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MINING INDUSTRY WHITE PAPER

Decarbonizing Mining Thermal Processes Using CSP Solar

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EXECUTIVE SUMMARY

The **International Council of Mining & Metals (ICMM)** has committed its Members to achieve Net-Zero Scope 1 and Scope 2 GHG emissions by 2050 or sooner.

While many Mines are developing or implementing strategies for decarbonizing their **Power** and **Material Movement** sources of GHG emissions, the GHG emissions from **Thermal Processes** has been a major techno-economic challenge for the Mining Industry.

Mining Thermal Process such as Calcining, Drying, Steam Production, Roasting, Smelting and Refining can produce 15%-30% of a Mine's GHG Emissions.

INTRODUCTION

Mining thermal processes typically use fossil fuels such as natural gas, diesel, propane, coal and HFO.

Unfortunately, these fuels can be expensive, subject to market pricing volatility and produce significant GHG emissions.

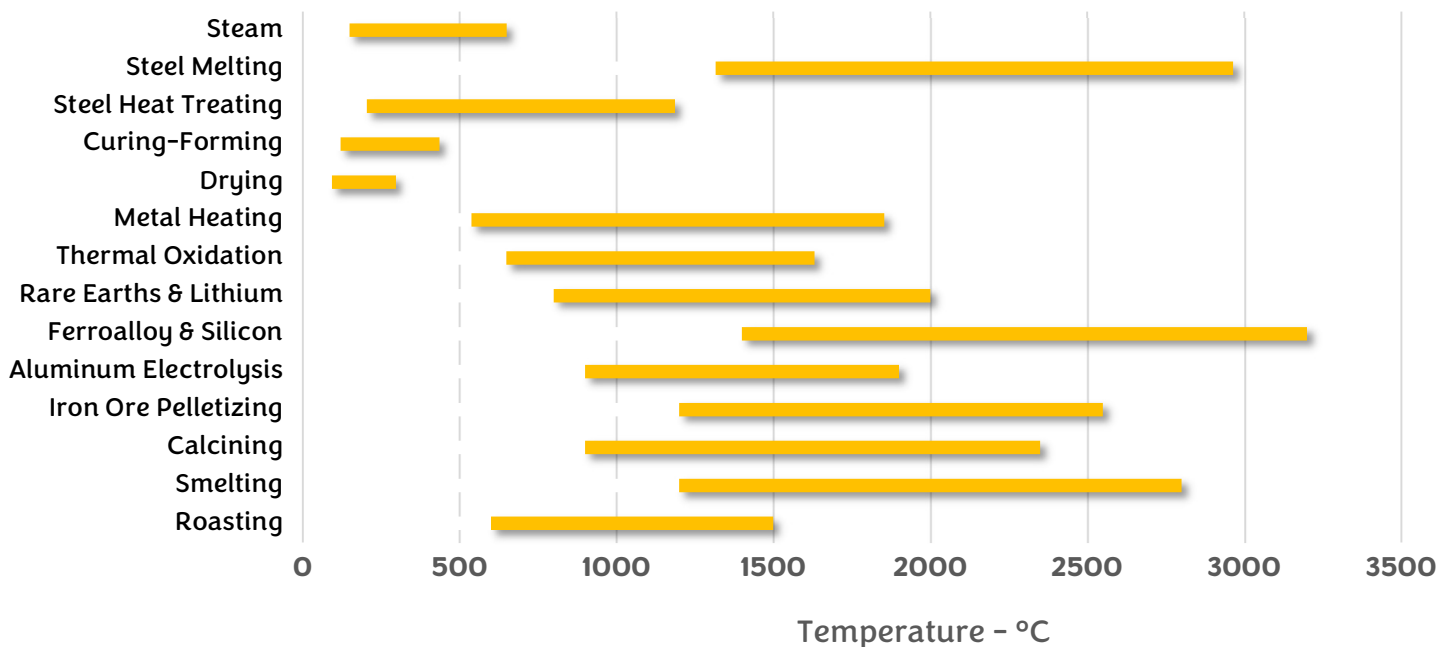
Renewable and storable **Solar Thermal Energy** can be used as an effective techno-economical **Decarbonizing** strategy to provide the various medium to high temperatures that mining operations require for their onsite thermal processes.





Mining Processes

Temperature Requirements

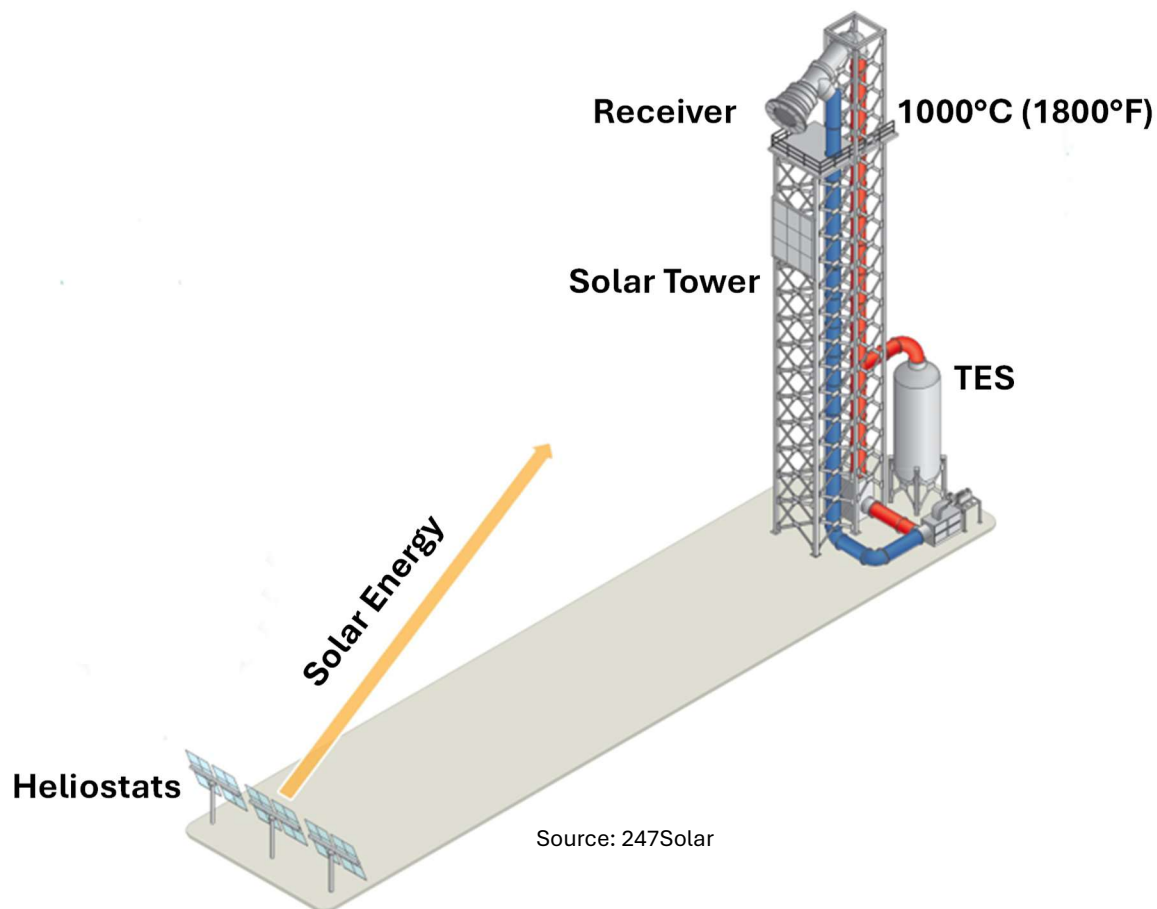


Steam production and Dryers are a good example of a Medium Temperature (**250°C - 600°C**) mining process. For example, Dryers are common in such operations as drying ore, concentrates (copper, zinc, lead, gold, silver, PGM, lithium, nickel, cobalt and manganese) and iron ore pellets.

The types of Dryers that are being used in the mining industry include rotary (most common), flash, fluidized bed, belt and spray. These medium temperature processing applications can all be operated on **Concentrated Solar Power (CSP) Tower** based technologies with **integrated Thermal Energy Storage (TES)** to meet their partial or full thermal demand. Newer TES technologies use superheated air and ceramics instead of heat transfer fluids and Molten Salts to avoid high stress, corrosion, deformation, purification, leaking and thermal cycling problems.

Similarly, CSP based **Solar Tower** technology with **TES** can provide up to **1000°C** of renewable thermal energy for higher temperature mining processes such as roasting, calcining, smelting, heat treating, etc.

CSP Tower Based Solar Technology



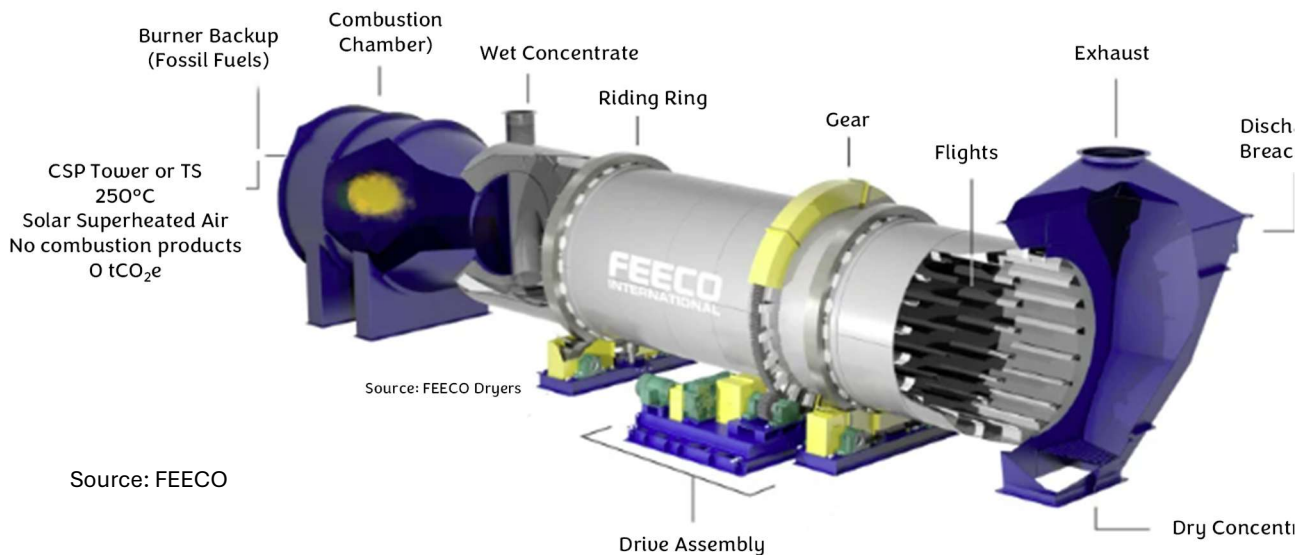
Source: 247Solar

Solar towers (power towers) use many sun-tracking mirrors called heliostats to focus sunlight onto a receiver at the top of a 35m tower. The superheated air (**1000°C**) produced from this renewable energy strategy can be **utilized** and **stored** (ceramic pellets) to provide medium and high temperature process heat for the previously discussed mining processes, thus eliminating or reducing fossil fuel usage.

Typical Process Applications

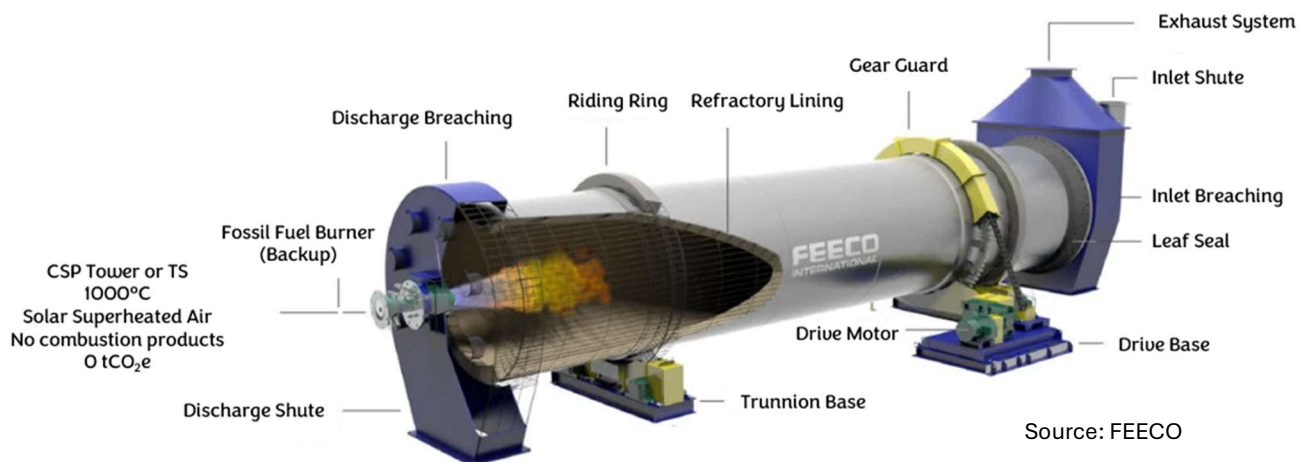
CSP Thermal Energy

Medium Temperature Example (Concentrate Dryers)



Dryers are commonly used for drying ore concentrates such as copper, spodumene, zinc, gold, lead, silver, nickel, cobalt and manganese or drying iron ore pellets.

High Temperature Example (Rotary Kilns)



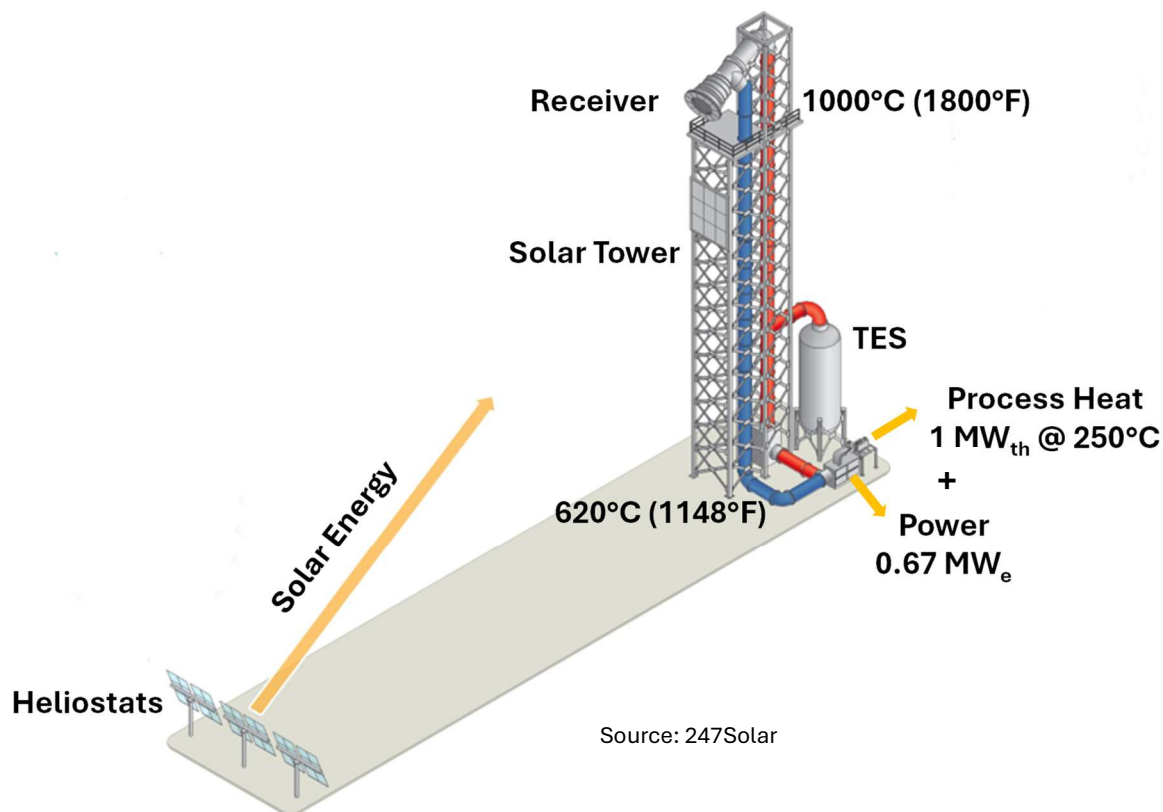
A rotary kiln (calciner) is a rotating heat treatment furnace used for continuously calcining or sintering materials to cause a chemical reaction or physical change. This technology is utilized by the Mining Industry for the calcination (lime, etc), reduction roasting and sintering/hardening for ores and other materials.

CSP Thermal Energy And Renewable Power

As power is required for mining operations and can represent a significant operating cost and source of GHG emissions, some mines may want a renewable strategy that addresses both their thermal requirements and their power needs as well. This is of extreme importance especially for remote mine sites that may be operating on diesel fueled gensets and process equipment.

For every **1 MW_{th} of thermal energy at 250°C**, it is possible to also produce **about 0.67 MWe of renewable power** from a **CSP Tower plant**. Therefore, a CSP plus TES plant with an installed designed capacity of **10 MW_{th} (34 MMBtu/hr) for process heat** at 250°C, could also produce about **6.7 MWe of renewable power** for the mine site as well.

The 250°C (482°F) of **continuous** process heat (10 MW_{th}) could be used in a concentrate dryer and the **continuous** renewable power (6.7 MWe, 58,700 MWh/yr) could be used to operate electric haul trucks, mills, hydrogen production, motors, pumps, fans, electrowinning processes, conveyors, hoists, lighting, refrigeration, and the mine's other electrical loads.

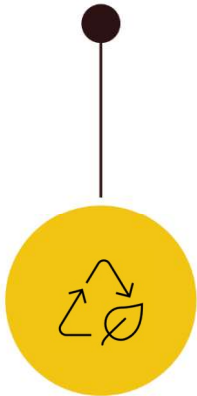


CSP Solar Tower

Advantages & Benefits

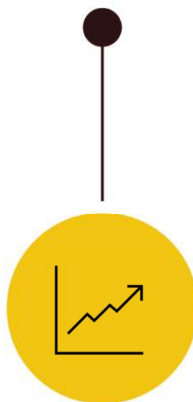
Net Zero Goals

Addresses the decarbonization of process heat for the Mining Industry



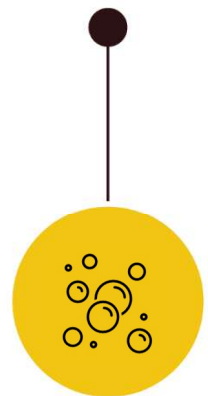
Reduce Price Volatility

Unlike fossil fuels, solar energy is immune to market price volatility (simplifies budgeting)



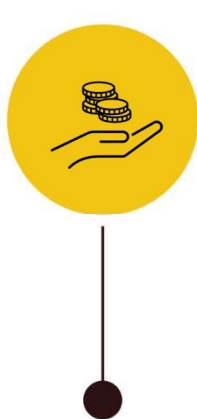
Thermal Storage

Utilizes superheated air and ceramic TES instead of heat transfer fluids and Molten Salts for continuous supply of heat.



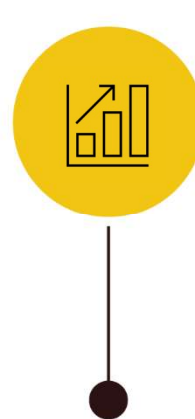
Reduce Costs

Can reduce the energy and operating cost of the mine site and the impact of carbon taxes.



Scalable

Easily scalable to meet partial or full thermal requirements of the various mining process.



Converting from fossil fuels to CSP with integrated storage provides many environmental, economic, social and risk strategy benefits to mines that currently require onsite processing or are considering onsite processing but haven't due to their remoteness and the difficulty or cost of getting fuels to the site.



CONCLUSION

Solar Tower CSP plus an integrated Thermal Storage system is an effective strategy for the Mining Industry to Decarbonize their Process Heating Requirements



1
Easily scalable to meet partial or full thermal process energy requirements



2
Decarbonize and reduce the costs for Medium and High Temperature Mining Processes



3
CSP Tower and integrated TS Technology can help Mine's meet their Net Zero target



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