Global Energy Trends, The Role of Renewable Energy & Implications for Indonesia

Seminar & Workshop on Renewable Energy & Sustainable Development In NTT, Kupang, 8-9 June 2010

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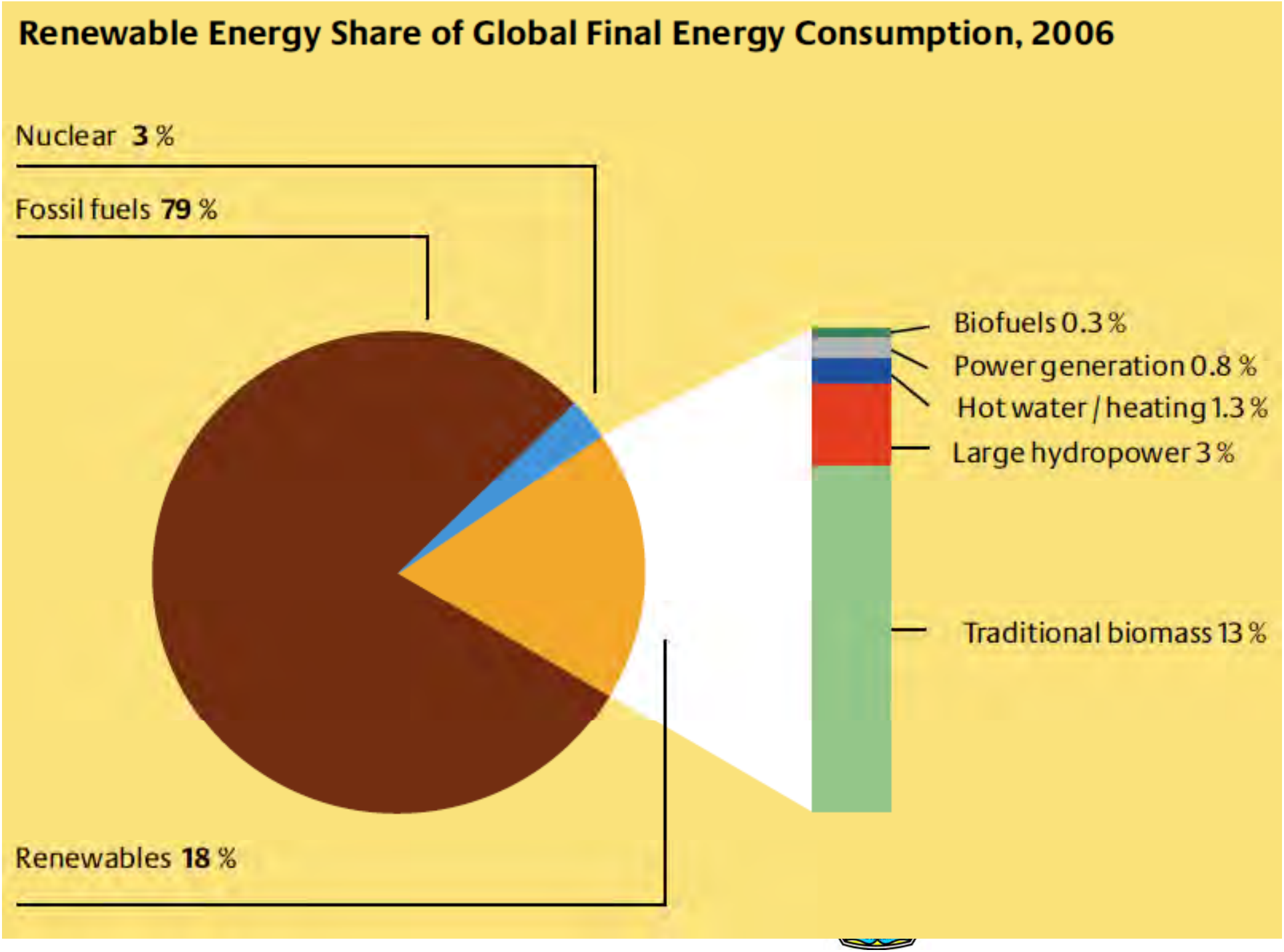
http://www.ceem.unsw.edu.au/content/RenewableEnergyinIndonesia.cfm?ss=1

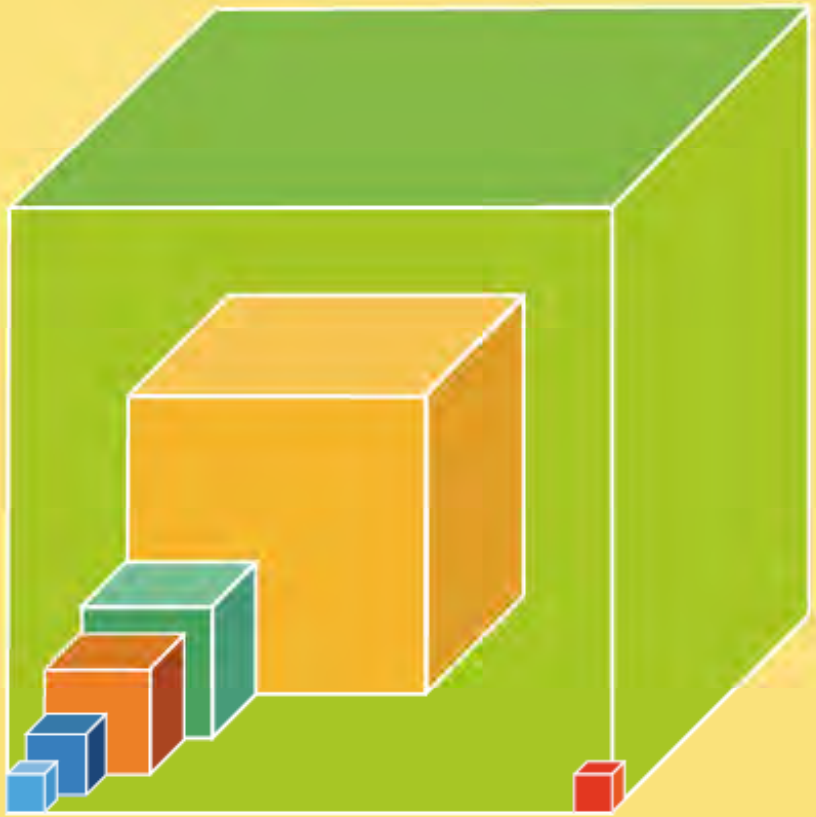
Outline

- Drivers for increasing use of renewable energy:
  - High & volatile fossil fuel prices, particularly for oil
  - Climate change emissions from fossil fuel combustion
- Renewable energy – current use & future potential
  - Solar, wind, biomass, geothermal, ocean, hydro
- Renewable energy engineering:
  - Solar, wind, biomass, geothermal, ocean, hydro


Renewable Energy Share of Global Final Energy Consumption, 2006
Nuclear 3 %
Fossil fuels 79 %
Renewables 18 %
Biofuels 0.3 %
Power generation 0.8 %
Hot water / heating 1.3 %
Large hydropower 3 %
Traditional biomass 13 %

The physical potential of renewable energies

"Founding an International Renewable Energy Agency", IRENA, 2009

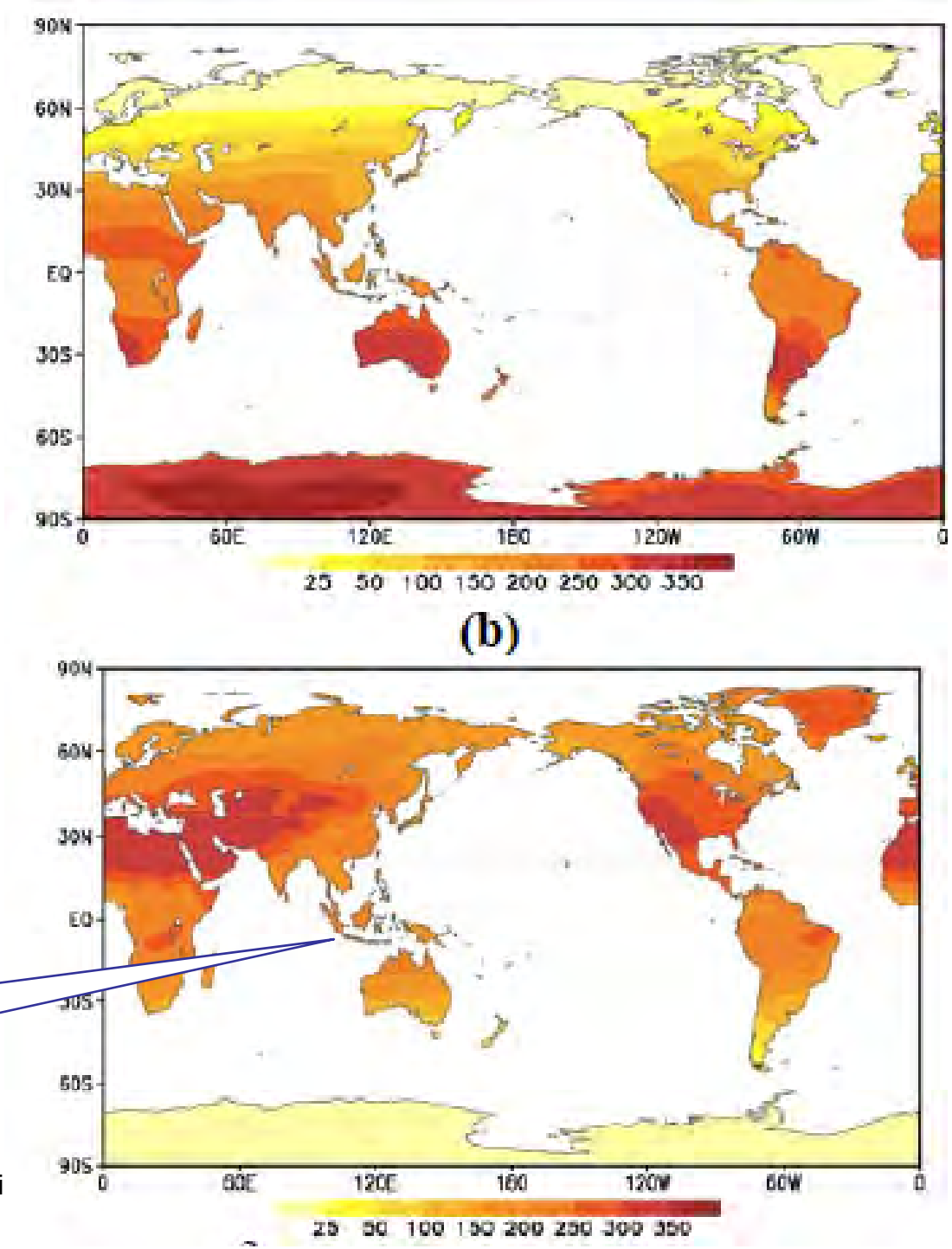


- Current global primary energy consumption (GPEC)
- Solar radiation (continents) (1800 x GPEC)
- Wind energy (200 x GPEC)
- Biomass (20 x GPEC)
- Geothermal energy (10 x GPEC)
- Ocean and wave energy (2 x GPEC)
- Hydro energy (1 x GPEC)

Note: solar & wind energy are variable & non-storable energy fluxes

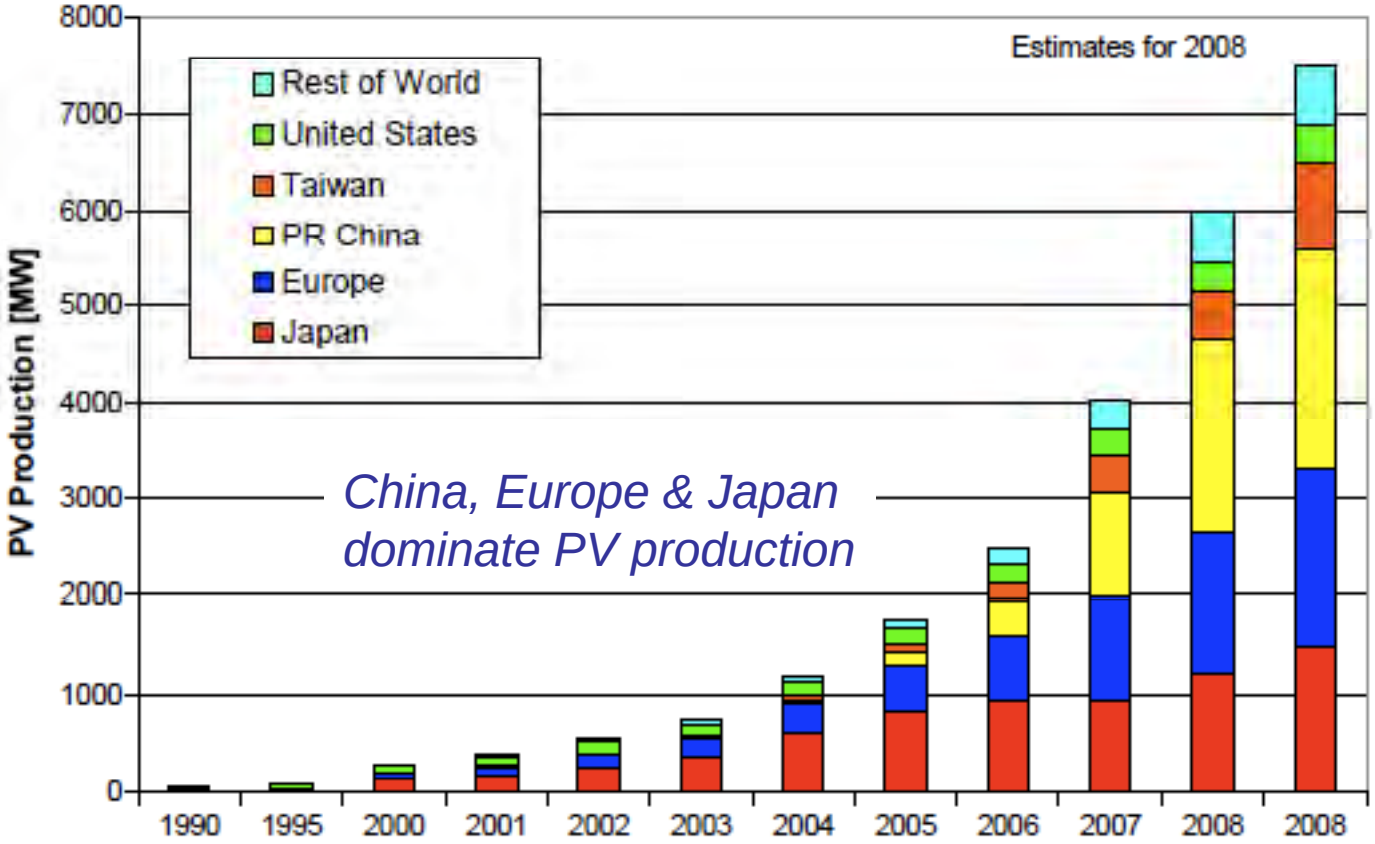
Source: Nitsch, F. (2007): Technologische und energiewirtschaftliche Perspektiven erneuerbarer Energien. Deutsches Zentrum für Luft- und Raumfahrt.

Solar radiation on a perpendicular plane at the earth's surface: Southern hemisphere summer (top) & winter (bottom) (ipcc)



Indonesian solar energy resource ~ 17.5 MJ/m^2/day ave

Solar PV production, MW/yr (based on IEA data)



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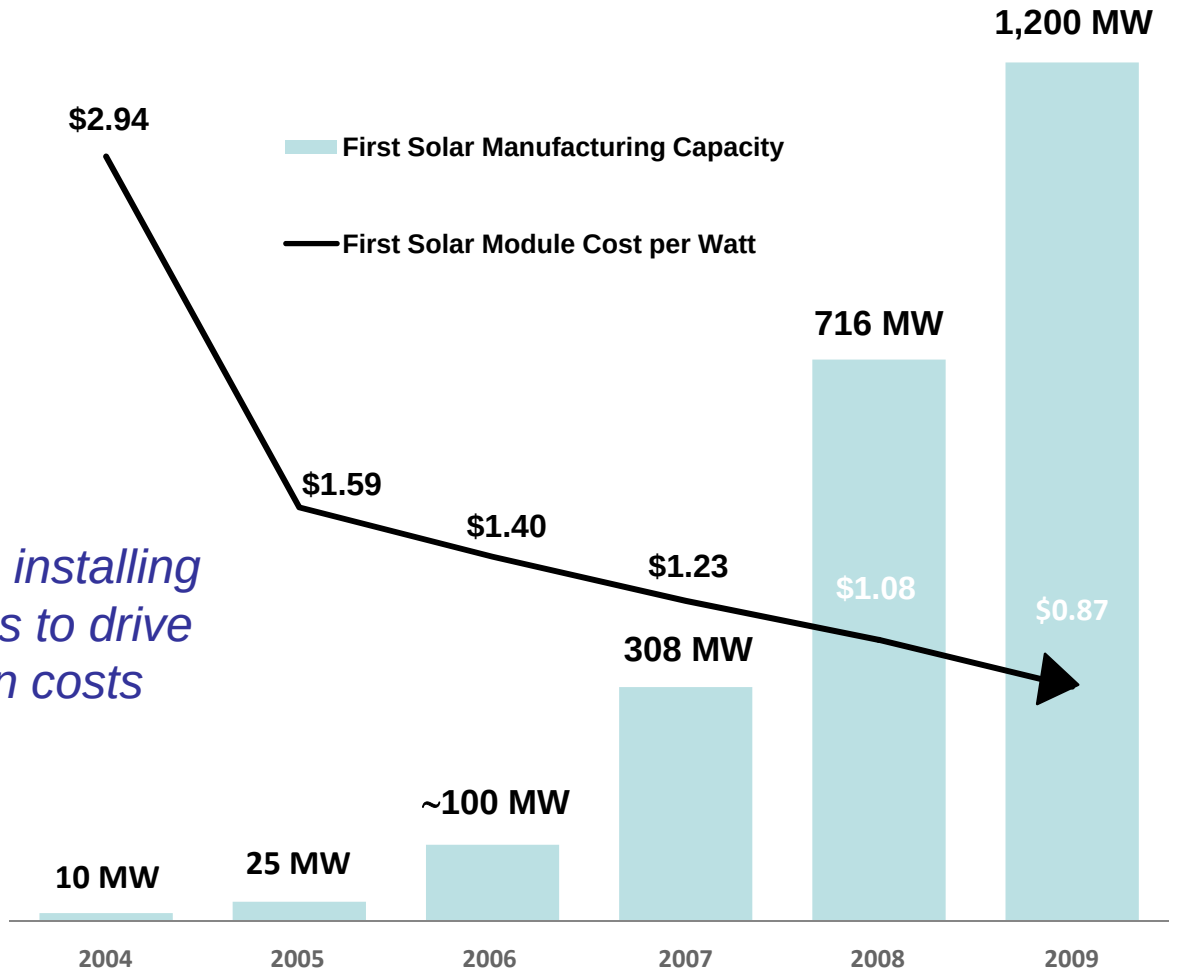
PV cost reduced by increasing manufacturing scale (MW/yr)

(First Solar, 2009)



PV companies are installing very large factories to drive down production costs

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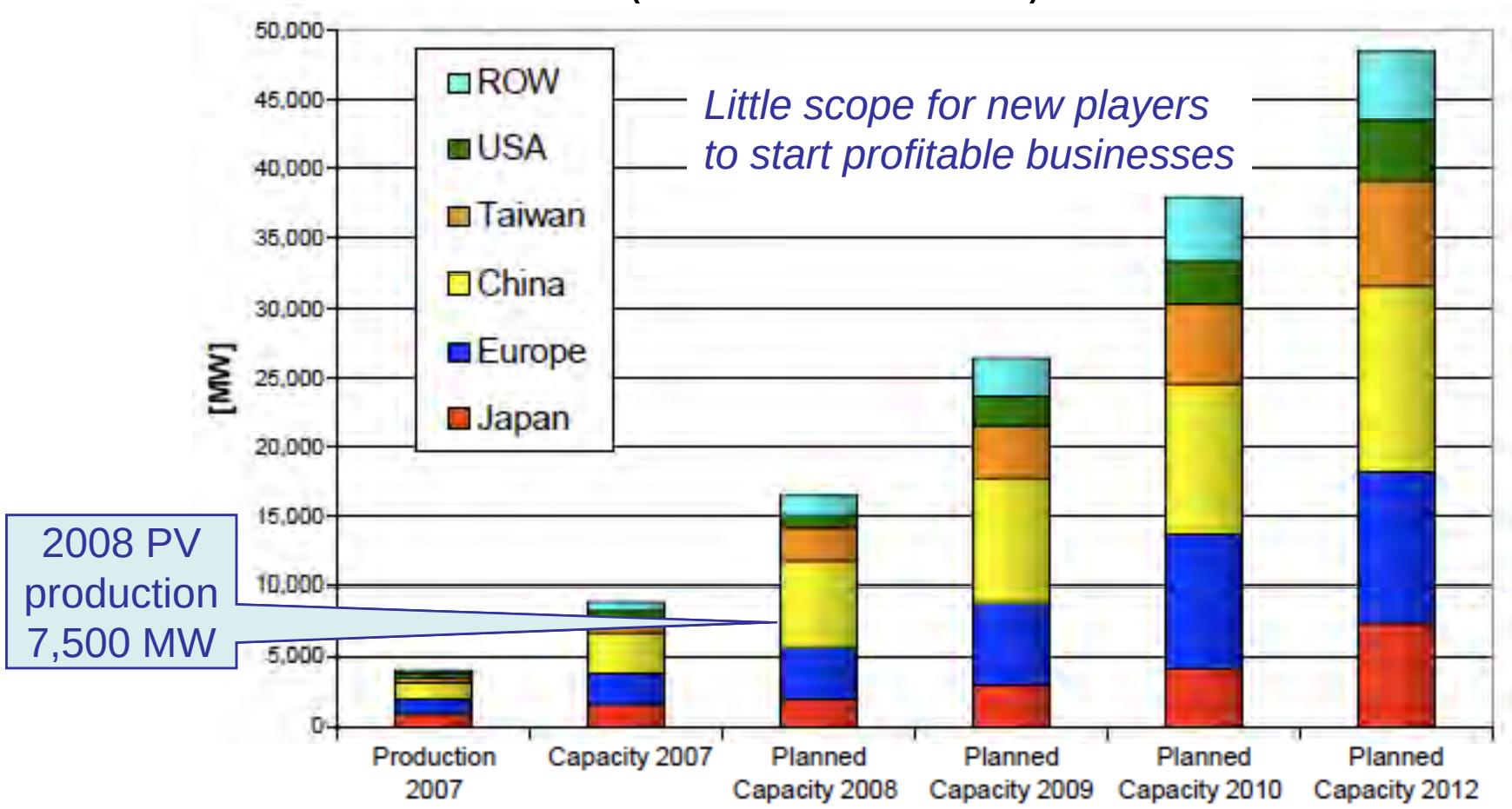
Planned global PV production capacity

(based on IEA data)



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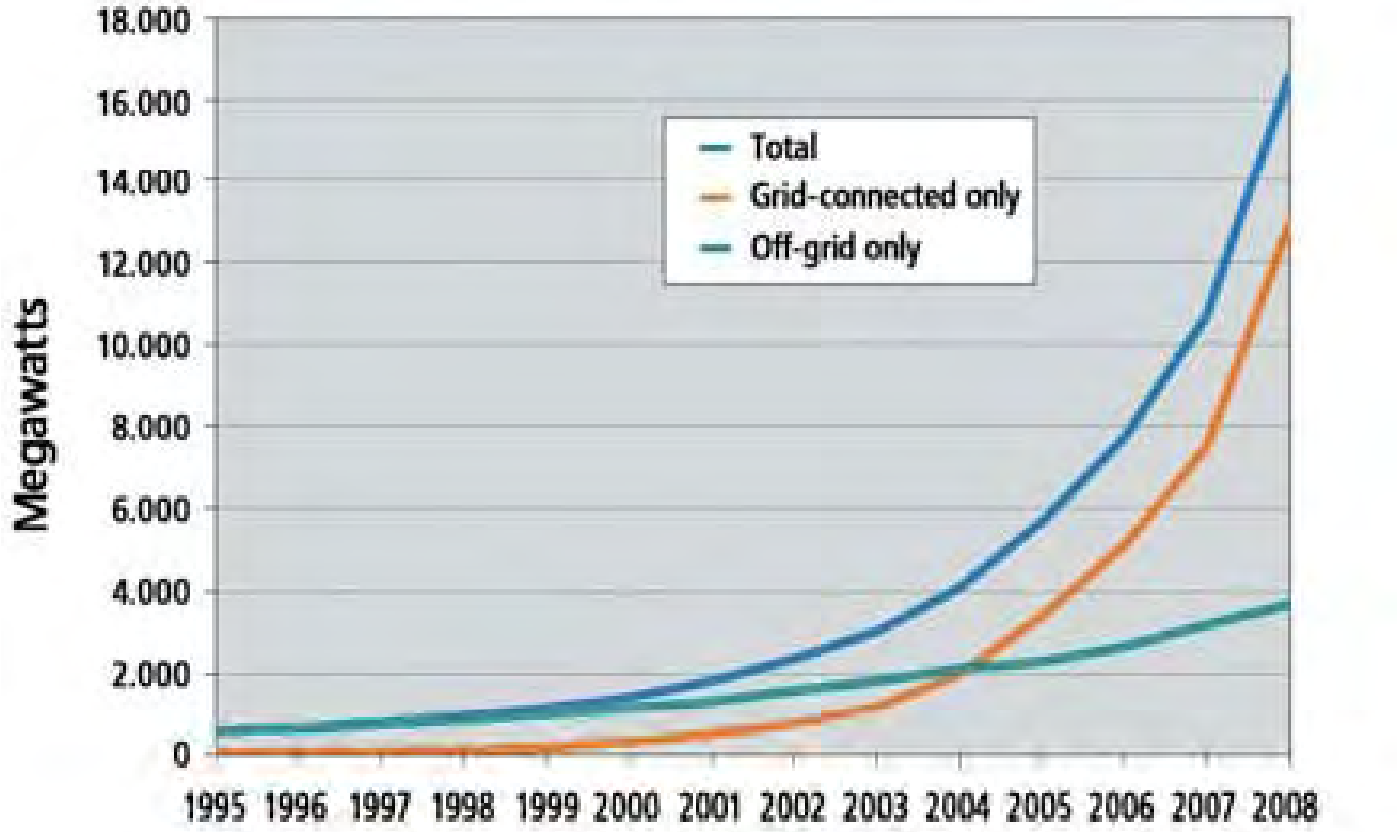
Cumulative installed PV capacity (REN21, 2009)



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A range of energy-efficient lighting solutions for poor countries (Philips, 2009)

Homes, communities, shops

Orientation

Education

Uday Solar lanterns
(Cfli)
Status:
-Uday available (Ghana)
-Uday mini: com. release Q4 2009 (India-Africa)

Solar portable lantern
(Led + cfli)

Status: commercial release in Q4 2009 (Africa)

Solar Lighting System
(led, multi light)

Status: in development -release in Q1 2010 (Africa)

Led crank torch
(led+dynamo)

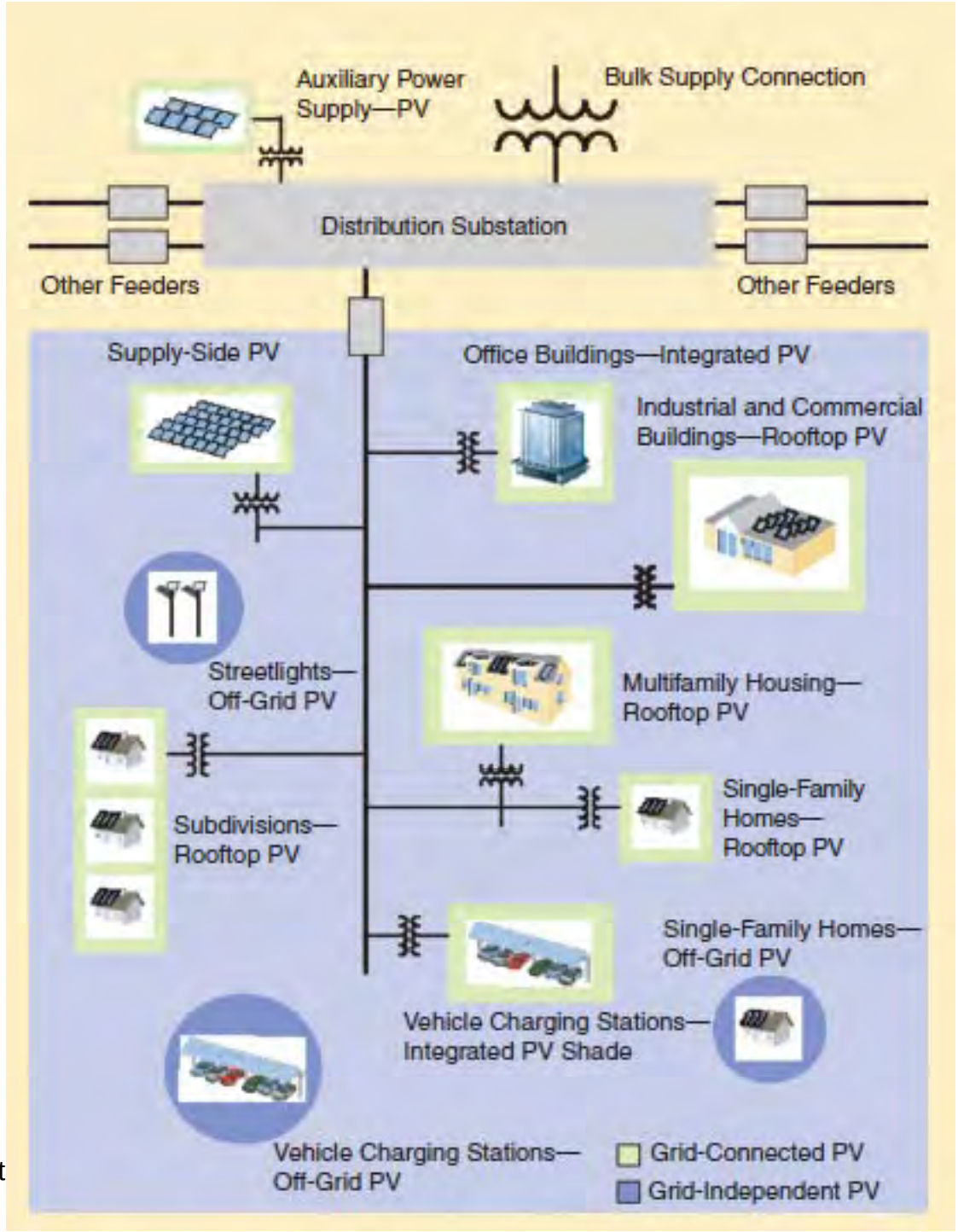
Status: commercially available (Africa, India)

Solar Reading Light
(led)

Status: in pilot and development

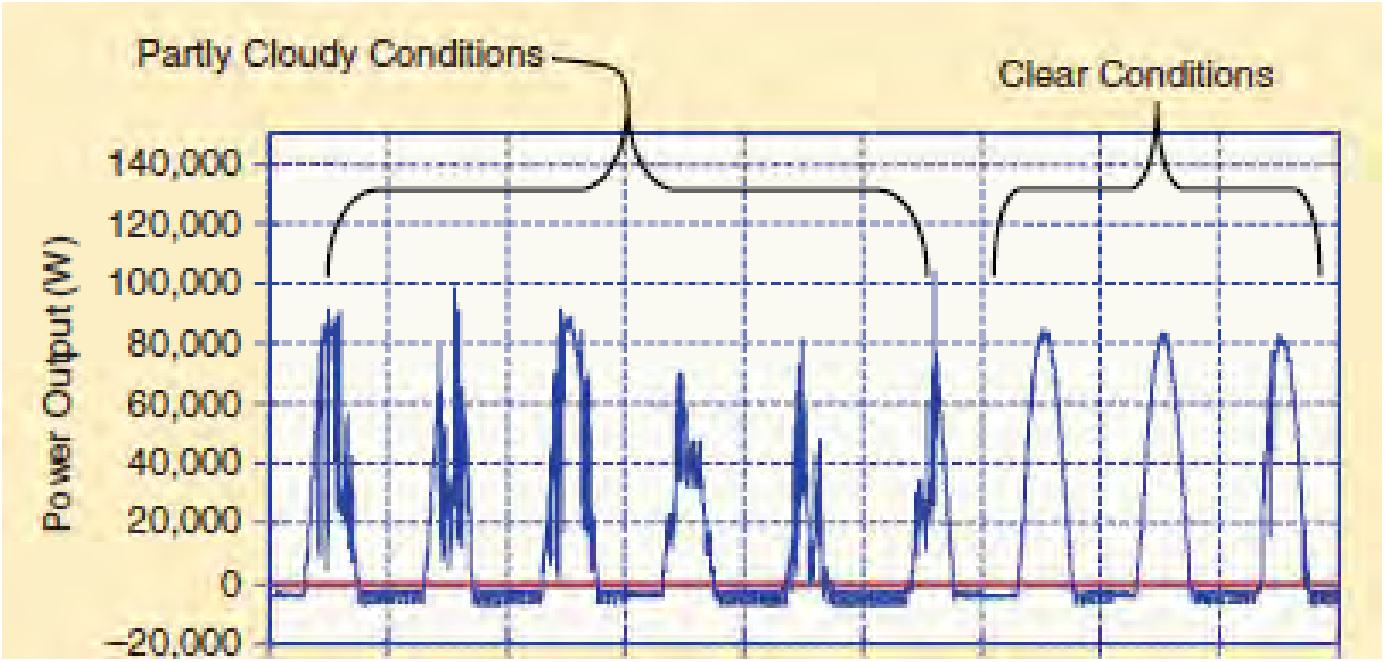
Some possible grid-connected PV applications

(T Key, IEEE Power & Energy Magazine, May/June 2009, p 34)

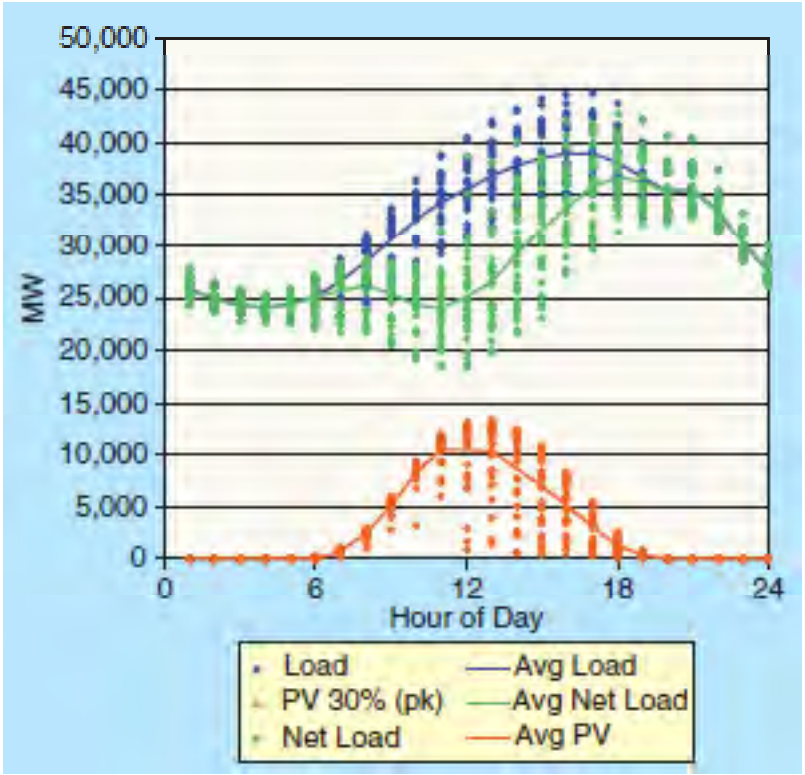


Variability of PV production due to cloud cover

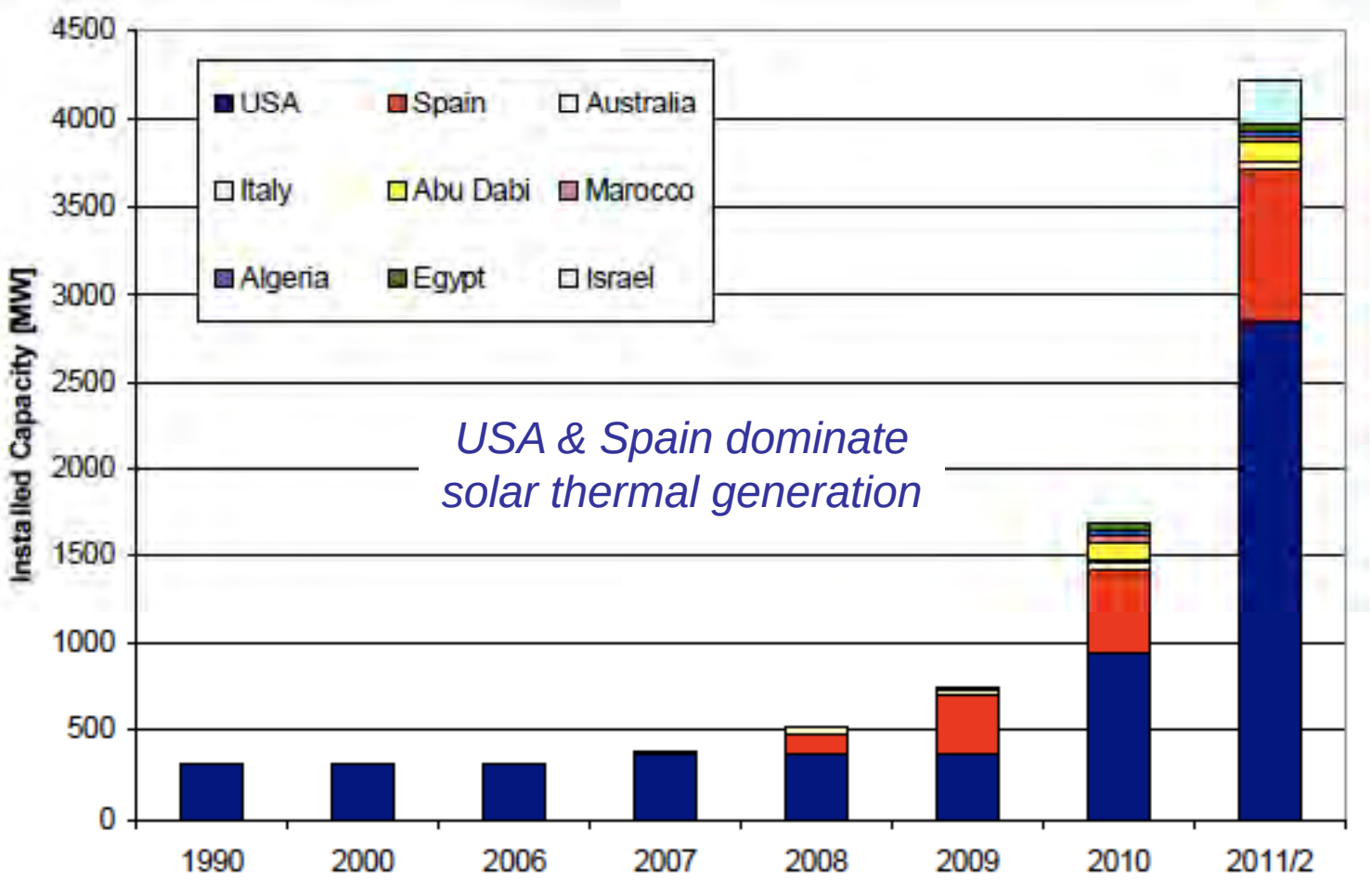
(T Key, IEEE Power & Energy Magazine, May/June 2009, p 34)



(Bebic et al, IEEE Power & Energy Magazine, May/June 2009, p 45)



Concentrating solar thermal electricity generation (installed capacity & projections (IPCC))



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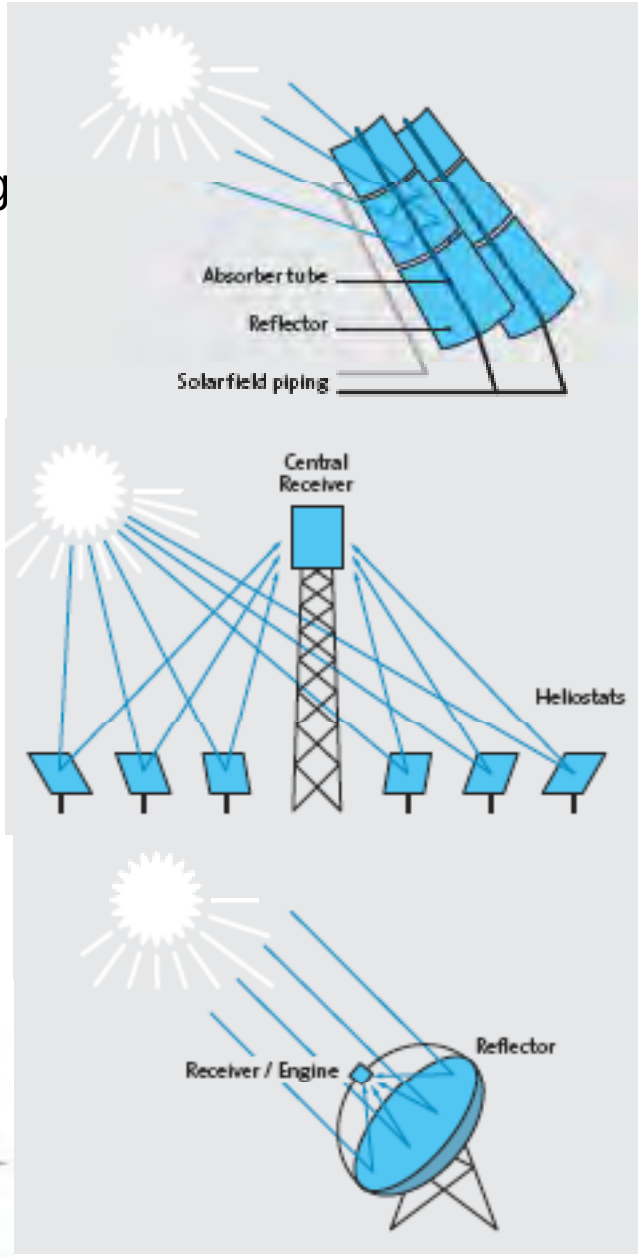
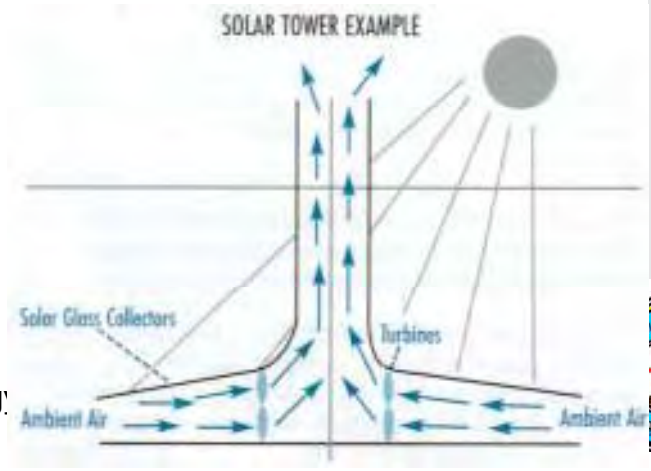
Solar thermal concentrators for electricity generation (www.greenpeace.org

- Parabolic trough (~350MWe):
  - Most mature but low efficiency
- Central receiver (~10MWe):
  - High efficiency but pre-commercial
- Parabolic dish (<1MWe):
  - High efficiency but pre-commercial
- Tower (50MWe)
  - Wind from temperature differential; pre-commercial





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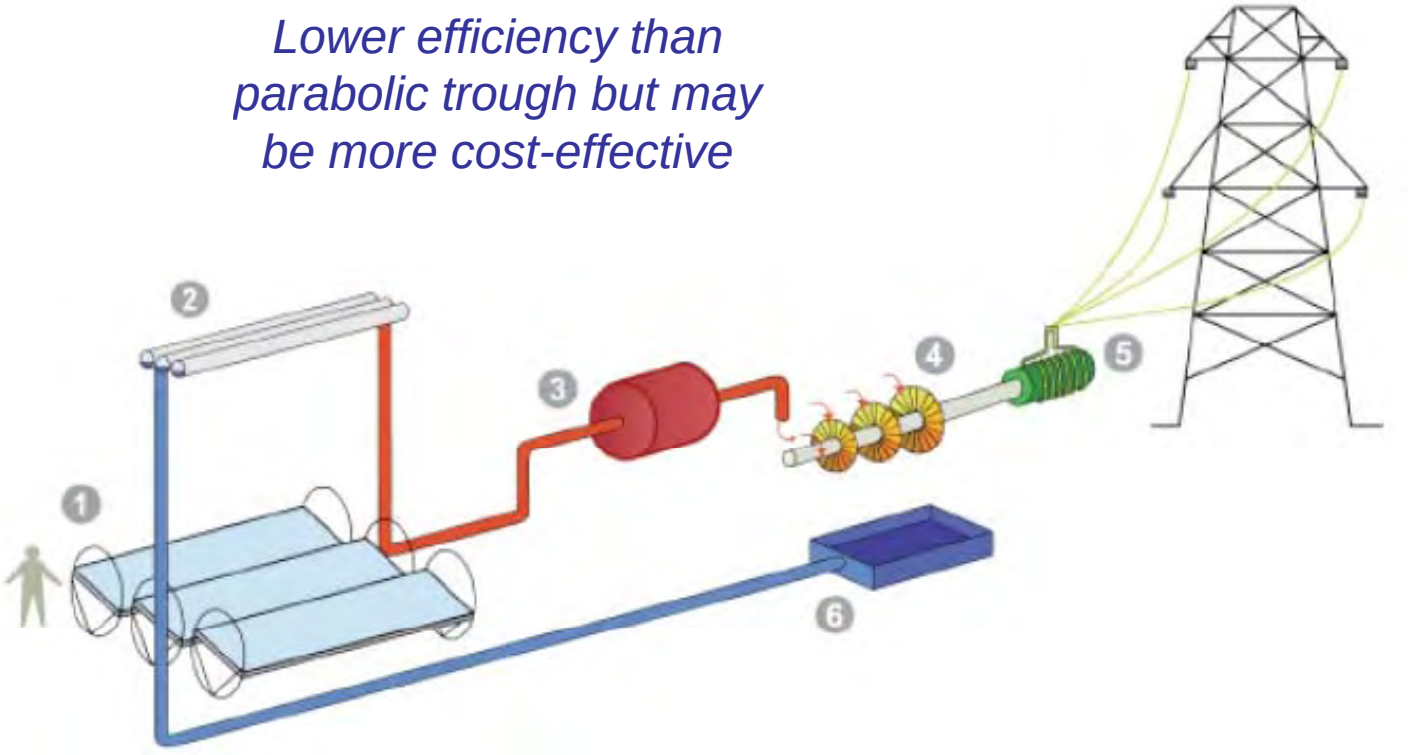
Fresnel solar thermal electricity generation
(www.ausra.com, 2008)

Lower efficiency than parabolic trough but may be more cost-effective



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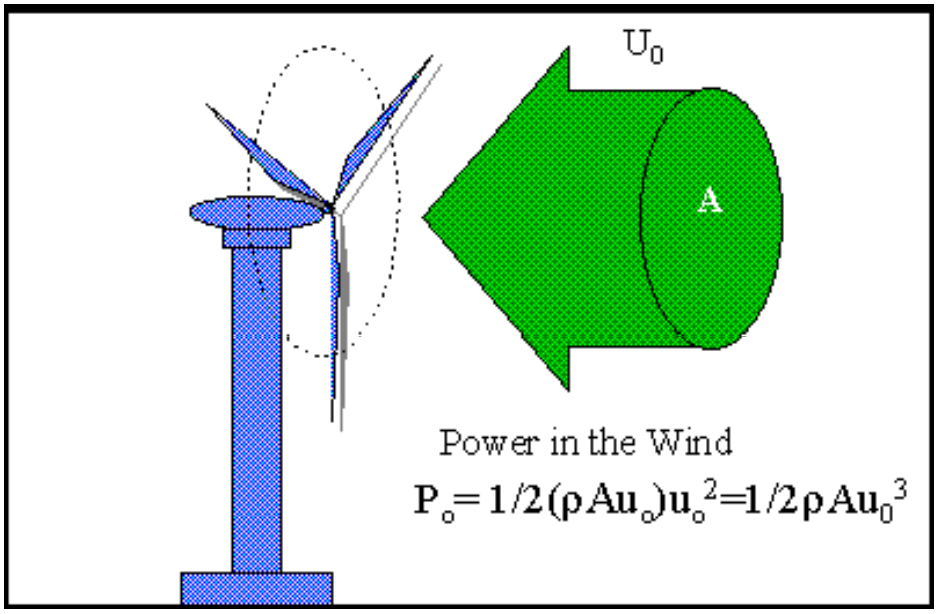
Wind power density



- Wind power is a non-storable energy flux
- Doubling the wind speed increases the wind power density eight times
- Doubling the turbine swept area only doubles the turbine power

(European Commission, 2005)

Prototype of RePower 5 MW wind turbine installed at Brunsbüttel, Germany. With a rotor diameter of 126 m, it is the largest wind turbine ever built.

A 2MW wind turbine (www.vestas.com)

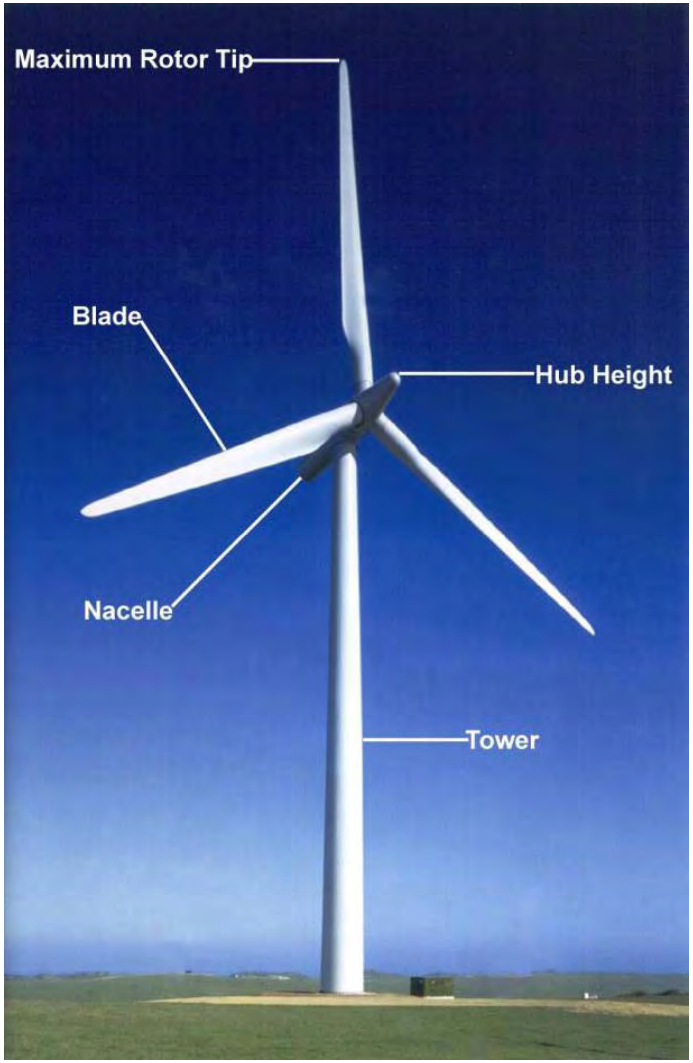
Vestas V80

- Rotor Diameter: 80 m
- Speed revolution: 16.7 rpm
  - Operational: 9 - 19 rpm
- Number of blades: 3
- Tower Hub height: 60 - 67 - 78 - 100 m

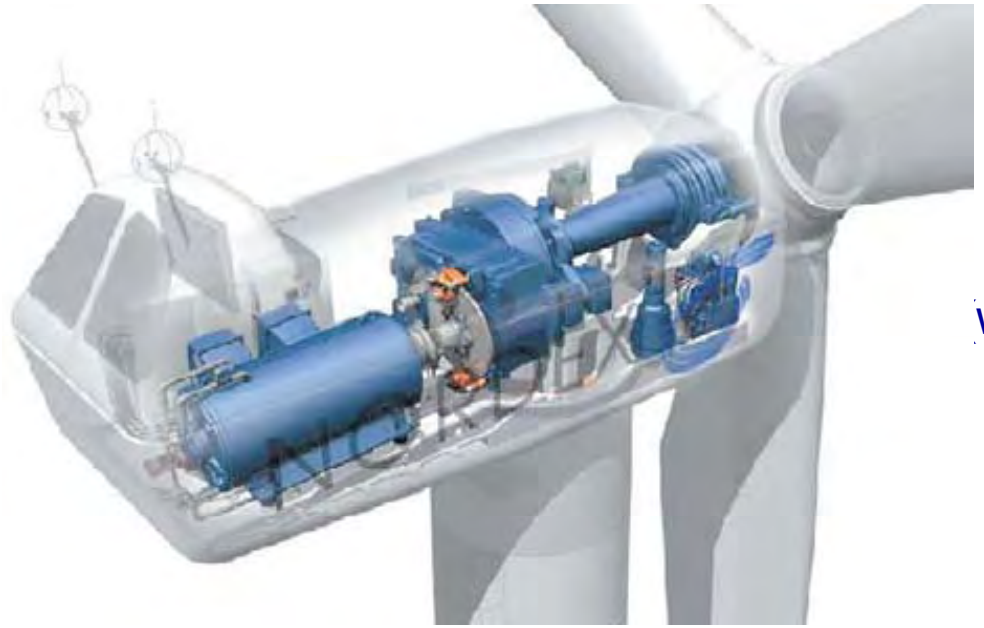
- Operational data
  - Cut-in wind speed: 4 m/s
  - Nominal wind speed: 15 m/s
  - Stop wind speed: 25 m/s

- Generator Type: Asynchronous
- Gearbox Type: Planet/parallel axles

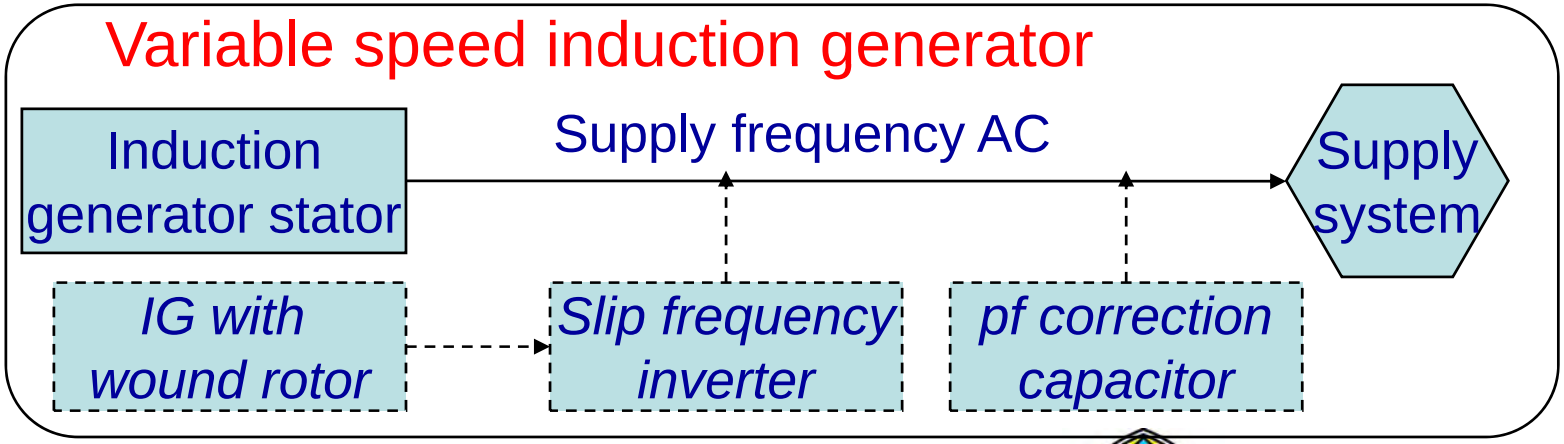
- Control Type: Microprocessor; optional remote. Output regulation & optimisation via OptiSpeedT and OptiTip® pitch regulation.



Wind turbine design option:
gearbox & variable speed induction generator



(www.hydro.com.au)



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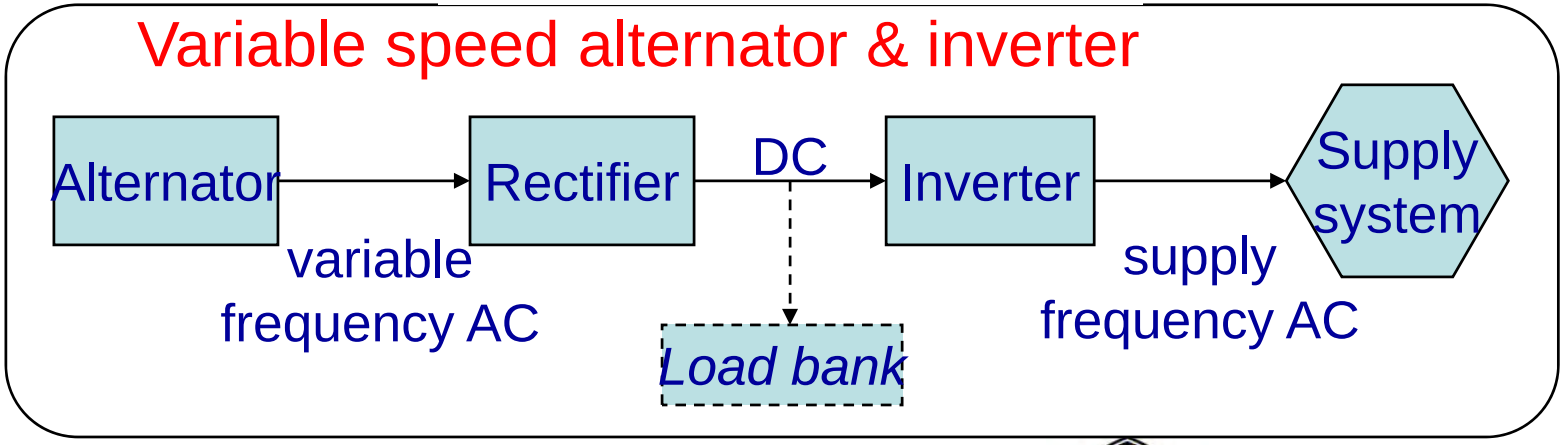
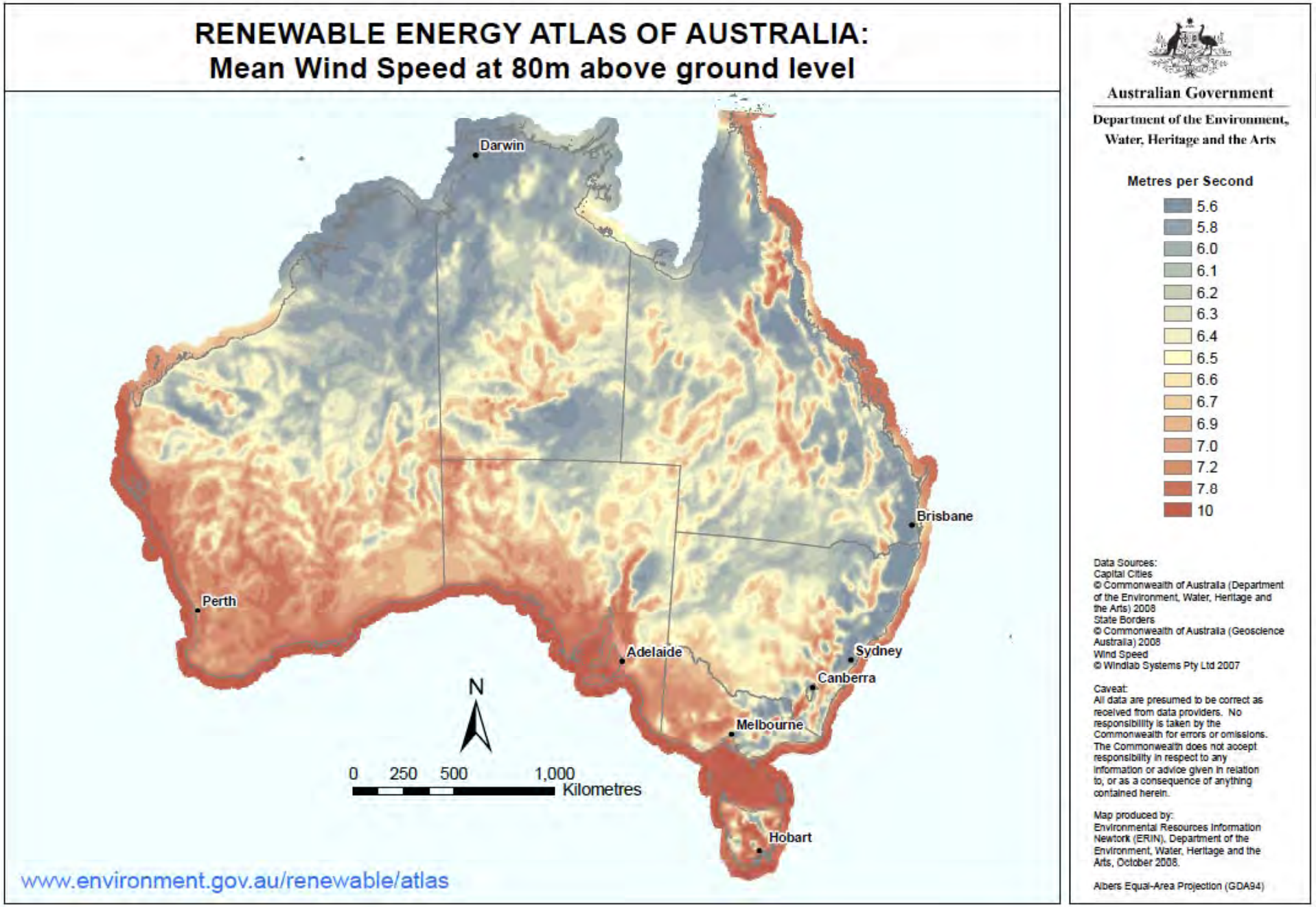
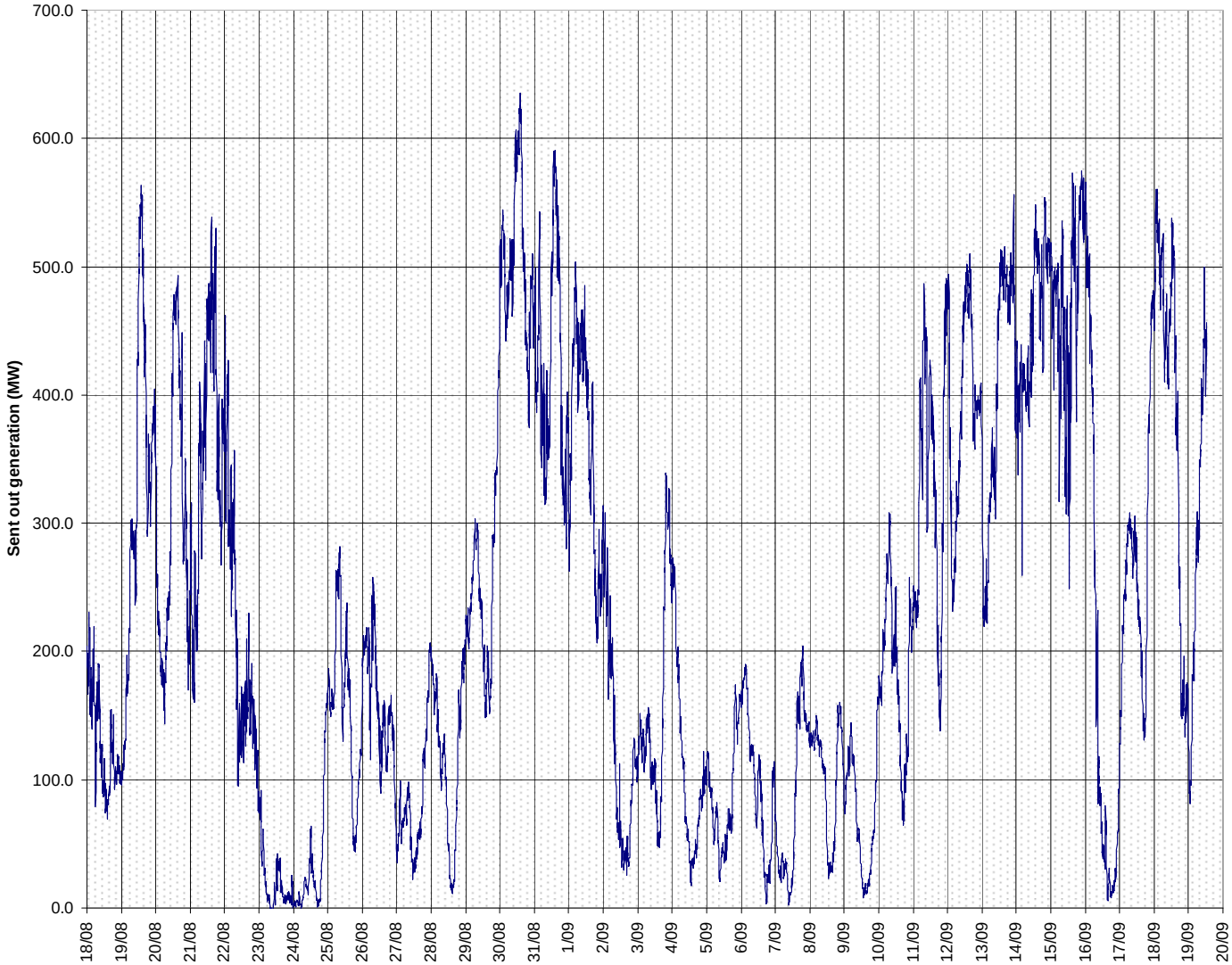
Wind turbine design option: *direct-drive variable speed alternator*

(www.enercon.de)




RENEWABLE ENERGY ATLAS OF AUSTRALIA:
Mean Wind Speed at 80m above ground level
Darwin
Perth
Adelaide
Brisbane
Sydney
Canberra
Melbourne
Hobart
N
0 250 500 1,000
Kilometres
www.environment.gov.au/renewable/atlas
Australian Government
Department of the Environment, Water, Heritage and the Arts
Metres per Second
5.6
5.8
6.0
6.1
6.2
6.3
6.4
6.5
6.6
6.7
6.9
7.0
7.2
7.8
10
Data Sources:
Capital Cities
© Commonwealth of Australia (Department of the Environment, Water, Heritage and the Arts) 2008
State Borders
© Commonwealth of Australia (Geoscience Australia) 2008
Wind Speed
© Windlab Systems Pty Ltd 2007
Caveat:
All data are presumed to be correct as received from data providers. No responsibility is taken by the Commonwealth for errors or omissions. The Commonwealth does not accept responsibility in respect to any information or advice given in relation to, or as a consequence of anything contained herein.
Map produced by:
Environmental Resources Information Network (ERIN), Department of the Environment, Water, Heritage and the Arts, October 2008.
Albers Equal-Area Projection (GDA94)

Wind generation in South Australia, Aug 08



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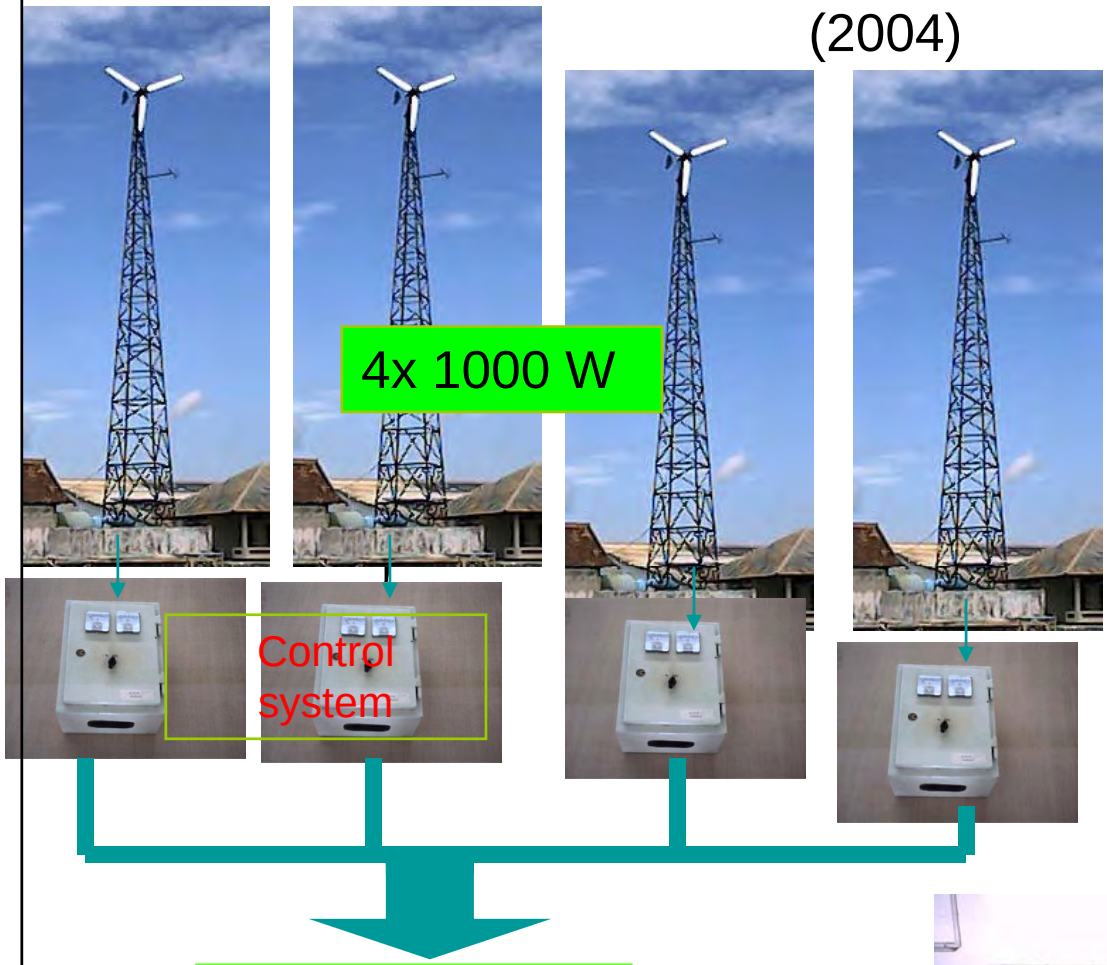
Pulau Karya in Pulau Seribu

(2004)



An off-grid wind application in Indonesia

Inverter 2500 W
12Vdc to 220V ac

Applications :
- Lighting
- Computer
- Water Pumping

Global ... gy & implications fo...

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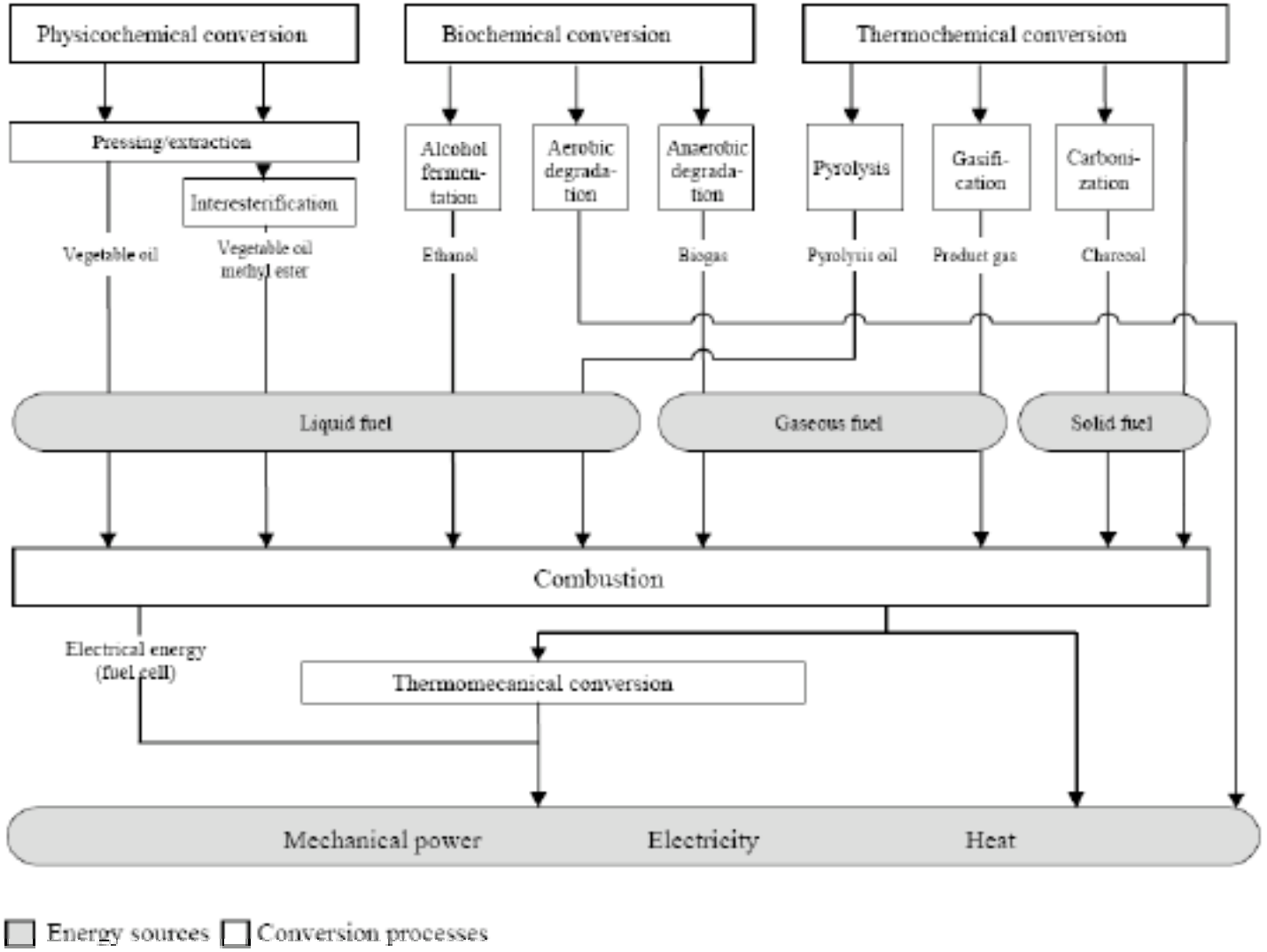
Pathways for producing energy from biomass
(IPCC SRREN)



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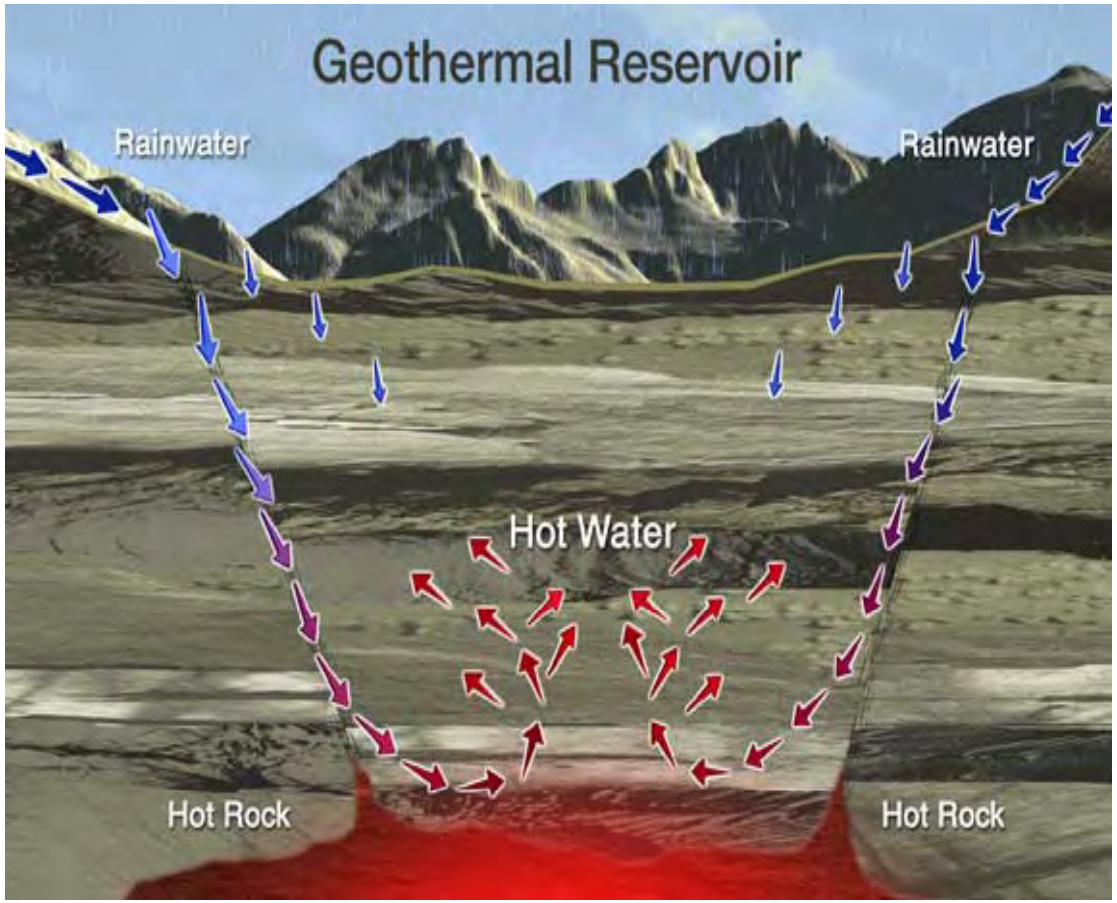
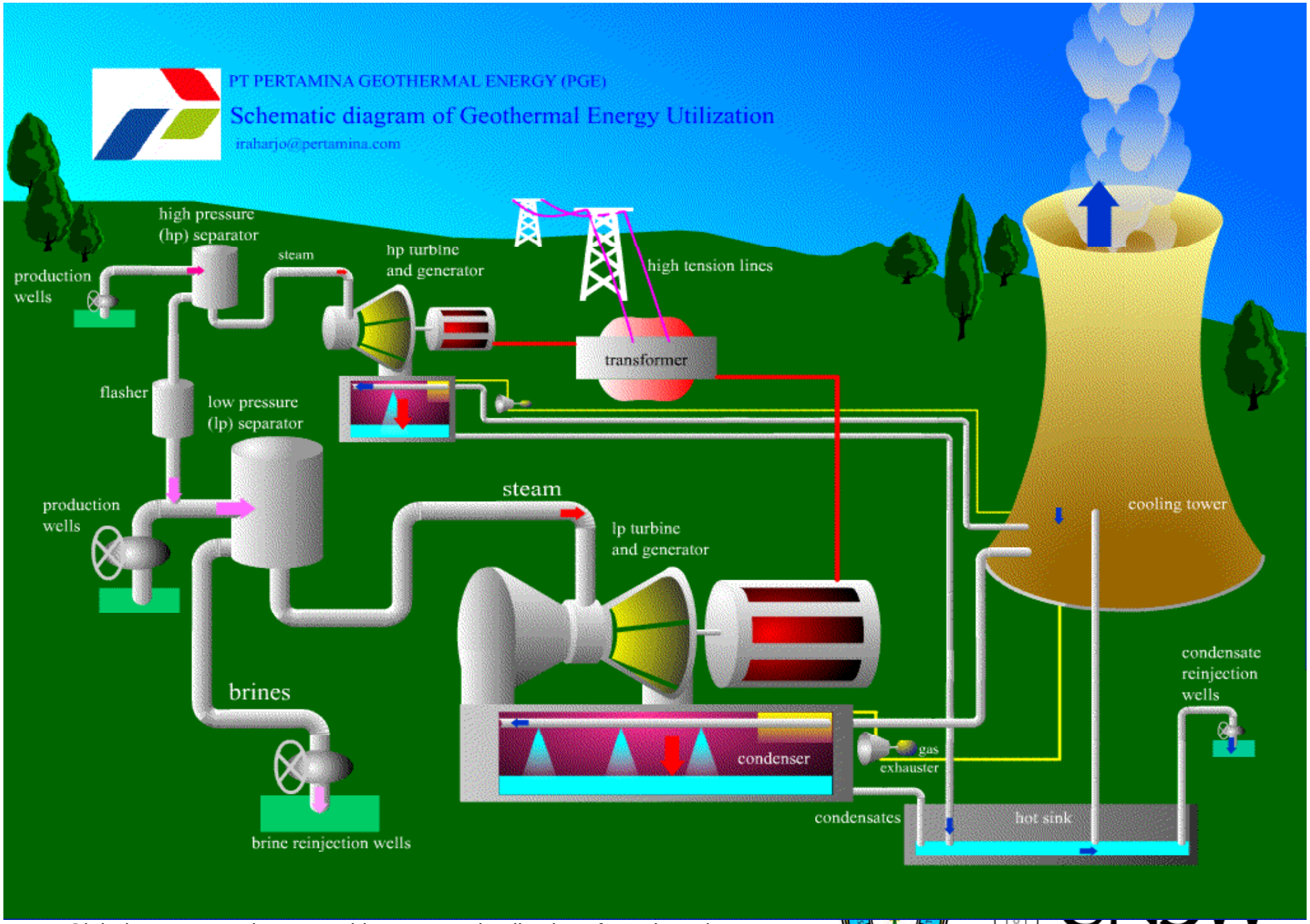
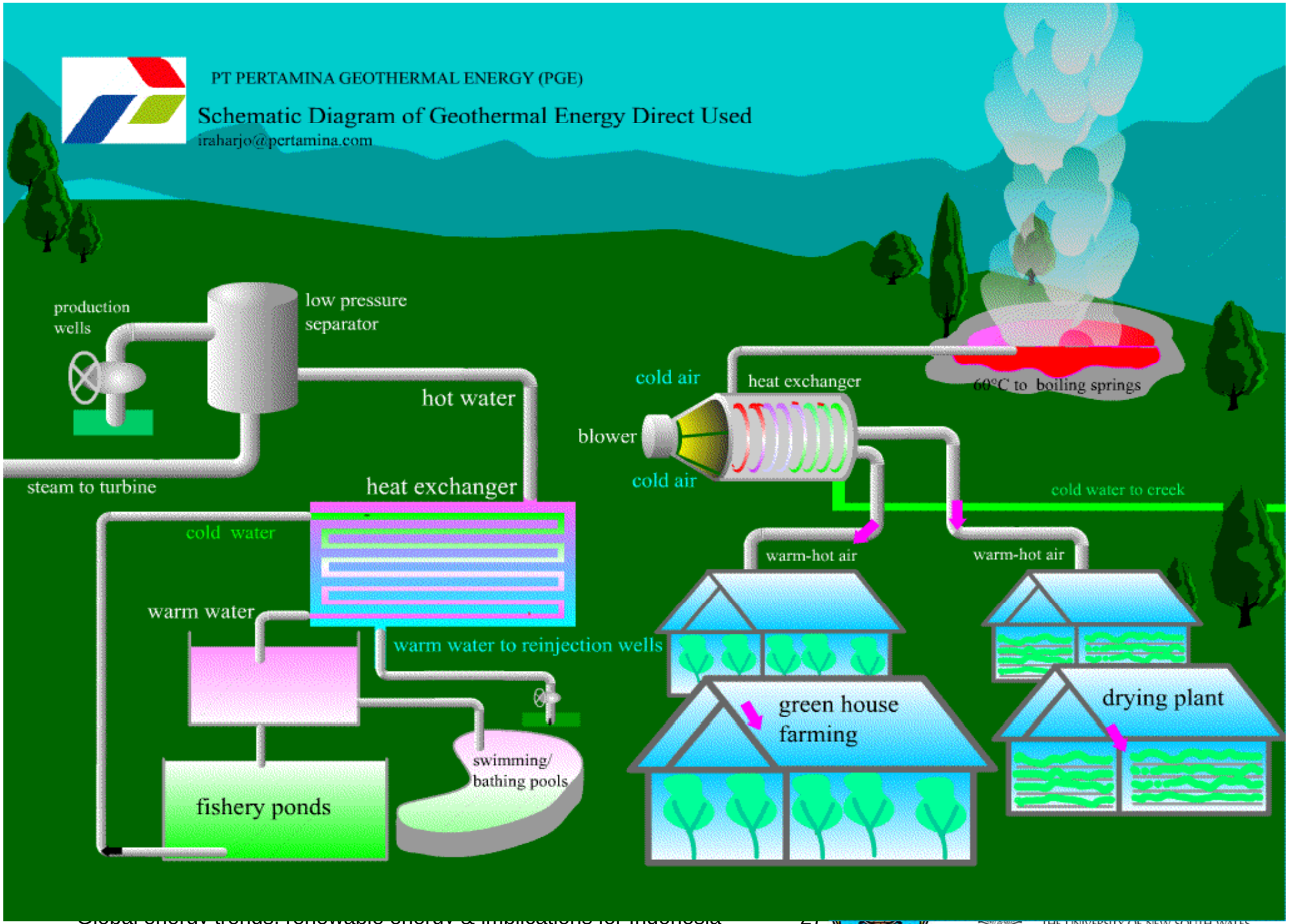
Projected increase in global biofuel use

- Increase 7–9% pa to meet 4–7% of global road transport fuel demand by 2030 (IEA WEO, 2006)
- Could meet 13% of global road transport fuel demand by 2050 (IEA ETP, 2006)
- Underlying concern – potential conflicts between:
  - Biofuels (ethanol & biodiesel)
  - Food production
  - Ecosystem services

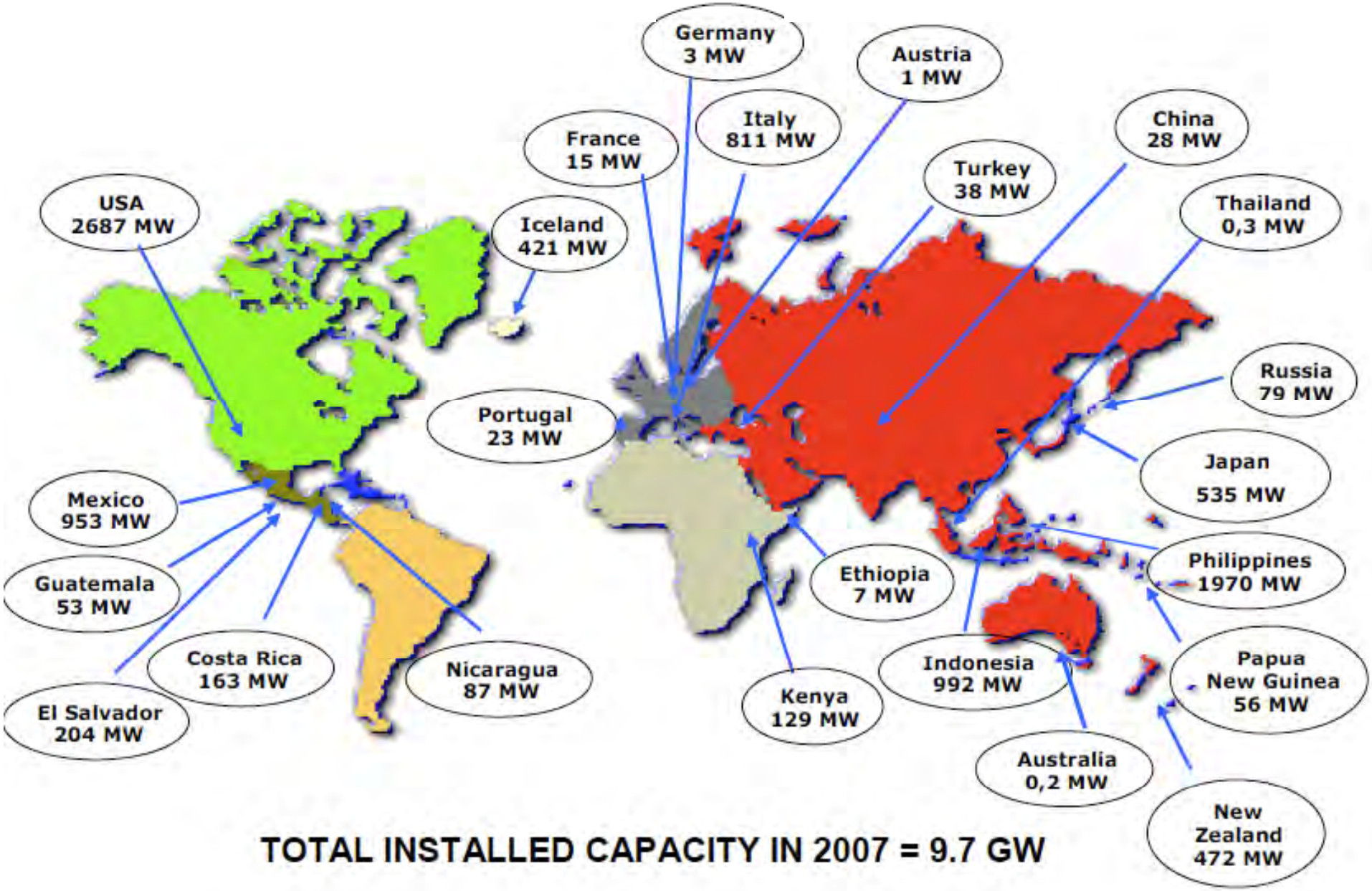
Geothermal energy (PT Pertamina, 2009)



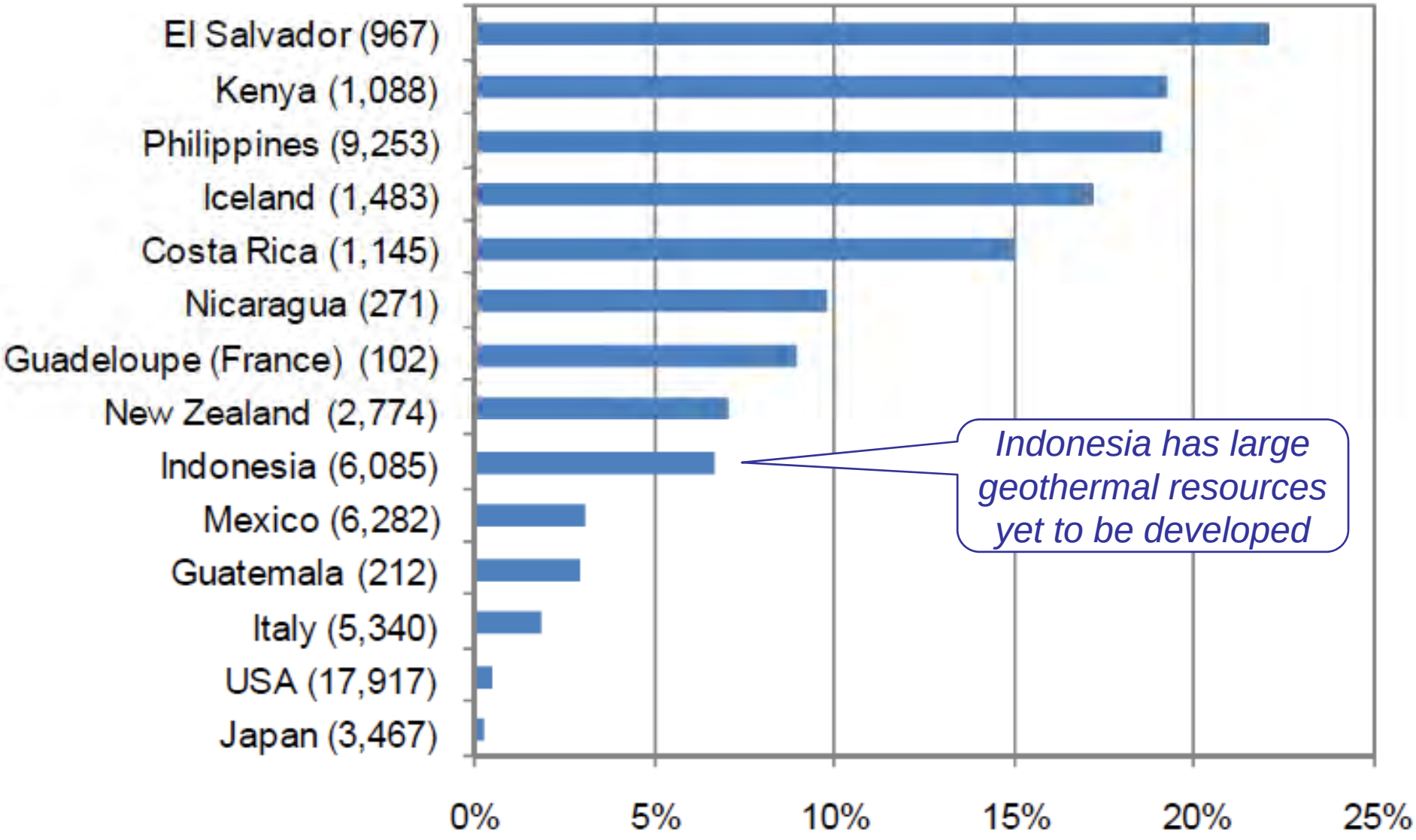



PT PERTAMINA GEOTHERMAL ENERGY (PGE)
Schematic Diagram of Geothermal Energy Direct Used
iraharjo@pertamina.com
production wells
low pressure separator
hot water
steam to turbine
heat exchanger
cold water
warm water
warm water to reinjection wells
fishery ponds
swimming/ bathing pools
cold air
heat exchanger
60°C to boiling springs
blower
cold air
cold water to creek
warm-hot air
warm-hot air
green house farming
drying plant

Installed geothermal capacity, 2007



Countries with high share of geothermal electricity (2007) (GWh/yr & %)



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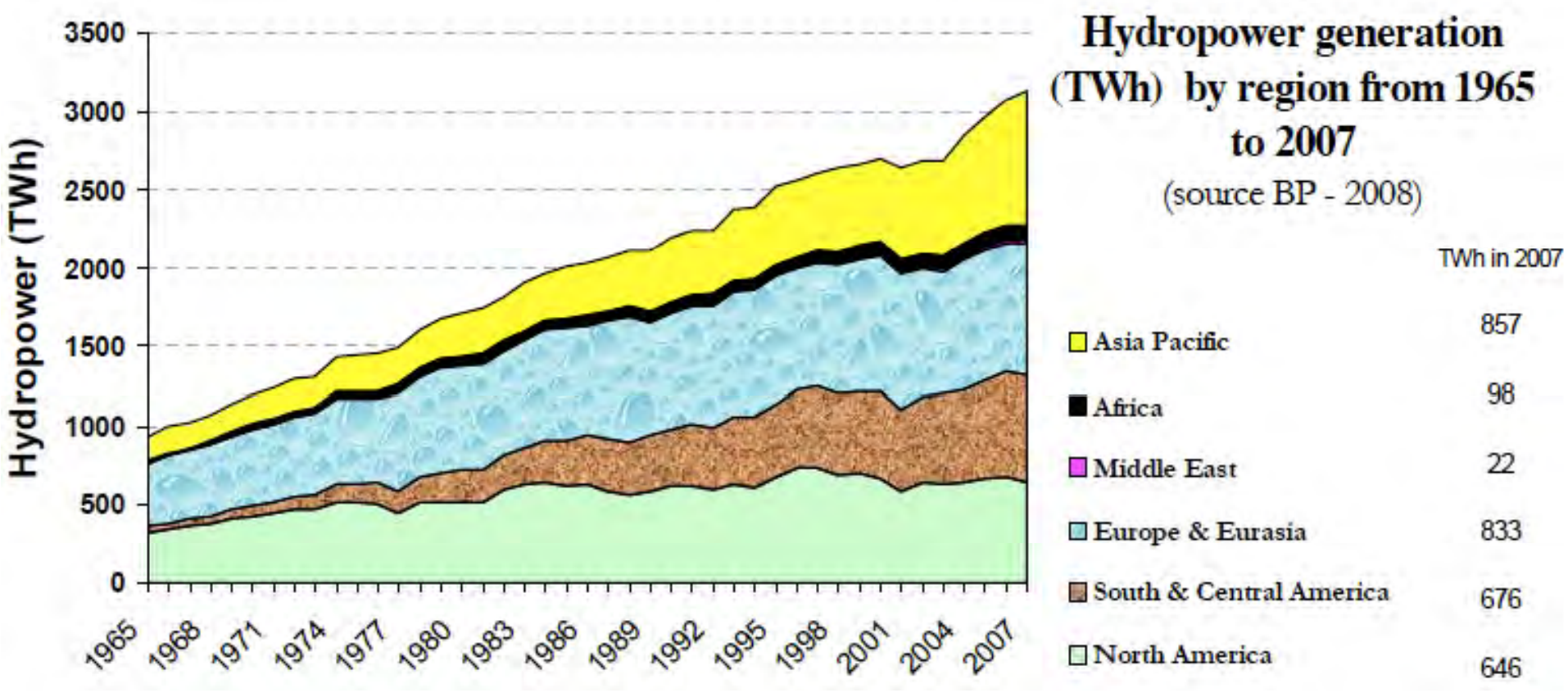
Hydro generation – historical use (TWh pa)

Hydro is an important option for reducing climate emissions. Installed capacity may double by 2030
Mini- & micro-hydro important in Indonesia



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Indonesia has a well-established micro-hydro industry

X-flow Turbine T-14 D300
head: 3 – 100 meter
power: 10 – 150 kW

X-flow Turbine T-14 D150
head: 3 – 40 meter
power: 3 – 30 kW

X-flow Turbine T-15 D500
head: 5 – 100 meter
power: 50 – 600 kW

PROFILE *product - turbine*

HEKSA HYDRO

Peltric Turbine
head: 15 – 100 meter
power: 1 – 30 kW

Propeller S-Turbine
head: 2 – 13 meter
power: 10 - 150 kW

Pelton Turbine
head: 70 – 300 meter
power: 50 – 1000 kW

Conclusions

- Renewable energy may contribute to:
  - Responding to high fossil fuel prices
  - Reducing climate change emissions
  - Facilitating sustainable development
- To promote renewable energy in Indonesia:
  - Identify promising regional resources & applications
  - Develop understanding of renewable energy in policy makers, engineers and the community
  - Undertake well-planned renewable energy projects
  - Develop domestic renewable energy industries & expertise

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Hugh Outhred is a Professorial Visiting Fellow at the University of New South Wales (UNSW), an Adjunct Professor at Murdoch University, *Guru Besar Luar Biasa* at STTNAS Jogjakarta, Indonesia and a Director of Ipen Pty Ltd, which provides advisory and educational services on energy, society and the environment.

Hugh retired in 2007 after a 35-year career at UNSW, most recently as Presiding Director, Centre for Energy and Environmental Markets and Head, Electrical Energy Research Group, School of Electrical Engineering and Telecommunications.

During his career, Hugh has been a Fulbright Senior Fellow at the University of California Berkeley, a Board Member of the Australian Cooperative Research Centre for Renewable Energy, an Associate Director of UNSW's Centre for Photovoltaic Devices and Systems, a Member of CSIRO's Energy Flagship Advisory Committee, a Member of the National Electricity Tribunal and a Member of the New South Wales Licence Compliance Advisory Board. He is a Lead Author for the IPCC Special Report on Renewable Energy & Climate Change Mitigation, to be published in 2010.

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