



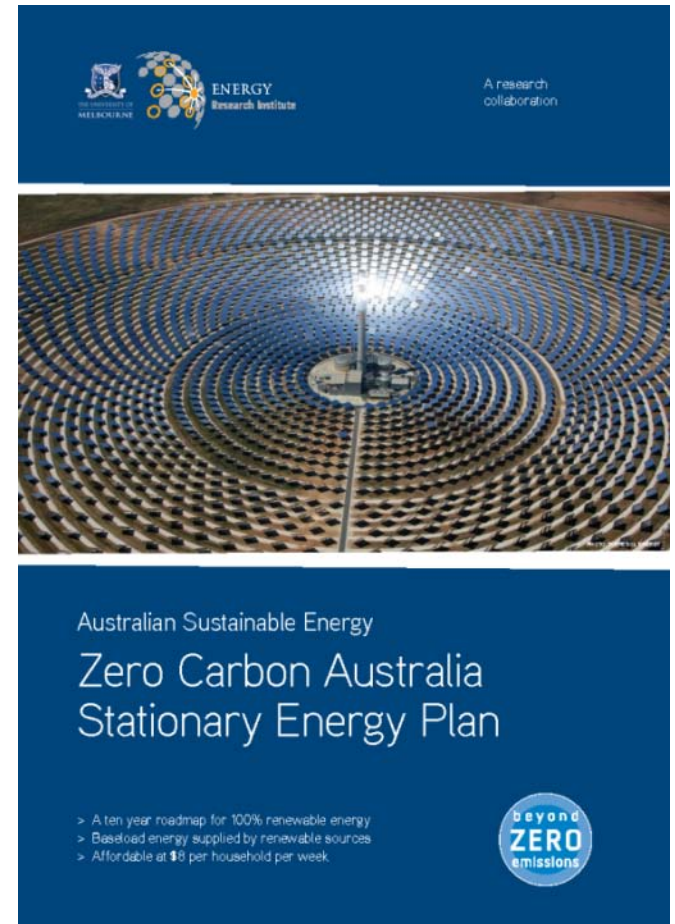
Zero Carbon Australia Stationary Energy Plan

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



Major questions

- Need?
 - Technology?
 - Reliability?
 - Resources?
 - Jobs?
 - Economics?
-
- Social and Political Will?
 - What can I do?



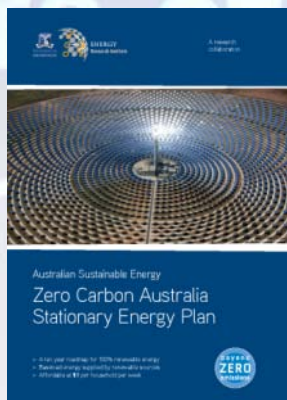
Science based - Solutions focused



(BZE)

- Completely independent
- Probono contributions
- Staff coordinators
- Run on your donations

Zero Carbon Australia Stationary Energy Plan Contributors





ExxonMobil

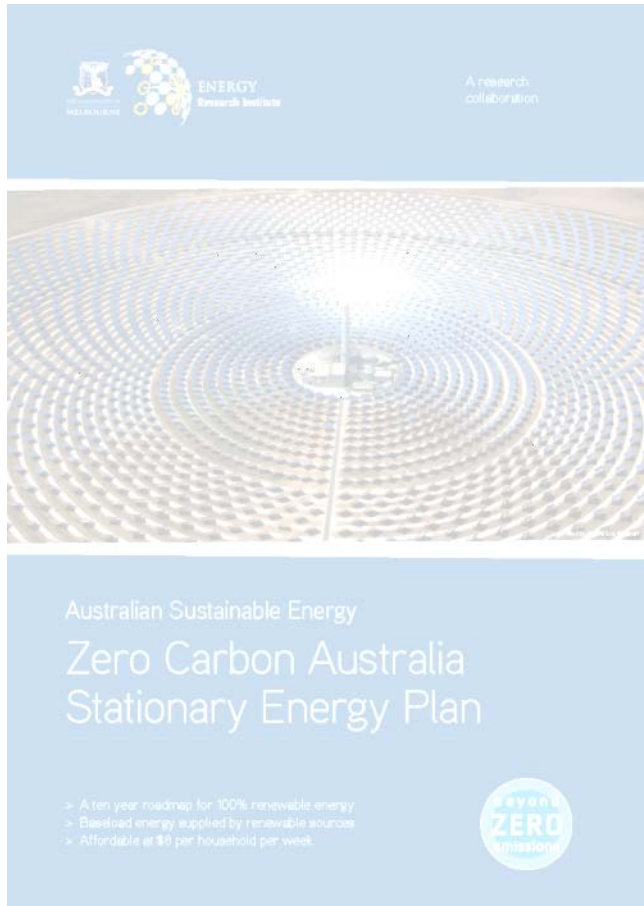


beyondZEROemissions.org

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



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 BATTERHAM
KERNOT PROFESSOR OF ENGINEERING, UNIVERSITY OF MELBOURNE
PRESIDENT, AUSTRALIAN ACADEMY OF TECHNOLOGICAL SCIENCES AND ENGINEERING
FORMERLY CHIEF SCIENTIST OF AUSTRALIA

The Zero Carbon Australia 2020 plan shows that it is technically feasible and 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
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University of Melbourne, July 2010
www.energy.unimelb.edu.au



International
Energy Agency



Peter Gration – former Chief of Defence

Robin Batterham,
Former Australian Chief Scientist

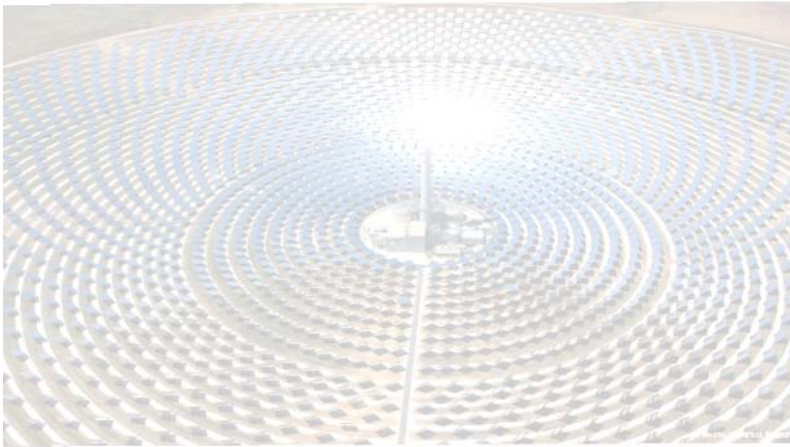
Ian Dunlop - Former Executive Director,
Australian Coal Association

Malcolm Turnbull MP






ENERGY
 Research Institute

A research collaboration



Australian Sustainable Energy
Zero Carbon Australia
 Stationary Energy Plan

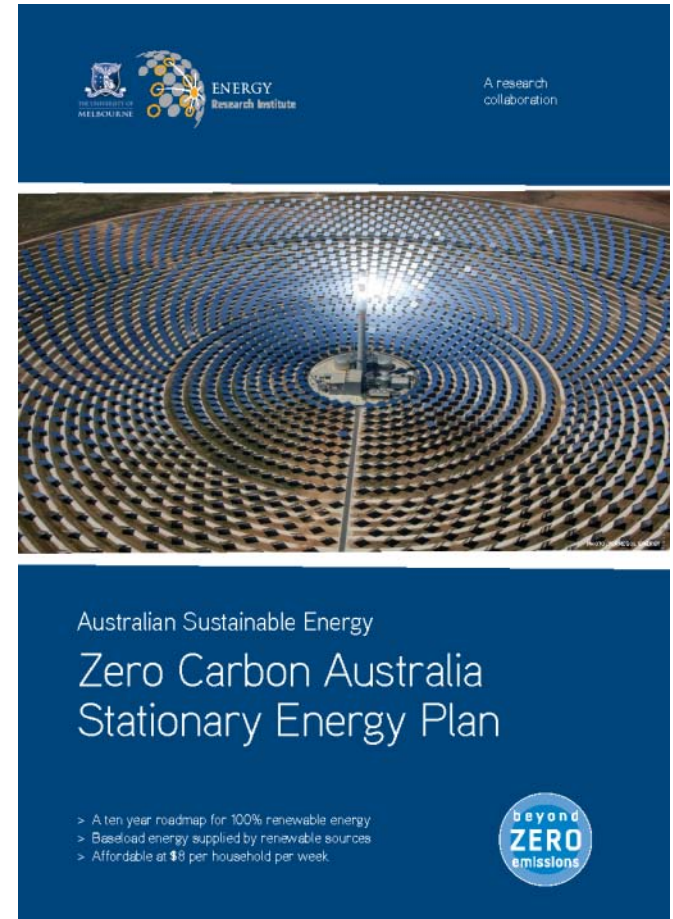
- > A ten year roadmap for 100% renewable energy
- > Baseload energy supplied by renewable sources
- > Affordable at \$8 per household per week


 beyond
ZERO
 emissions



Major Questions

- Need? - **Part One**
 - Technology?
 - Reliability?
 - Resources?
 - Jobs?
 - Economics?
-
- Social and Political Will?
 - What can I do?





CLIMATE
COMMISSION



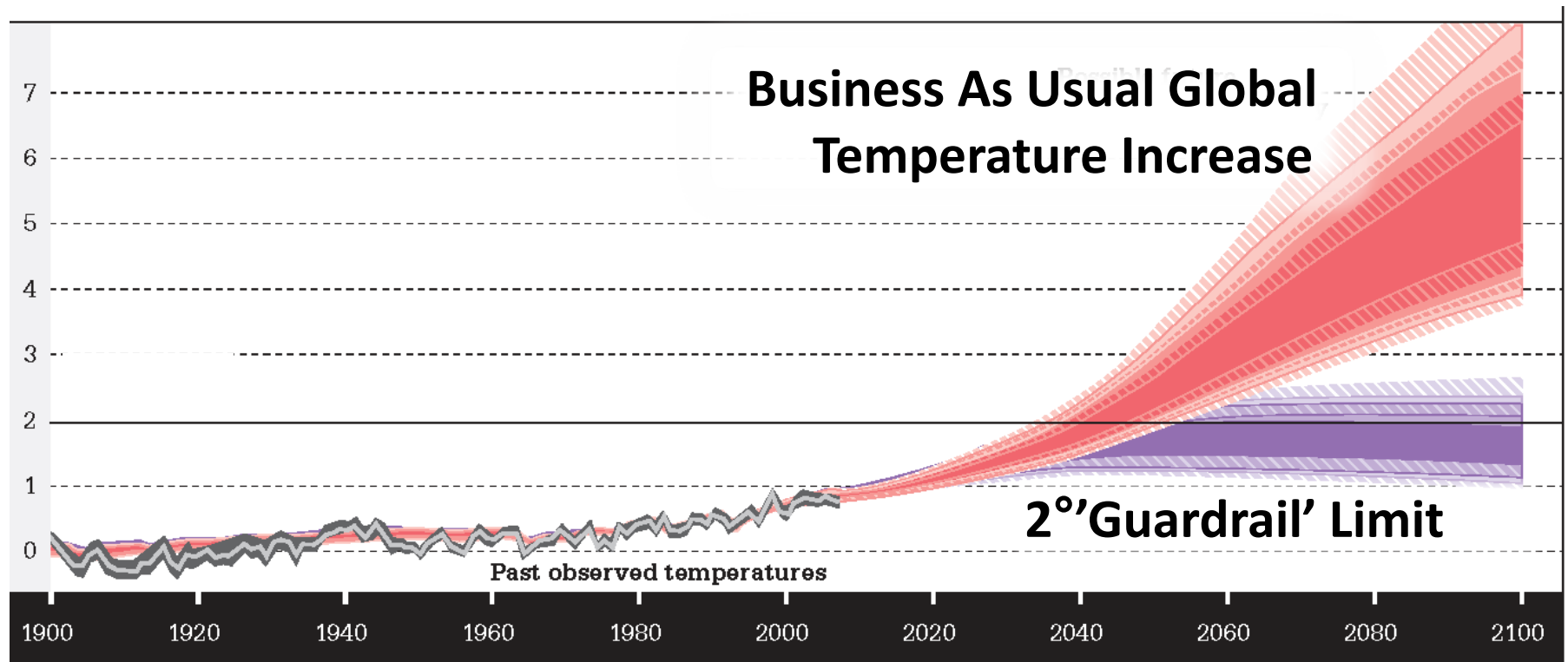
THE CRITICAL DECADE



ONE TRILLION TONNES

2000 2050

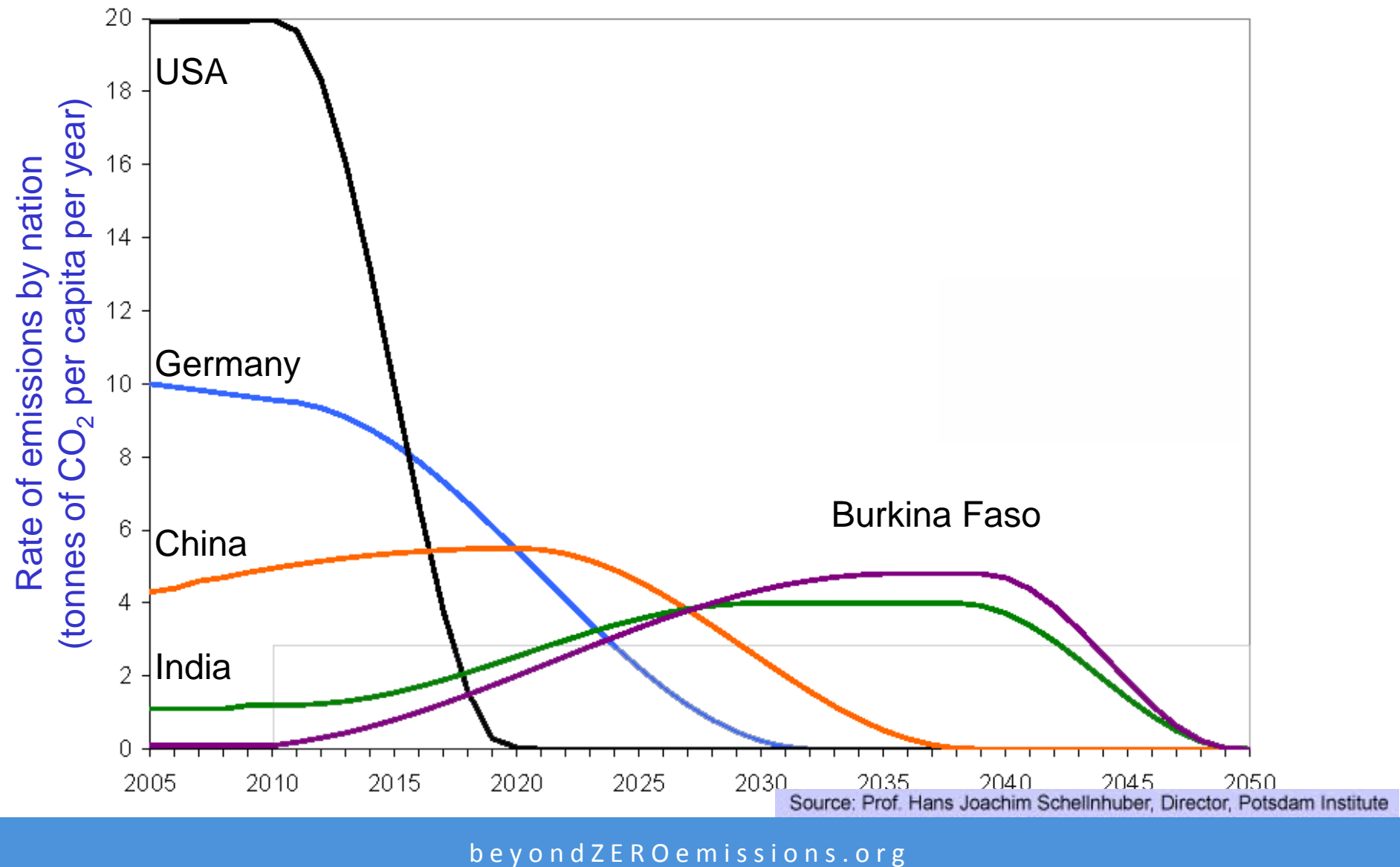
HUMANITY CAN EMIT NOT MORE THAN 1 TRILLION TONNES OF CO₂
BETWEEN 2000 AND 2050 TO HAVE A 75% CHANCE OF LIMITING
TEMPERATURE RISE TO 2 °C OR LESS.



*“The difference between
2° & 4°
is human civilisation”*

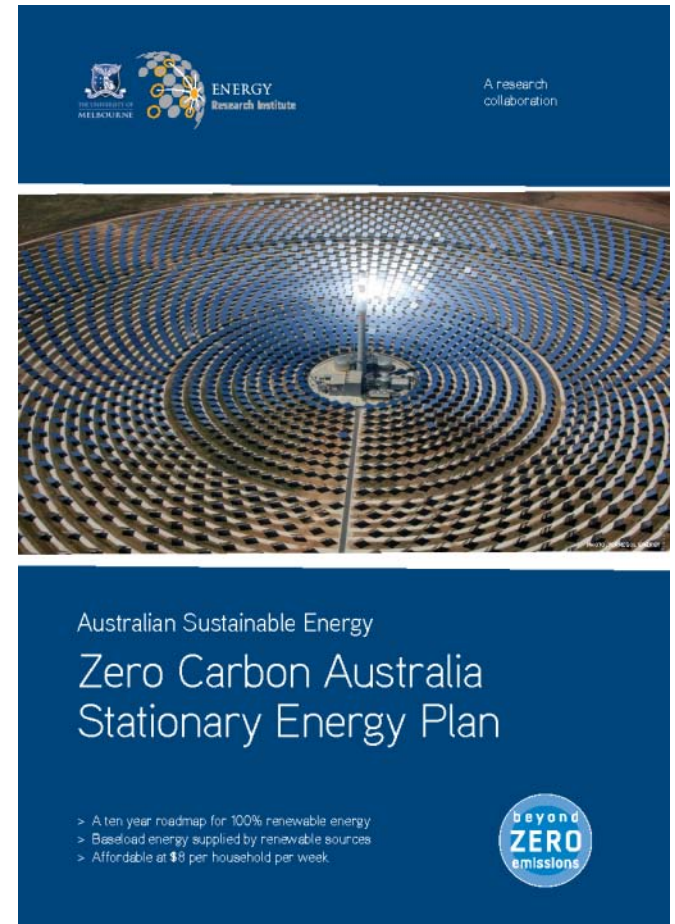


Per Capita Global Carbon Budget 2010-2050

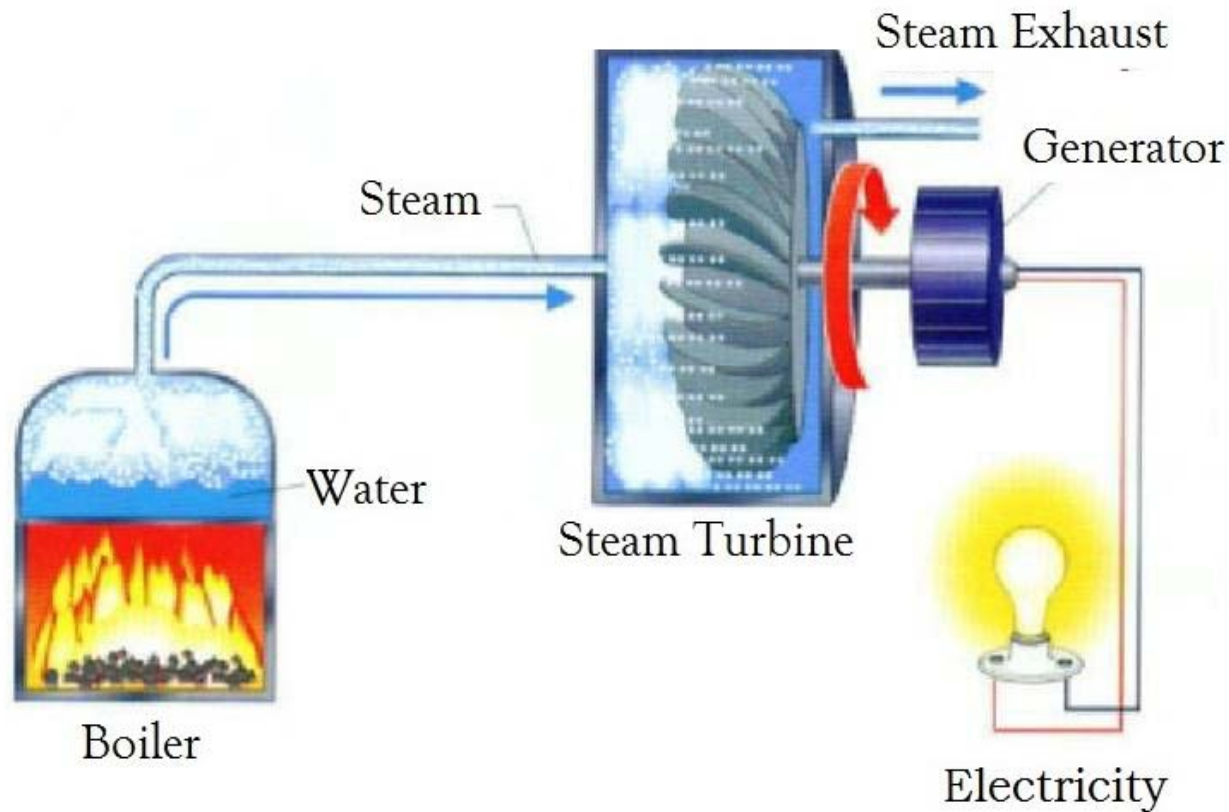


Major Questions

- Need ✓
 - Technology? - **Part Two**
 - Reliability?
 - Resources?
 - Jobs?
 - Economics?
-
- Social and Political Will?
 - What can I do?



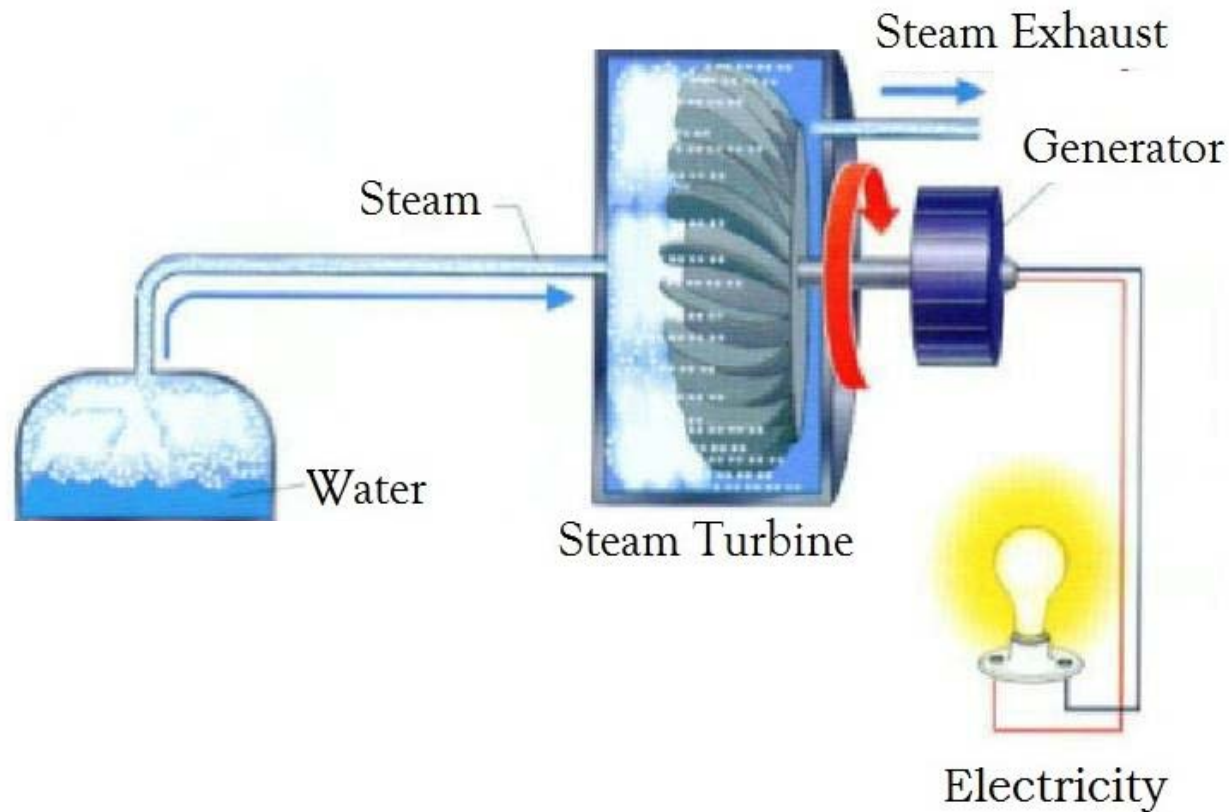
Traditional Power Generation



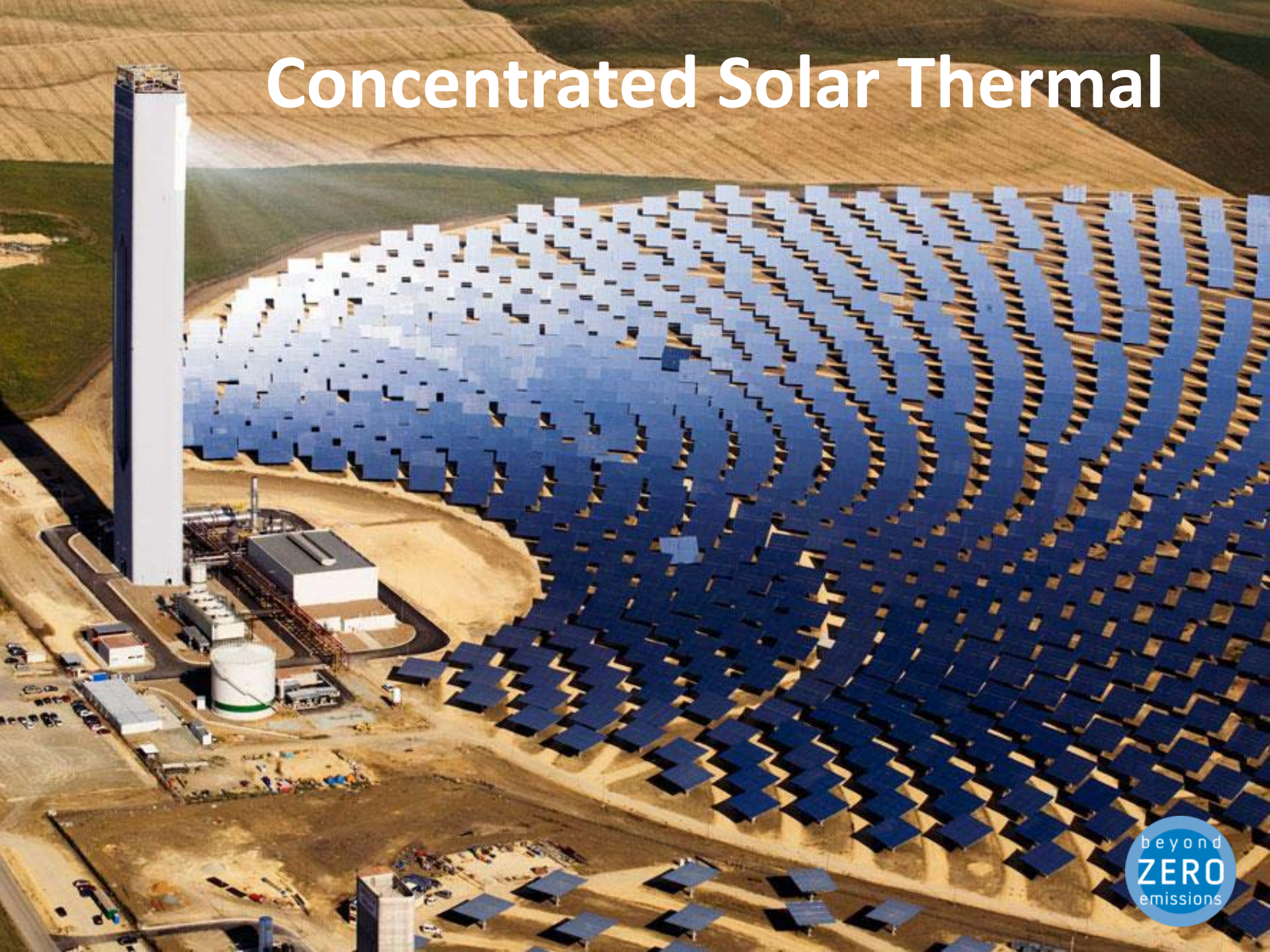




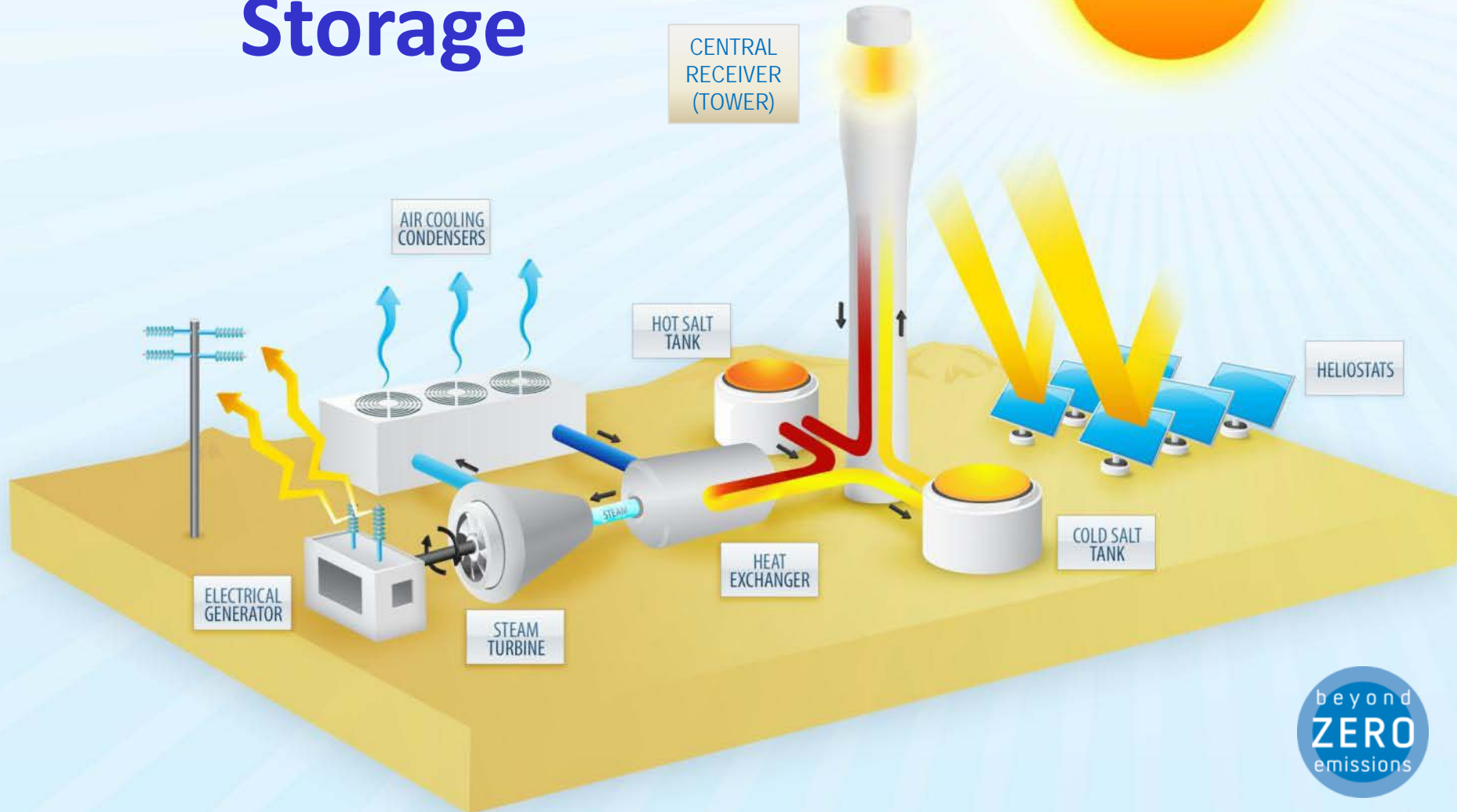
Traditional Power Generation



Concentrated Solar Thermal



Concentrated Solar Thermal with Storage



Heliostat



Torresol Gemasolar in full operation



Heliostat Field









Solid
salt



Hot & Cold Tanks
exterior view

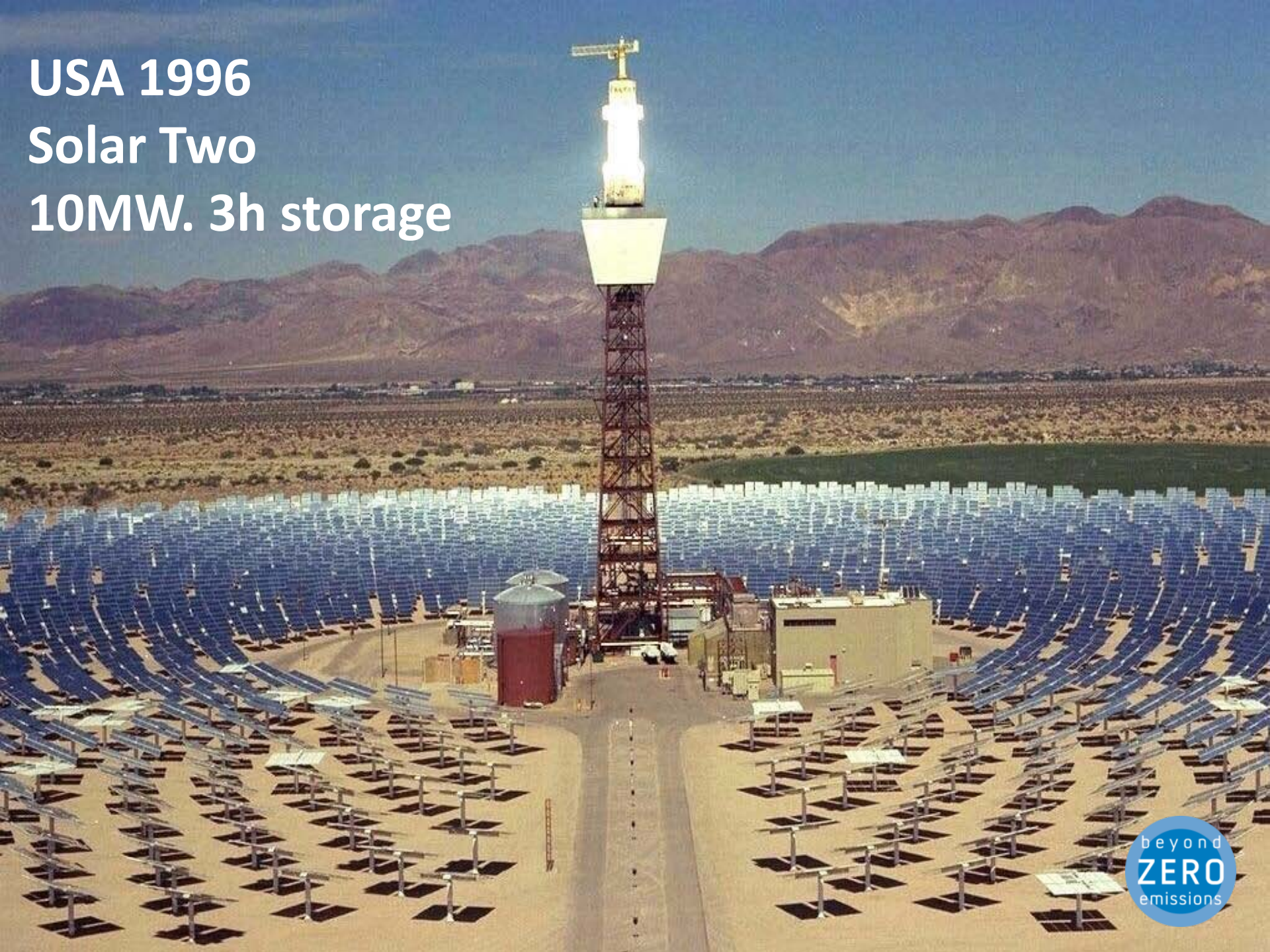


**Thermal
Storage**

Interior of
tank under
construction



USA 1996
Solar Two
10MW. 3h storage



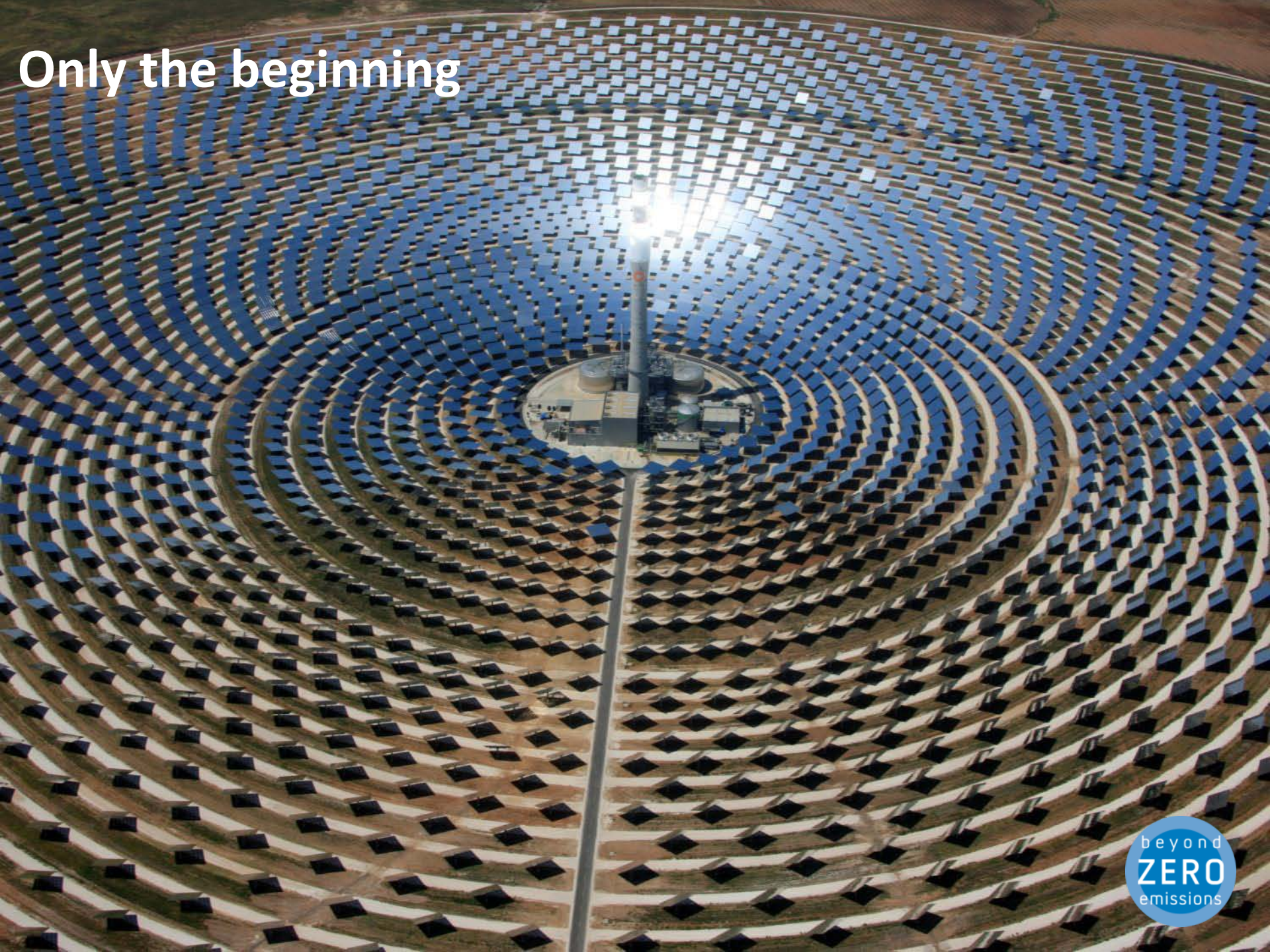
Spain 2011

Torresol Gemasolar

20MW. 15h storage



Only the beginning



USA - Nevada 2013
Solar Reserve Tonopah
110MW
25-40%
saving



©SolarReserve

15. 12. 2011



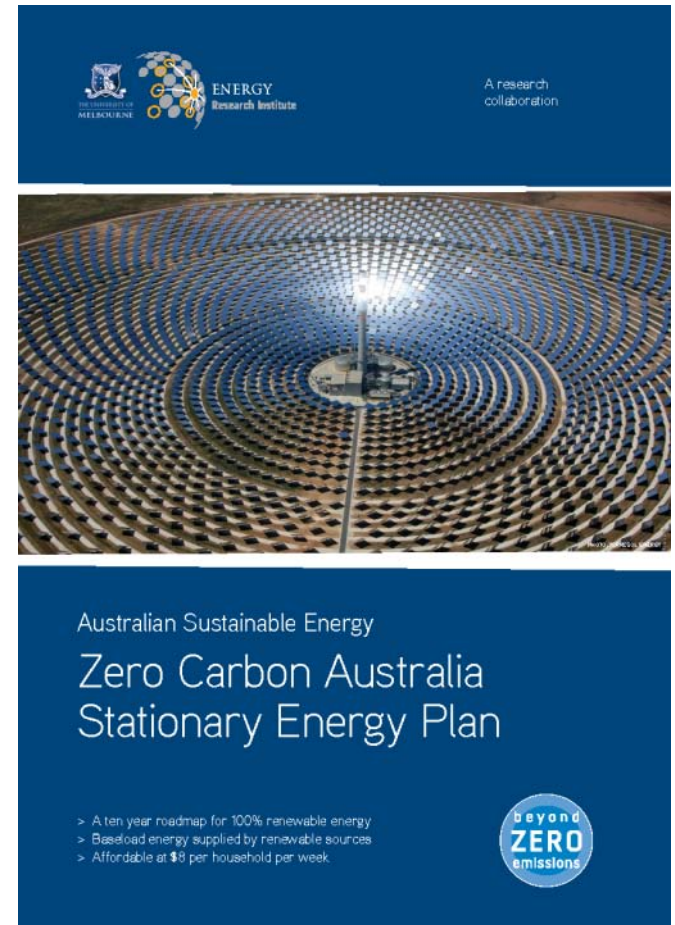
World Wind Power growth

- Global investment increased 30% p.a. in last decade
- China 150,000 MW by 2020
- Denmark 50% by 2025
 - 20% in 2010
- Sweden 1100 Enercon Turbine Farm



Major Questions

- Need ✓
 - Technology? - **Part Three & Five**
 - Reliability?
 - Resources?
 - Jobs?
 - Economics?
-
- Social and Political Will?
 - What can I do?



100% Renewable Energy for Australia - three main components



**Concentrated solar
thermal power**



Wind power



**Upgraded
electricity grid**

Zero Carbon Australia Total Electricity Energy Demand

- 325 TWh/year in 2020
(Up from 230 TWh/year in 2010)

- population growth
- energy efficiency
- electrified transport & heating

Ashmore and Cartier Islands

Gulf of Carpentaria

Coral Sea Islands

Queensland

Prairie

Longreach

Charleville

Roma

Moree

Bourke

South Australia

Port Augusta

Broken Hill

Dubbo

New South Wales

Mildura

Victoria

Canberra

220MW

$\times 17 = 1$

3700MW

Solar region



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

Carnarvon

Kalgoorlie

Repower Port Augusta

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Port Augusta looks to new power source

Posted October 28, 2011 21:40:00

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Featured Video

Ashmore and Cartier Islands

Gulf of Carpentaria

Artherton

Georgetown

Coral Sea Islands

Colinsville

7.5MW
Enercon
E-126
Turbine

$\times 330 = 1$
2500MW
Wind region

Geraldton

Stanthorpe

Walcha

Ceduna South Australia

Silverton

Streaky Bay

Port Augusta

Yongala

Orange

New South Wales

Crookwell

Canberra

Victoria

Cooma

Ballarat

Western Victoria

Wonthaggi

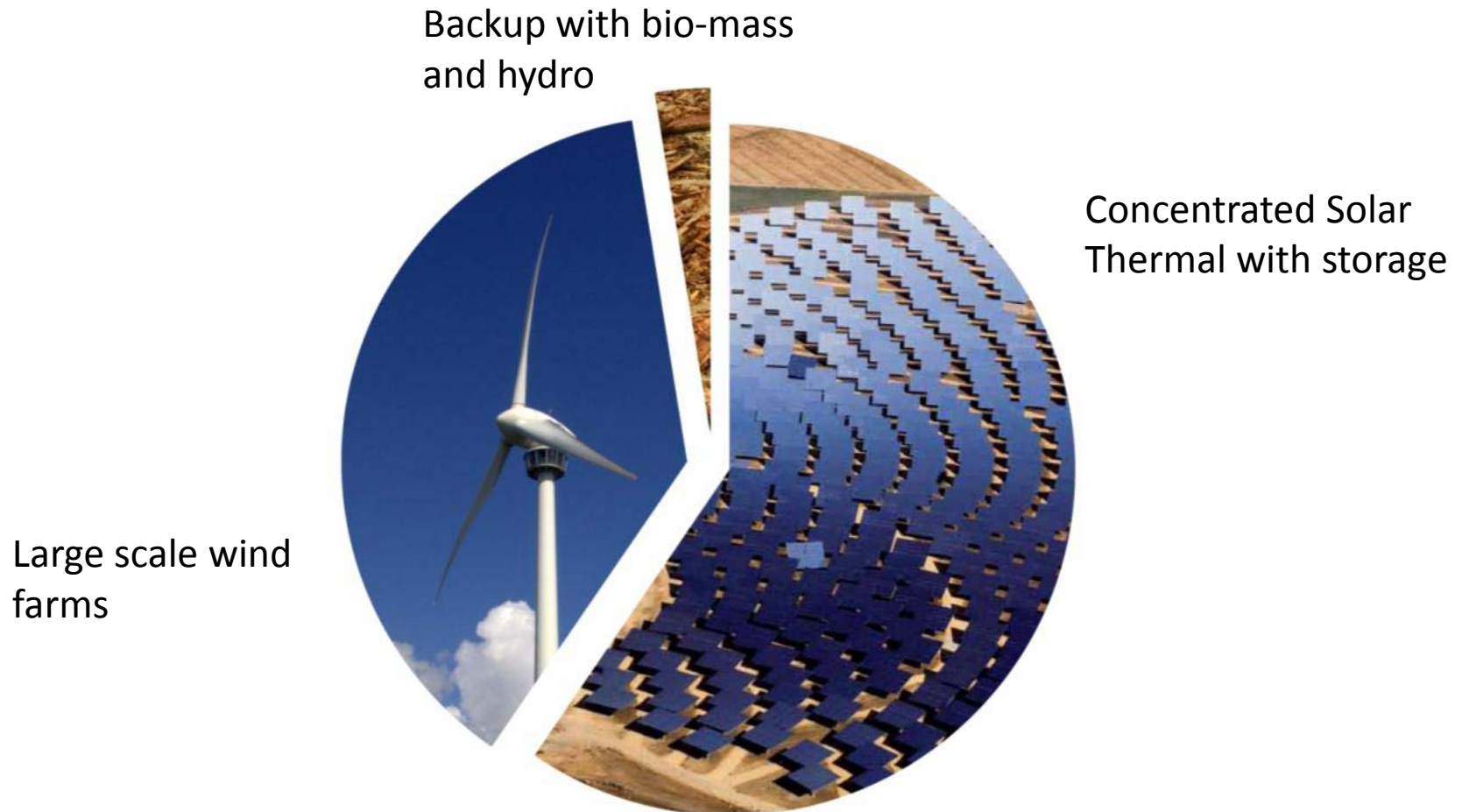
Bunbury

Albany

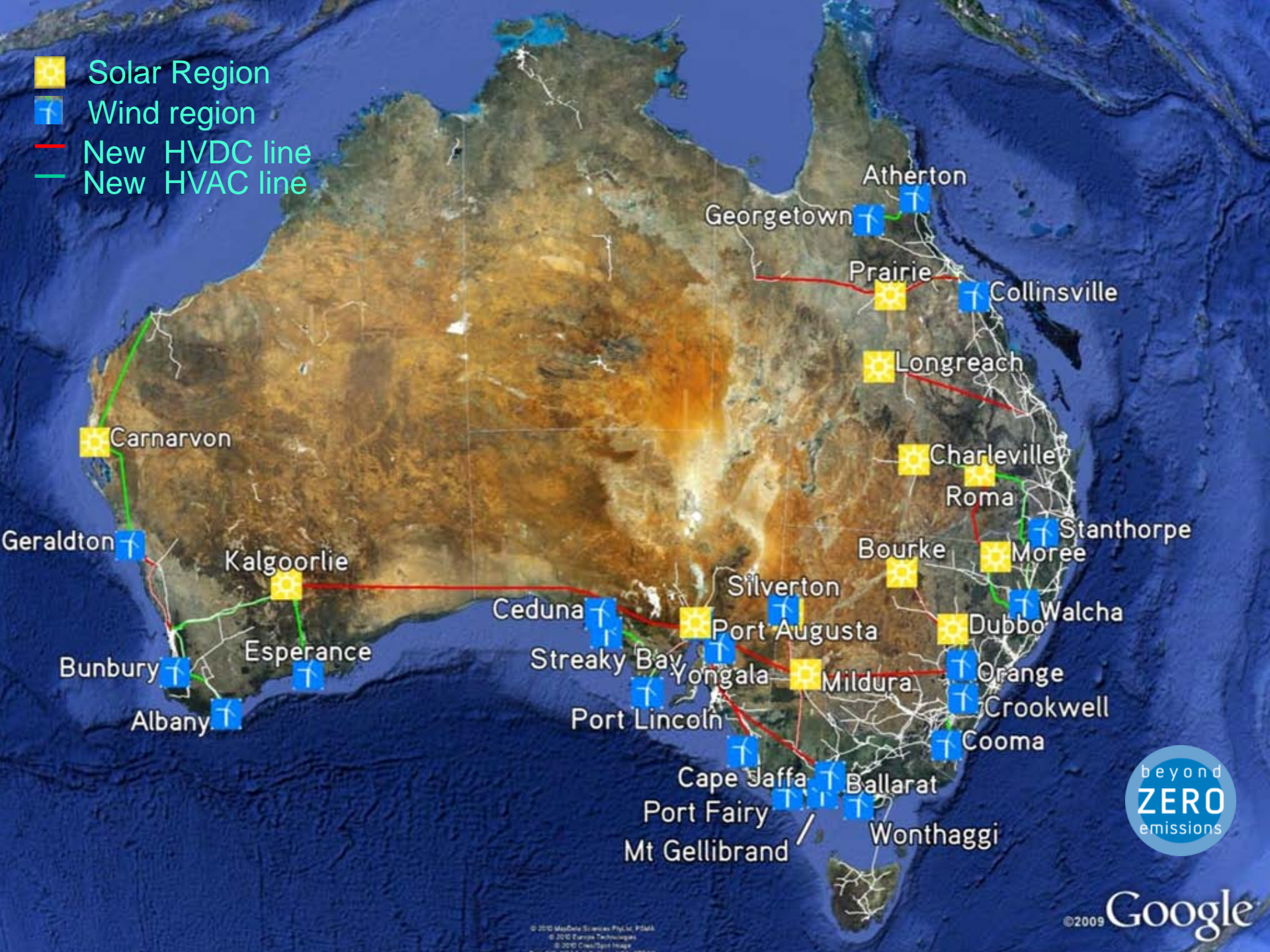
$\times 23 = 40\%$ of Australia's
Stationary Energy delivered by
Wind

Great Australian Bight

100% Renewable Stationary Energy

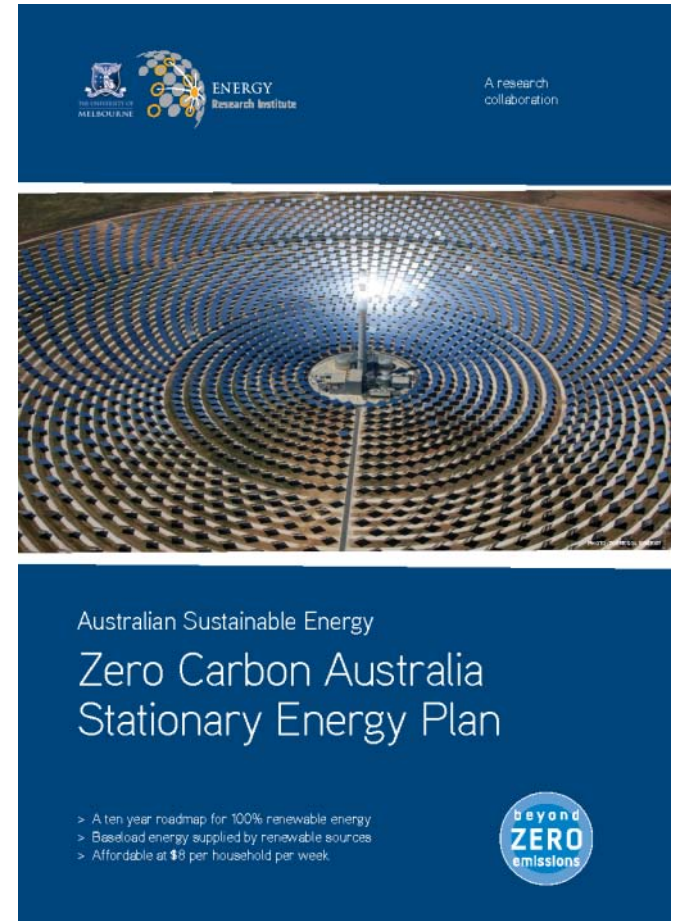


-  Solar Region
-  Wind region
-  New HVDC line
-  New HVAC line

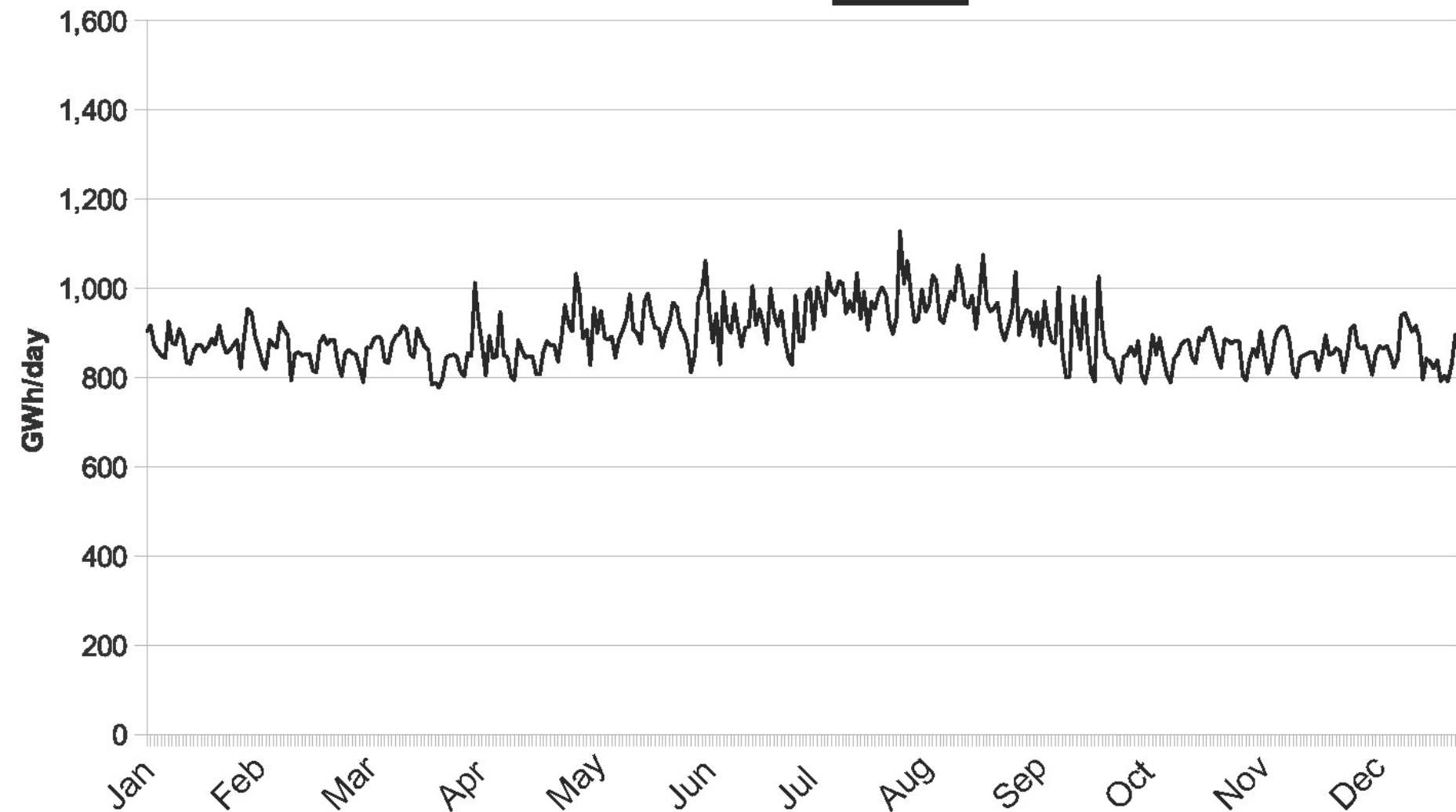


Major Questions

- Need ✓
 - Technology ✓
 - Reliability? - **Part Four**
 - Resources?
 - Jobs?
 - Economics?
-
- Social and Political Will?
 - What can I do?



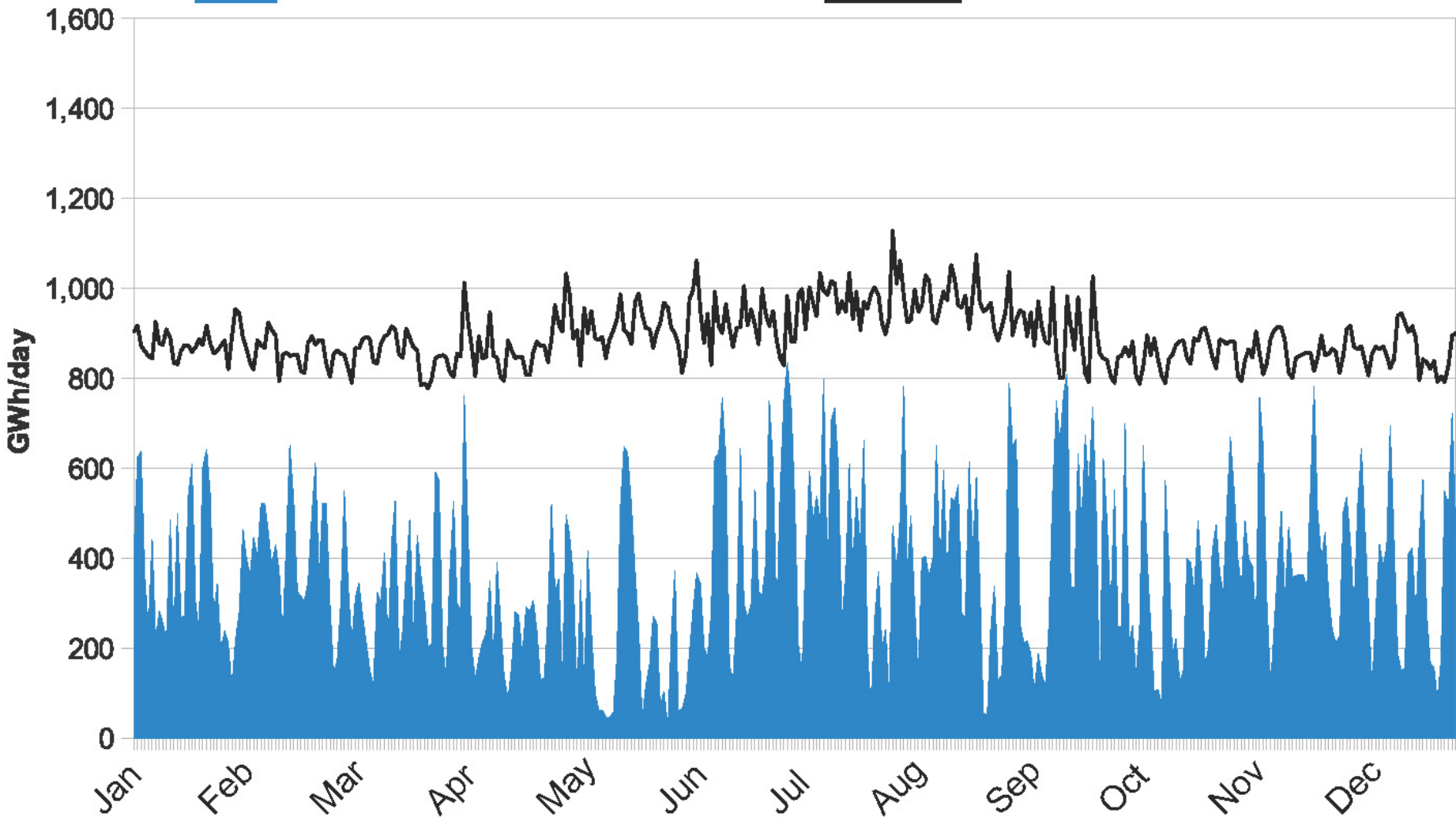
Demand



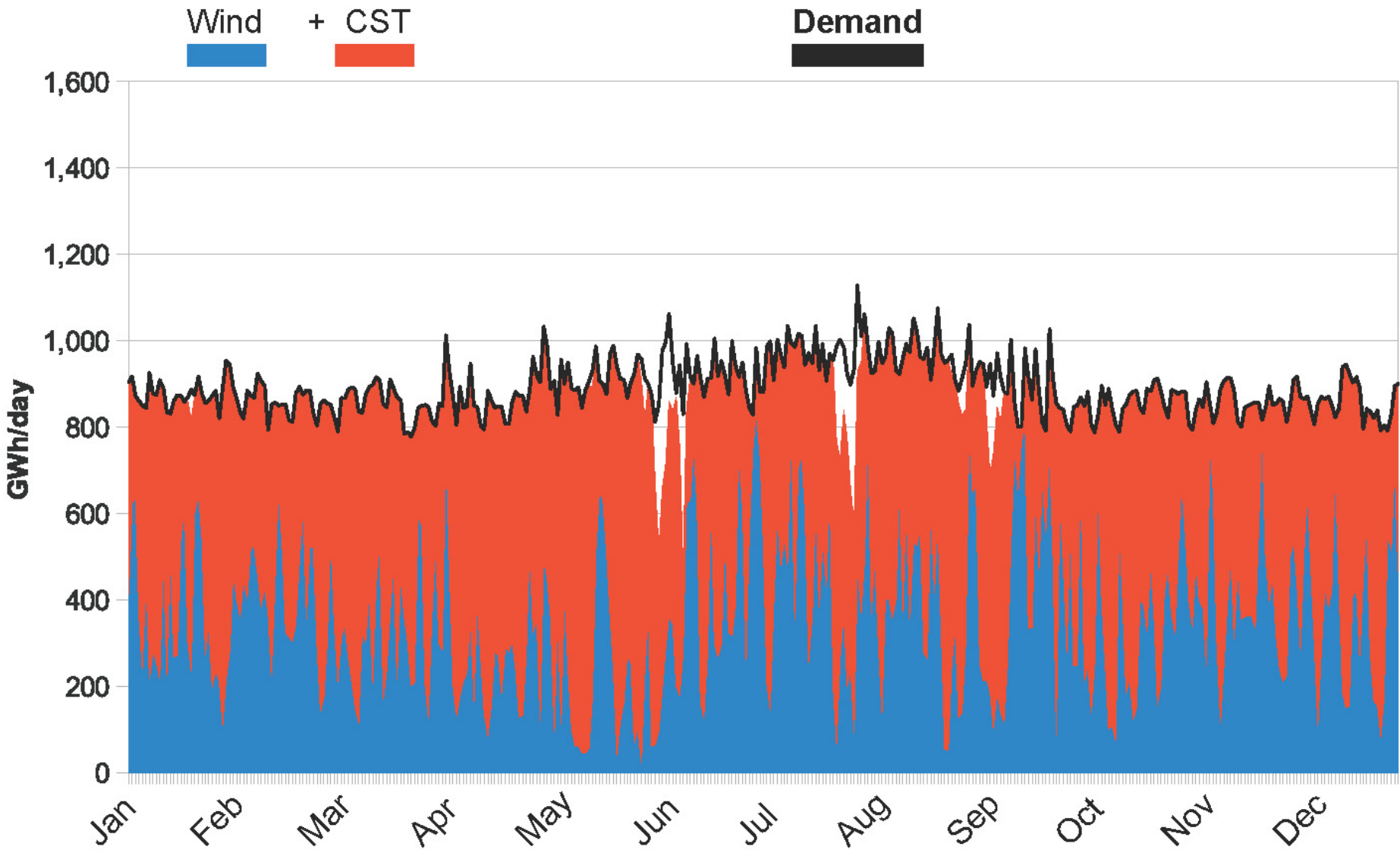
2008 Grid Model Results

Wind

Demand

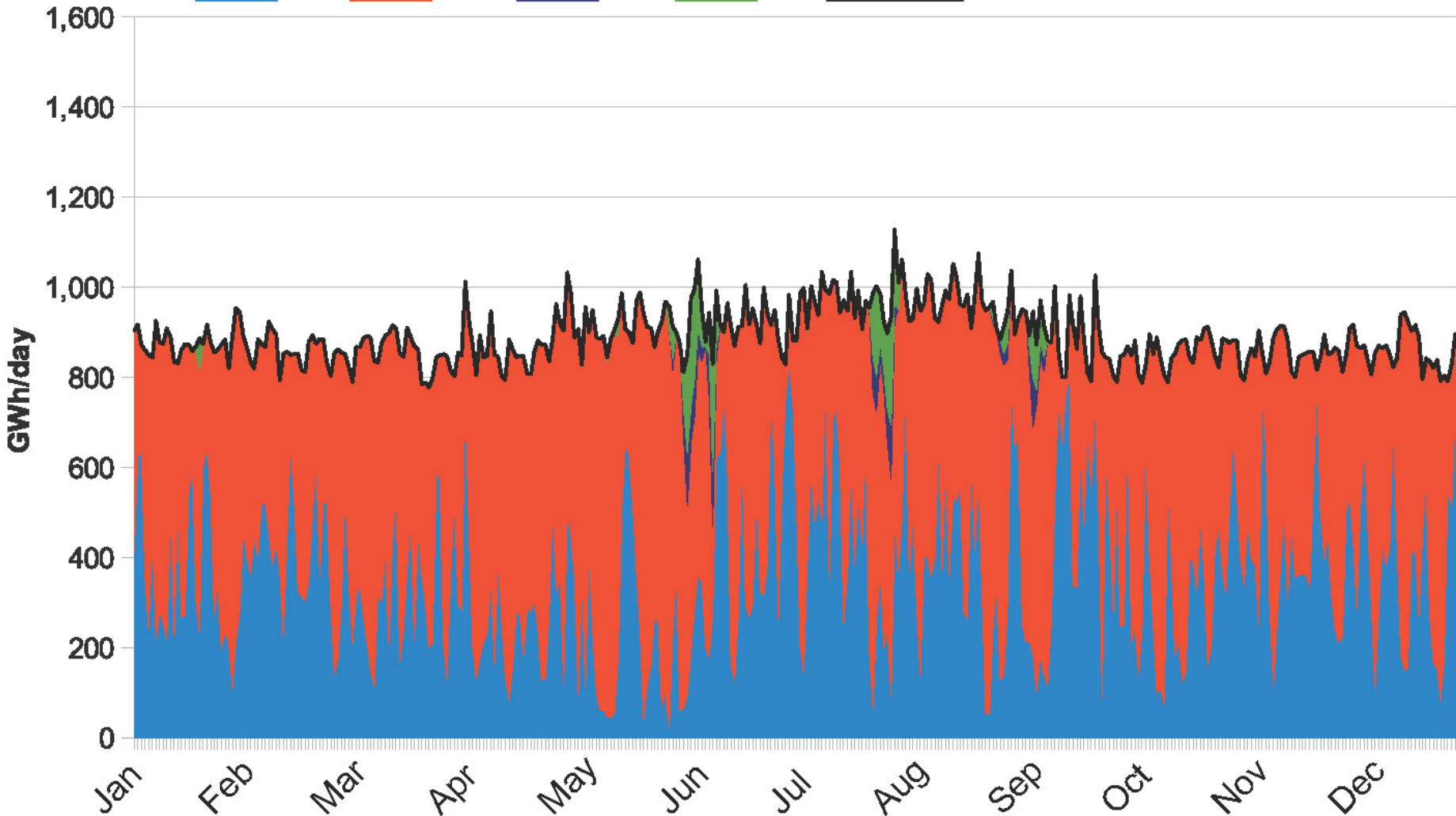
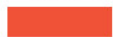


2008 Grid Model Results



2008 Grid Model Results

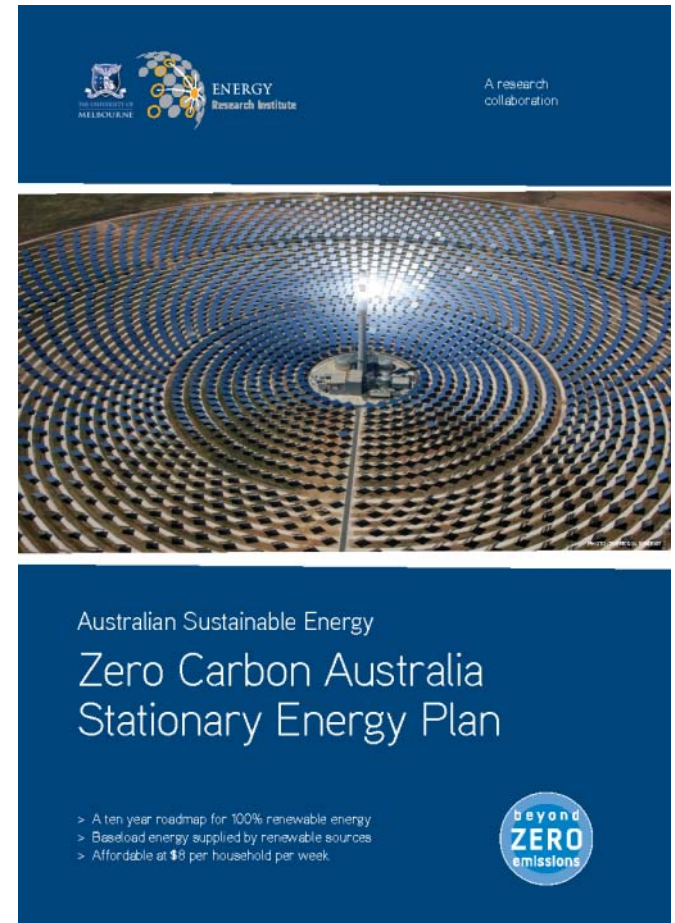
Wind + CST + Hydro + Bio = Demand



2008 Grid Model Results

Major Questions

- Need ✓
 - Technology ✓
 - Reliability ✓
 - Resources? }
 - Jobs? } **Part Six**
 - Economics? }
-
- Social and Political Will?
 - What can I do?



Getting the job done in 10 years



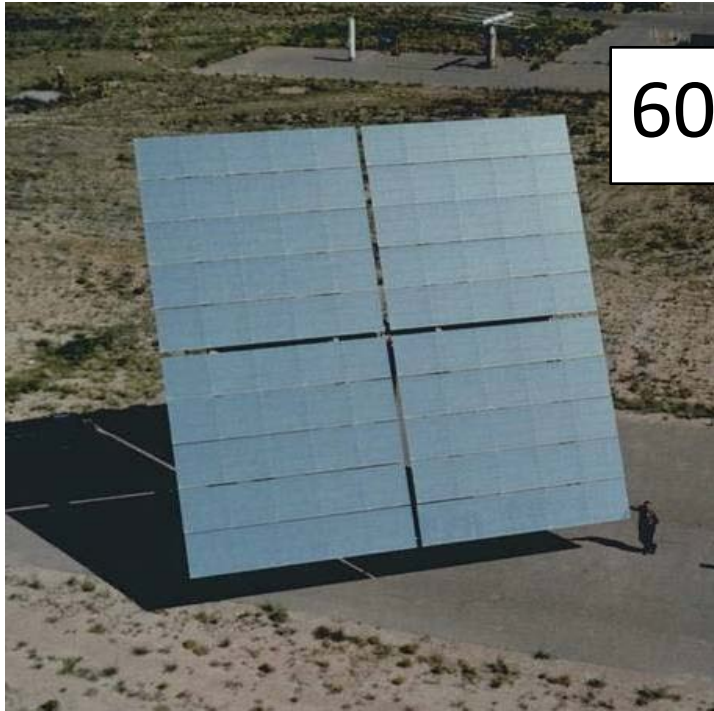
Manufacturing



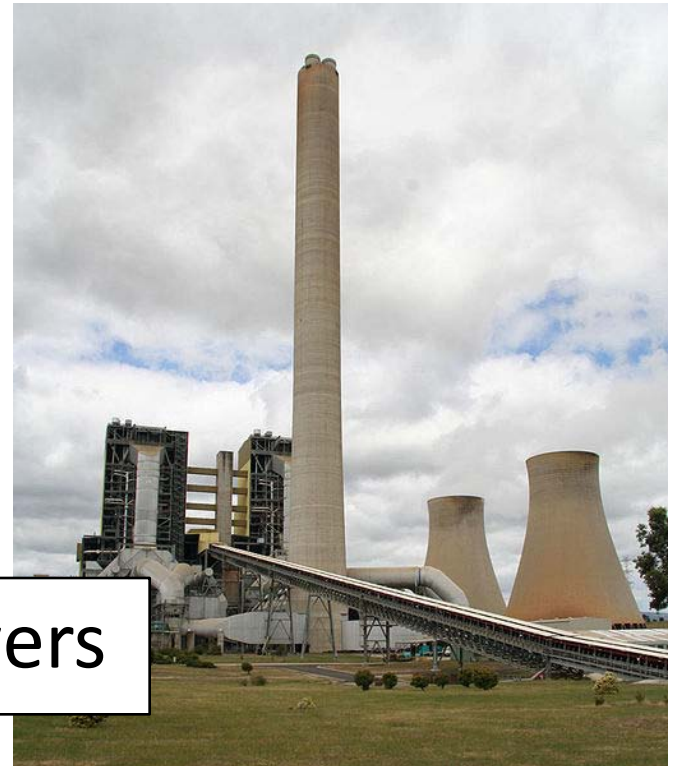
Construction



Peak Concentrated Solar 'roll-out'



600,000 Heliostats




30 concrete towers

Enercon Viana Do Costelo Wind Turbine blade and tower factories Portugal

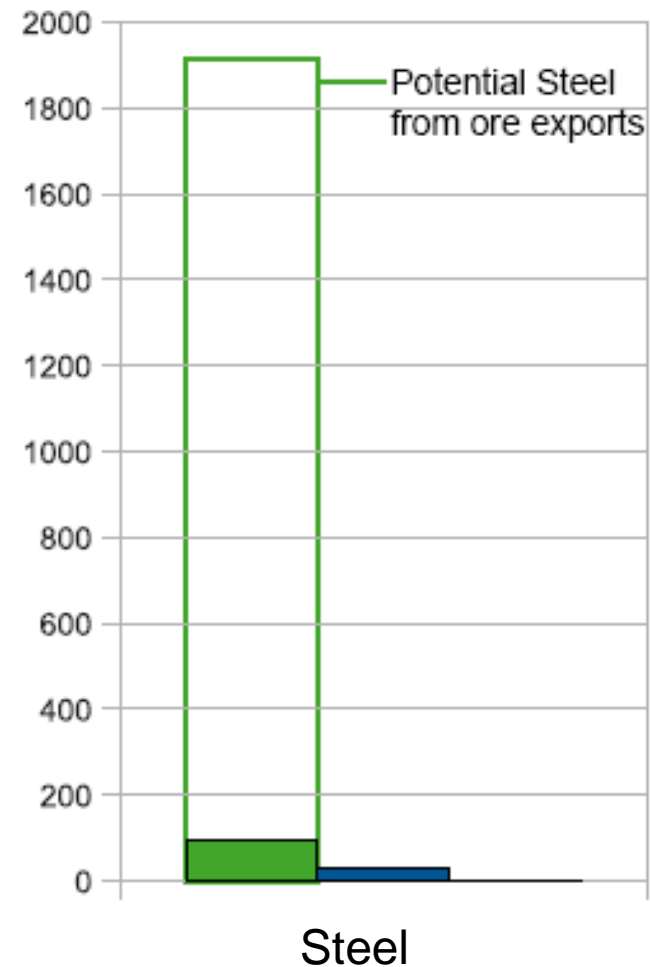
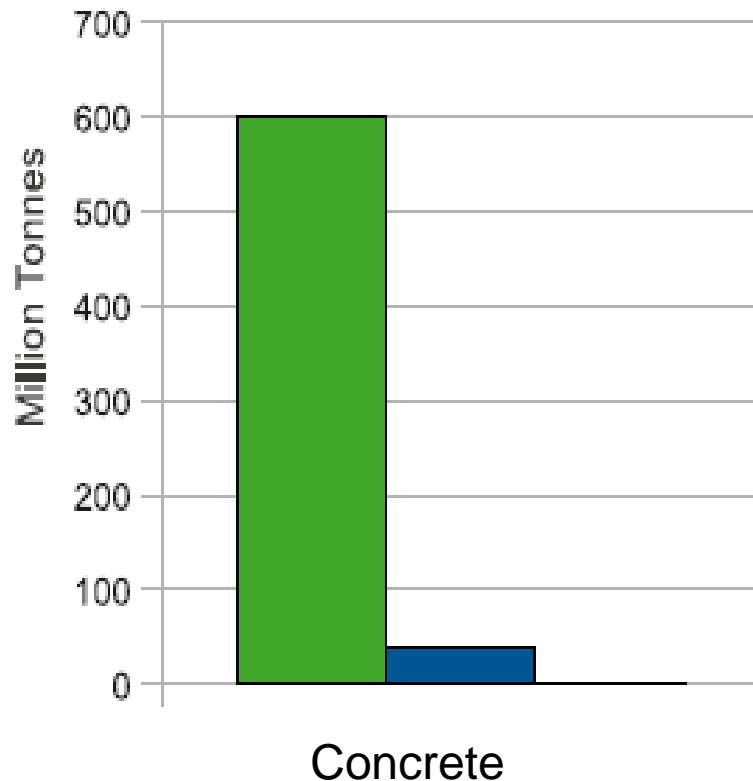
250 towers per year 400 Jobs



ZCA 10 year Resource Requirements

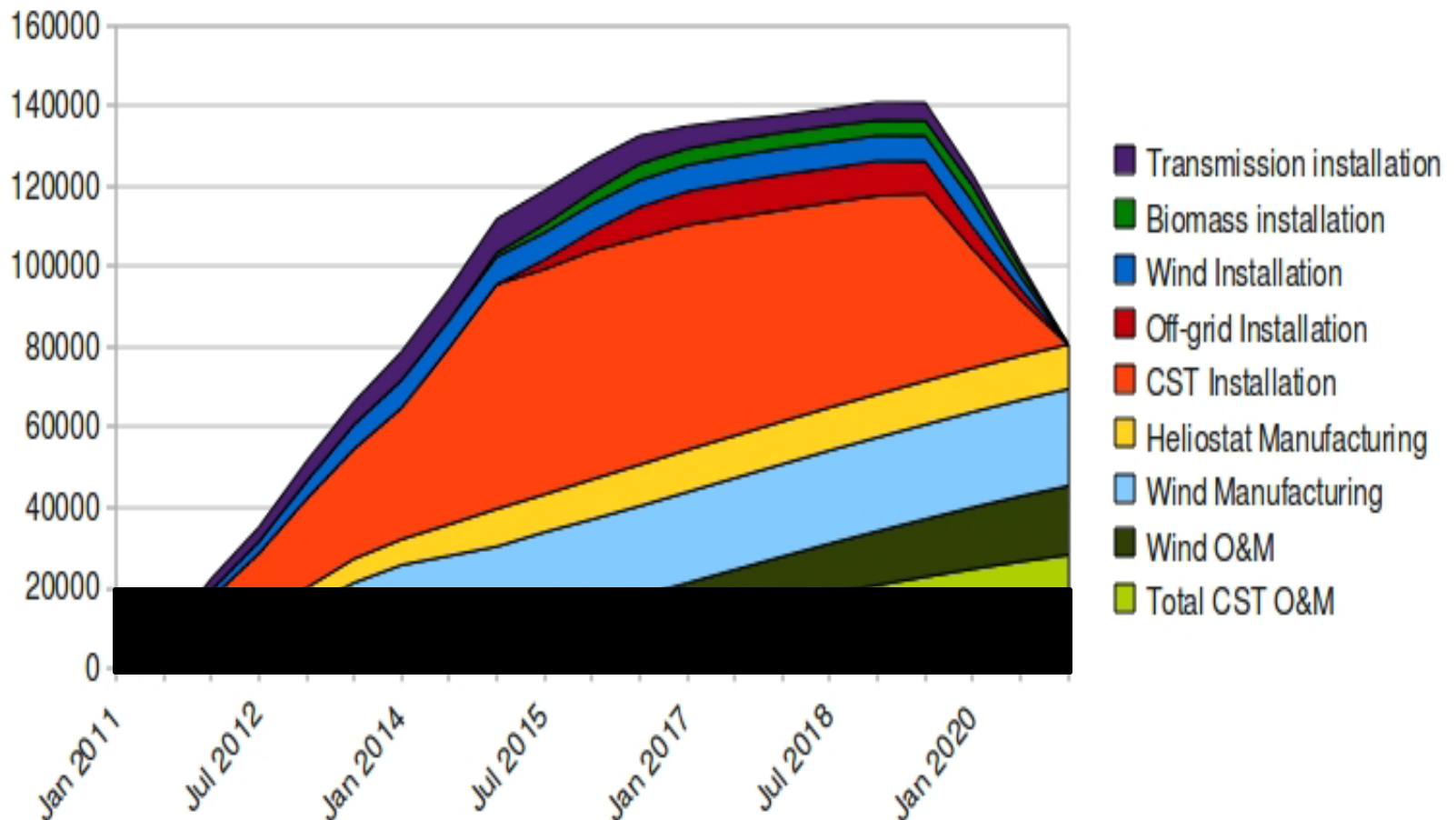
 Australia 10 year production

 ZCA

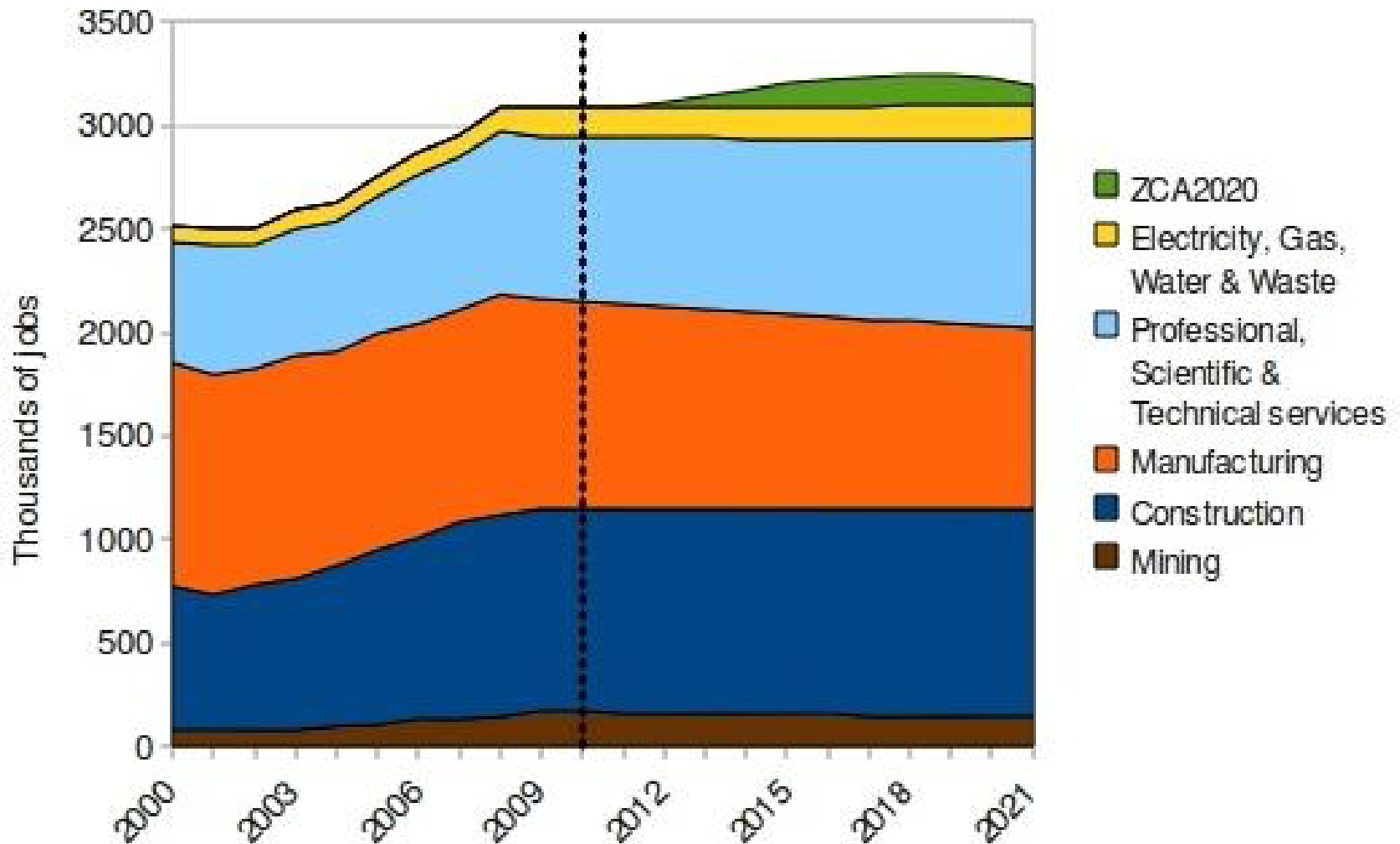


Labour Requirements

Total Installation Jobs for ZCA2020 electrical generation

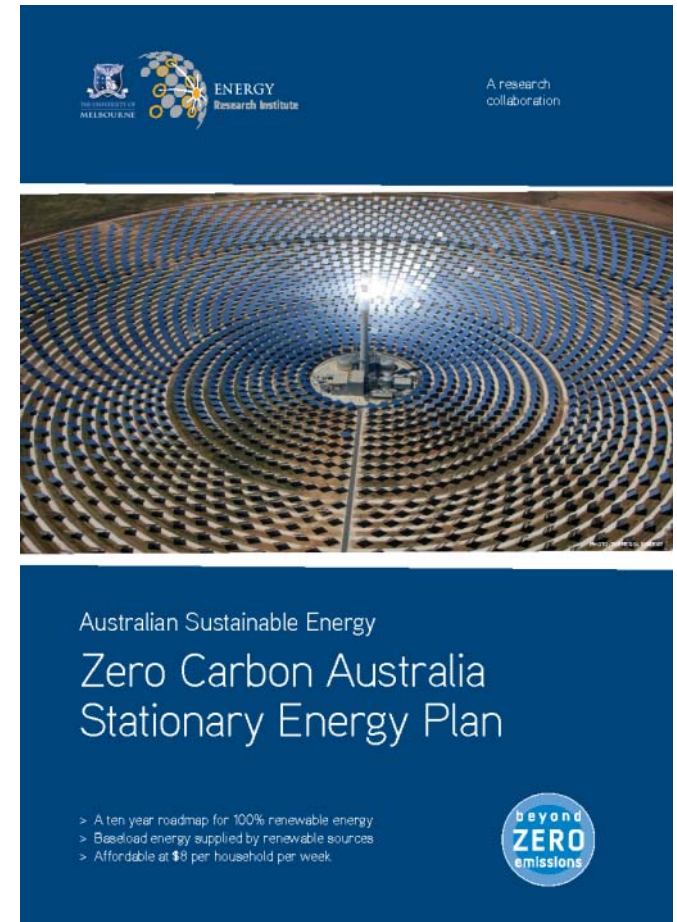


Achievability – Jobs in context

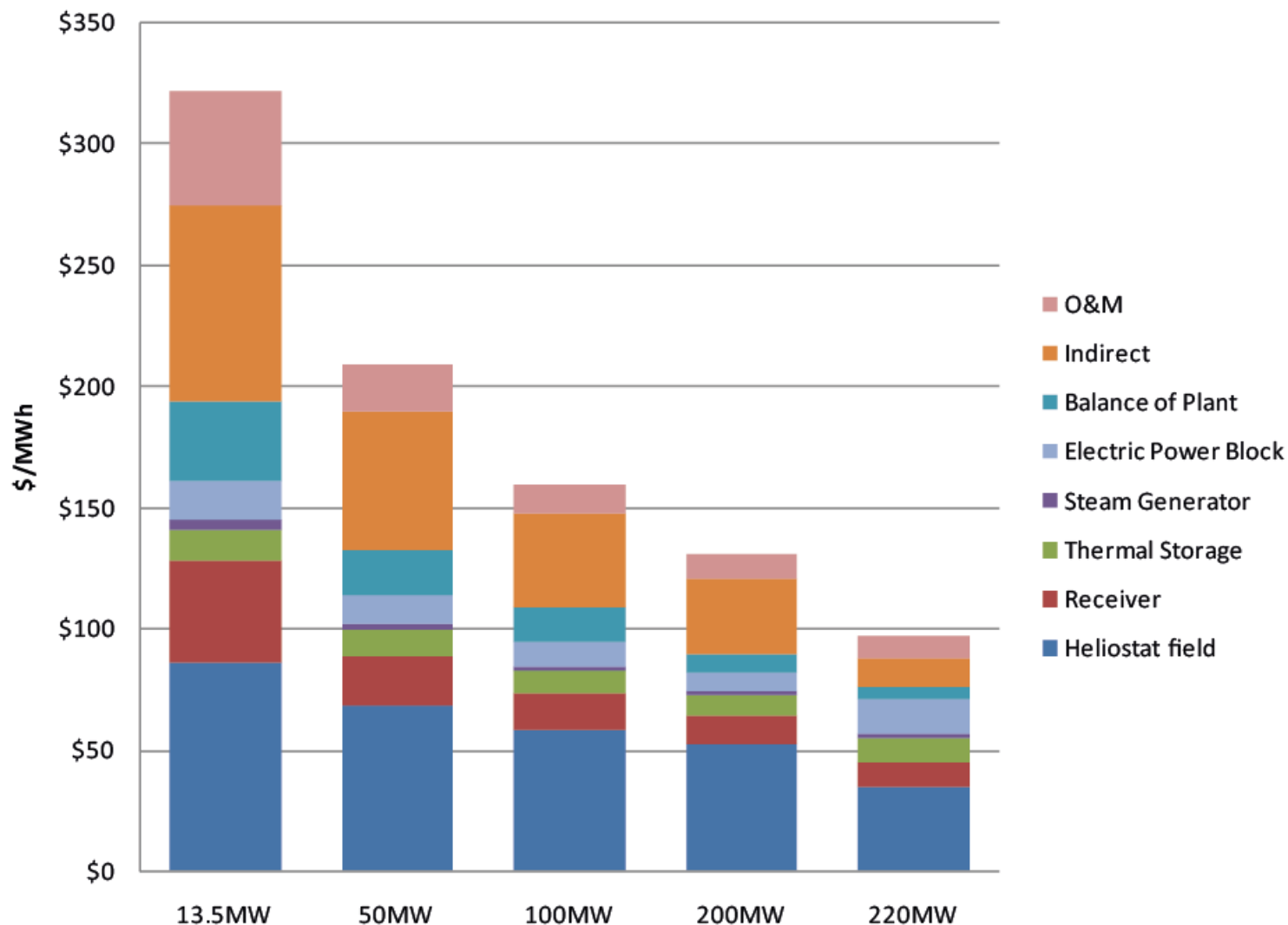


Major Questions

- Need ✓
 - Technology ✓
 - Reliability ✓
 - Resources ✓
 - Jobs ✓
 - Economics? - **Part Seven**
-
- Social and Political Will?
 - What can I do?



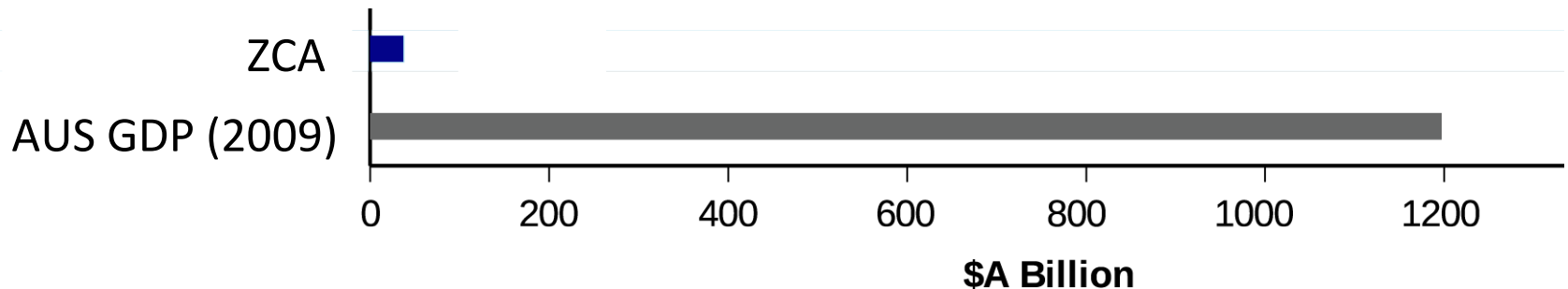
Solar Thermal Cost Reduction



Investment: 3% of GDP for 10 years

Component	\$AU,Bn
CST	\$175
Backup Heaters	\$8
Bioenergy supply	\$6
Wind	\$72
Transmission	\$92
TOTAL	\$353
Off-grid CST + Backup	\$17
TOTAL + Offgrid	\$370

ZCA per year and Australia's GDP

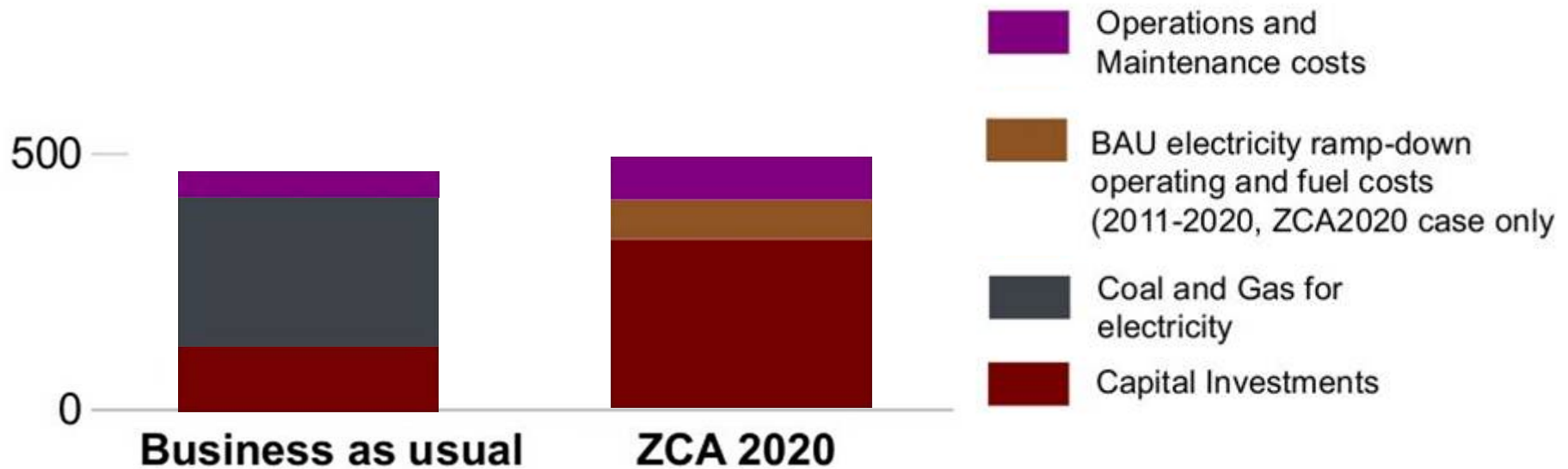


- ZCA – \$37Bn for 10 years
- Australian Gambling 2009 – \$20Bn
- Australian Insurance 2009 – \$23Bn

Economic Cost

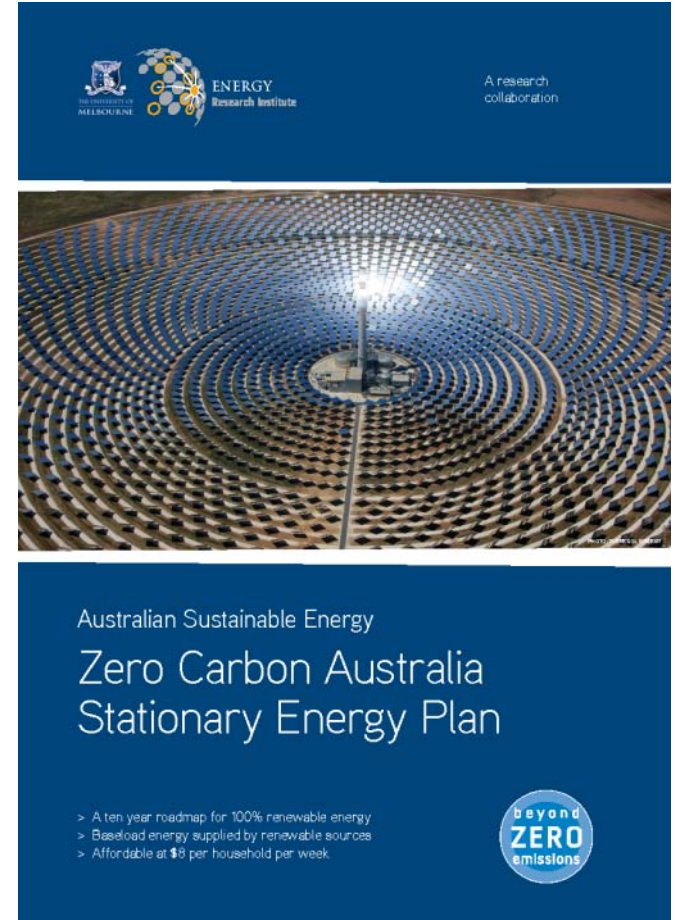
325TWh/yr electricity

Net present value 2010-2040
(real 2010 AUS\$ Billion, 1.4%)



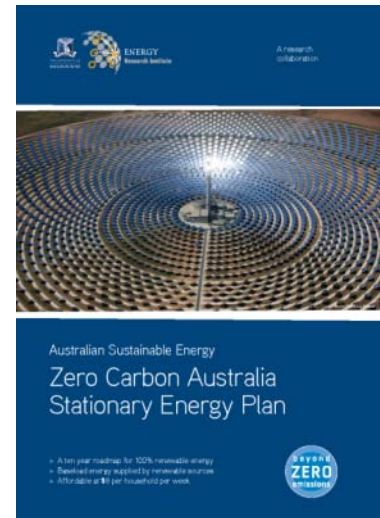
Major Questions

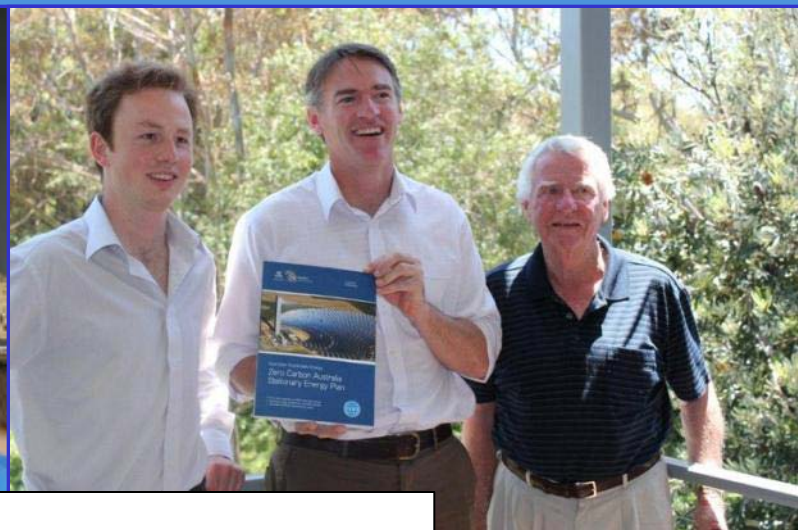
- Need ✓
 - Technology ✓
 - Reliability ✓
 - Resources ✓
 - Jobs ✓
 - Economics ✓
-
- Social and Political Will?
 - What can I do?



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





Social & Political Will?

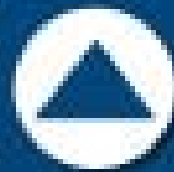


An aerial photograph of a solar tower (CSP) system. The central receiver tower is surrounded by thousands of heliostats (mirrors) arranged in concentric circular patterns, reflecting sunlight onto the tower. The heliostats are blue and silver, creating a dense, textured field.

What can I do?

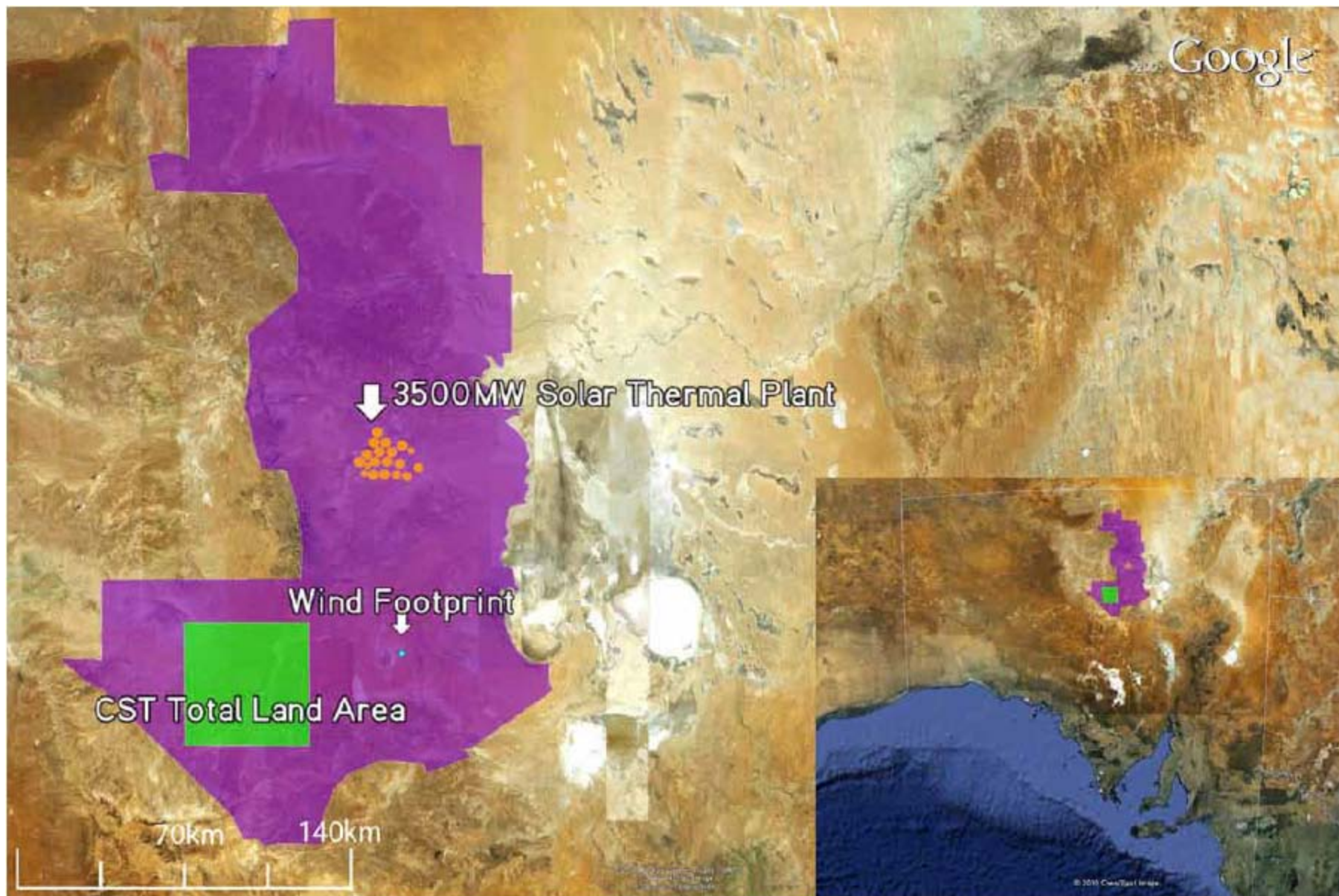


Donate

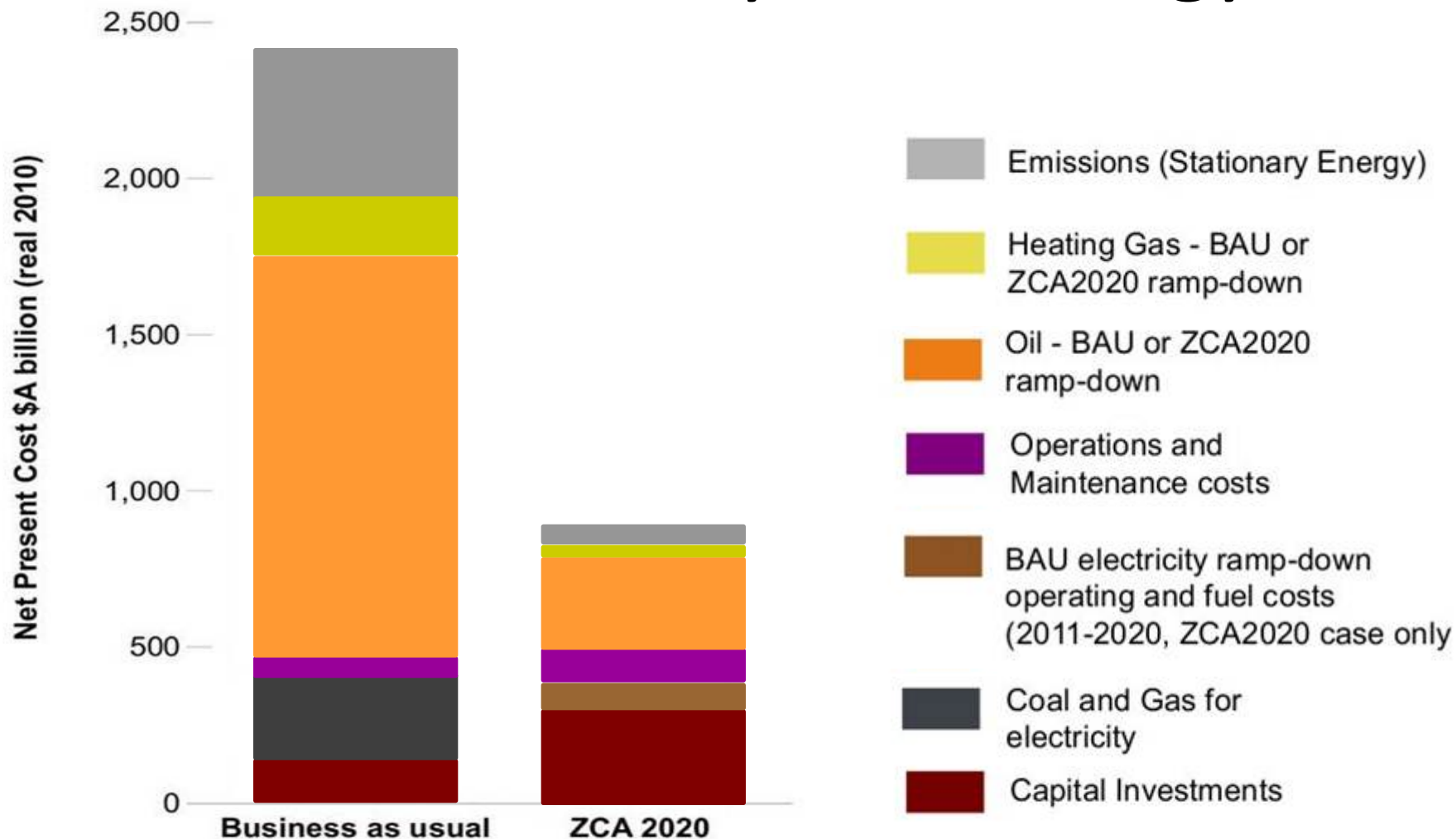


Contribute

beyond
ZERO
emissions



Cost to Economy – all energy



What about solar photovoltaic (PV) panels?

Germany – currently 20 GW / 82 million people

What if Australia had 5 GW (~22 million people)?

Detailed market modelling shows it would significantly reduce daytime electricity prices - \$625 million in 2010

