

Presentation to STERG Symposium



Solar thermal heat for the minerals processing industry

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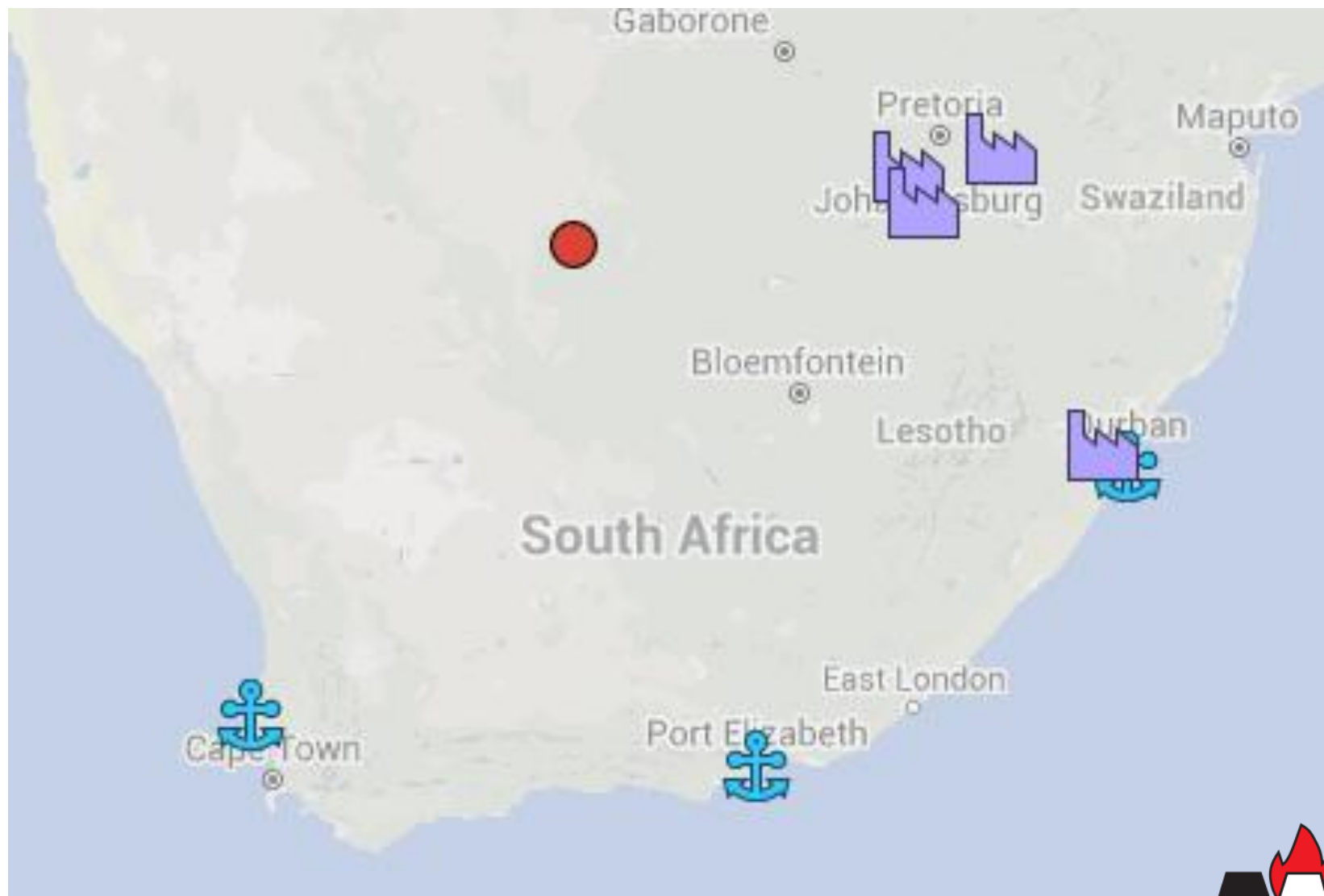


Solar heat – minerals processing

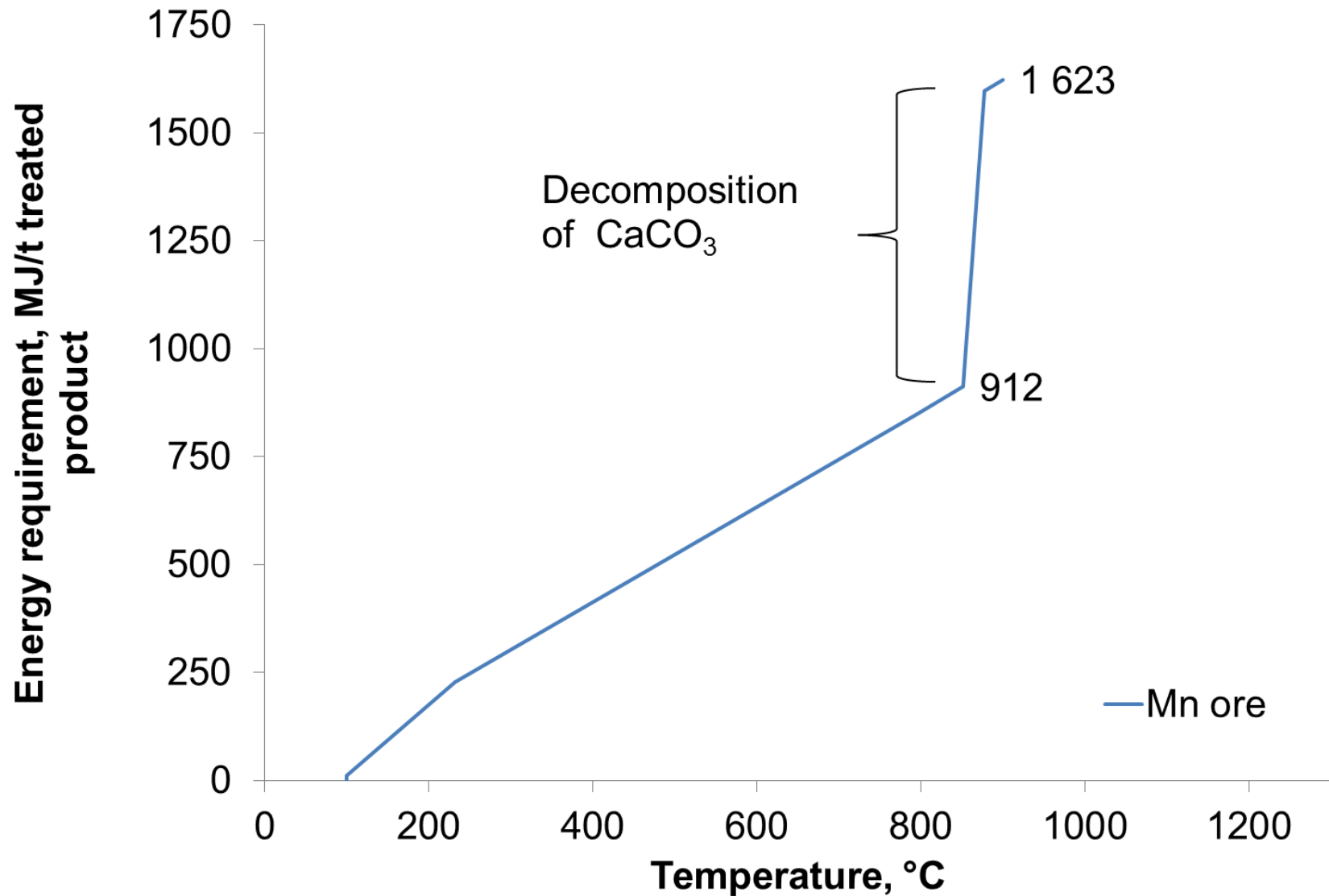
- Thermal decomposition of ZnO
- Cracking of CH_4 to C and H_2
- Thermal decomposition of CaCO_3
- Water heating and steam production



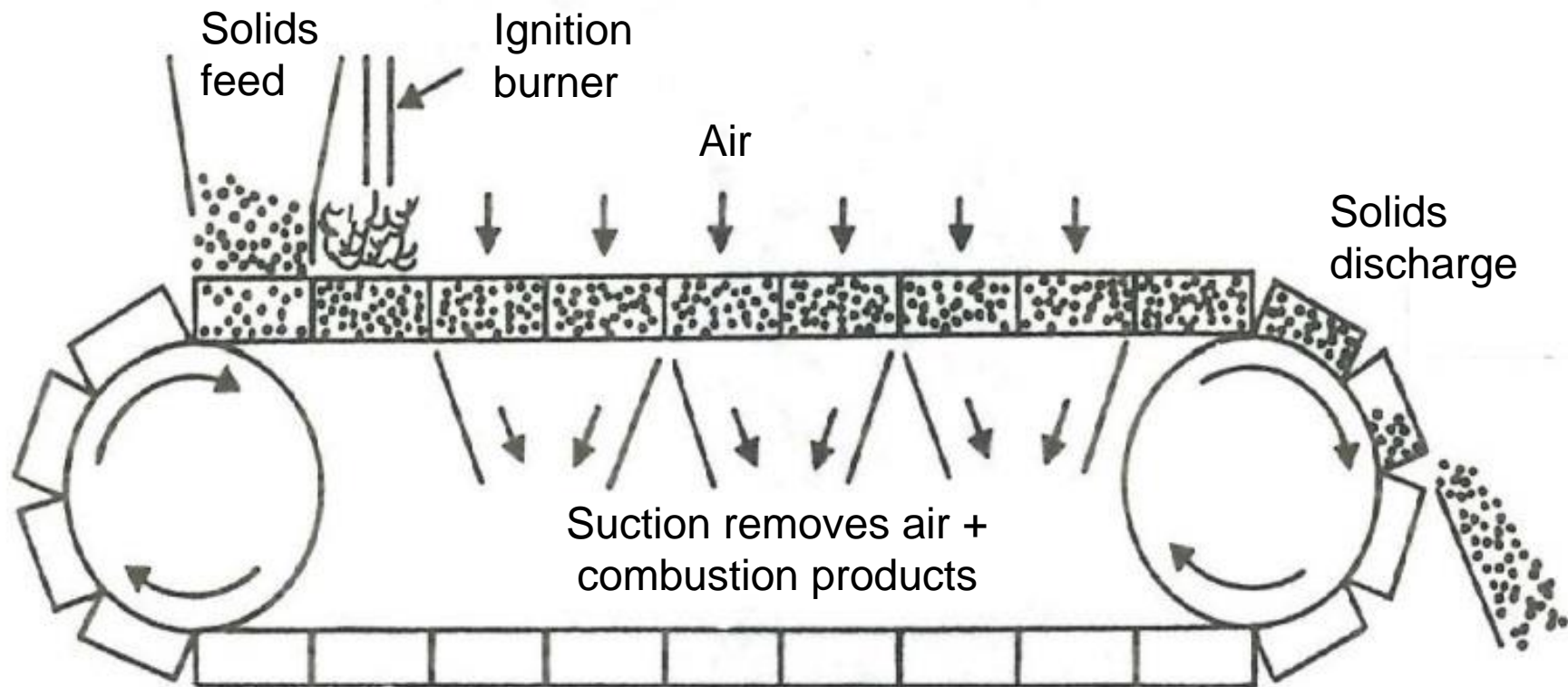
Why manganese ores?



Energy and temperature requirements



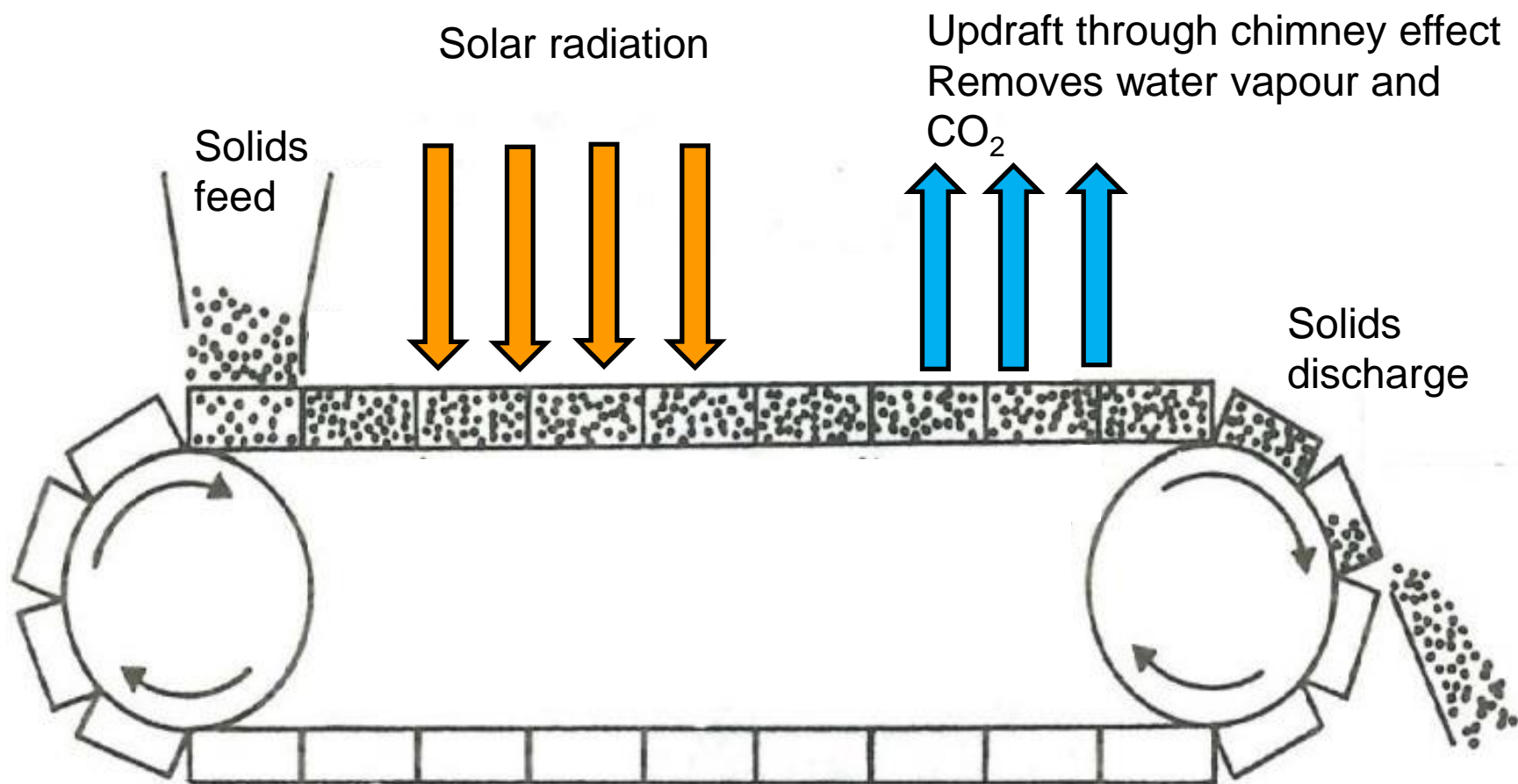
Sinter machine – Current technology



Drawing adapted from Hayes, 1993



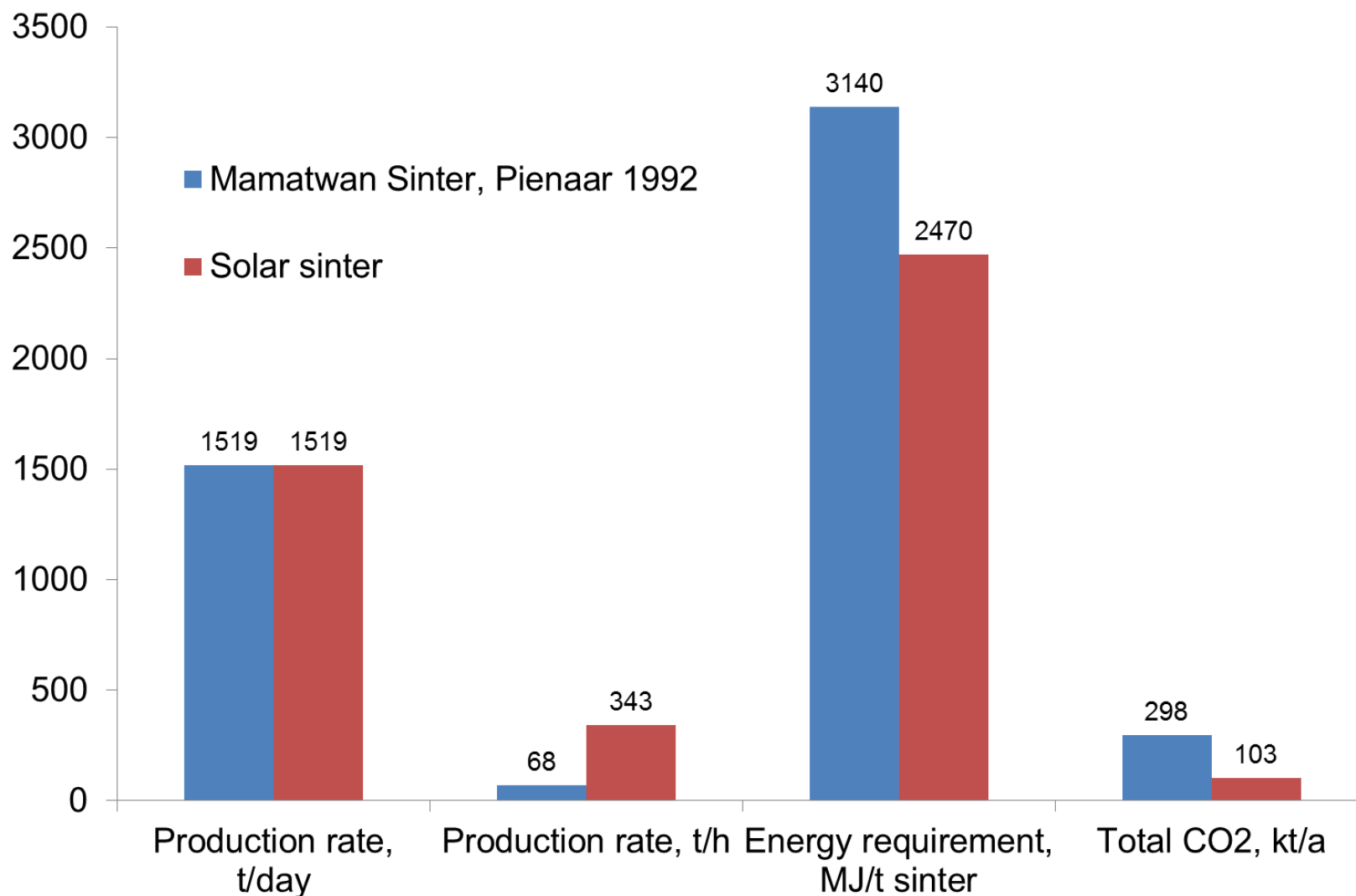
Solar sinter/preheater?



Drawing further adapted from Hayes, 1993



Conventional vs. solar sinter



How much space?

| Collector rating | Collector area | Plant area |
|----------------------|----------------|------------|
| 393 MW _{th} | 30 ha | 32 ha |



Khi Solar 1, 50 MW electricity @ Upington, Pic credit: Abengoa

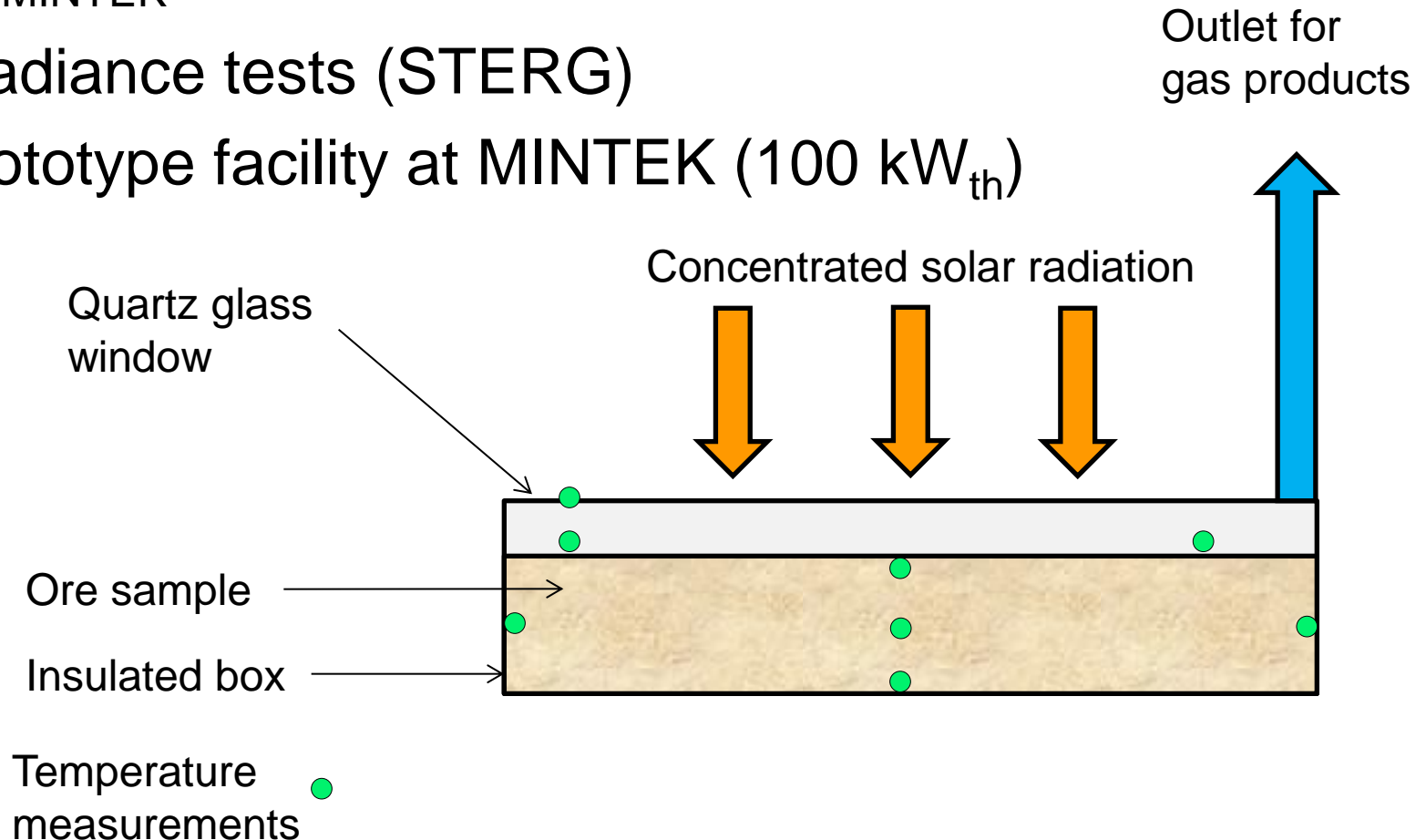
What do we need to know?

- Composition
 - Ore, binder
- Heat transfer properties
 - Refractive index, infrared absorption, scattering, radiation diffusion coefficient as well as thermal conductivity
- Behaviour for solar heating
 - Decomposition or sintering
 - Degree of pre-reduction



How will we determine it?

- Chemical and mineralogical analysis
 - SUN
 - MINTEK
- Irradiance tests (STERG)
- Prototype facility at MINTEK ($100 \text{ kW}_{\text{th}}$)



Conclusion

- It should be possible to treat ores with concentrated thermal radiation to achieve drying, thermal decomposition and pre-reduction
- Research is needed to
 - Determine optical properties of ores
 - Confirm kinetics of the reactions under solar radiation
 - Confirm efficiencies achieved in large scale solar concentrators

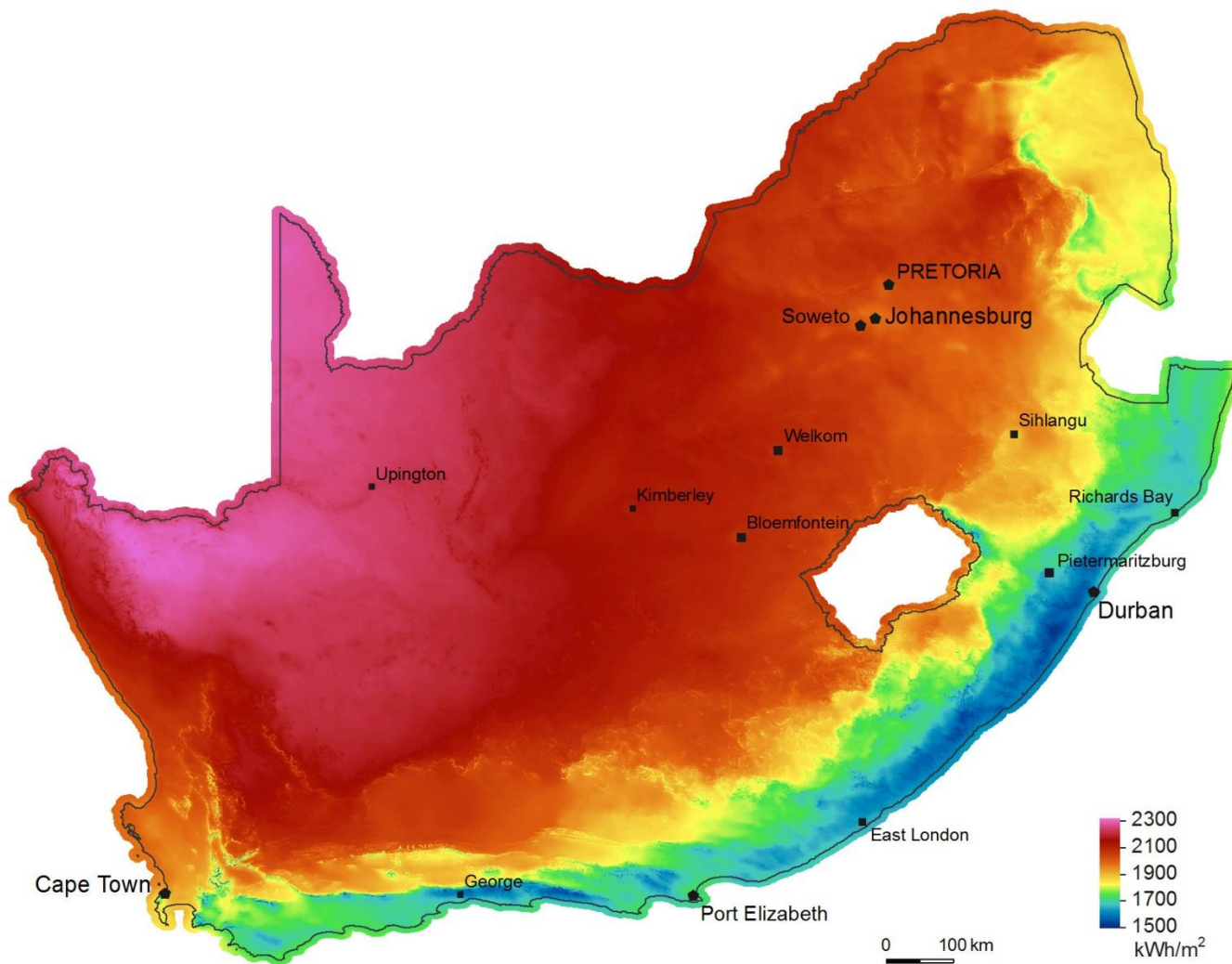


Thank You
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MINTEK

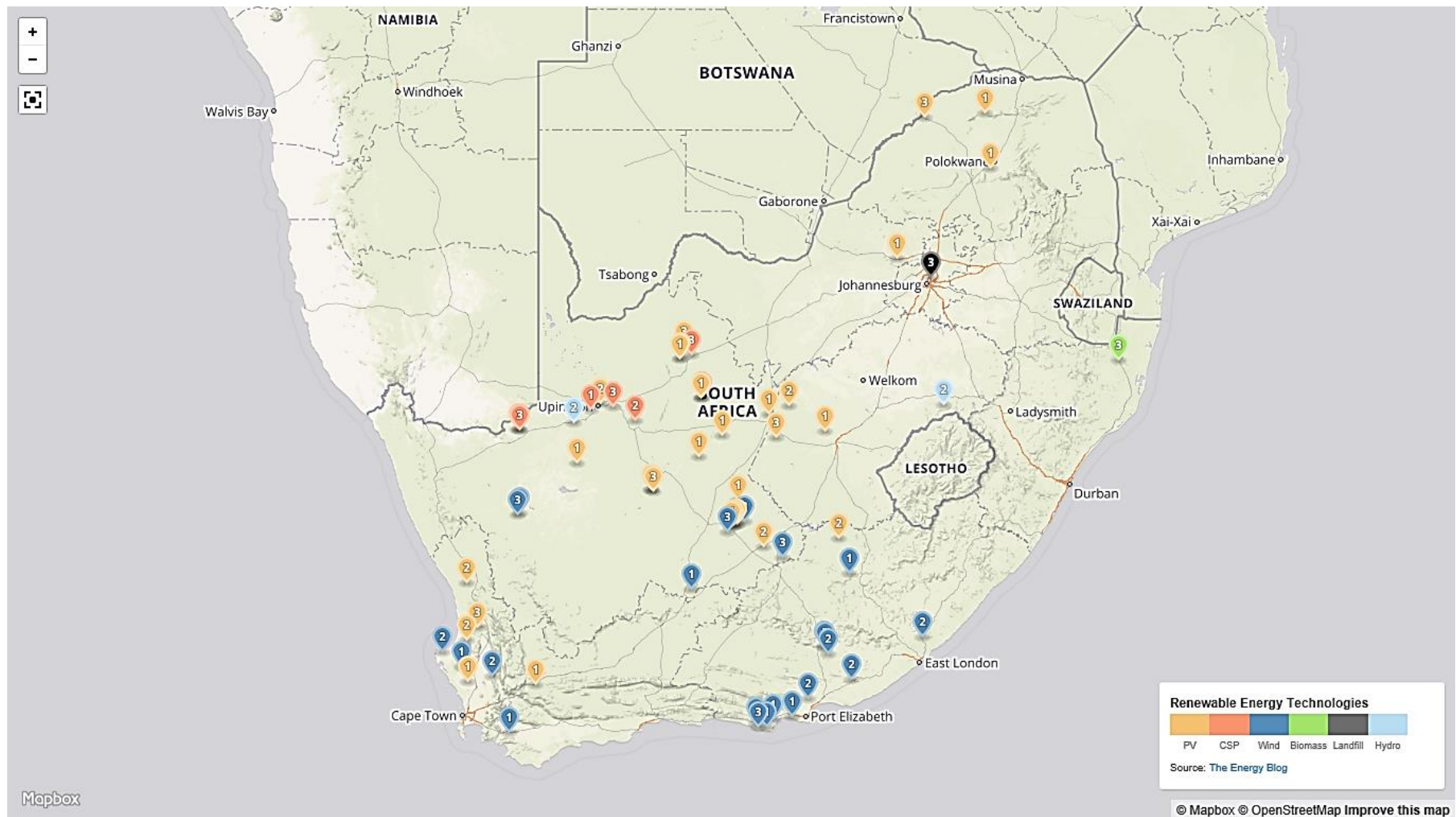
Solar thermal - Why?



SolarGIS Global horizontal irradiance



Solar thermal – Why?



<http://energy.org.za/>



Ferromanganese smelting

Challenges:

- Rising energy costs (2.8 kWh/t alloy*)
- Produces CO and CO₂ (13.4 and 12.57 kmol/ t metal*)
- Low global demand

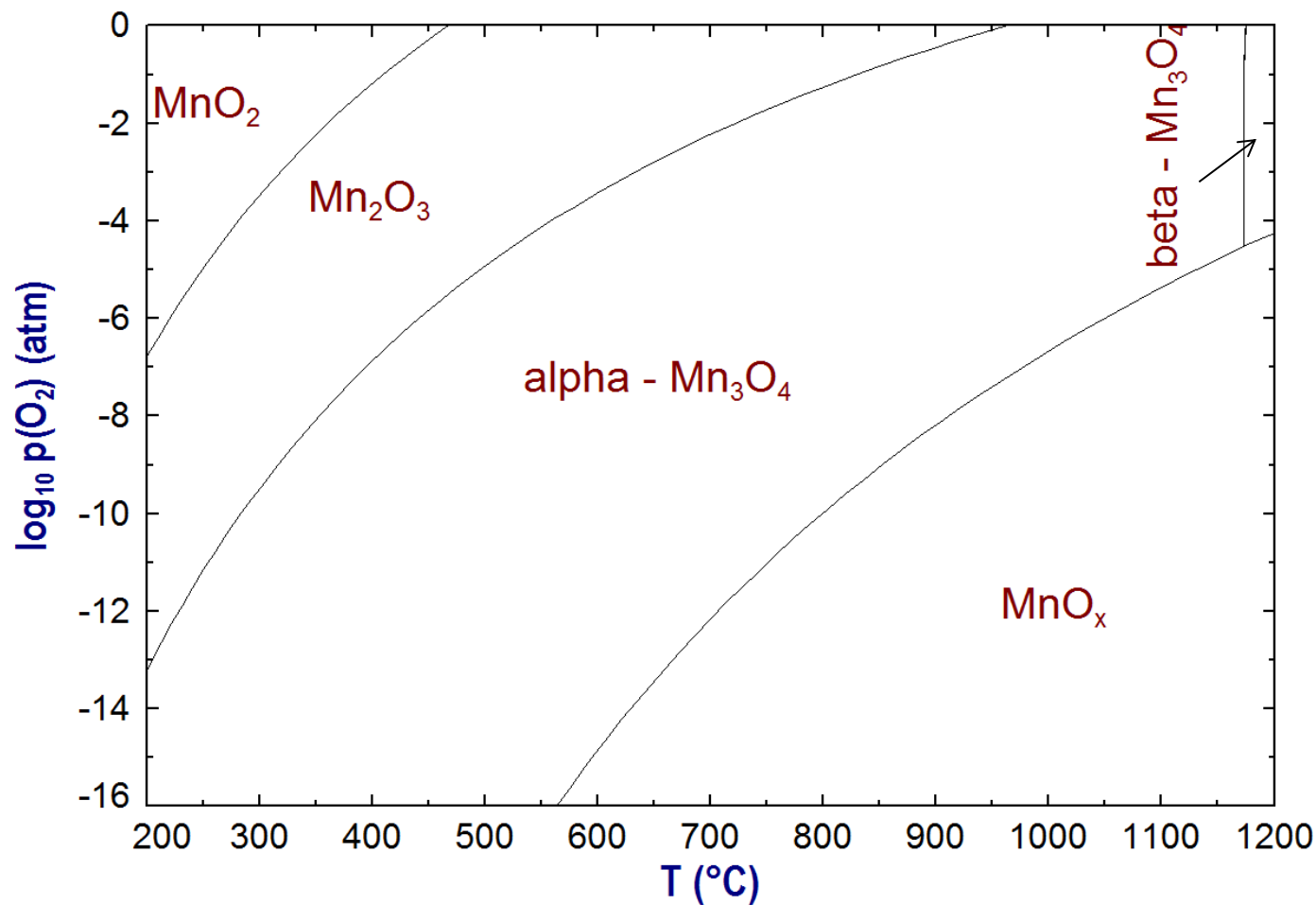
Mitigations:

- Pre-reduction
- Pre-heating
- Energy efficiency

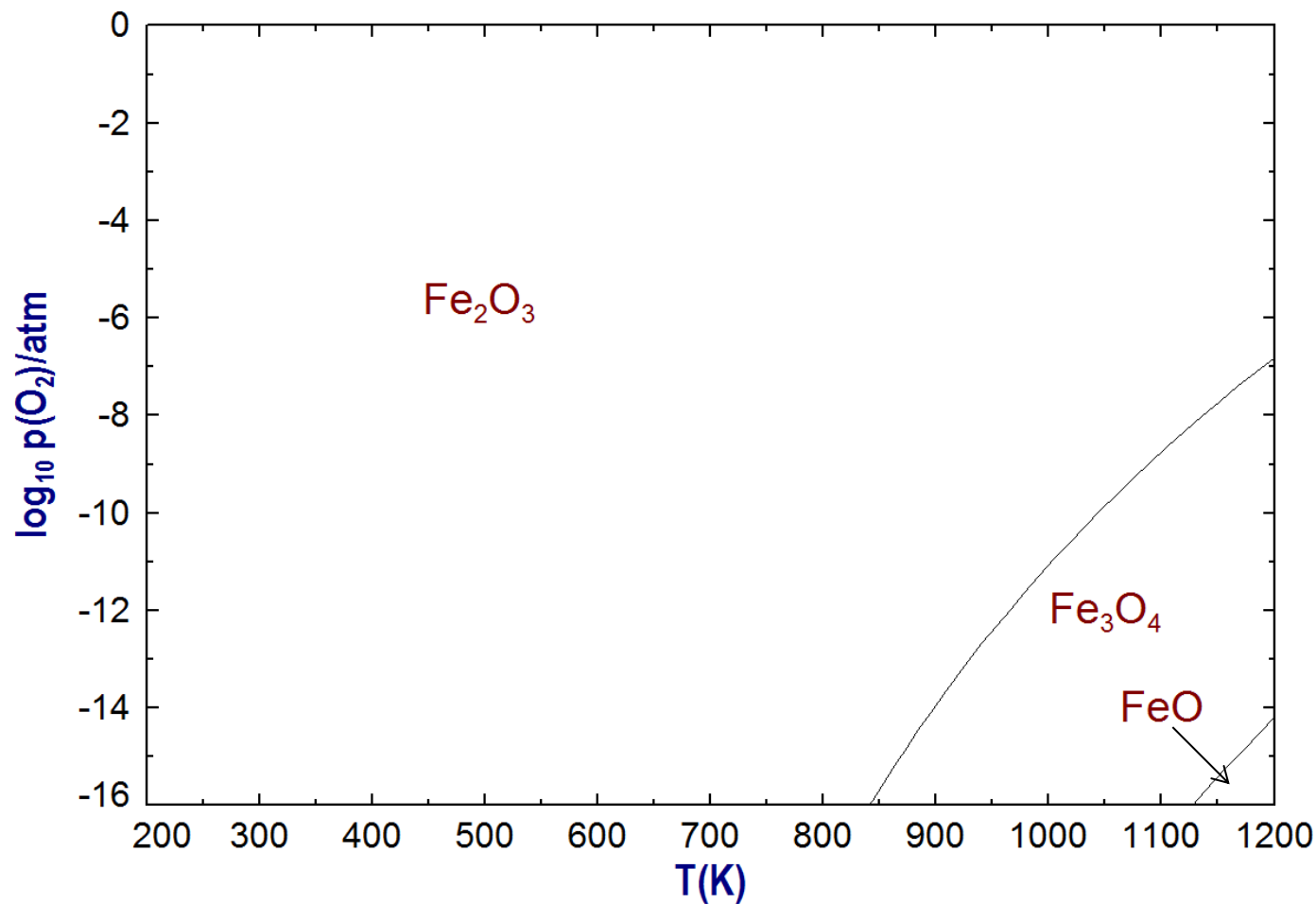


*Tungstad, Production of Manganese Ferroalloys, 2007

Manganese oxide phase diagram



Iron oxide phase diagram



What happens when the sun does not shine?

- **Thermal storage**

Increased hours means lower throughput rates required, but collector field must increase to provide energy for storage.

- **Batch operation**

No night shifts.

- **Hybrid systems**

Build your collector field as you can afford it and supplement with fossil fuels



MINTEK

What about money (Rough estimates)?

- Estimated cost of solar sinter : R3 billion
- Estimated cost of conventional sinter: R365 million
- Estimated savings of solar sinter:
 - R 50 million a year coal cost
 - R 51 million a year coal transport cost
 - 195 kt/year CO₂ emissions
with effective Carbon tax of R12 to R48/t CO₂ =
R2.3 to R9.4 million a year
Net saving R101 to R110 million a year

