

Salt Partners

Energy balance of salt production
speaks in favour of solar saltworks

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Salt production world-wide

Salt type	World production
Solar salt	100,000,000 t/y
Rock salt	100,000,000 t/y
Brines	100,000,000 t/y
Total	300,000,000 t/y

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Salt consumption world-wide

Salt user	Salt consumption
Industry	200,000,000 t/y
Food	60,000,000 t/y
Other	40,000,000 t/y

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Prime energy consumption for multiple effect vacuum salt crystallisation

Water evaporation	3 t / t of salt
Steam to first effect	10 – 12 bar g
Number of effects	6
Steam consumption	0.7 t / t of salt
Boiler efficiency	85%
Prime energy consumption	450 kWh / t of salt

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Prime energy consumption for salt crystallisation by thermocompression with mechanical vapour recompression

Water evaporation	3 t / t of salt
Power consumption	160 kWh / t of salt
Power generation efficiency	35%
Prime energy consumption	450 kWh / t of salt

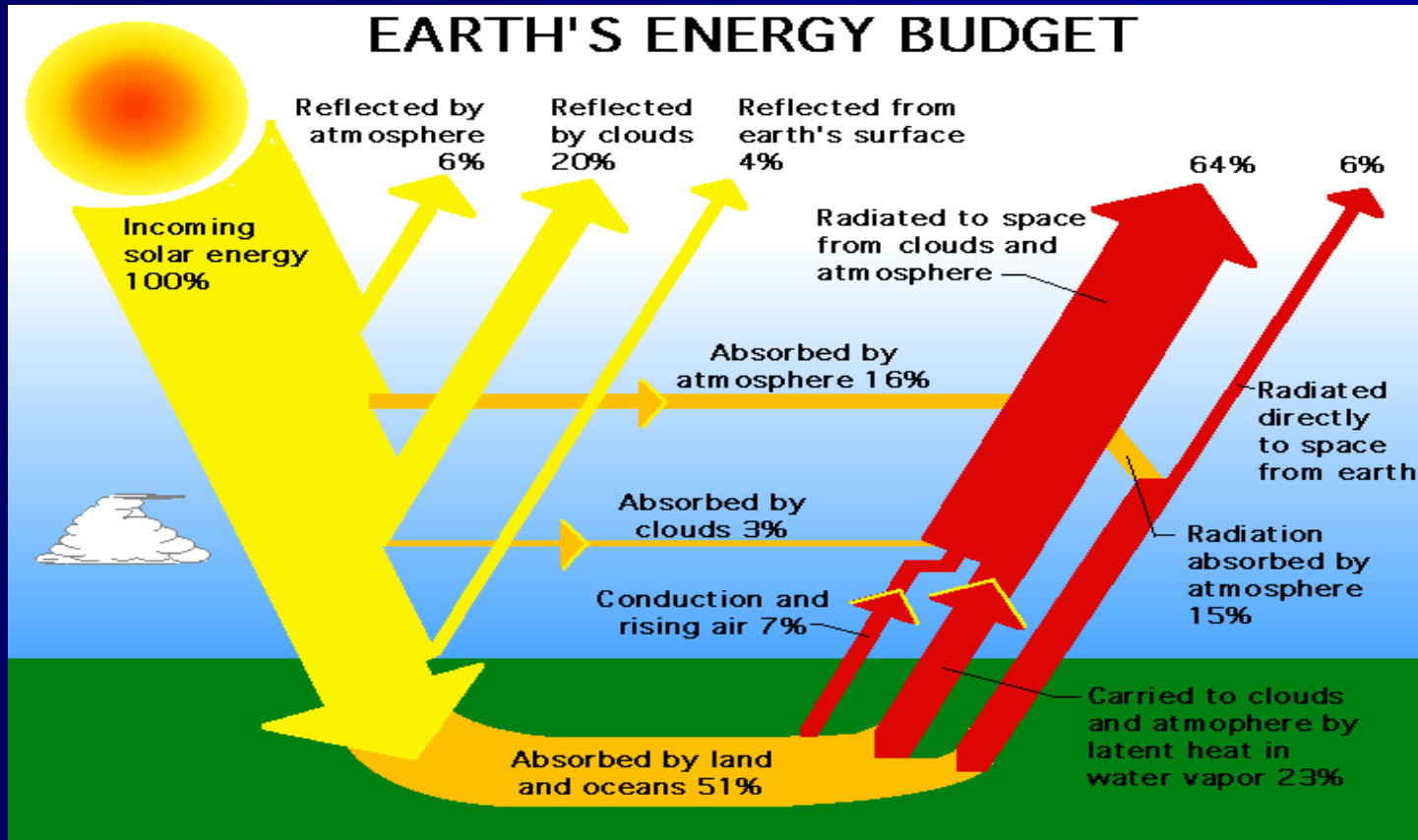
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Solar salt evaporation

Sea water density	3.85°Bè
NaCl content	30.09 kg NaCl / m ³
Bitterns density	28.53°Bè
NaCl in bitterns	8.37 kg
NaCl crystallised	21.72 kg
Water evaporated	949.93 kg
Water evaporation	43.74 t H ₂ O / t NaCl
Heat of water evaporation	0.675 kWh / kg H ₂ O
Solar energy consumption	29'520 kWh / t NaCl

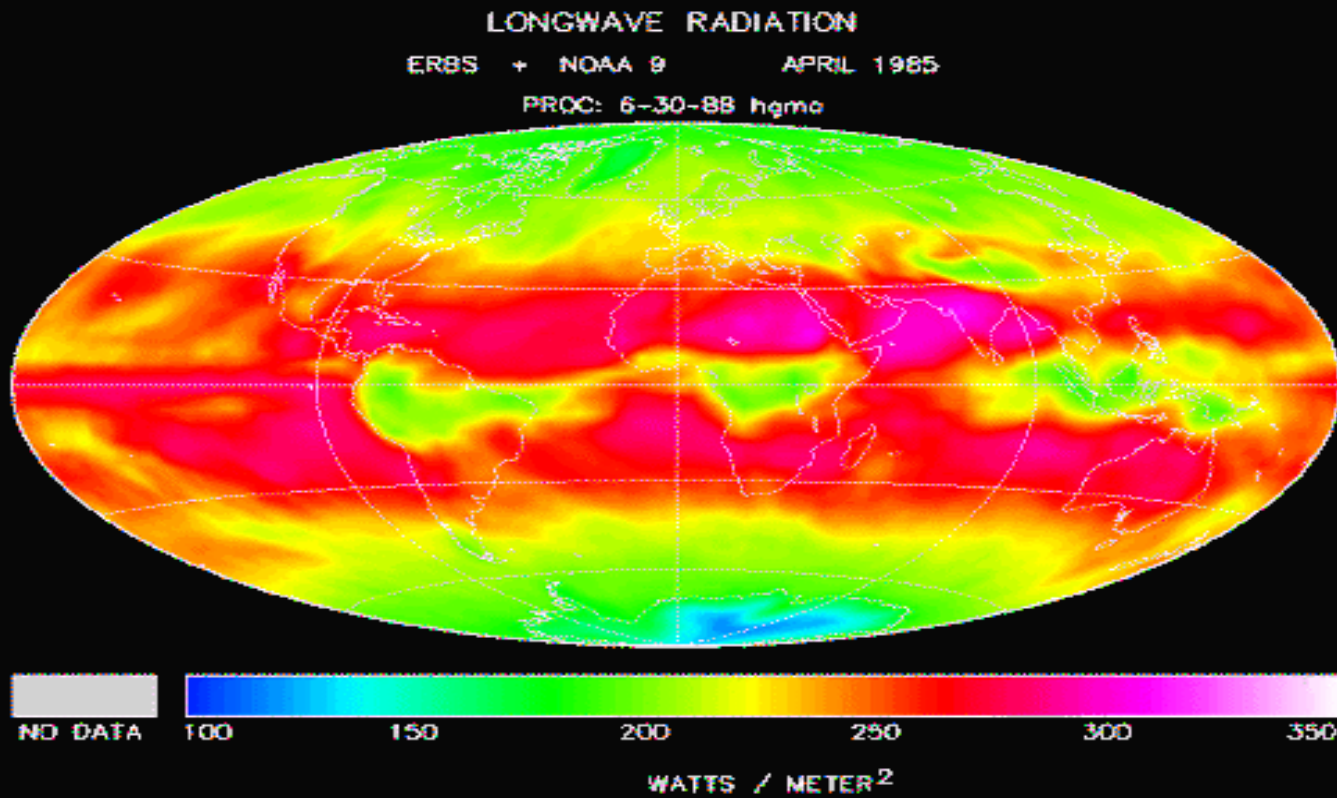
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Earth's solar energy budget



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Solar energy on the planet Earth



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Energy sources on planet Earth

Earth annual solar energy receipt	54'385 10^{20} J
Energy stored in Earth's coal	1'952 10^{20} J
Energy stored in Earth's oil	179 10^{20} J
Energy stored in Earth's natural gas	134 10^{20} J
Energy stored in North Sea oil	3 10^{20} J
Annual USA energy consumption	1 10^{20} J
Annual UK energy consumption	0.1 10^{20} J
Heat flux from Earth interior	0.03 10^{20} J
Energy in UK produced grain crop	0.006 10^{20} J

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Solar energy conversion into evaporation

Earth insolation	1.366 kW / m ²
Surface insolation absorbed	51%
Solar energy absorbed in zenith	0.697 kW / m ²
Daily solar energy absorption	5 – 7 kWh / m ² / day
Conversion efficiency	45%
Daily solar evaporation energy	2 – 3 kWh / m ² / day
Heat of water evaporation	0.675 kWh / kg H ₂ O
Daily evaporation	3 – 5 kg H ₂ O / day
Annual evaporation	1.1 – 1.8 m H ₂ O / year

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Solar evaporation conversion into salt

Annual evaporation	1.1 – 1.8 m H ₂ O / year
Salt crystallised per tonne of sea water evaporated	22.86 kg / t H ₂ O
Corresponding salt production	27 – 44 kg NaCl / m ² / year
Crystalliser area	10%
Salt layer in crystallisers	270 – 440 kg NaCl / m ² / year
Salt layer density	2 t / m ³
Salt layer thickness	13 – 22 cm

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Conversion efficiencies

Photovoltaic cells	8 – 15%
Solar collectors with stirling engine	30%
Super critical steam power plants	40 – 45%
Solar salt production	45%

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**40 t/h salt upgrading
plant in Portugal
producing purest
industrial salt in Europe**

		Performance test
Ca	ppm	0.6
Mg	ppm	0.2
SO4	ppm	53

Efficiency	97.4%
NaCl losses	< 4%



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