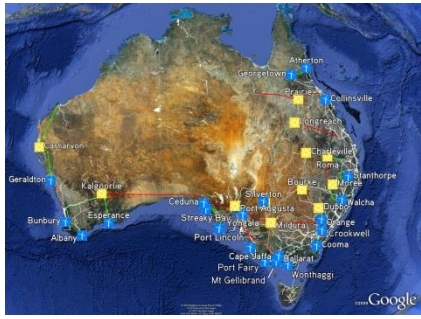
Zero Carbon Australia Stationary Energy Plan



A plan to repower Australia with 100% renewable energy in 10 years

beyond ZERO emissions

Science based - Solutions focused

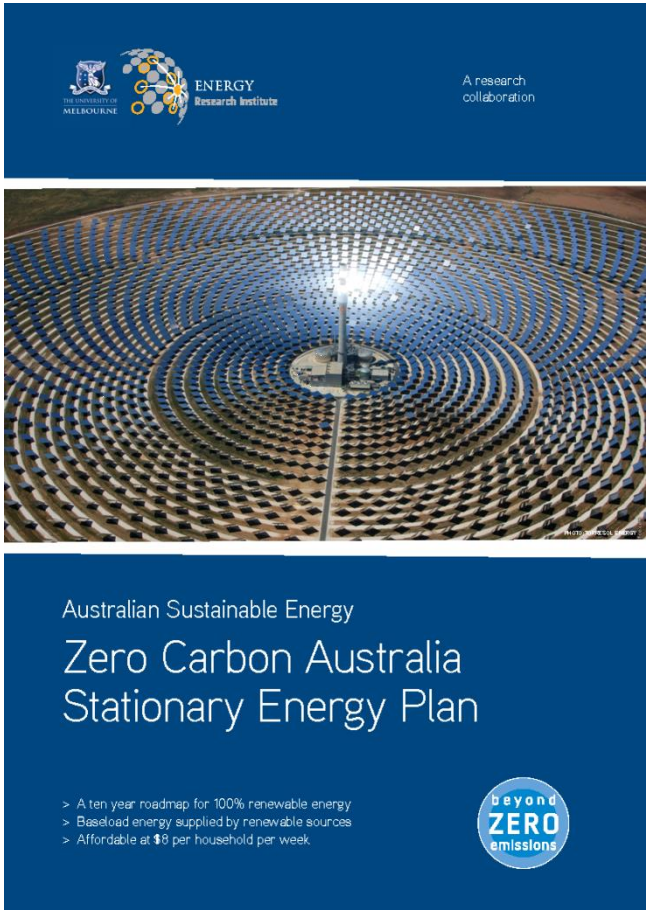
(BZE)

- Research & Communications
- Completely independent
- Probono contributions
- Staff coordinators
- Run on your donations

Zero Carbon Australia Plan (ZCA) - Guiding Principles

- **Blueprint for a Zero Carbon Australia in 10 years**
- Fully accept latest climate science evidence
- Specifies only Commercial-Off-The-Shelf technology
- Maintain or enhance Australia's:
  - Energy Supply security and reliability
  - Food and water security
  - Standard of living

ZCA Stationary Energy Plan



- Stationary Energy = Electricity from power stations
- A detailed, fully costed, resourced model of
- One way to
- **Repower Australia with 100% renewable energy in 10 years**

Endorsements

THE UNIVERSITY OF MELBOURNE
ENERGY Research Institute

As the IEA has shown in its research, solar energy is now a serious global player for providing the world's energy. Australia has one of the world's best solar energy resource, especially suited for concentrating solar thermal power plants, which can dispatch electricity when it is needed. The Zero Carbon Australia Plan is based on up-to-date and sound information and provides quality insights on how a country well-endowed in renewable resources can transition to a solar and wind economy.

CÉDRIC PHILIBERT
RENEWABLE ENERGY DIVISION
INTERNATIONAL ENERGY AGENCY

With our natural advantage Australia can and should be positioning itself as a global renewable super power for future prosperity. This report will help shift the climate debate to focus on energy, security, affordability, export and of course opportunity. Beyond Zero Emissions offers a new and invigorating message that is much needed.

ROBIN BATTER
KERNOT PROFESSOR OF ENGINEERING, UNIVERSITY OF MELBOU
PRESIDENT, AUSTRALIAN ACADEMY OF TECHNOLOGICAL SCIENCES AND ENGINEER
FORMERLY CHIEF SCIENTIST OF AUSTRA

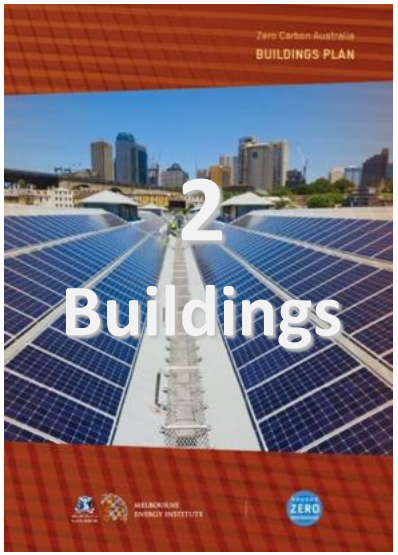
The Zero Carbon Australia 2020 plan shows that it is technically feasible a affordable to replace all fossil fuel electricity with 100% renewable energy given the willpower and commitment to do so. This is a cutting-edge science-based plan that should be read by every energy decision maker and politician in Australia.

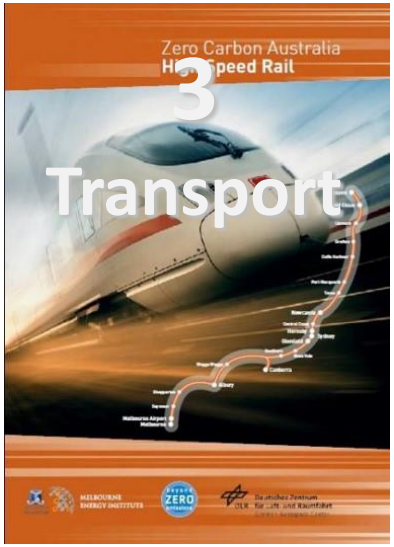
MARK Z. JACOBSON
PROFESSOR OF CIVIL AND ENVIRONMENTAL ENGINEERING
PROFESSOR BY COURTESY OF ENERGY RESOURCES ENGINEERING
DIRECTOR, ATMOSPHERE/ENERGY PROGRAM
STANFORD UNIVERSITY, USA

iea International Energy Agency

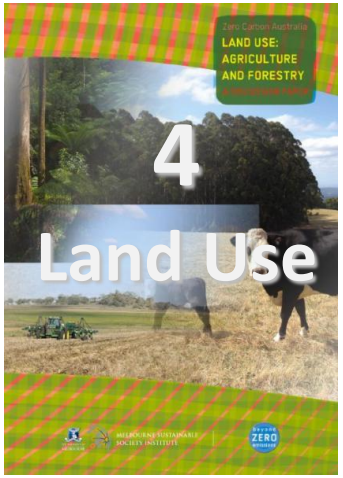
Sir Gustav Nossal

Former Australian Chief Scientist
Robin Batterham


Zero Carbon Australia
BUILDINGS PLAN
2
Buildings


Zero Carbon Australia
3
Transport


Fossil economy
A research collaboration
Laggard to Leader
How Australia Can Lead the World to Zero Carbon Prosperity
Repowering Port Augusta
2012
HEALTH AND SOCIAL HARMS OF COAL MINING IN LOCAL COMMUNITIES
Spotlight on the Hunter Region
> A ten year roadmap for 100% renewable energy
> Baseload energy supplied by renewable sources
> Affordable at $8 per household per week


Zero Carbon Australia
LAND USE: AGRICULTURE AND FORESTRY
4
Land Use

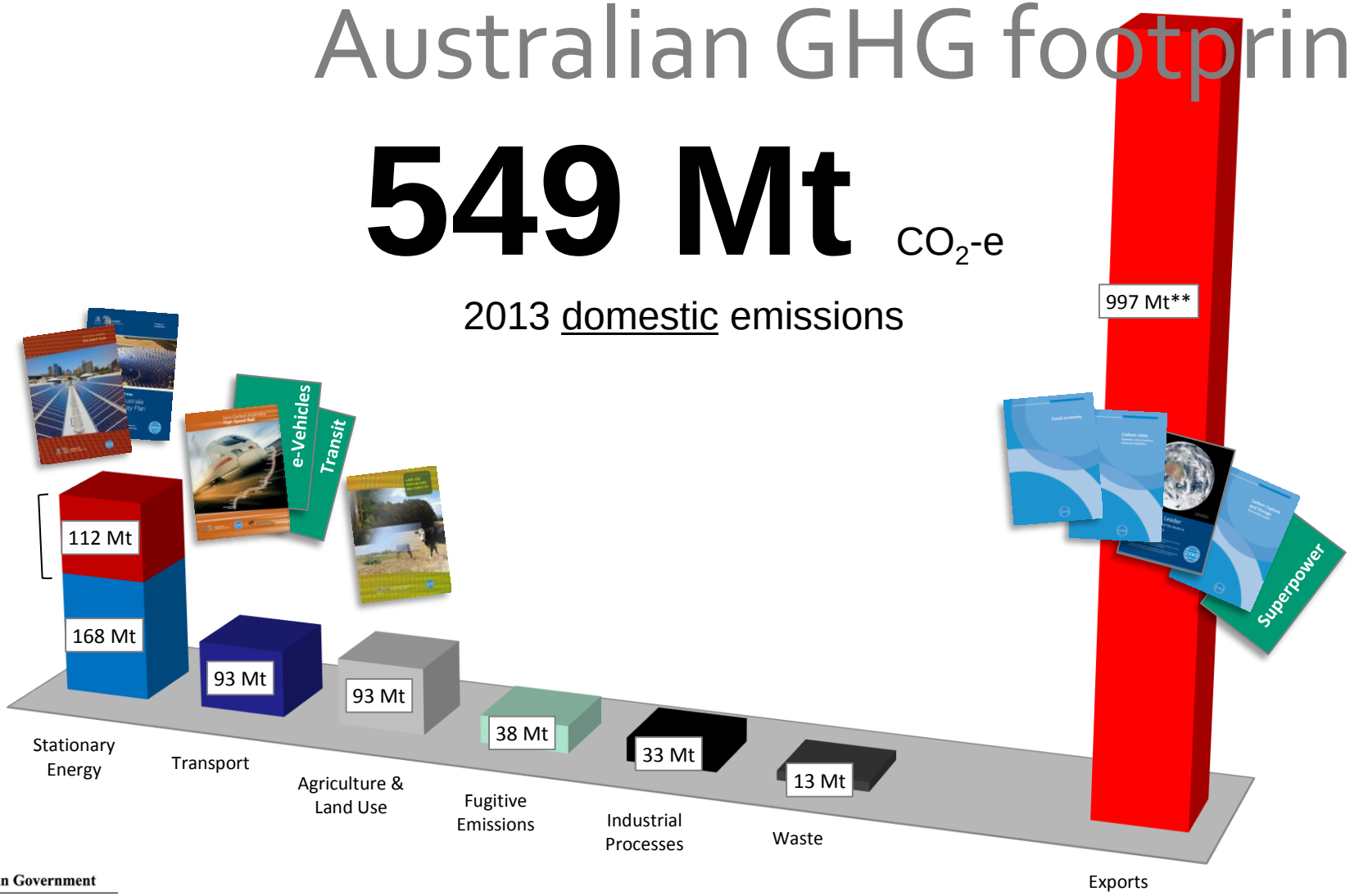

5
Industrial Processes


6
Renewable Energy Superpower

Australian GHG footprint

549 Mt CO_2-e

2013 domestic emissions



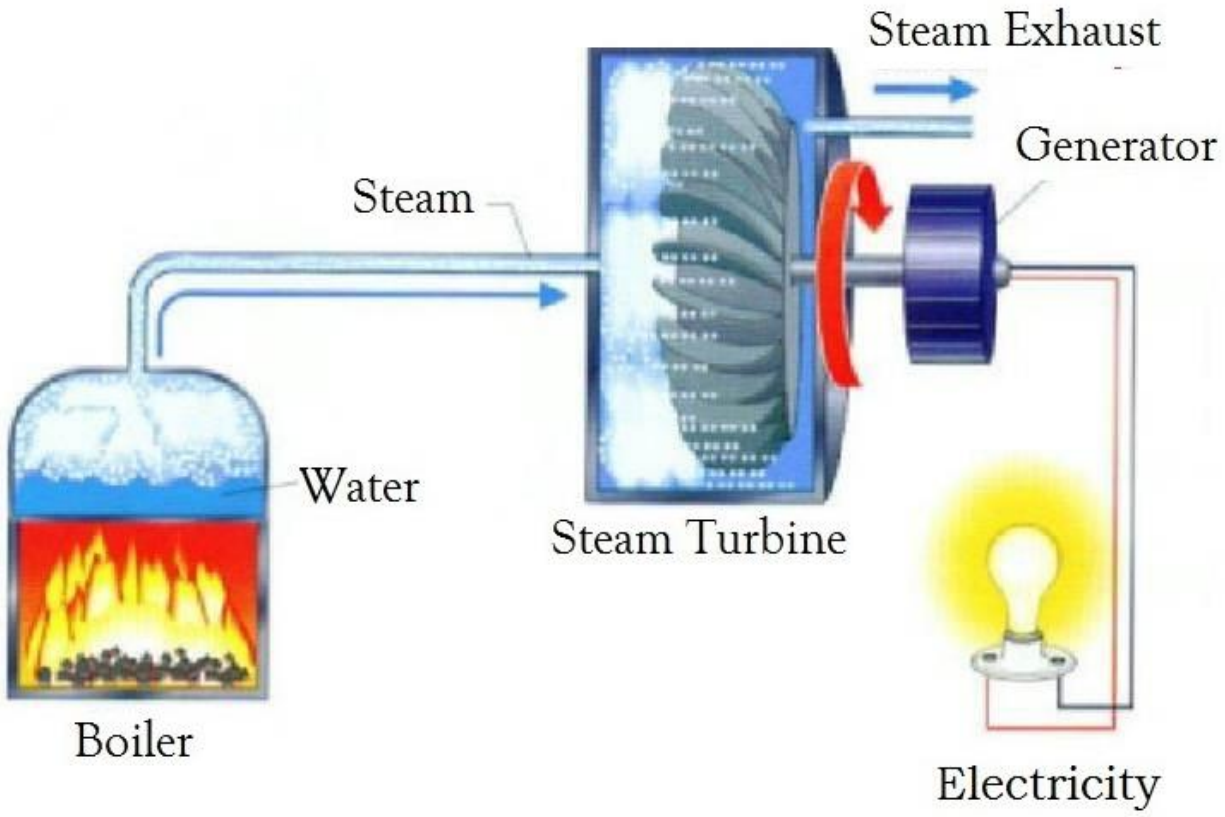
Australian Government
Department of the Environment

2013 National Greenhouse Gas Inventory
*Building emissions estimated using residential and commercial sector scope 1 and scope 2 energy emissions

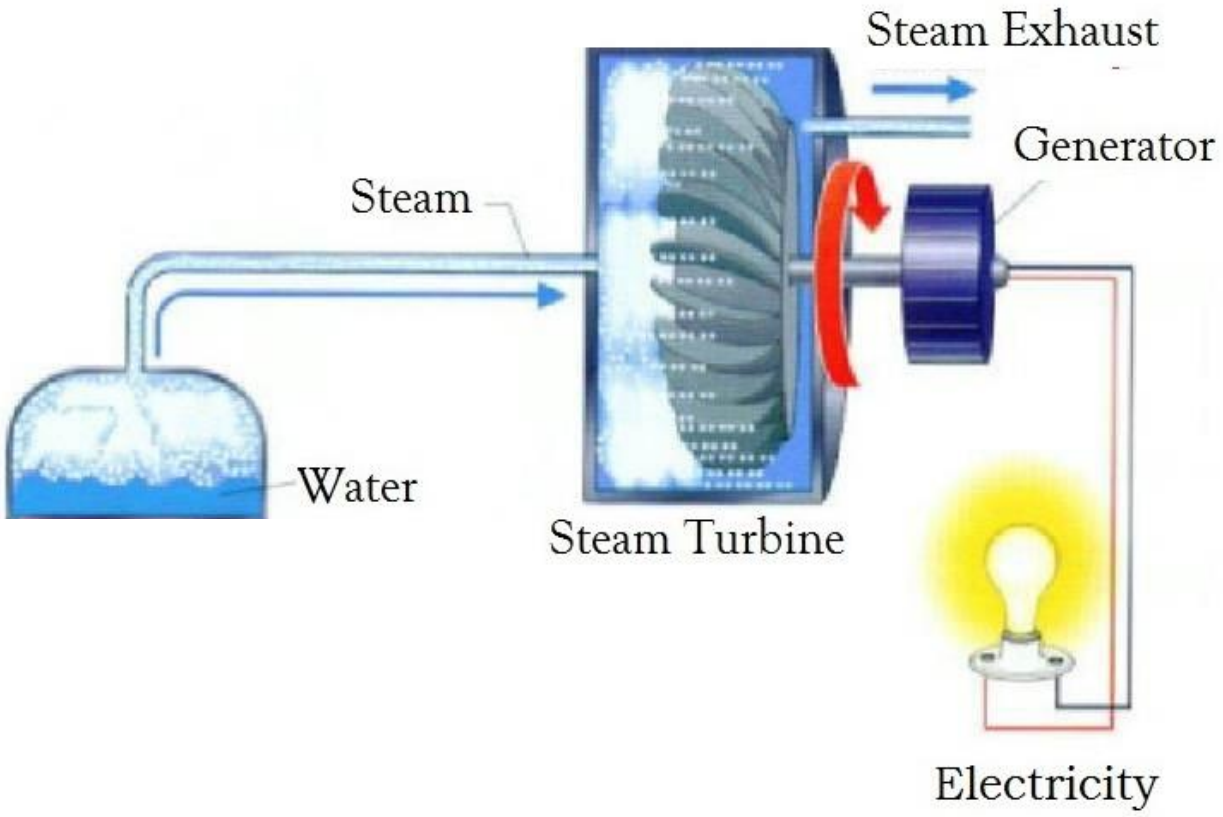
bze.org.au

2014 Australian energy projections 2049-50
** Exprted coal and gas converted into CO2 emissions using National Greenhouse Accounts Factors

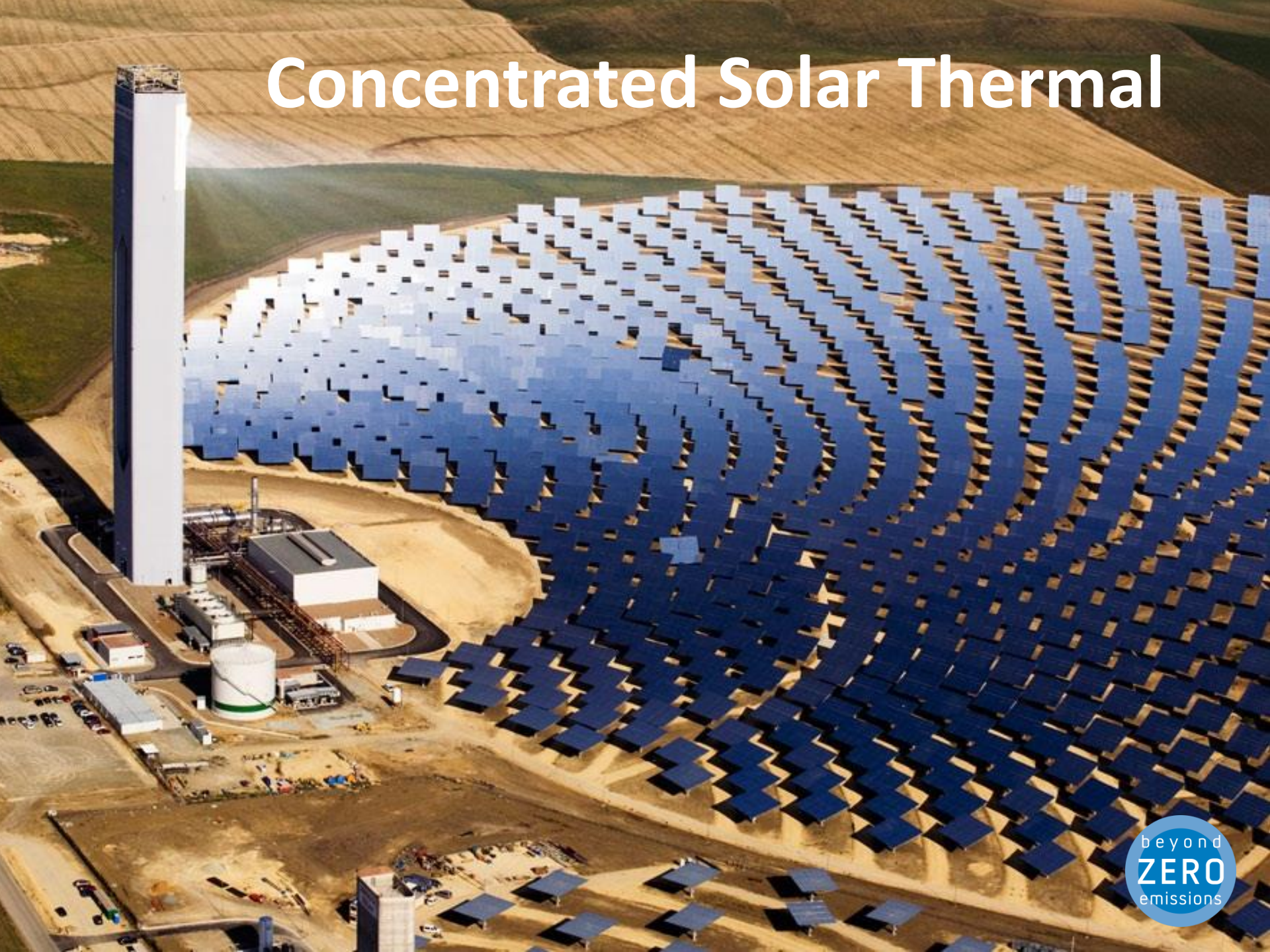
Traditional Power Generation



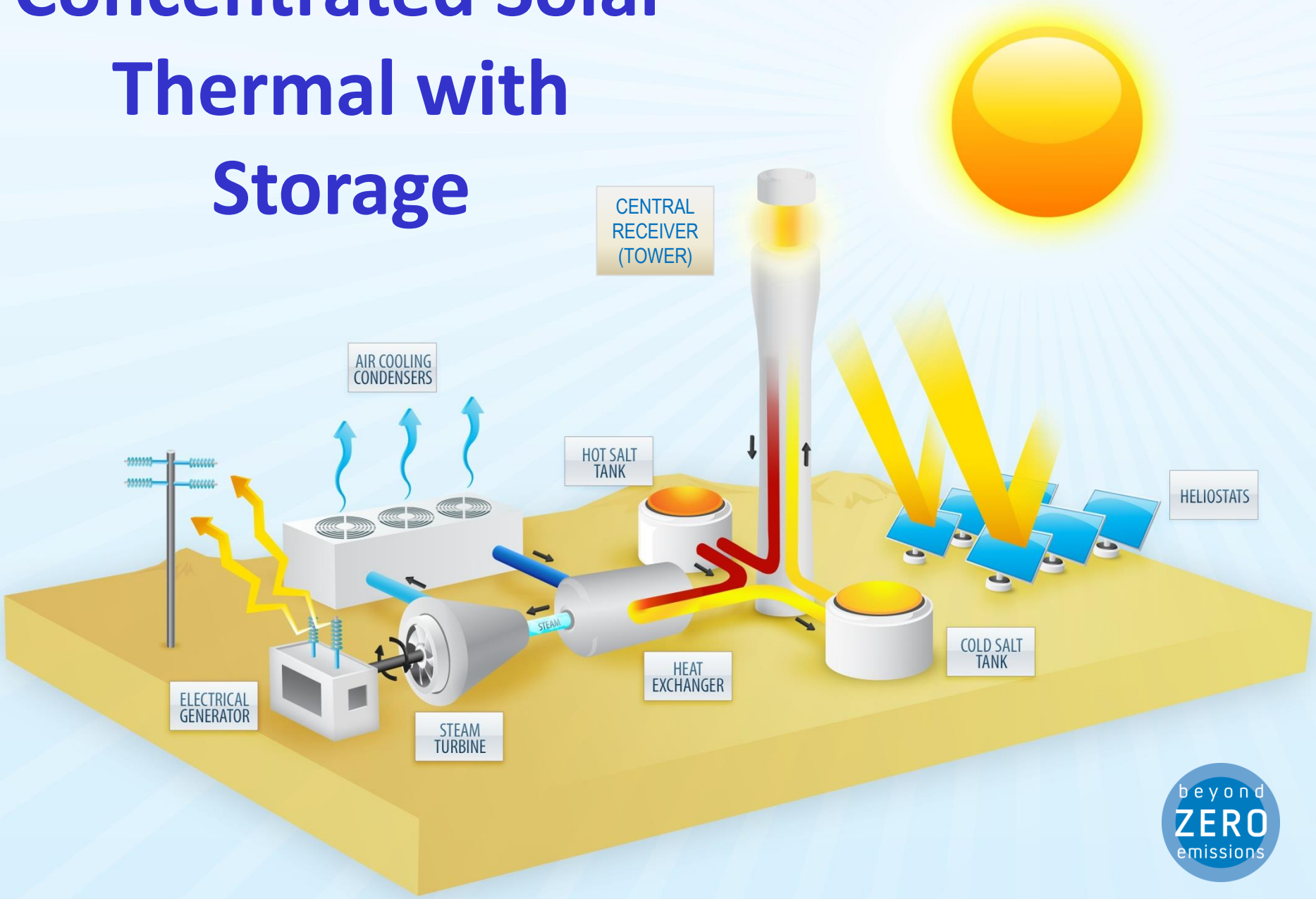
Traditional Power Generation



Concentrated Solar Thermal



Concentrated Solar Thermal with Storage



beyond ZERO emissions

Heliostat

Heliostat Field & Receiver

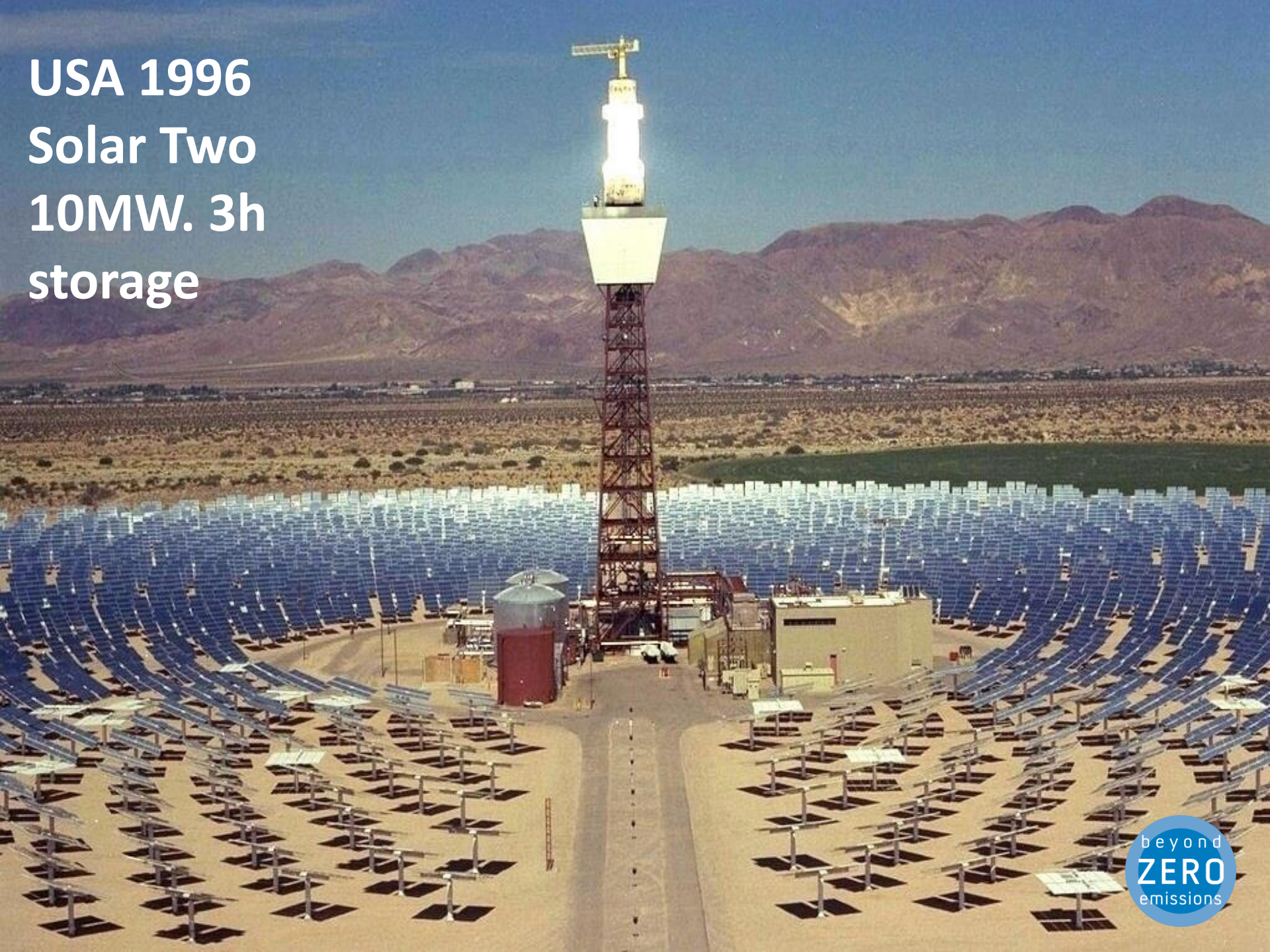
View from the receiver


CENTRAL RECEIVER (TOWER)
565ºC
HOT SALT TANK
565ºC
HELIOSTATS
HEAT EXCHANGER
290ºC
COLD SALT TANK
Molten salt to move and store heat (mixture of potassium nitrate + sodium nitrate)
beyond ZERO emissions


‘Un-Molten’
Salt
beyond
ZERO
emissions

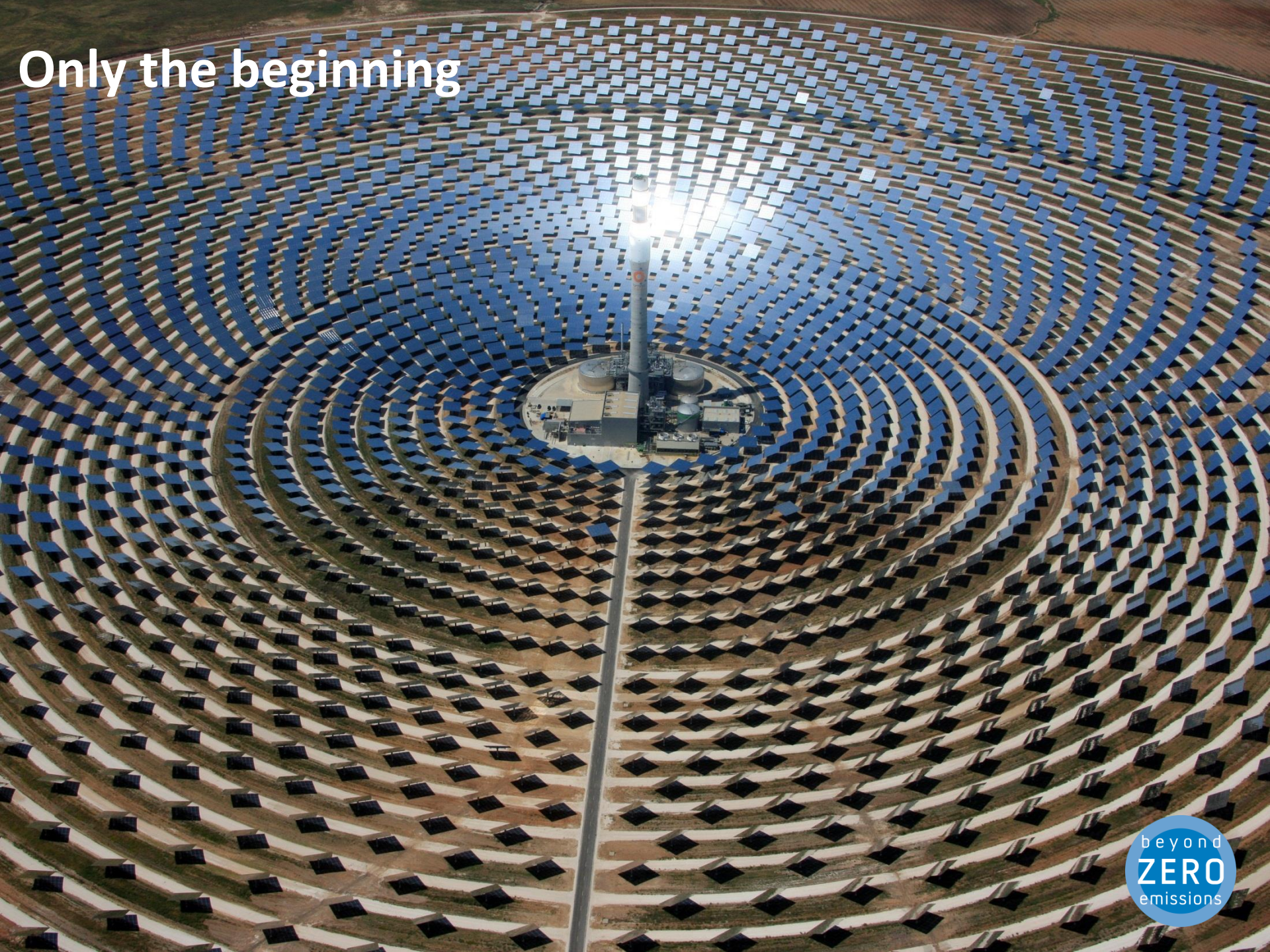
Thermal Storage

beyond ZERO emissions

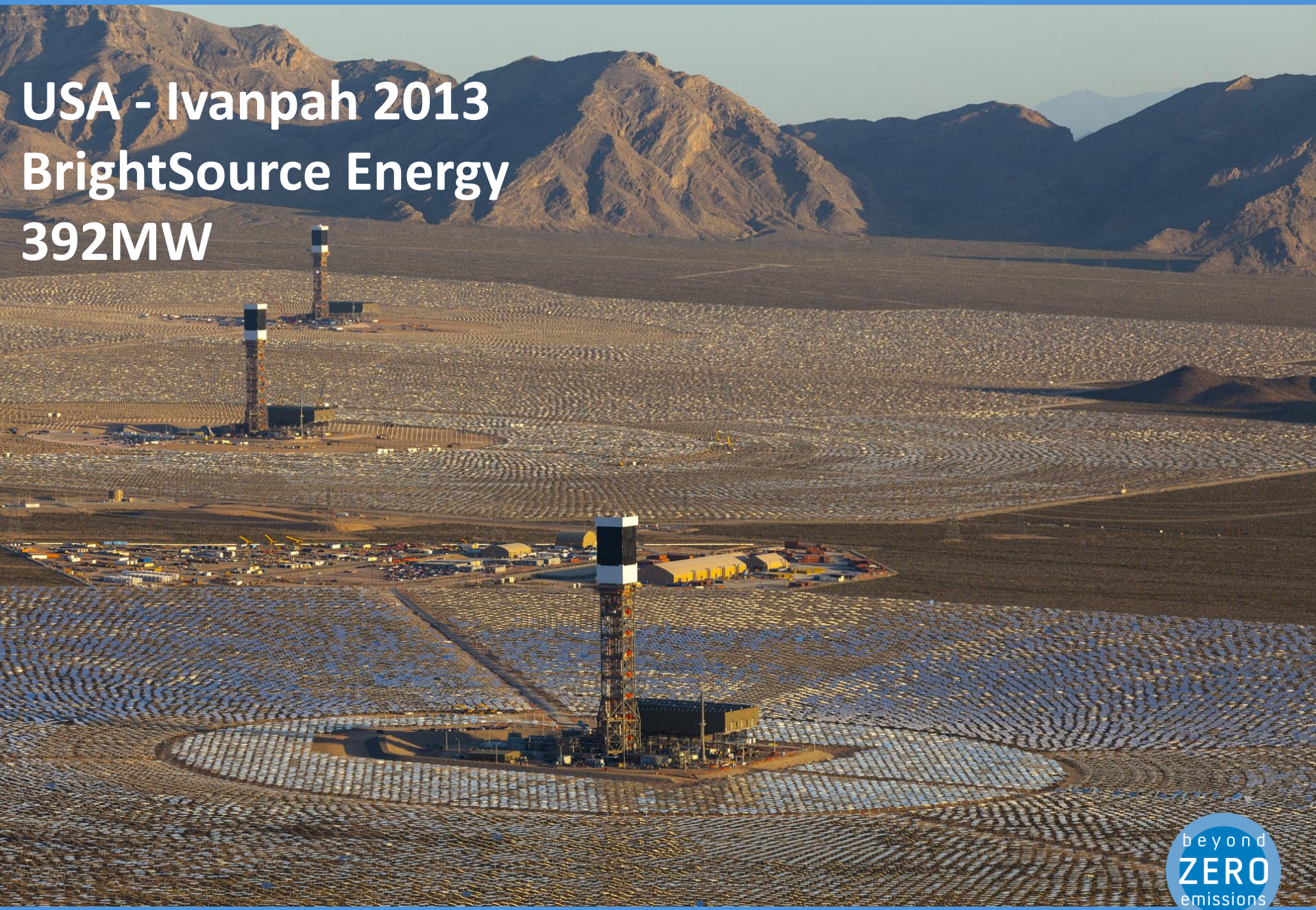

USA 1996
Solar Two
10MW. 3h
storage
beyond
ZERO
emissions


Spain 2011
Torresol Gemasolar
20MW. 15h storage
beyond
ZERO
emissions

Only the beginning

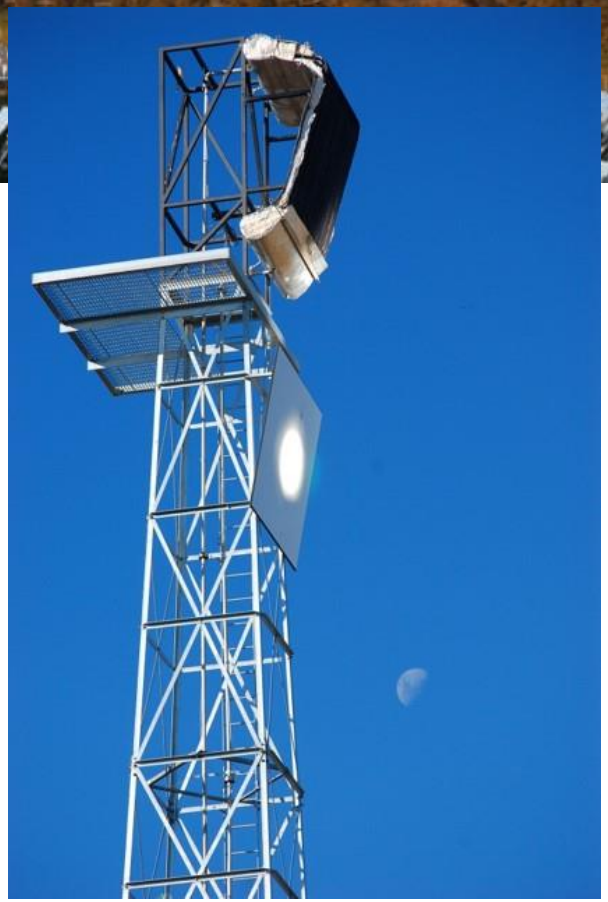



USA - Nevada 2015
Solar Reserve Tonopah
110MW
25-40%
saving


USA - Ivanpah 2013
BrightSource Energy
392MW

Australia - Jemalong
Vast Solar

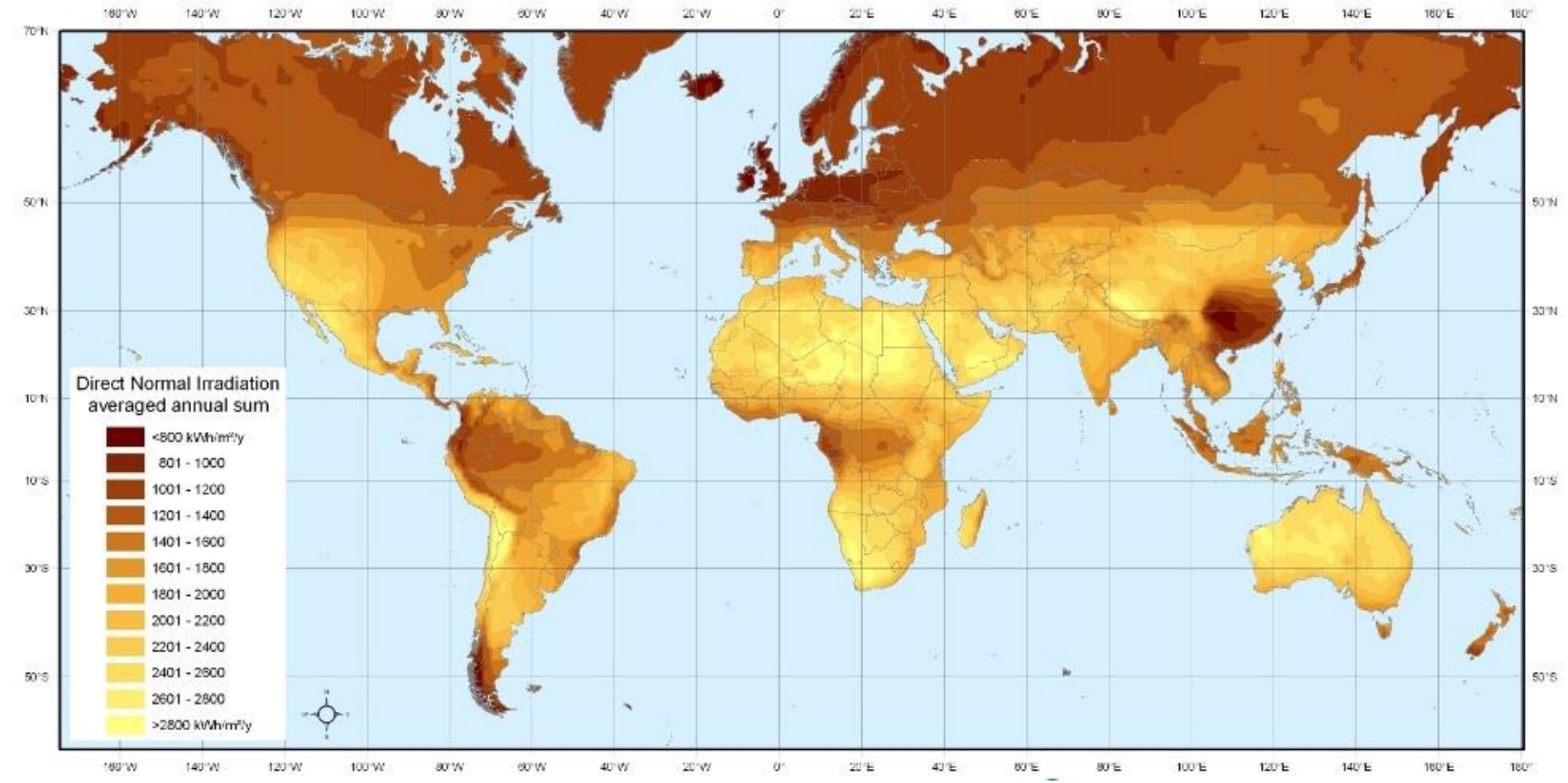
- 1MW – 2011
- 6MW – 2014
- 30MW - 2015



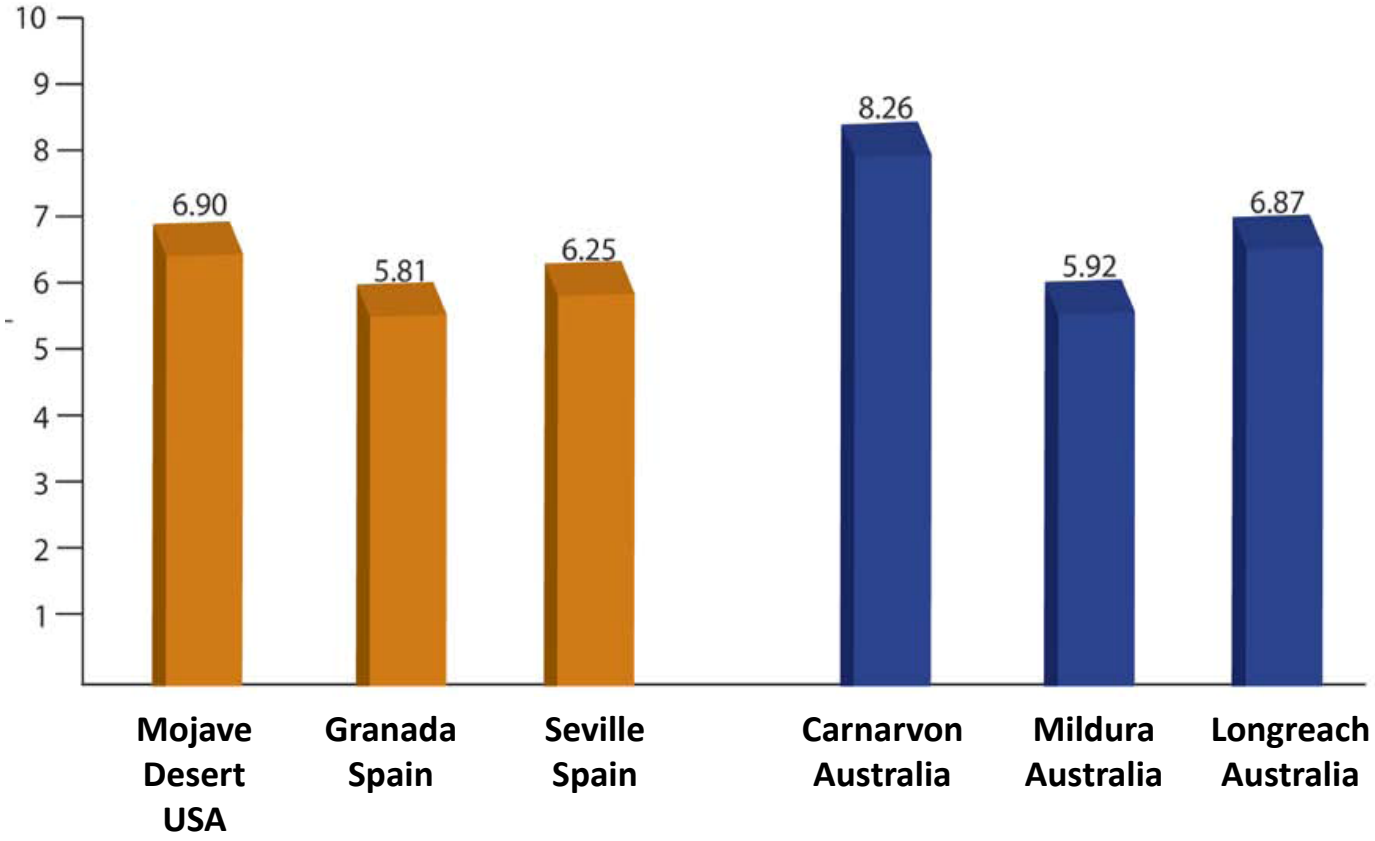
Global Solar Thermal Deployment

- 4.3GW operating (Jan 2015)
  - 2.5GW under construction
- USA/Spain/China/Saudi Arabia

Australia – Best Solar Resource in the World



Solar irradiation (Kilowatt-hours per square metre per day)



More Bang for our Buck!

30 Years

1m² mirror

OR

6 tonnes of coal


beyond
ZERO
emissions

World Wind Power growth

- Global investment increased 30% p.a. in last decade
- China 200 GW by 2020 (98.6GW installed Aug 2014)
- Denmark 50% by 2020
  - 39.1% in 2014
- Sweden 1100 Enercon Turbine Farm

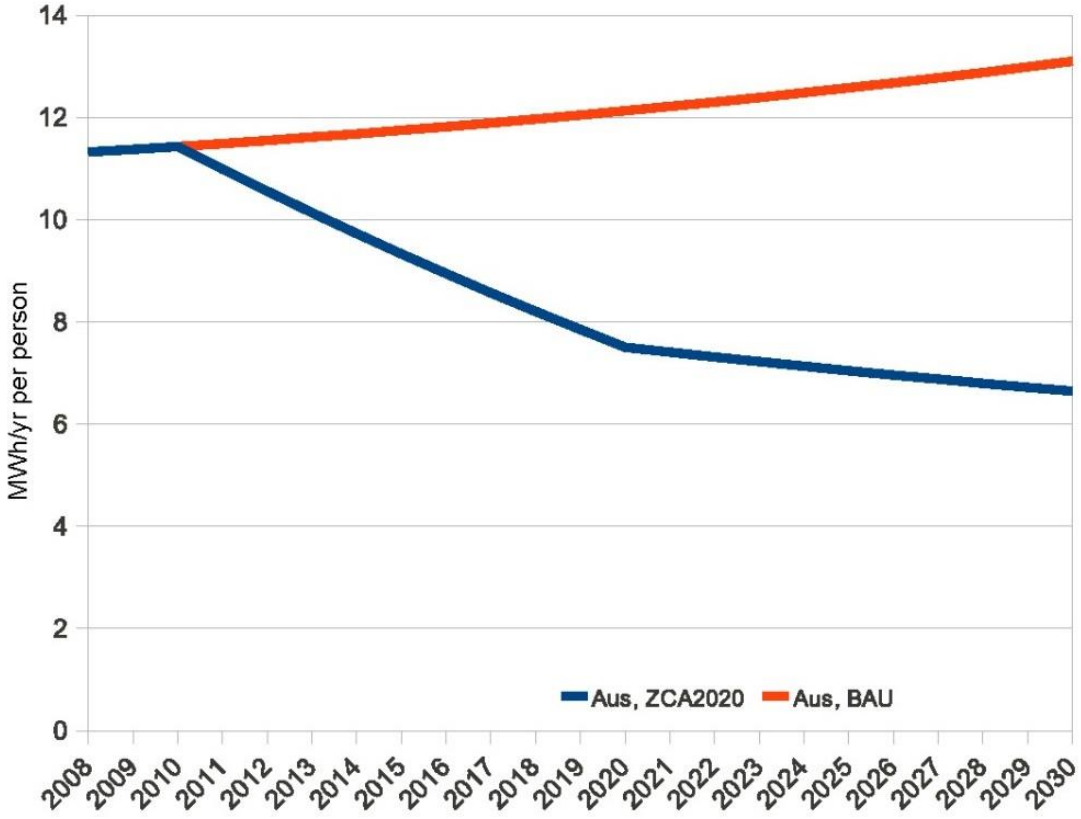

30 years
507,000
tonnes
CO_2 saved

Who is backing this?

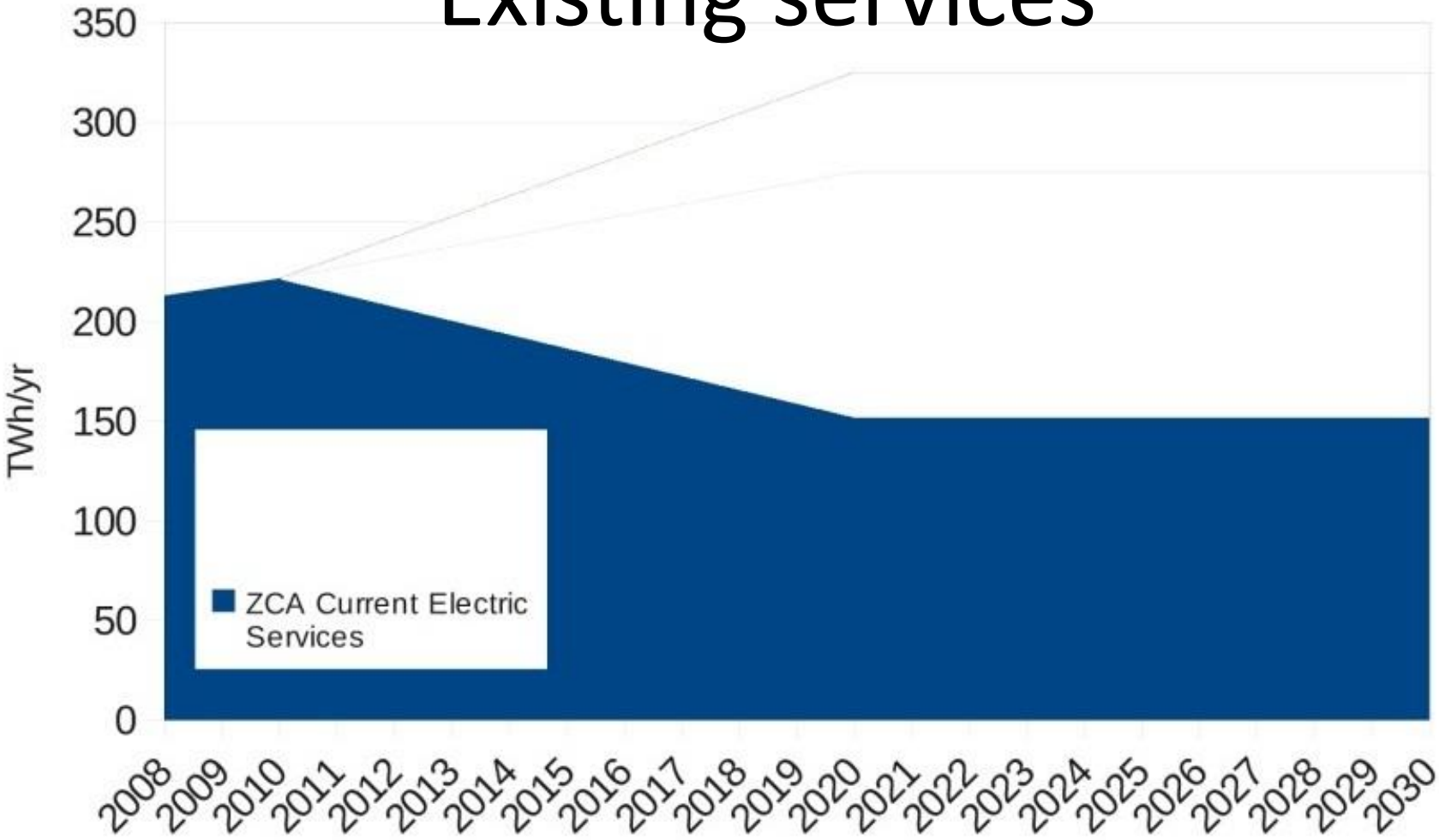
- Built by biggest engineering and construction companies in the world
- Investment flowing from smart, forward thinking companies

Zero Carbon Australia Electricity Use

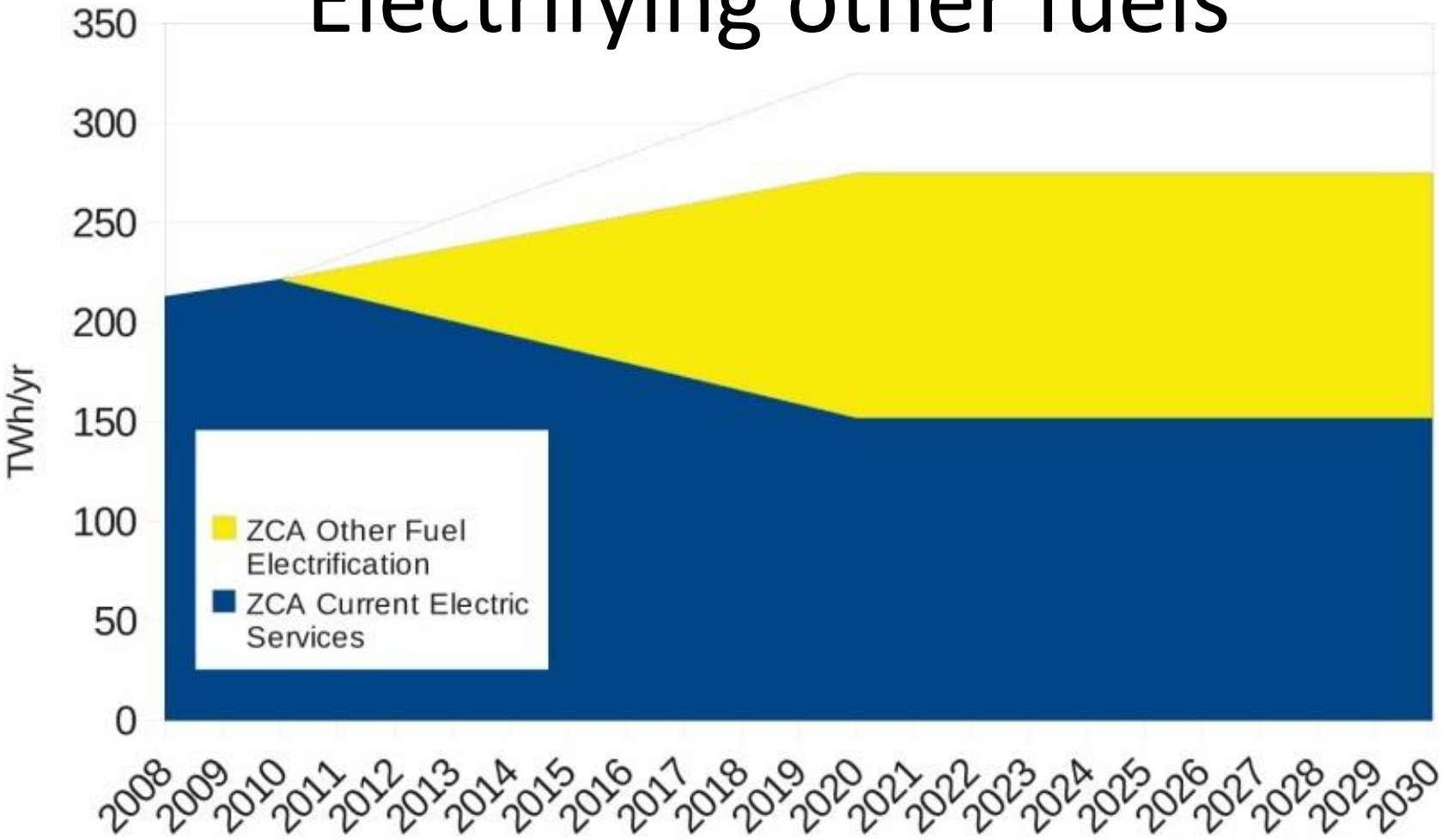
MW hours per person per year (2010 – 2030)



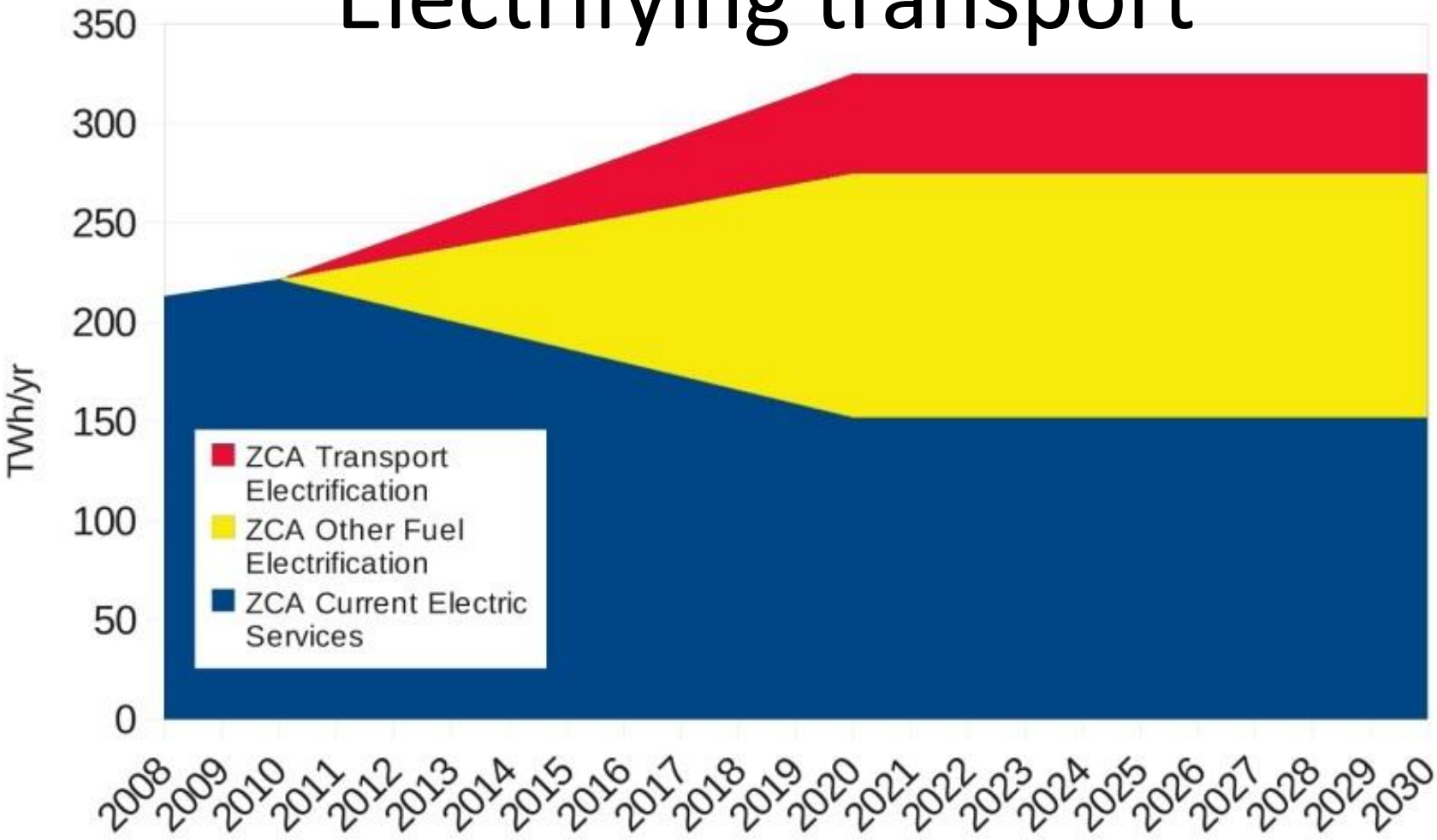
ZCA Total Energy Demand Existing services



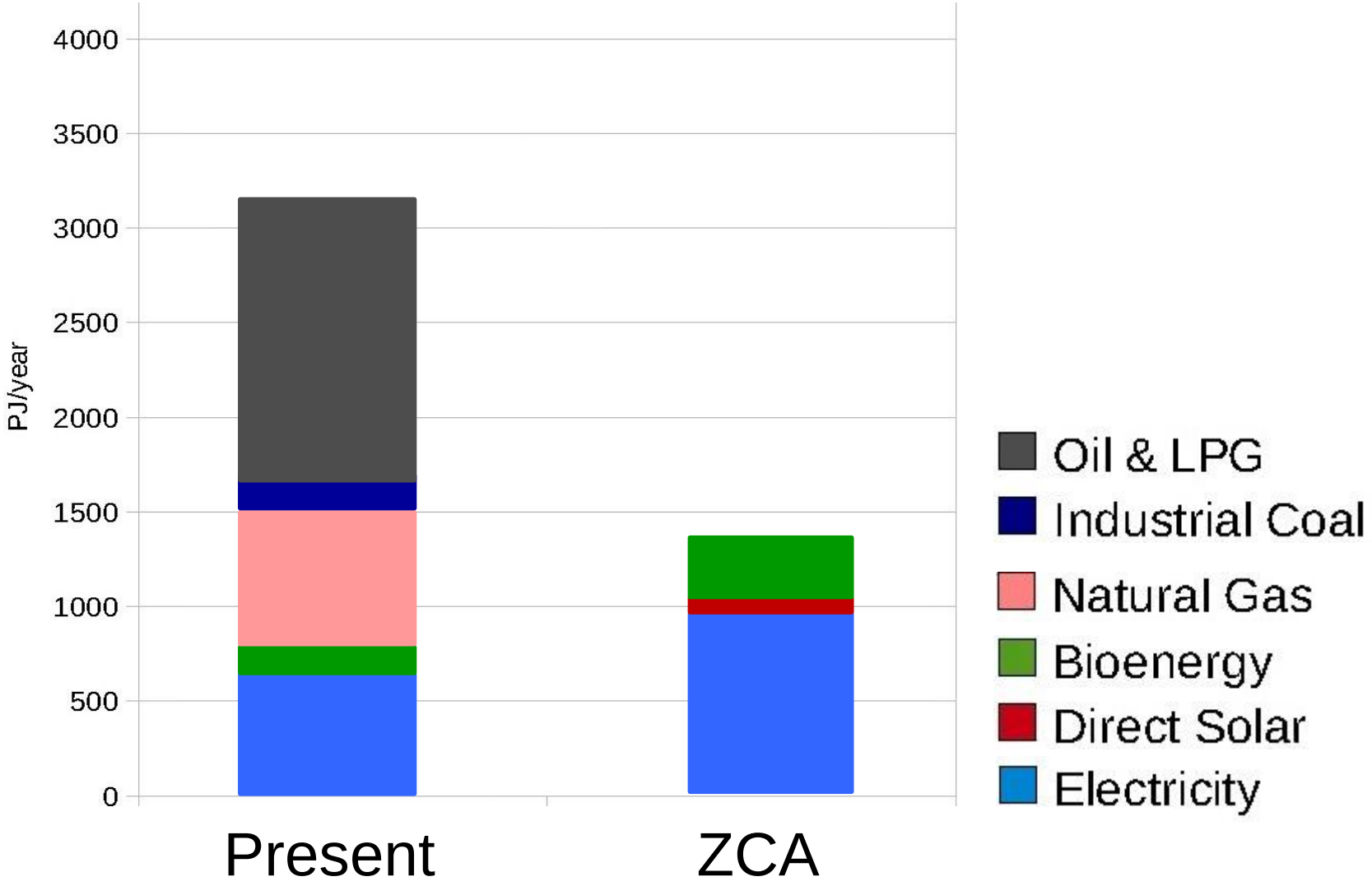
ZCA Total Energy Demand Electrifying other fuels



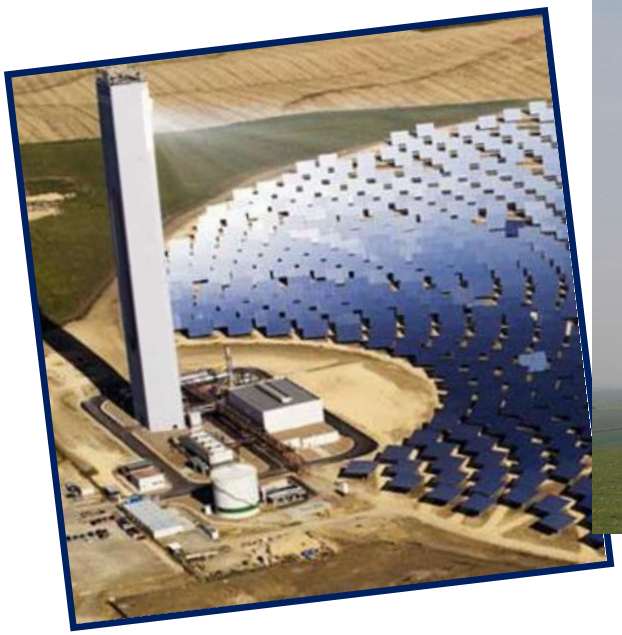
ZCA Total Energy Demand Electrifying transport



Australian End-Use Energy



100% Renewable Energy for Australia - three main components



Concentrated solar thermal power

Wind power

Upgraded electricity grid

Concentrated solar thermal power

220MW

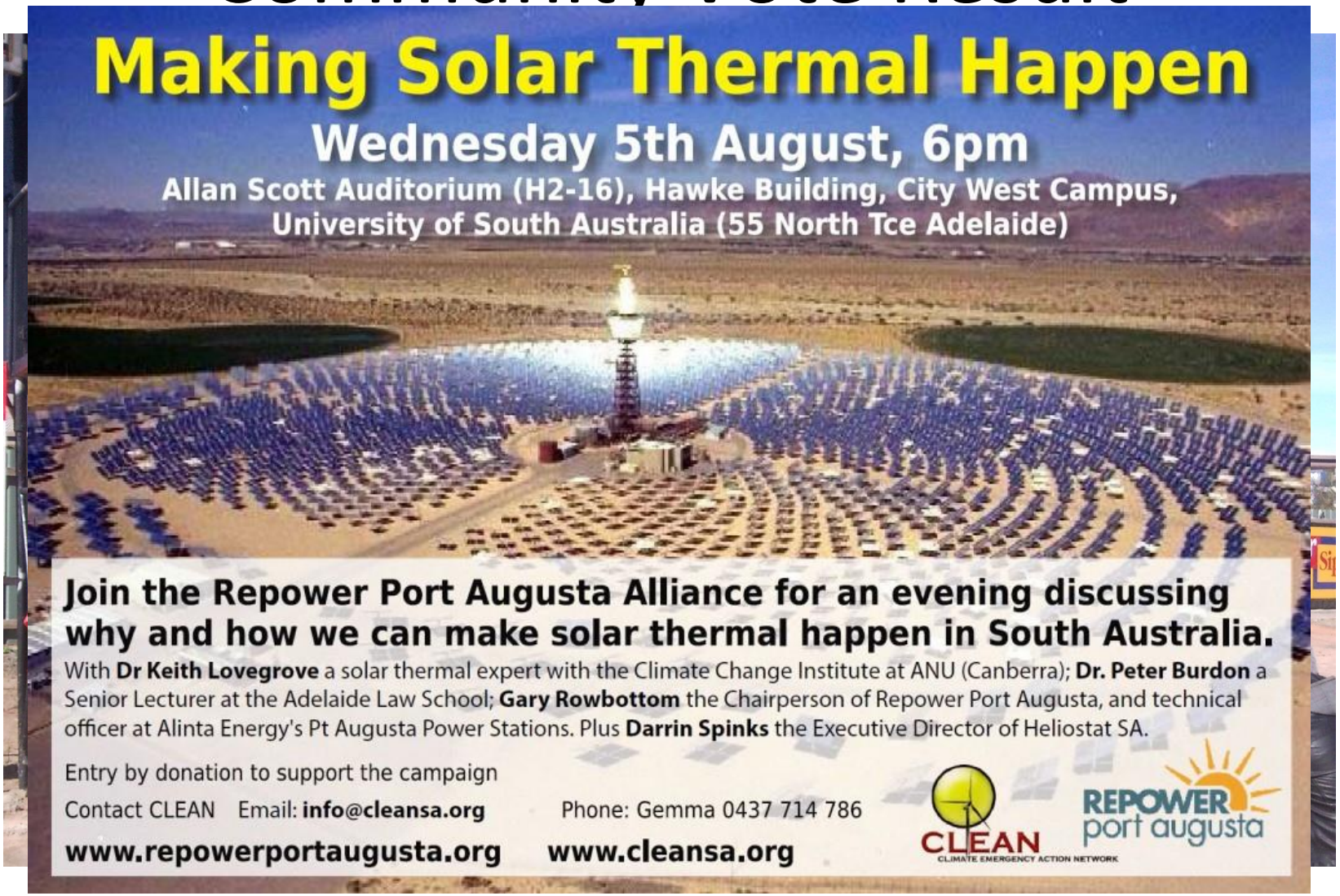
× 17 = 3700MW solar region

12 regions = 60% of Australia's Stationary Energy delivered by Solar Thermal with storage

Port Augusta SA

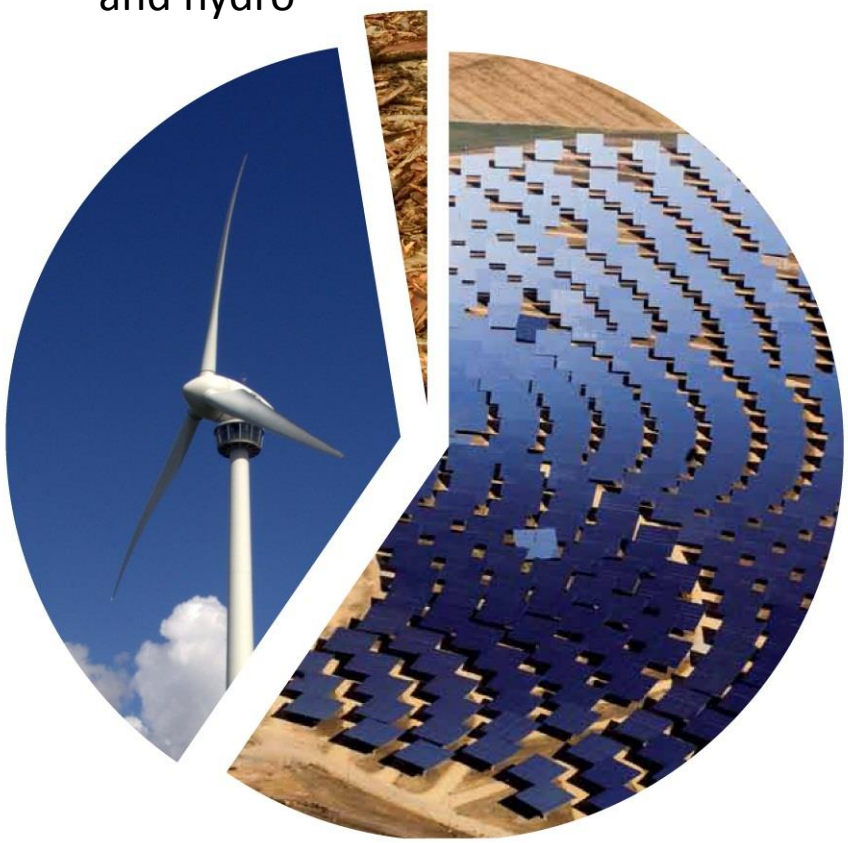
Repowering Port Augusta Proposal

Community Vote Result



100% Renewable Stationary Energy

Backup with bio-mass
and hydro



Concentrated Solar
Thermal with storage

Large scale wind
farms

Wind power

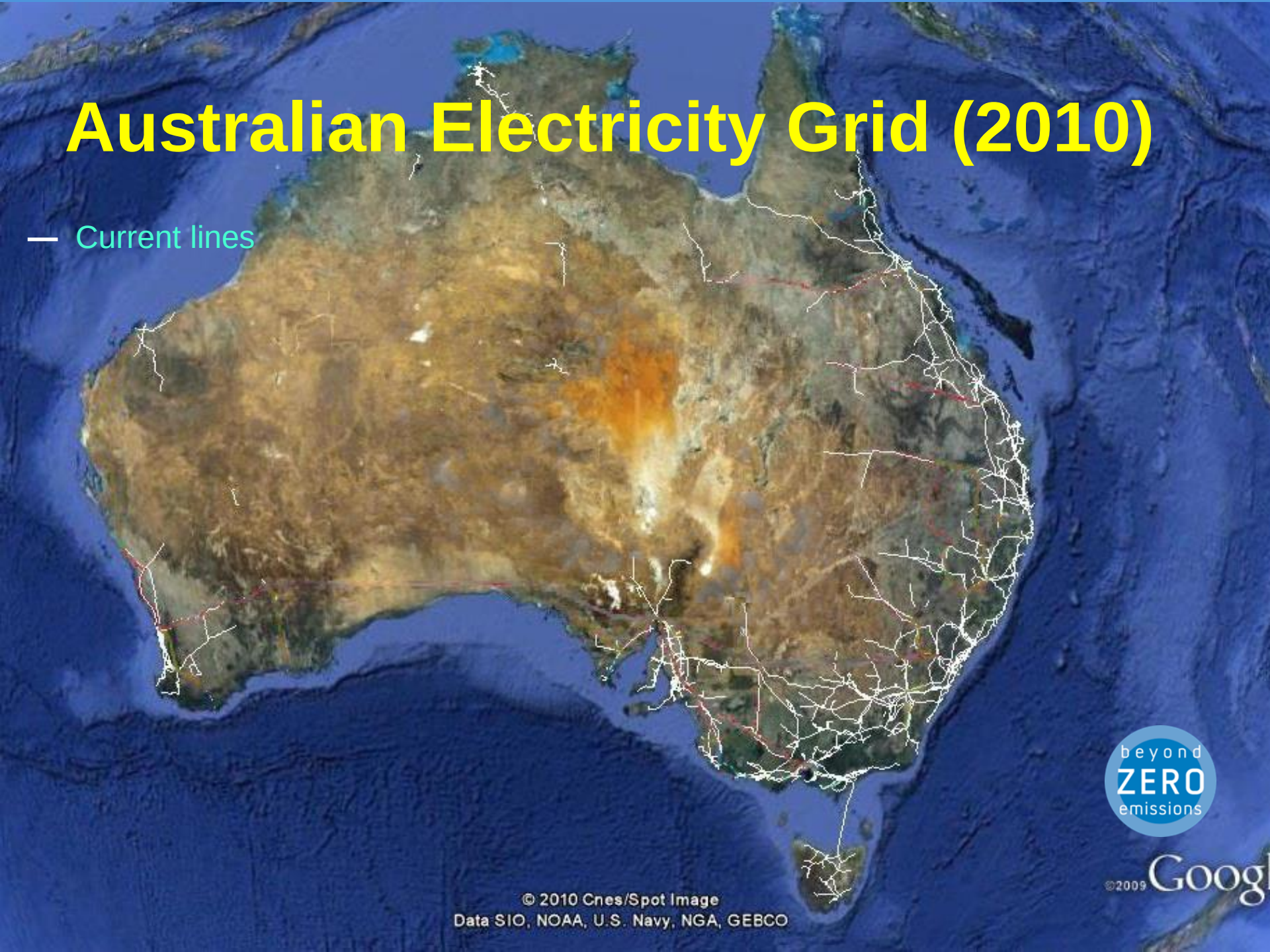
7.5MW

× 330 = 2500MW wind region

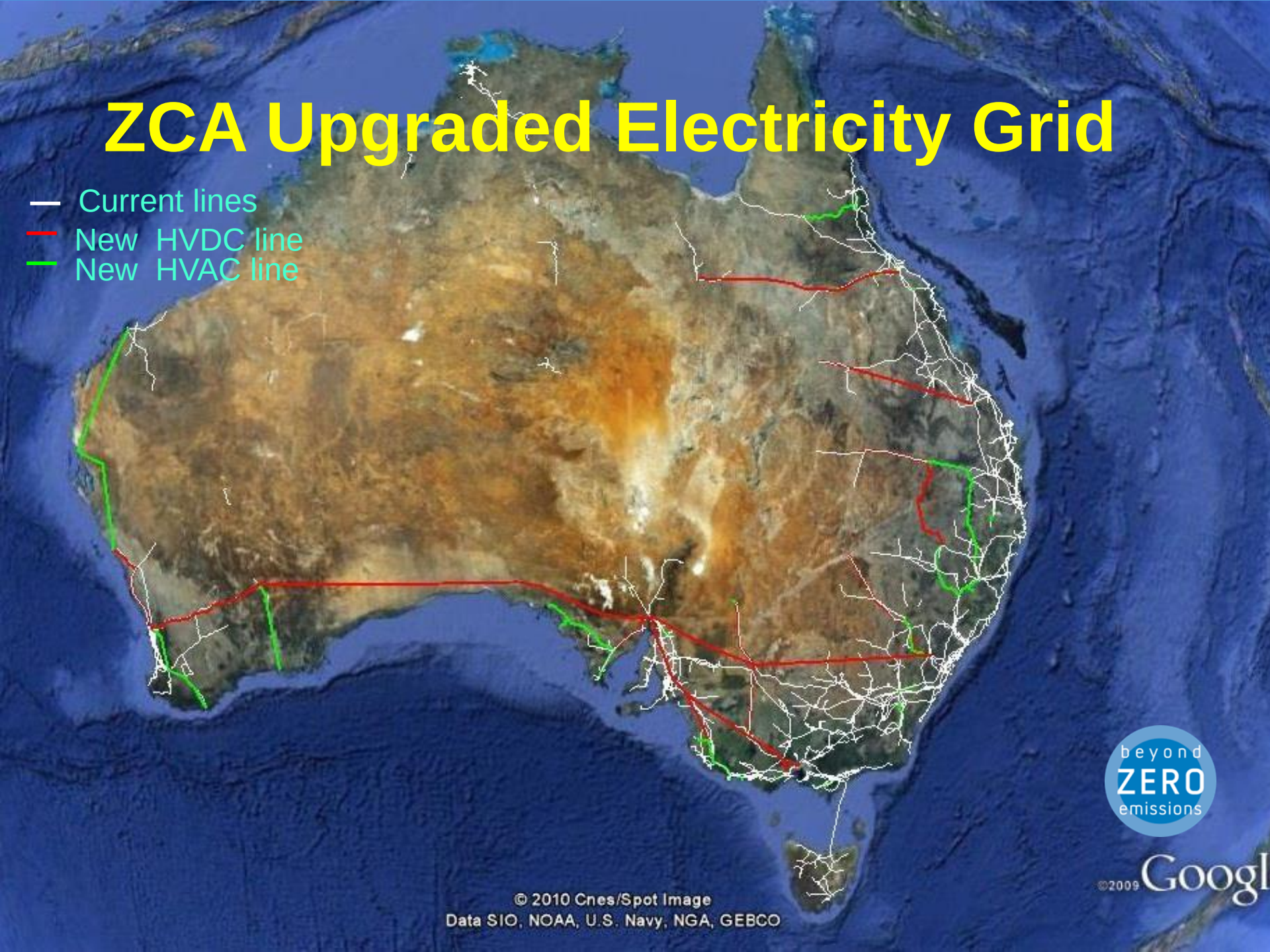
23 wind regions = 40% of Australia's Stationary Energy delivered by Wind

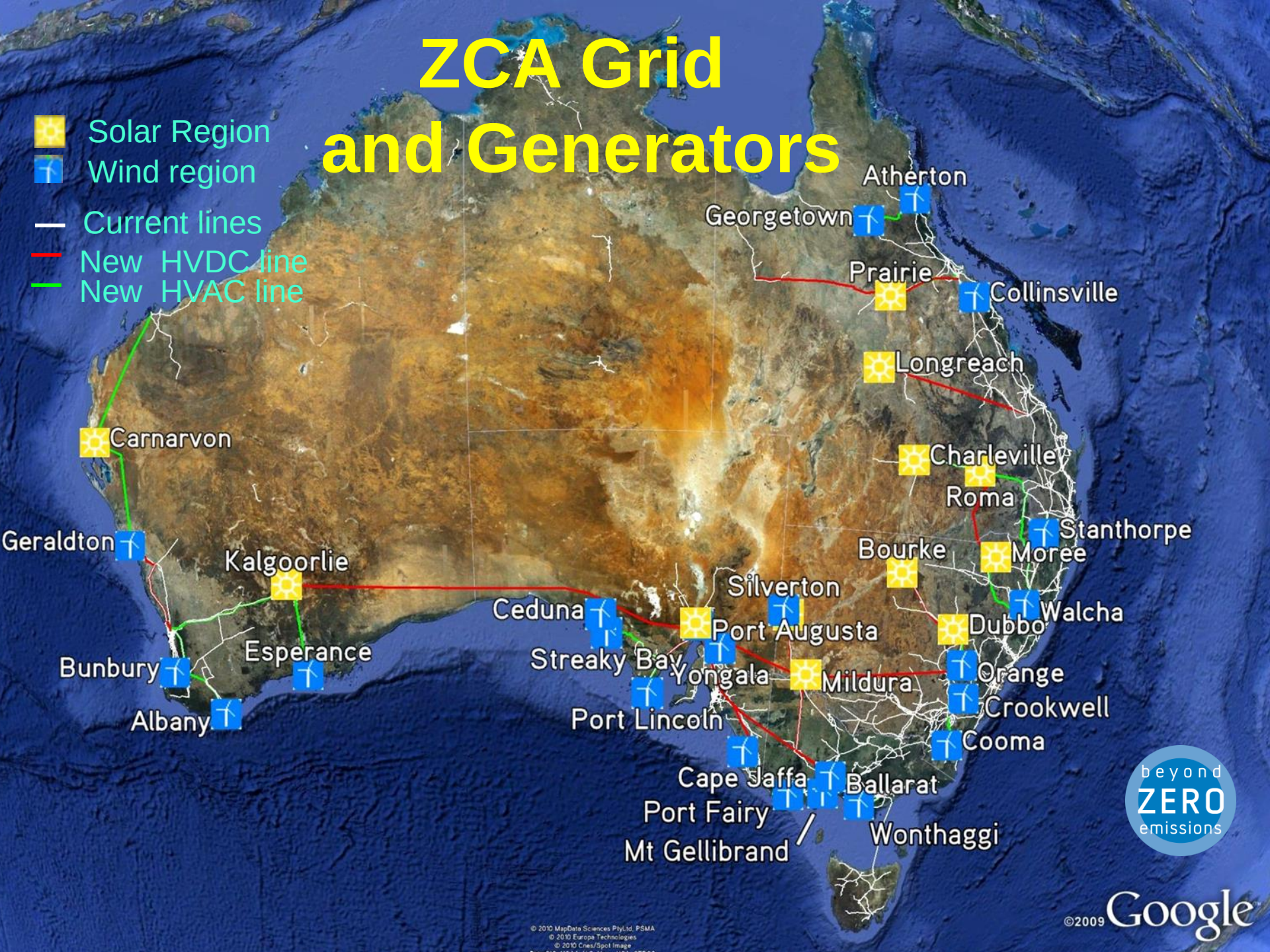
Australian Electricity Grid (2010)

- Current lines



ZCA Upgraded Electricity Grid




ZCA Grid
and Generators
Solar Region
Wind region
Current lines
New HVDC line
New HVAC line
Atherton
Georgetown
Prairie
Collinsville
Longreach
Carnarvon
Charleville
Roma
Stanthorpe
Geraldton
Bourke
Moree
Kalgoorlie
Silverton
Ceduna
Walcha
Port Augusta
Dubbo
Esperance
Streaky Bay
Yongala
Mildura
Orange
Bunbury
Crookwell
Albany
Port Lincoln
Cooma
Cape Jaffa
Ballarat
Port Fairy
Wonthaggi
Mt Gellibrand
beyond ZERO emissions
©2009 Google

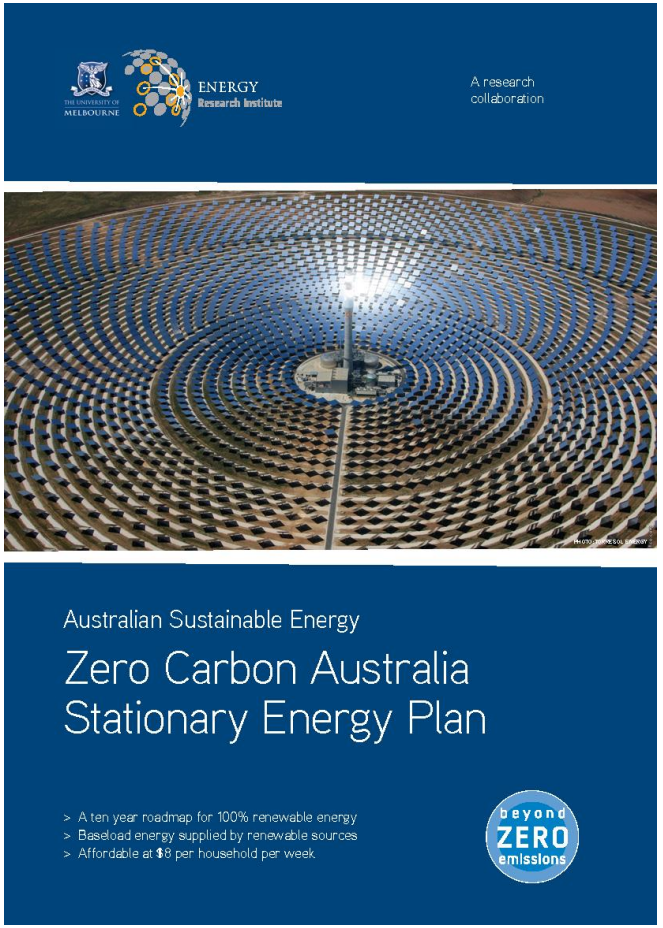
Leading engineering consultancy review of grid

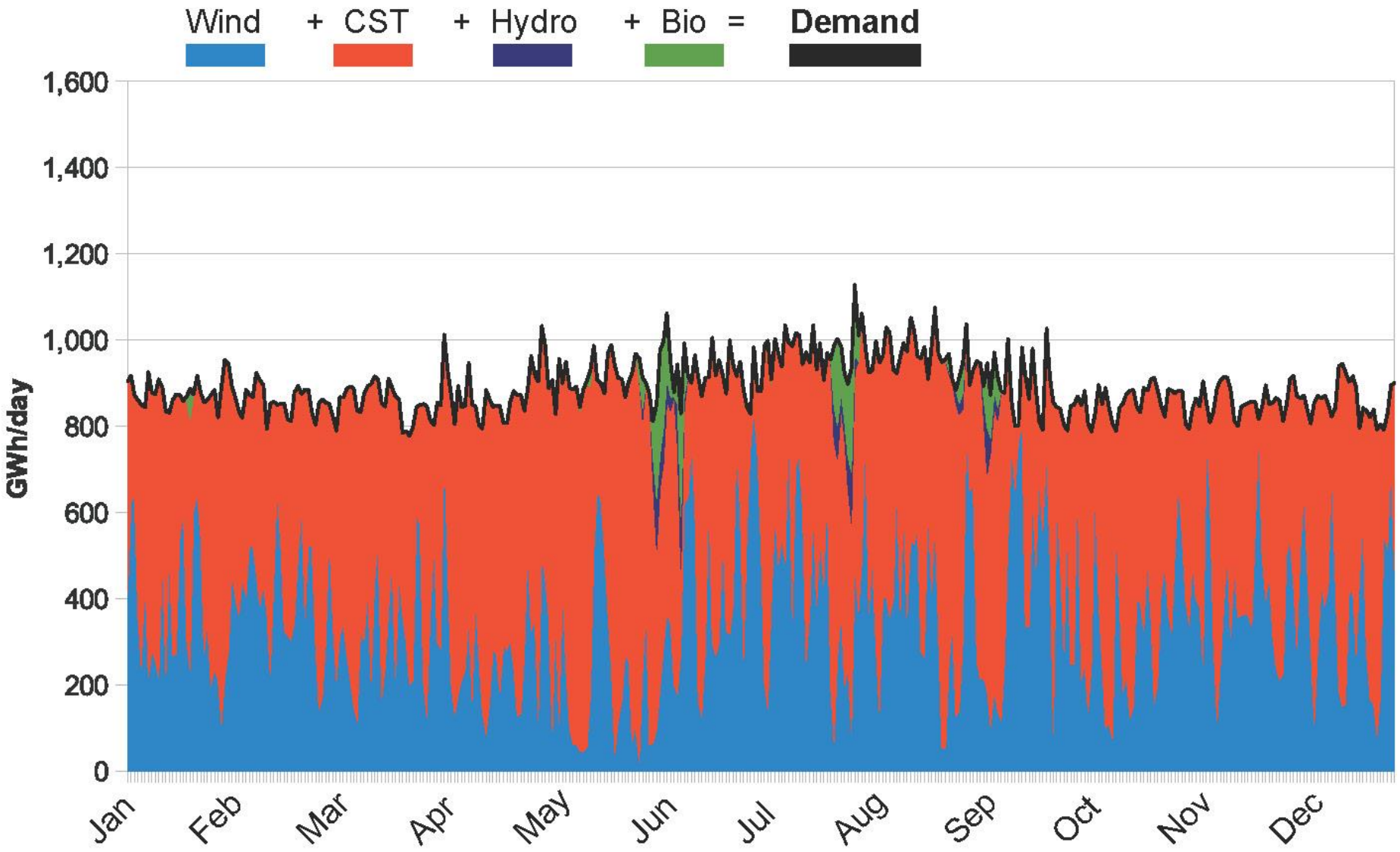
"The review finds that the transmission scenario proposed is technically feasible in terms of capacity and reliability. In addition, the proposed transmission uses mature technology with proven capability around the world."

SINCLAIR KNIGHT MERZ
SKM

Major Questions

- Technology ✓
- Reliability? **- Part Four**
- Resources?
- Jobs?
- Economics?
- Social and Political Will?





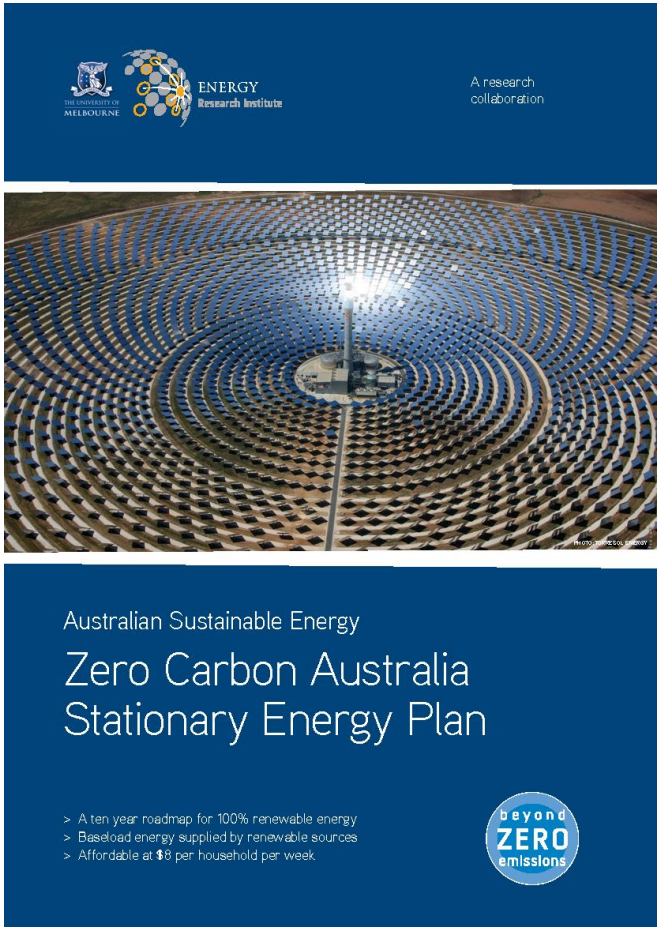
2008 Grid Model results scaled up to 2020 demand projections

Major Questions

- Technology ✓
- Reliability ✓
- Resources?
- Jobs?
- Economics?

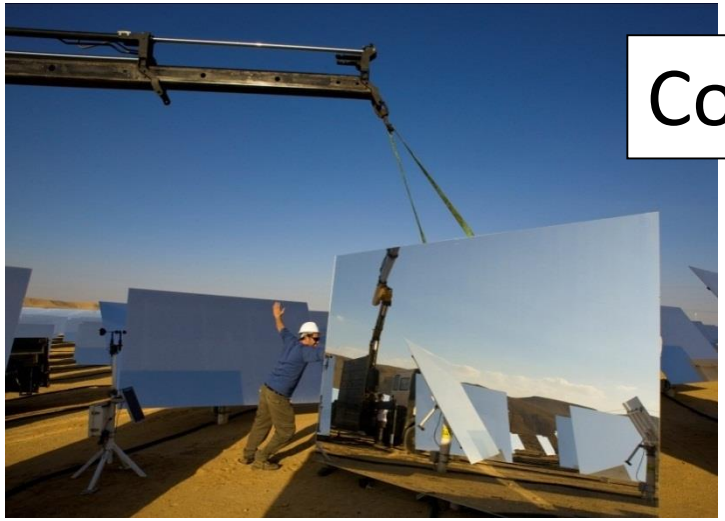
Part Six

- Social and Political Will?



Getting the job done in 10 years

Manufacturing



Construction

Peak Concentrated Solar ‘roll-out’

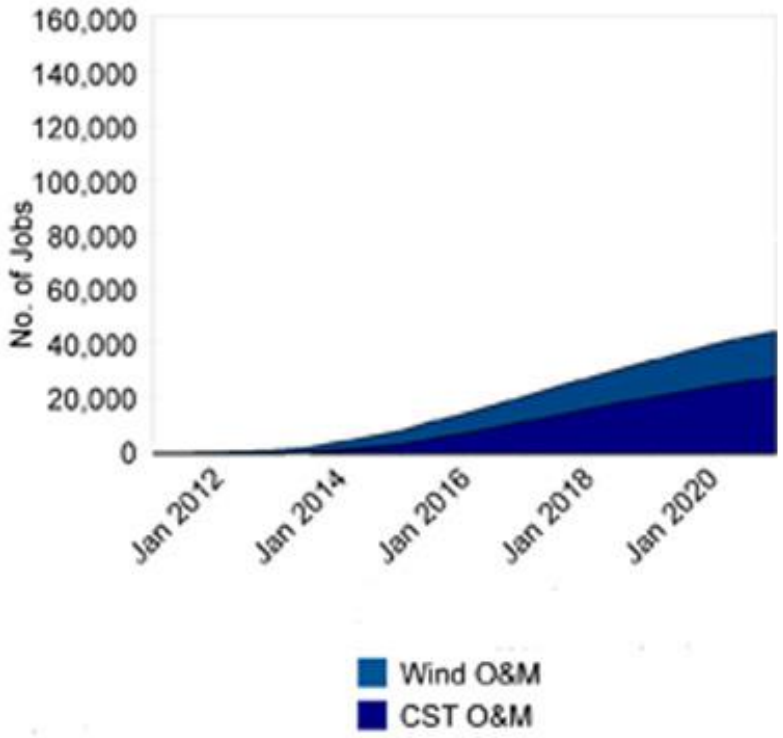
600,000 Heliostats

30 concrete towers

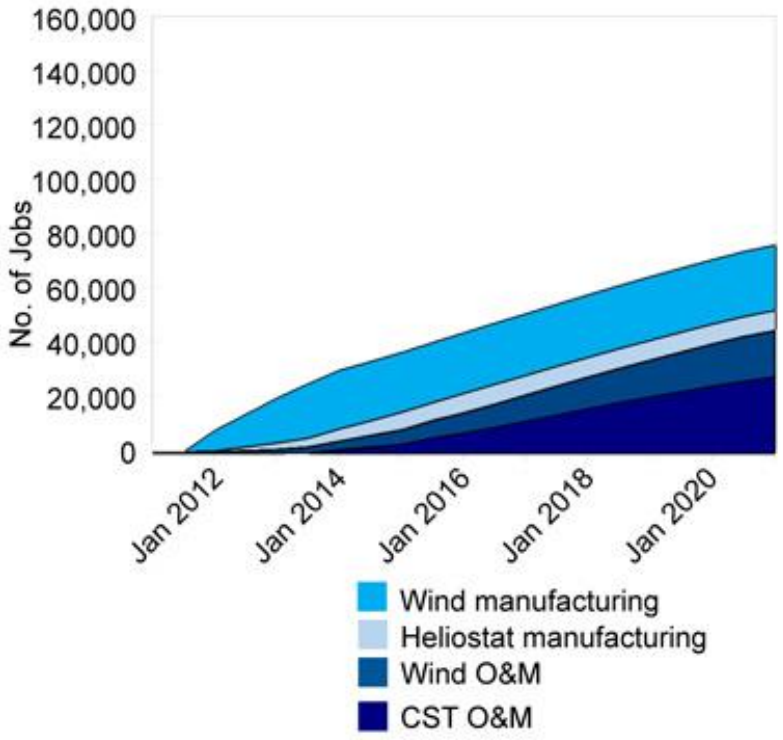
Enercon Viana Do Costelo Wind Turbine blade and tower factories Portugal
250 towers per year 400 Jobs

ZCA 10 year Resource Requirements

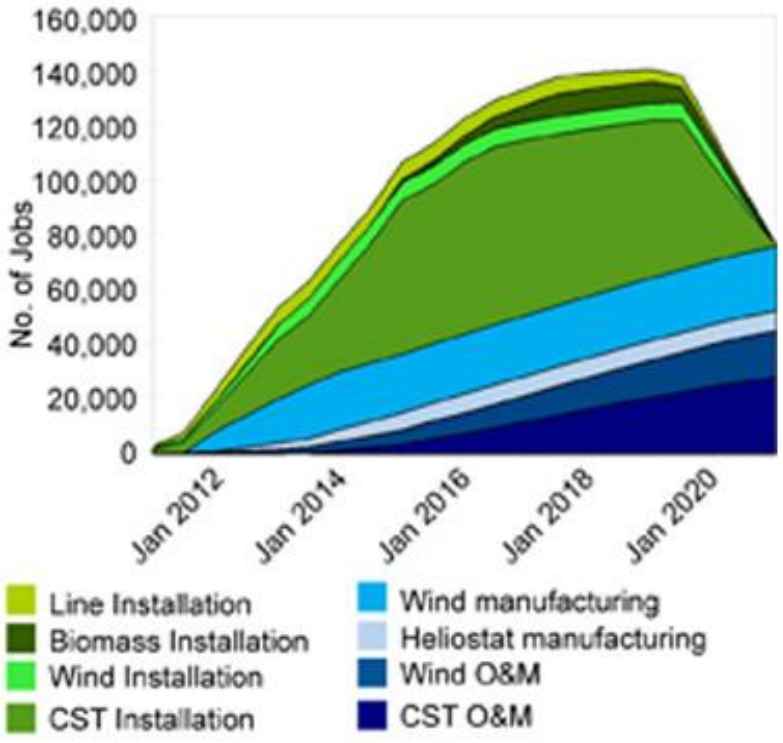
Labour Requirements



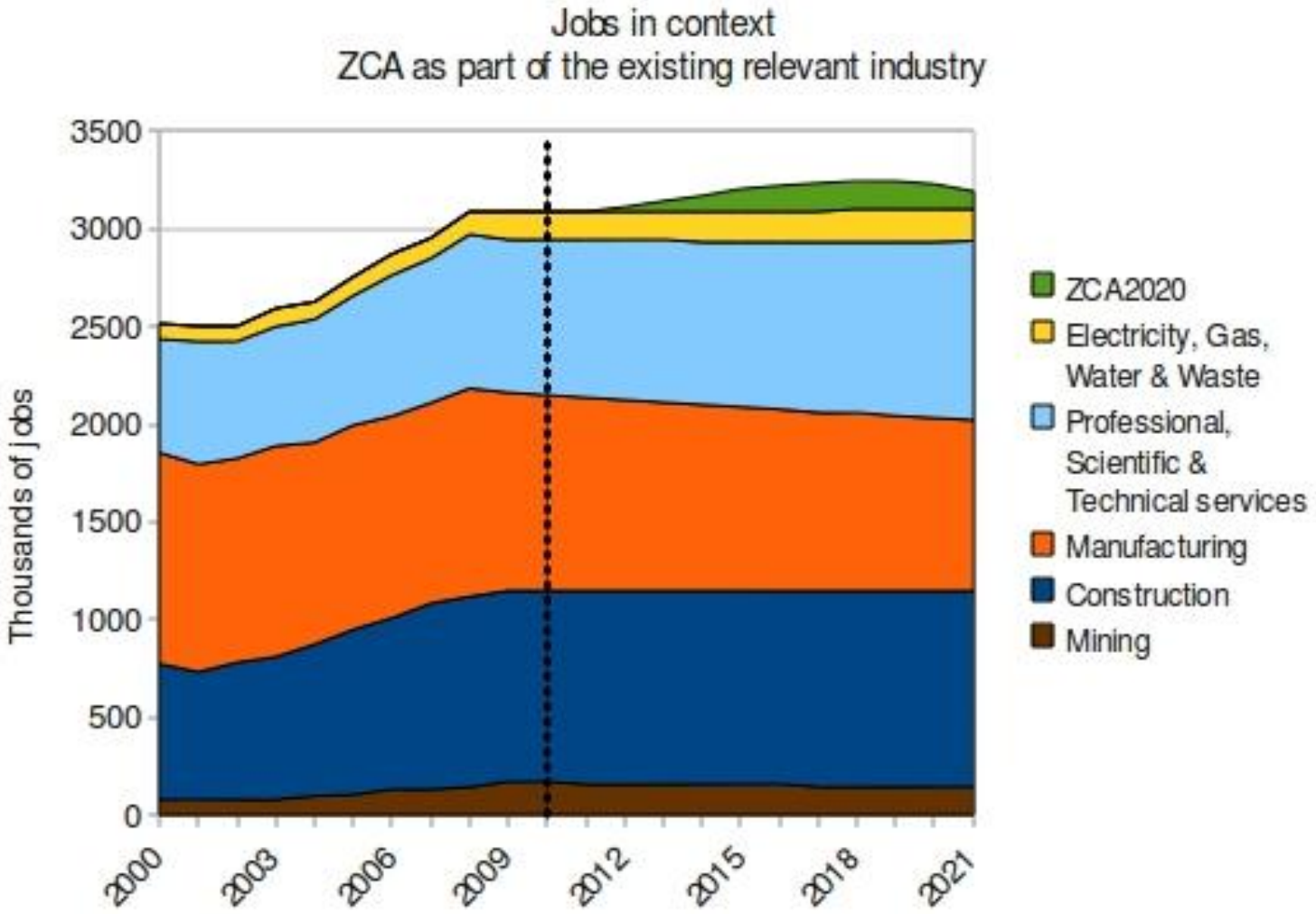
Labour Requirements



Labour Requirements

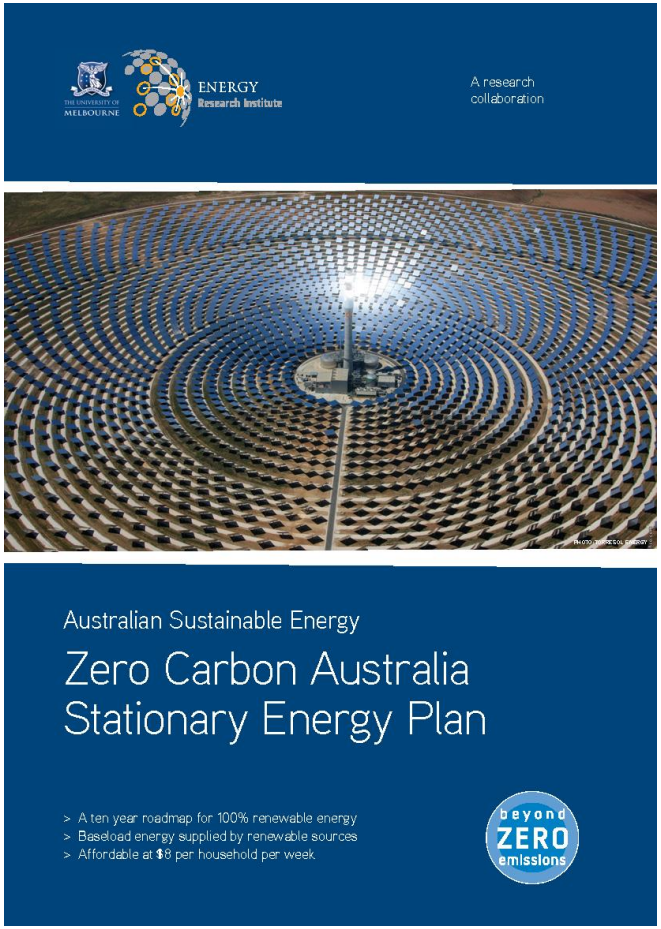


Achievability: Jobs In Context

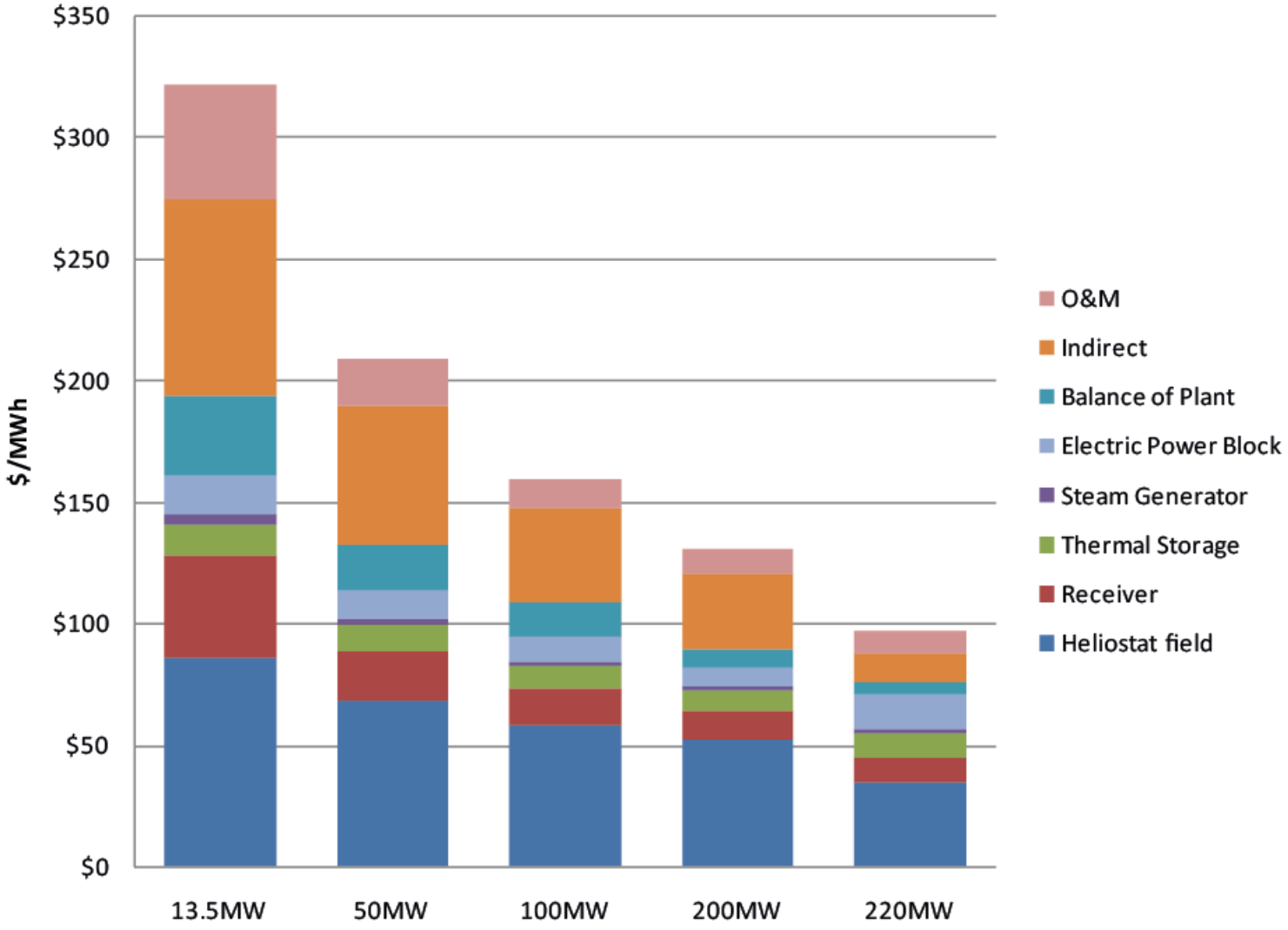


Major Questions

- Technology ✓
- Reliability ✓
- Resources ✓
- Jobs ✓
- Economics? **- Part Seven**
- Social and Political Will?



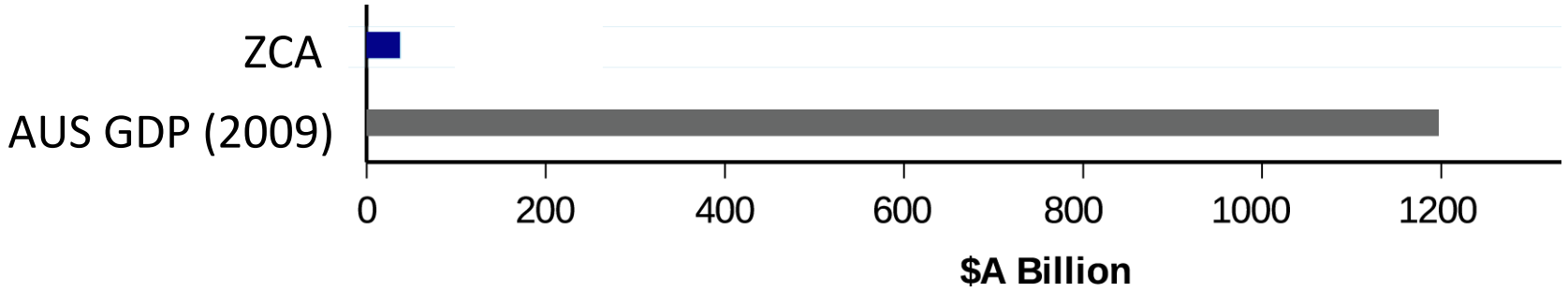
Solar Thermal Cost Reduction



ZCA investment - $370 billion – 3% of AUS GDP for 10 years

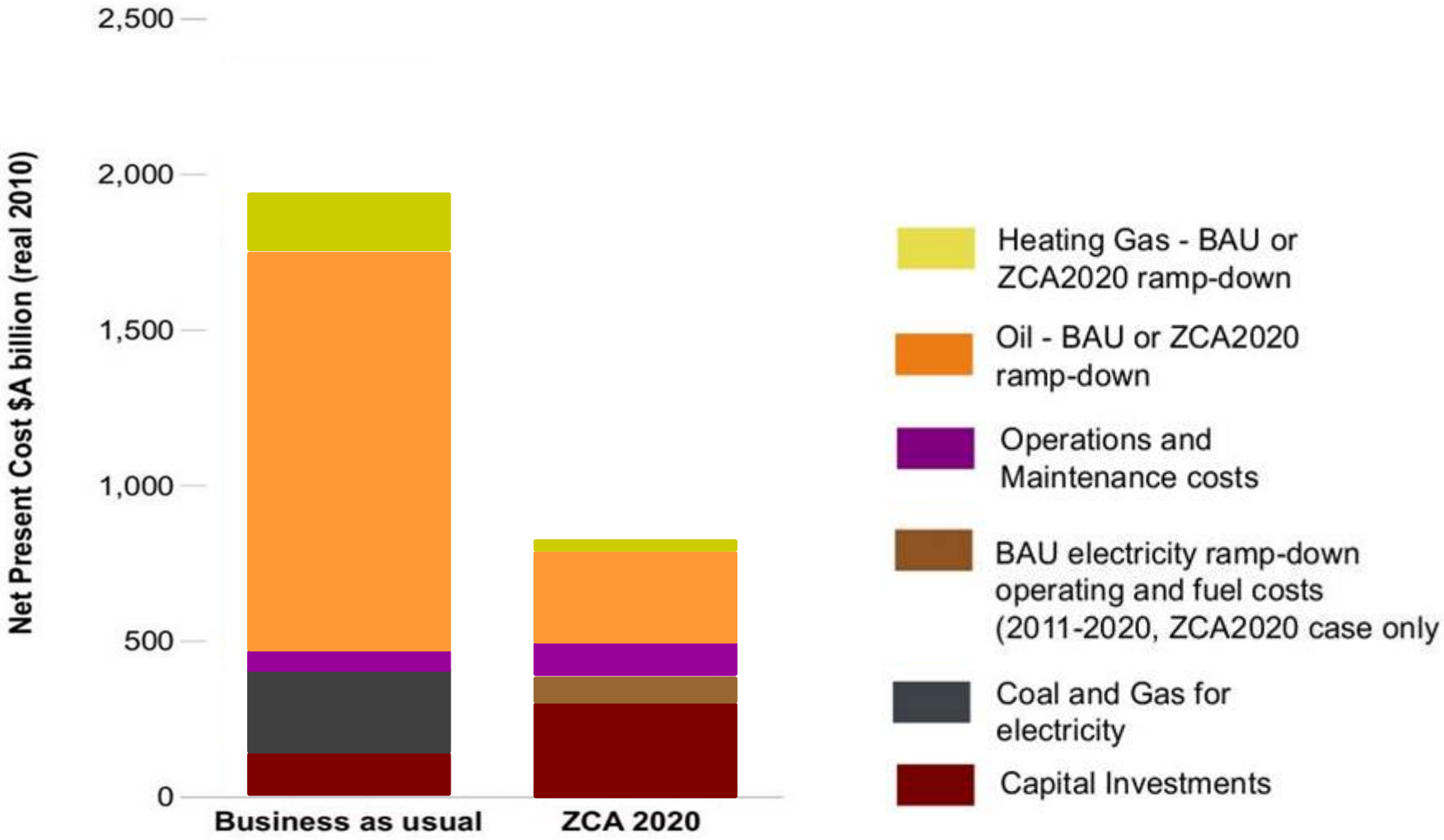
Component	$AU,Bn
Solar Thermal	$175
Wind	$72
Transmission	$92
Other	$31
Total	**$370**

ZCA per year and Australia's GDP



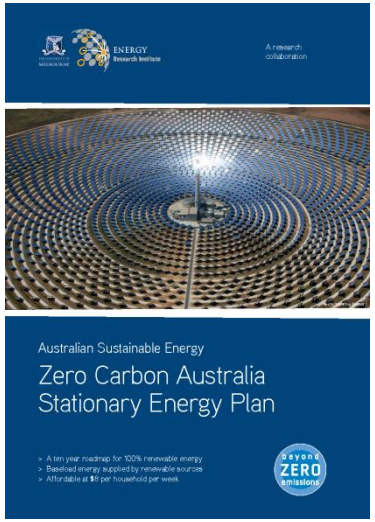
- ZCA – $37Bn for 10 years
- Australian Gambling 2009 – $20Bn
- Australian Insurance 2009 – $38Bn

30 year Cost to Economy – all energy

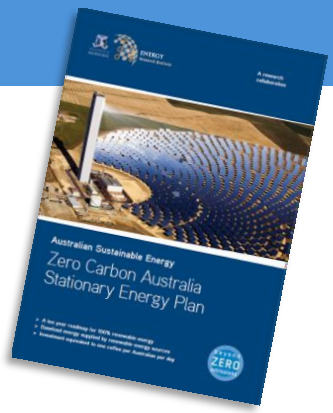


Zero Carbon Australia - Conclusion

- Will secure our climate and future
- Technically doable
  - Uses commercially available technologies
- Fully Resourced
  - We have the materials
  - Jobs rich
- Fully Costed
  - 3% of GDP for 10 years



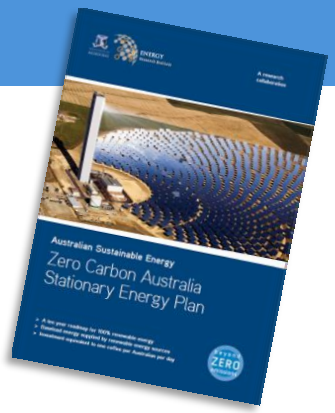
Energy



So What Happened?

- Five years since the creation of the SEP
- What has been the progress?
- What have been the stumbling blocks?

Energy



Centralised architecture

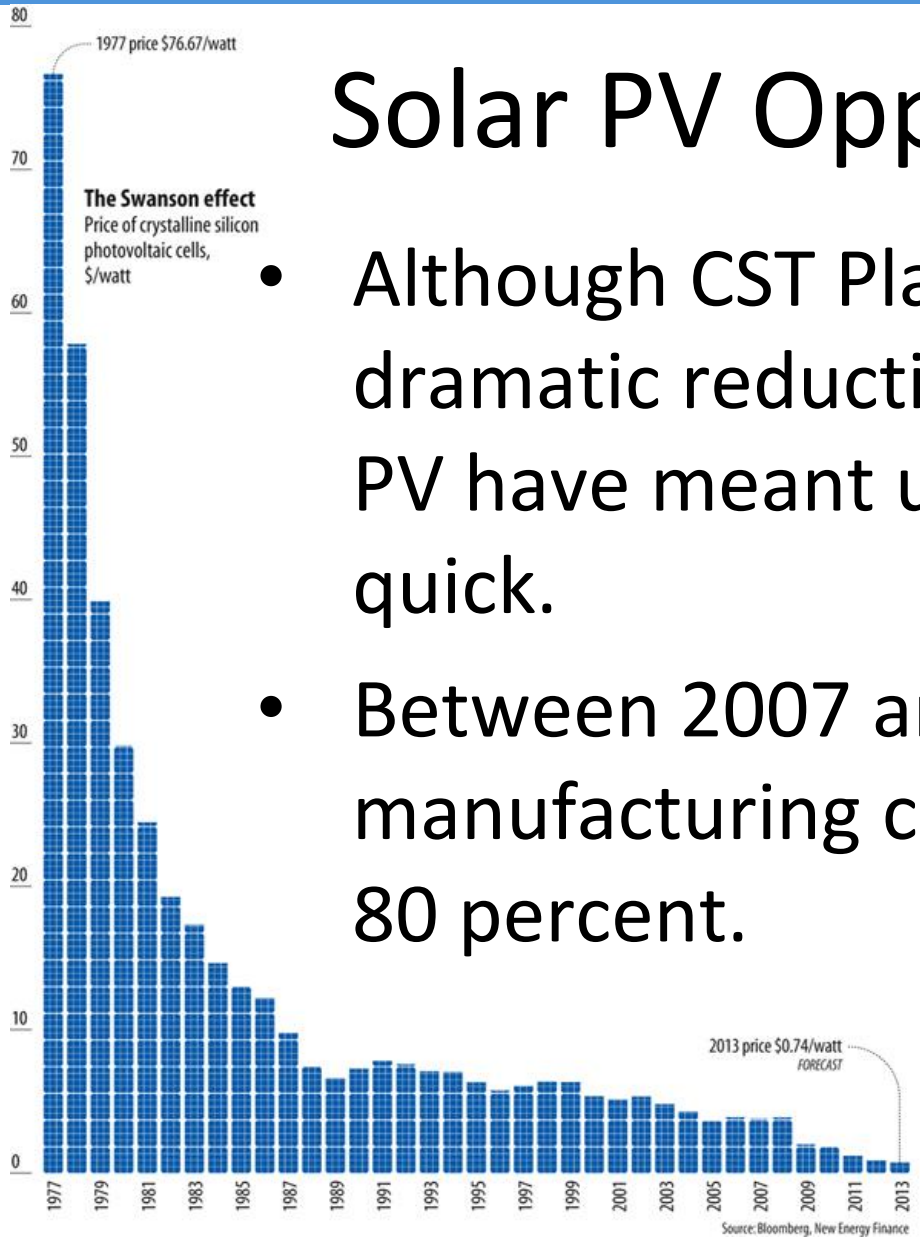
Solar PV was very minor

Things change very quickly!

Distributed power is a growing force

The new challenge will be integrating
diverse energy solutions

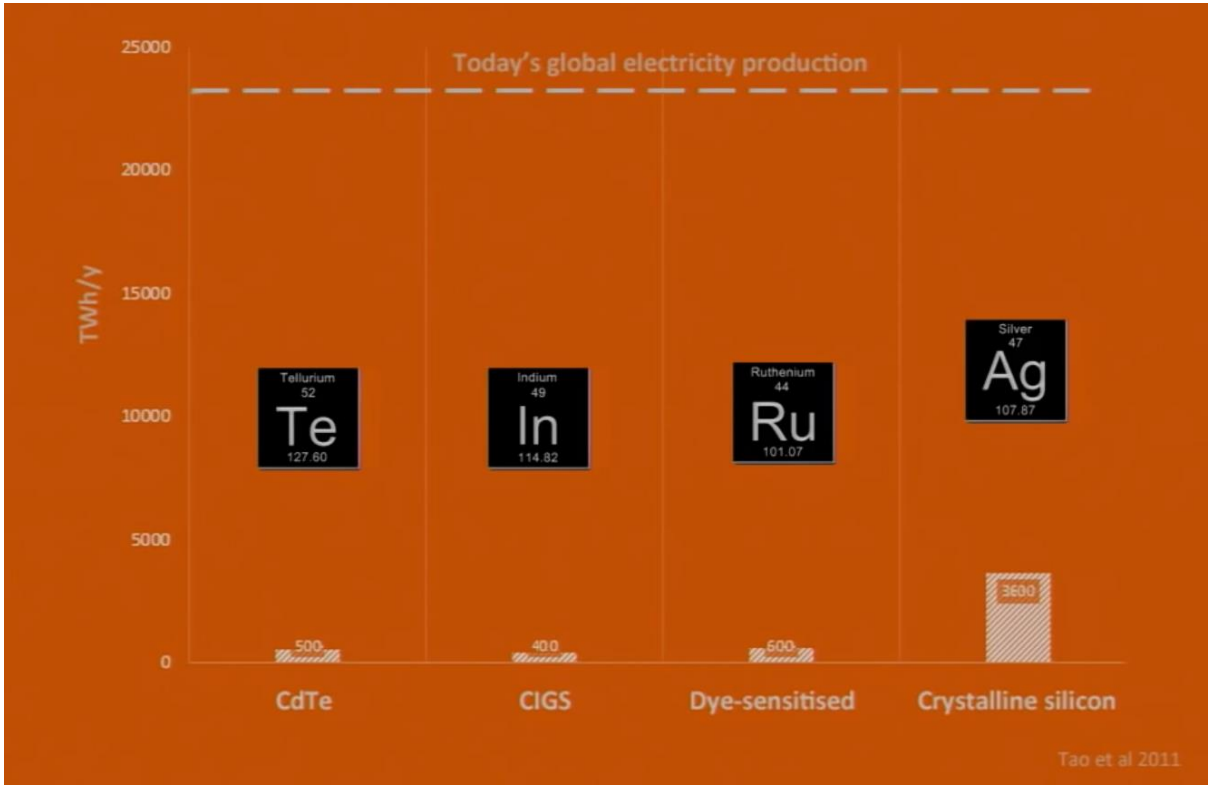
Solar PV Opportunities



- Although CST Plants continue to be built, dramatic reductions in the cost of solar PV have meant uptake has not been as quick.
- Between 2007 and 2013, solar manufacturing costs fell between 70 and 80 percent.

Resource Limits for PV

- Solar PV is up against resource limits



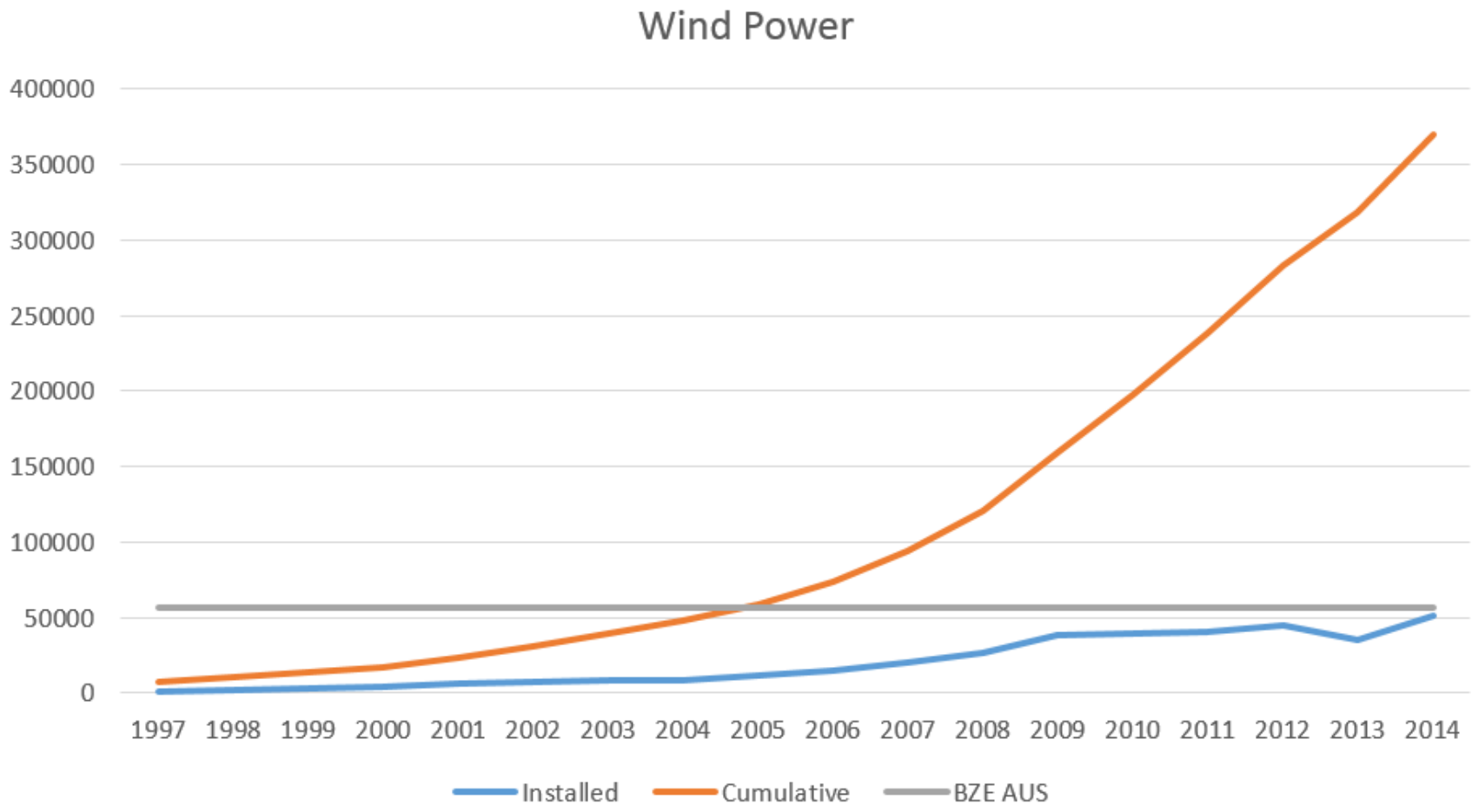
Solar Thermal Progress

- Between 1984 and 2010, 555MW of Solar Thermal Generation had been constructed
- Now the cumulative total is 4605MW (roughly!)
- That's almost 9x in 5 years what was built in the previous 26 years.

Wind Progress

- The march of solar thermal is nothing to the progress of wind power globally
- At the beginning of 2010, there was just under 160GW of global wind generation
- By the end of 2014, there was almost 370GW
- That's more than doubled in 4 years!
- But wind was already doing well…

Wind Progress

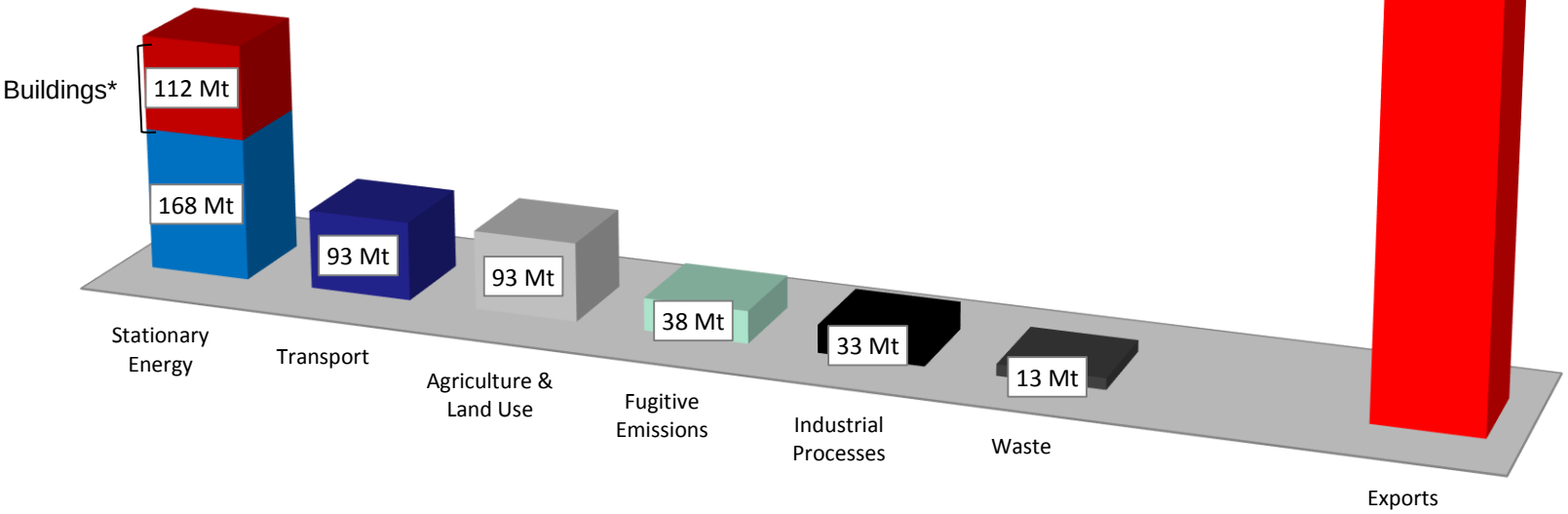


A New Mix

- UNSW study from late 2013 also examined the optimum mix of renewables for the Australian environment.
- Wind 46%, CST 22%, PV 20%, Biofuel Gas 6%, Existing Hydro 6%. No batteries required.
- BZE predicted:
- Wind 39%, CST 59%, Existing Hydro + Biomass < 2%

Australian GHG footprint

> *This important report underscores the reality that at some point in the second half of the century, we need to have achieved climate neutrality—or as some term it zero net or net zero—in terms of overall global emissions.*



Thank you

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