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The Transition to a Sustainable Energy Future

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The 3 Driving Forces of CO_2 Emissions from Energy Generation: the Ehrlich-Holdren Identity

Emissions = Population x Consumption per person x Tech 'dirtiness'

$$= \text{Population} \times \frac{\text{Energy}}{\text{Population}} \times \frac{\text{Emissions}}{\text{Energy}}$$

We need:

- Population policy
- Energy efficiency (EE) policy to address consumption per person
- Energy efficiency & renewable energy policies to clean up technologyies

Population:

Australia should stabilise its population because...

- It has one of highest rates of population growth in OECD
- It has the biggest per capita GHG emissions in industrialised world
- Therefore, every additional Australian has a bigger greenhouse impact than an additional person almost anywhere else
- Despite its large land area, Australia is driest inhabited continent and has very little fertile land

Consumption per Person:
‘Developed Countries should shift to Steady-State Economies’ – Nicholas Stern

- SSE is not a failed growth economy
- SSE can be defined in biophysical terms: low throughput of energy, materials and land
- Ideas from Herman Daly (1970s onwards), Tim Jackson (2009) , Center for the Advancement of the Steady State Economy <http://steadystate.org>

Technology:
All countries should shift to clean energy

- To combat global warming, peak oil and local pollution of air, water and land
- The only genuinely clean technologies that could make big contributions before 2020 are efficient energy use and renewable energy
- Neither coal with carbon capture & storage (CCS) nor nuclear energy could make a significant global contribution before 2025 (2030 in Australia)
- Gas could assist in the transition to ecologically sustainable energy

Status of Low-Carbon Electricity Supply Techs

Market penetration ↑

			Energy efficiency, Generation II nuclear
			On-shore wind; CHP
			Biomass combustion
		Micro CHP	PV
		Off-shore wind	Conventional geothermal
Novel PV, IFR, CCS	Marine, hot rocks, fast reactor (GenIV)	Solar thermal, Gen III nuclear	Conventional tidal
R&D	**Demonstration**	**Pre-commercial**	**Commercial**

Modified from Foxon et al. (2005).

Technology status →

Bioenergy, Rocky Point, Qld

Wind, Albany, WA

Concentrated solar

Energy efficiency
Wind
Biomass
Solar, Geothermal

Solar-efficient homes, Christie Walk, Adelaide

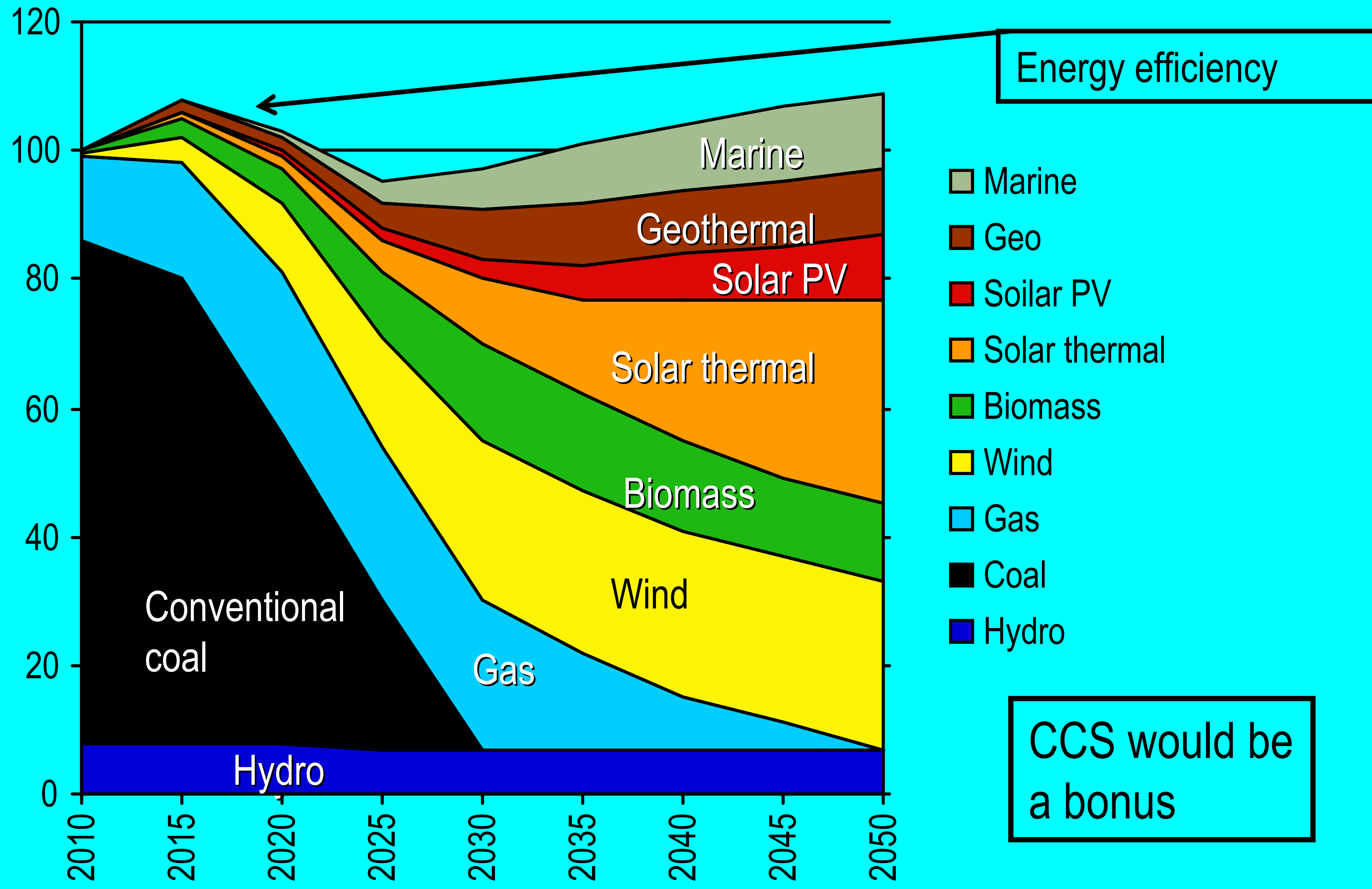
Sustainable Energy Mix

PV solar tiles, Sydney

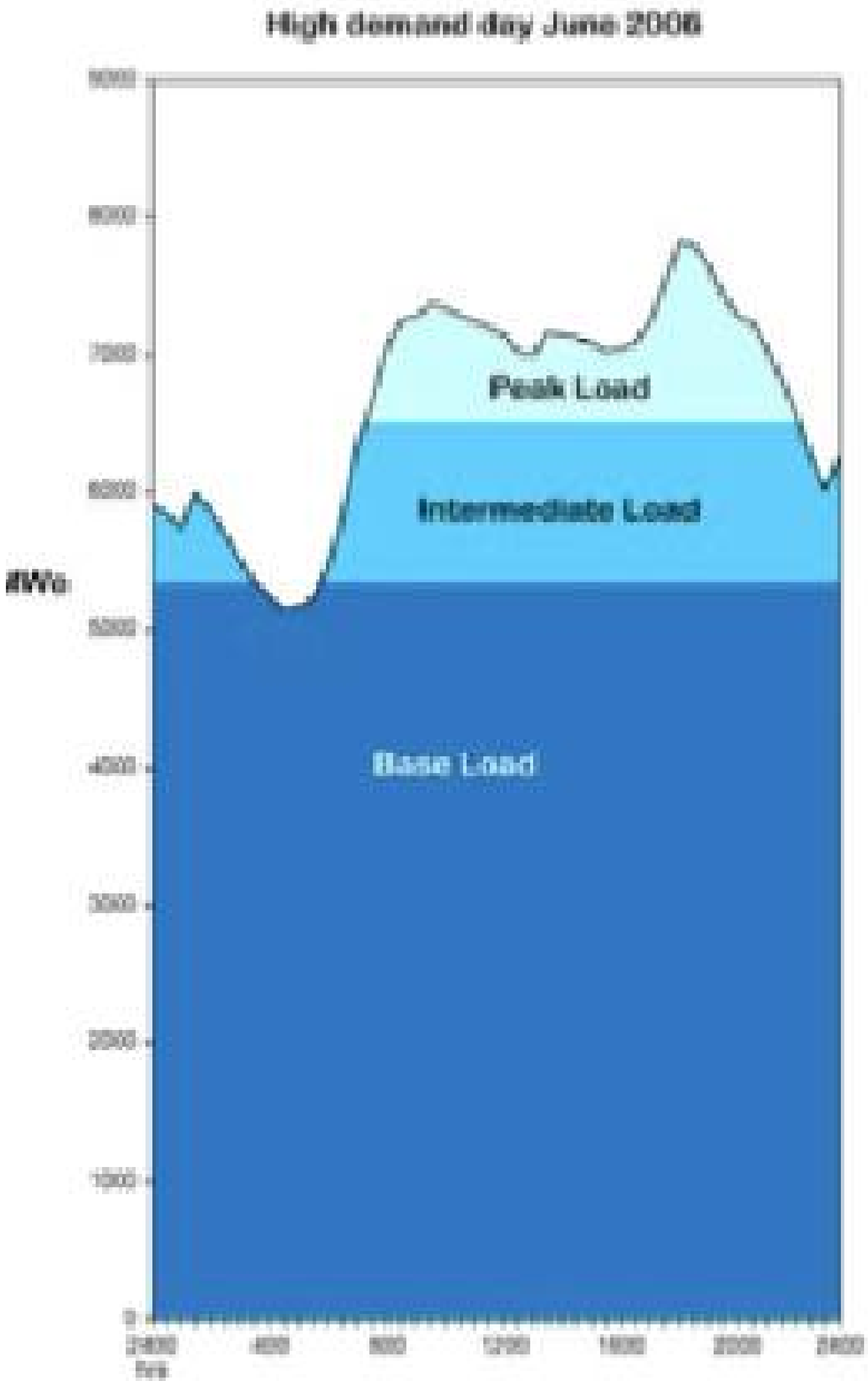
Sustainable Energy Systems

- A mixture of different technologies with different properties
- Together can provide an energy system just as reliable as fossil fuels
- Can be ecologically sustainable
- Can create more local employment

Scenario for Australian Electricity, 2010–2050



CCS would be a bonus



Daily Demand met by 100% Renewable Elec Supply by 2050

Peak-load: Hydro; CST + thermal storage; biofuelled gas turbines; PV

Int.-load: CST+ thermal storage, bioenergy; PV

Base-load:

- Demand reduction by solar hot water and energy efficiency;
- CST + long-term thermal storage;
- Bioenergy
- Wind with supplementary peak-load
- Geothermal (when commercially available)

Wind Power

Wind could generate 20–30% of USA's, Europe's & Australia's electricity

- Global wind capacity at end 2009: 159,000 MW; growth rate 25–30%
- Biggest contributor to new generating capacity in EU in 2008 & 2009
- 20% of electricity achieved in Denmark in 2003; increases planned
- Changes to transmission network are needed
- Large-scale dispersed wind farms, with a little extra peak-load back-up, can substitute for coal

Albany wind farm, Western Australia.

Bioenergy from Crop Residues
Does not use Additional Land

- Residues & organic wastes cheapest & fastest
- Generates base-load power and heat (cogeneration)
- Biomass residues don't compete with food production
- Ash is back-loaded to fields

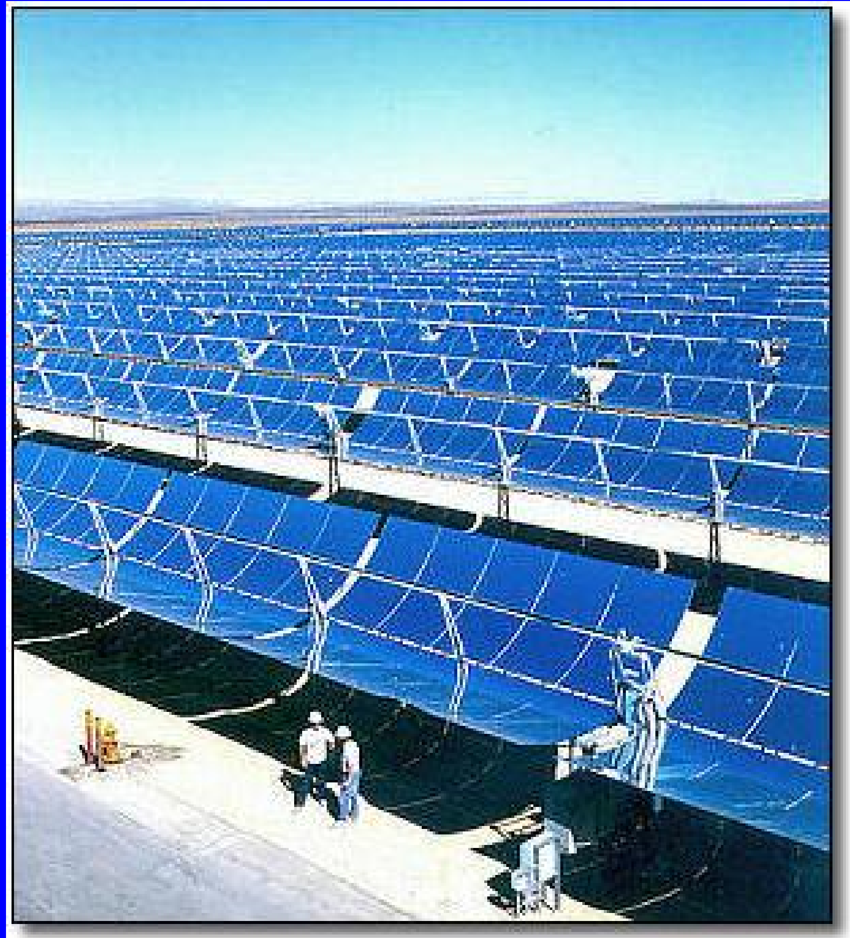
Burning sawmill & sugar cane residues in Queensland, Australia

Solar Photovoltaic (PV) Modules
could supply most *residential* electricity from roofs

- Global capacity at end 2009: 22,000 MW
- Annual production 2009: 7,000 MW; typical growth rate 30–40% per year
- Electrical storage is still expensive so PV is daytime power
- Just as important as base-load
- Tech advances and expanding market are reducing price
- Needs R&D funding and market stimulus

Concentrated Solar Thermal Electricity

- Revival post-2004 in Spain and USA
- 600 MW operating; 800 MW under construction; 8000 MW advanced planning
- Thermal storage in molten salts, water, concrete, graphite, ammonia
- Thermal storage much cheaper than electrical storage
- Can generate either peak-load or base-load (24-hour) power
- Now is semi-commercial technology



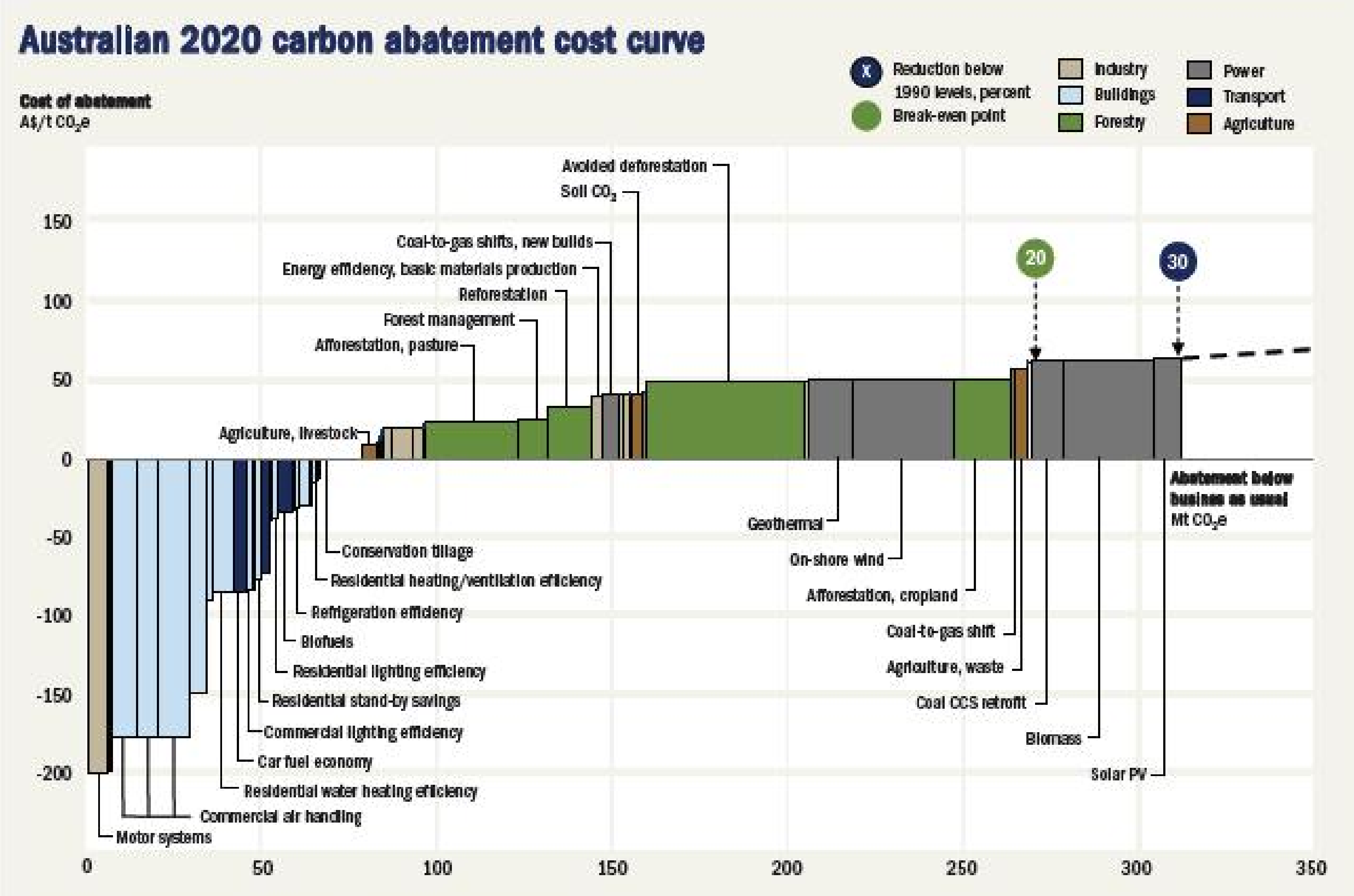
‘Old’ 354 MW system in California

New Solar Thermal Power with Thermal Storage

eSolar 5 MW
California

Andasol 1, Spain, 50 MW, 7.5 hr storage

Exhibit 4



Note: Abatement opportunities are not additive to those of previous years

Source: McKinsey Australia Climate Change Initiative

McKinsey Cost Curve 2008

Economic savings from EE can pay for large fraction of additional costs of RE.

Transport and Urban Form

- Increase urban transportation by rail, bus, cycling and walking
- Urban consolidation around train stations
- Foster electric vehicles, charged by renewable energy, for suburban travel
- Build high-speed inter-city rail
- Foster biofuelled vehicles for rural travel

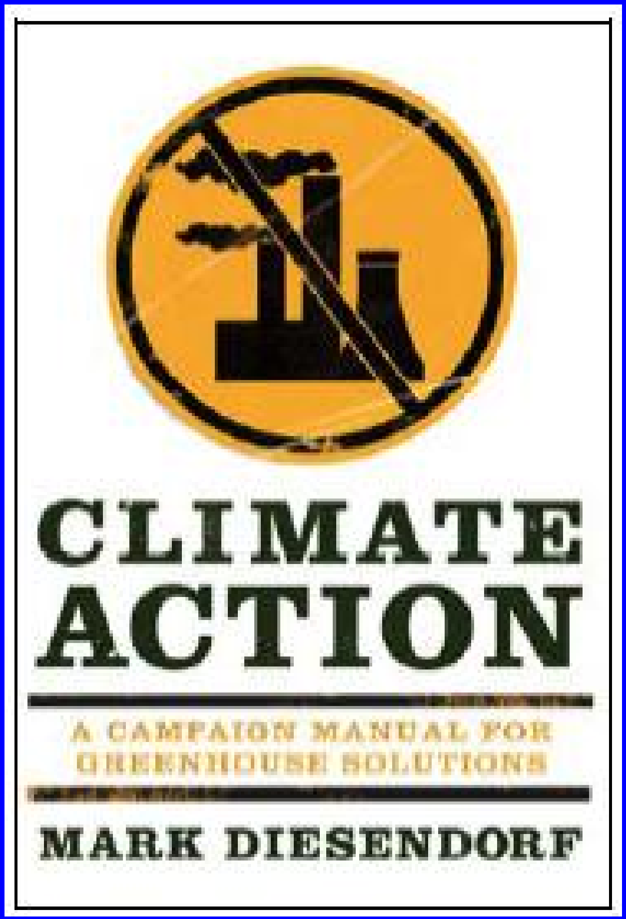
Principal Government Policies Needed for Sustainable Energy & Transport

- Stronger greenhouse targets
- Strong targets for renewable electricity, renewable heat & energy efficiency
- Feed-in tariffs for large and small renewable electricity systems
- Carbon price with no exemptions apart from border adjustments
- Ban on new conventional coal-fired power stations
- Upgraded infrastructure for electricity transmission, rail transport, cycling, walking
- Mandatory Energy Performance Standards, ratings and labelling for all buildings and appliances
- Just transition programs for workers and low-income earners

Additional Policies Needed

- Rebuild manufacturing capacity for sustainable energy systems
- Increase funding for education & training in sustainable energy and sustainable development in general
- Stabilise population by reducing total immigration, while increasing refugee immigration quota, and removing birth incentives
- Integrate urban and transport planning
- Introduce official indicators of social and environmental performance, while reducing status of GDP
- Reduce working hours
- Implement a basic minimum income for all and work towards setting a maximum income
- Fund research on a steady state economy

Further Reading



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