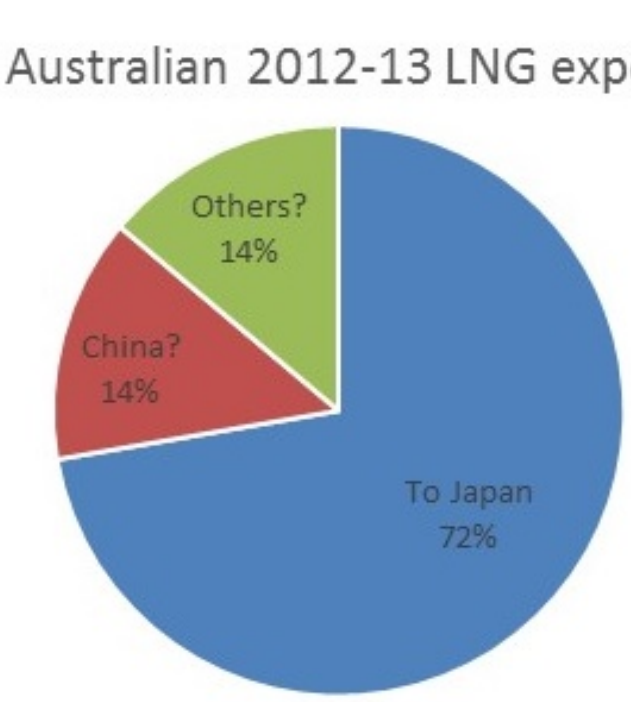
New Opportunities for Solar Process Heat as Gas Prices Rise

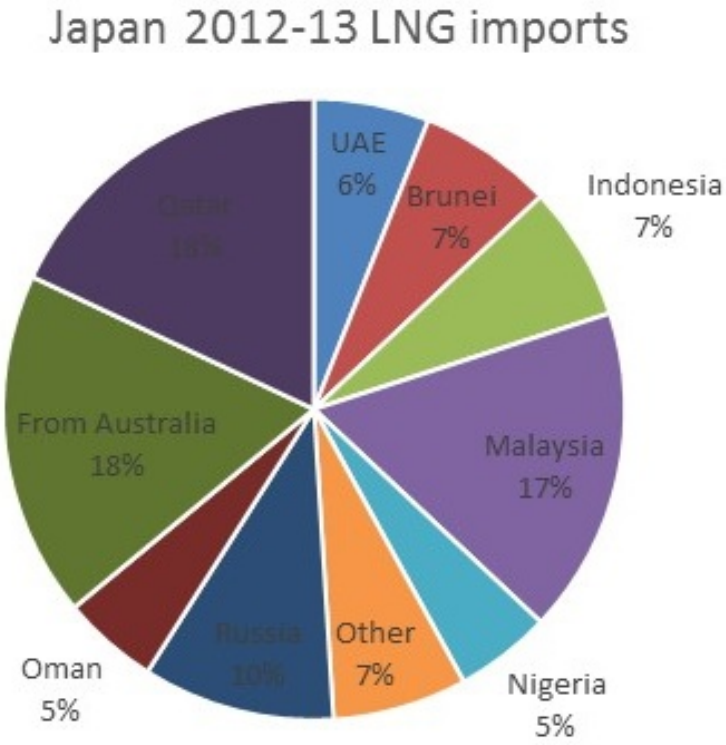
Dr Keith Lovegrove
Head – Solar Thermal, IT Power Group, http://www.itpau.com.au
(with acknowledgements to Steve Edwards, Josh Jordan, Juergen Peterseim, Hugh Saddler, Jay Rutovitz, Muriel Watt, Joe Wyder)

Japan needs our gas



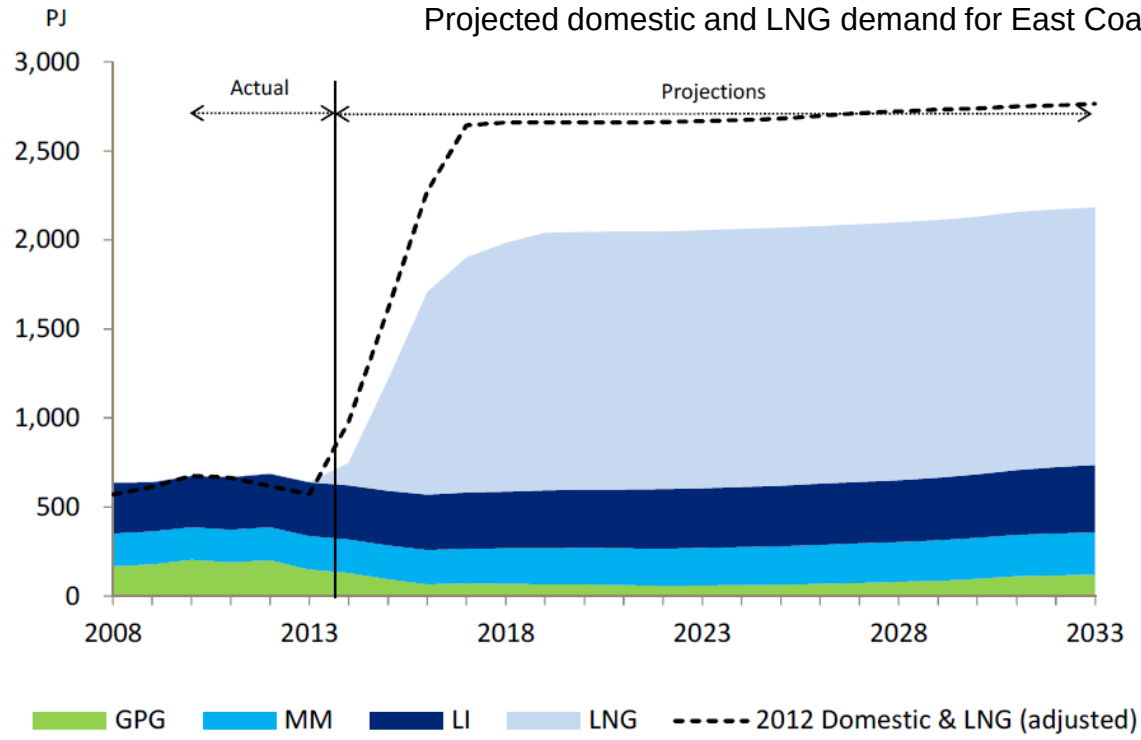
15.7 million tonnes = 857 PJ

AUD 10.3 billion = 12$/GJ ?



New LNG plants will increase demand

Projected domestic and LNG demand for East Coast (Deloitte 2014)



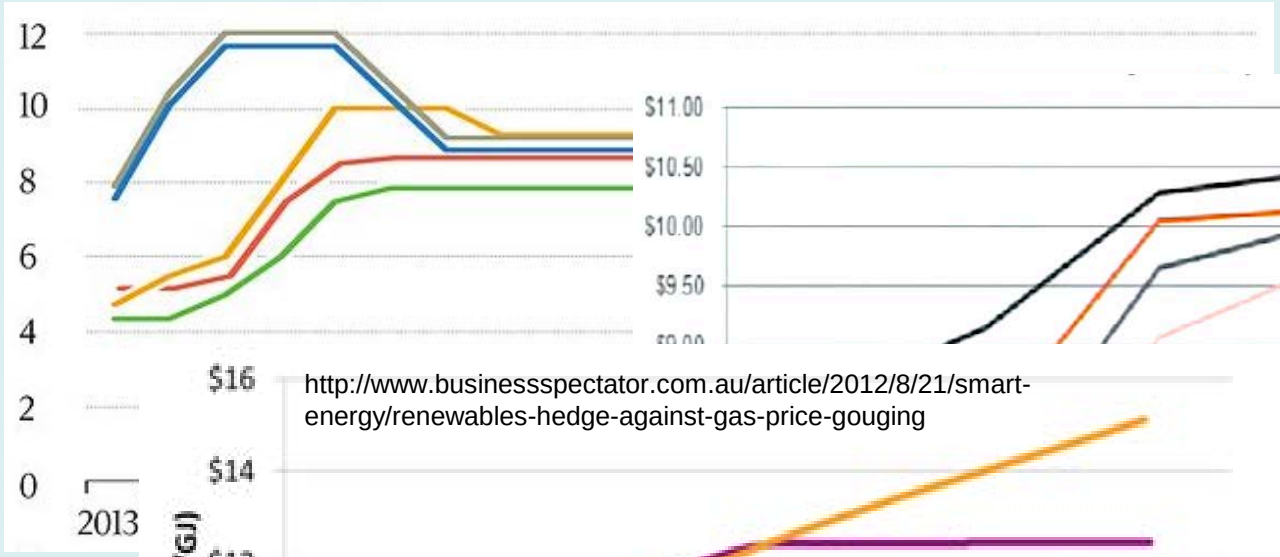
Source: AEMO 2013, Gas Statement of Opportunities

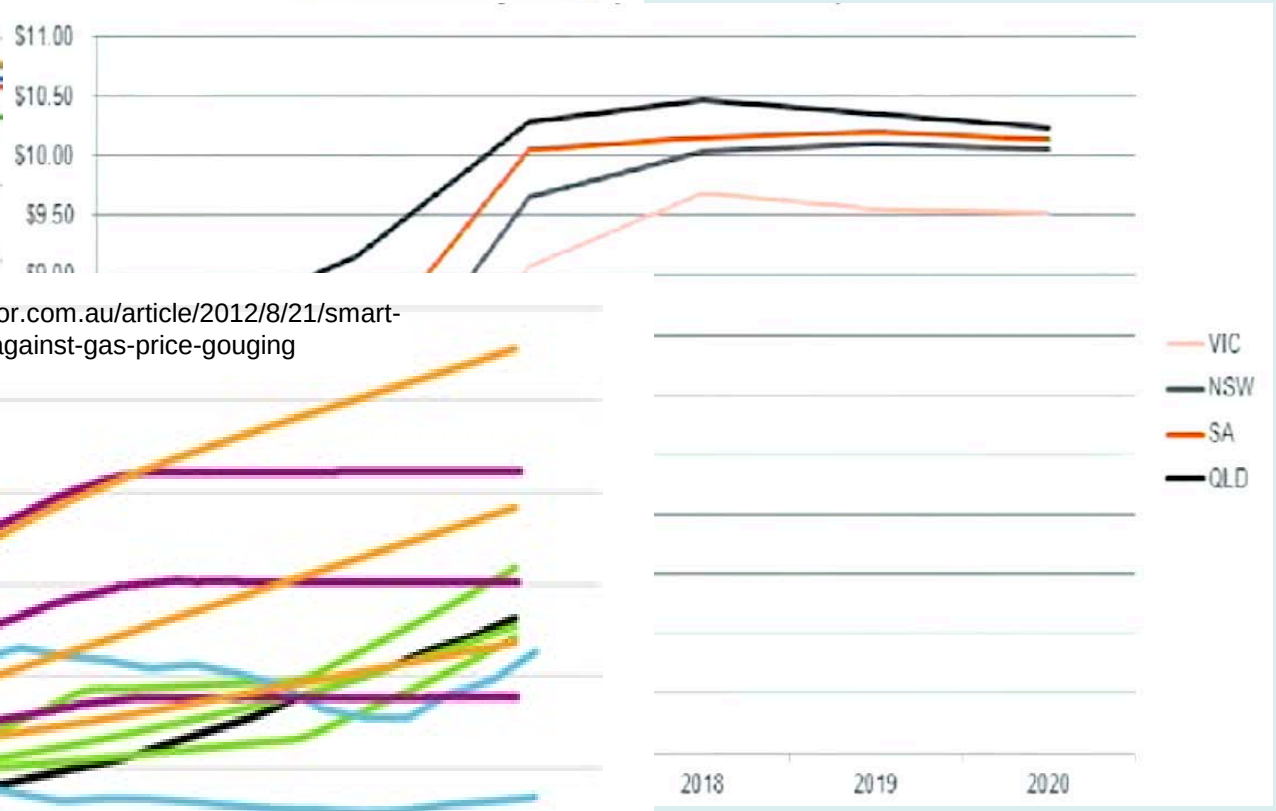
NB: AEMO's 2013 projections do include Arrow Energy

GPG refers to Gas Powered Generation, MM refers to Mass Market (residential and commercial)_LI refers to Large Industrial

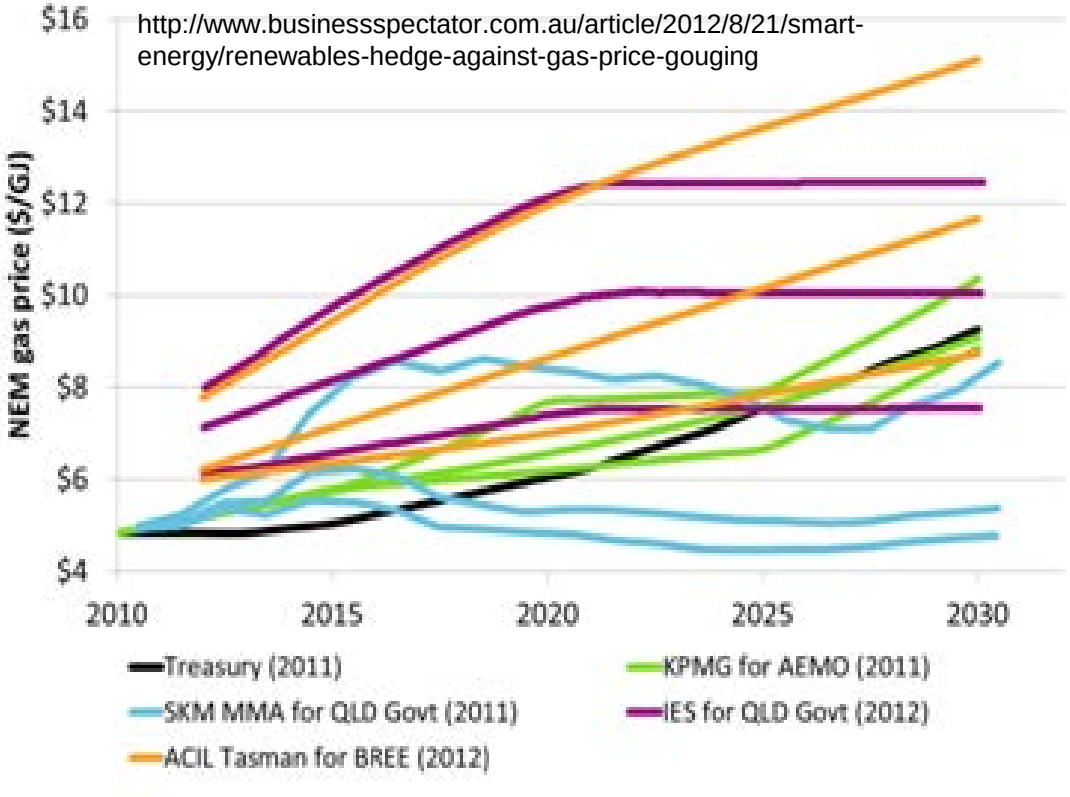
- General expectation that wholesale gas prices will rise to "export netback" levels

Where will prices end up?





http://www.businessspectator.com.au/article/2012/8/21/smart-energy/renewables-hedge-against-gas-price-gouging



ARENA commissioned study

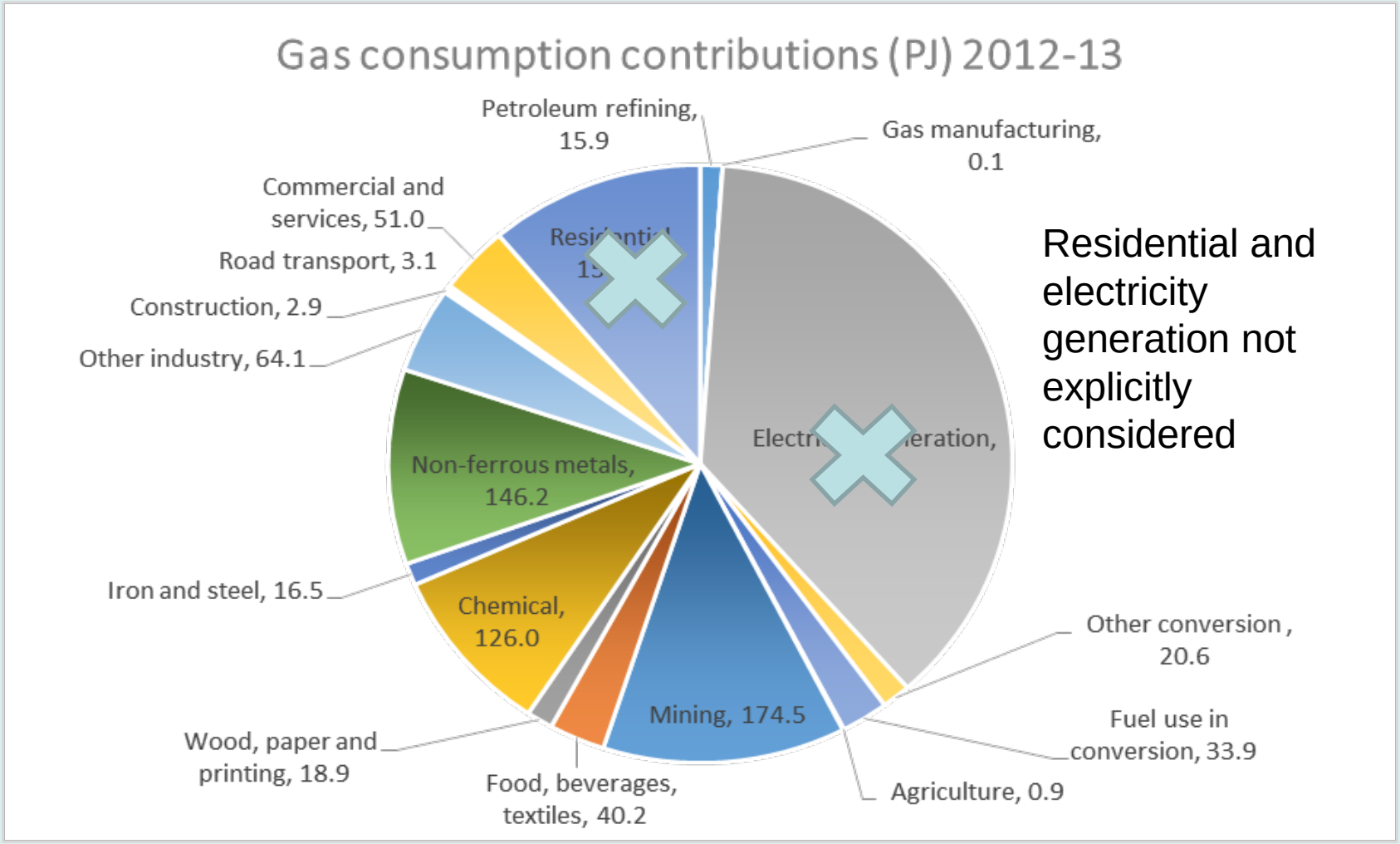
- Options for direct (partial or full) substitution of renewables for gas within the boundaries of an existing industrial operation
- IT Power, with Pitt&Sherry, UTS Institute for Sustainable futures and 2B advertising and design
- Goals
  - Study opportunities and challenges
  - Background technical report
  - Public summary report plus evaluation tool
  - Aiming for completion at end of March

Industry uses gas for:

- Steam raising and hot water, and also for various types of drying processes,
- High temperature thermal processes, in kilns, furnaces etc.,
- Fuel for power generation and
- Chemical feedstock, principally for the production of ammonia,

A cost effective renewable energy alternative to gas could be a win (for gas users), win (for renewables), win (for gas industry)

Current gas use



Current mass market industrial use

Mass market users (distribution connected currently at around $9 to more than $20/GJ)	Hot water	Low temp (steam / drying)	High temp (steam / drying)	High temp (direct heat / steam)	Specialist	
Temperatures (°C)	**<150**	**150 to 250**	**250 to 800**	**800 to 1300**	**>1300 / feedstock**	
Agriculture	0.4	0.5				
Dairy product manufacturing		7.2				
Sugar and confectionery manufacturing		1.2	1.2			
All other food product manufacturing		10.6	13.5			
Beverage & tobacco product manufacturing		1.8	1.6			
Textile, leather, clothing & footwear manufacturing	0.1	0.7	1.2			
Wood product manufacturing		0.3	1.9	1.0		
Pulp, paper & converted paper product manufacturing		1.5	8.5	4.5		
Printing (including the reproduction of recorded media)		0.1	0.8			
Polymer product & rubber product manufacturing		0.2	1.2			
Fabricated metal product manufacturing		0.6	1.7	0.5		
Transport equipment manufacturing	0.1	1.1	1.8			
Machinery and equipment manufacturing	0.1	0.8	1.3			
Furniture and other manufacturing		0.1	0.1			
Relevant technologies	Small biomass boiler, Solar	Biomass boiler, Evacuated tube solar, Concentrating solar	Biomass boiler, Concentrating solar parabolic troughs & fresnel	Biomass gasification & combustion, Concentrating solar heliostats & parabolic troughs	Biomass gasification, Concentrating solar heliostats & tower	
Total Mass market (PJ)	**0.8**	**26.6**	**34.8**	**6**	**0**	**68.2**

PJ/year

Current large scale industrial use

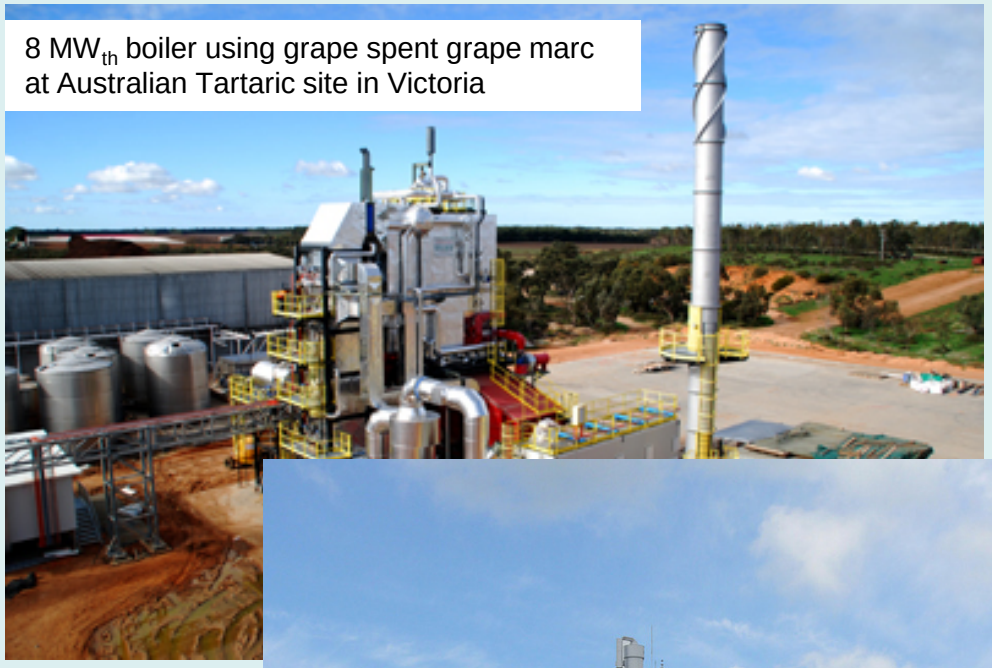
Large gas users (transmission connected currently at $7 to $9/GJ)	Hot water	Low temp (steam / drying)	High temp (steam / drying)	High temp (direct heat / steam	Specialist	
Temperatures (°C)	**<150**	**150 to 250**	**250 to 800**	**800 to 1300**	**>1300 / feedstock**	
Metals (includes Alumina)			80.0		80.0	
Non metalic Minerals processing (includes cement)		8.1	2.6	24.2	22.6	
Basic Chemicals (includes ammonia)			6.0	30.0	90.0	
Relevant technologies	Small biomass boiler, Solar	Biomass boiler, Evacuated tube solar, Concentrating solar	Biomass boiler, Concentrating solar parabolic troughs & fresnel	Biomass gasification & combustion, Concentrating solar heliostats & parabolic troughs	Biomass gasification, Concentrating solar heliostats & tower	
Total Large gas users (PJ)	**0**	**8.1**	**88.6**	**54.2**	**192.6**	**343.5**

PJ/year

Technology options

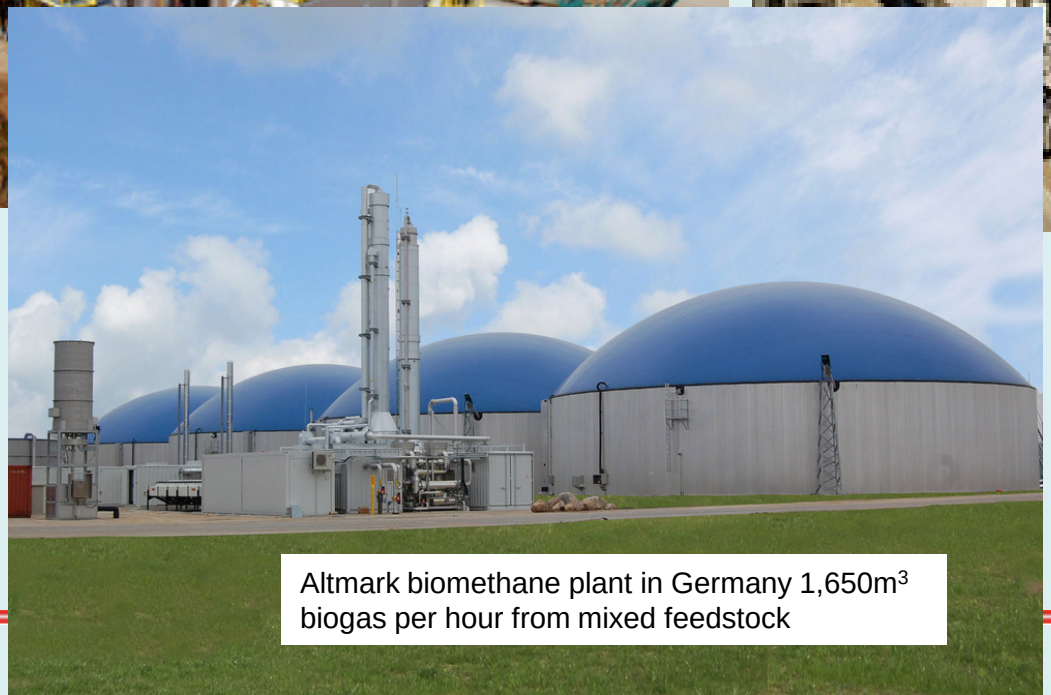
- solar thermal systems for process heat across all temperature ranges,
- biomass combustion for hot water and steam,
- biomass pyrolysis or gasification for chemical feedstocks or for combustion,
- anaerobic digesters for gas for combustion or feedstock,
- direct use geothermal heat for low to medium temperature processes, and
- heat pumps with photovoltaic systems.

Bio Examples



8 MW_{th} boiler using grape spent grape marc at Australian Tartaric site in Victoria

Construction and demolition timber supply to the Birkenhead cement plant in South Australia

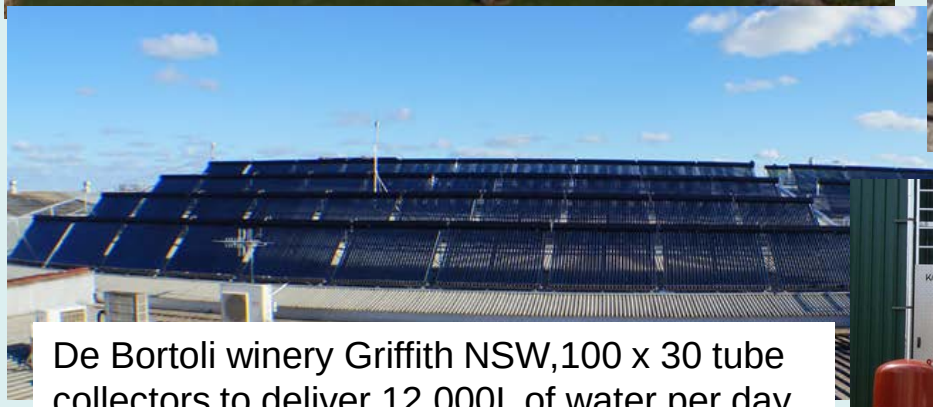


Altmark biomethane plant in Germany 1,650m^3 biogas per hour from mixed feedstock

Solar Thermal Examples

AIS aquatic centre, 1,500m^2 of unglazed collector

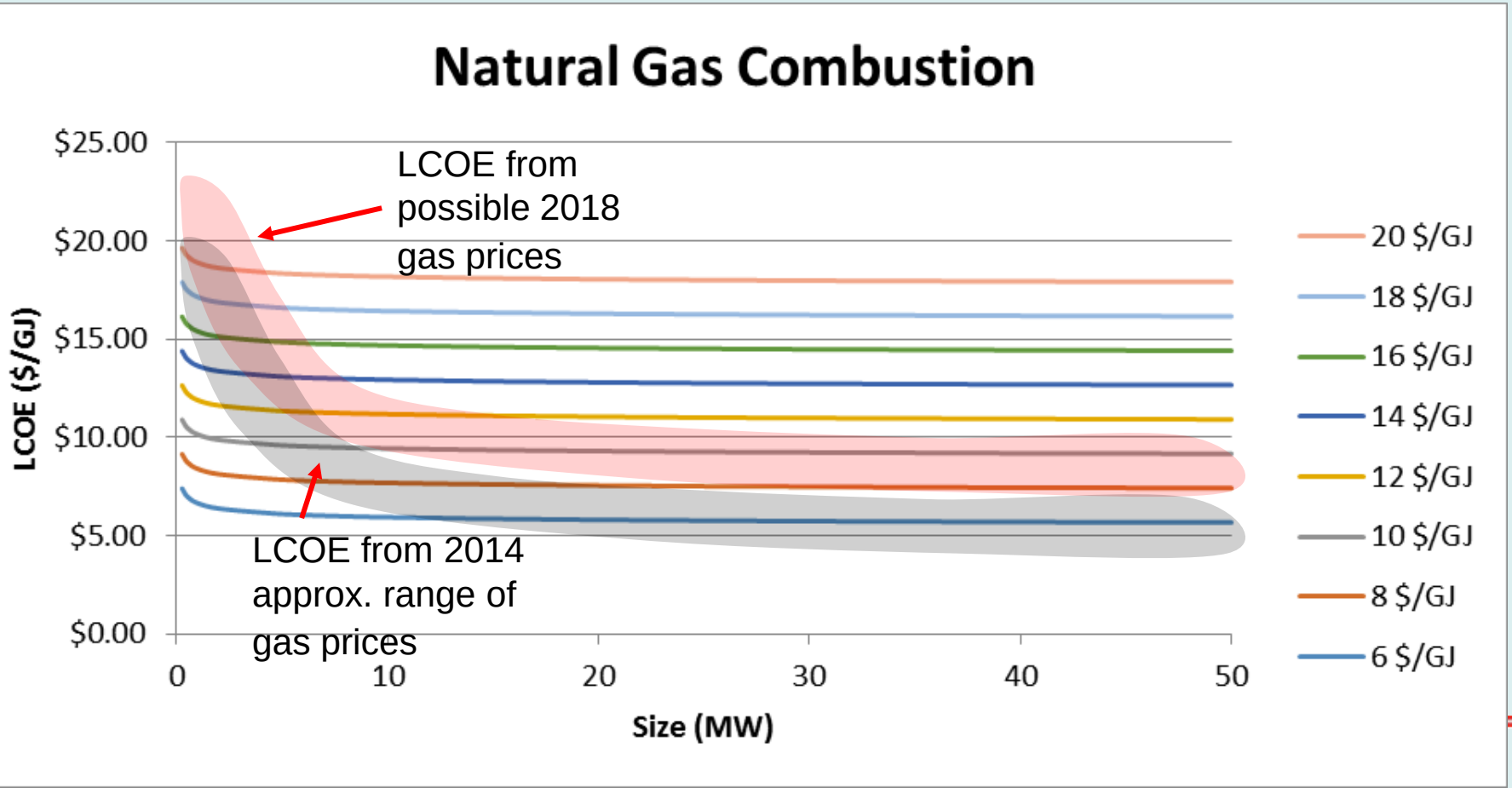
$10MW_{th}$ solar thermal trough array for 250°C, at a copper mine in the Atacama Desert Chile.



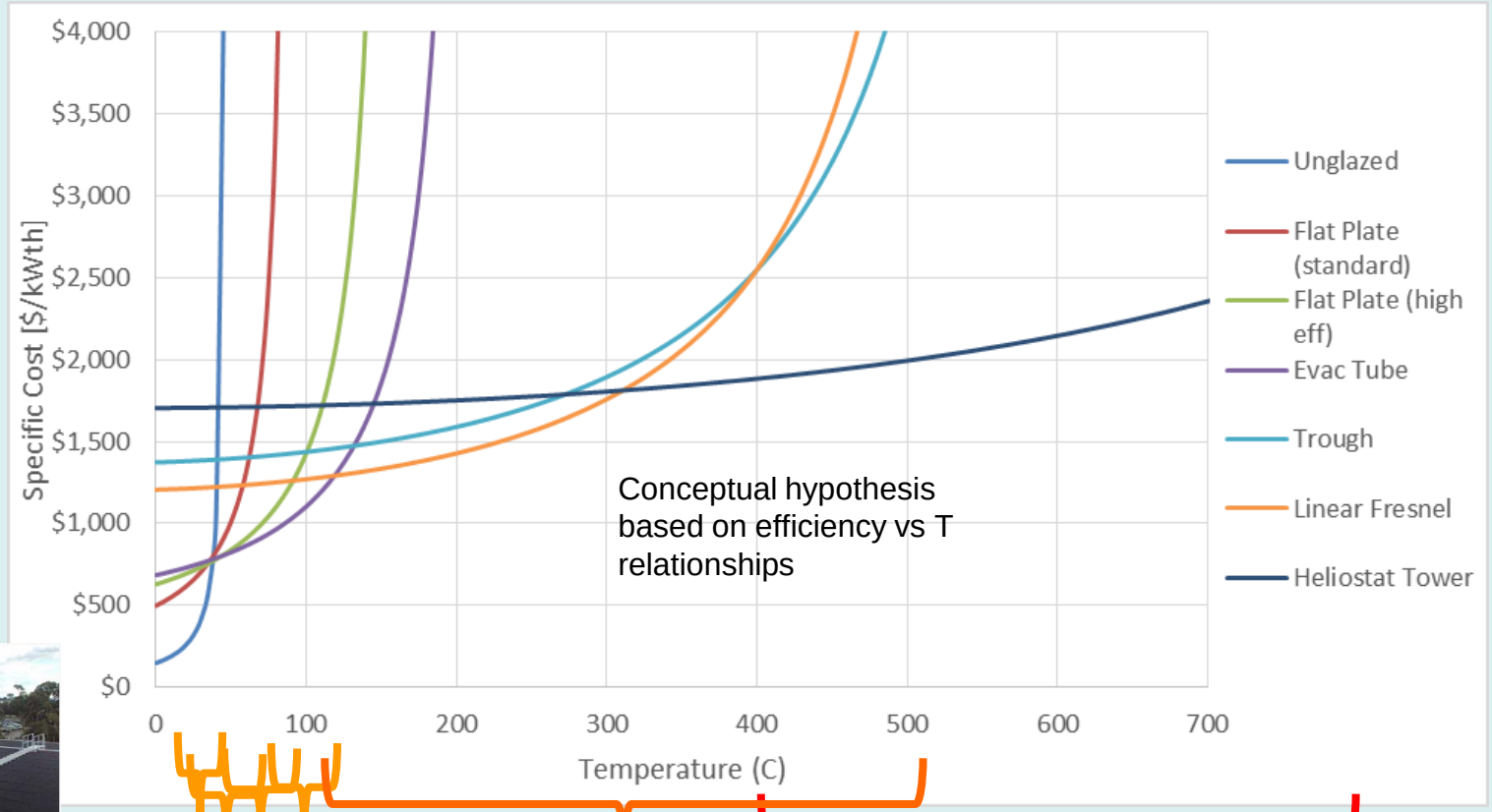
De Bortoli winery Griffith NSW,100 x 30 tube collectors to deliver 12,000L of water per day, at 95°C

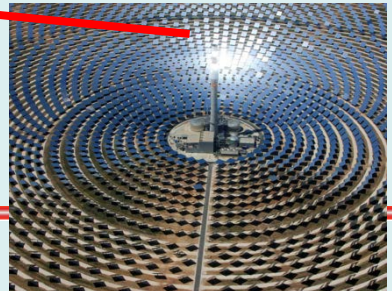
The economics

- Baseline parameters for LCOE; 7.5% on 60% debt, 10% on equity, 15 year depreciation, 20yrs life, 30% corporate tax…
- The new build gas case; cost of gas to user is less for larger users



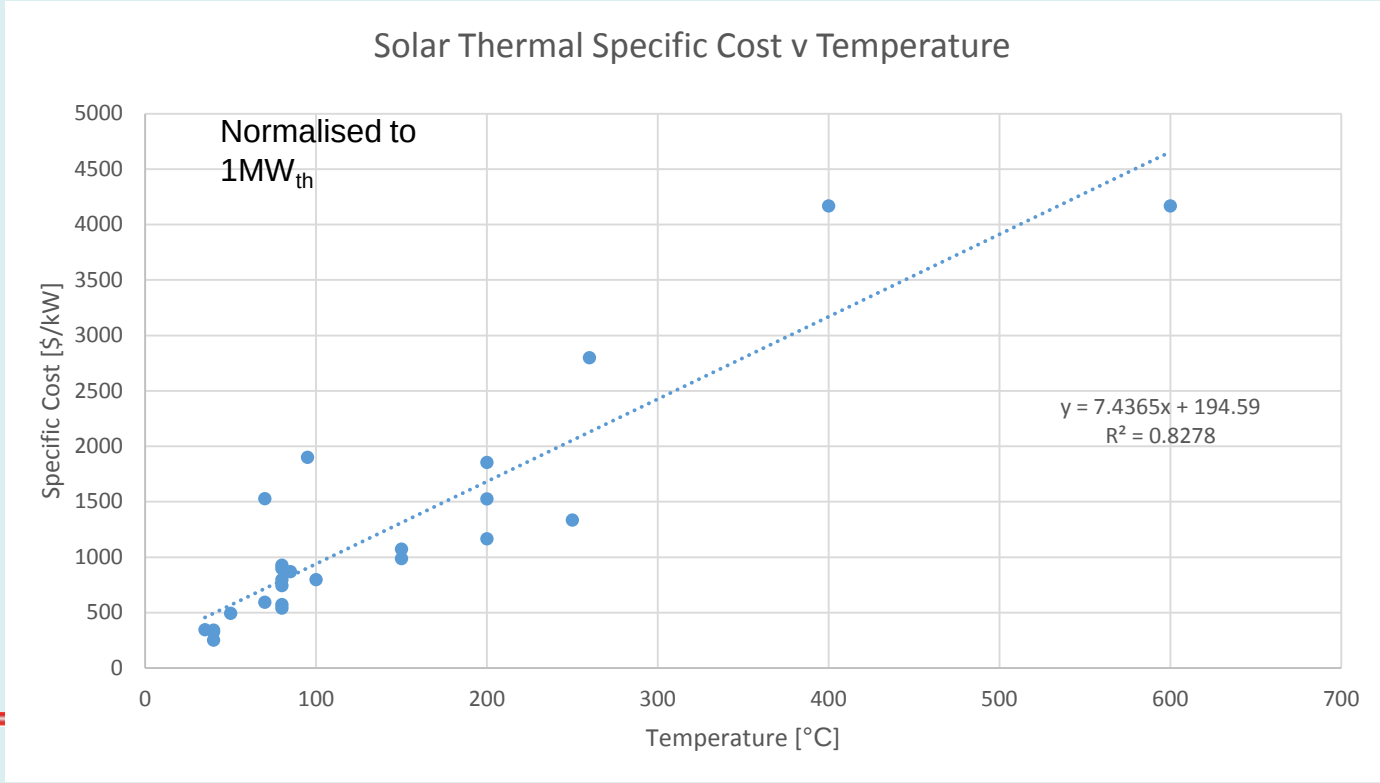
Capital costs for solar



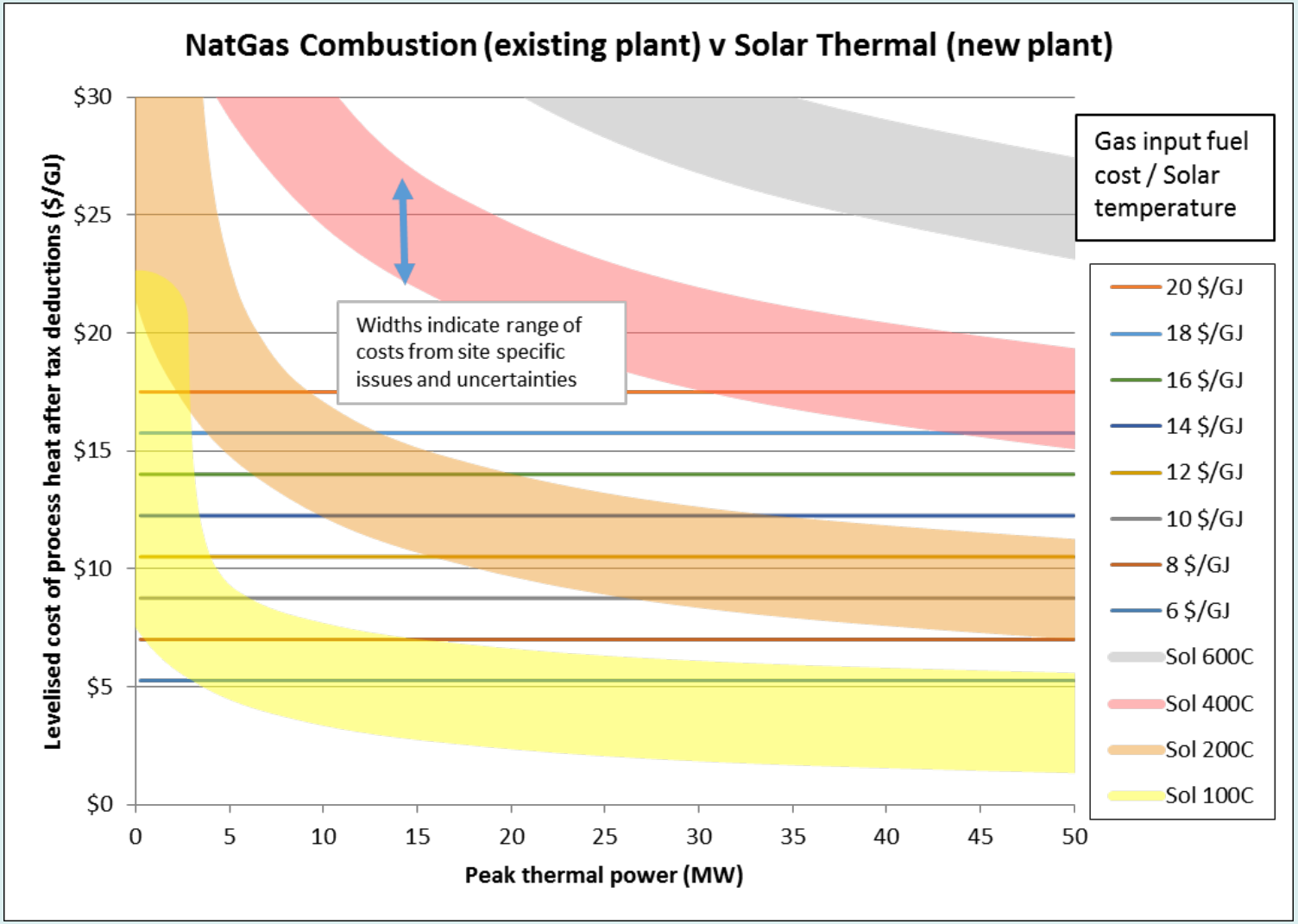


Capital costs for solar

- Uncertain, site specific, size, storage level and temperature dependant
- Used data available to give rough rule of thumb for systems with “reasonable” storage
- Assumed cost proportional to size^(0.7)



Solar thermal LCOE vs Gas



Considerations of gas users

- Wide concern on future gas prices
- A strong interest but limited knowledge on renewable alternatives
- Concerns to business continuity paramount – technically risk averse
  - Business continuity
  - Market position
  - Contractual (supply) risk
  - Future fuel prices
  - Technology risk
- Frequently limited access to capital
- Short payback time / High IRR expectations
- Sliding block tariff structure
- Solutions need to be “plug in” with gas systems retained

Currently close to cost effective solutions

Industrial gas users should consider:

- Biomass if a low cost suitable biomass resource is available convenient to the location.
  - Combustion boilers
  - Digester gas where the composition of combustion products does not affect the process.
  - Gasifiers where the composition of combustion products does not affect the process.
- Heating of water or steam on any scale at temperatures below approximately 250^{o}C in areas of reasonable solar resources.
- Hot sedimentary aquifers for low temperature process heat where a resource exists nearby to the point of use at modest depth

Conclusions

- Rising gas prices are creating a challenge to users and an opportunity for renewables
- Solar thermal technology providers should target the gas replacement market
  - Opportunities for 3rd party energy service supply business models
  - Strong potential for expanding commercial efforts with small solar concentrators
  - Greater commercial take up of low temperature solar collectors should improve supply chains and drive prices down.
- There is considerable scope for policy initiatives involving grants for pilots and low interest financing for close to commercial solutions
- For higher temperature / feedstock applications the solar thermal solution has a “cost gap to fossil” that is smaller than the cost gap of CSP to wholesale electricity.