Concentrating Solar Thermal

– an opportunity for Australia

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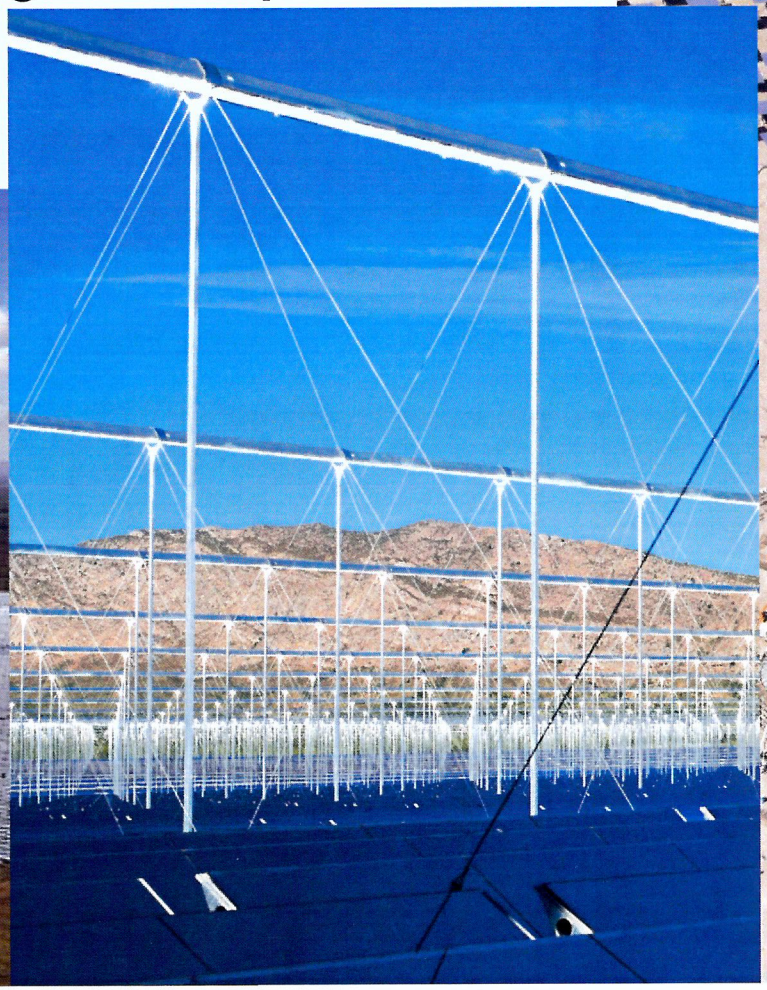
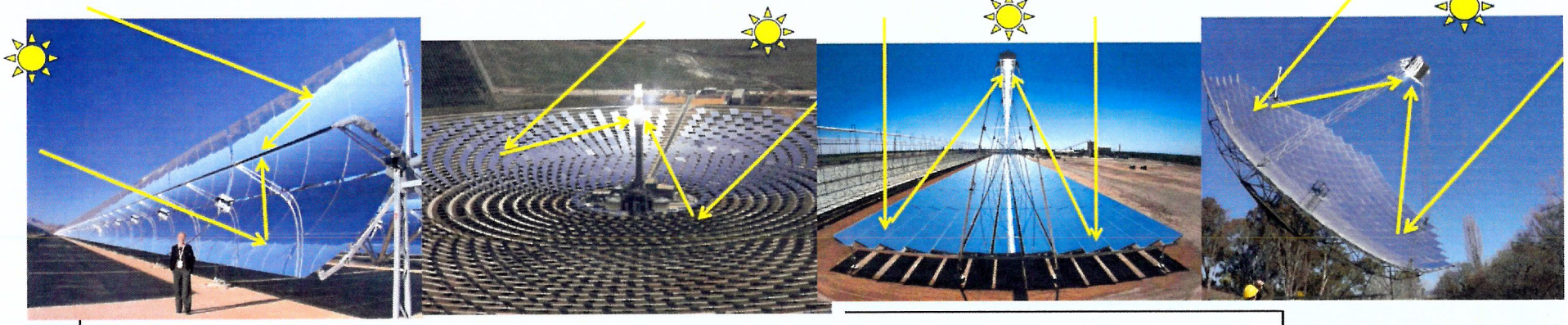
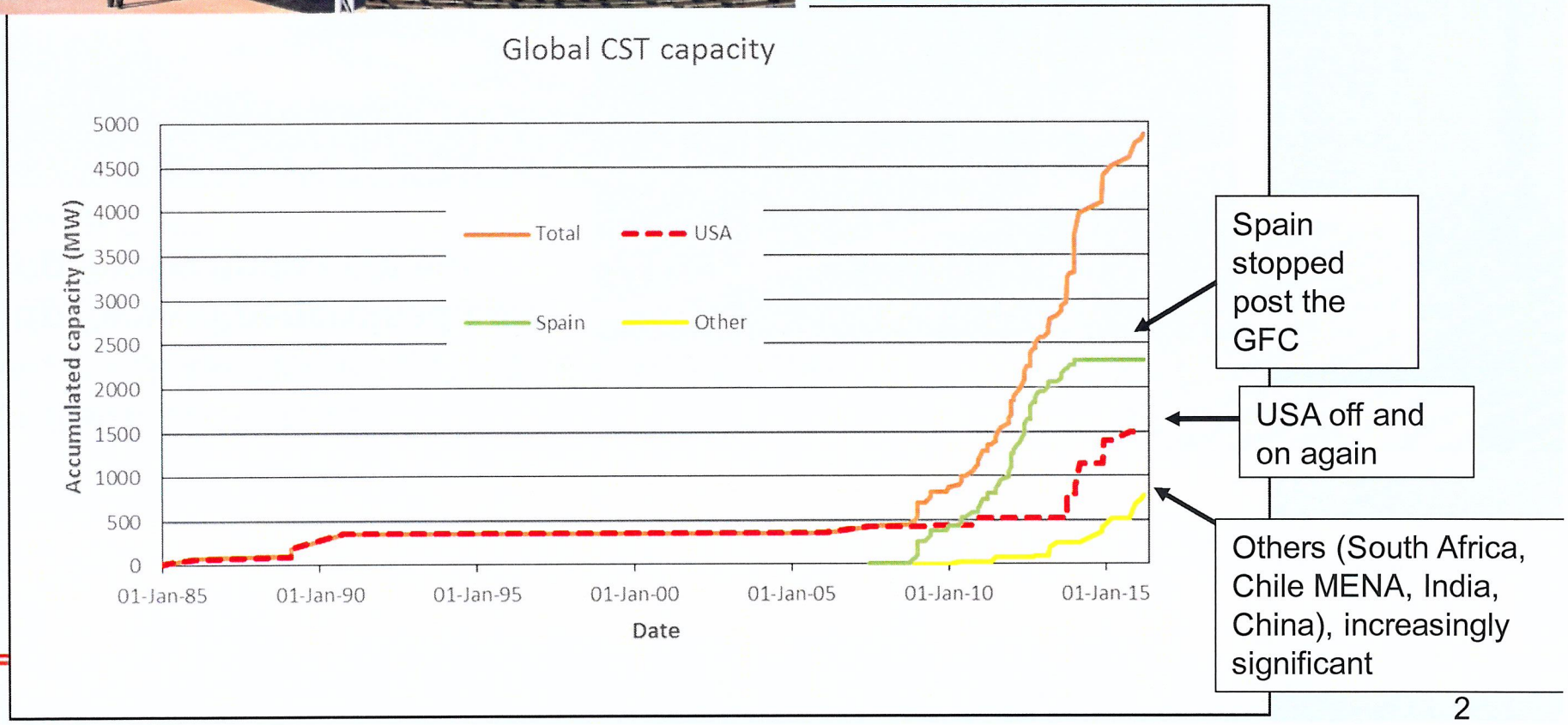
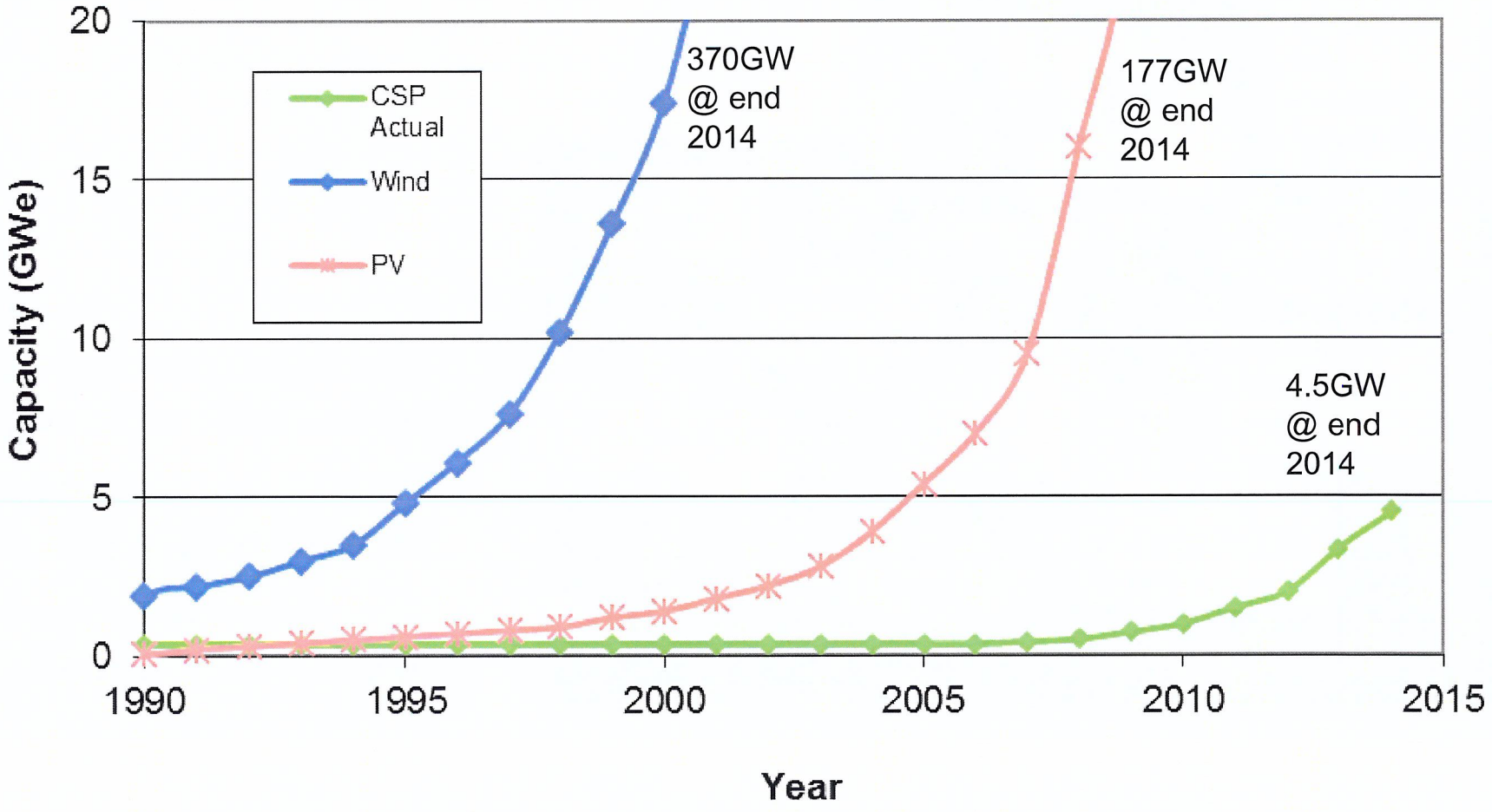


Concentrating Solar Power growing strongly



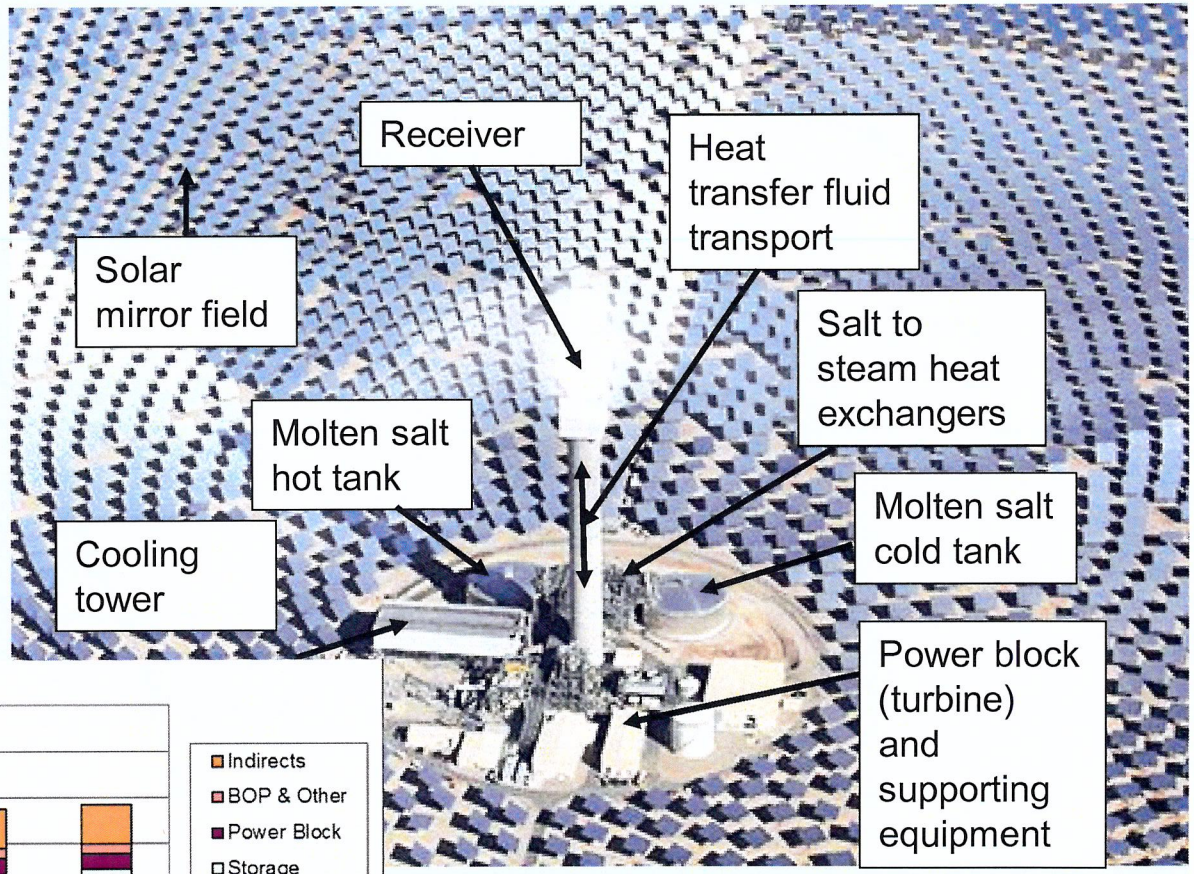


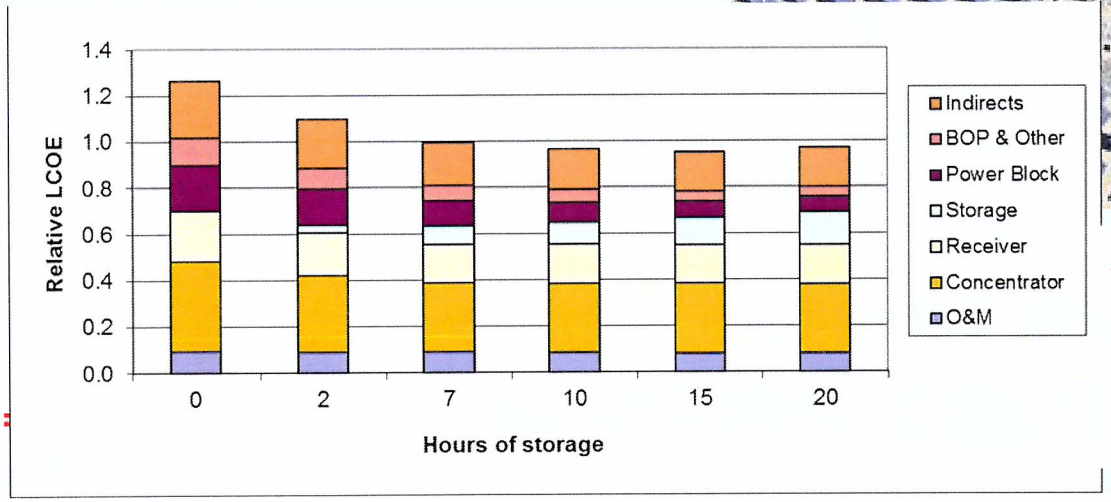
In context, CSP deployment is 1 decade behind PV



Proven Thermal Energy Storage is CSP's big competitive advantage

- Two tank molten salt is proven / standard
- A Higher temp makes it cheaper
- Salt tanks have electrical heaters as ultimate back up.





- Thermal storage is "integrated" – improves output, little or no extra cost, lowers LCOE!

Andasol 3 a Typical Spanish 50MW$_e$ trough plant

- 7.5hrs molten sa storage
- High efficiency customised turbine
- 18 months from ground breaking to on grid

Gemasolar, Seville

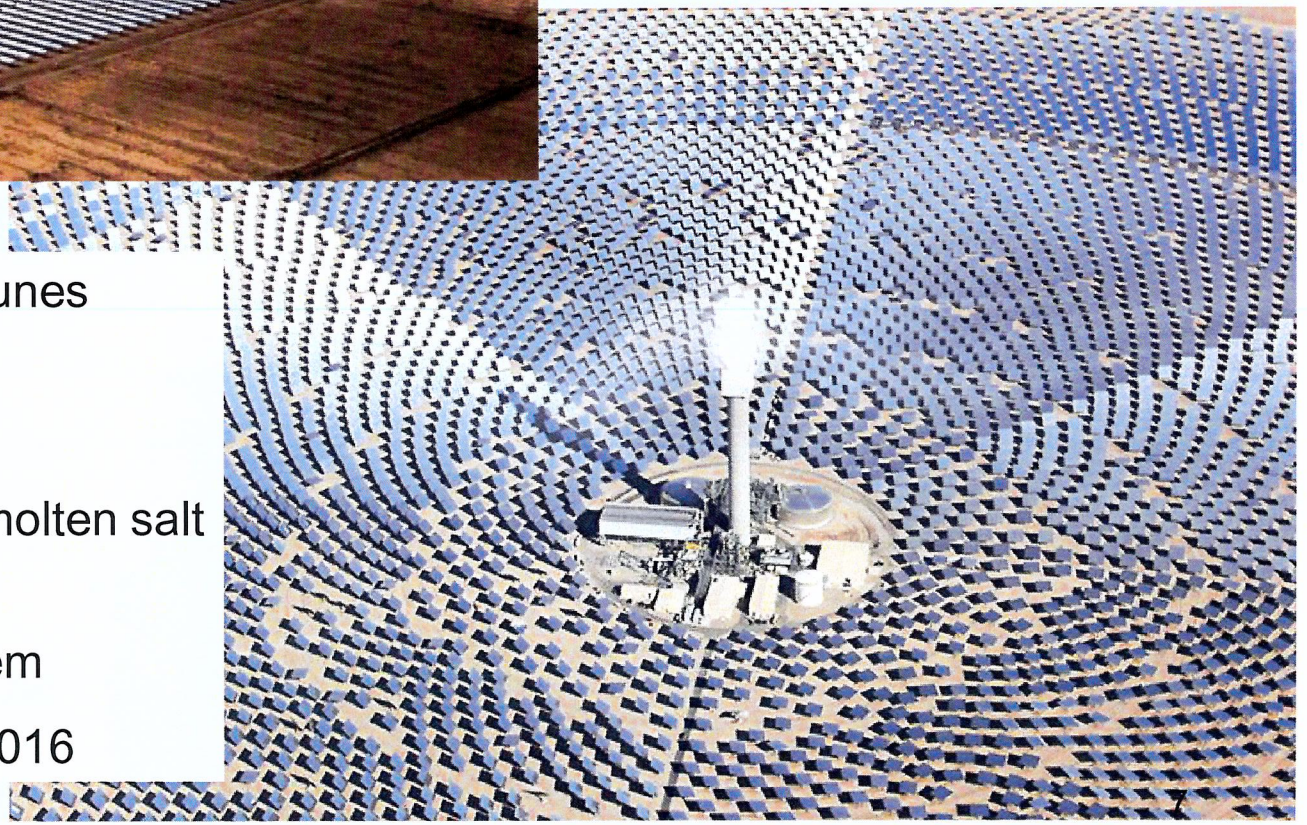
- First commercial tower plus salt
- Operating since October 2011
- 19.9MWe turbine
- 15 hours storage, 75% capacity factor
- Achieved 36 days non stop generation Oct 2013

Novatech's PE 2 plant in Spain

- Operating since 2012
- 28 rows of linear Fresnel collectors, conventional steam turbine equipment and generator
- Solar Field 302,000 m²
- Power Capacity 30 MW_e
- Most successful utility scale LFR plant so far

Abengoa's Solana plant, Arizona

- Trough concentrators
- 280 MW_e trough plant with six hours of thermal storage.
- Operation since October 2013



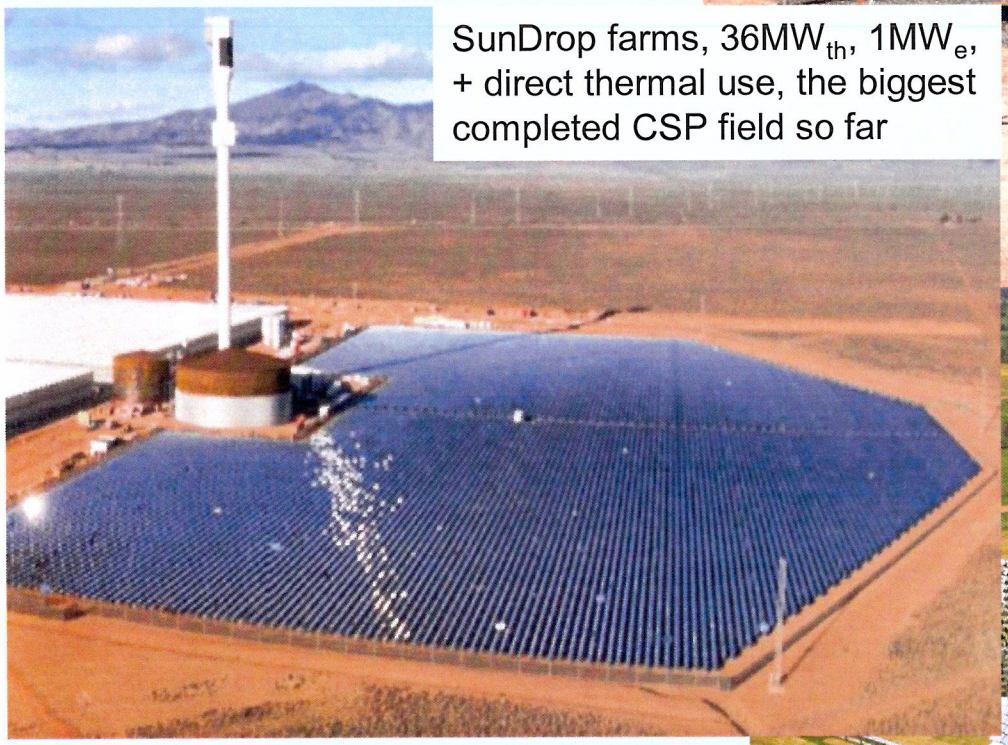
SolarReserve's Crescent Dunes plant, Nevada

- Tower and heliostats
- 110MW_e with 10 hours molten salt energy storage
- Biggest ever tower system
- Operational from early 2016

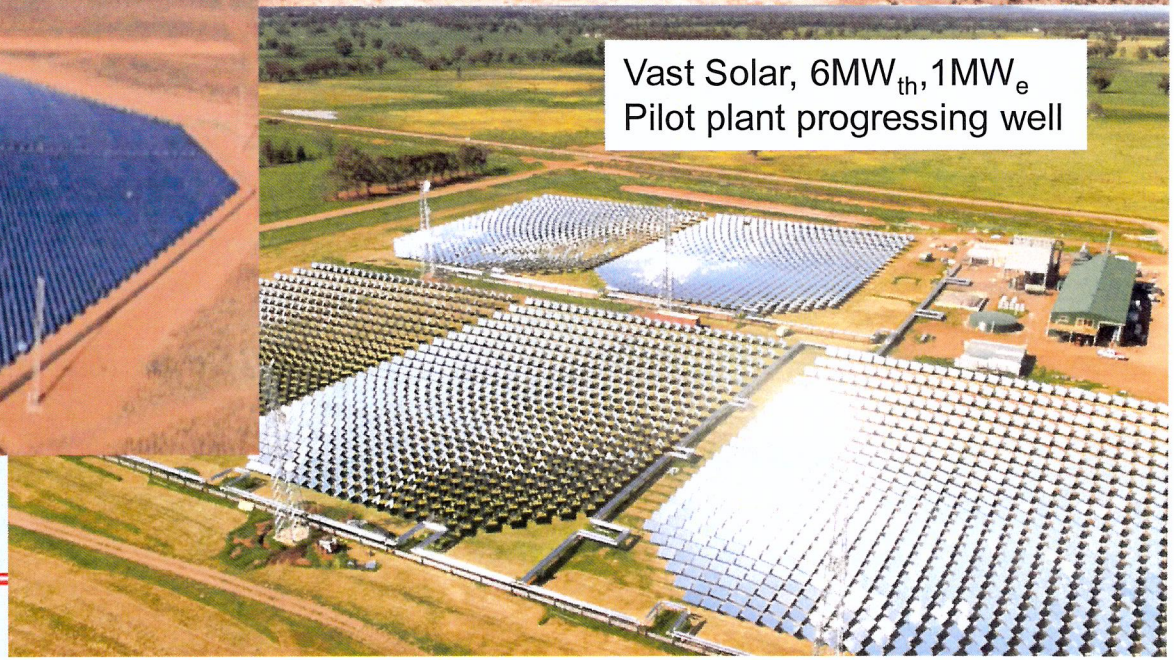
Australia still taking baby steps

Kogan Creek Solar Boost.
130MWth AREVA LFR
solar field 75% complete
but project stalled!!!

SunDrop farms, 36MW_{th}, 1MW_e,
+ direct thermal use, the biggest
completed CSP field so far

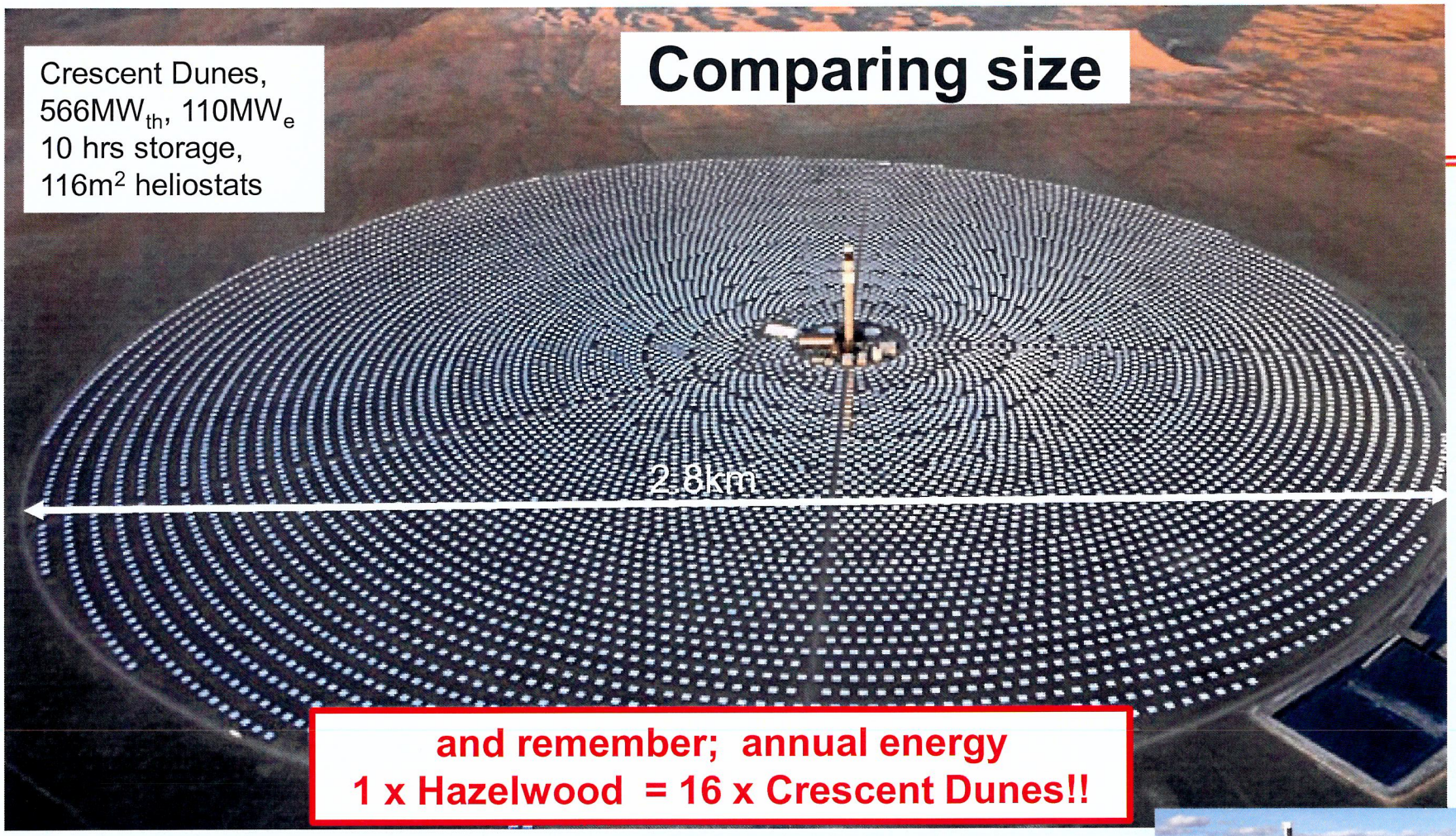


Vast Solar, 6MW_{th},1MW_e
Pilot plant progressing well



Comparing size

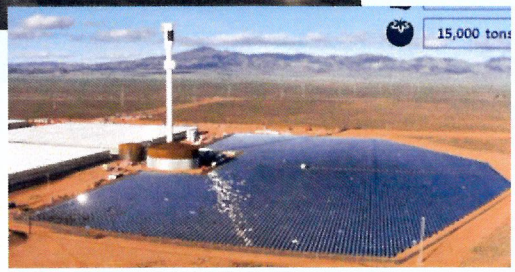
Crescent Dunes,
566MW$_{th}$, 110MW$_e$
10 hrs storage,
116m^2 heliostats



and remember; annual energy
1 x Hazelwood = 16 x Crescent Dunes!!

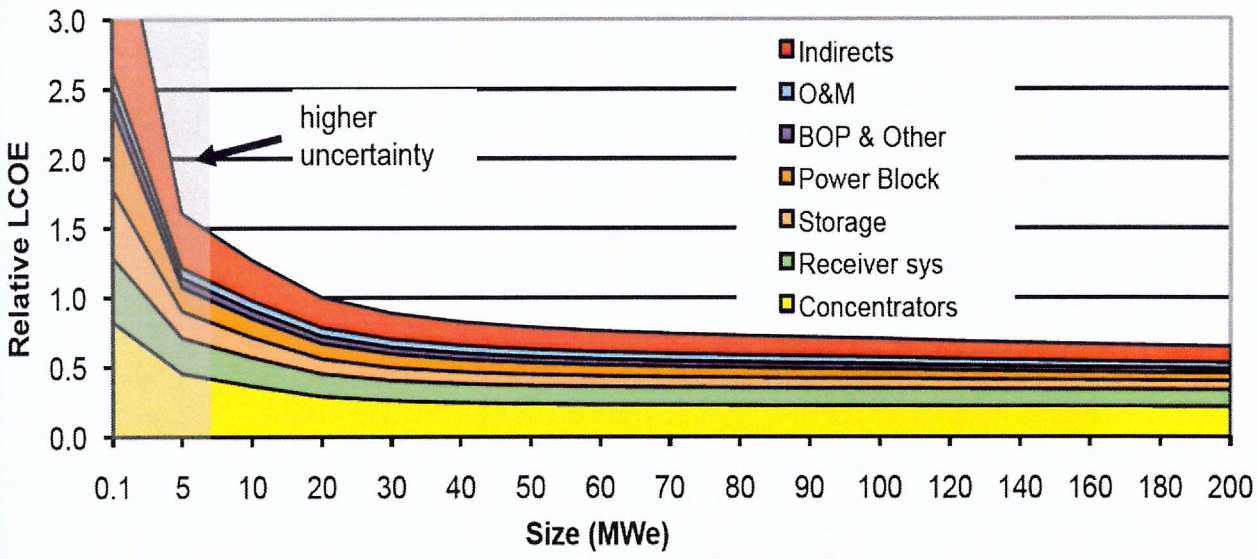
Vast Solar, Jemalong
6MW$_{th}$,1MW$_e$
1/2 hr storage

SunDrop farms,
36MW$_{th}$, 1MW$_e$, +
direct thermal use,
2m^2 heliostats



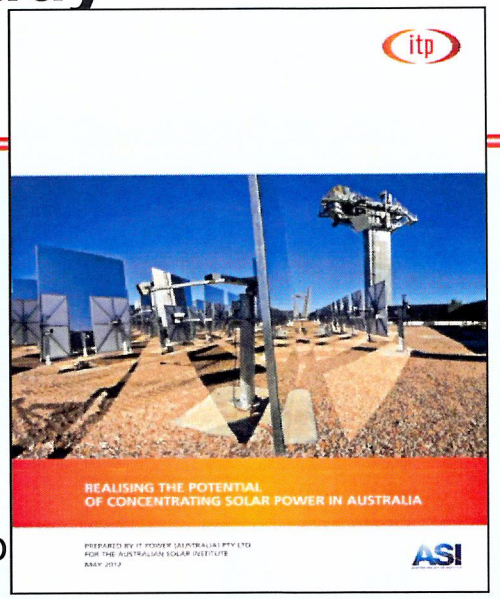
Cost of a CSP system

- Once a developer has chosen a basic CSP technology set:
- Installed cost (and hence average LCOE) depends on:
  - Size of solar field
  - Size of storage
  - Size of power island
- The cost dependency on size is non linear
- 100MW – 200MW is a sweet spot



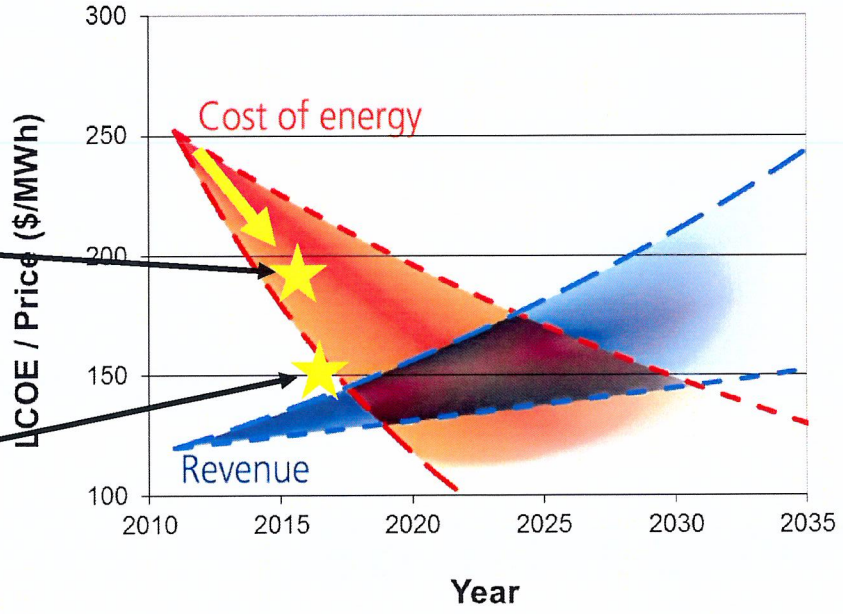
Looking back at ITP's 2012 study of CSP for Australia

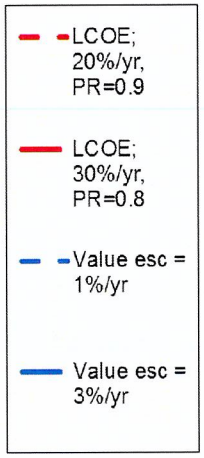
- Around 15GW could be realistically installed in Australia without major grid extensions
- Solar Flagships was a missed opportunity for CSP
- Global capacity in CSP has increased 300% in last 4 years
- Systems with thermal storage now dominate
- Cost reduction is at best side of predictions; from $252/MWh down to 150/MWh in 4 years



ITP Study for Abengoa, beginning 2015

SolarReserve's offered price for South Australia in 2016





In 2012, a Nth of a kind trough plant 64MW no storage, in 2016 a 100MW tower plant with 10hours storage

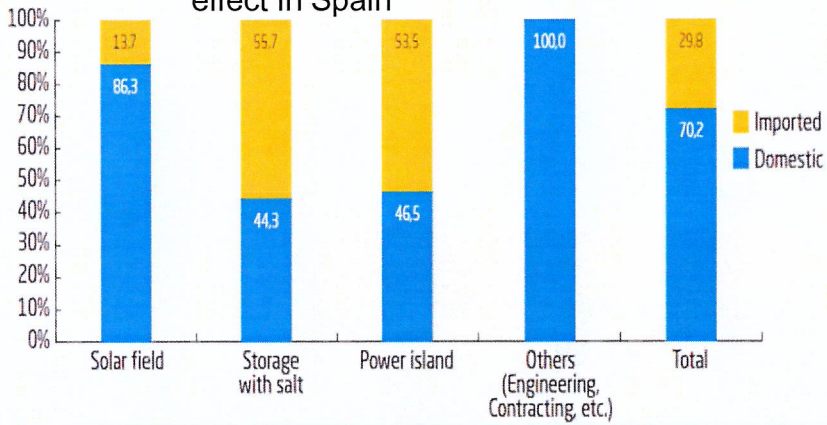
http://www.itpau.com.au/review-of-the-potential-for-concentrating-solar-power-in-australia-australian-solar-institute-asi/

CSP Value Proposition

- CSP Cost of energy ($150/MWh) is 50% more than PV, 100% more than wind but…

Source of Value	Estimate relative value increase over intermittent renewable energy
Time of Day benefit	5% – 100%
Ancillary services	0% – 10%
Network benefits	-10% – 100%
Societal / option value	10% – 20%
Total extra for CSP with storage	**50% - 150%**

Deloitte's 2011 study of macroeconomic effect in Spain



- Value propositions must be optimised on a case by case basis
- Values change with geographical area, market rules and the other generating assets in place.

Conclusions

- CST is growing strongly globally, about 1 decade behind PV.
- CST offers high value dispatchable renewable electricity generation.
- CST offers the developer country a bigger position in the value chain.
- Need to build utility scale CSP power systems to build experience and supply chain.
- We need all of:
  - First utility scale systems by a globally experienced players
  - Engagement between R&D institutions and global CST industry
  - Nurture local content and start-ups
- Renewable Energy Policy (RET) should reward extra values with preferential tariffs
  - eg x 2.5 for 4.30pm – 9.30pm or multiplier proportional to pool price
  - Parallel zero emissions ancillaries market