Zero Carbon Australia Stationary Energy Plan

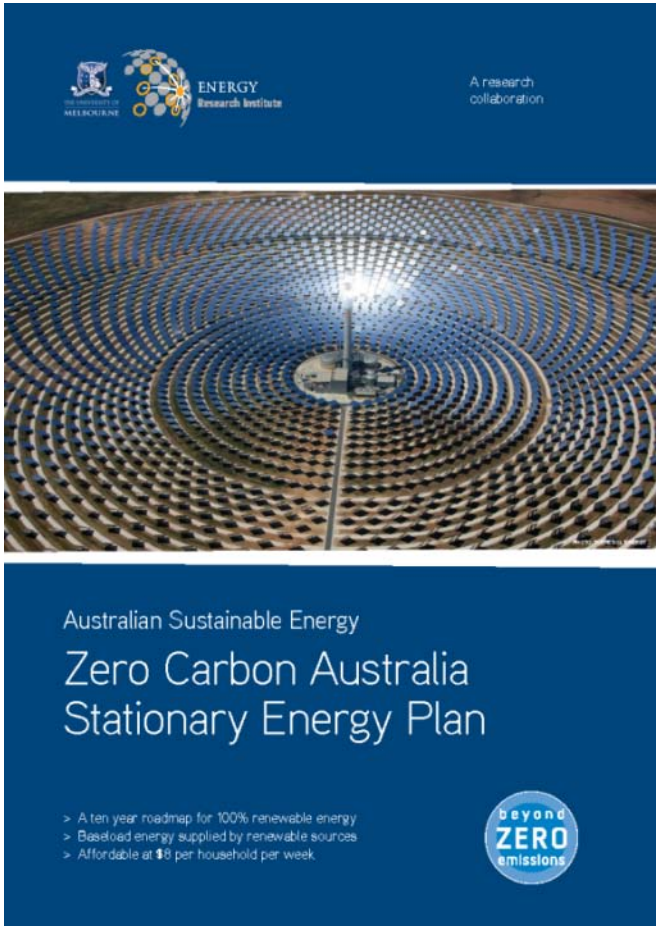
A plan to repower Australia with 100% renewable energy in 10 years

beyond ZERO emissions

Major questions

- Need?
- Technology?
- Reliability?
- Resources?
- Jobs?
- Economics?

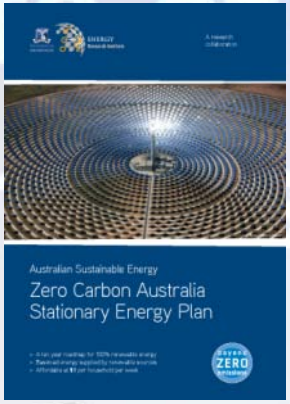
- Social and Political Will?
- What can I do?



Science based - Solutions focused

(BZE)

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



Zero Carbon Australia Stationary Energy Plan Contributors

THE UNIVERSITY OF MELBOURNE

ENERGY Research Institute

beyond ZERO emissions

ExxonMobil

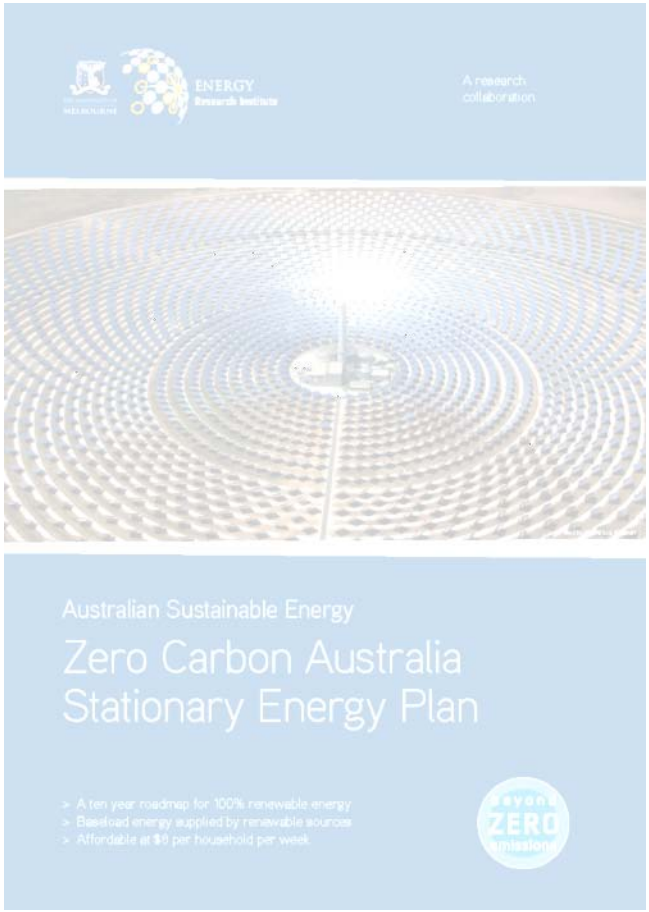
THE UNIVERSITY OF MELBOURNE
ENERGY Research Institute

beyond ZERO emissions

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

iea International Energy Agency

Peter Gration – former Chief of Defence

Robin Batterham,
Former Australian Chief Scientist

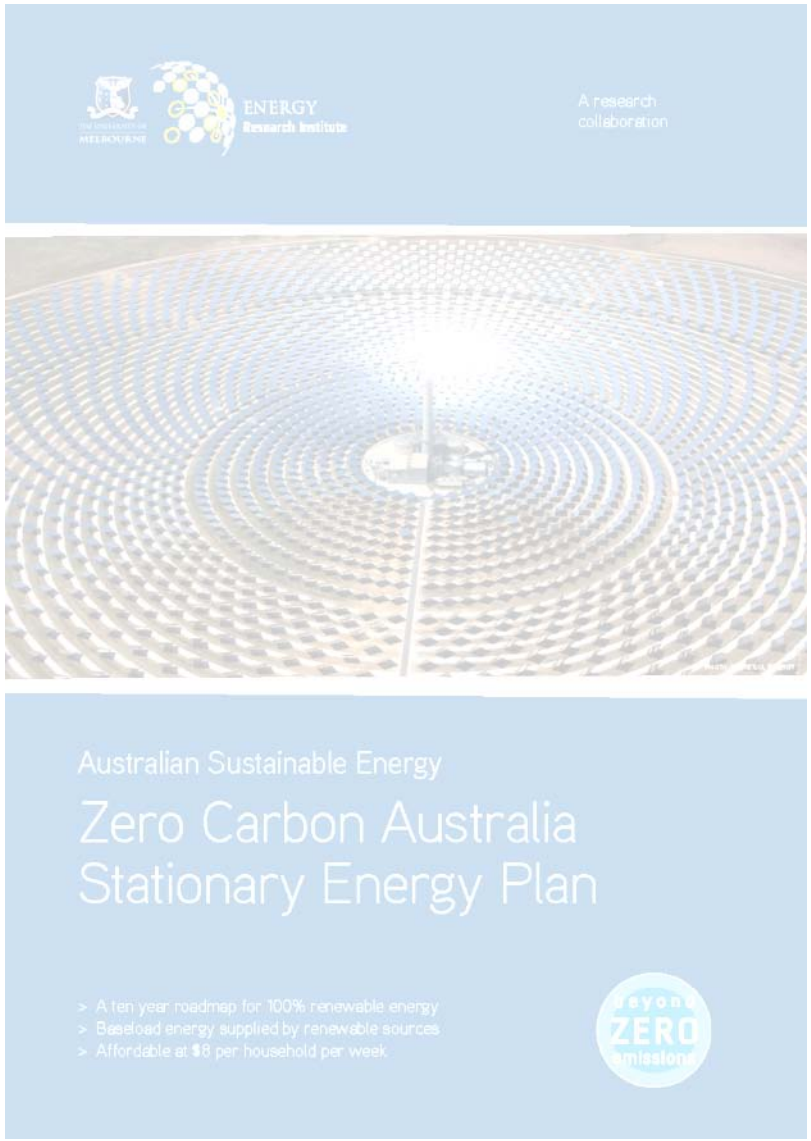
Ian Dunlop - Former Executive Director,
Australian Coal Association

Malcolm Turnbull MP


2
Buildings


3
Transport


4
Land Use


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

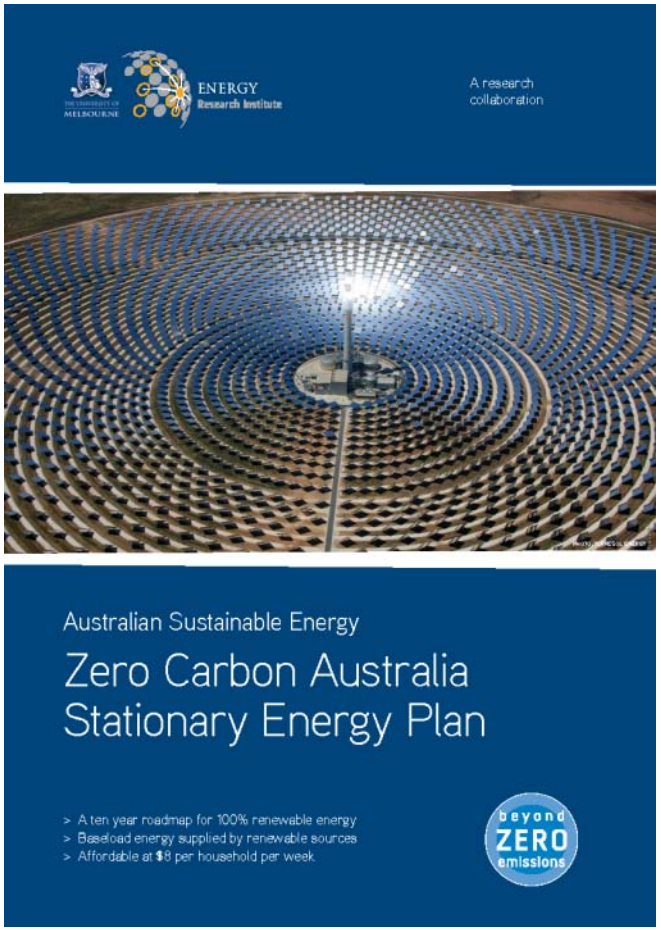

5
Industrial
Processes

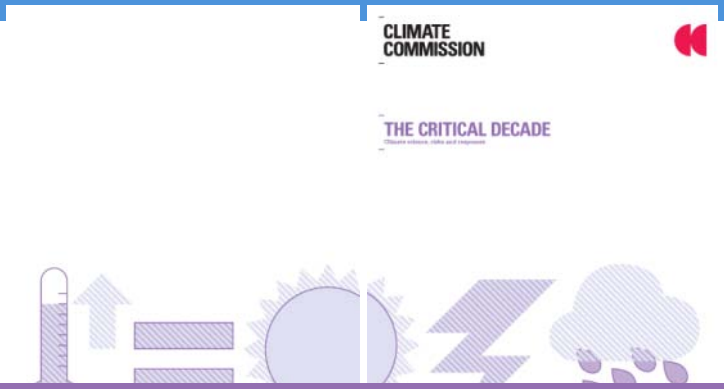

6
Renewable
Energy
Superpower

Major Questions

- Need? **- Part One**
- Technology?
- Reliability?
- Resources?
- Jobs?
- Economics?

- Social and Political Will?
- What can I do?

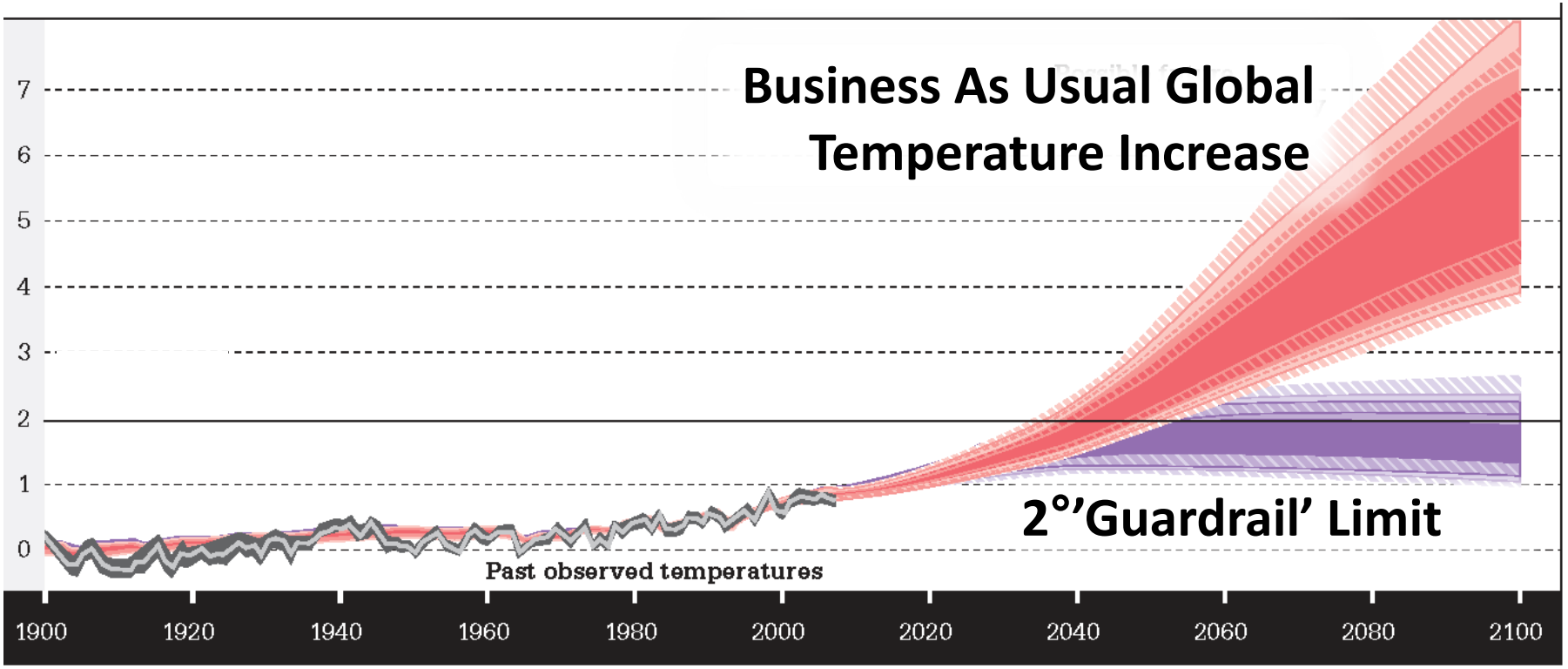




ONE TRILLION TONNES

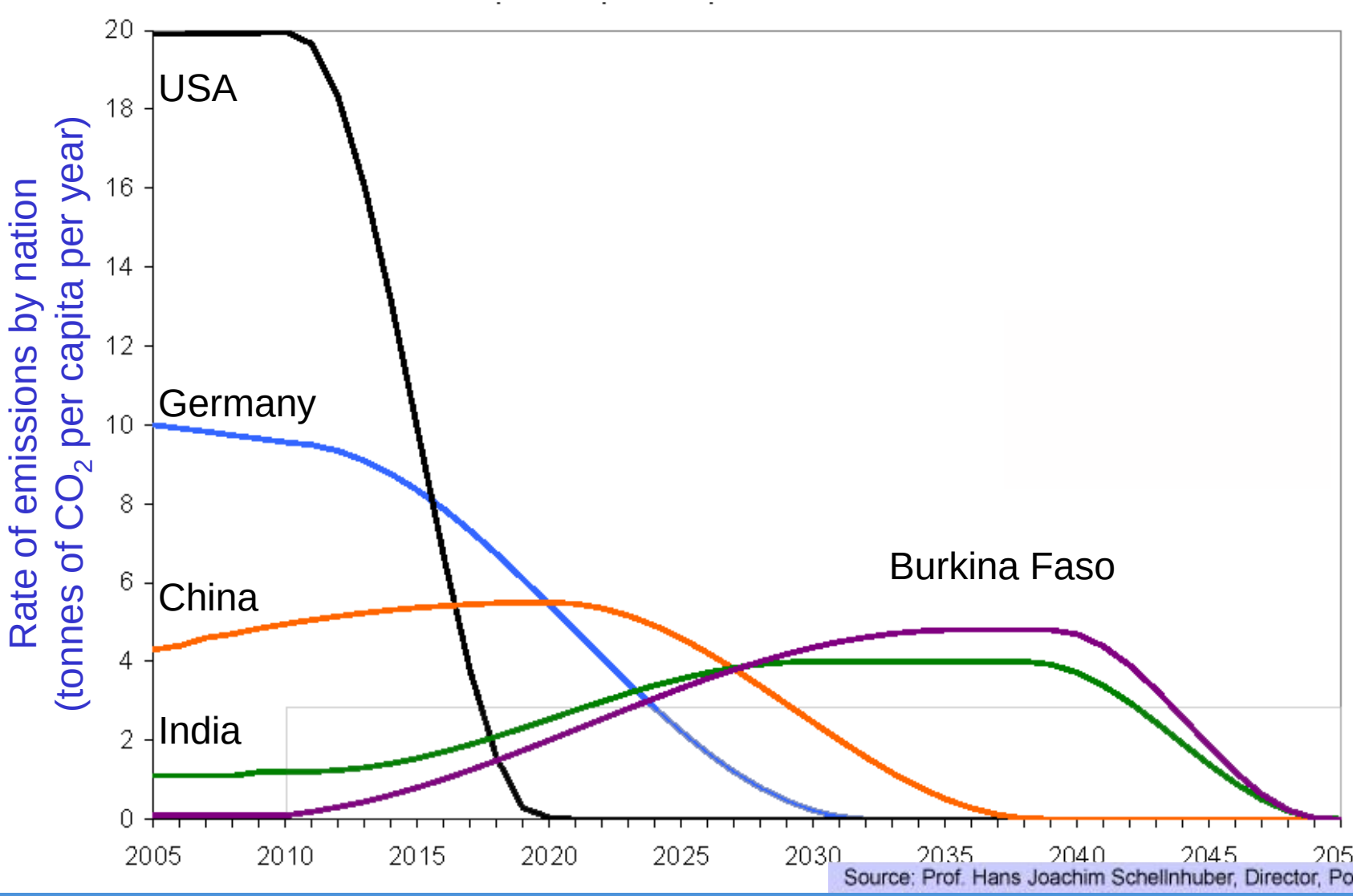
2000 CO_2 2050

HUMANITY CAN EMIT NOT MORE THAN 1 TRILLION TONNES OF CO_2 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

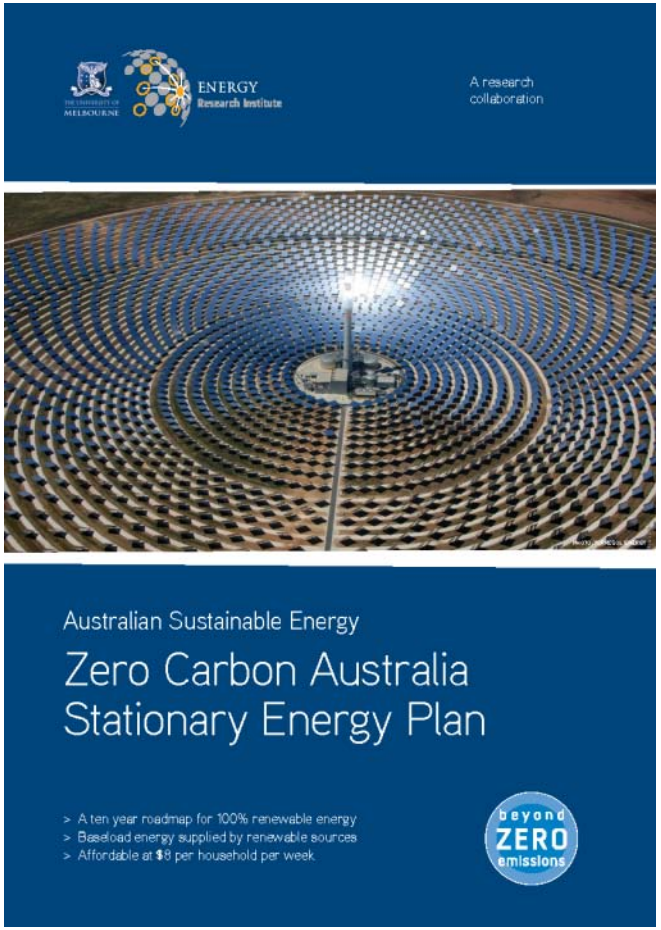


Source: Prof. Hans Joachim Schellnhuber, Director, Potsdam Institute

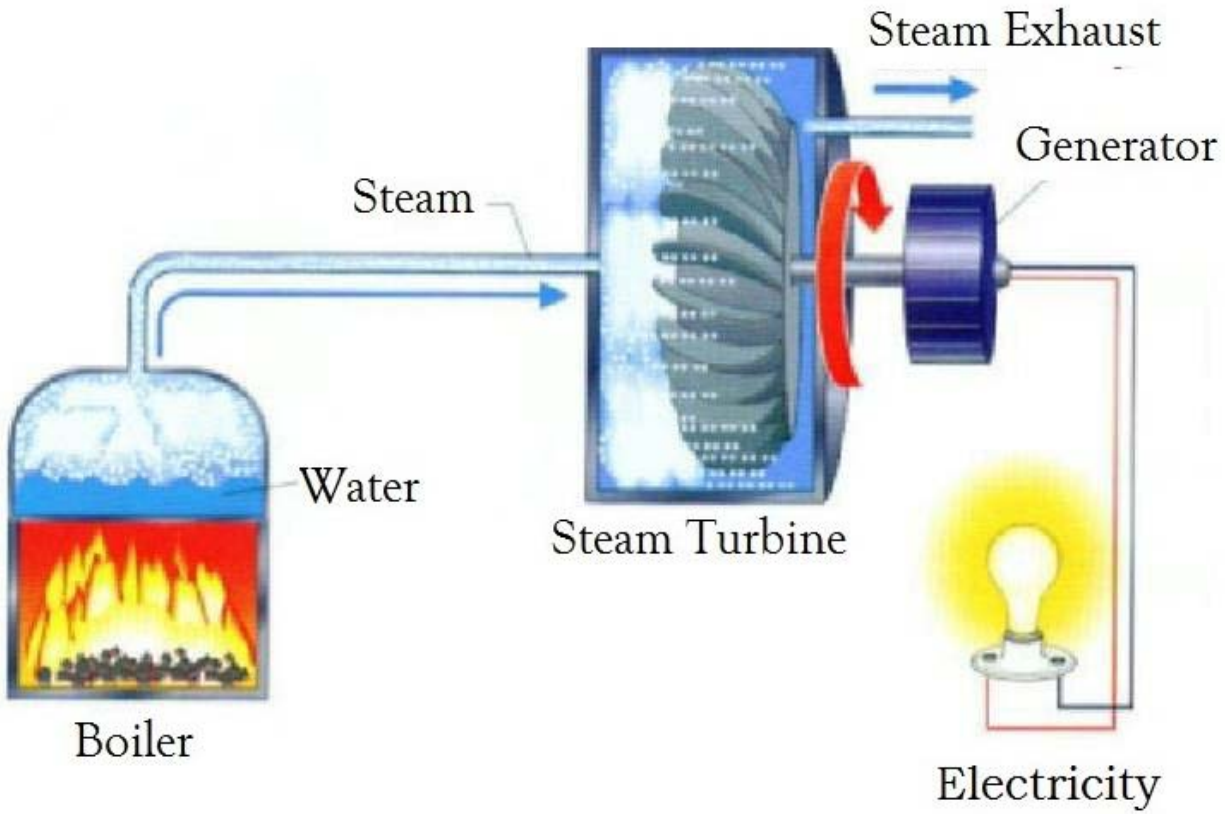
Major Questions

- Need ✓
- Technology? **- Part Two**
- Reliability?
- Resources?
- Jobs?
- Economics?

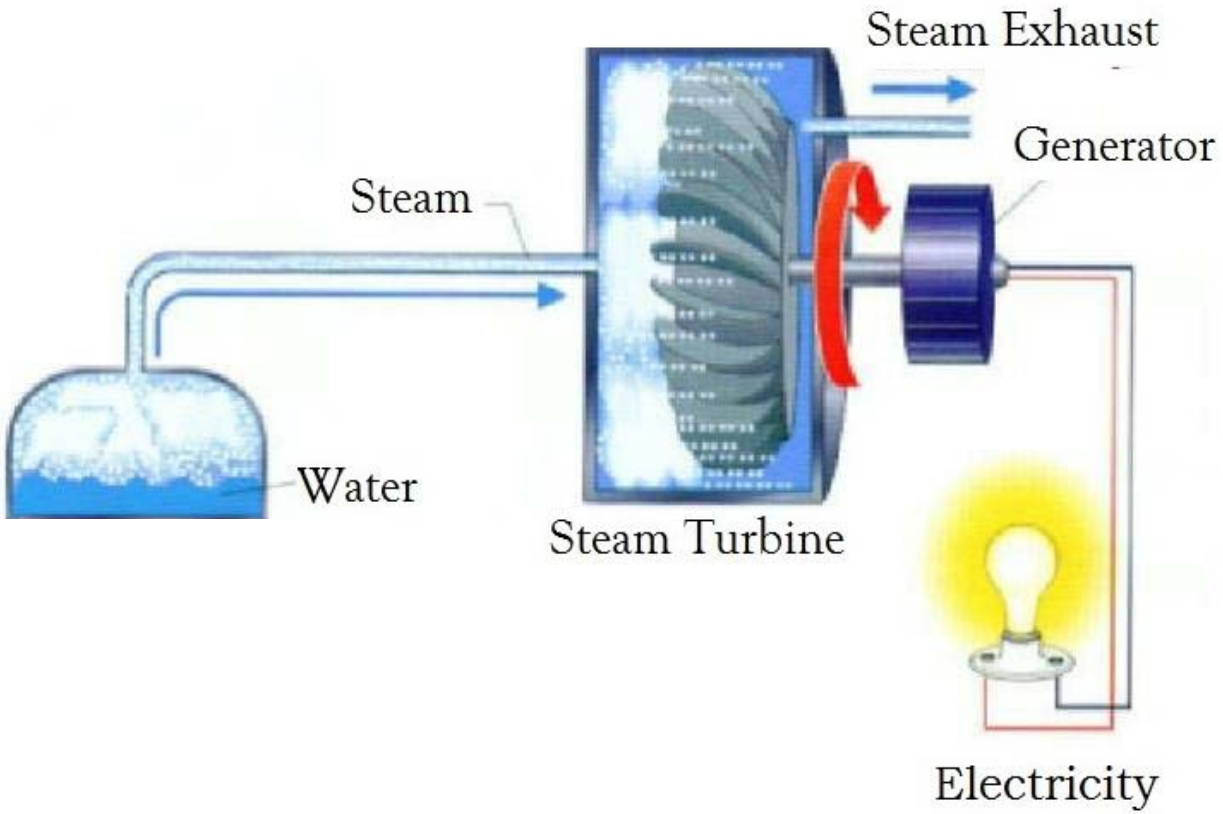
- Social and Political Will?
- What can I do?



Traditional Power Generation

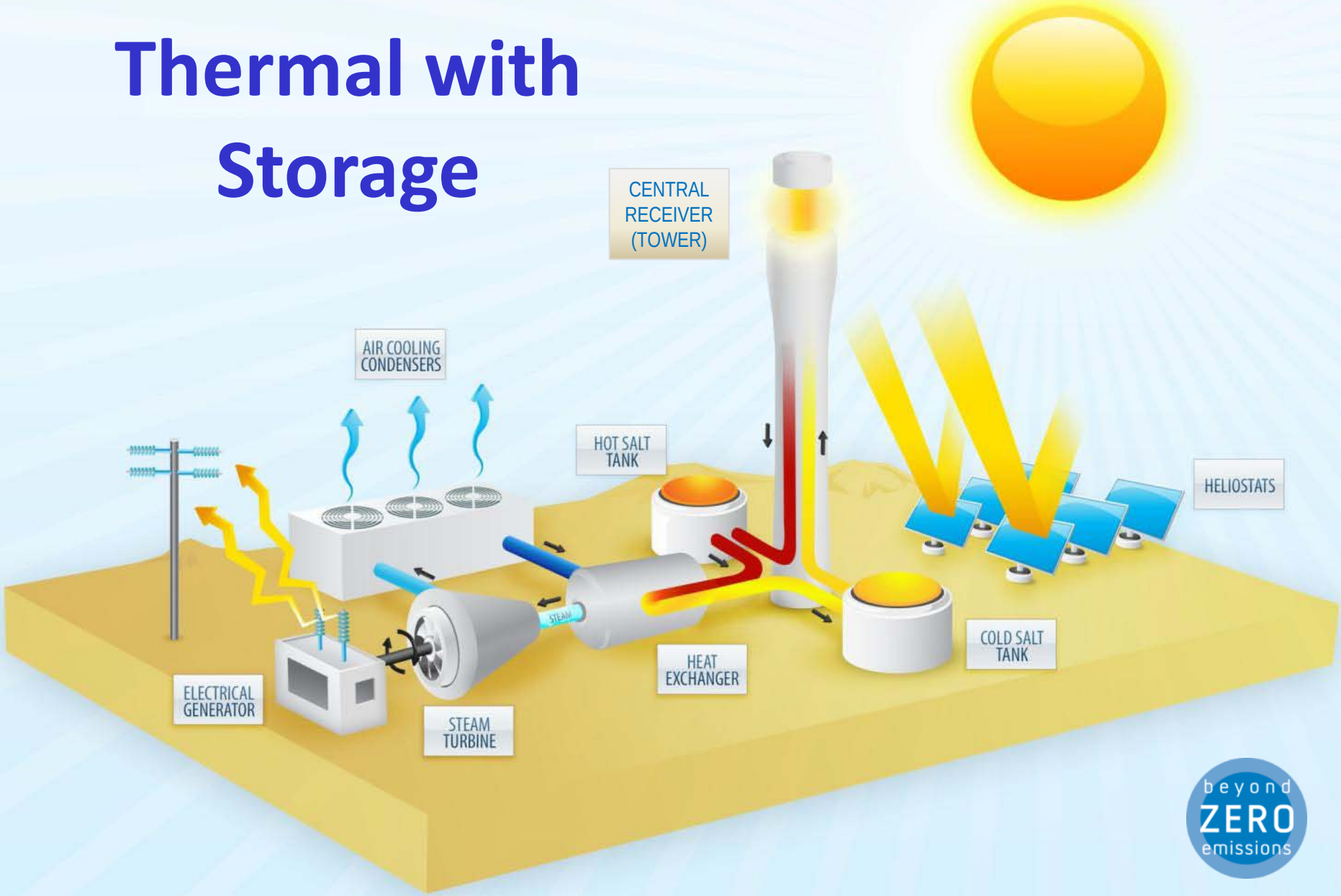


Traditional Power Generation



Concentrated Solar Thermal

Concentrated Solar Thermal with Storage



beyond ZERO emissions


Heliostat


Heliostat Field


Torresol Gemasolar in full operation
beyond ZERO emissions

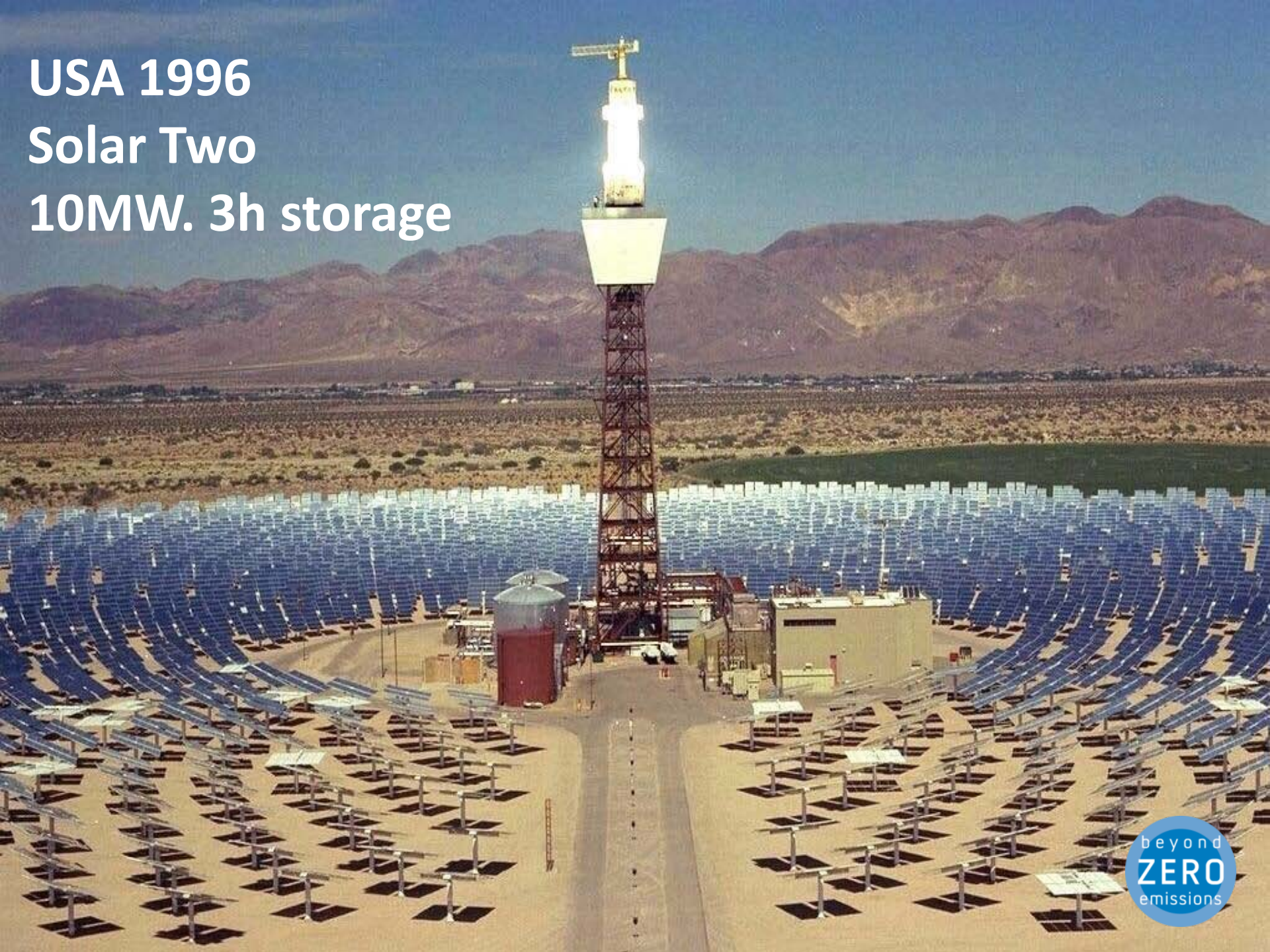

CENTRAL RECEIVER (TOWER)
565ºC
HOT SALT TANK
565ºC
HELIOSTATS
HEAT EXCHANGER
290ºC
COLD SALT TANK
beyond ZERO emissions

Solid salt

Hot & Cold Tanks exterior view

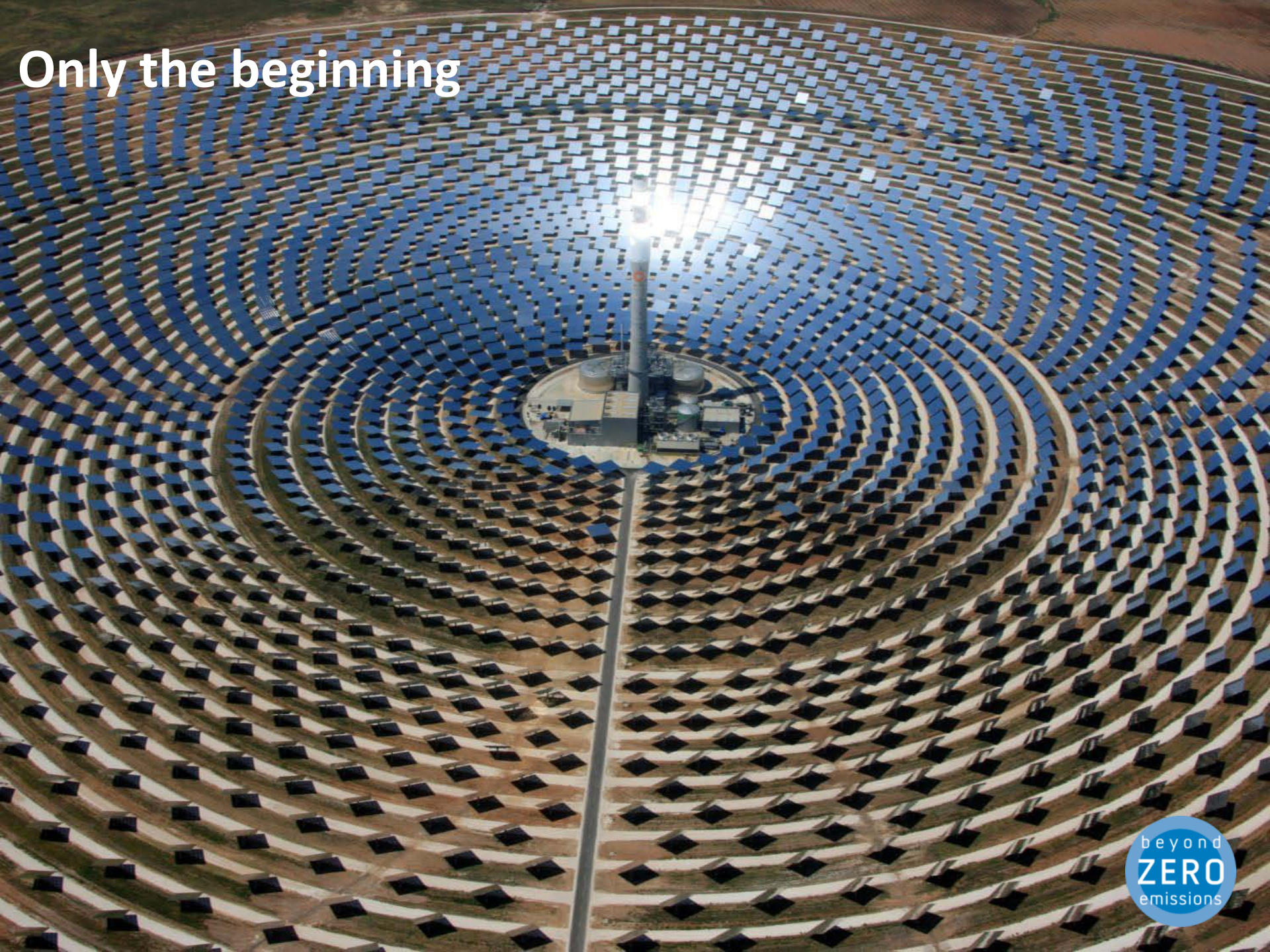
Thermal Storage

Interior of tank under construction


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


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

Only the beginning



beyond ZERO emissions

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

beyond ZERO emissions


beyond
ZERO
emissions

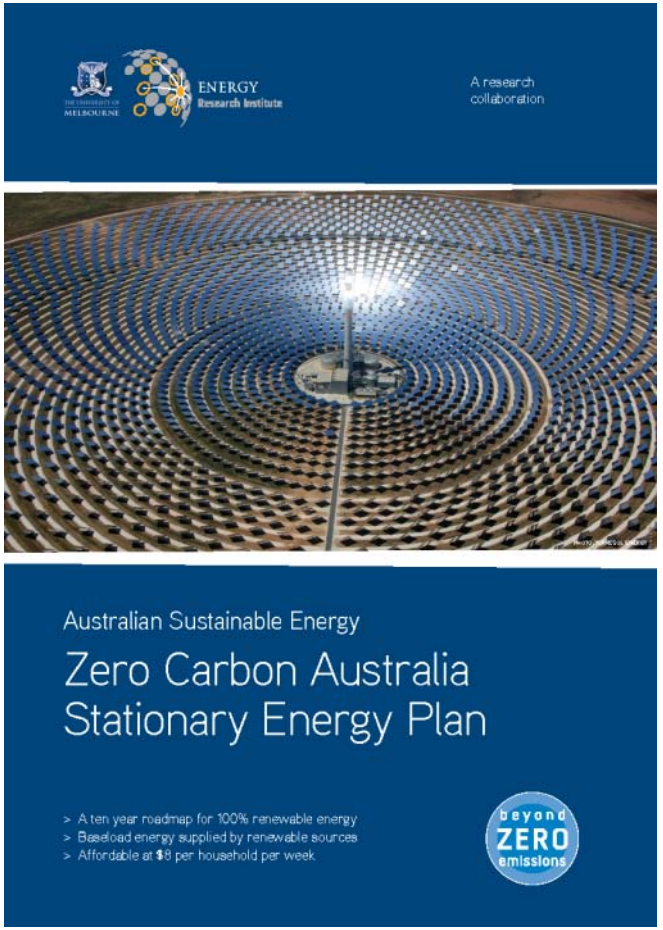
World Wind Power growth

- 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

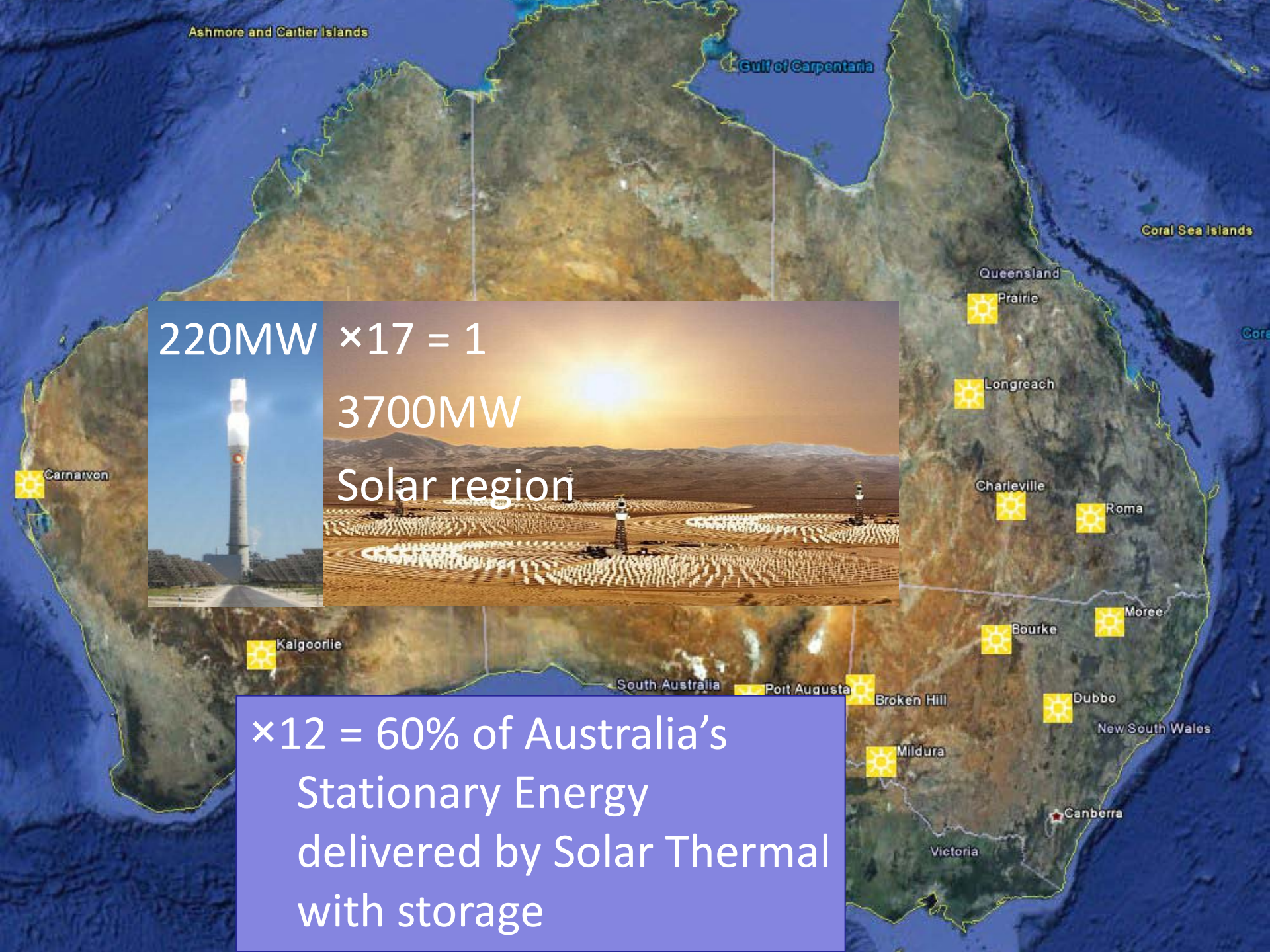
Upgraded electricity grid

Zero Carbon Australia Total Electricity Energy Demand

- 325 TWh/year in 2020

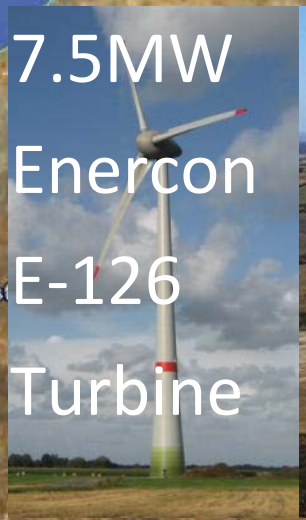
(Up from 230 TWh/year in 2010)

- population growth
- energy efficiency
- electrified transport & heating



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

Repower Port Augusta



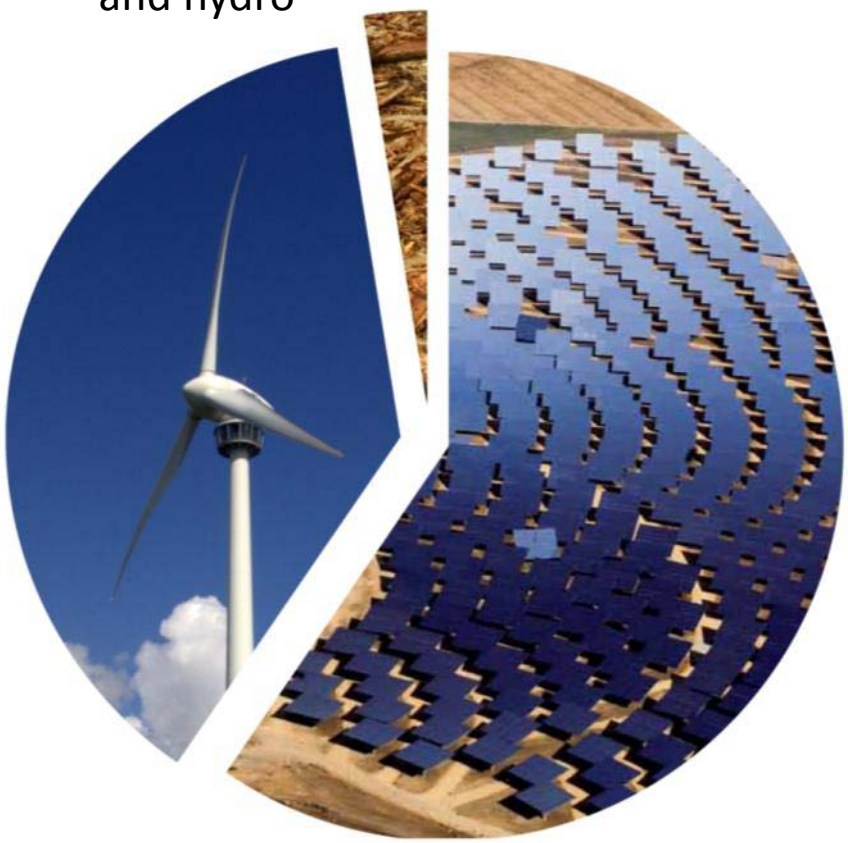
7.5MW
Enercon
E-126
Turbine

×330 = 1
2500MW
Wind region

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

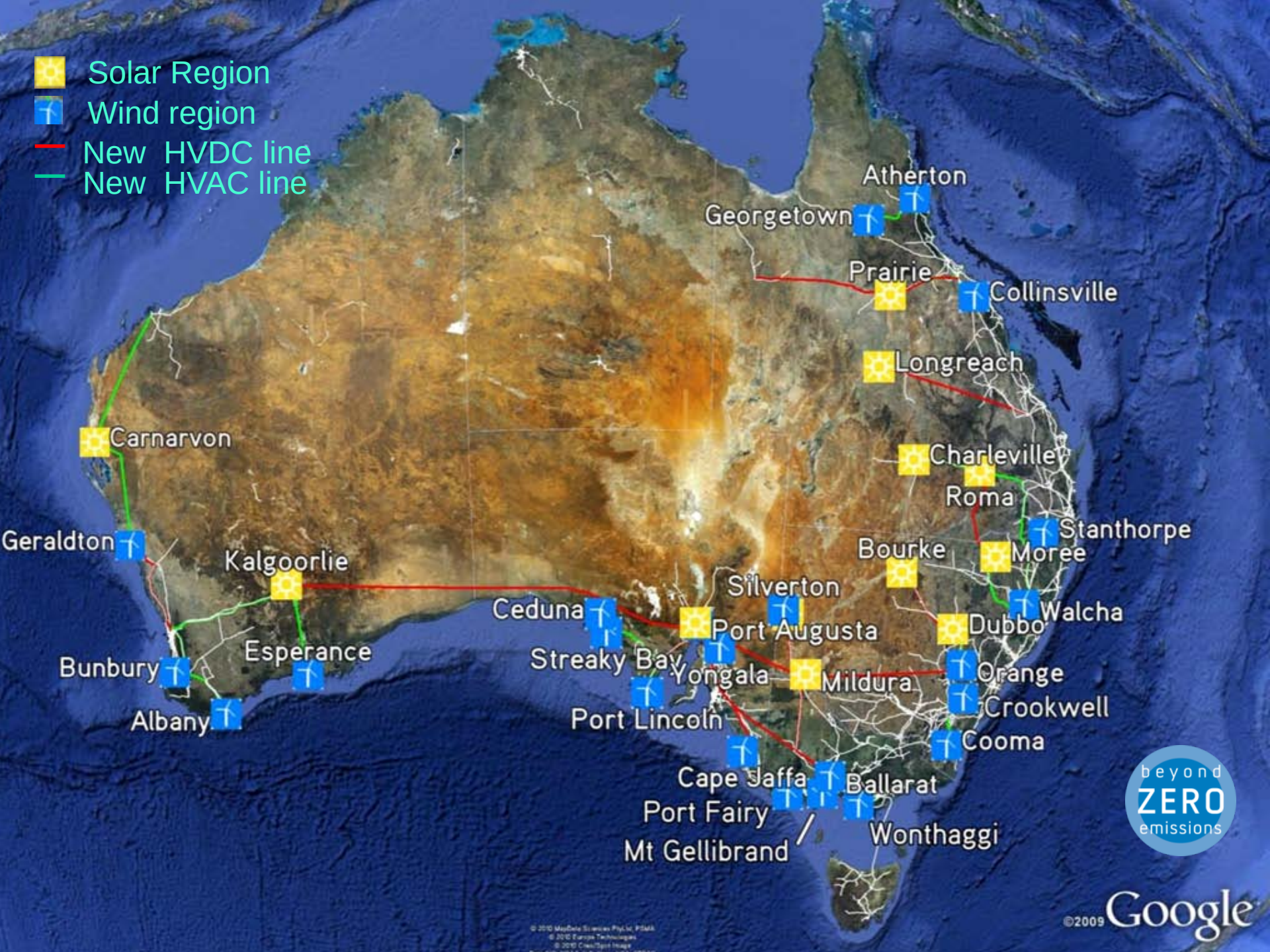
100% Renewable Stationary Energy

Backup with bio-mass
and hydro



Concentrated Solar
Thermal with storage

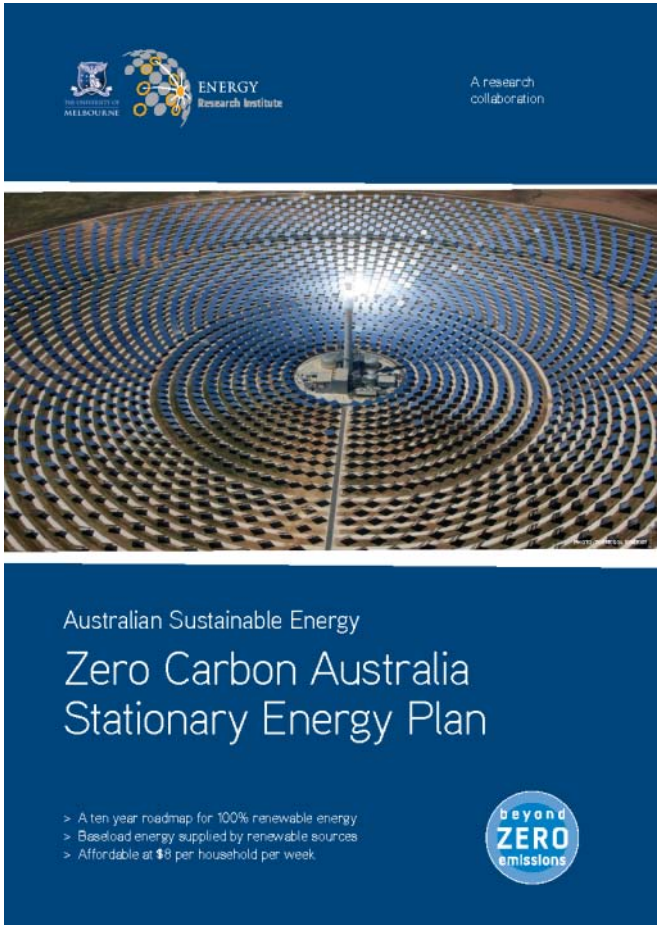
Large scale wind
farms

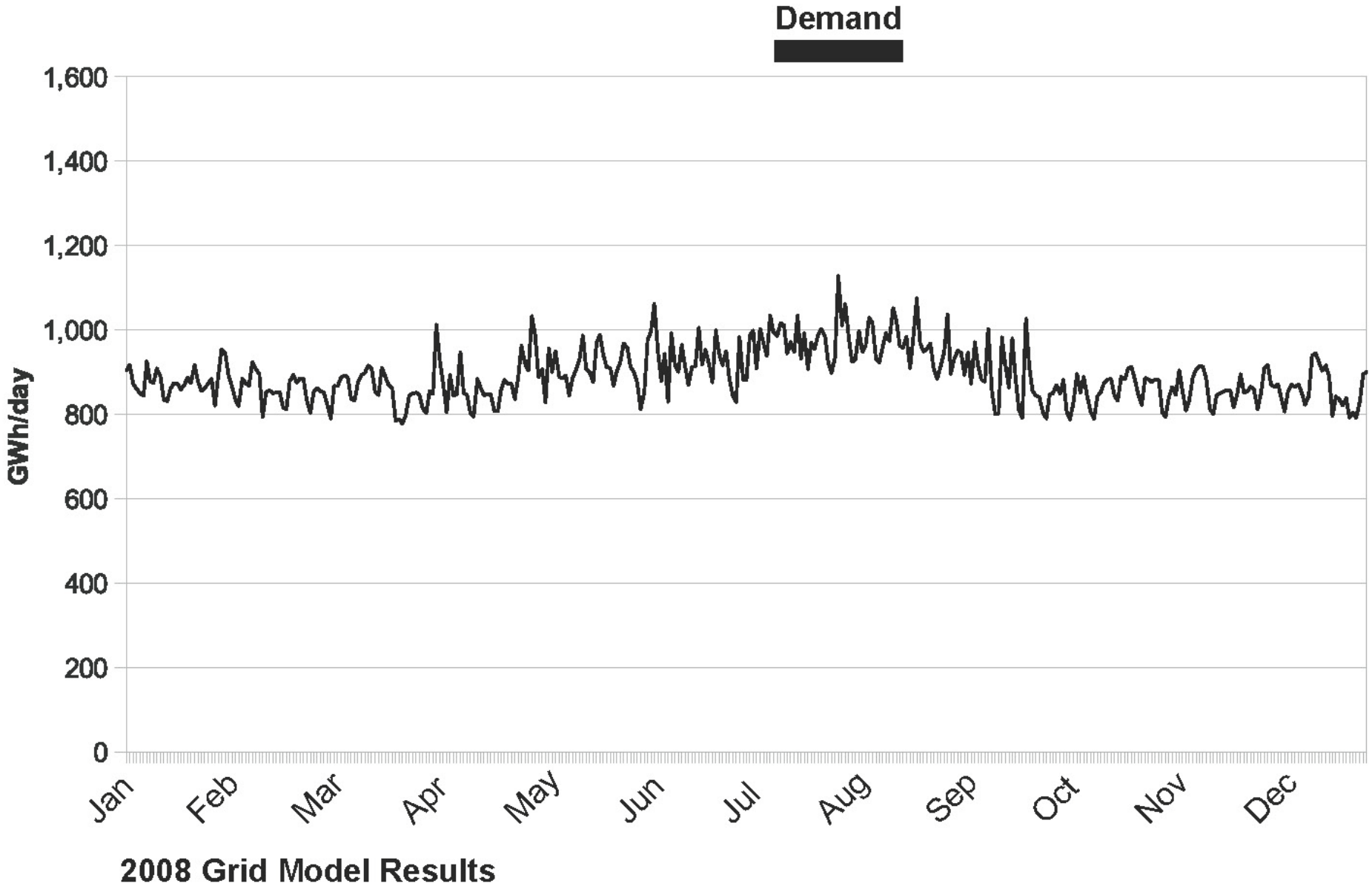

Solar Region
Wind region
New HVDC line
New HVAC line
Atherton
Georgetown
Prairie
Collinsville
Longreach
Carnarvon
Charleville
Roma
Stanthorpe
Geraldton
Bourke
Moree
Kalgoorlie
Silverton
Ceduna
Walcha
Port Augusta
Dubbo
Esperance
Streaky Bay
Yongala
Mildura
Orange
Bunbury
Crookwell
Albany
Port Lincoln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

Major Questions

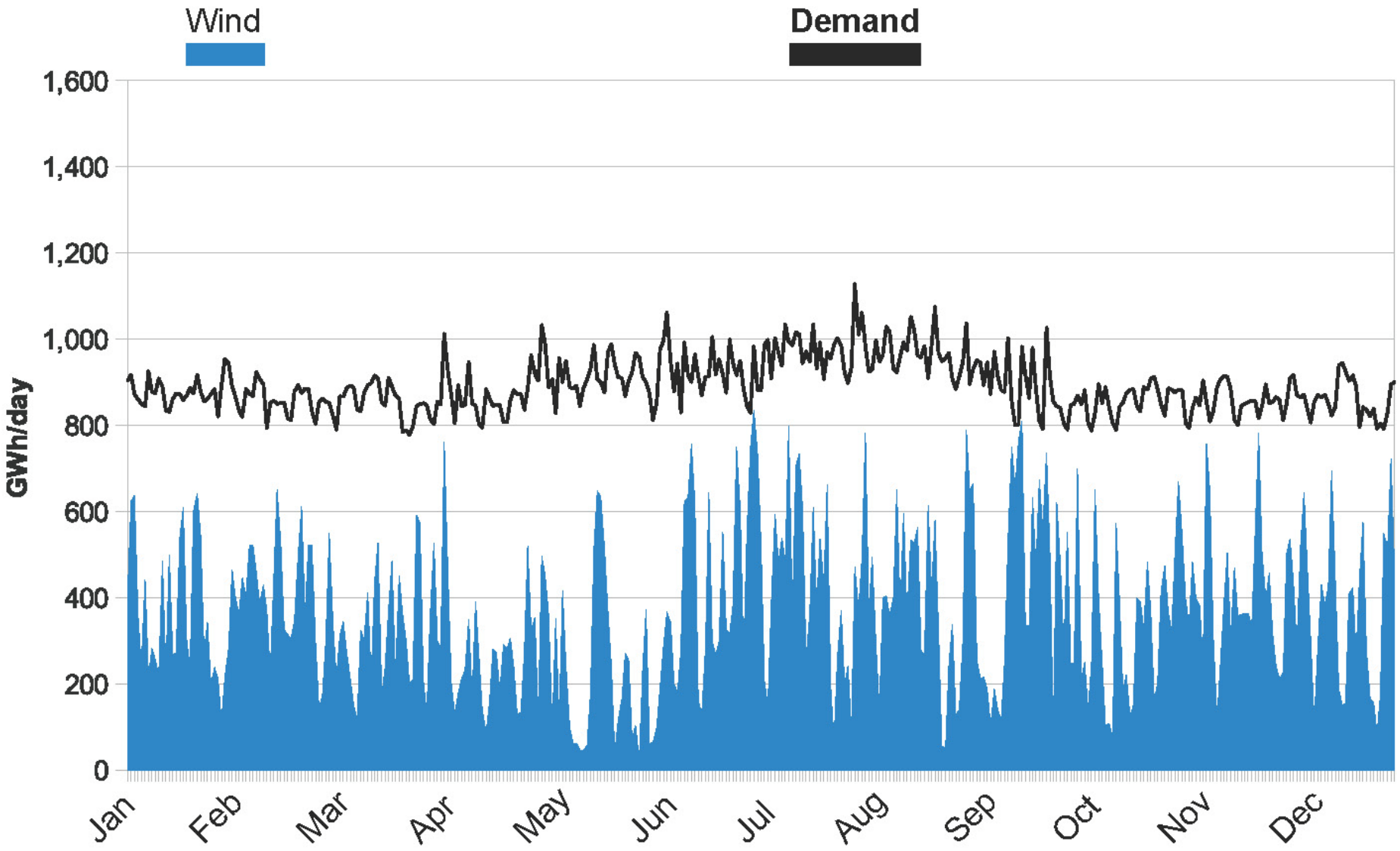
- Need ✓
- Technology ✓
- Reliability? **- Part Four**
- Resources?
- Jobs?
- Economics?

- Social and Political Will?
- What can I do?

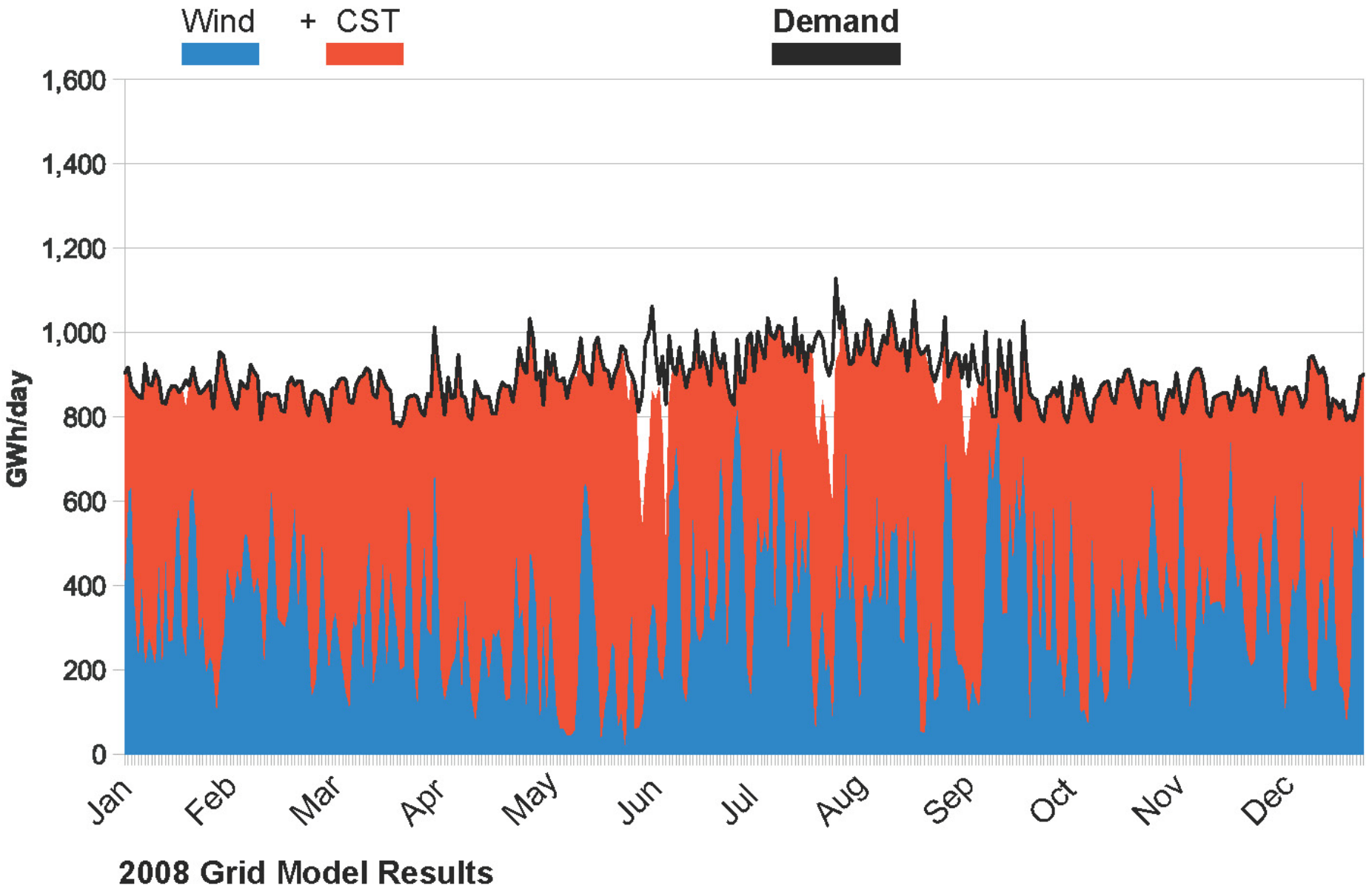


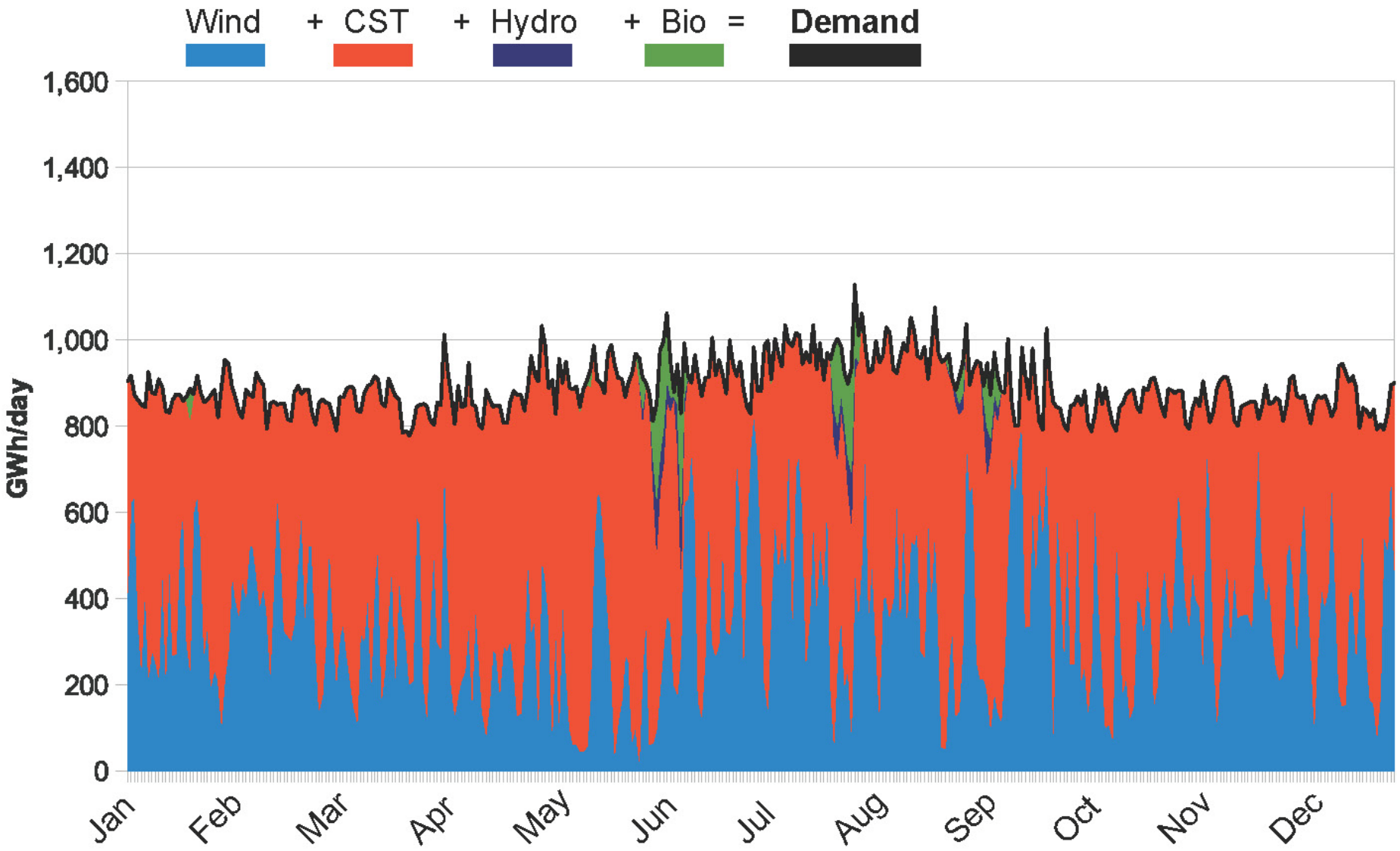


2008 Grid Model Results



2008 Grid Model Results


Wind + CST
Demand
1,600
1,400
1,200
1,000
800
600
400
200
0
GWh/day
Jan
Feb
Mar
Apr
May
Jun
Jul
Aug
Sep
Oct
Nov
Dec
2008 Grid Model Results

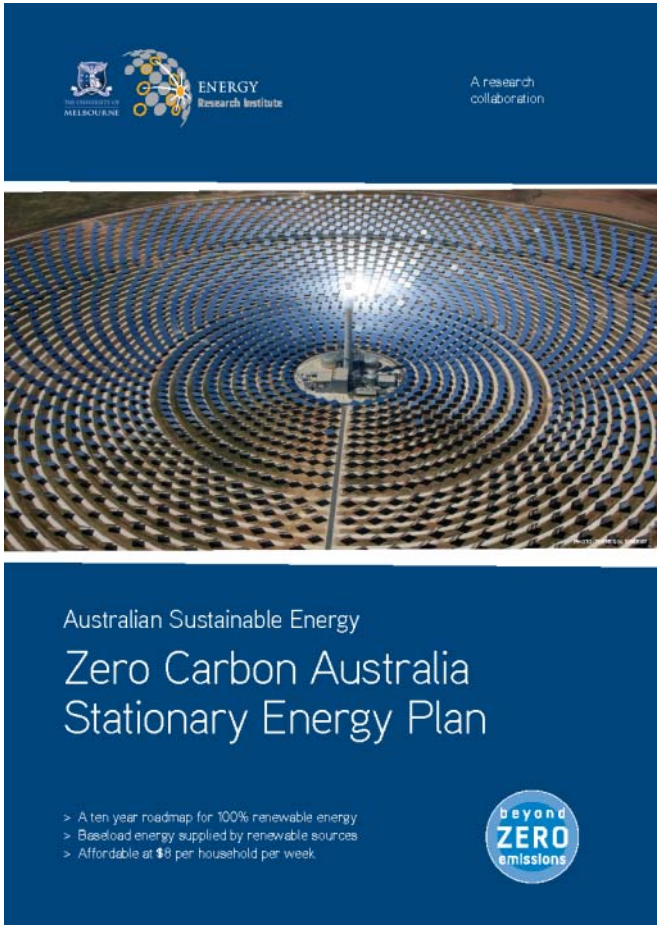


2008 Grid Model Results

Major Questions

- Need ✓
- Technology ✓
- Reliability ✓
- Resources? } **Part Six**
- Jobs? } **Part Six**
- Economics? } **Part Six**

- Social and Political Will?
- What can I do?

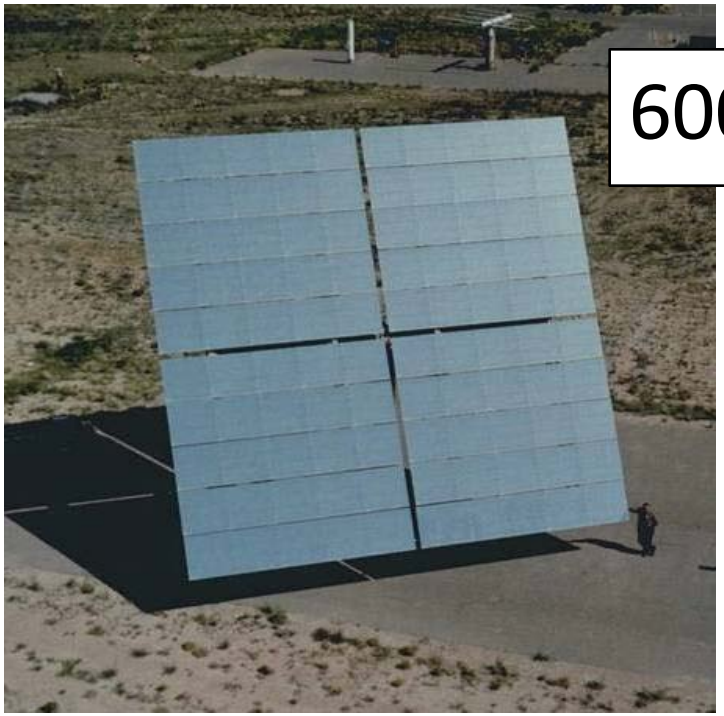


Getting the job done in 10 years

Manufacturing

Construction

Peak Concentrated Solar ‘roll-out’



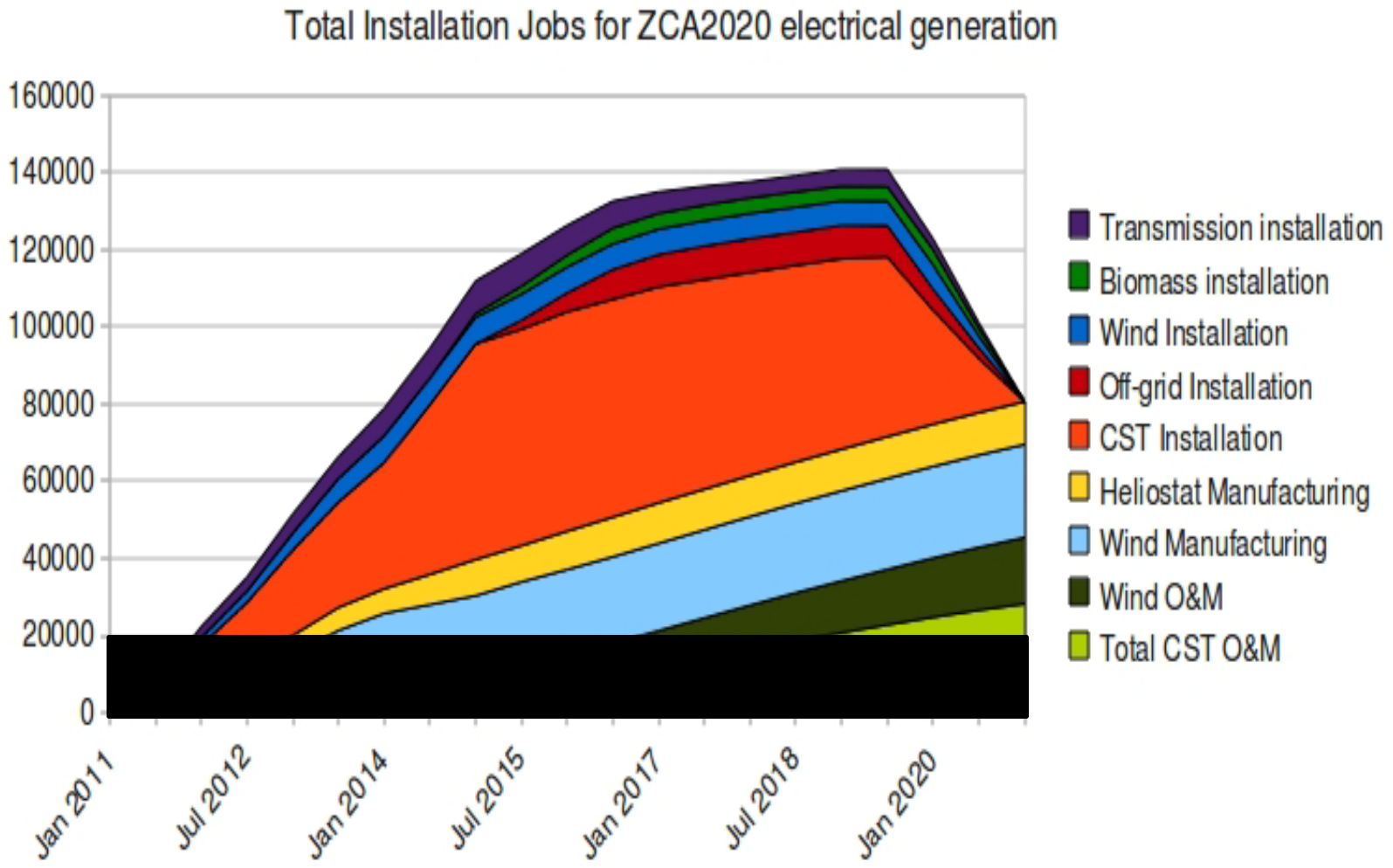
600,000 Heliostats

30 concrete towers

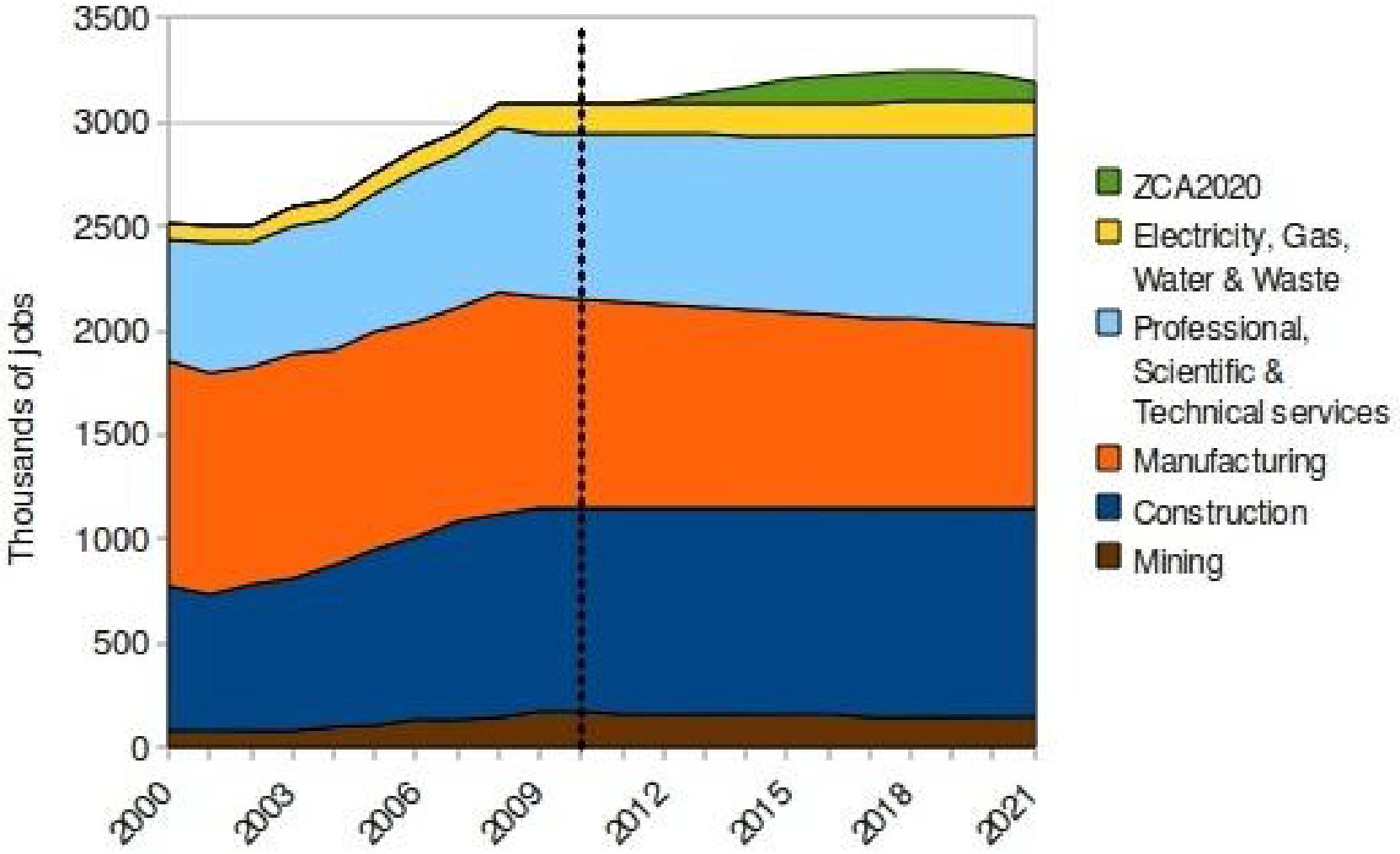
Enercon Viana Do Costelo Wind Turbine blade and tower factories Portugal
250 towers per year 400 Jobs

ZCA 10 year Resource Requirements

Labour Requirements



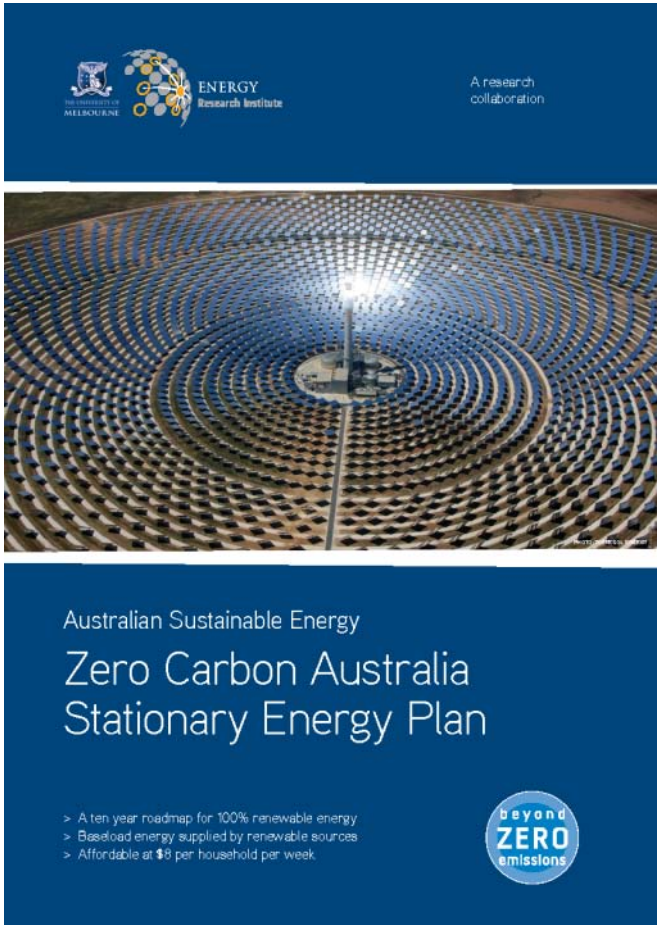
Achievability – Jobs in context



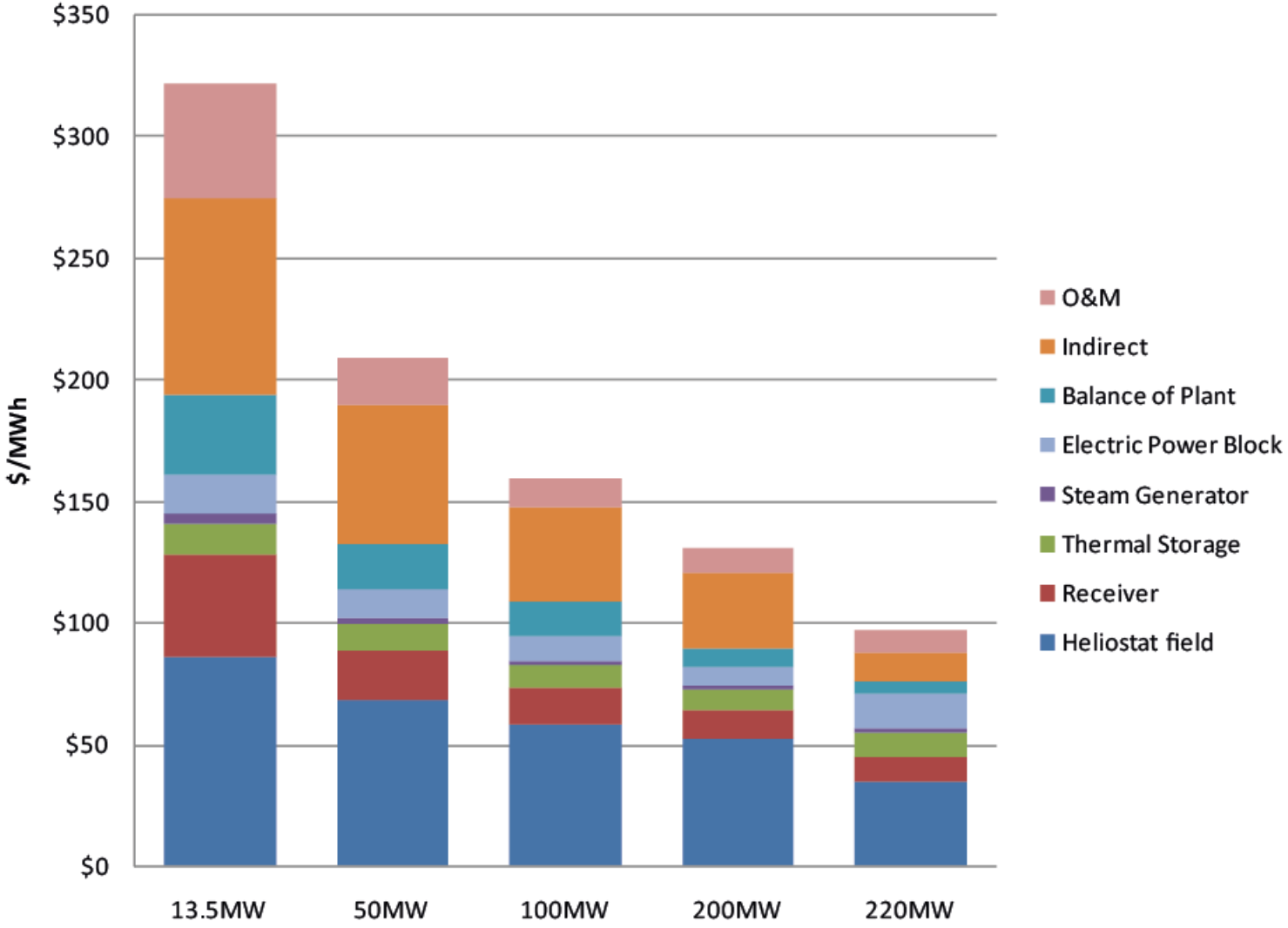
Major Questions

- Need ✓
- Technology ✓
- Reliability ✓
- Resources ✓
- Jobs ✓
- Economics? **- Part Seven**

- Social and Political Will?
- What can I do?



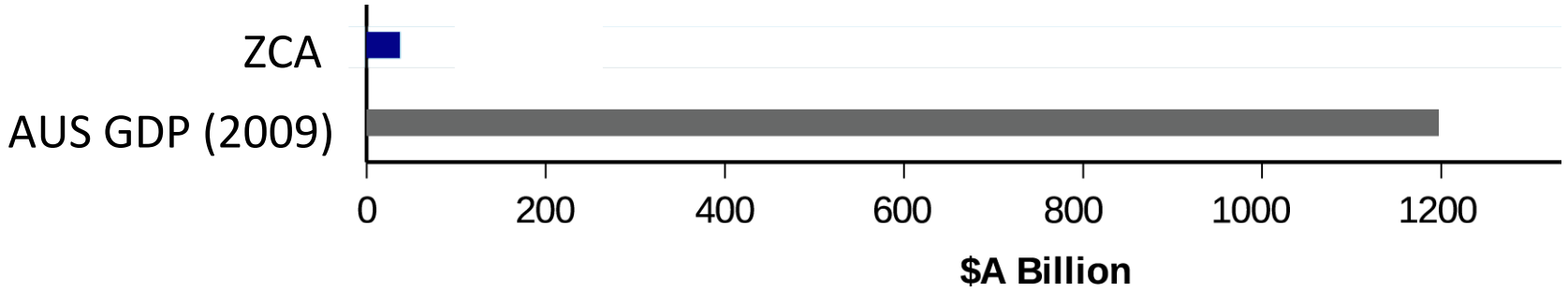
Solar Thermal Cost Reduction



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**

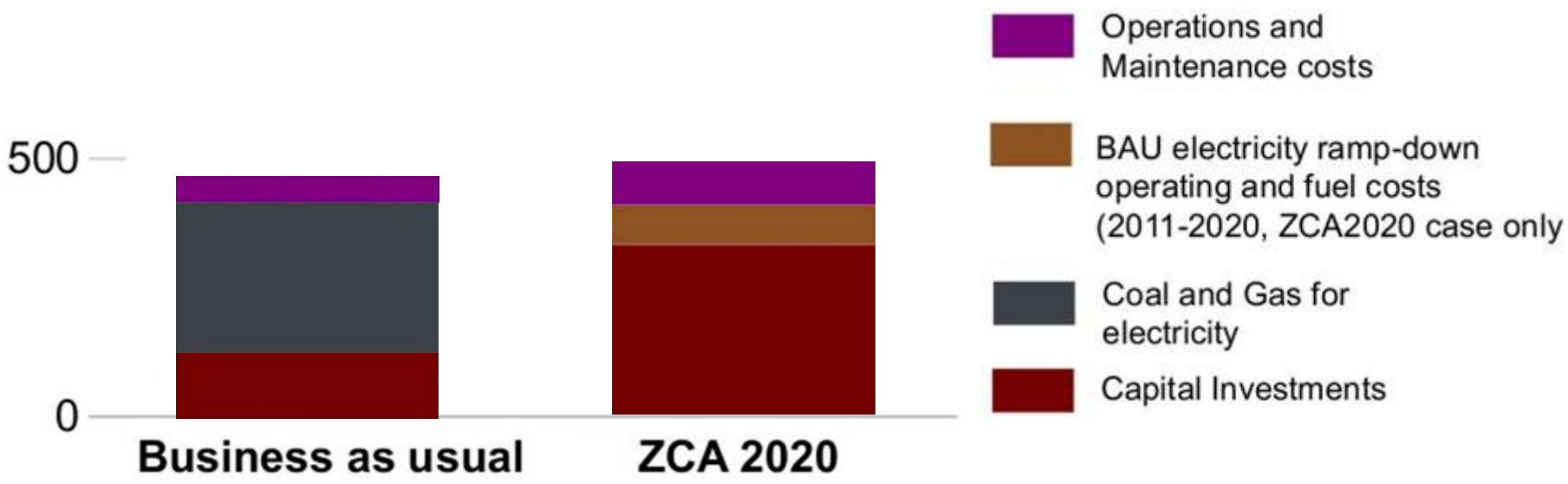
ZCA per year and Australia's GDP



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

Economic Cost

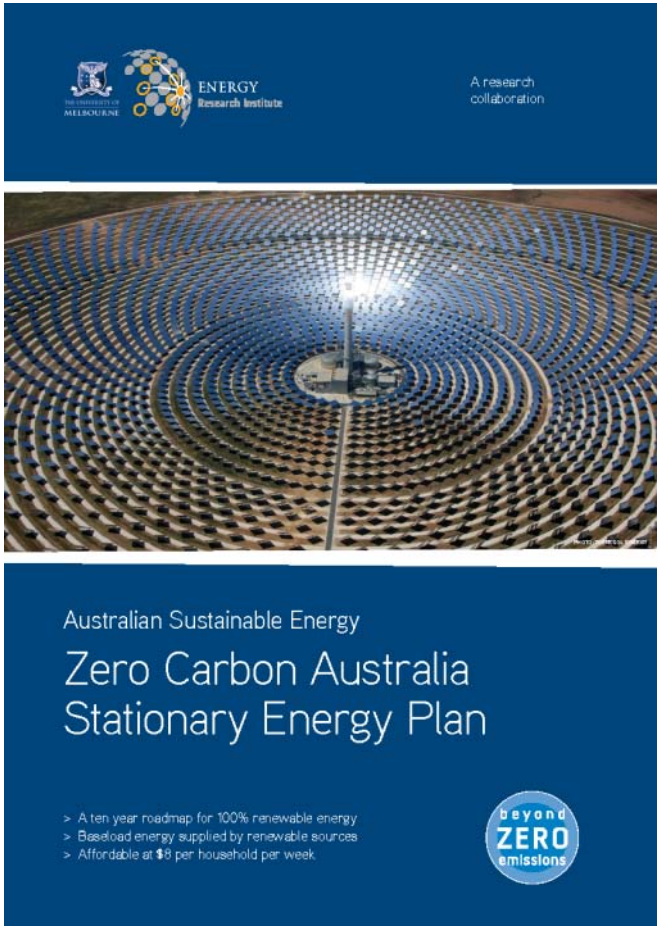
325TWh/yr electricity
Net present value 2010-2040
(real 2010 AUS$ Billion, 1.4%)



Major Questions

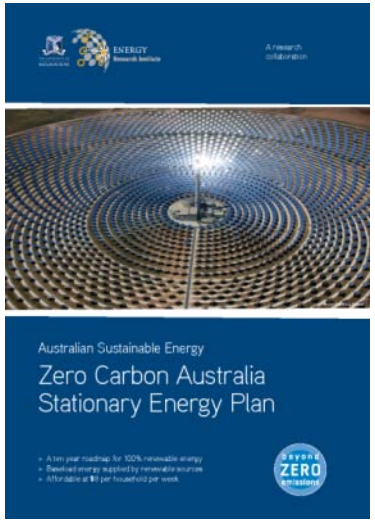
- Need ✓
- Technology ✓
- Reliability ✓
- Resources ✓
- Jobs ✓
- Economics ✓

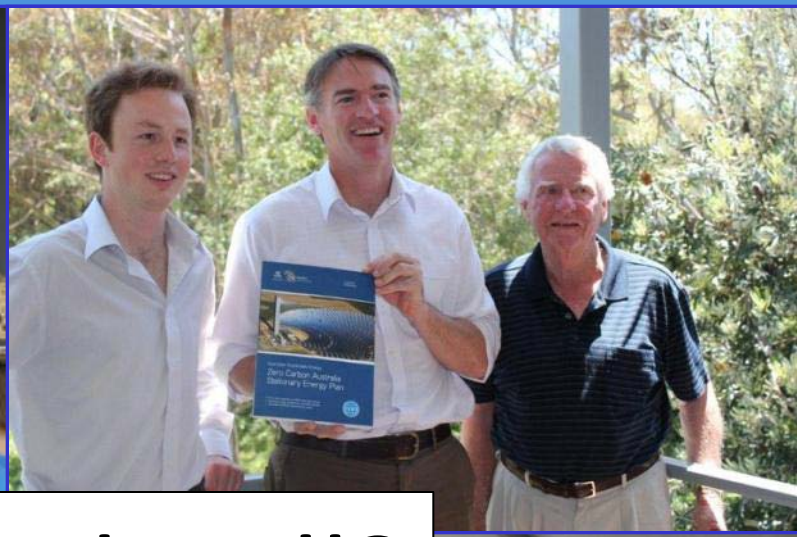
- Social and Political Will?
- What can I do?



Zero Carbon Australia - Conclusion

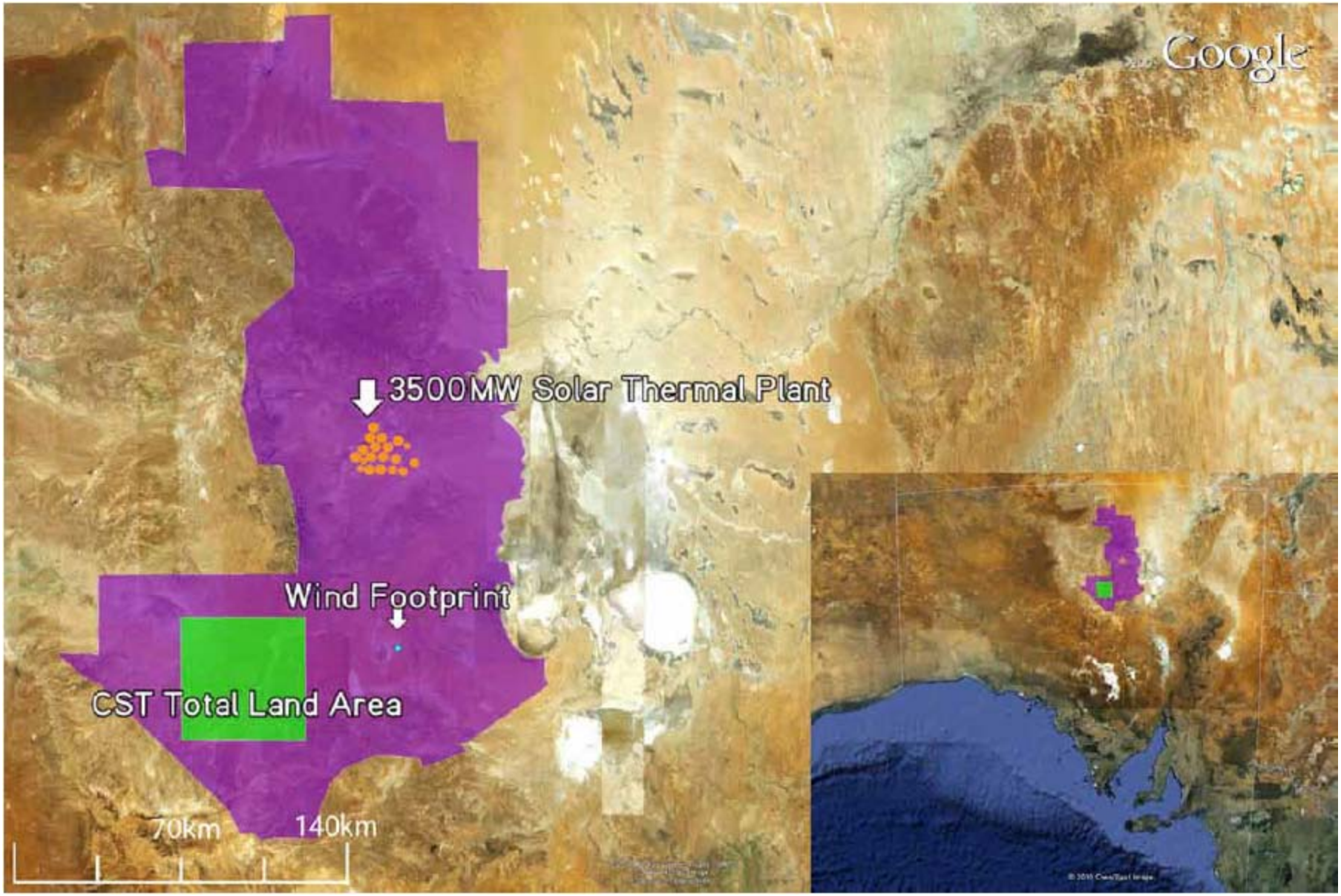
- Will secure our climate and future
- Technically doable
  - Uses commercially available technologies
- Fully Resourced
  - We have the materials
  - Jobs rich
- Fully Costed
  - 3% of GDP for 10 years



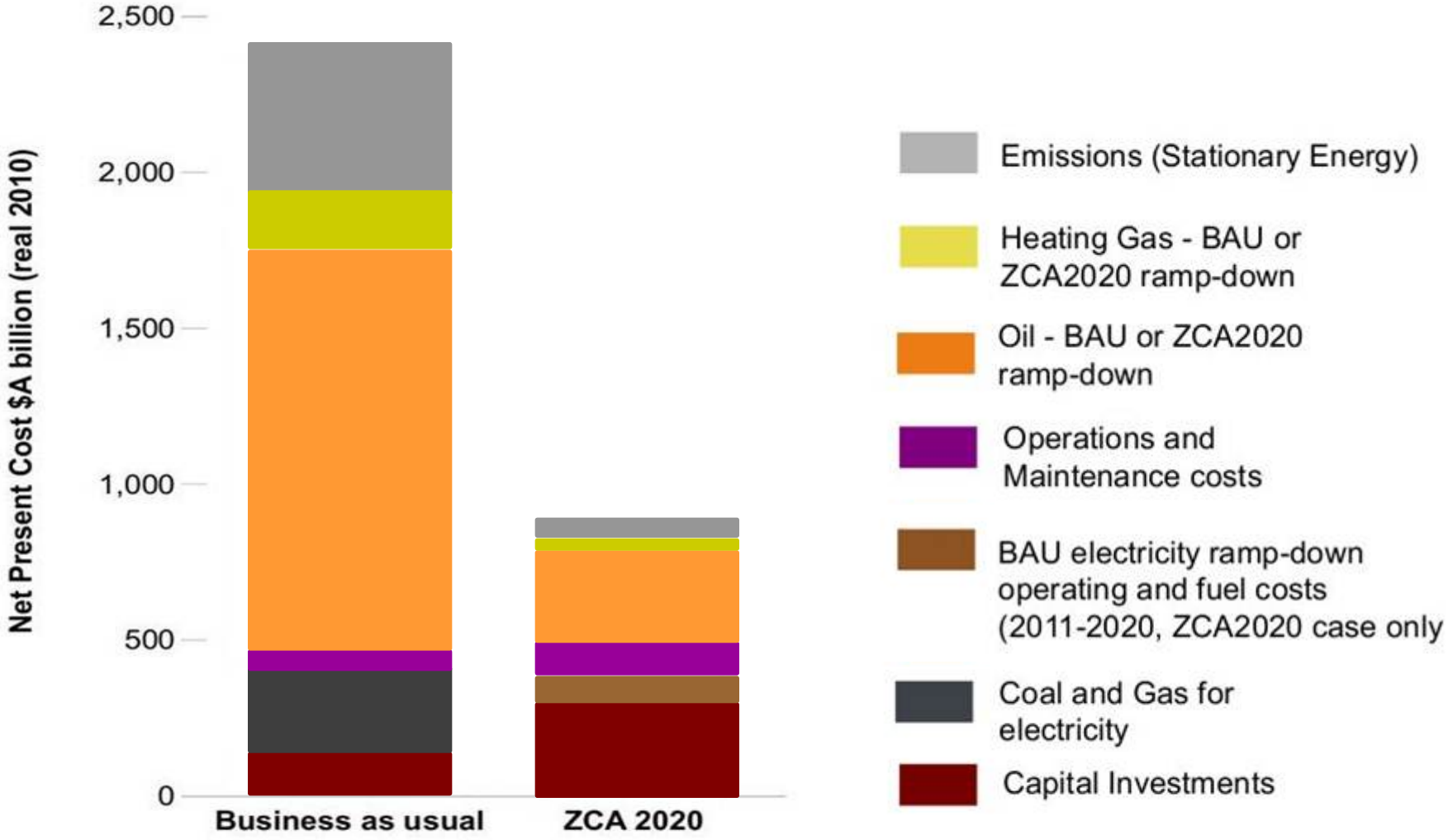


Social & Political Will?

What can I do?


Google
3500MW Solar Thermal Plant
Wind Footprint
CST Total Land Area
70km
140km

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 - <u>$625 million in 2010</u>