



Integration of Renewable Energy and Energy Efficiency into High Temperature Applications

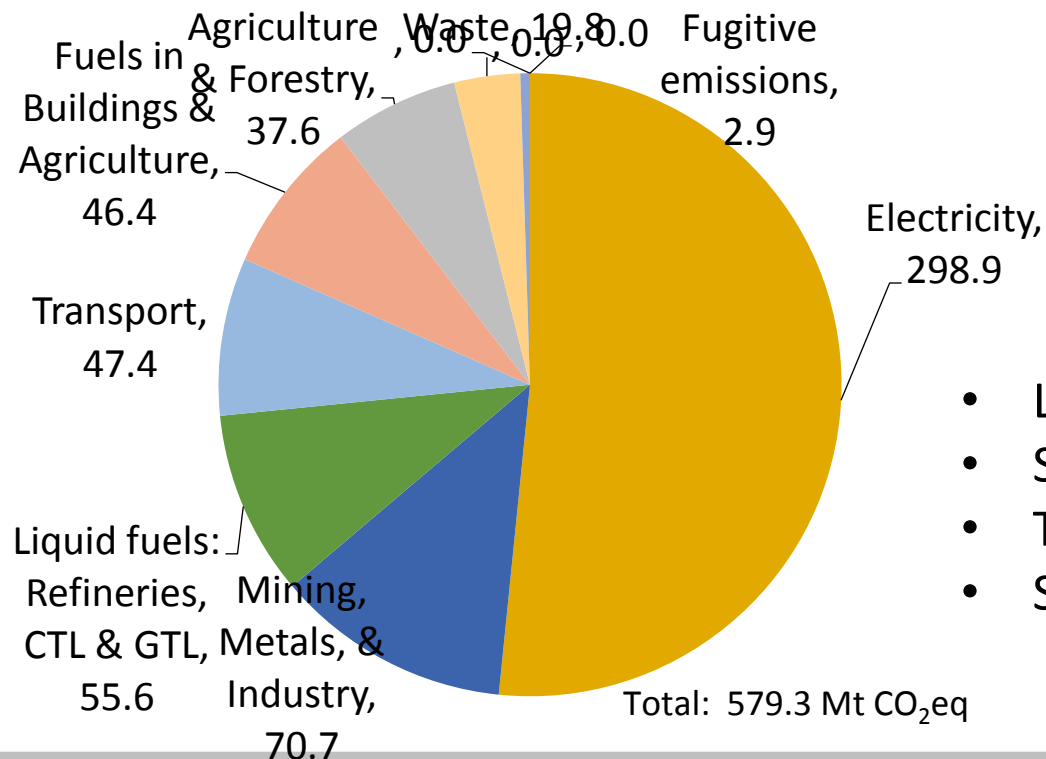
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The opportunity...

- Renewables have shown significant growth in the past 20 years
 - Almost exclusively as a result of Wind, Solar PV and now Solar thermal.
 - All Electricity Generating Technology, yet only 50% of the Emissions.



- Low/Med Temperature Applications
- Solar Materials
- Transitional Fuel Technology
- Solar Fuels

Low/Med Temperature applications

- Thermal Energy – Steam boiler facilities
- Cooling – Absorption Chillers have been demonstrated at scale
- Enhanced Oil Recovery
- Desalinization



Solar Materials (Thermal Energy)

- Concentrating Solar Energy replacing or integrating with combustion systems for thermal energy
 - High temperature recycling of waste materials (e.g. aluminium, sulfuric acid)
 - Development of solar heated reactors – solar heated rotary kilns
 - Development and demonstration of production processes
- Lime Production
- Carbothermal reduction processes eg Alumina



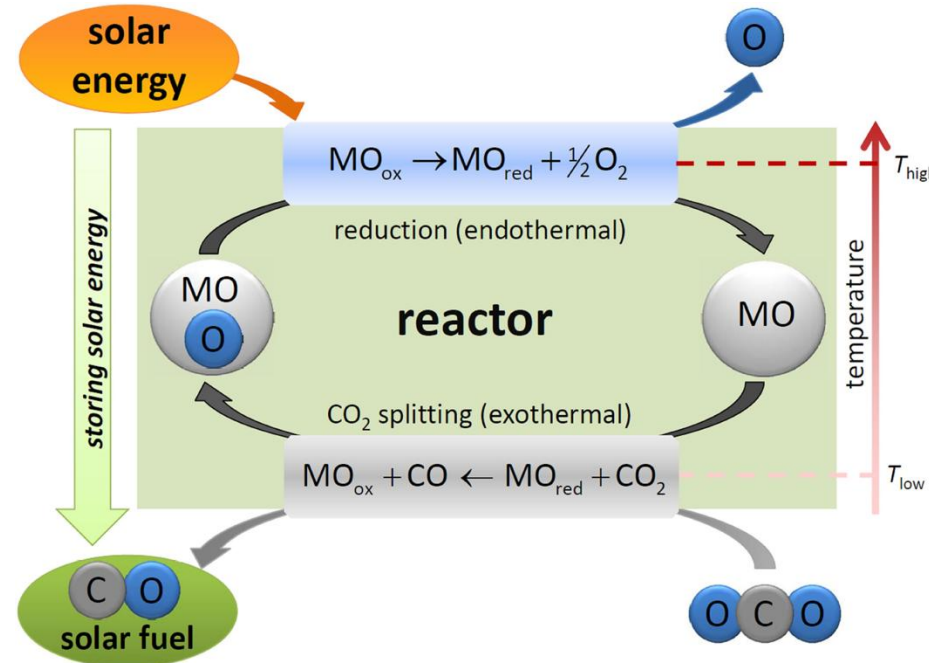
Transitional Fuel Technology (Energy Embedding)

- Syngas (H_2/CO) Production by Concentrating Solar Thermal Energy
 - Gasification processes (Biomass/coal)
 - Steam reforming – 95% of the worlds Hydrogen
 - Dry Reforming – Utilizing captured Carbon Dioxide
- Syngas is the precursor to most carbon based commodities
 - Petroleum/FT liquids
 - Methanol → Plastics, DME, Diesel Replacement
 - Ammonia → Fertilizers, Explosives
 - Hydrogen → refining, Fuels Cells
- Demonstrated at MW scale
- All can be run in parallel with existing industrial processes
- Approaching Cost Competiveness.
- Application in gas constrained areas

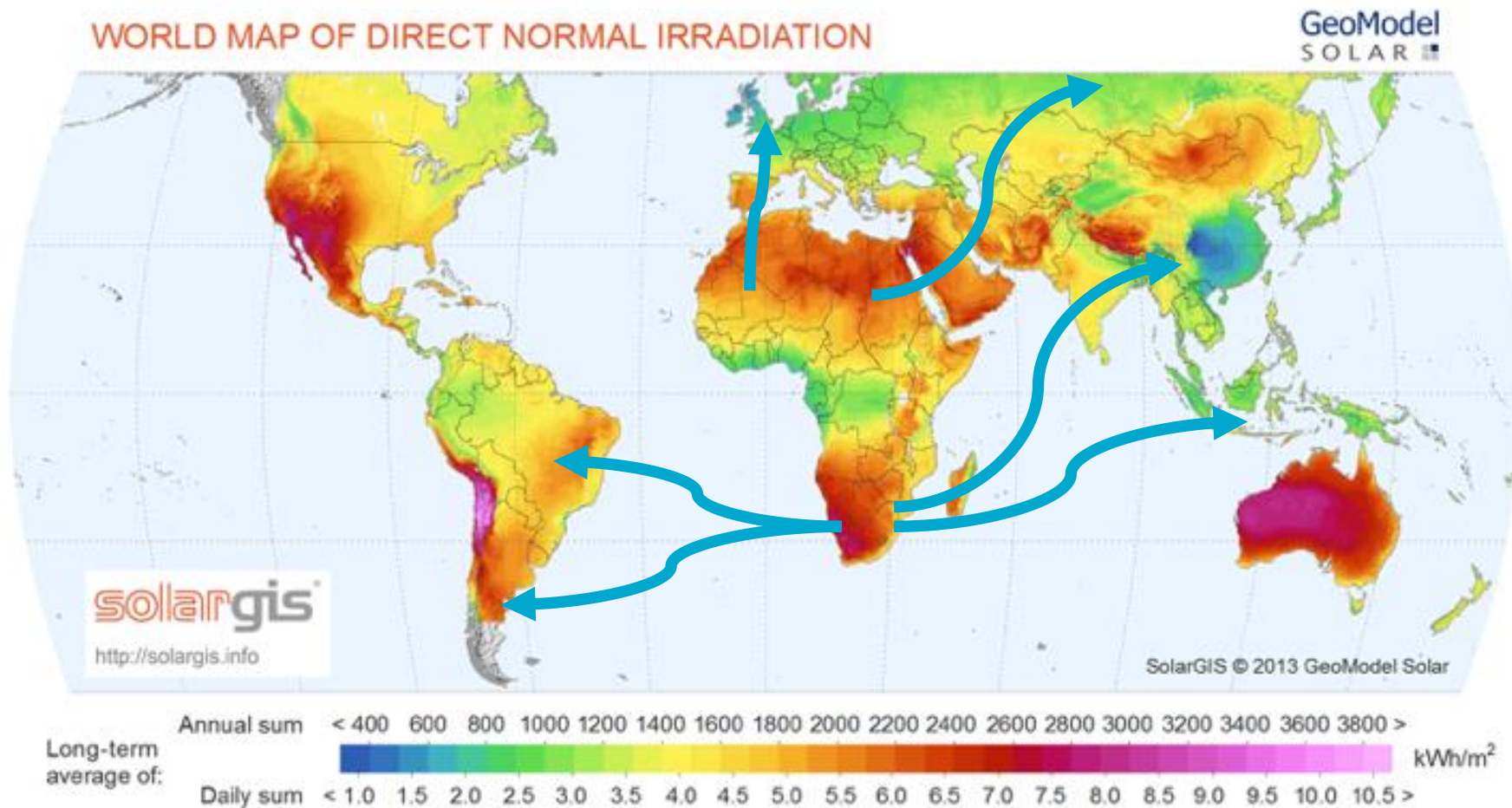


Solar Fuels

- Water Splitting for Hydrogen
 - Truly renewable hydrogen fuel
- Carbon Dioxide Splitting for CO
 - Enables Recycling of captured CO₂
- Combined processes enable syngas production for production of traditional Fuels



Solar Fuels – a new industry



Technology Readiness



THERMAL STORAGE

- ✓ Thermal Energy
- ✓ Cooling
- ✓ Enhanced Oil Recovery
- ✓ Desalinization




CHEMICAL STORAGE

- ☑ Solar Materials Processes
- ☑ Transitional Fuel Technology
- ☑ Solar Fuels

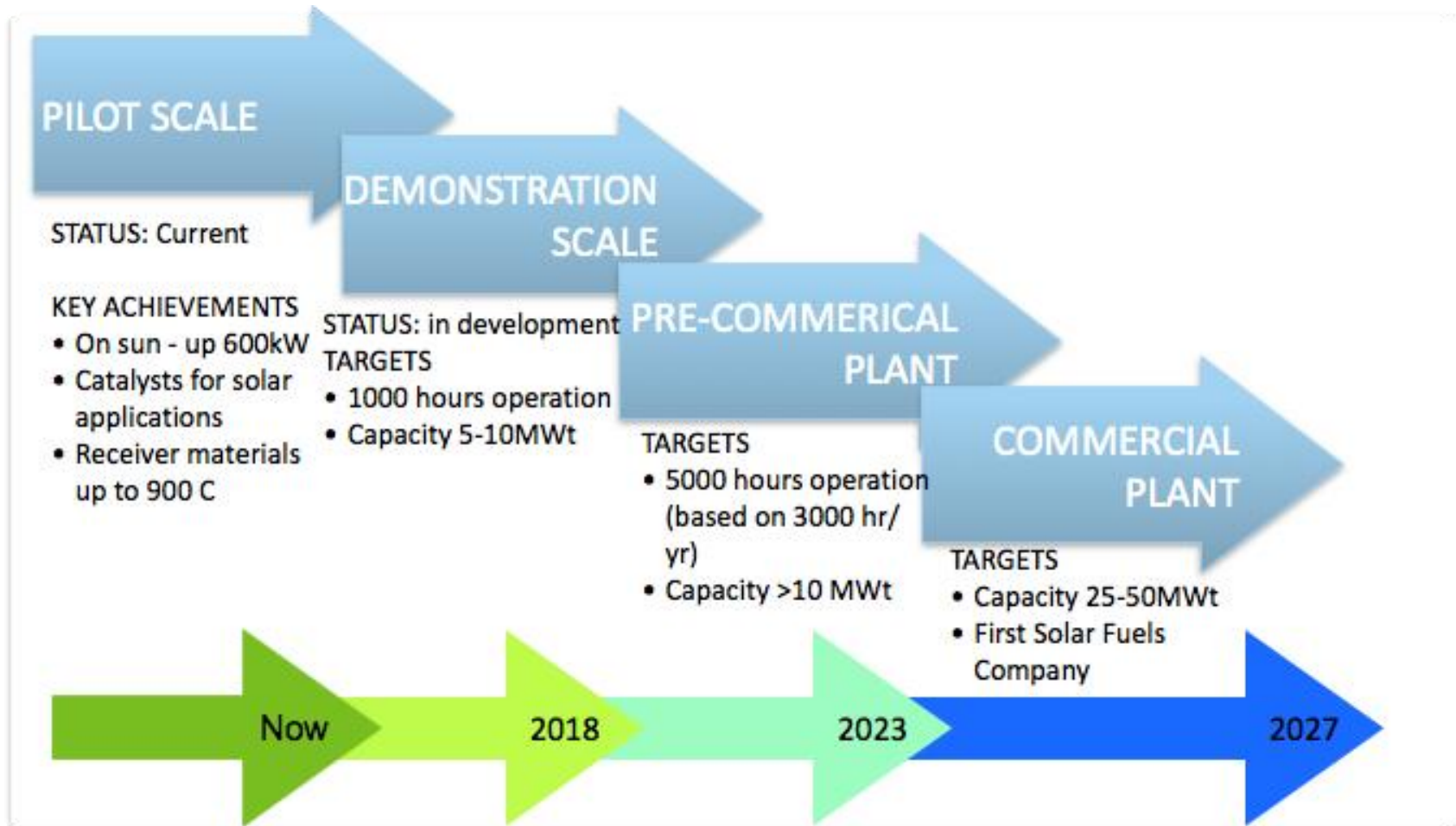
Driving Change in Industry – addressing RISK

- Delivering a high capital process to market requires sustained investment
 - Challenging when the next investment is \$10-15 million
 - Reality is need bankable (demonstrated) technologies
 - Need to identify high value niche markets for early uptake
- Technology Risk
 - All technologies have been demonstrated at MW scale
 - Risk comes from scale up and Lifetime.
- Financial risk
 - New technologies are difficult to finance
 - Positive aspect is that solar energy is fixed price, hydrocarbon fuels are subject to market fluctuations



Government Opportunity
to drive change

From the Australian Solar Fuels Roadmap.



Renewables – more than Electricity!

- Renewable solar thermal technologies are capable of meeting the needs of Industrial processes to provide Low or No emission operations
- Solar thermal technology can transform the industry sector reducing reliance on electricity
- Engagement with Industry critical
- Government can accelerate the change with early support to address risk

Thank you

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