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COMPLIANCE OF THE ORGANIC PRODUCTION OF SEA SALT AND OTHER SALTS FOR FOOD AND FEED WITH THE OBJECTIVES AND GENERAL PRINCIPLES OF REGULATION (EU) 2018/848

Life Cycle Assessment (energy consumption, greenhouse gas emission, water footprint)

of salt production and transport and comparison with production of organic sugar

SALT

1. Energy consumption for salt production

- Production of sea salt and solar salt requires electricity, diesel, and natural gas or oil. This includes thermal drying of the harvested wet salt.
- Production of rock salt requires electricity and diesel. Drying of the extracted dry salt is not necessary.
- Production of evaporated salt requires electricity, natural gas, oil or biomass. This includes thermal drying of the produced wet salt.
  The best available techniques with the lowest possible energy consumption are used to produce evaporated salt (MVR, MEE, Recrystallization). Nevertheless, the production of evaporated salt consumes a multiple of primary energy compared to the production of rock salt and solar salt. Brine treatment (softening) before evaporation and crystallization guarantees that the heat transfer during brine heating is not hindered by deposits with hardness builders on metallic surfaces, thus minimizing energy consumption. Whenever possible, combined heat and power generation is used to generate electricity and steam, and the highest possible proportion of renewable energy is used.
- Consumption figures are in the following Table 1 [1,2,3.4,5]. The energy consumption for salt drying, which is not yet published, was additional calculated [6].

Tab. 1 Energy consumption of salt production („cradle-to-gate“)

Salt type	Energy consumption
Rock salt (vertical shaft, mix cutting/blasting)	Electricity 15 kWh/t NaCl; Diesel 0.5 l/t NaCl
Evaporated salt (MEE, MVR, Recrystallization)	Electricity 30 – 160 kWh/t NaCl; Steam 75 - 800 kg/t NaCl
Solar salt and **sea salt** (dried with hot air/flue gas)	Electricity 10 kWh/t NaCl; Steam for hot air 50 - 75 kg/t NaCl (alternative: gas for direct drying with flue gas); Diesel 0.25 l/t NaCl

2. Greenhouse gas emissions (CO_2-eq) of salt production

- The CO2-eq emissions depend on the share of renewable energies in the total energy consumption for salt production. The contribution of NO_x from the detonation of explosives is negligible.
- Emission figures are in the following Table 2 [1,2,3.4,5,6].

Tab. 2: Carbon footprint of salt production („cradle-to-gate")

Salt type	**CO_2-eq (kg/t salt)**
Rock salt	9-15
Evaporated salt (MEE, MVR, or Recrystallization technology)	18-160
Evaporated salt (open pan technology**)** – Natural brine/waste heat – Live steam (gas), etc.	 1.5 ≥900
Solar salt (without cogeneration, dried with hot air), – Brine from solution mining – Brine from dissolving rock salt on surface	 5-10 10-20
Sea salt – Wet – Dried (hot air)	 1.5 5-10

3. Greenhouse gas emissions (CO_2-eq) of salt transport

- The emissions from salt transport outside of the production facilities can be higher than during production, depending on transport mode and transport distance. Therefore, salt production takes place as close as possible to the consumer. The locally available salt resources are used for production and to supply the regional market. This avoids long transport routes. Long transport distances have a detrimental effect on the ecological advantage of a product at the production level [1,2,3,4,5].
- Examples with CO_2 emissions of two transport scenarios are in the following Table 3 [6].

Tab. 3: Carbon footprint of salt transport

Transport route (truck >32 t)	**CO_2-eq (kg/t salt)**
Valencia (ES) – Paris (FR) 1,375 km	192
Margherita di Savoia (IT) – Munich (DE) 1,163 km	163

4. Water footprint of salt production

- The production of rock salt, sea salt and salts from natural brine uses the least amount of water.
- Sea salt production need water for dilution of the bittern (2% to 5% of the used seawater) before disposal to the sea (dilution 1:5 to 1:24). In cases were no seawater for dilution is available a lot of water is necessary.
- If brine from solution mining or brine from on surface dissolved crystallized salt is evaporated in open ponds or open pans, a lot of water is required.
- In evaporator systems that work according to the principles of MEE, MVR, and Recrystallization, most of the water evaporated from the brine is recovered and reused to dissolve the salt.
- Consumption figures are in Table 4.

Tab. 4: Water footprint of salt production [6].

Salt type	**Water consumption (Liter/t salt)**
Rock salt	0-20
Evaporated salt (MEE, MVR, Recrystallization technology) Brine from solution mining, or from dissolving rock salt, or natural brine	100-750
Evaporated salt (open pan technology**)** - Natural brine - Brine from solution mining, or from dissolving solar salt or rock salt on surface	 10-100 3,000
Solar salt - Natural brine - Brine from solution mining or brine from dissolving rock salt on surface	 10-100 3,000
Sea salt	0-20

SUGAR

- Production of organic sugar follows similar process steps as the production of evaporated salt: treatment (precipitation, etc.) of beet juice, concentration of beet juice in evaporators, crystallization of sugar in evaporators, centrifugation, drying, etc.
- Key indicators for the production of beet sugar and cane sugar are energy efficiency, carbon footprint, and water consumption [7,8,9].
- Table 5 shows the key indicators for the production of beet sugar, including organic beet sugar, of the Nordzucker facility Schladen for the year 2019.

Tab. 5: Key indicators in year 2019 for beet sugar production at the Nordzucker facility Schladen in Germany [9]

Indicator	**Result**
Energy efficiency	1.453 kWh/t sugar
Carbon dioxide emission	311 kg/t sugar
Water consumption	510 Liter/t product (sugar, etc.)

- In comparison with salt production, particularly with the production of evaporated salt, the production of sugar, including organic sugar, requires much more energy and emits more greenhouse gas. One reason for this is the need for thermal concentration (water evaporation) of the beet juice before the sugar crystallization with similar techniques as for evaporated salt.

Literature

[1] Goetzfried, F., Kondorosy, E.: Recrystallization process for the upgrading of rock- and solar salts. In *Proceedings of the 9th International Symposium on Salt*, pp 700-711, Beijing (China), 2009 (edited by Sha Zuoliang, Gold Wall Press, Beijing)

[2] Specklin, G., Matrat, M.: Empreinte environnementale – Influence du mode de production et de transport du sel de dèneigement. *RGRA*, No. 879, 2009

[3] Goetzfried, F., Stratmann, B., Quack, D.: Life cycle assessment of sodium chloride production and transport. *Biodiversity, Sustainability and Solar Salt Conference*, 22-23 May 2012, Sevilla (Spain)

[4] Goetzfried, F.: Global Warming Potential of Deicers. In *Proceedings of the PIARC XVth International Winter Road Congress*, Gdansk (Poland), 2018

[5] Stettler, C., Kägi, T.: Ökobilanz Auftausalze. Carbotech, 2019 (Ökobilanz Auftausalz Riburg v2.2cs)

[6] Goetzfried, F.: Personal communication.

[7] climatop: CO_2 Balance: Sugar. Factsheet, Zürich (CH), 18.03.2010 (https://www.myclimate.org/fileadmin/user_upload/myclimate_-_home/02_Take-action/01_Corporate_clients/15_Climatop_label/Products/Migros/Produkte/Migros_Rohrzucker_Bio_Max_Havelaar/Factsheet_e_Migros_Rohrzucker_Bio_Max_Havelaar.pdf)

[8] Klenk, I., Landquist, B., Ruiz de Imana, O.: The Product Carbon Footprint of EU beet sugar. Reprint from *Sugar Industry* 137 (62) No 3, 169-177 and No 4, March 2012 (https://www.academia.edu/4006729/The_Product_Carbon_Footprint_of_EU_Beet_Sugar_2012_)

[9] Nordzucker: Umwelterklärung 2019/20, Werk Schladen (https://www.emas.de/fileadmin/user_upload/ue/reg/DE-111-00002_Nordzucker-AG_Schladen.pdf)