

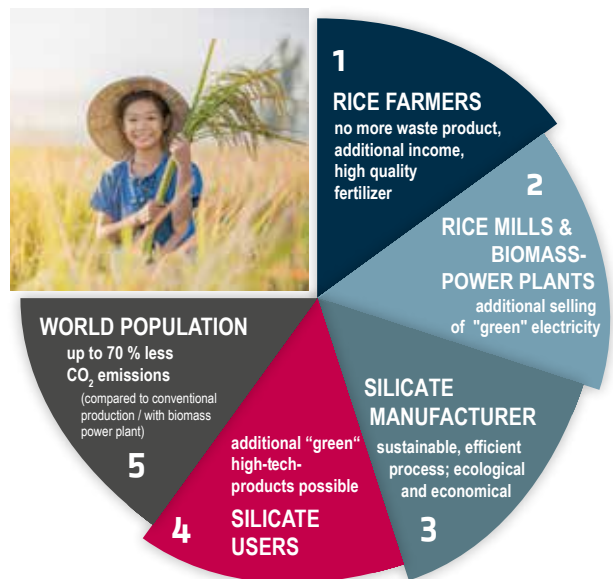


BIO-SILICATE TECHNOLOGY

PÖRNER TECHNOLOGY FOR POWER AND PROFIT

All over the world, the removal of the rice hulls during the process in numerous rice mills causes a serious environmental problem. Millions of tons of rice hulls are left to rot or burn slowly in the field. This agricultural waste however has a significant calorific value and a high percentage of amorphous silica.

Now there is a better way: The Pörner Bio-Silicate Technology transforms waste rice hulls into renewable, carbon-neutral electricity for thousands of homes and further converts rice hull ash into a wide range of high purity silicate products. Thus a serious environmental issue is transformed into truly carbon-neutral and sustainable sources of power and high value silicate products.



All parties involved in the value creation process benefit from the Pörner technology

GREEN TECHNOLOGY WITH BENEFIT

Rice hulls comprise 20 % of the annual rice paddy harvest weight. The 940 million metric tons (MT) of harvested rice produced in 2019 caused 190 million MT of hulls. Only 30 % are used commercially, leaving over 130 million MT available. The average global harvest continues to grow at one percent every year as the world population expands. Pörner Group in Grimma / Germany provides clients worldwide a green process technology for maximum utilization of this agricultural byproduct.

Advantages include:

- a strong environmental position
- vastly superior product quality, and
- competitive economics.

Pörner Group is offering a patented process technology for clients wanting to create a smarter, cleaner world while also enjoying quite significant financial benefits. The Pörner Bio-Silicate Technology includes green power generation from rice hulls and high purity Bio-Silicate production. Projects executed with precision German engineering from the process experts in Grimma.



Rice producing countries

BIO-SILICATE TECHNOLOGY

TRANSFORMING HULLS INTO ENERGY & ASH

Raw hulls from various rice mills are transported to the power plant where they are conveyed to special hull storage silos until requested by the automated control system. Later the stored hulls are ground and screened before transferred to one or more furnaces. The furnace feed system maintains a precise rate of flows into the burner. Air to the burner is automatically adjusted according to local temperature and humidity conditions to achieve the ideal combustion parameters.

CO₂ released to the environment corresponds to the CO₂ captured during rice plant growth.

Rice hulls have a caloric value of about 14 MJ/kg, around 35 % of diesel or bunker oil. Approximately 55,000 MT/Year of hulls can fuel a biomass power plant with ~6,5 MW [~52 GWh/Year] and 10,000 MT/Year premium quality ash.



Raw rice is processed to white rice for consumption



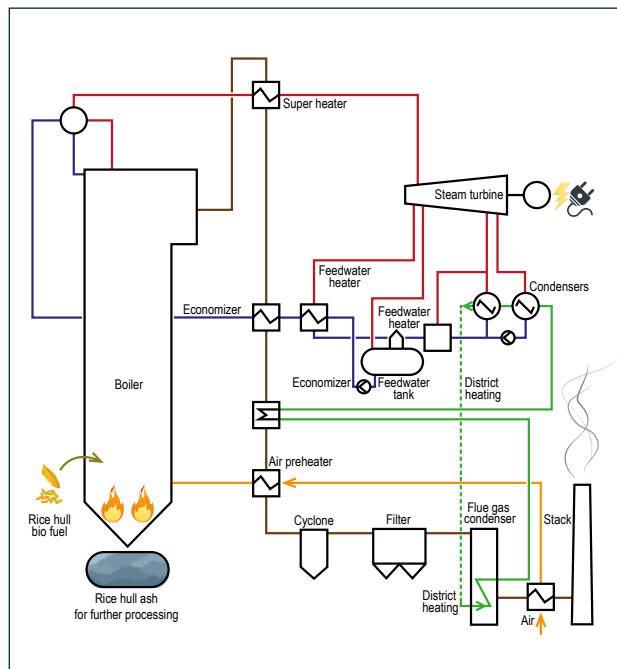
The waste product - unground and ground rice hulls - are further processed

RICE HULL ASH GENERATION POSSIBILITIES

The proprietary rice hull combustion system produces steam from a high efficiency boiler and ash. Most of the steam is directed to a steam turbine-generator system to produce clean, renewable electric power. Some of the electricity and steam is used at the power plant and nearby Bio-Silicate plant.

The majority of power produced is sold to the public grid, enough to supply thousands of modern homes. Pörner Technology is optimized to produce not only maximum power but also ash rich in silica. The ash is collected from the combustion unit and stored in silos before automated pneumatic transfer to the silicate plant.

Rice hull ash from a Pörner power plant contains approximately 90 % amorphous silica (SiO₂), 5 % carbon, 2 % water, 2 % inerts and less than 1 % crystalline silica.



Pörner Rice Hull Power Plant

BIO-SILICATE TECHNOLOGY

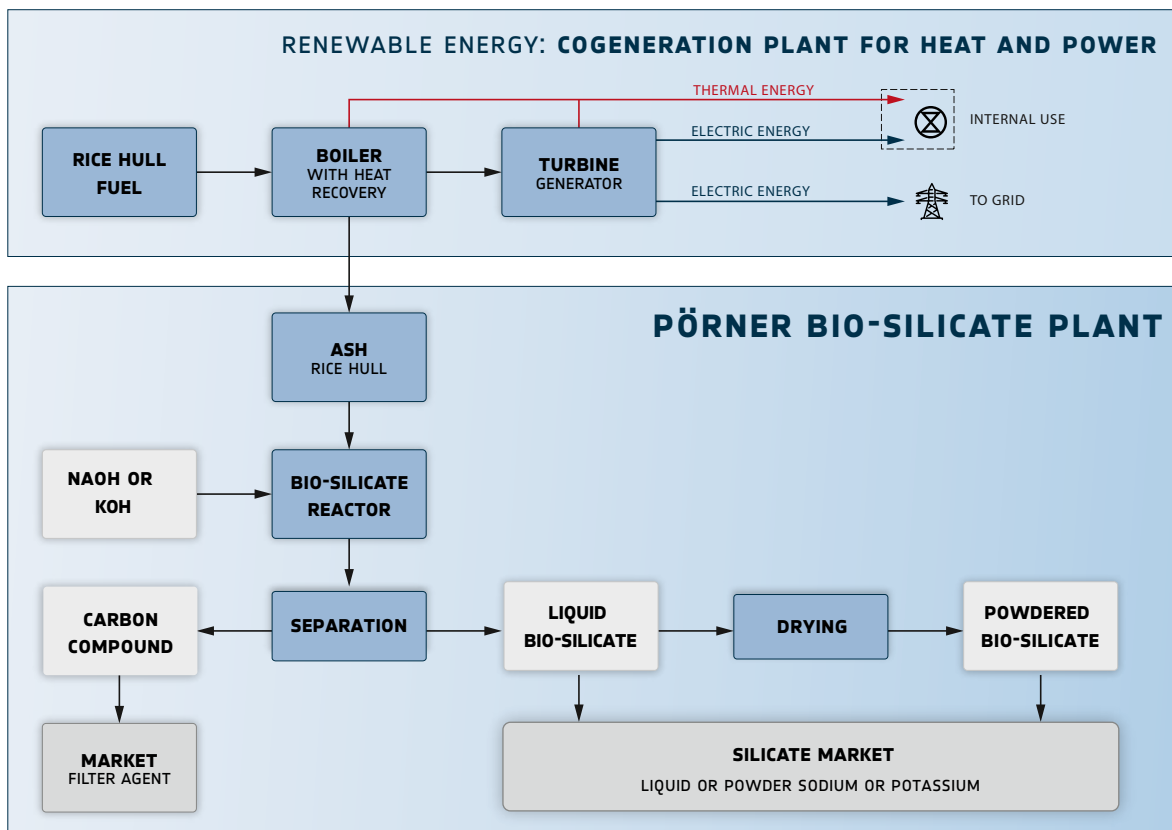
SODIUM AND POTASSIUM SILICATE MANUFACTURING

Rice hull ash from a Pörner Biomass Power Plant contains 90 % amorphous silica (SiO_2). The ash is processed with heat, water and sodium hydroxide (NaOH, caustic soda) to produce sodium silicate. If potassium silicate is desired then potassium hydroxide (KOH, caustic potash) is used. After reaction the raw liquid silicate and nanoporous carbon particles are separated. The raw silicate is concentrated and adjusted to the required sales specification if not supplied direct via pipeline to downstream manufacturing process. Large quantities of liquid silicate products are sold to a wide range of markets. For long range transport powder Bio-Silicates can ease logistics.

A Pörner Bio-Silicate Plant can produce from 10 to 50 MT/year dry Bio-Silicates **at any specified purity and grade** (up to ratio 4.0). Pörner Bio-Silicates provide all features to optional downstream processes to make high quality prod-

ucts. Pörner can provide process solutions for large scale production of high purity Bio-Silicate suitable for additive manufacturing, or conversion to high grade metallurgical silicon for solar wafer production, or UHP Silicon Nitride production. Pörner potassium silicate is an essential plant nutrient, biopesticide and can be used as liquid fertilizer via irrigation or foliar application.

Special equipment can be supplied for high volume production of dry sodium silicate or potassium silicate. Manual or automated packaging systems are included for containers of any size. The residual carbon can be dried and packaged in a separate area if desired. The dry carbon powder will have a residual water content of 8-12 % and a specific surface area from 200 to 600 sqm/gram, making it ideal for many applications currently using more expensive activated carbon products.



Process Overview - Silicate is a global key commodity

BIO-SILICATE TECHNOLOGY

PRODUCTION AND MARKETS

Potassium Silicates:

Weight ratios of SiO₂ to K₂O from 1.6 to 2.5

- Agriculture / hydroponics
- Protective coating
- Welding rods
- Soaps & detergents
- Refractory cements
- Adhesive coatings
- Silica gels
- Antifreeze
- CRT manufacturing
- Protective and decorative coatings

Liquid Sodium Silicates:

Weight ratios of SiO₂ to Na₂O from 1.6 to 4.0

- Detergents and cleaning compounds
- Adhesives & cements
- Paints & coatings
- Pulp & paper processing
- Ceramics & binders
- Water treatment
- Textile processing
- Mining & mineral processing
- Petrochemical processing

Carbon Compound:

Carbon compound (*is a kind of carbon processed to have small, low-volume pores for adsorption or chemical reactions.*)

- Sweetener
- Solvent recovery
- Air purification
- Sowing earth
- Steel industry (tundish powder)

OWN DEMONSTRATION PLANT

To showcase the process and to provide an open venue for client testing, Pörner Group built a dedicated semi-industrial demonstration plant in Freiberg / Germany. The facility is specifically designed to optimize key process parameters and is capable of producing a wide range of high quality silicate products within strict specification limits.

Clients may ship quantities of ash for testing or Pörner Group can provide a standardized ash under signed agreements for testing and limited production of pure liquid silicates. Additional laboratory and prototype equipment are located within the building for a timely analytical support. We provide you with real-world proof of process.



Demonstration plant in Freiberg / Germany provides evidence of product purity

PÖRNER - GLOBAL LEADER IN SUSTAINABLE SILICATE TECHNOLOGY

The Pörner Group is offering the Bio-Silicate Technology as an EPC or EPCM Contractor.

As global leader in silicate conversion technology and sustainable silicate process plants, clients benefit from an automated and reliable manufacturing of a wide range of different products. The technology can be realized with and

without the upstream biomass power plant, giving customers maximum flexibility.

By providing all engineering services from one source: from pilot testing to basic and detail engineering, procurement and project management up to commissioning, Pörner Group realizes all projects tailored to the customer's requirements.

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