Center for Electric Car and Energy Conversion (EC&EC)

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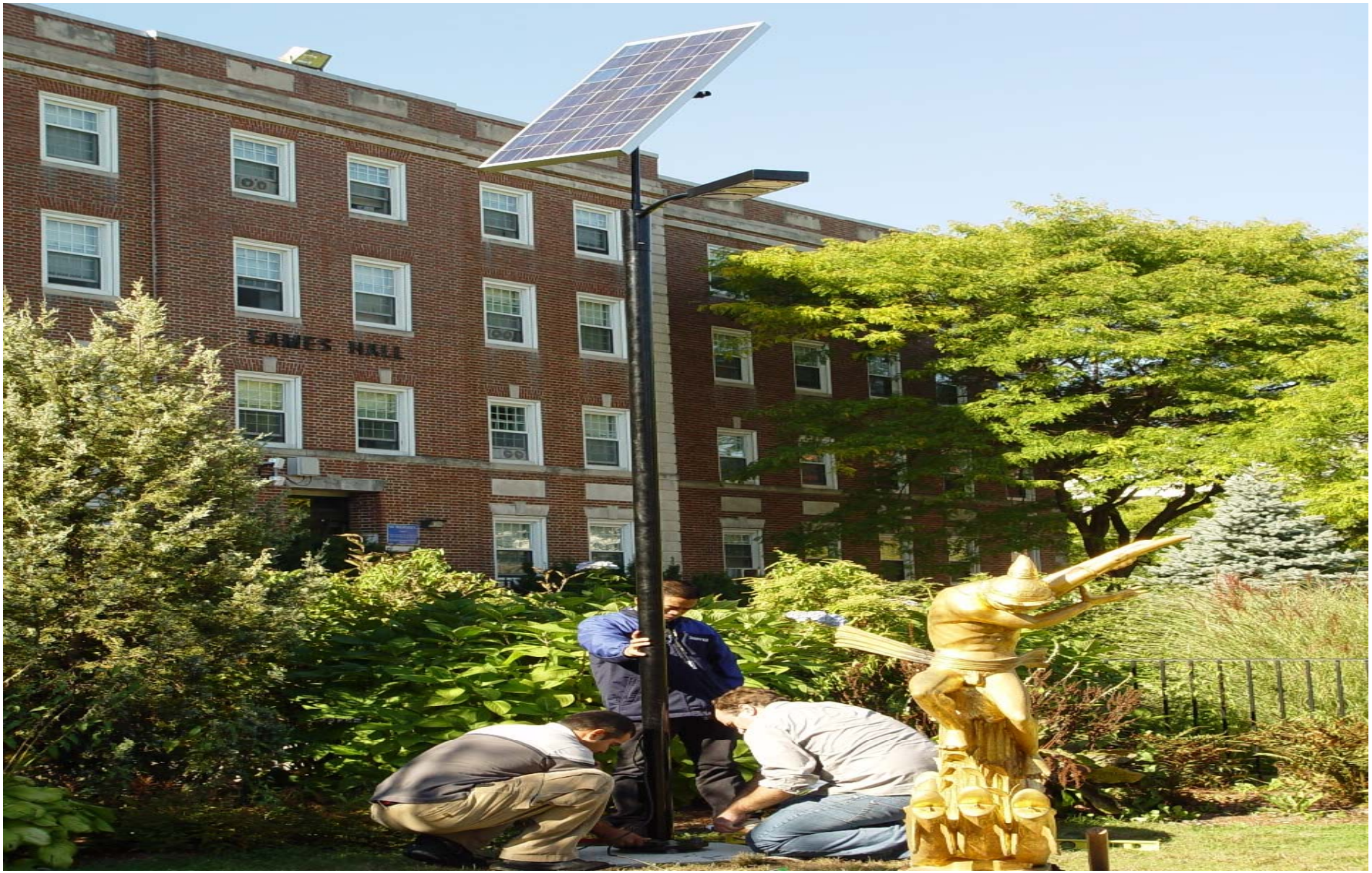
Reneable Energy Sources and Their Impact on Utility Grids

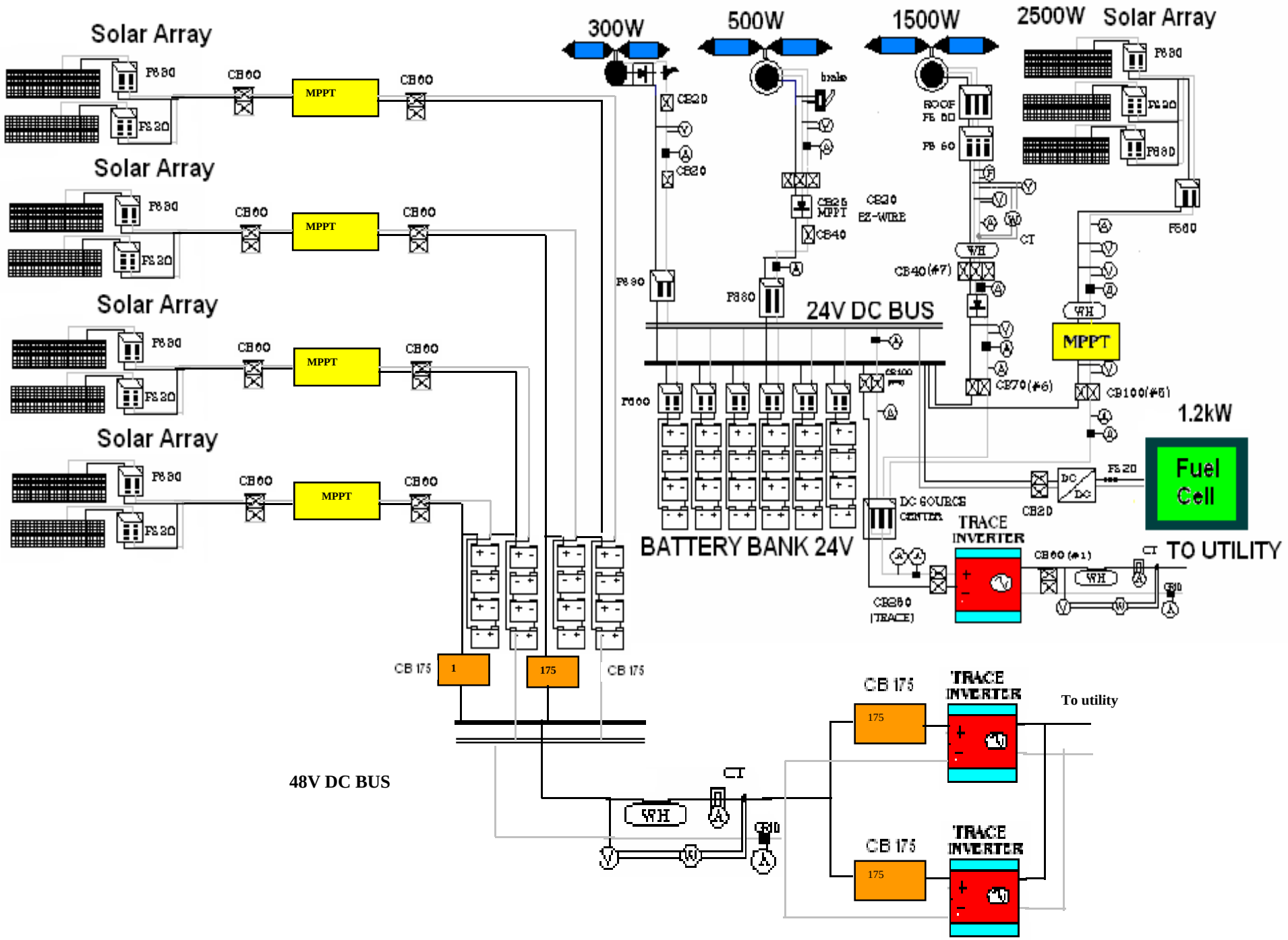
- ***Renewable Energy at University of Massachusetts _Lowell***
- ***Renewable Energy Sources / Brief***
- ***World Wide Renewable Energy***
- **Why the Enormous Interest in Renewable Energy**
- **Impact of Renewable Energy on Utility Grids**

PV Powered Street Light




DATA ACQUISITION
CONTROL SYSTEM
1600W

10.56kW


Solar Array
Solar Array
Solar Array
Solar Array
MPPT
MPPT
MPPT
MPPT
300W
500W
1500W
2500W Solar Array
24V DC BUS
BATTERY BANK 24V
MPPT
1.2kW
Fuel Cell
TRACE INVERTER
TO UTILITY
DC SOURCE CENTER
48V DC BUS
CB 175
TRACE INVERTER
To utility
CB 175
TRACE INVERTER


CENTER FOR ELECTRIC CAR
& ENERGY CONVERSION
NOTICE
SOLECTRIA
ELECTRIC VEHICLE
force
MASSACHUSETTS
STATE 669F
OFFICIAL
2003 10 1

Renewable Energy Sources

Applications of WECS:
Stand Alone & Grid Connected

- **1. Small Scale Wind Energy Systems <10KW**

  houses, Small Farms, Boats, Remote Weathering Stations …

- **Intermediate Scale , 10KW-100KW**

  Remote Villages, Islands, Ranches……

- **Large Scale ,Wind Farms**

Antarctica

Village Electrification/Russia

Danish off shore Wind farm

Texas Horse Hollow Wind Farm/735MW

World largest wind turbine (6 MW) Germany/ Enercon E-126

GE 3.6MW Turbine

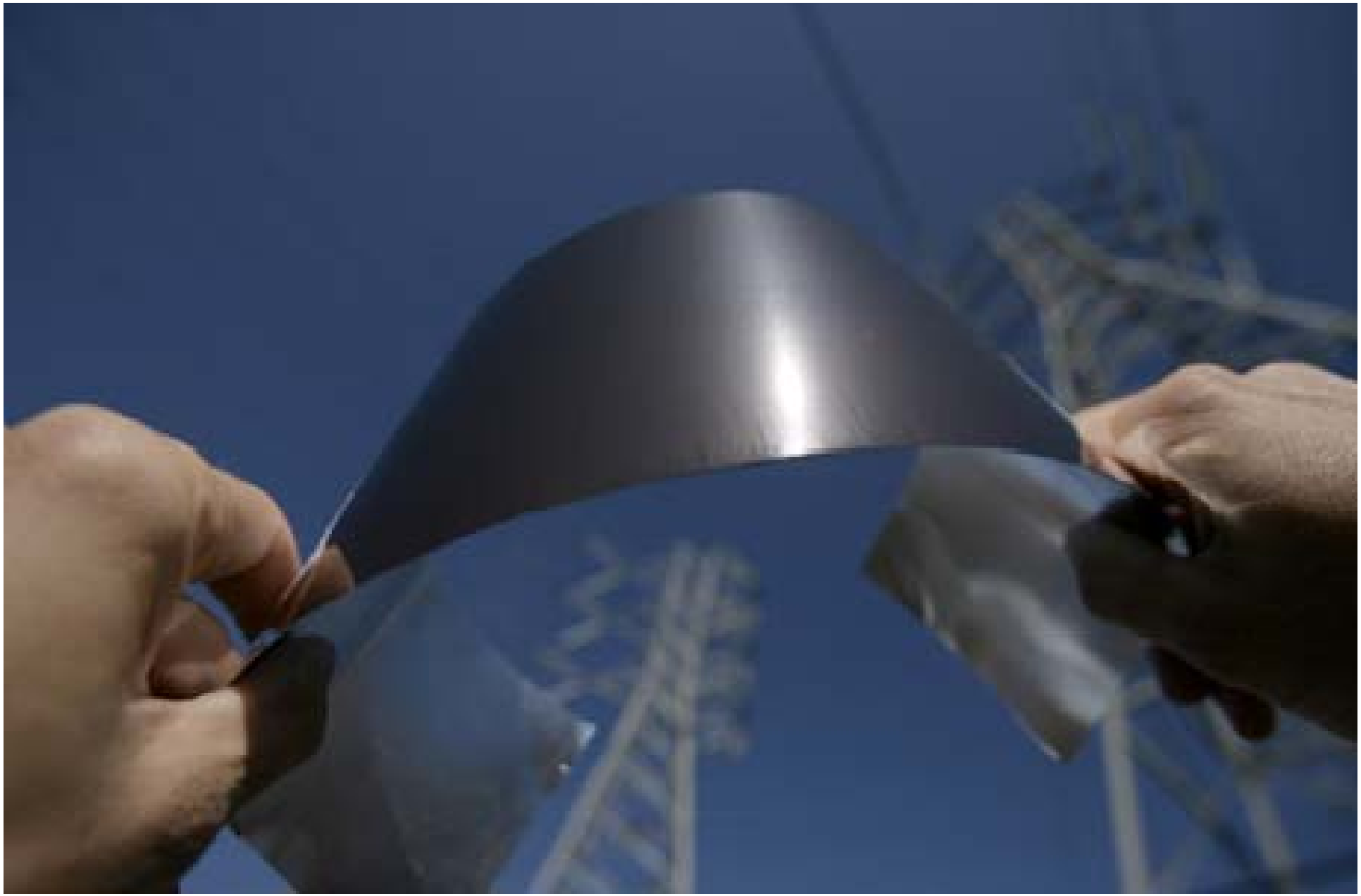
PV Powered House in MA

PV Powering Indian Reservation

12WM PV Farm in Arnstein Germany

Flexible PV Sheets/Konarka

Nanosolar



Biomass

Definition: Biomass material of plants or animals(organic material), include wood, Solid waste ,animal waste, sewage, crop residue, garbage

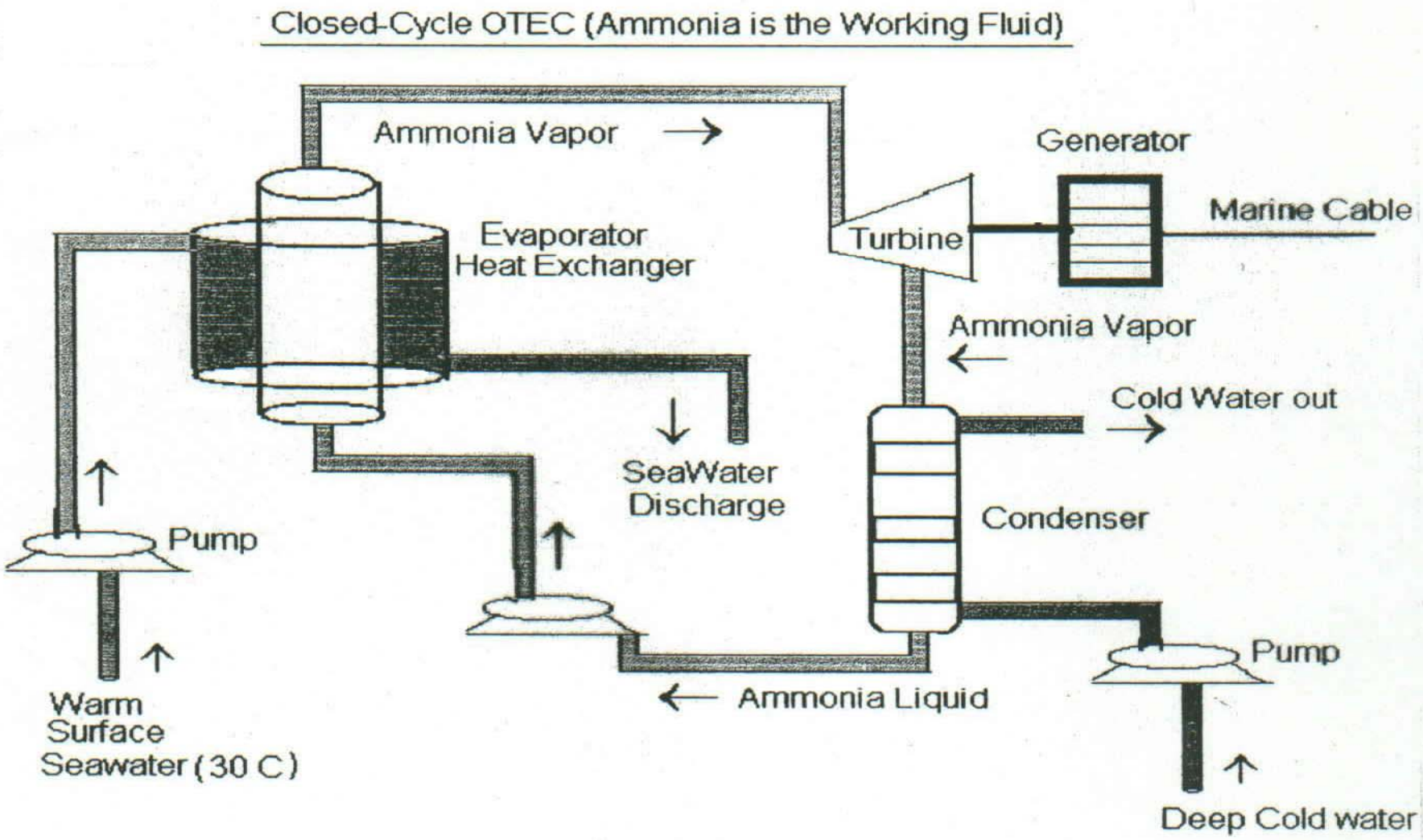
50-60% of energy sources in developing countries come from Biomass .

Energy from Biomass is released by two ways:

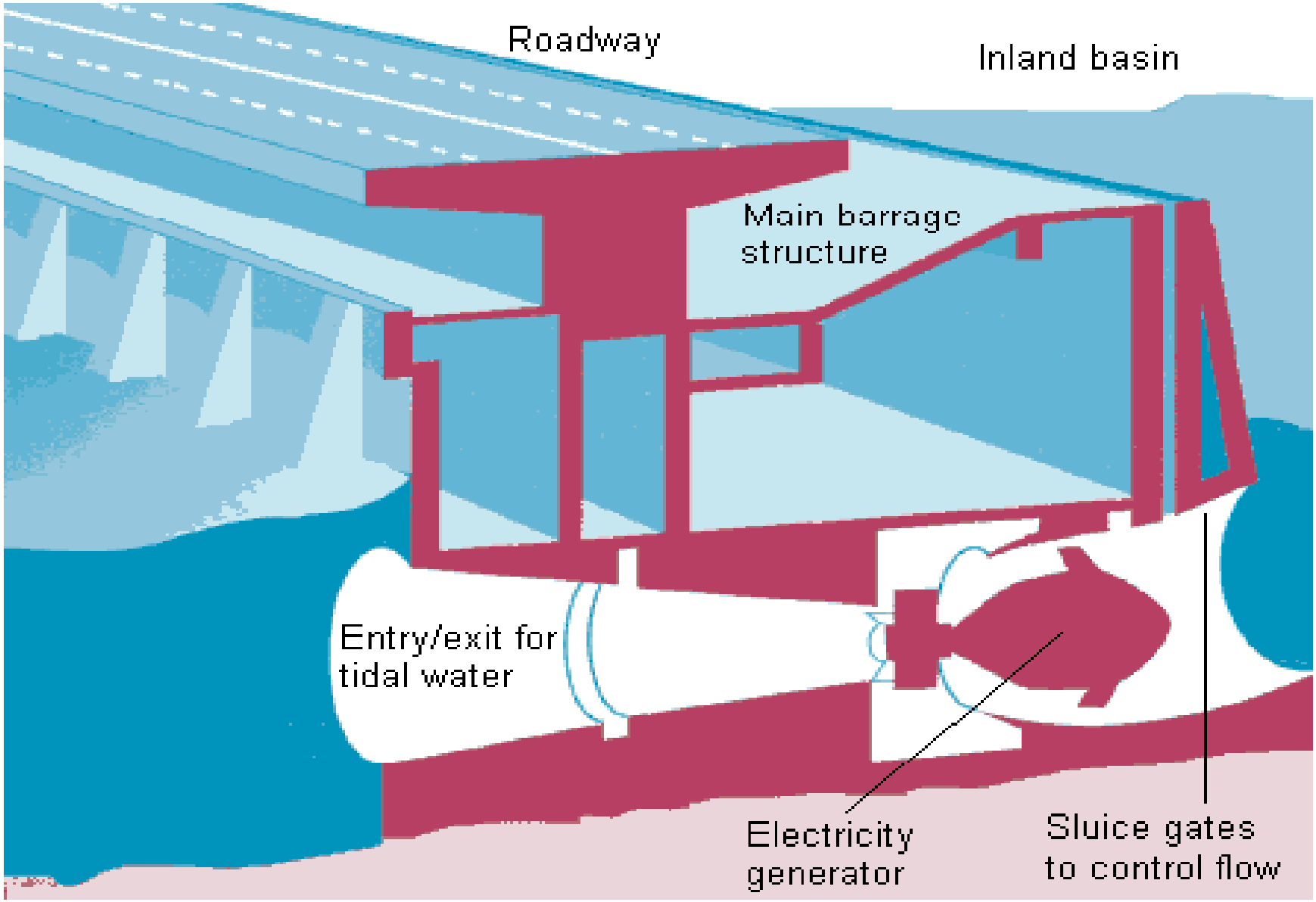
1. **Direct Combustion :burning :weather in fireplaces or to generate steam and run turbines and generate electricity**
2. **Transfer it through chemical and biological processes to produce bio fuel such as:**

   Ethanol, Methanol and Bio-diesel

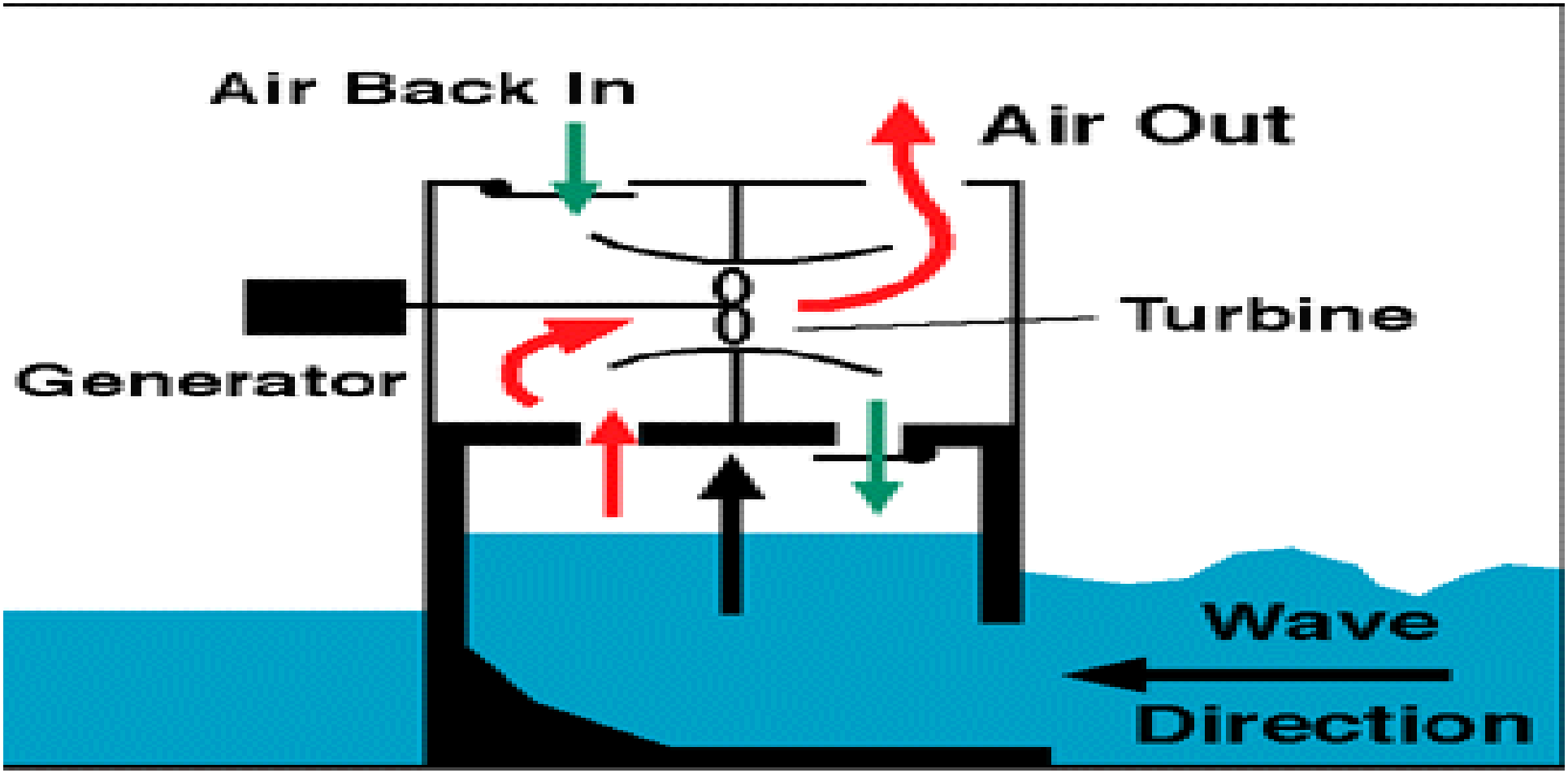
Ocean Thermal Energy Conversion (OTEC)



Tidal Power


Roadway
Inland basin
Main barrage structure
Entry/exit for tidal water
Electricity generator
Sluice gates to control flow

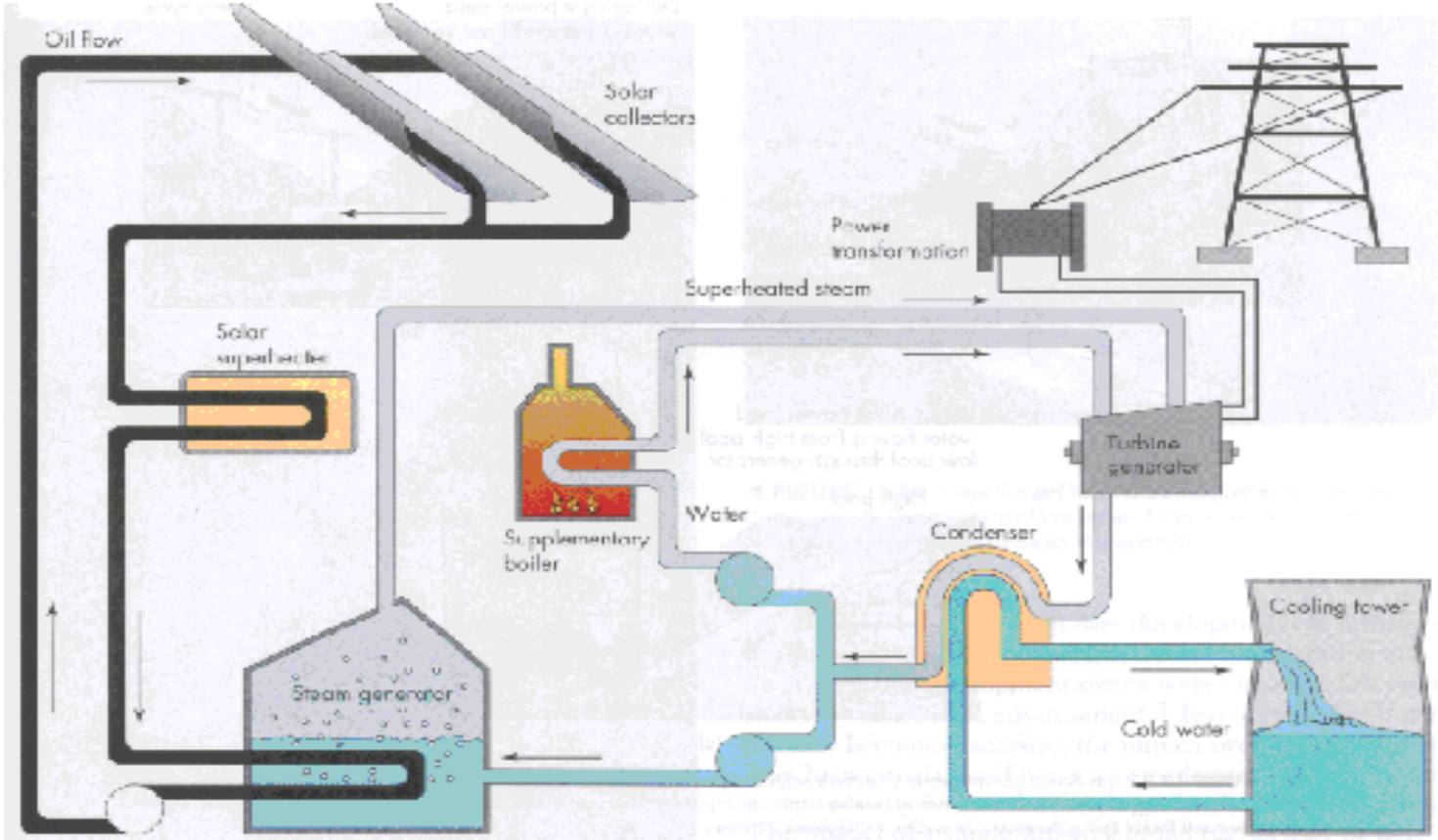
Wave Power



Submarine Turbine

10MW central Power Station

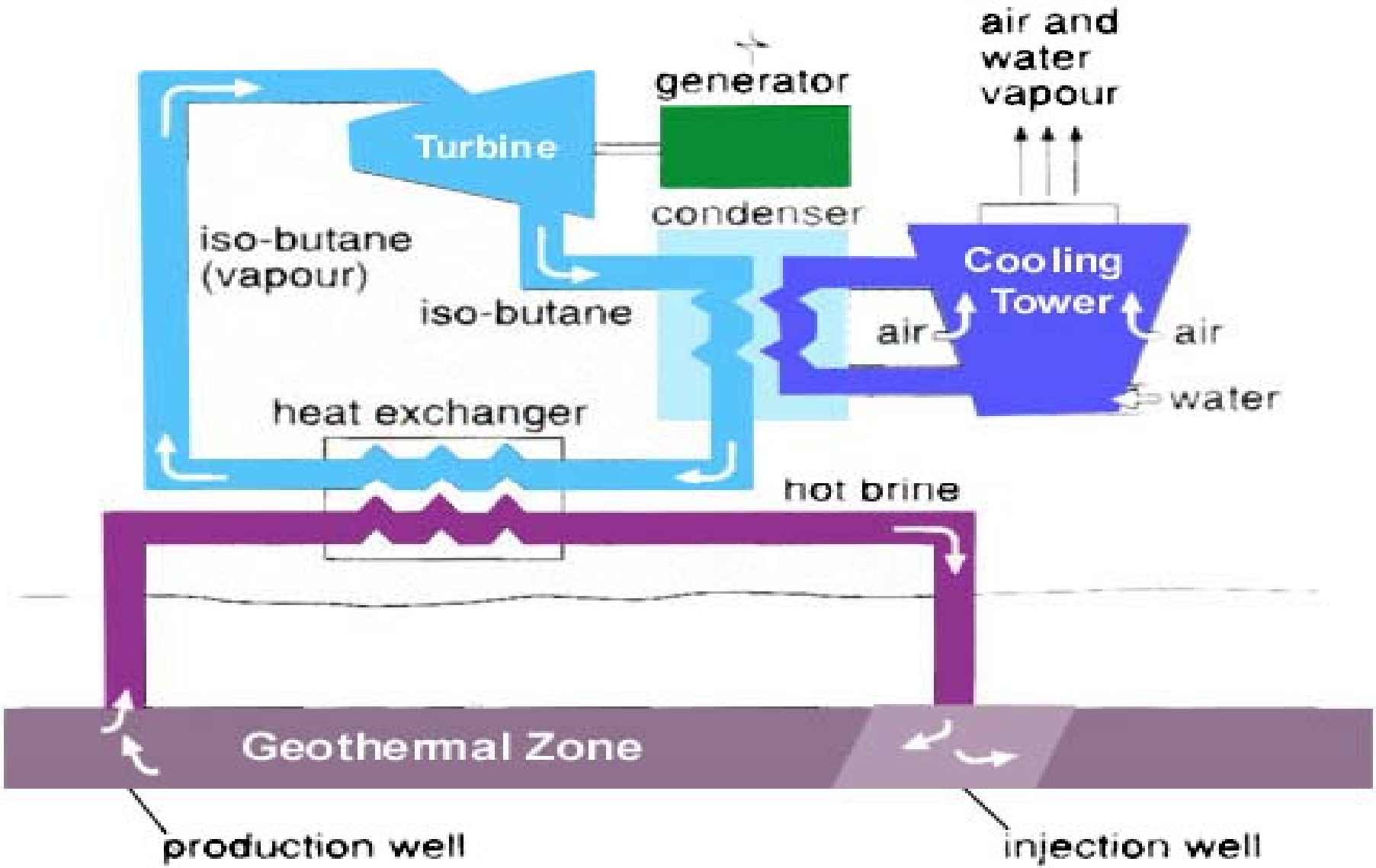
Thermal Power/Trough System



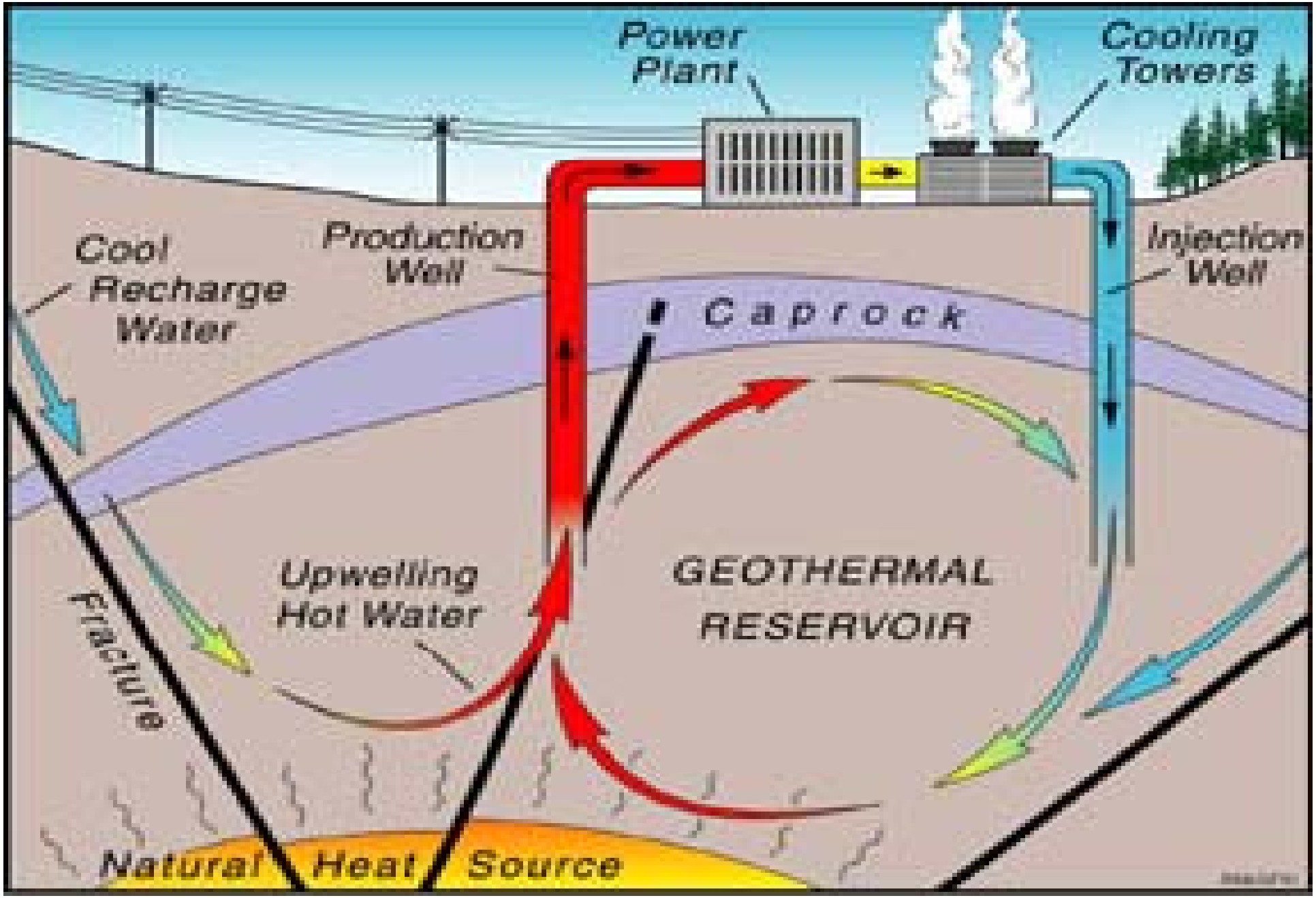
▲ FIGURE 15.36 Idealized diagram showing how the LUZ solar electric generating system works. (Courtesy of LUZ)

Geothermal Energy

Binary Cycle



Hot Rock Technology

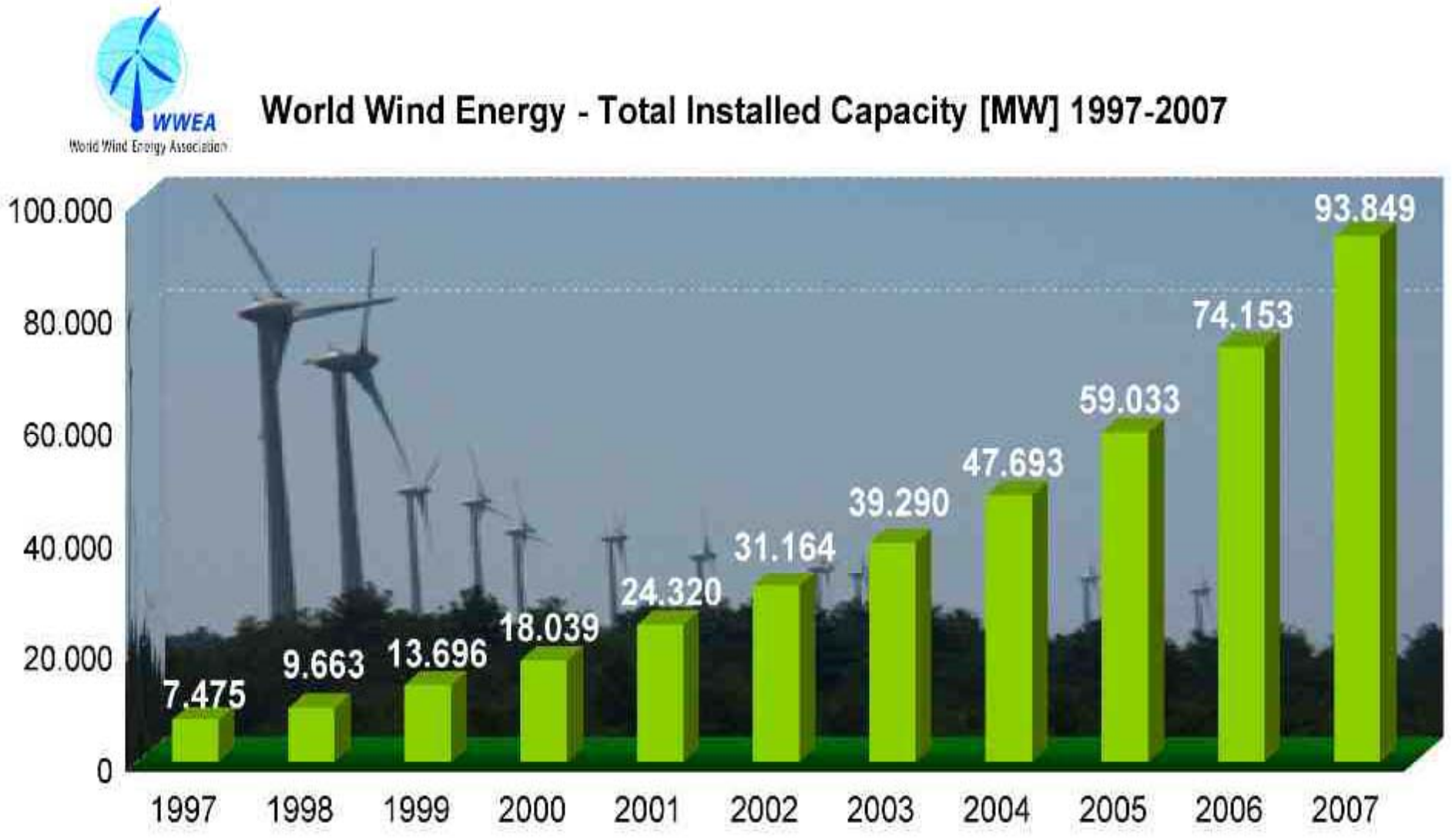


Advantages of Renewable Energy Sources

- **Clean Sources of Energy / No Pollution**
- **Modular**
- **Renewable**
- **More efficiently Used / Placed Right Where the Consumer is**

World Wide Renewable Energy

World Wide Wind Power Production

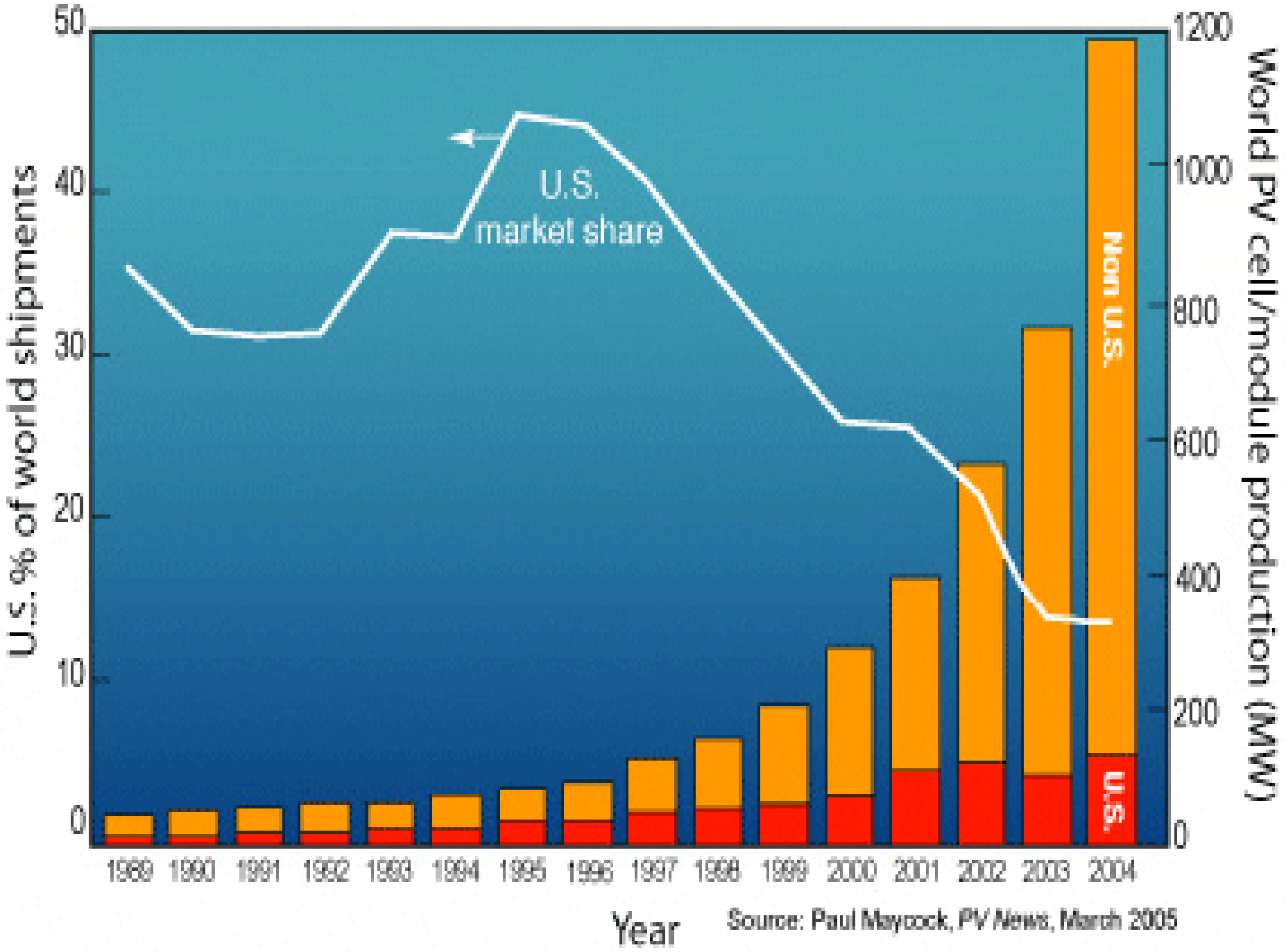


Germany

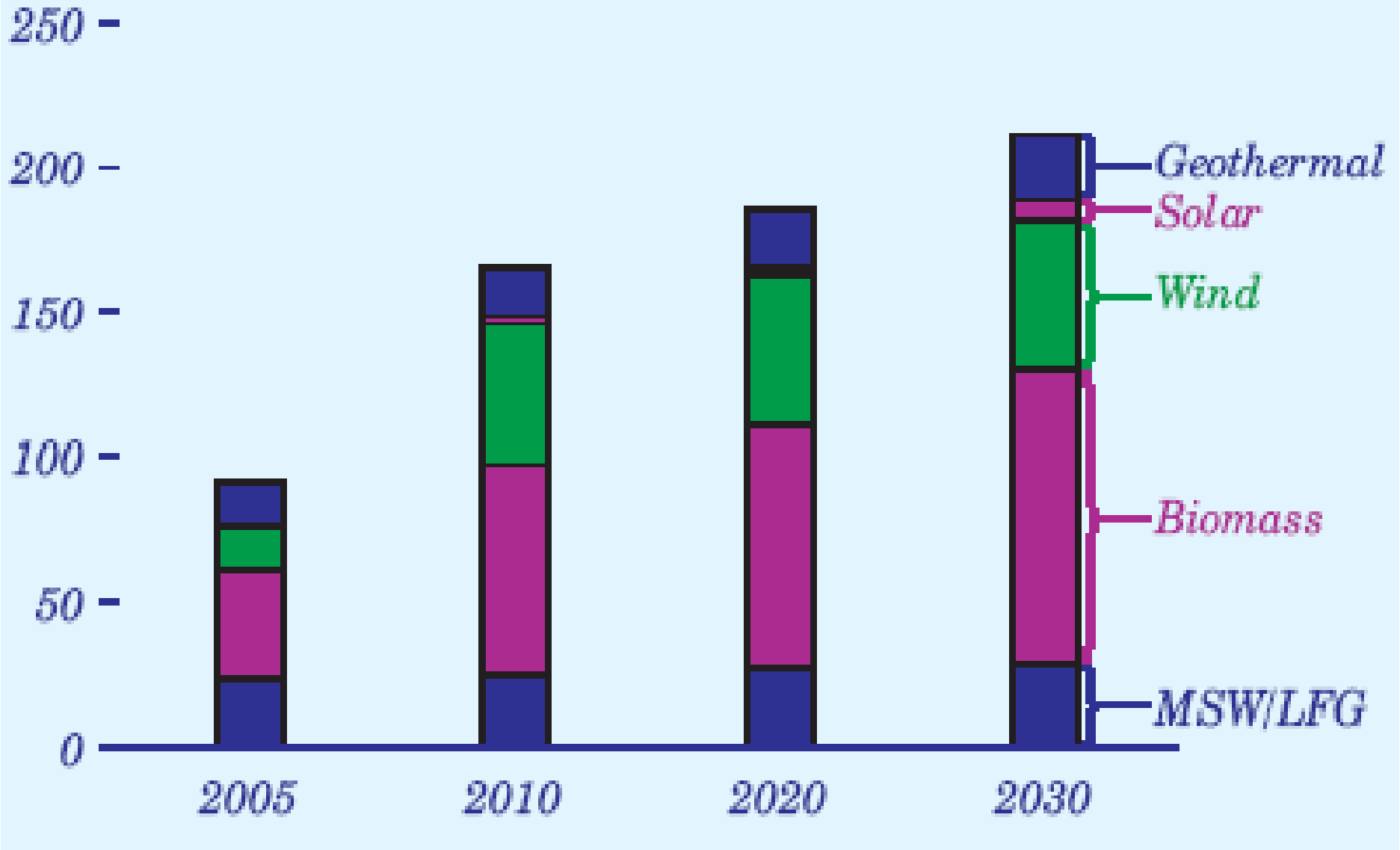
- **Germany has been the world leader in wind power capacity for many years**
- **2007 Capacity: 22,247 MW**
- **18,600 Wind turbines**
- **2007 Total output: 38.5 TWh (6.3% of Germany's electricity)**
- **Official target: 12% of Germany's electricity produced by wind by 2010, though this goal may be reached sooner**

USA

- **2007 Capacity: 16,818 MW**
- **45% growth in 2007**
- **Top ten largest wind farms in the world are in The USA**
- **Horse Hollow in Texas is world's largest wind farm with 735.5 MW capacity**
- **Texas has surpassed California as largest wind power producing state**

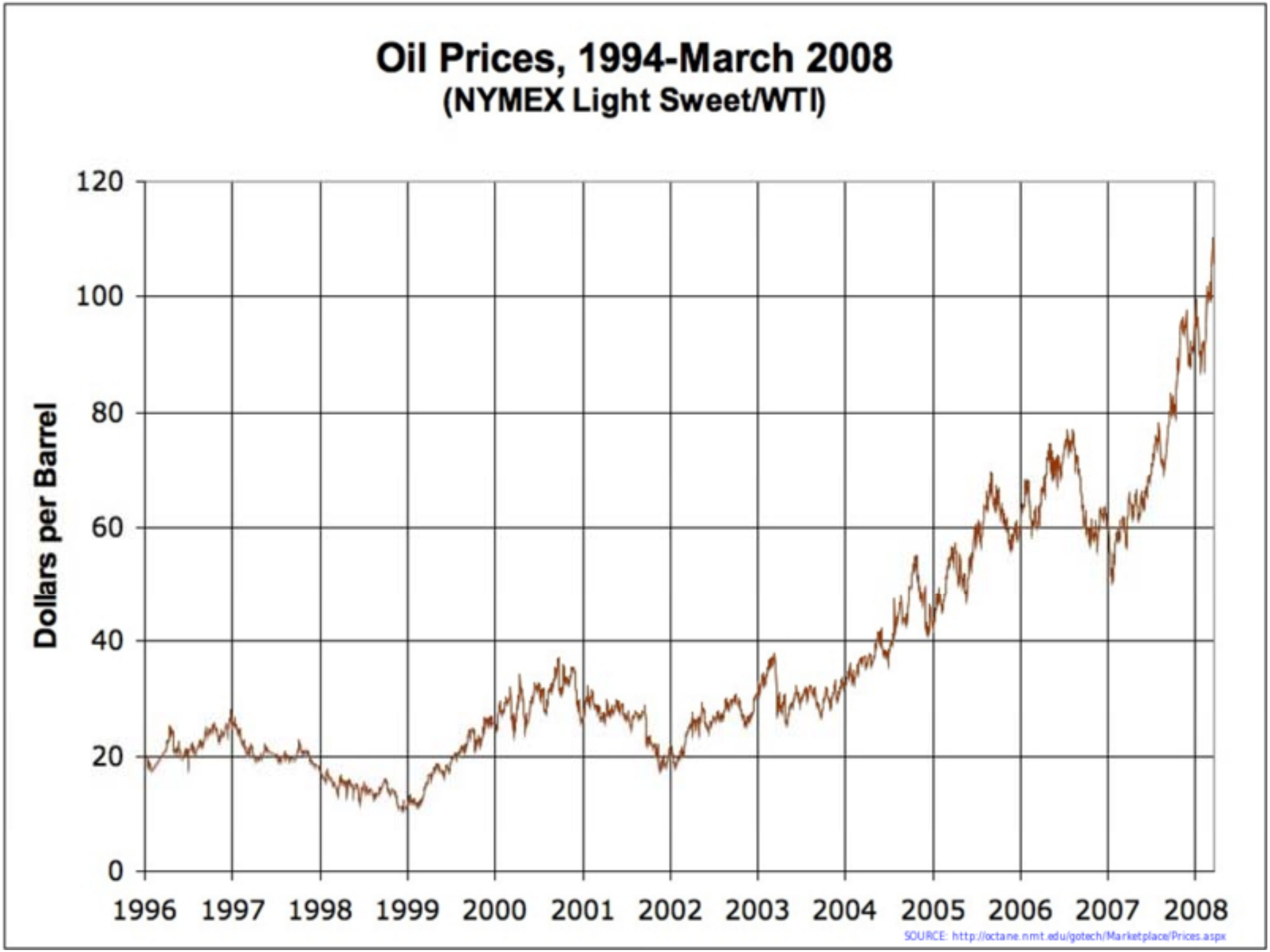

U.S. % of world shipments
World PV cell/module production (MW)
U.S. market share
Non U.S.
U.S.
50
40
30
20
10
0
1200
1000
800
600
400
200
0
1989 1990 1991 1992 1993 1994 1995 1996 1997 1998 1999 2000 2001 2002 2003 2004
Year
Source: Paul Maycock, PV News, March 2005

Renewable Energy Production in Billions KWH/Projection

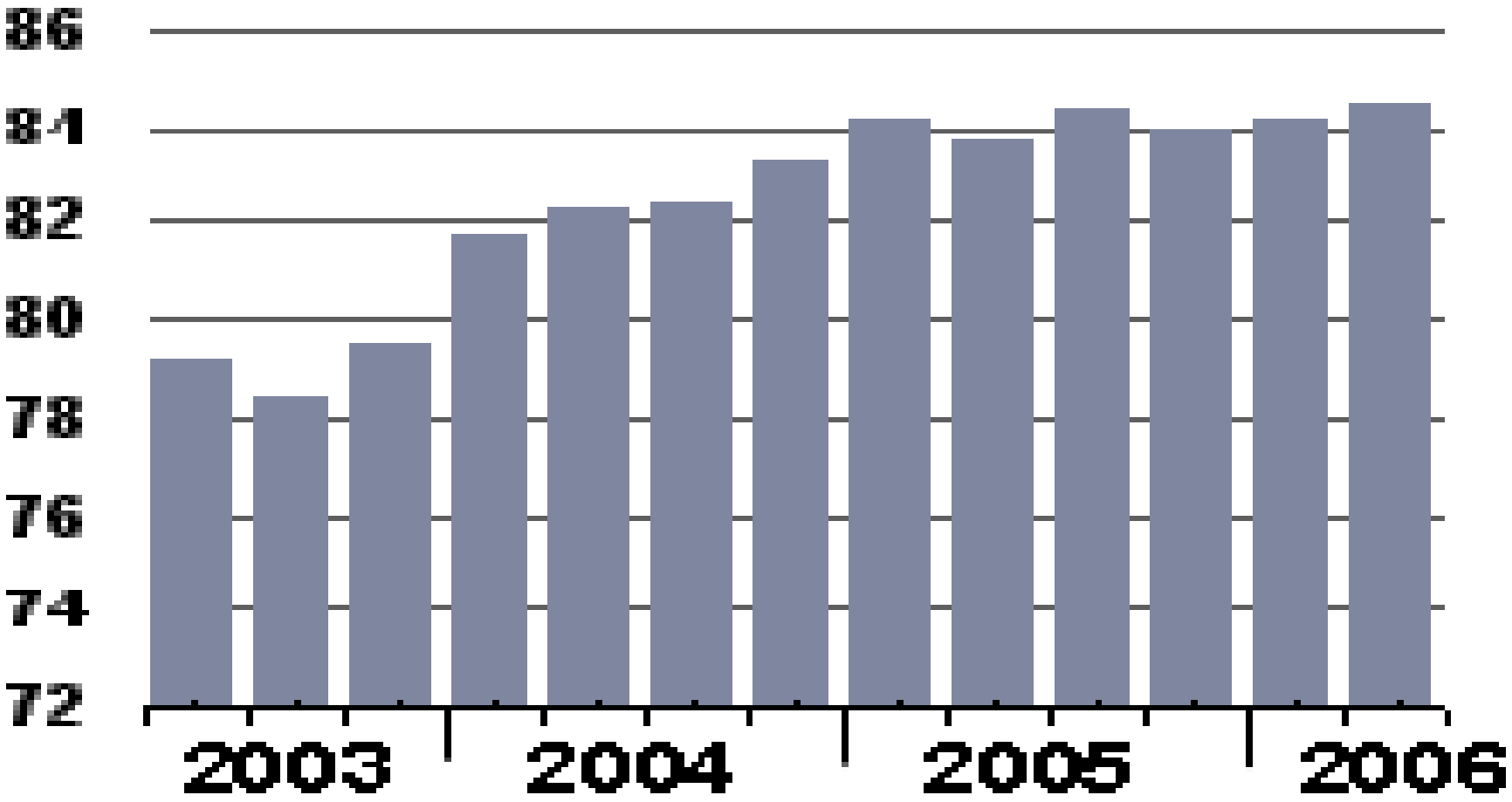


Why The Enormous Interest in Renewable Energy

1. High Oil Prices

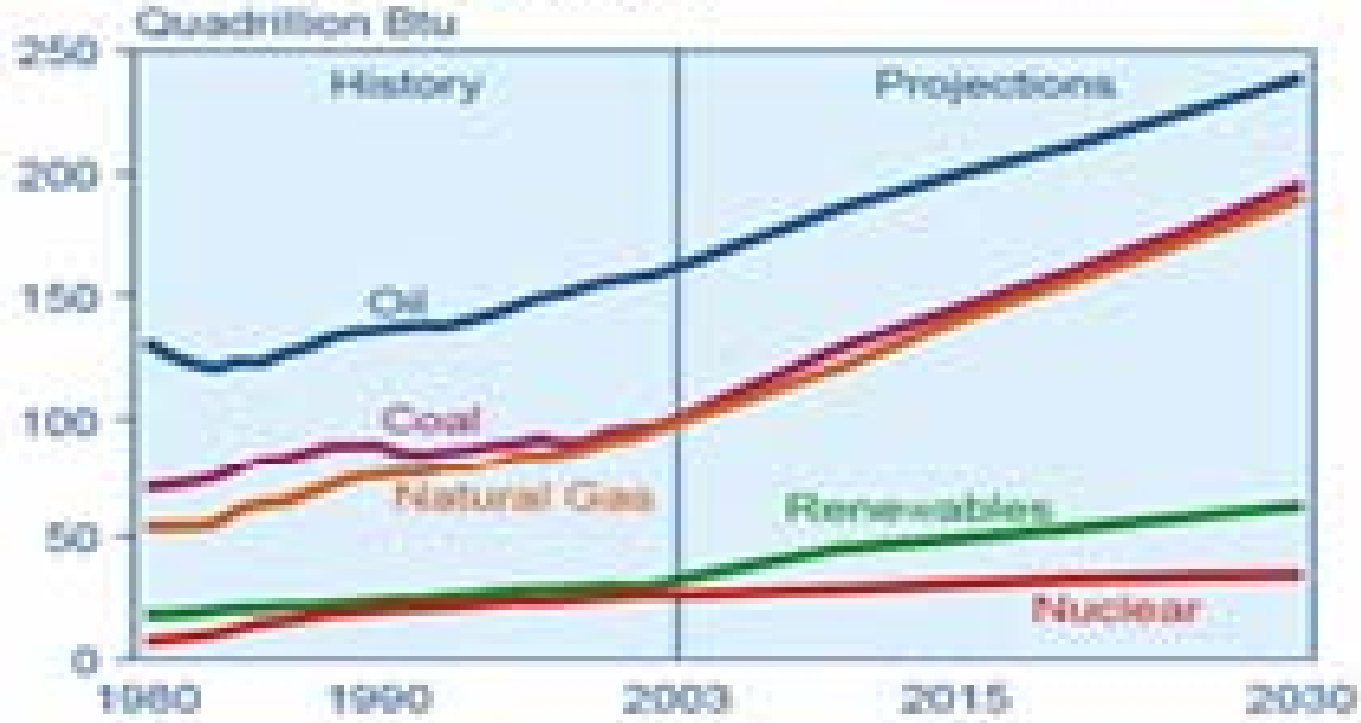

Oil Prices, 1994-March 2008
(NYMEX Light Sweet/WTI)
Dollars per Barrel
120
100
80
60
40
20
0
1996
1997
1998
1999
2000
2001
2002
2003
2004
2005
2006
2007
2008
SOURCE: http://octane.nmt.edu/gotech/Marketplace/Prices.aspx

World Oil Production I millions of barrels per day



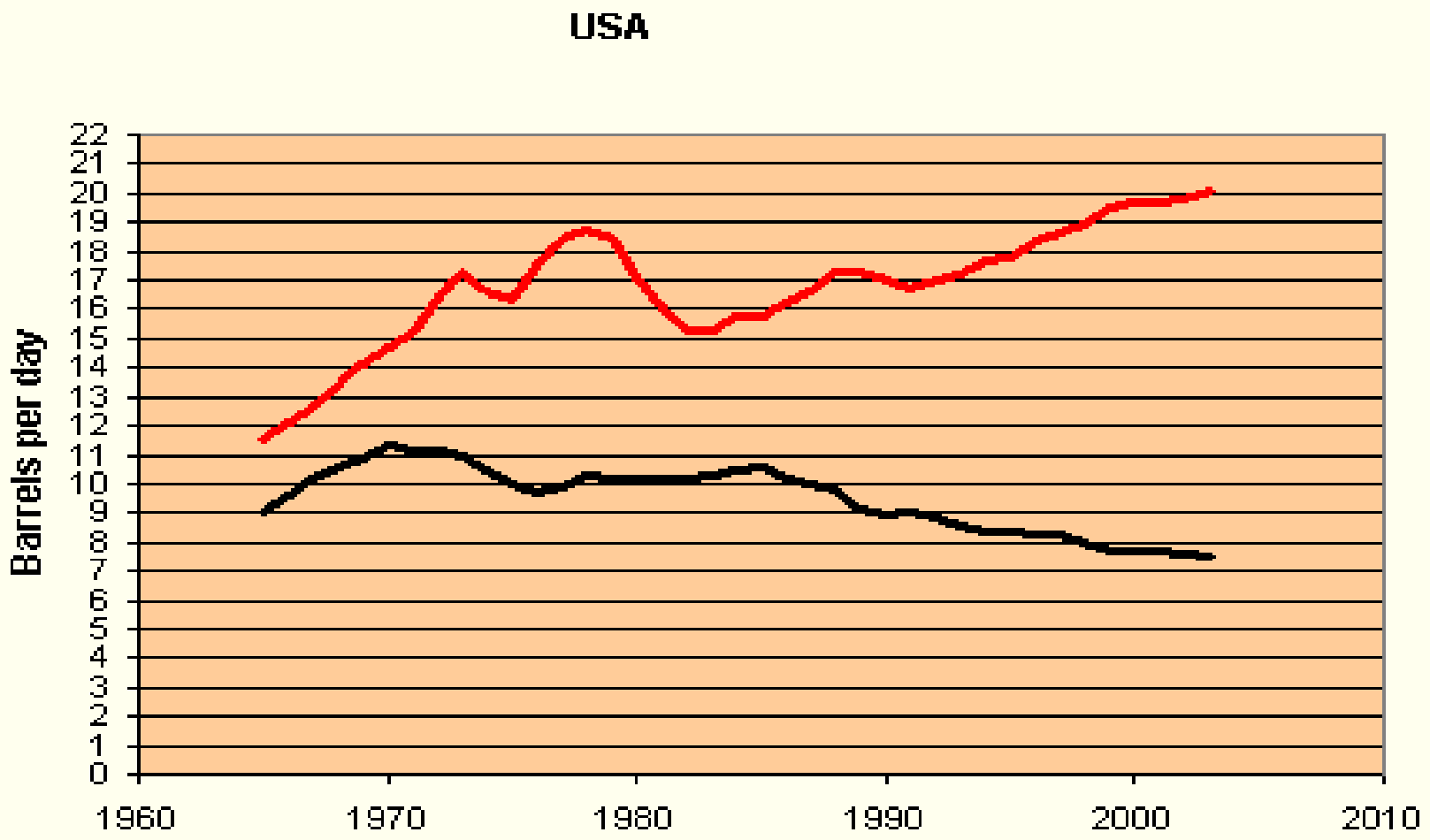
World Energy Consumption

Figure 3. World Marketed Energy Use by Energy Type, 1980-2030

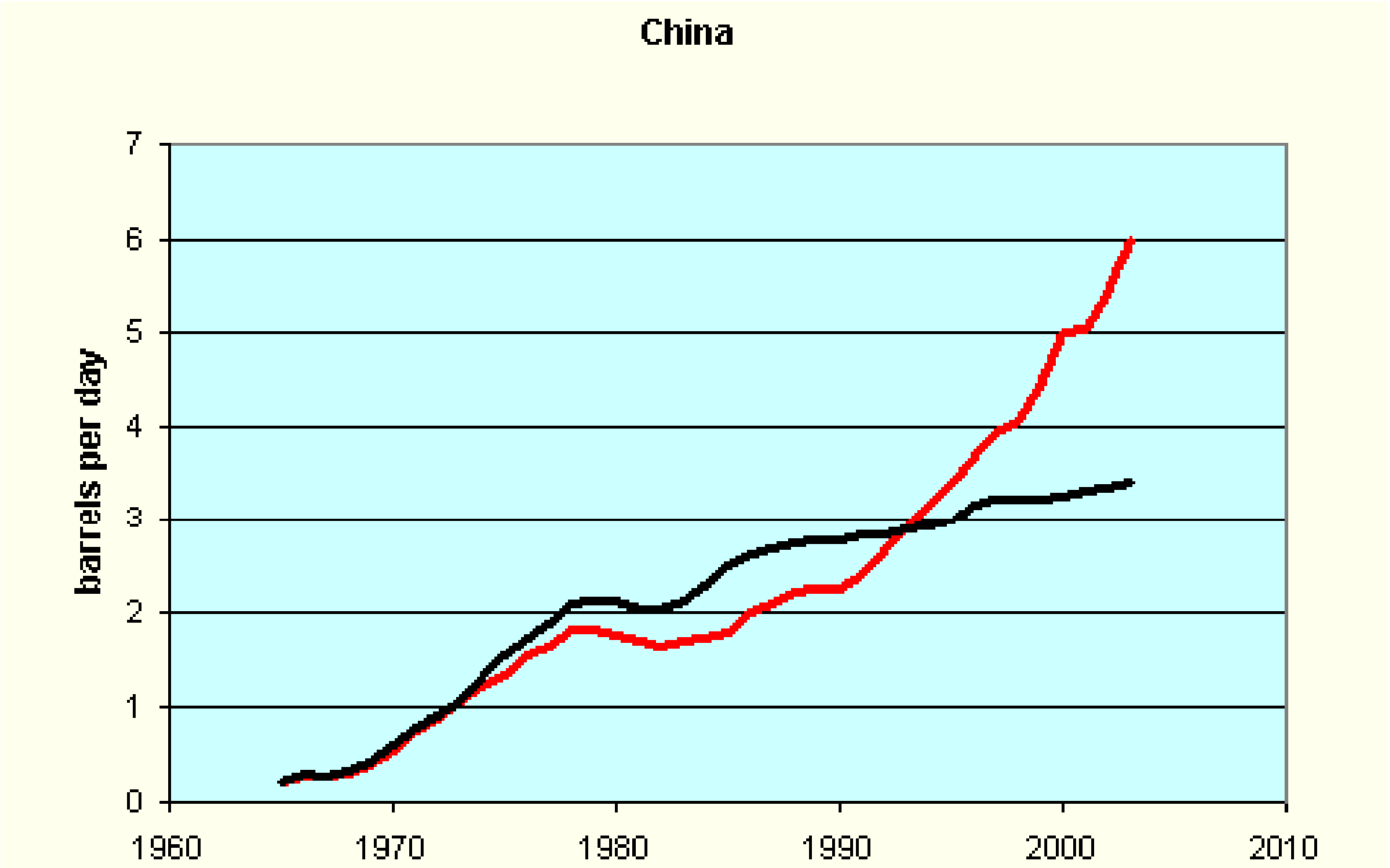


Sources: **History:** Energy Information Administration (EIA), *International Energy Annual 2003* (May-July 2005), web site www.eia.doe.gov/iea/. **Projections:** EIA, System for the Analysis of Global Energy Markets (2006).

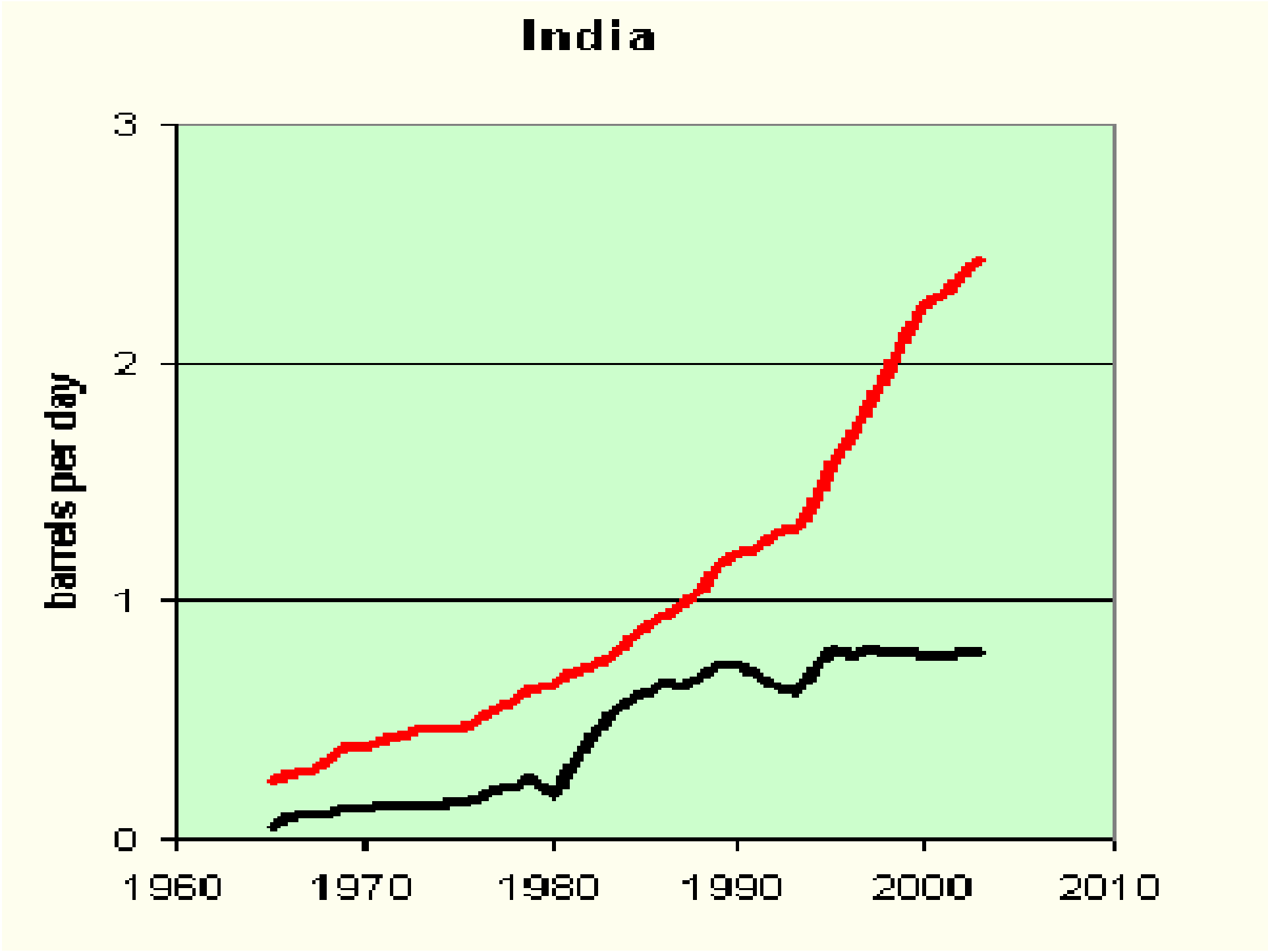
Oil Consumption by country (millions of barrels per day)



The USA remains by far the largest oil consumer with declining domestic production now meeting considerably less than 50% of consumption.

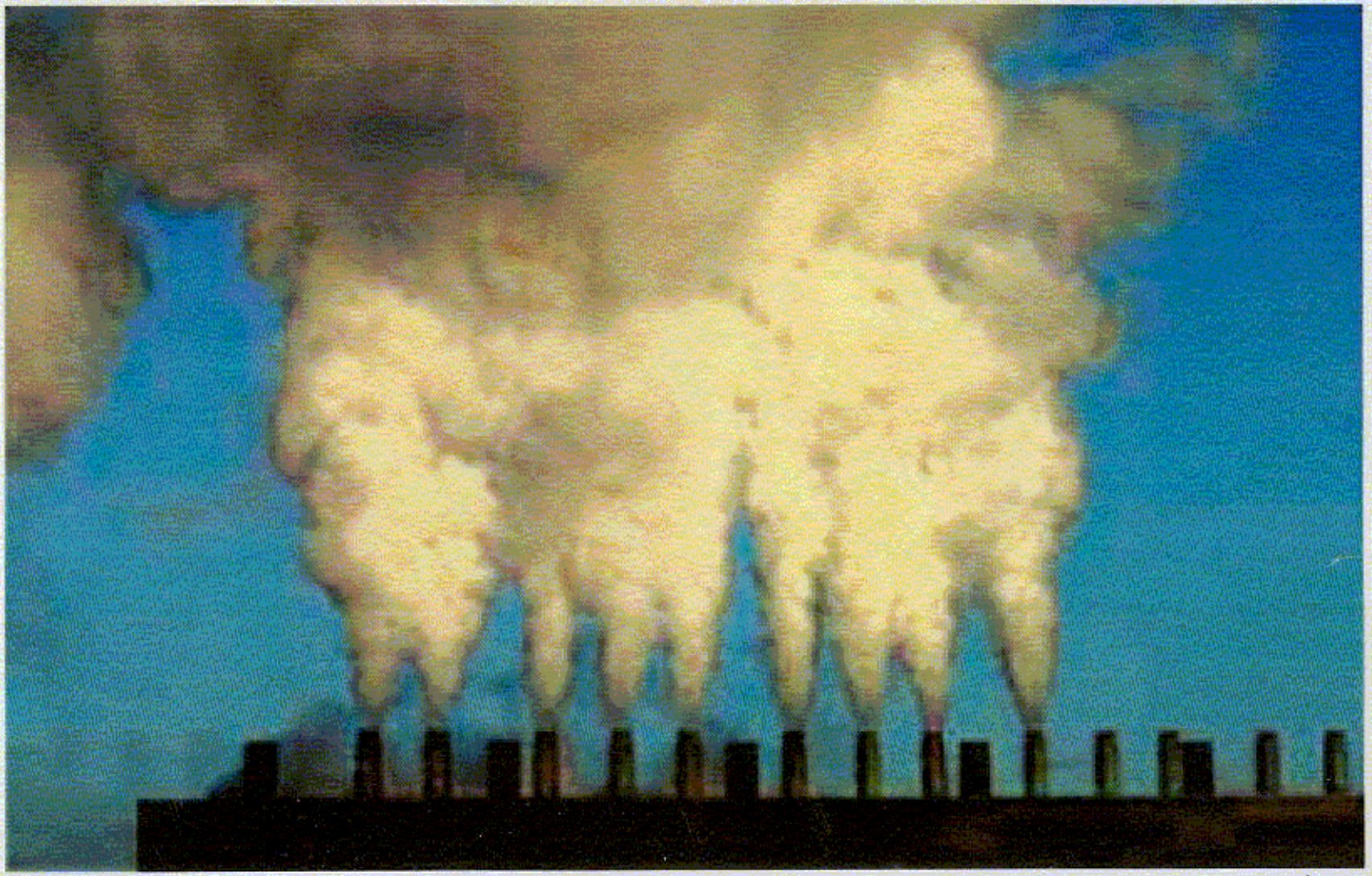


China became a net importer in 1993 and is now on a trajectory to compete with the USA for remaining reserves around the world.


India
barrels per day
3
2
1
0
1960
1970
1980
1990
2000
2010

2. Pollution

Pollution from Fossil Fuel Economy



Air Pollution

Carbon monoxide (CO): is a product of incomplete combustion

Carbon dioxide CO2: is a “greenhouse gas” that traps the earth’s heat

Hydrocarbon Hydrocarbons react in the presence of nitrogen oxides and sunlight to form ground-level ozone **(Smog)**

Nitrogen Oxides: NOx. Contribute to acid rain

Sulfur Dioxide, contributes to acid rain

Smog Over LA

Procurement Pollution

- **Damage Due to Petroleum Procurement**

About 60 tanker accidents are reported annually in global waters

- **Damage Due to Natural Gas Procurement**

Explosions of gas carrying vessels could cause severe tolls on the environment and on human lives

- **Damage Due to Coal Procurement**

Coal excavation damages land areas

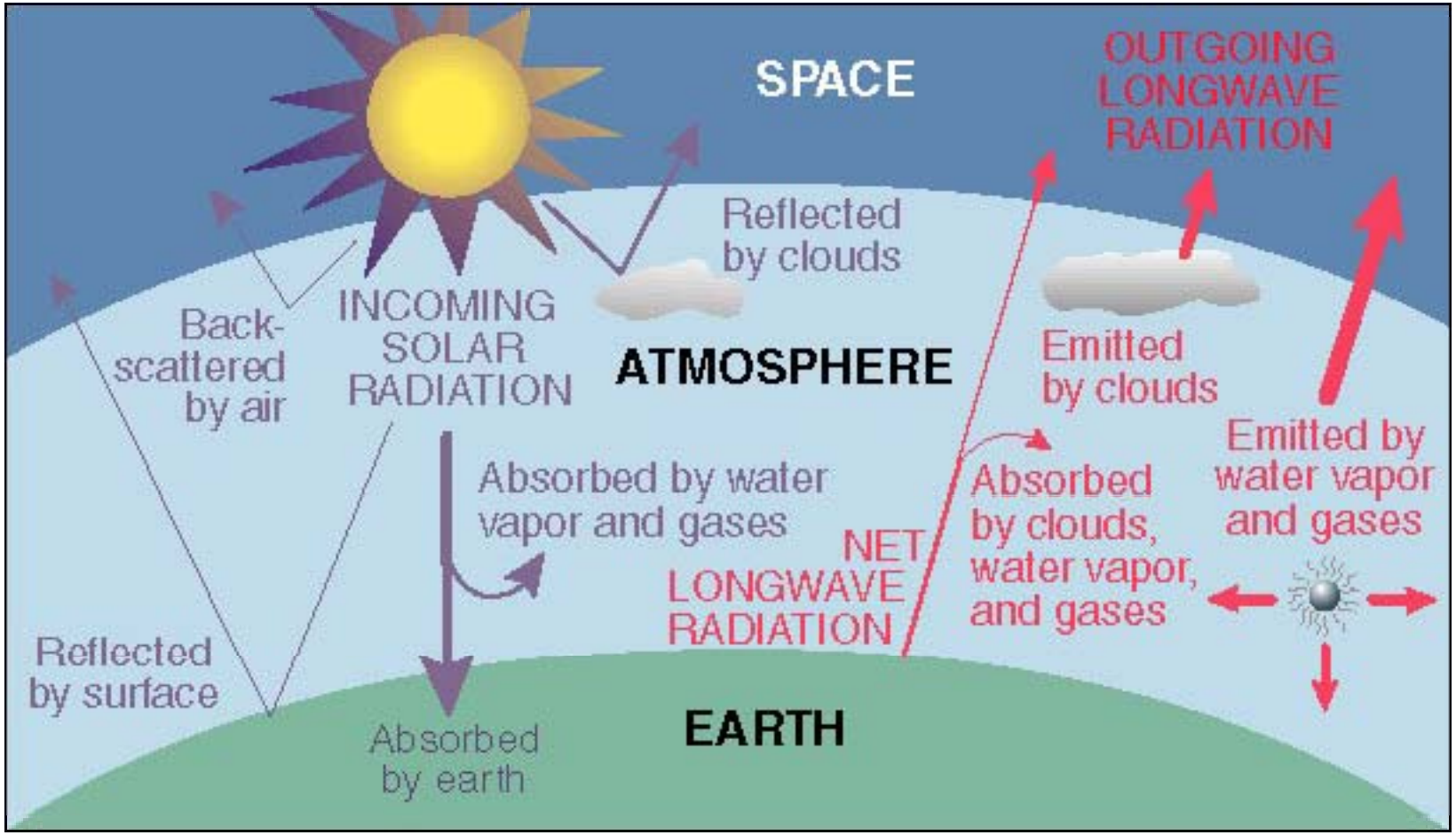
Explosions in mines cost life

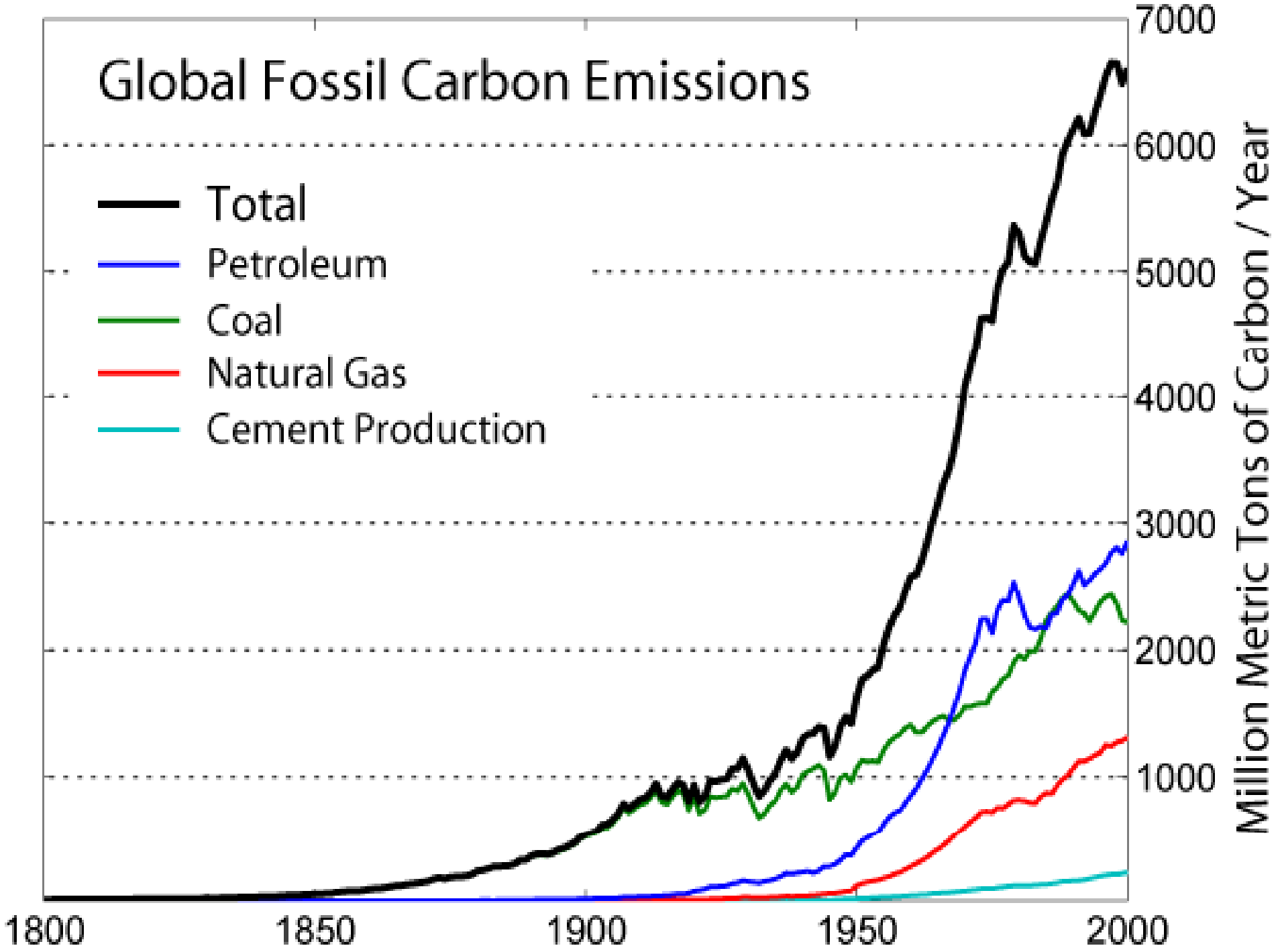
Dust inhalation causes damage to miner’s lung

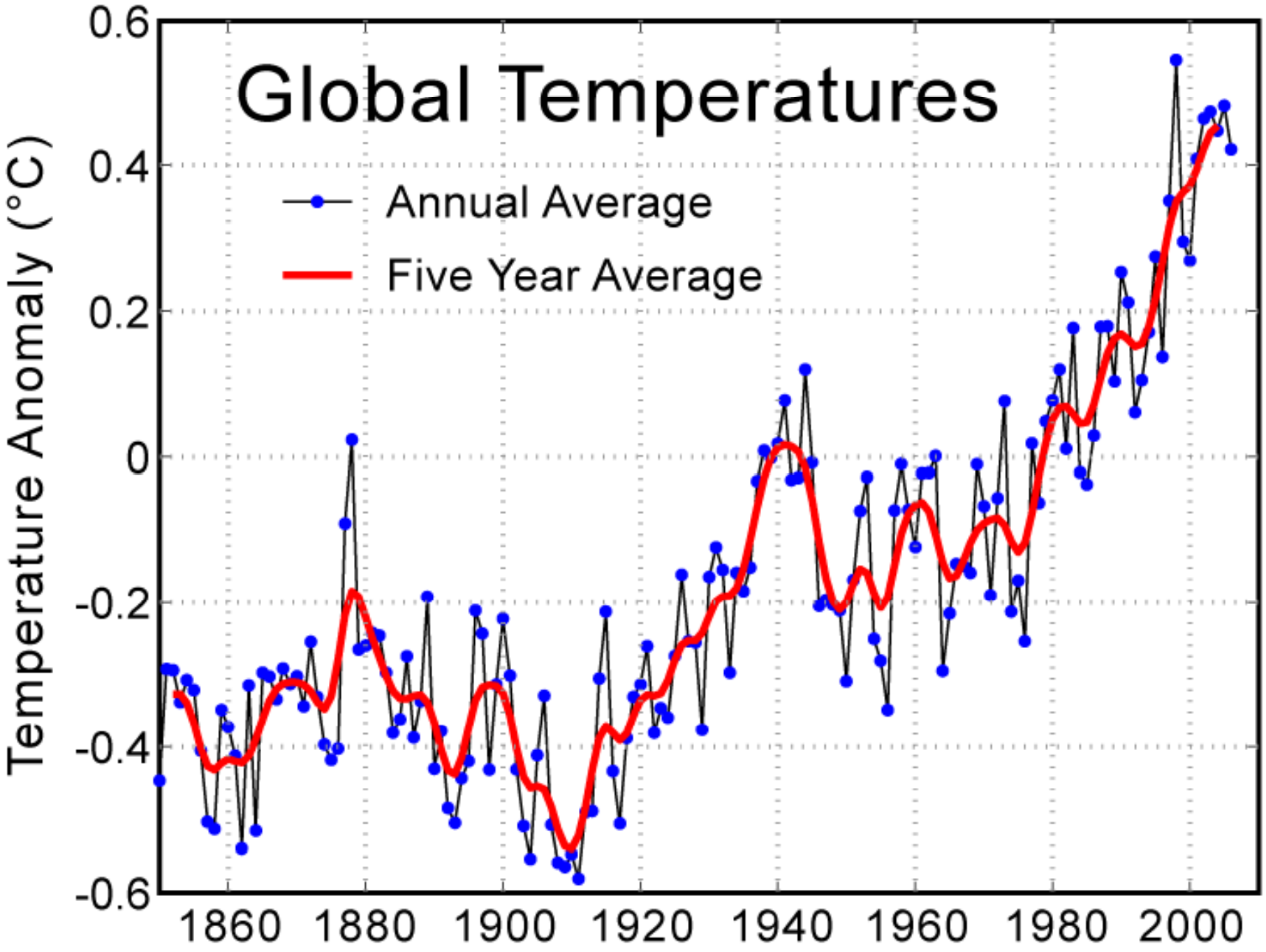
Arabian Gulf Spills

3. Global Warming

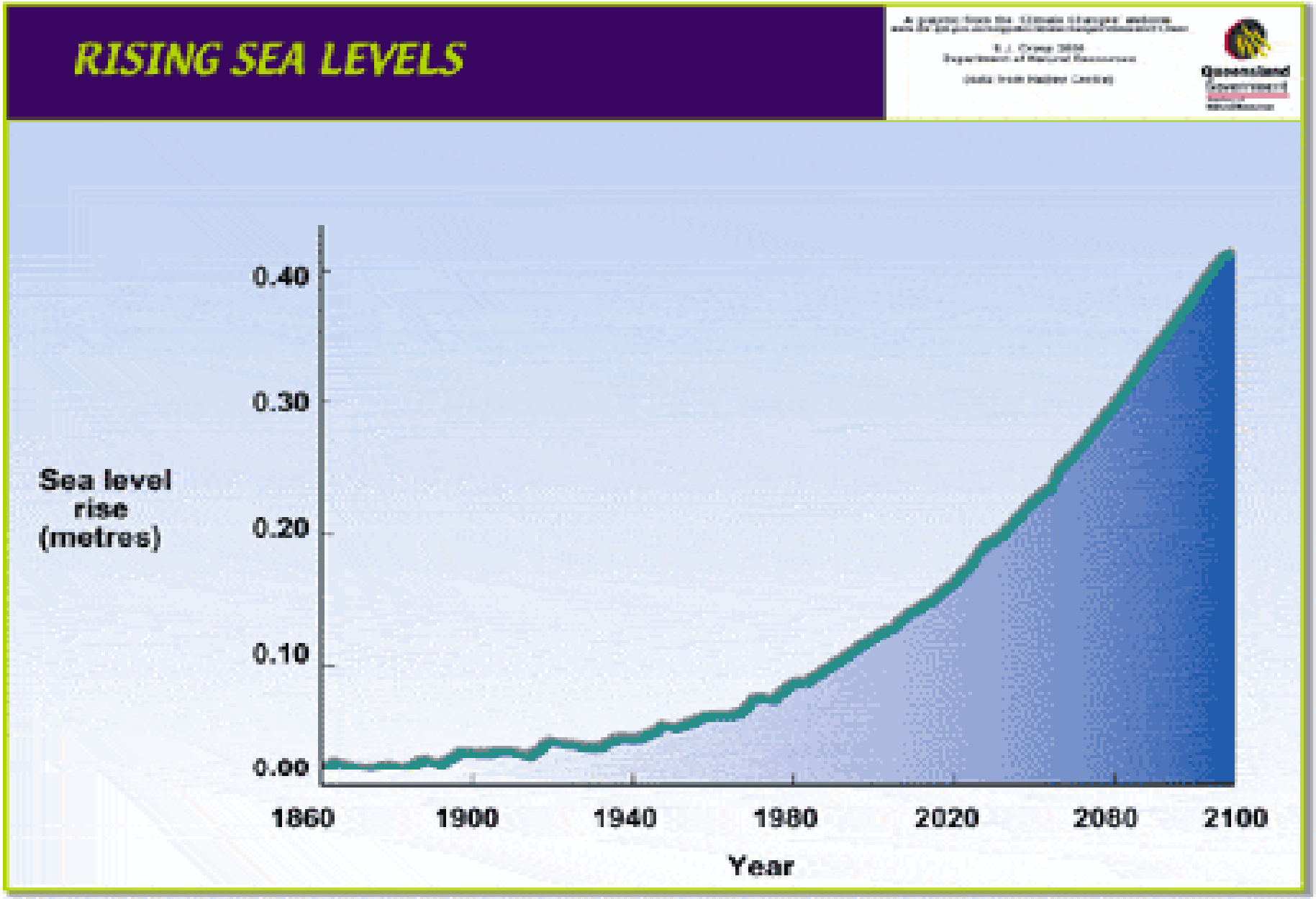
Green house process




Global Fossil Carbon Emissions
Total
Petroleum
Coal
Natural Gas
Cement Production
7000
6000
5000
4000
3000
2000
1000
Million Metric Tons of Carbon / Year
1800
1850
1900
1950
2000


Global Temperatures
Annual Average
Five Year Average
Temperature Anomaly (°C)
0.6
0.4
0.2
0
-0.2
-0.4
-0.6
1860
1880
1900
1920
1940
1960
1980
2000

Rising sea Level



Incentives

- **Rebates by Governments for the installation of RES**
- **State and Federal Tax incentives**
- **The Trade in (Carbon Dioxide) CO_2 Credit, Companies are Voluntarily buying CO_2 credit from RES Companies/ The money is used to add more RES**

Massachusetts State and Federal Tax Incentives for Wind Energy

Massachusetts State Tax Incentives	**Federal Tax Incentives**
State Income Tax Credit: Income tax credit of **15%** or **$1,000**, whichever is less, for the purchase a wind system.	**Federal Production Tax Credit**: **2** cents/kWh for first **10** years of project's life.
State Sales Tax Exemption: Exempts from the state sales tax, the sale of a wind system that is used as primary or auxiliary source of energy for a residence.	**Modified Accelerated Cost Recovery System**: Deduct **50%** of value of property for **5** years to mitigate taxes on property.
Local Property Tax Exemption: Exempts from local sales tax, the sale of a wind system.	**Business Investment Tax Credit**: Deduct **10%** of cost for investing in a wind project.

Impact of Renewable Energy Sources as Distributed Energy Systems on Utility Grids

Renewable Energy Sources as Distributed Energy Systems

- **Located right where the customers are, so they are more efficiently used**
- **No overhead line losses**
- **Easily and fast installed, as opposed to building a power station that will take long time.**
- **No pollution**
- **renewable**

Direct impact on the Utility grids

- **Reduction on the demand side, helps the utilities meet the overall increasing demand on energy in their jurisdictions**
- **Reduce Summer Peaks load (10:00AM-4:00PM)**
- **Increase the reliability of the Utilities by not relying solely on big generators , the outage of which causes great power failure**
- **Companies should have Solar Monitoring Network of the solar projects in their areas to plan meeting the loads demand**