure 23.

The climate change fossil value of the final Product is 0.00156 kg CO_2 e.

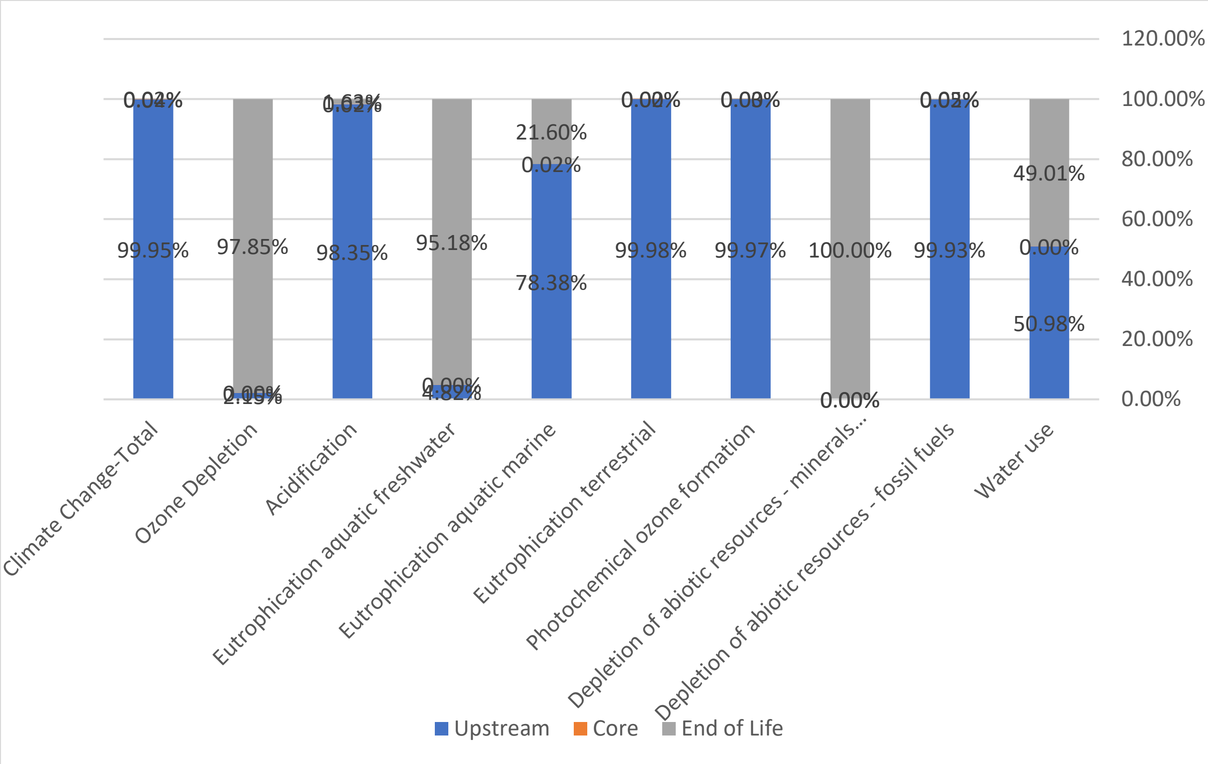

Figure 24: Potential environmental impact per module for 1 kg of sodium bicarbonate-smallbag

Environmental indicators caused by per life cycle module 1 kg of Sodium Bicarbonate is presented in Figure 24. Environmental impacts caused by Core module is appeared to be dominant for climate change and it is the main hotspot in all environmental impact indicators.

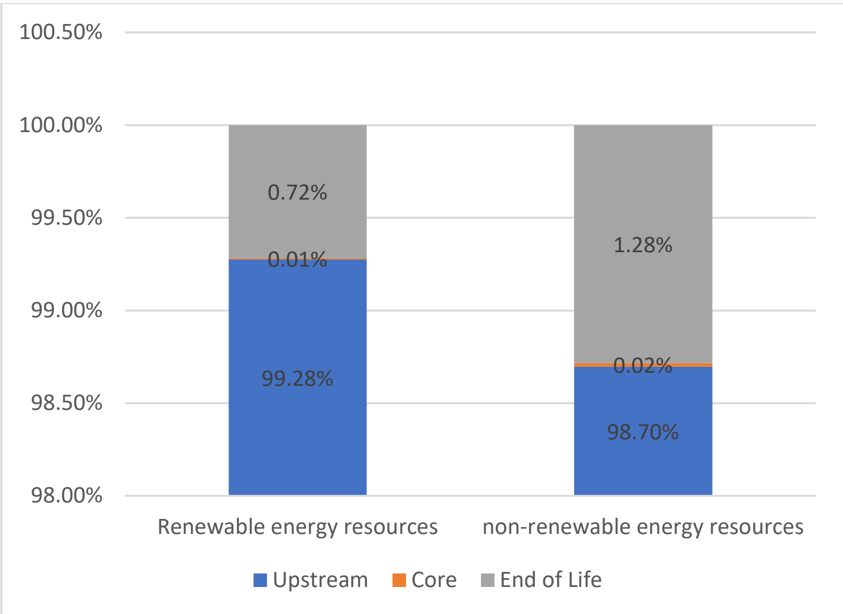

Figure 25: Energy consumption per module for 1 kg of sodium bicarbonate-smallbag

Figure 25 shows the energy consumption at each module of the life cycle by source (renewable or non-renewable). Fossil energy sources are the most dominant at Core life cycle stage.

7.8 Sodium Bicarbonate -Only Packaging Materials-Pallet

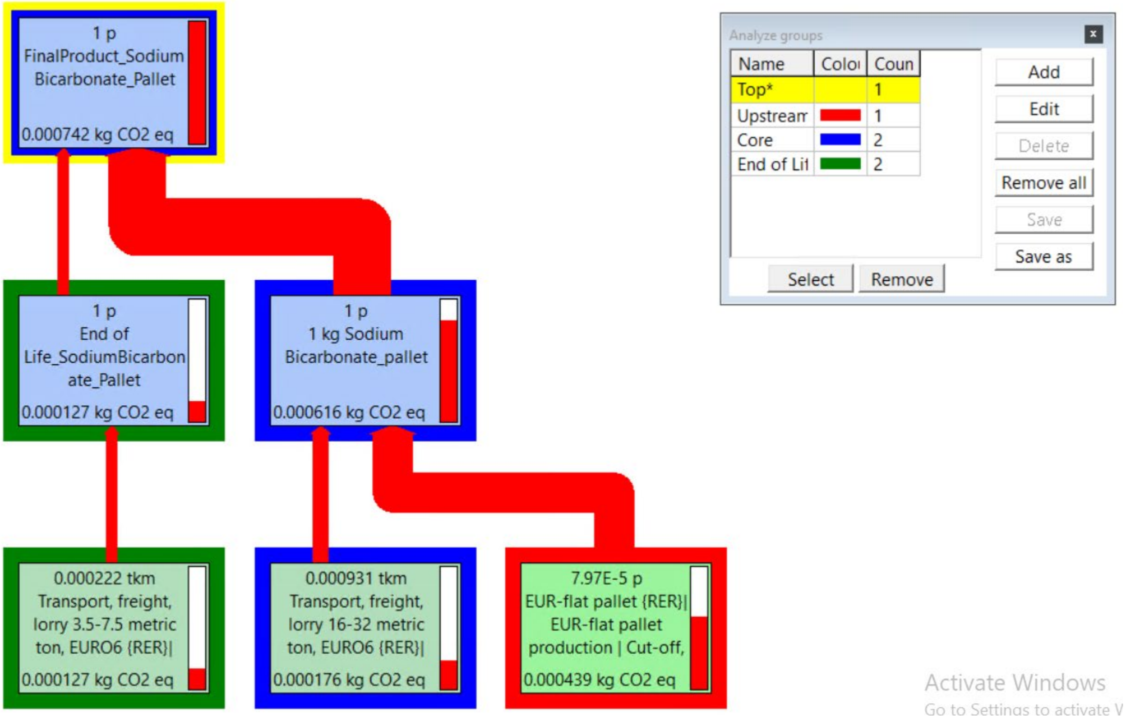

Figure 26: Global Warming Potential network flow for 1 kg of sodium bicarbonate-pallet

The relative impacts of all life cycle stages for 1 kg of Sodium Bicarbonate is presented in Figure 26 for each impact category. Electricity of the product life cycle appears as the highest impact contributor.

Long-term emissions (>100 years) are not taken into consideration in the impact estimate. In this interpretation section, SimaPro LCA model is presented for only considering Climate Change Fossil results as kg CO2 eq. All other LCIA results are also presented as bar charts in the Figure 26.

The climate change fossil value of the final Product is 0.000742 kg CO_2 e.

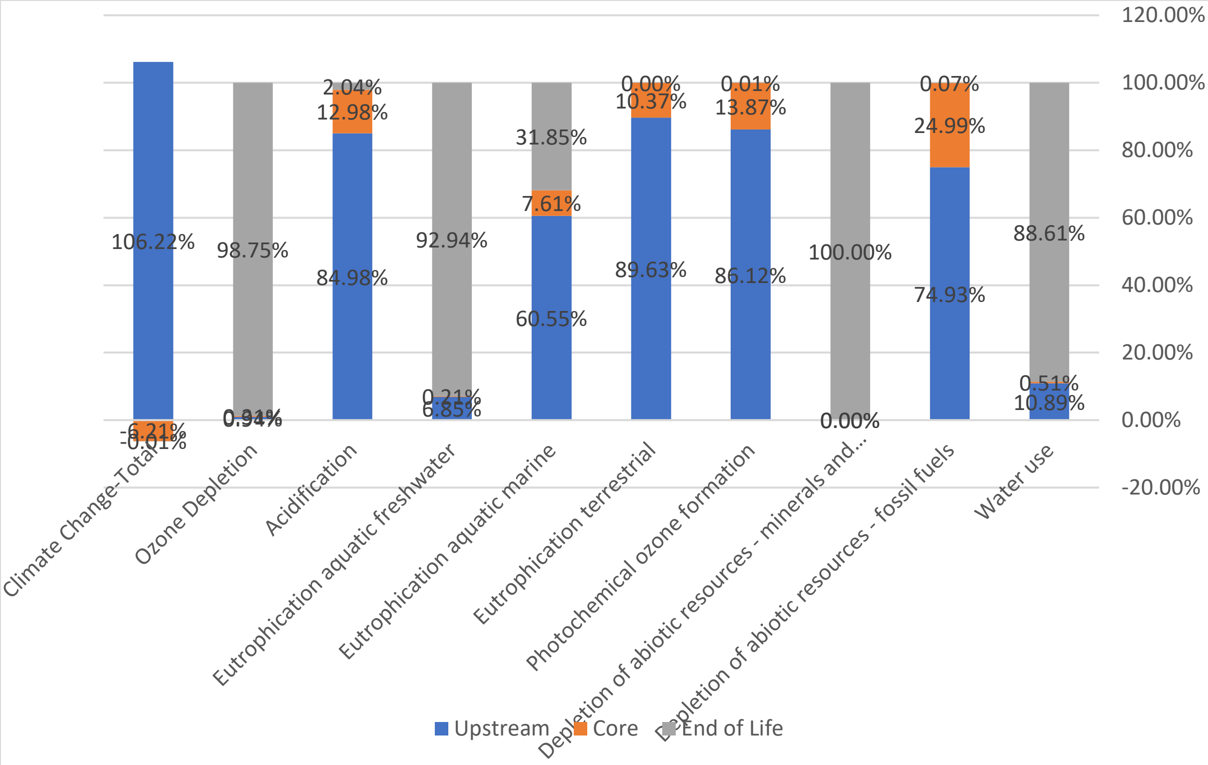

Figure 27: Potential environmental impact per module for 1 kg of sodium bicarbonate-pallet

Environmental indicators caused by per life cycle module 1 kg of Sodium Bicarbonate is presented in Figure 27. Environmental impacts caused by Core module is appeared to be dominant for climate change and it is the main hotspot in all environmental impact indicators.

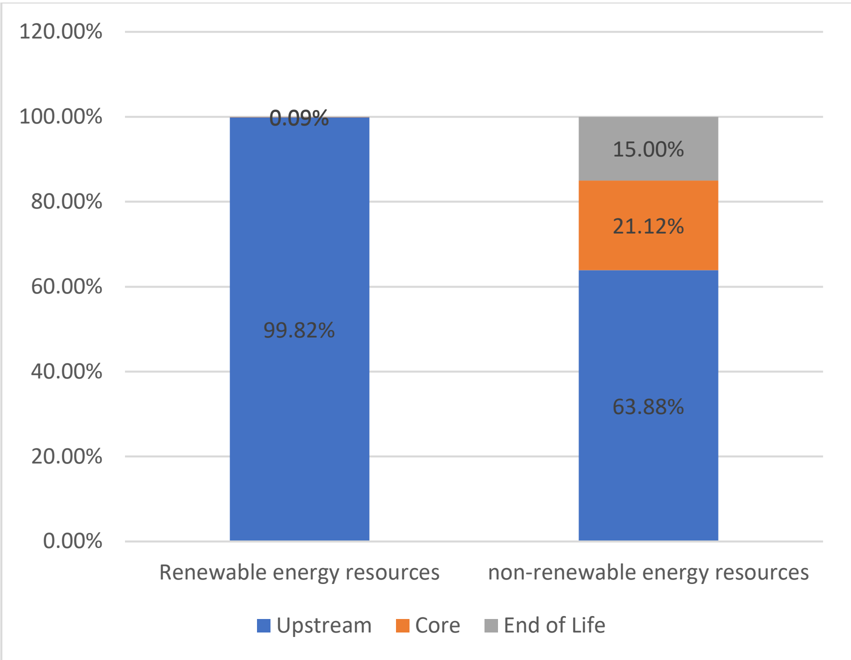

Figure 28: Energy consumption per module for 1 kg of sodium bicarbonate-pallet

Figure 28 shows the energy consumption at each module of the life cycle by source (renewable or non-renewable). Fossil energy sources are the most dominant at Core life cycle stage.

8. REFERENCES

ISO 14040: 2006 Environmental management -- Life cycle assessment -- Principles and framework

ISO 14044: 2006 Environmental management -- Life cycle assessment -- Requirements and guidelines

ISO 14025: 2006 Environmental labels and declarations -- Type III environmental declarations -- Principles and procedures

The International EPD® System / www.environdec.com

The International EPD® System / The General Programme Instructions / http://www.environdec.com/tr/The-International-EPD-System/General-Programme-Instructions/

he International EPD® System / PCR Basic chemicals v1.1.1 https://api.environdec.com/api/v1/EPDLibrary/Files/e07abf16-6efc-4abd-a2d8-08db196e9a1c/Data

Ecoinvent 3.9.1 / http://www.ecoinvent.org/

SimaPro LCA Software / https://simapro.com/

Kazan Soda / http://www.kazansoda.com

SEMTRIO

APPENDIX I: BACKGROUND DATA DESCRIPTION

DATABASE	DESCRIPTION	Modelled in
Data available in Ecoinvent		
Quicklime, in pieces, loose {RoW}| quicklime production, in pieces, loose | Cut-off, S	Geography: The inventory is modelled for Rest-of-World Technology level: Current Technology: The company KFN works on a technically high level. Two vertical kilns are in use. The fuel for the calcination process is heavy fuel oil. Start date: 01/01/2000 End date: 31/12/2022	Upstream
Sodium hydroxide, without water, in 50% solution state {GLO}| market for sodium hydroxide, without water, in 50% solution state | Cut-off, S	Geography: The inventory is modelled for Global Technology level: Current Technology: Start date: 01/01/2011 End date: 31/12/2022	Upstream
Propylene glycol, liquid {RER}| propylene glycol production, liquid | Cut-off, S	Geography: The inventory is modelled for Europe Technology level: Current Technology: Production from propylene oxide and water with a process yield of 95%. Inventory bases on stoechiometric calculations. The emissions to air (0.2 wt.% of raw material input) and water were estimated using mass balance. Treatment of the waste water in a internal waste water treatment plant assumed (elimination efficiency of 90% for C). Start date: 01/01/2000 End date: 31/12/2022	Upstream
Transport, freight, lorry 16-32 metric ton, EURO6 {RER}| transport, freight, lorry 16-32 metric ton, EURO6 | Cut-off, S	Geography: The inventory is modelled for Europe Technology level: New Technology: Diesel and diesel engine. Lorry transport is further differentiated with respect to vehicle weight and emission technology standard (EURO-standard). Technology classifications are based on those used widely within the works of the European Environment Agency, particularly in the Emissions Inventory Guidebook. Start date: 01/01/2009 End date: 31/12/2022	Core
extrapolated_Electricity, high voltage {TR}| heat and power co-generation, natural gas,	Geography: The inventory is modelled for Turkey Technology level: 2	Core

combined cycle power plant, 400MW electrical | Cut-off, U	Technology: Combined cycle power plant of 400MWe class with a gas turbine 265MWe and a steam turbine 140MWe. The plant is used for middle load with 5000 hours of operation at full capacity per year. The plant is assumed to operate 180000 hours during its lifetime. Start date: 01/01/2000 End date: 31/12/2020	
Extrapolated_Heat, district or industrial, natural gas {TR}| heat and power co-generation, natural gas, combined cycle power plant, 400MW electrical | Cut-off, U	Geography: The inventory is modelled for Turkey Technology level: 2 Technology: Combined cycle power plant of 400MWe class with a gas turbine 265MWe and a steam turbine 140MWe. The plant is used for middle load with 5000 hours of operation at full capacity per year. The plant is assumed to operate 180000 hours during its lifetime. Start date: 01/01/2000 End date: 31/12/2020	Core
Electricity, medium voltage {TR}| market for electricity, medium voltage | Cut-off, S	Geography: The inventory is modelled for Turkey Technology level: Current Technology: Average technology used to transmit and distribute electricity. Includes underground and overhead lines, as well as air-, vacuum- and SF6-insulated high-to-medium voltage switching stations. Electricity production according to related technology datasets. Definition of the voltage levels: - High voltage level above 24 kV (large scale industry) - Medium voltage level between 1 kV and 24 kV (medium to small scale industry, service sector and public buildings) - Low voltage level below 1 kV (Households) Start date: 01/01/2014 End date: 31/12/2022	Core
Heat, district or industrial, natural gas {RoW}| market for heat, district or industrial, natural gas | Cut-off, S	Geography: The inventory is modelled for Rest-of-World Technology level: Current Technology: Start date: 01/01/2011 End date: 31/12/2022	Core
Transport, freight, lorry >32 metric ton, EURO6 {RER}| transport, freight, lorry >32 metric ton, EURO6 | Cut-off, S	Geography: The inventory is modelled for Europe Technology level: New Technology: Diesel and diesel engine. Lorry transport is further differentiated with respect to vehicle weight and emission technology standard (EURO-standard).	Downstream

	Technology classifications are based on those used widely within the works of the European Environment Agency, particularly in the Emissions Inventory Guidebook. Start date: 01/01/2009 End date: 31/12/2022	
Transport, freight, sea, container ship {GLO}| transport, freight, sea, container ship | Cut-off, S	Geography: The inventory is modelled for Global Technology level: Current Technology: Fuel consumption and emissions are representative of the current technology (used in 2012 and considering the age distribution of global fleet). Load capacity (43,000 tonnes), fuel consumption and emissions are global weighted averages on tkms over the size classes from IMO (2015). Start date: 01/01/2007 End date: 31/12/2022	Downstream
Emission from calcium carbonate combustion at Co-generation	CO_2	Core
Emission from calcination	CO_2	Core
Emission from calcination	CH_4	Core
Emission from calcination	N_2O	Core

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APPENDIX II: INVENTORY DATA USED IN THE LCA MODEL

Table 10: Inventory Data Used in LCA Model of Sustainable Denim Product

Soda Ash	1	kg		Kazan Soda

Inputs – 1 kg Soda Ash-Pre-production				
Material/Process	**Amount**	**Unit**	**Secondary Data/New Created Data**	**Source**
Trona	0.25549	Kg	Trona	Kazan Soda
Salt	0.01761	kg	Salt, unspecified	Kazan Soda
Quciklime	4.26E-03	Kg	Quicklime, in pieces, loose {RoW}| quicklime production, in pieces, loose | Cut-off, S	Kazan Soda
Caustic	4.20E-03	Kg	Sodium hydroxide, without water, in 50% solution state {GLO}| market for sodium hydroxide, without water, in 50% solution state | Cut-off, S	Kazan Soda
Antifoam	4.15E-05	Kg	Propylene glycol, liquid {RER}| propylene glycol production, liquid | Cut-off, S	Kazan Soda
Electricity_cogen	4.13E-02	Kwh	extrapolated_Electricity, high voltage {TR}| heat and power co-generation, natural gas, combined cycle power plant, 400MW electrical | Cut-off, U	Kazan Soda
Electricity_grid	3.70E-03	Kwh	Electricity, medium voltage {TR}| market for electricity, medium voltage | Cut-off, S	Kazan Soda
Water	2.46E-04	M3	Water, river, TR	Kazan Soda
Steam	9.55E-05	Kwh	Extrapolated_Heat, district or industrial, natural gas {TR}| heat and power co-generation, natural gas, combined cycle power plant, 400MW electrical | Cut-off, U	Kazan Soda
Natural Gas	1.69E-03	M3	Heat, district or industrial, natural gas {RoW}| market for heat, district or industrial, natural gas | Cut-off, S	Kazan Soda
Raw Materials Transportation	8.88E-01	Tkm	Transport, freight, lorry 16-32 metric ton, EURO6 {RER}| transport, freight, lorry 16-32 metric ton, EURO6 | Cut-off, S	Kazan Soda
Outputs - 1 kg Soda Ash-Pre-Produced				
Material/Process	**Amount**	**Unit**	**Secondary Data/New Created Data**	**Source**
Soda Ash PreProduced	1.00	kg		Kazan Soda
Process Emissions_CO2	1.29E-02	Kg	Carbon dioxide, fossil	Kazan Soda
Calcination_CO2	3.32E-03	Kg	Carbon dioxide, fossil	Kazan Soda
Calcination_CH4	5.95E-08	Kg	Methane, fossil	Kazan Soda
Calcination_N2O	5.95E-09	kg	Dinitrogen monoxide	Kazan Soda

Inputs – 1 kg Sodium Bicarbonate-Pre-production				
Material/Process	**Amount**	**Unit**	**Secondary Data/New Created Data**	**Source**
Trona	0.01343	Kg	Trona	Kazan Soda
Salt	0.00093	kg	Salt, unspecified	Kazan Soda
Quciklime	2.24E-04	Kg	Quicklime, in pieces, loose {RoW}| quicklime production, in pieces, loose | Cut-off, S	Kazan Soda
Caustic	2.21E-04	Kg	Sodium hydroxide, without water, in 50% solution state {GLO}| market for sodium hydroxide, without water, in 50% solution state | Cut-off, S	Kazan Soda

Antifoam	2.18E-06	Kg	Propylene glycol, liquid {RER}| propylene glycol production, liquid | Cut-off, S	Kazan Soda
Electricity_cogen	2.17E-03	Kwh	extrapolated_Electricity, high voltage {TR}| heat and power co-generation, natural gas, combined cycle power plant, 400MW electrical | Cut-off, U	Kazan Soda
Electricity_grid	1.95E-04	Kwh	Electricity, medium voltage {TR}| market for electricity, medium voltage | Cut-off, S	Kazan Soda
Water	1.29E-05	M3	Water, river, TR	Kazan Soda
Steam	5.02E-06	Kwh	Extrapolated_Heat, district or industrial, natural gas {TR}| heat and power co-generation, natural gas, combined cycle power plant, 400MW electrical | Cut-off, U	Kazan Soda
Natural Gas	8.89E-05	M3	Heat, district or industrial, natural gas {RoW}| market for heat, district or industrial, natural gas | Cut-off, S	Kazan Soda
Raw Materials Transportation	4.66E-02	Tkm	Transport, freight, lorry 16-32 metric ton, EURO6 {RER}| transport, freight, lorry 16-32 metric ton, EURO6 | Cut-off, S	Kazan Soda
Outputs - 1 kg Sodium Bicarbonate-Pre-Produced				
Material/Process	**Amount**	**Unit**	**Secondary Data/New Created Data**	**Source**
Sodium Bicarbonate PreProduced	1.00	kg		Kazan Soda
Process Emissions_CO2	6.78E-04	Kg	Carbon dioxide, fossil	Kazan Soda
Calcination_CO2	1.74E-04	Kg	Carbon dioxide, fossil	Kazan Soda
Calcination_CH4	3.13E-09	Kg	Methane, fossil	Kazan Soda
Calcination_N2O	3.13E-10	kg	Dinitrogen monoxide	Kazan Soda

Inputs – 1 kg Soda Ash production				
Material/Process	**Amount**	**Unit**	**Secondary Data/New Created Data**	**Source**
1 kg Soda Ash Pre Produced	4.510290567	Kg	Production 1_Soda Ash	Kazan Soda
Antifoam	0.000108615	kg	Propylene glycol, liquid {RER}| propylene glycol production, liquid | Cut-off, S	Kazan Soda
Electricity_cogen	0.113041949	Kwh	extrapolated_Electricity, high voltage {TR}| heat and power co-generation, natural gas, combined cycle power plant, 400MW electrical | Cut-off, U	Kazan Soda
Electricity_grid	0.010266337	Kwh	Electricity, medium voltage {TR}| market for electricity, medium voltage | Cut-off, S	Kazan Soda
Water	2.48009E-05	M3	Water, river, TR	Kazan Soda
Steam	0.000567491	Kwh	Extrapolated_Heat, district or industrial, natural gas {TR}| heat and power co-generation, natural gas, combined cycle power plant, 400MW electrical | Cut-off, U	Kazan Soda
Raw Materials Transportation	1.47E-01	Tkm	Transport, freight, lorry 16-32 metric ton, EURO6 {RER}| transport, freight, lorry 16-32 metric ton, EURO6 | Cut-off, S	Kazan Soda
Outputs - 1 kg Soda Ash-Production				
Material/Process	**Amount**	**Unit**	**Secondary Data/New Created Data**	**Source**
Soda Ash	1.00	kg		Kazan Soda

Inputs – 1 kg Sodium Bicarbonate production				
Material/Process	**Amount**	**Unit**	**Secondary Data/New Created Data**	**Source**
Sodium Bicarbonate Pre Produced	3.572637297	Kg	Production 1_SodiumBicarbonate	Kazan Soda

Electricity_cogen	0.086270059	Kwh	extrapolated_Electricity, high voltage {TR}| heat and power co-generation, natural gas, combined cycle power plant, 400MW electrical | Cut-off, U	Kazan Soda
Electricity_grid	0.005893184	Kwh	Electricity, medium voltage {TR}| market for electricity, medium voltage | Cut-off, S	Kazan Soda
Water	6.56104E-05	M3	Water, river, TR	Kazan Soda
Outputs - 1 kg Sodium Bicarbonate Production				
Material/Process	**Amount**	**Unit**	**Secondary Data/New Created Data**	**Source**
Sodium Bicarbonate	1.00	kg		Kazan Soda