Topic of Discussion

"Stabilizing Climate: Shifting to Renewable Energy"

Presented by
Plan B Project Team

Plan B 4.0: Mobilizing to Save Civilization
by Lester R. Brown

GENI Global Energy Network Institute

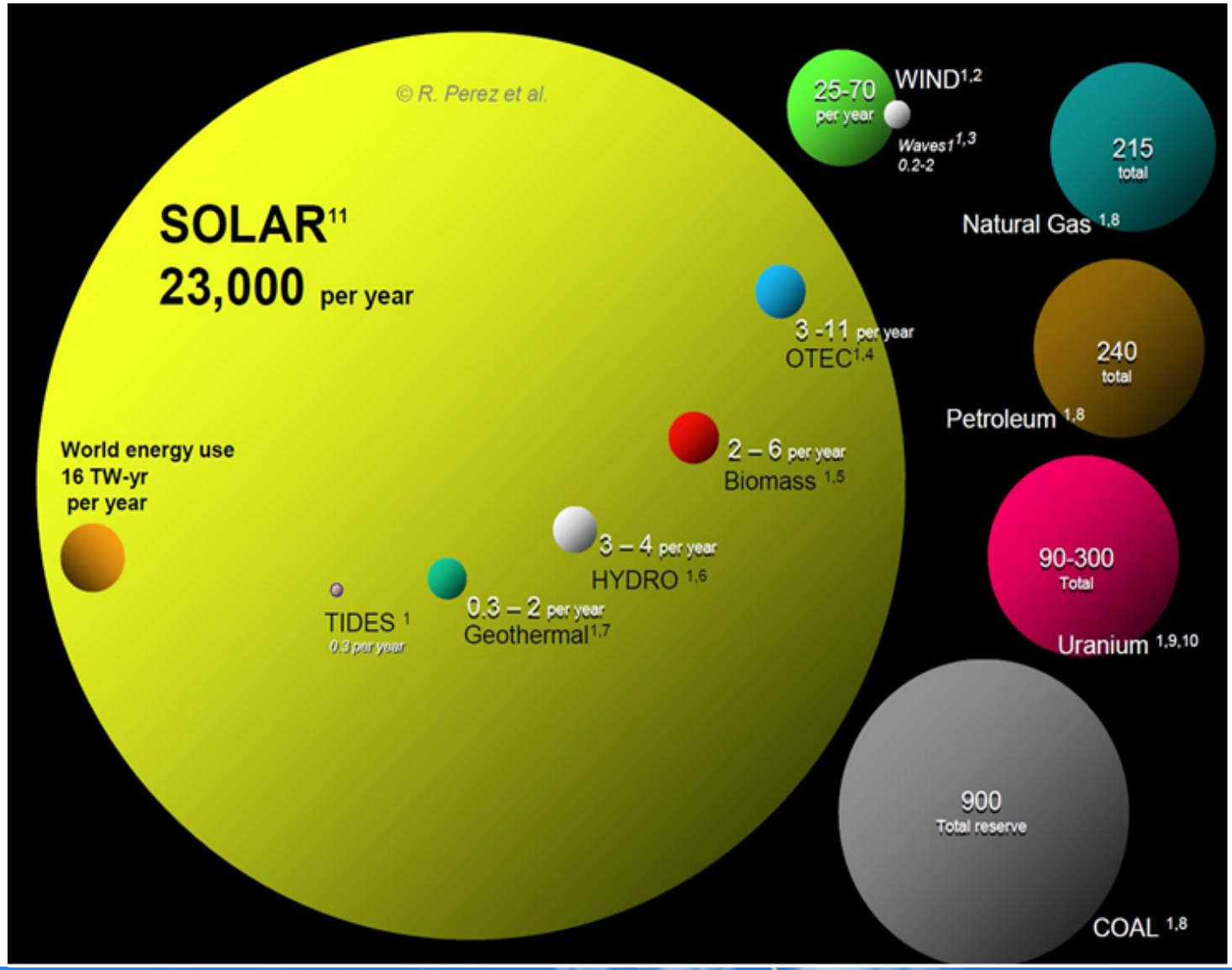
WORLD RESOURCES SIMCENTER

Renewable Energy

Energy that comes from continually replenishing sources.

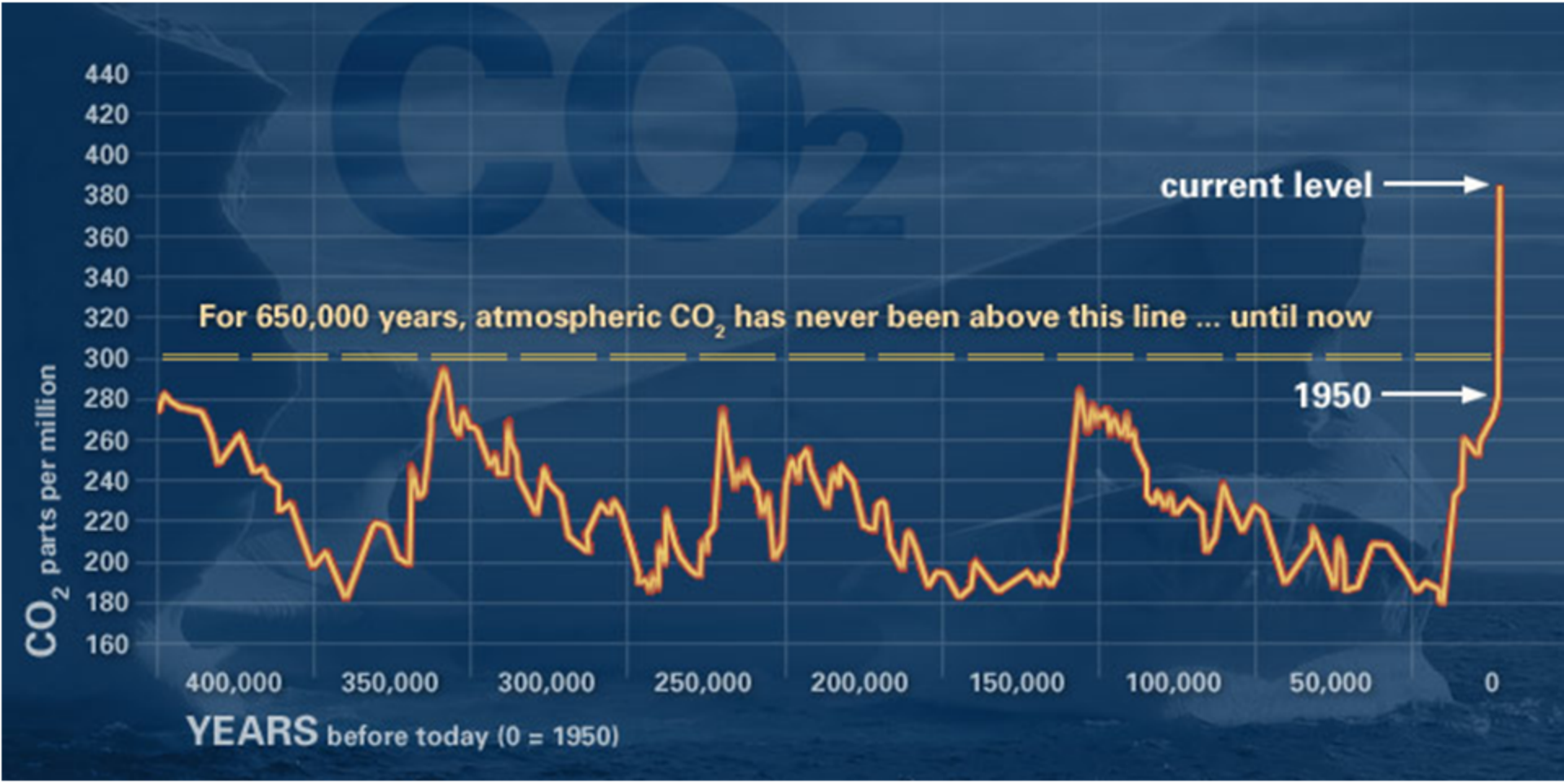
Source:TREIA

The Renewable Potential on Earth



Source: Perez et al

Why Should We Change to Renewables?



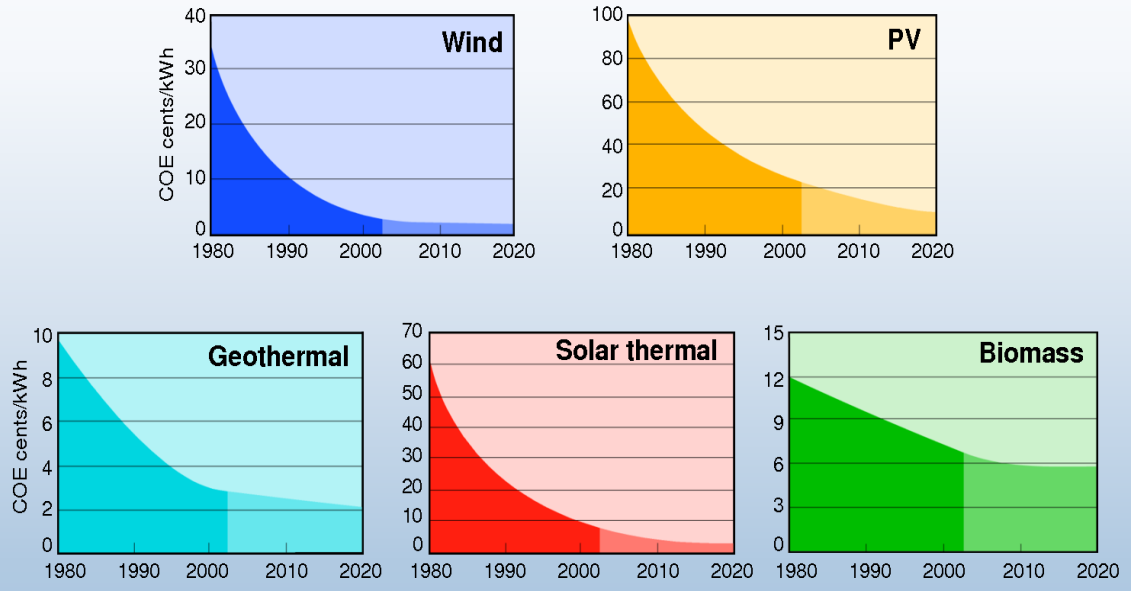
Source: UC Riverside

Why Should We Change to Renewables?

Cheaper Costs

Renewable Energy Cost Trends

Levelized cents/kWh in constant $2000[1]



Source: NREL Energy Analysis Office (www.nrel.gov/analysis/docs/cost_curves_2002.ppt)
[1]These graphs are reflections of historical cost trends NOT precise annual historical data.
Updated: October 2002

EAO Energy Analysis Office
Understanding Energy Issues

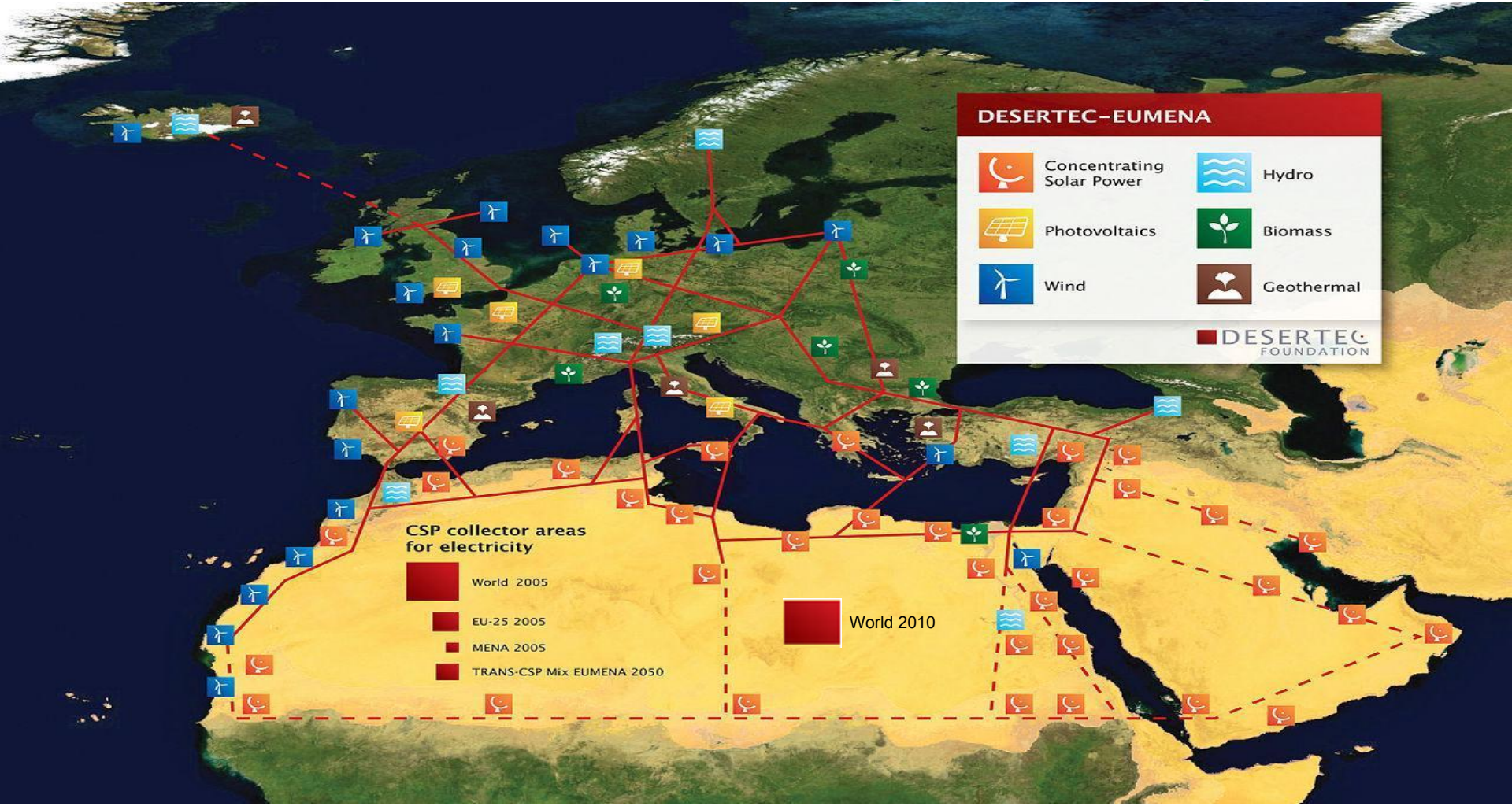
NREL National Renewable Energy Laboratory

Current Energy Price Trend: **INCREASING**

Source: NREL - National Renewable Energy Lab

Why Should We Change to Renewables?

More Than Enough Supply



Source: DESERTEC Initiative

How to Quantify Energy

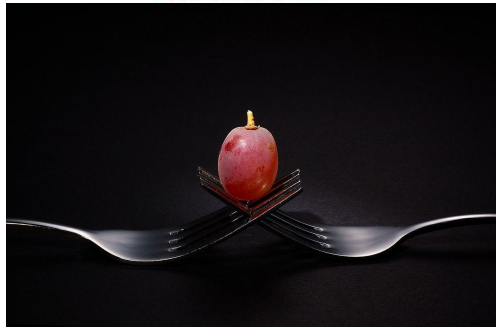
Energy - Joules

1 Joule

1 meter

1000 Joules

223.7 Miles per Hour



1 Grape
=
~14,000
Joules

Source: USDA

How to Quantify Power

Power (Energy per unit of time) - Watts (Joules per second)

Standard american unit of energy - **Kilowatt hour**

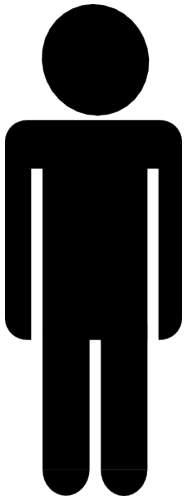
(number of watts or kilowatts used in one hour)

1 kWh

=

3,600,000 Joules

(~250 Grapes)



36.7 kWh

=

Energy an average human in the US uses in a **day**

=

~1.3 x 10^8 Joules

(~9000 Grapes)

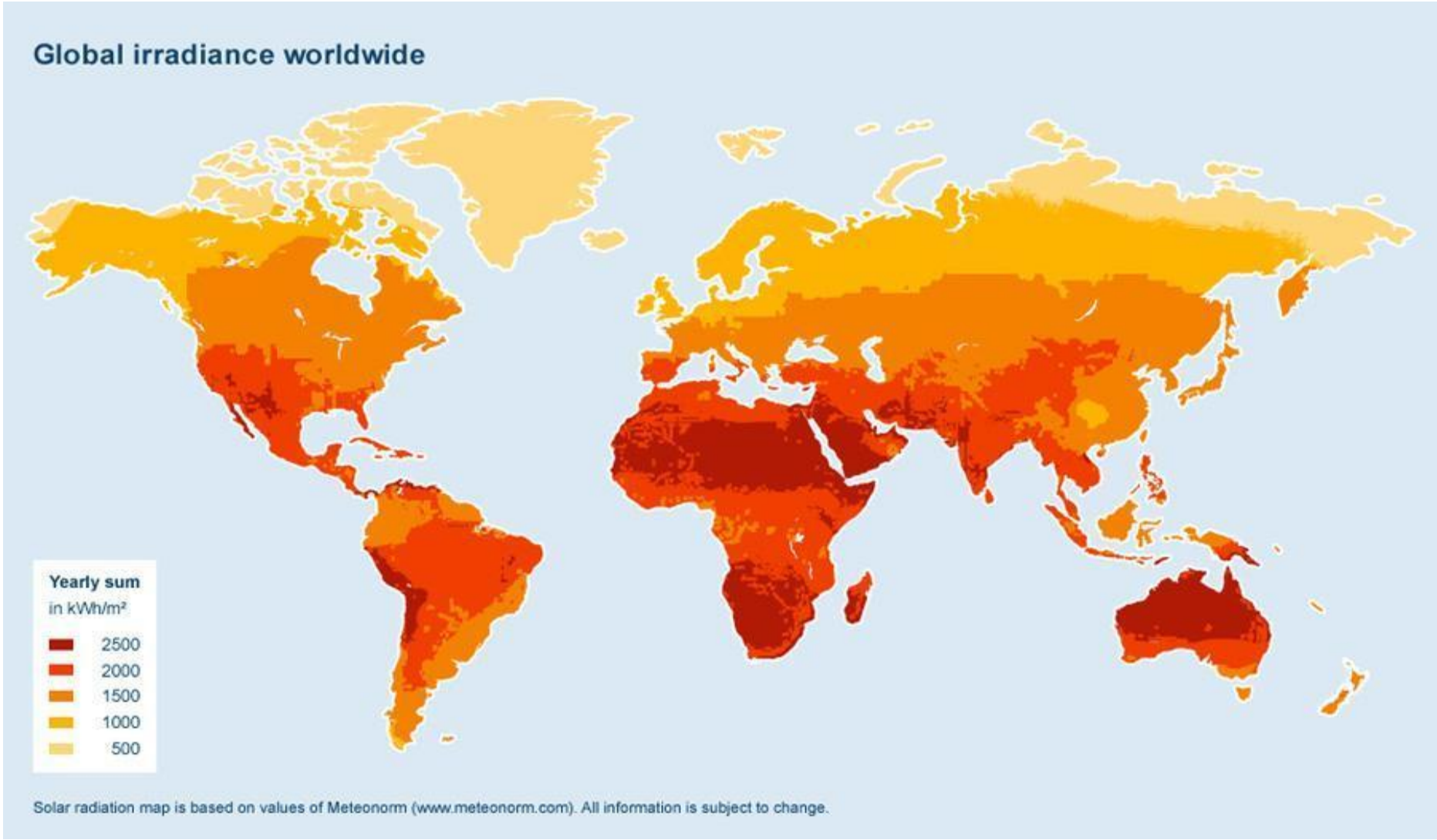
Enough to run a Smart *Electric Drive* for ~**70** **min.**

Source: Worldbank 2010

Our Renewable Resources

Source: Sustainable Energy Advantage

World Solar Potential



Source: Meteonorm

World Solar Potential

In only 88 minutes,

the **Sun** provides enough **Energy** to

power the World for

one entire year.

Source: Ramez Naam – Scientific American

World Solar Potential

World Energy Consumption 2010 = 17,500 TWh

17,500,000,000,000 kWh

Antelope Valley - PV Power Plant = 623 GWh

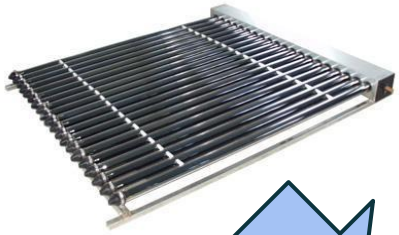
→ 2,100 acres

623,000,000 kWh

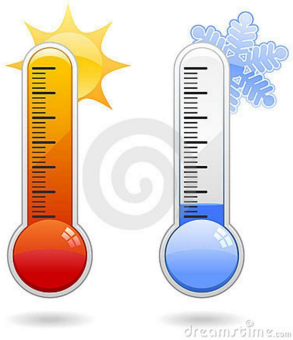
Another **22,000 Plants** like this are needed

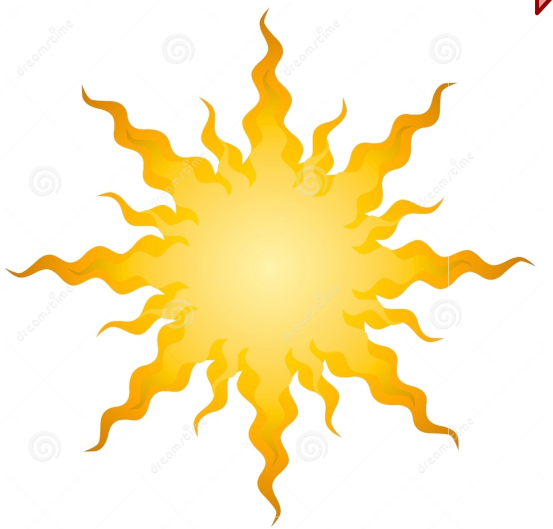
Source: Sandia.gov and World Energy Outlook 2010

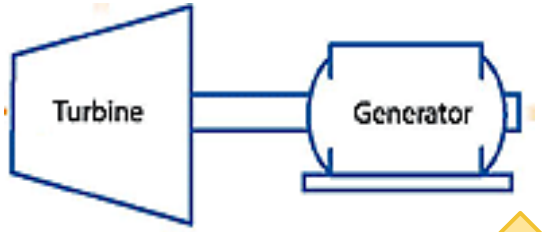
To heat up liquid



To heat up our homes

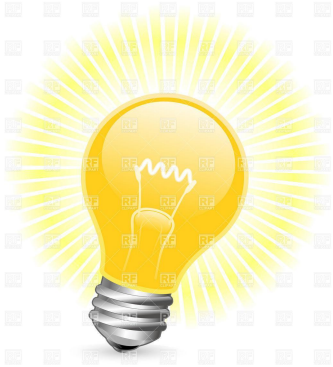




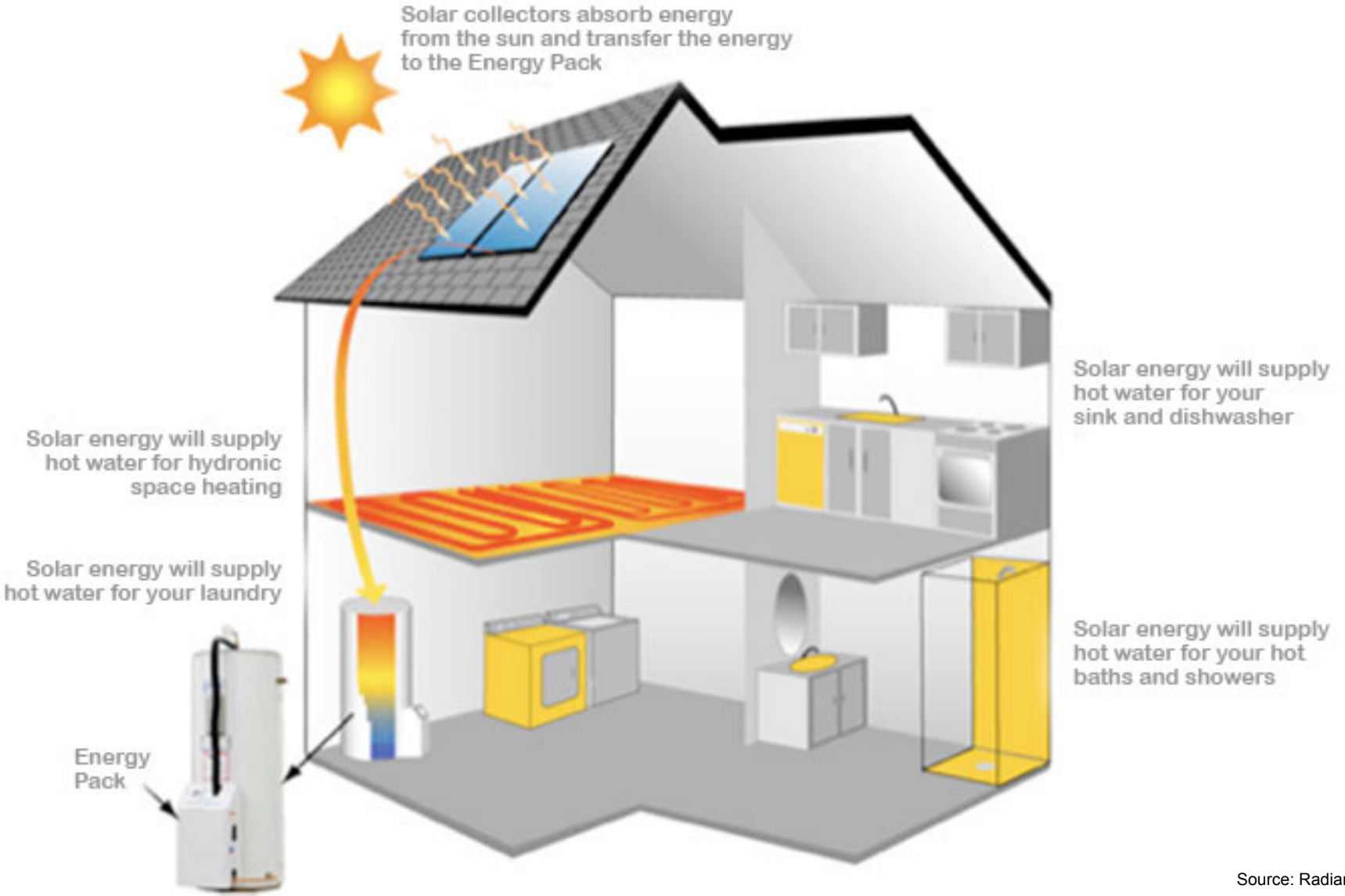


Gathering Radiation

To make electricity



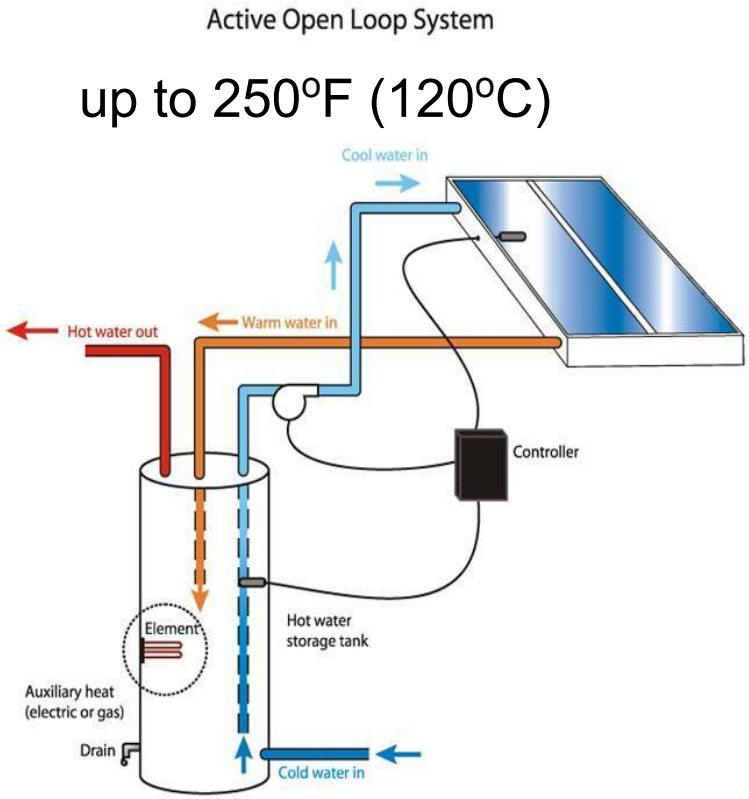
Solar Thermal Energy for Our Homes



Source: Radiance Solar

Most Common Types of Thermal Capturing

Direct Plate

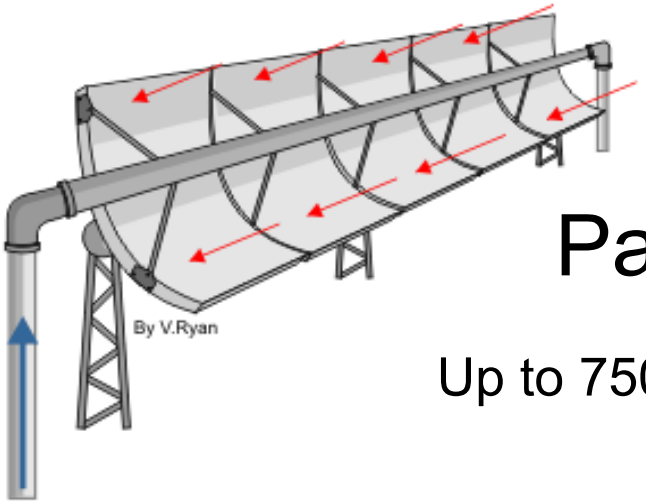


up to 250ºF (120ºC)

Solar Tower

Up to 1850ºF (1000ºC)

Parabolic



Up to 750ºF (400ºC)

CSP - Parabolic Solar Power Plant

ANDASOL - SPAIN
540 GWh
180 MW

Storage for 7.5 hr
Electricity for
200,000 People

CSP - Solar Tower

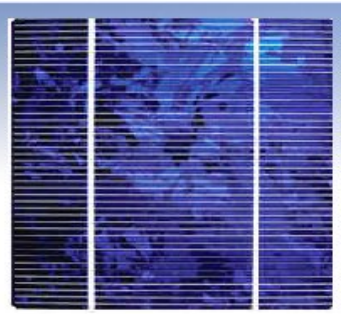
INVANPAH - USA / CA
1080 GWh
392 MW

170,000 Heliostats
Electricity for
400,000 People

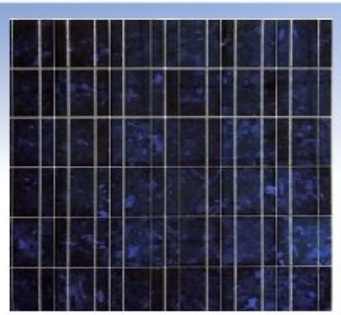
Solar Photovoltaic (PV)

Taking sunlight and directly turning it into electricity

Types of Solar PV Capturing

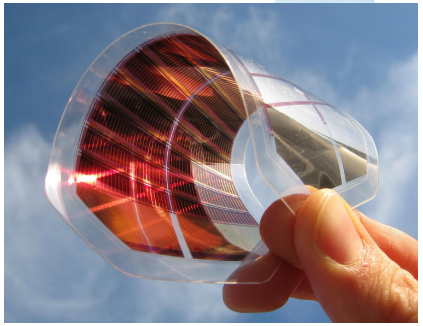


Mono-crystalline



Poly-crystalline

Amorphous silicon



Thin-film (Other)

Type of Solar PV Cell	Maximum Achieved Efficency (%)
Monocrystalline	Up to 27%
Poly-crystalline	Up to 20.4%
Amorphous silicon	Up to 13.4%
Thin-Film (Other material)	Up to 11.1%

Monocrystalline

Made from a single crystal of Silicon

Polycrystalline

Made from multiple crystals of Silicon

Amorphous

Made from a thin film of Silicon

Thin-film (includes organic solar cells)

Made from a thin film of other materials

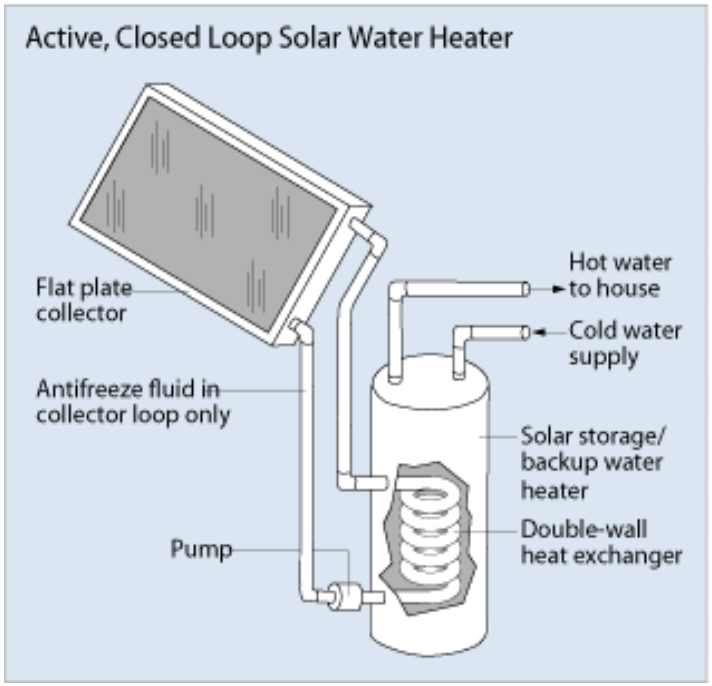
Source: NREL - National Renewable Energy Lab

PV Power Plant

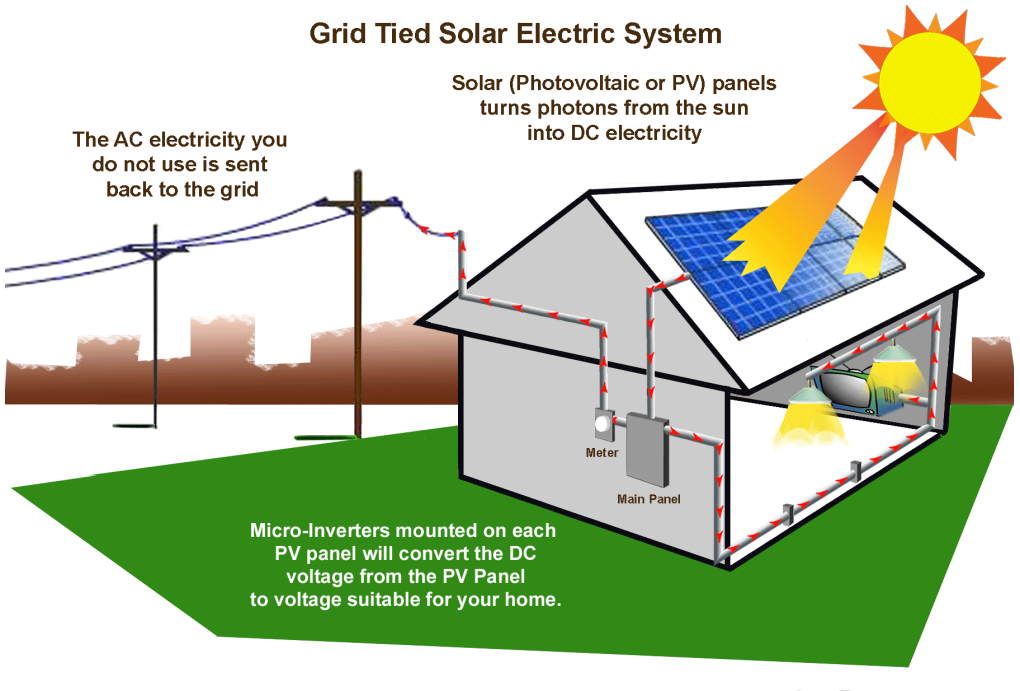
Antelope Valley - USA / CA
623 GWh
230 MW

3,700,000 PV Moduls
Electricity for
230,000 People

Home: Solar Energy



Solar heating - Getting hot water for homes

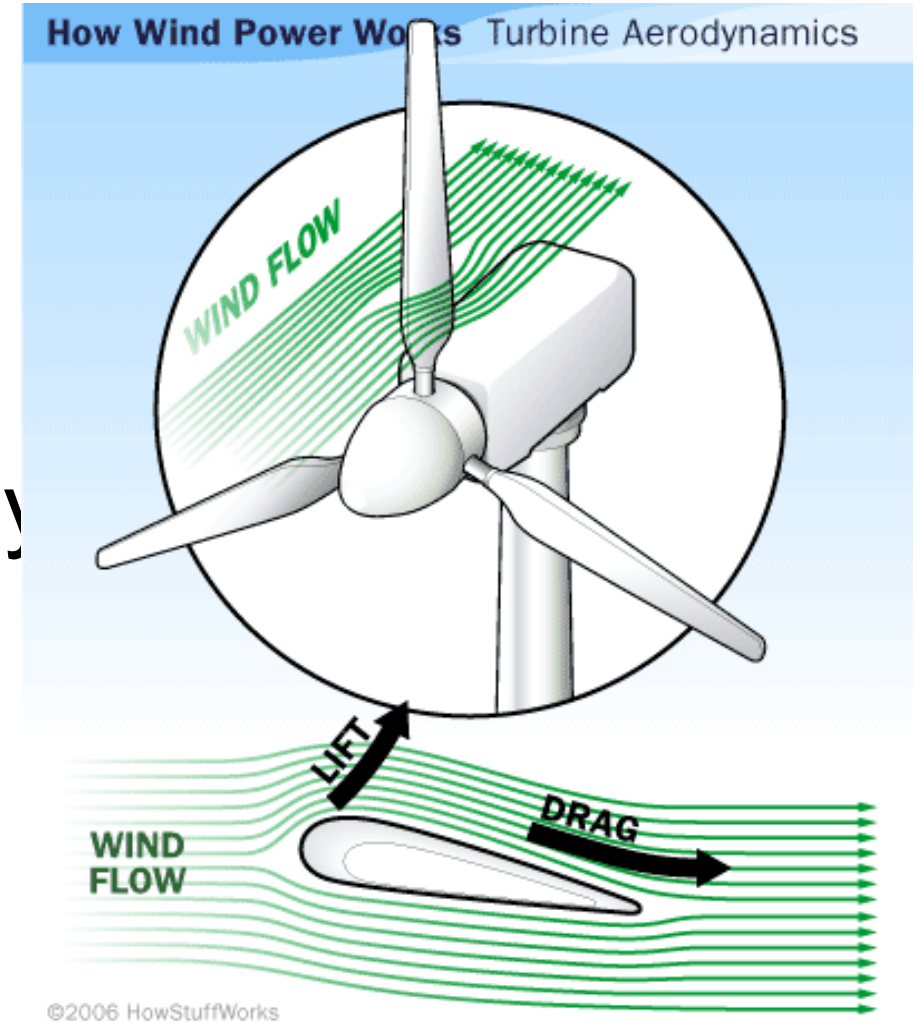


Home Solar panels - Create your own electricity and "sell back" excess energy

Source: ENERGY.GOV

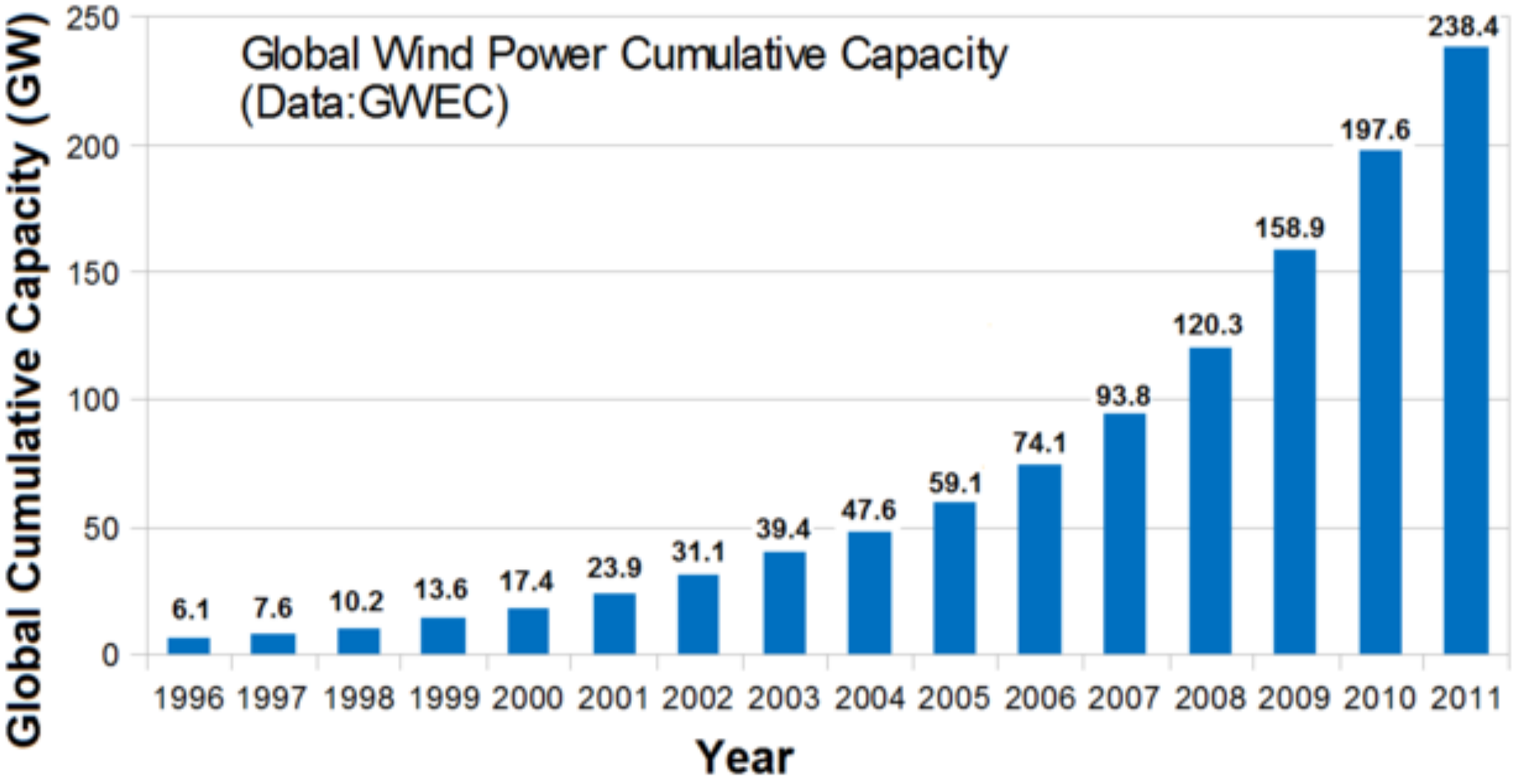
Wind Power

Converts the **kinetic energy** of the wind into mechanical energy then **into electricity**.

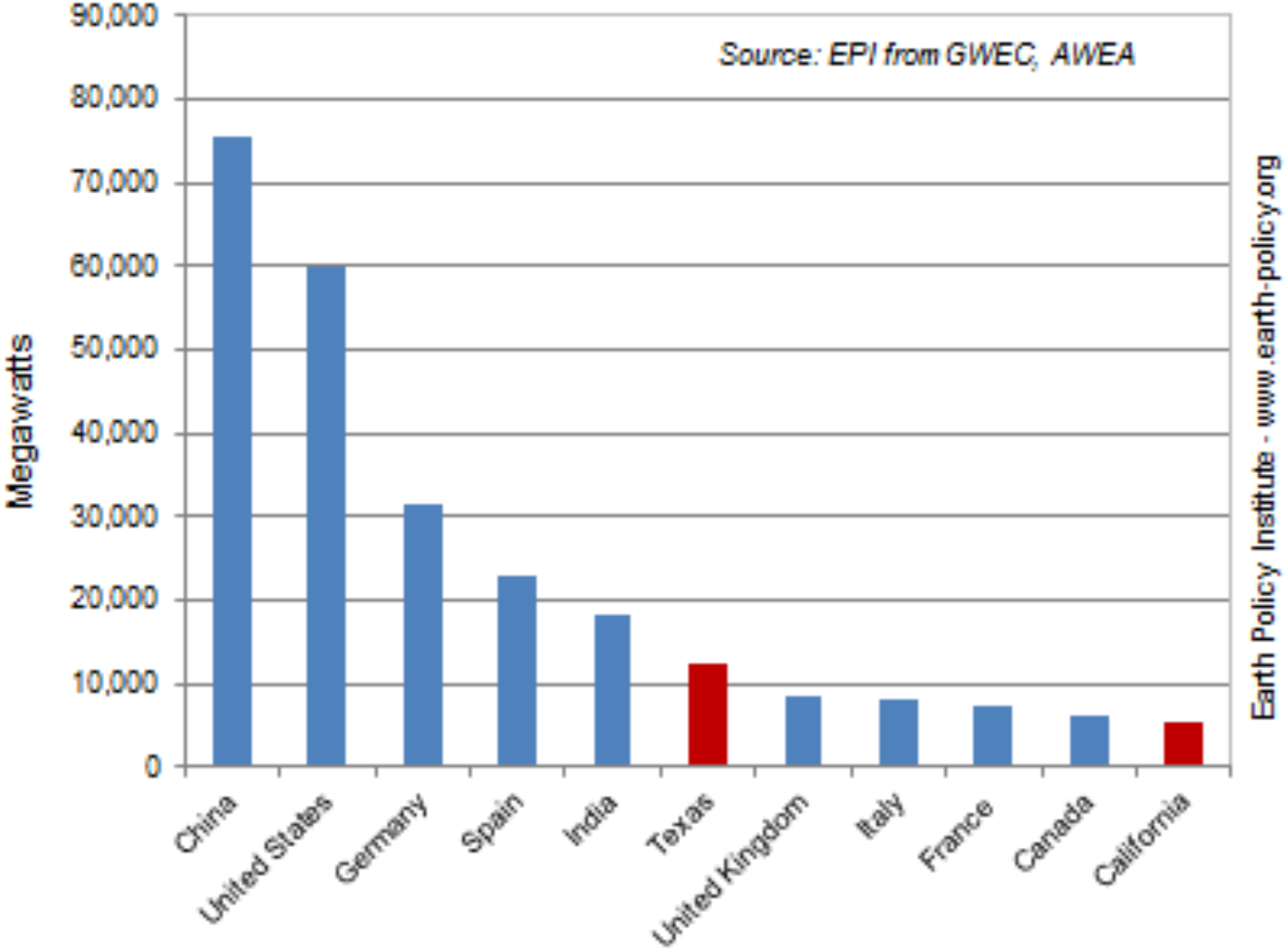


Source: Renewable Green Energy Power

Global Wind Power

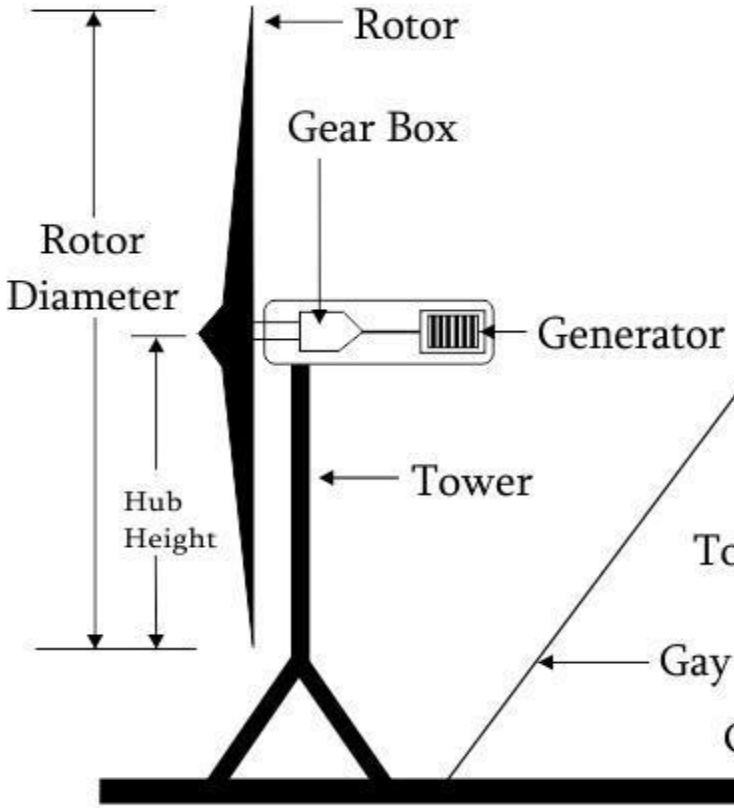


Cumulative Installed Wind Power Capacity in Leading Countries and U.S. States, 2012



Types of Windmills

Horizontal Axis Wind Turbine (HAWT)



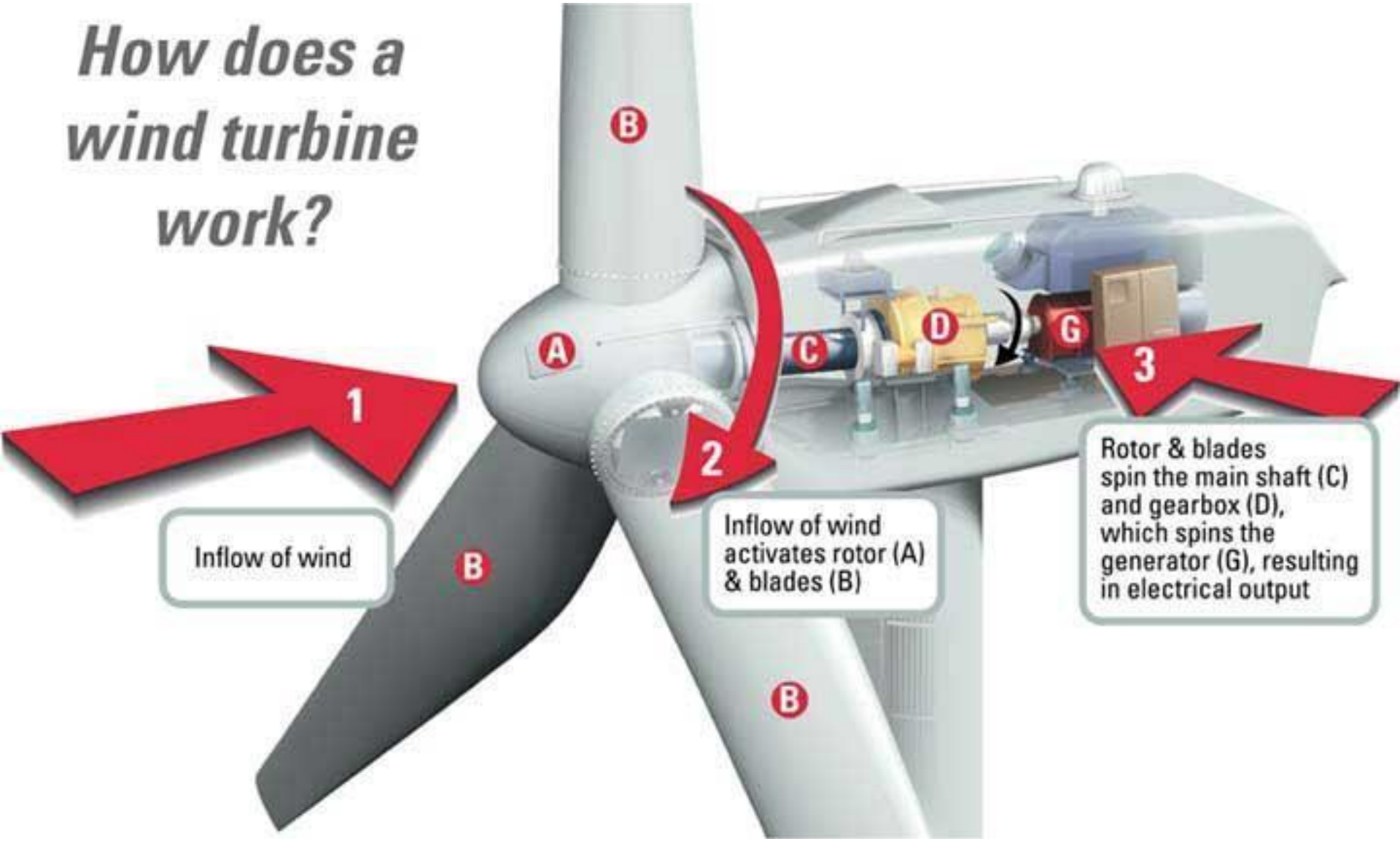
100 kW – 10,000 kW

Vertical Axis Wind Turbine (VAWT):

1 kW - 30 kW

Source: How Stuff Works

How does a wind turbine work?



Source: CCEDC

Small Scale Example

Wrigley Hall
at
Arizona State University

Using small scale HAWT to help support this building in sustain a green outlook.

Source: Arizona State University

Largest Onshore Windfarm

Alta Wind Energy Center - USA / CA
2,680 GWh
1,020 MW (2012)
3,000 MW(2020)

9,000 acres
Electricity for
1,000,000 People

Largest Offshore Windfarm

London Array - UK
1,575 GWh
630 MW (2013)

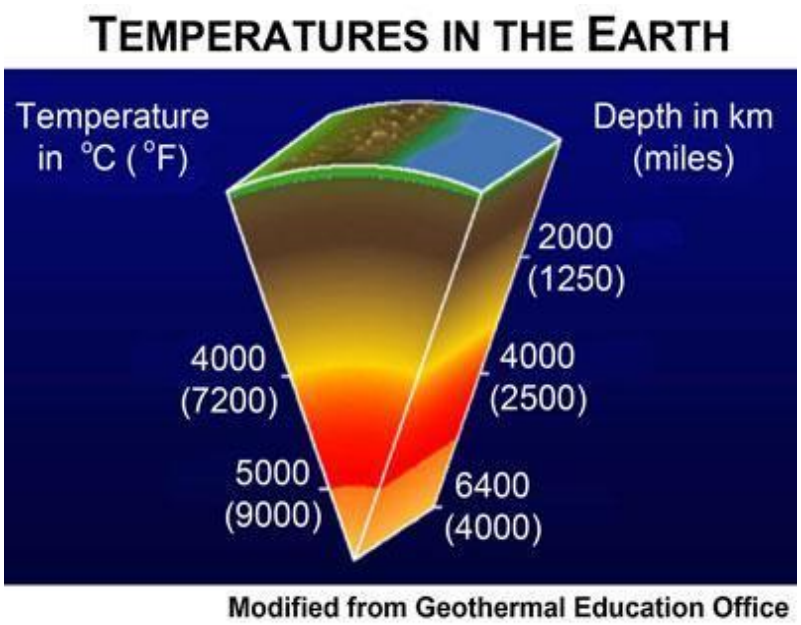
280 miles Cable
Electricity for
500,000 People

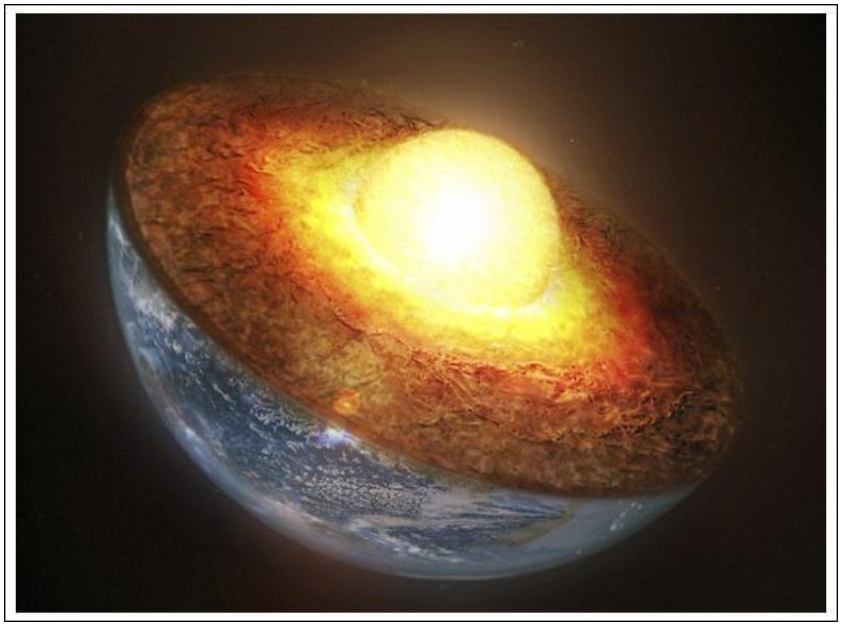
Geothermal

Obtaining heat from the earth

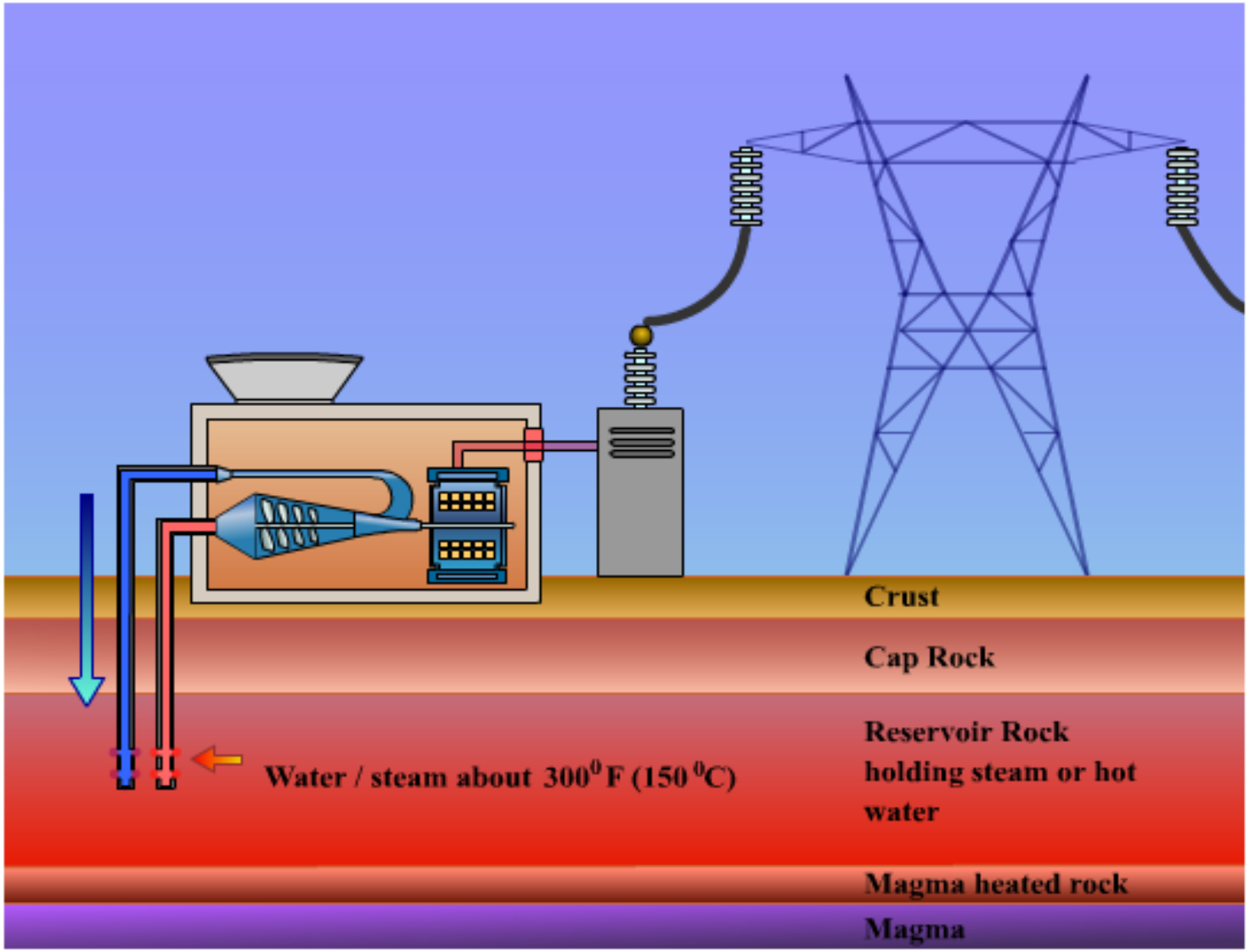
to heat and power our lives.

Enough energy (theoretically) in the first 6 miles of earth to **power the world 50,000 times over.**





Geothermal Power Plant



Source: California Energy Commission

Different types of Generators

Direct Dry Steam Generator

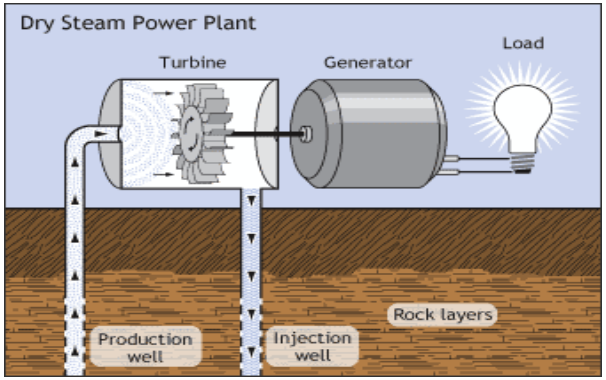
- Steam goes directly to generator.

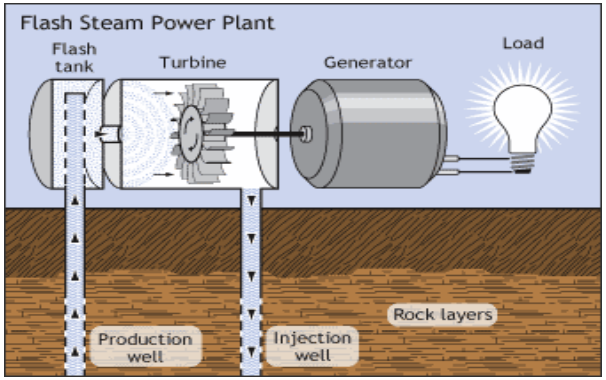
Flash Steam Generator

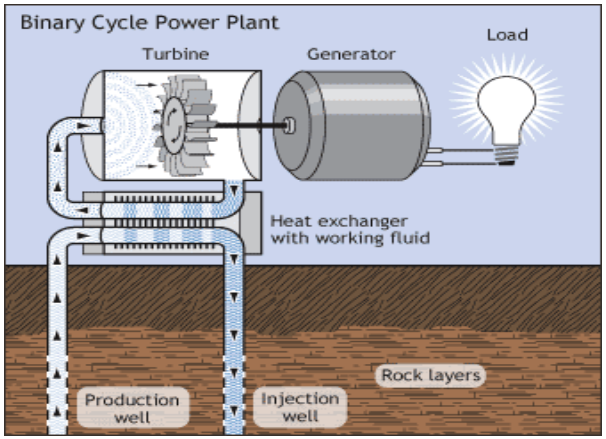
- Fluid is sprayed into a tank held at a much lower pressure than the fluid, causing some of the fluid to rapidly vaporize, or "flash."

Binary Cycle Generator

- Hot water flows from the pipes from the earth and heat up water in the plant to steam.

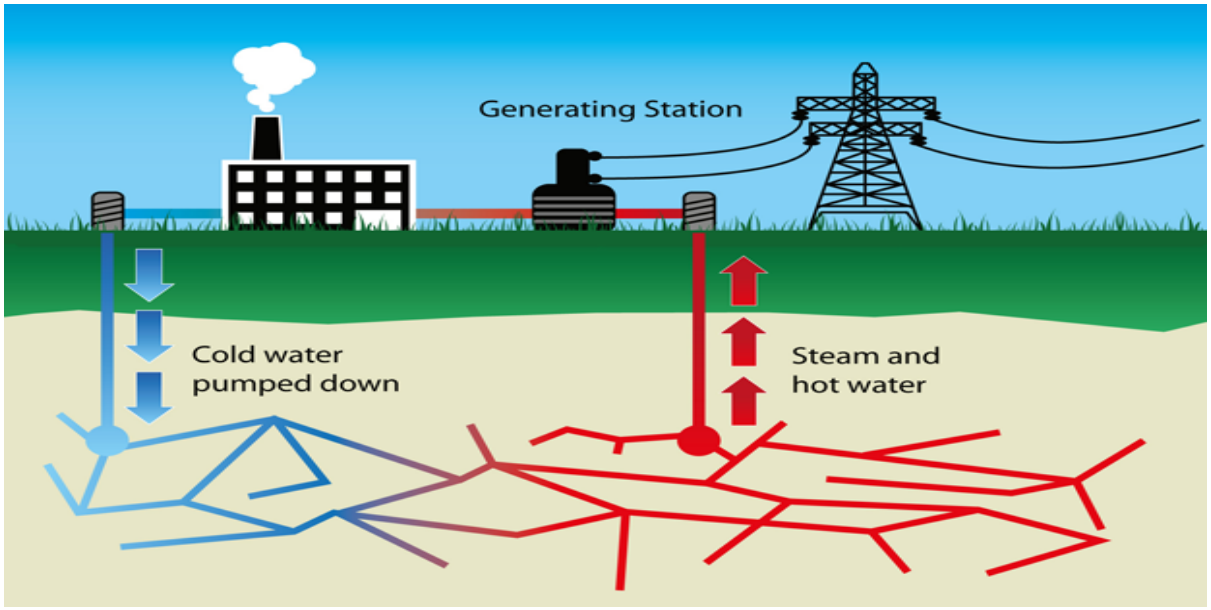




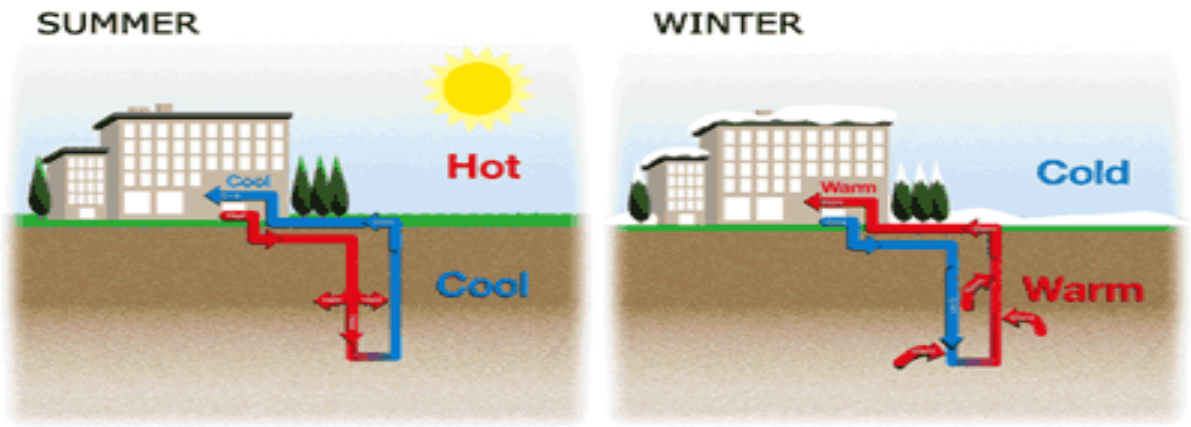


Source: Energy Almanac (CA)

Purpose

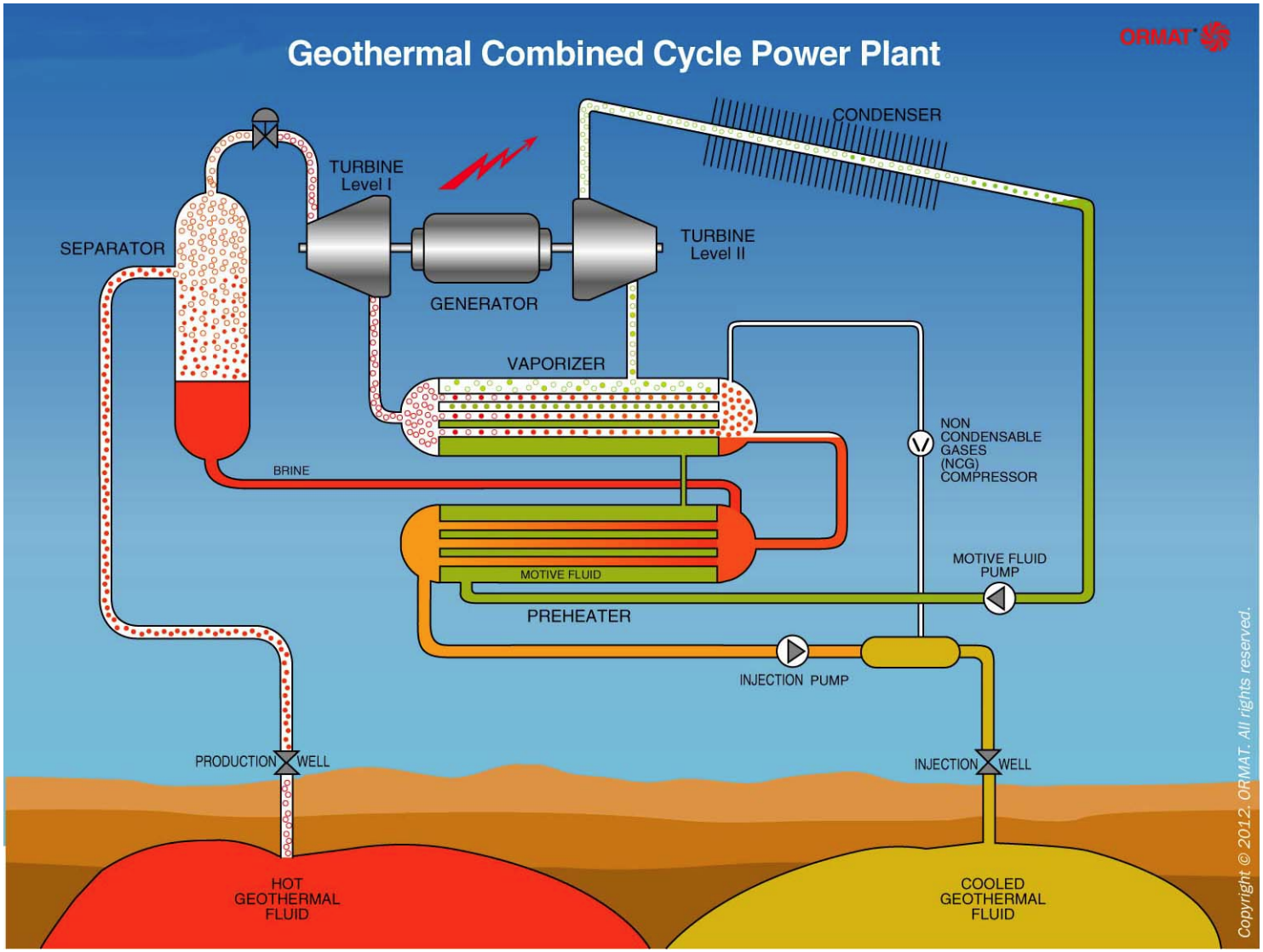


Electricity Generation



Direct heating or cooling

Heat and Electricity



Example
California

California Power plants:

Combined for over

2,500 MW of Power and

13,500 GWh of Energy

almost

5%

of the entire Californian energy demand

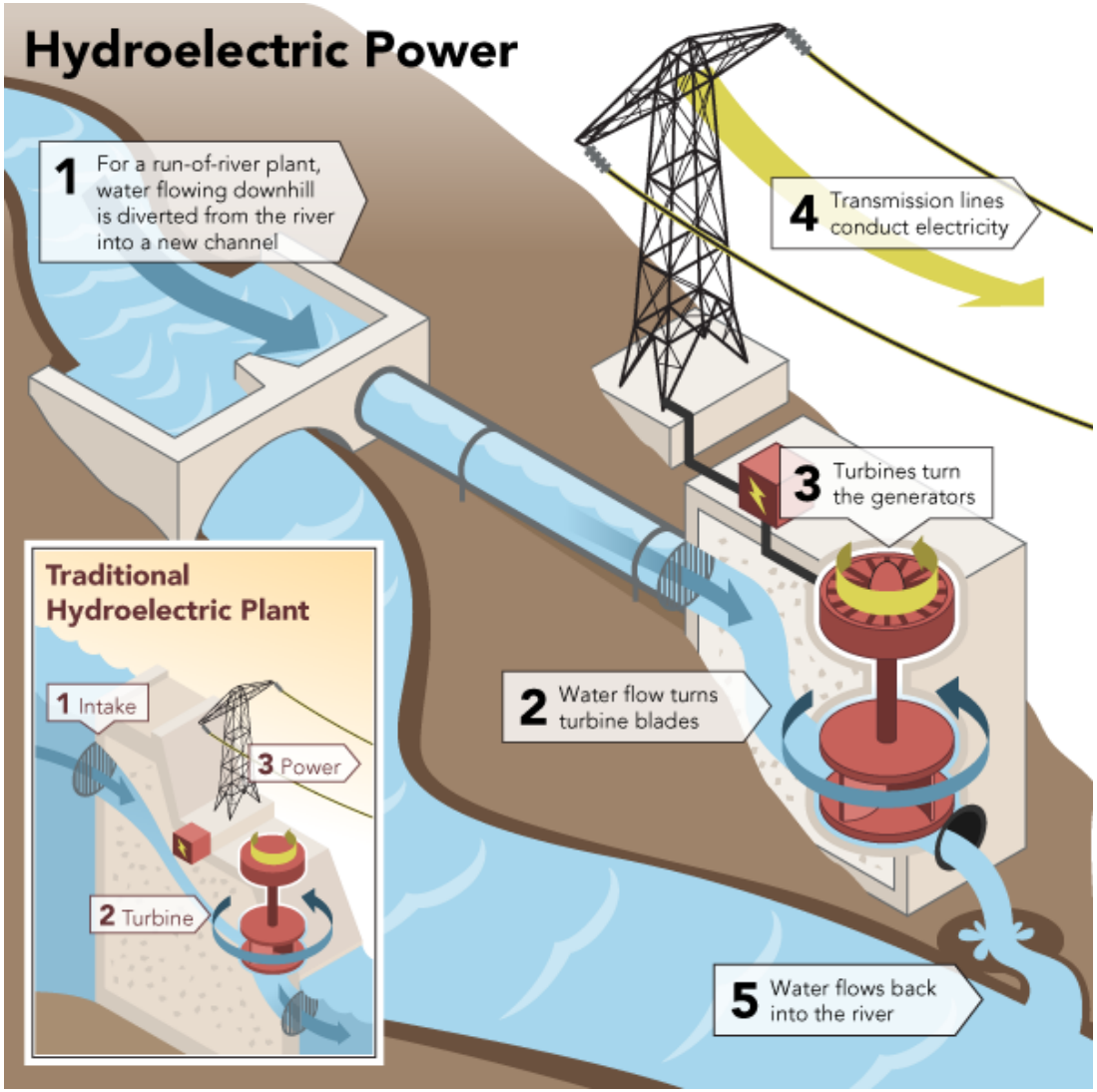
Source: California Energy Gov.

Hydro Power

Harnessing the kinetic energy found in the motion of water within various areas

Probably the most popular renewable energy source in the world

Hydroelectric Power



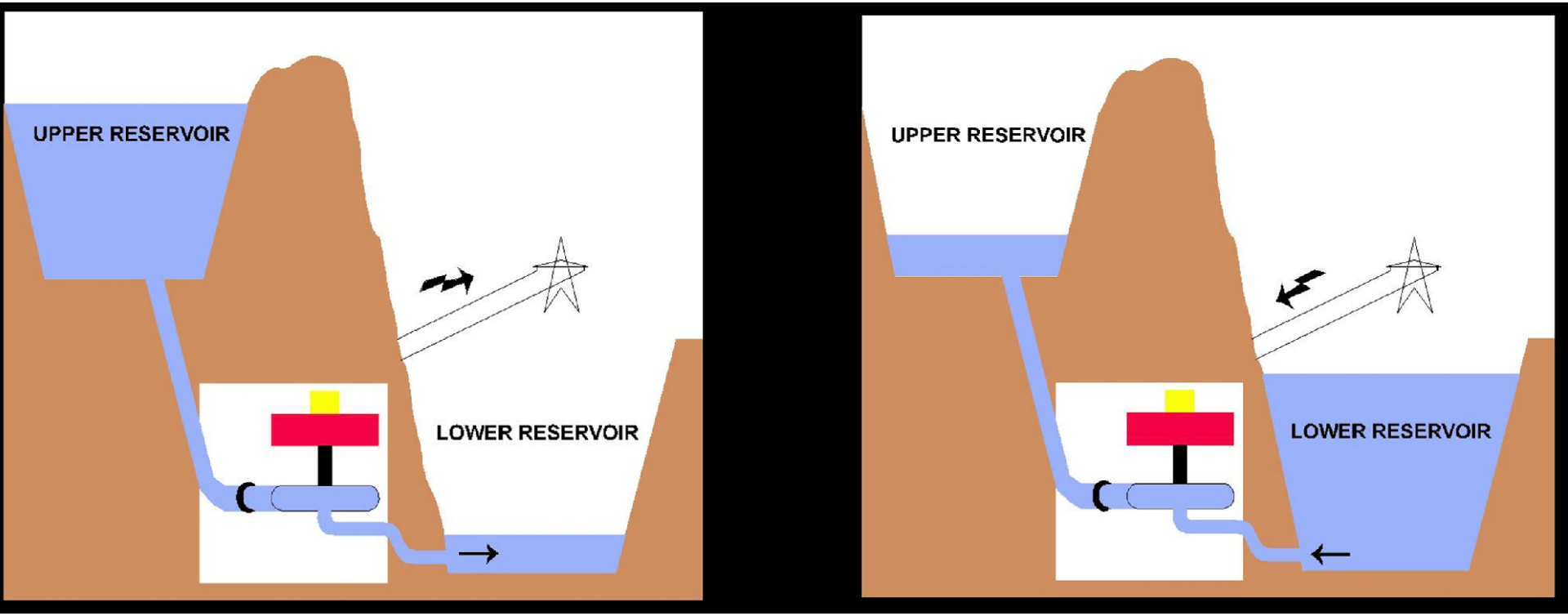
A hydroelectric power plant uses water to turn a turbine, which then turns a metal shaft in an electric generator.

The electric generator produces electricity.

Source: Renewable Green Energy Power

Pump and Storage Power Plants

Both generating and storage energy…
... which is really important for the future of energy supply

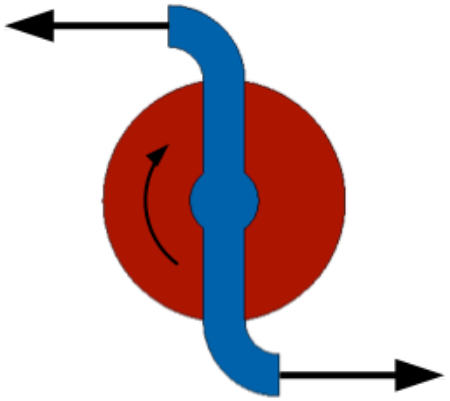


Source: ESKOM

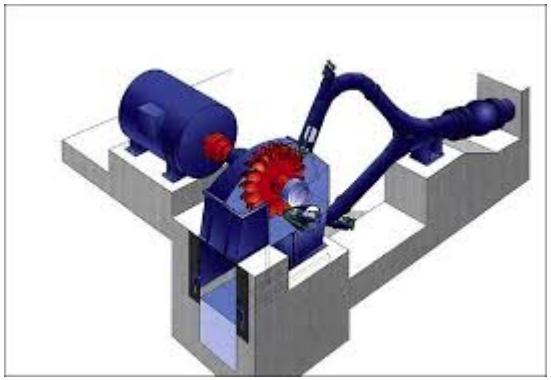
Different Types of Turbines

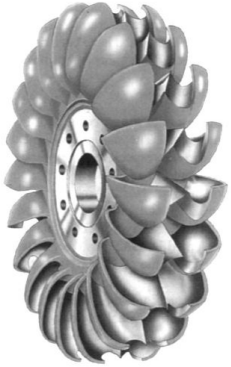
Reaction Turbine

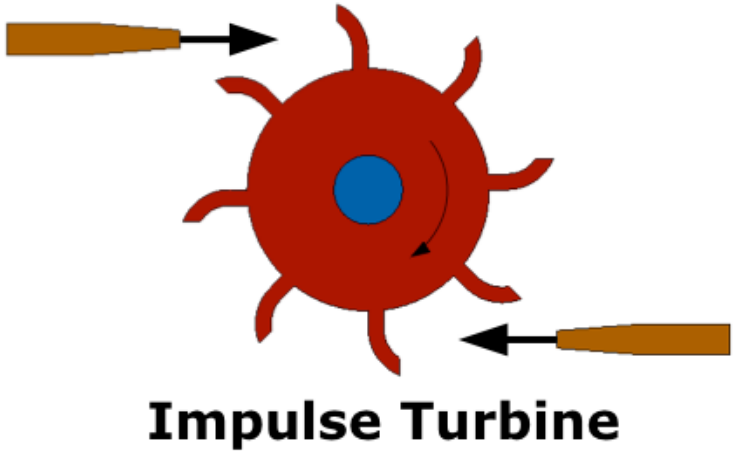
- such as Kaplan & Francis Turbine



Impulse Turbine *- such as Pelton Turbine*







Source: EERE

Tidal Turbines

Source: Renewable Energy Study

Hoover Dam - Nevada

4,200,000,000 kWh

1,700,000

World Largest Water Power Plant

Three Gorges Dam - China

80,000,000,000 kWh

22,500 MW

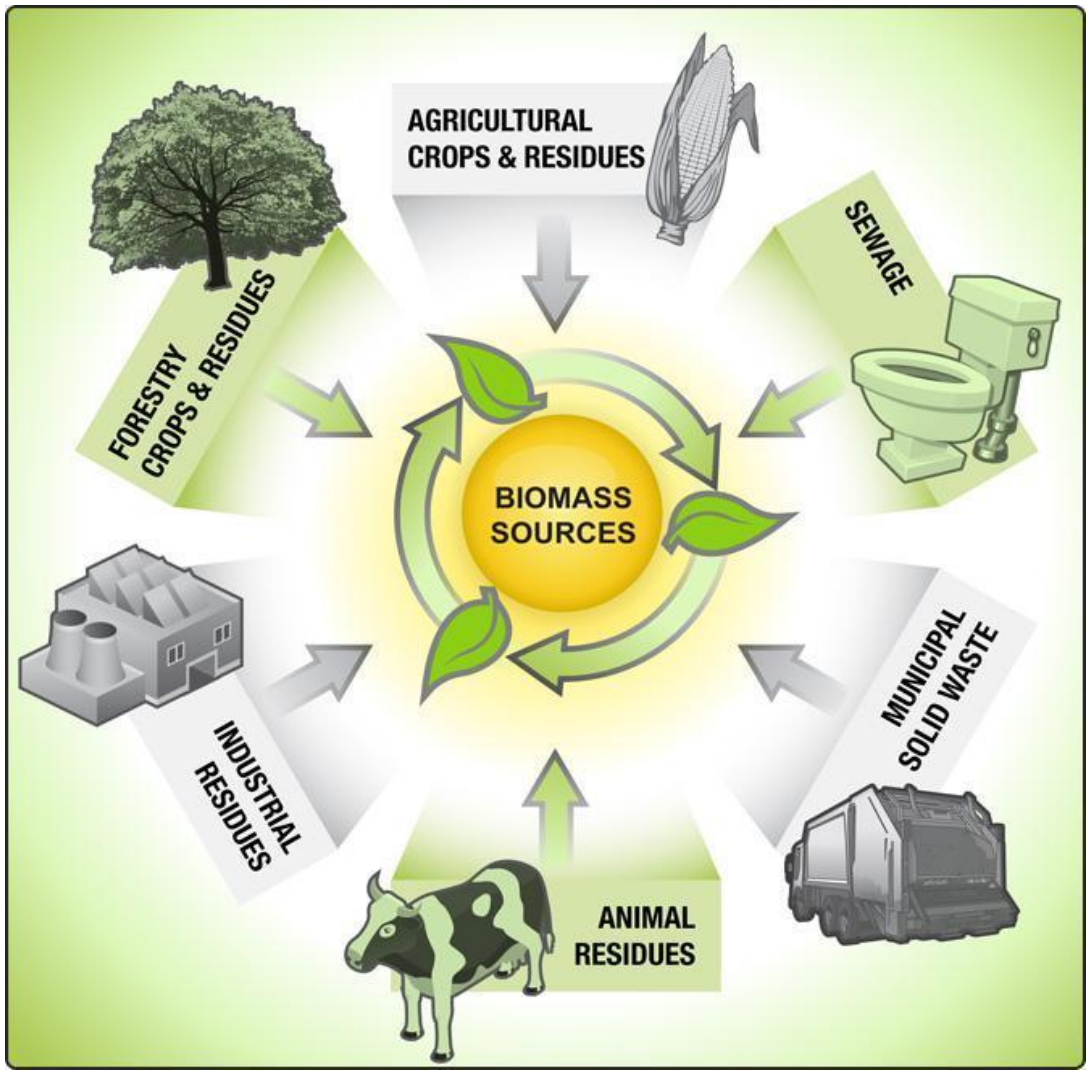
34 Turbines

enough to Power entire

GERMANY

World's Largest Water Power Plant

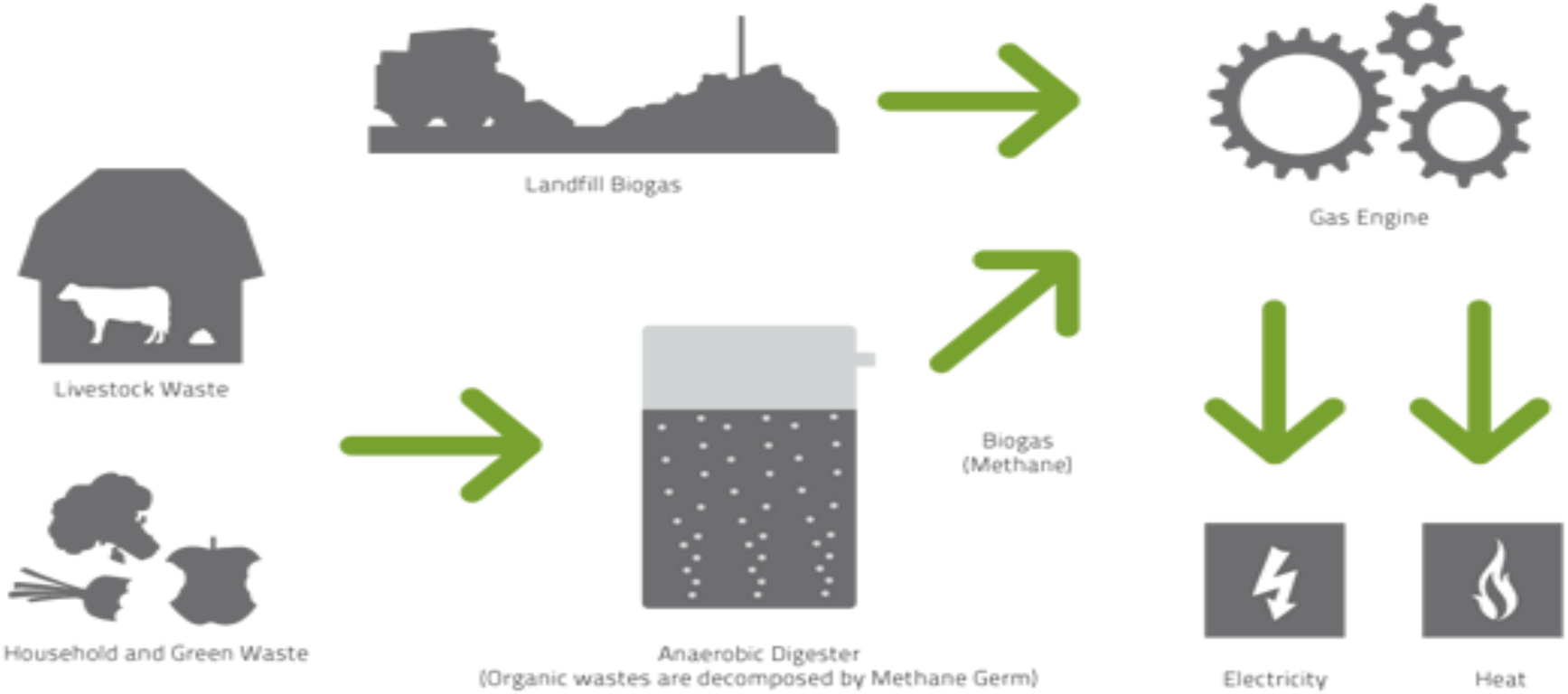
Biomass



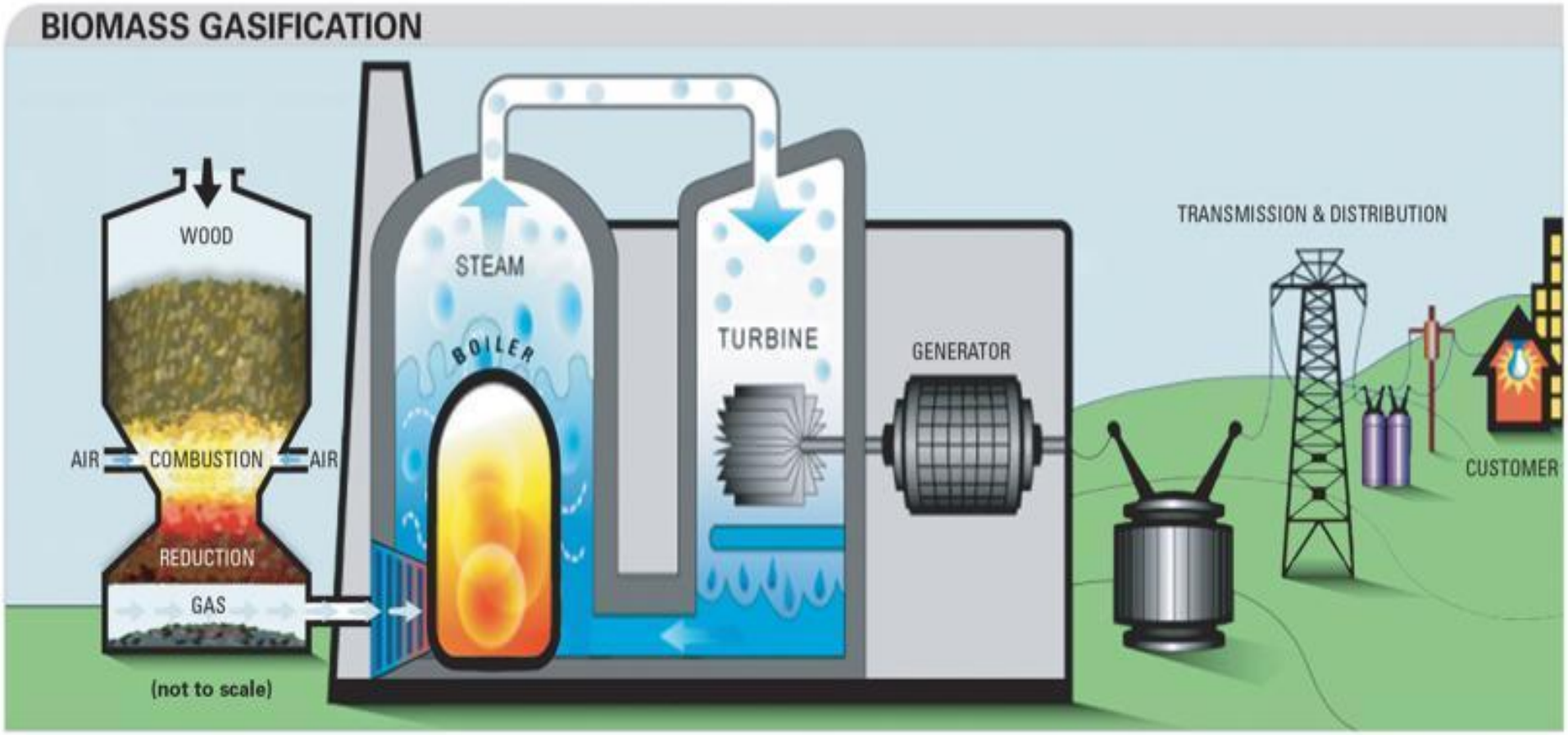
Source: http://greenrenewableenergy.org/tag/guidebook/

Biogas Gasification

Simplified Biogas Diagram



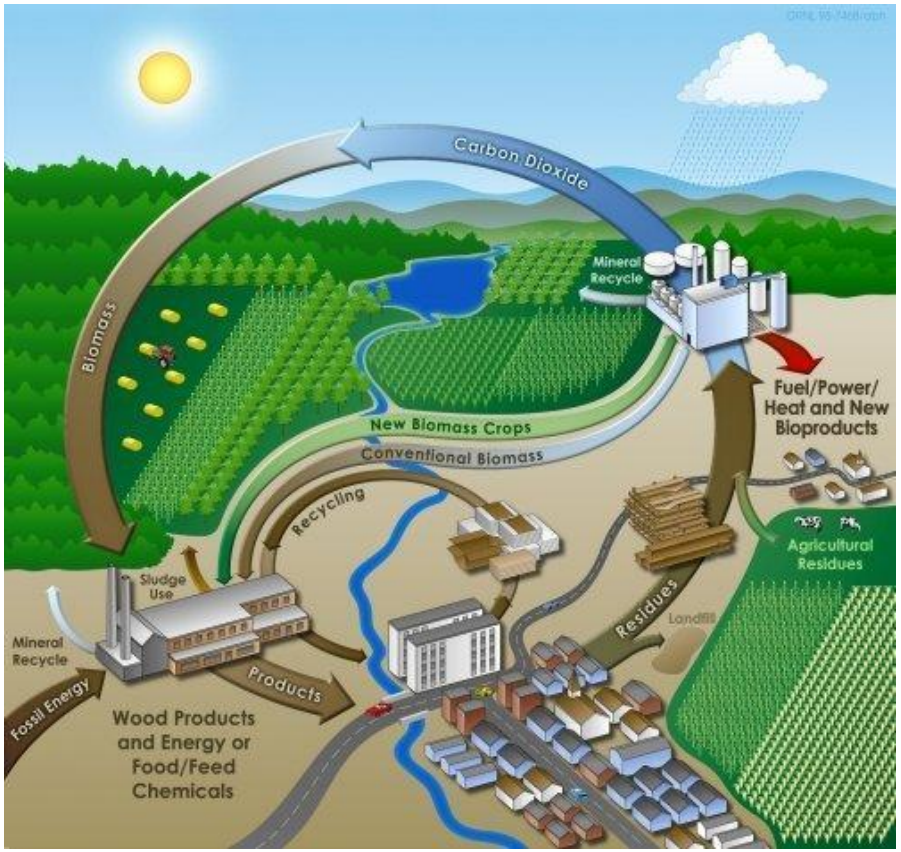
How It Works: Biomass Gasification



Benefits Regarding Biomass

While still releasing carbon emissions into the atmosphere, Biomass is beneficial to society by:

- Releasing a small amount of carbon compared to fossil fuels - **nearly ZERO**
- It can run **24/7** unlike many renewable resources
- It finds use for items that regarded in society as waste.



Small Scale Example
Fireplace

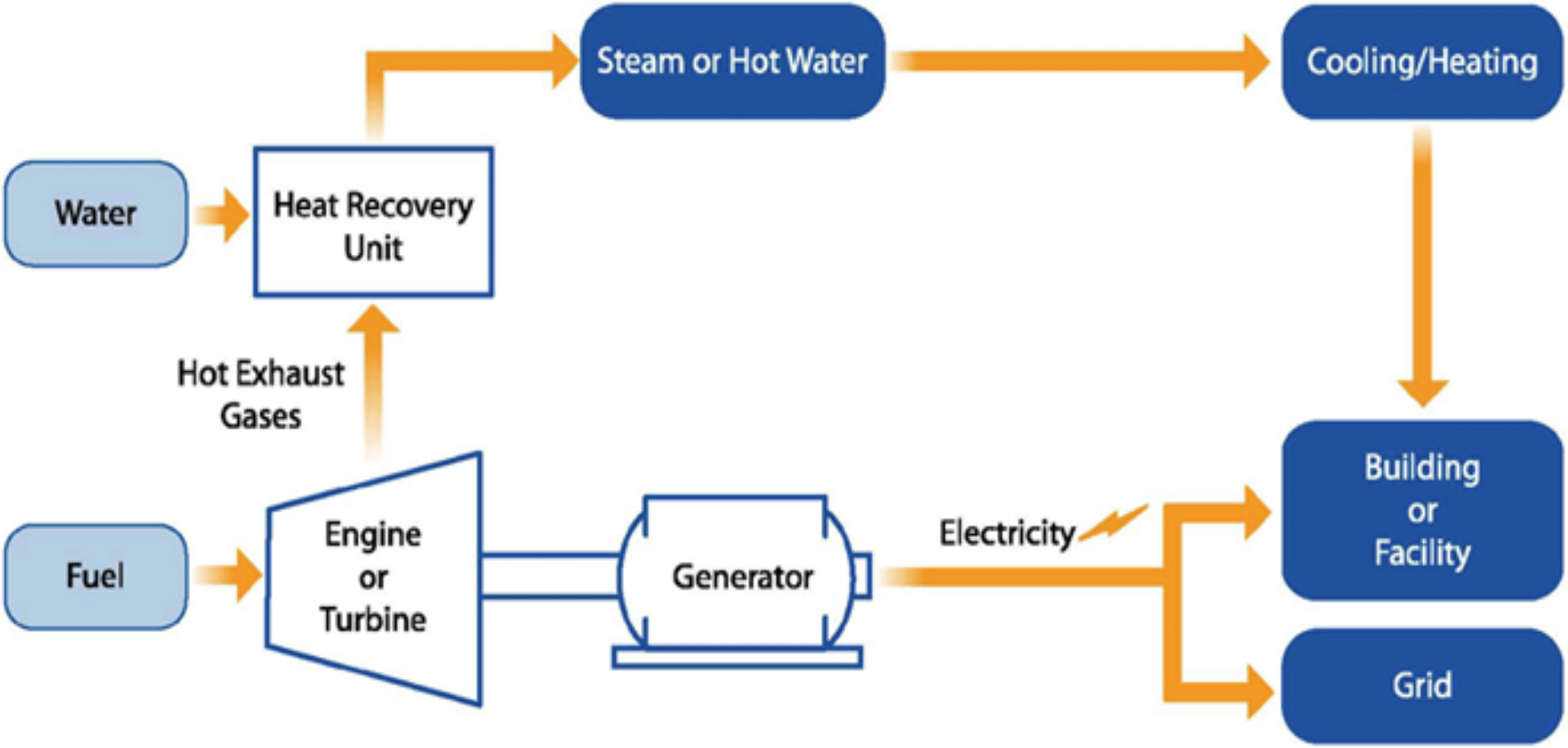
Large Scale Example
Lutosa Potato farm

In Belgium, LUTOSA Potato farms has one of the largest biogas plants in Europe.

Creates over **5,920,351 kWh** per year

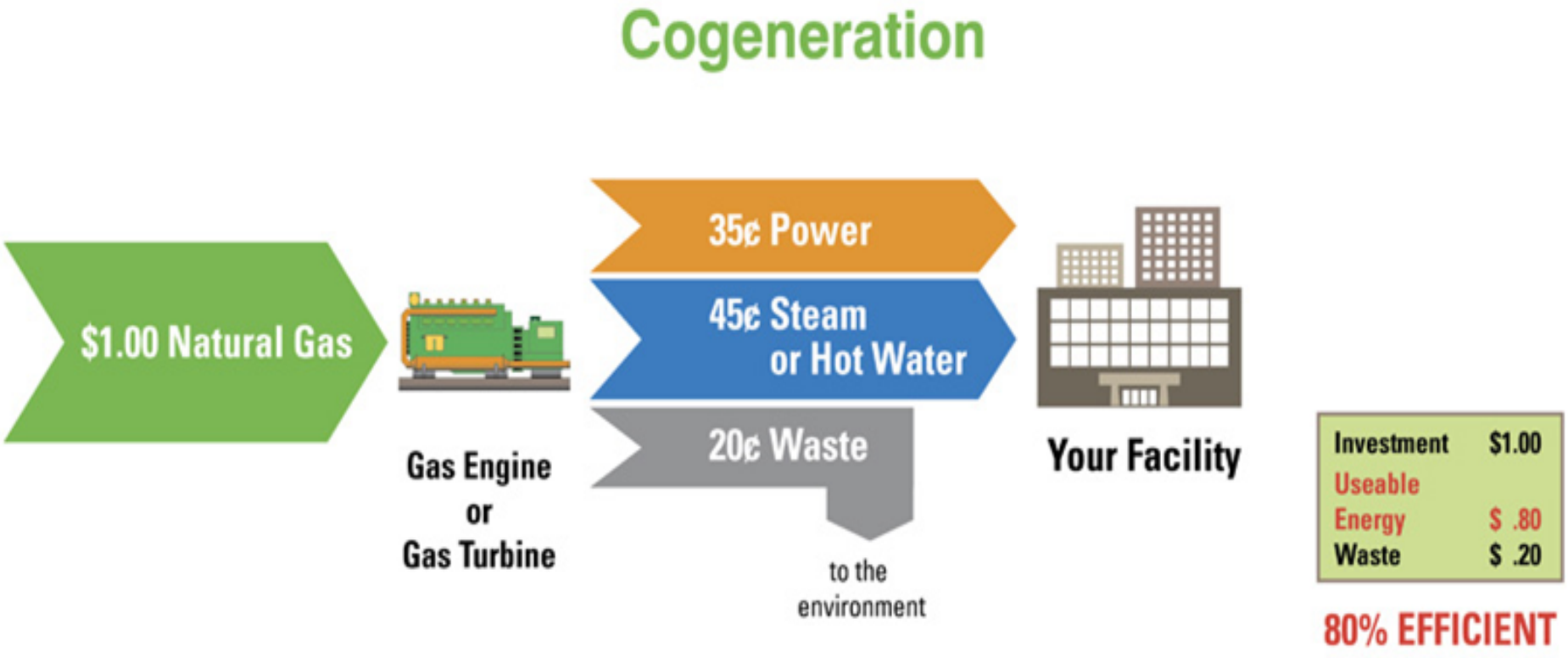
Power to over *2000 people* from **Waste**.

Cogeneration - Combined Heat and Power



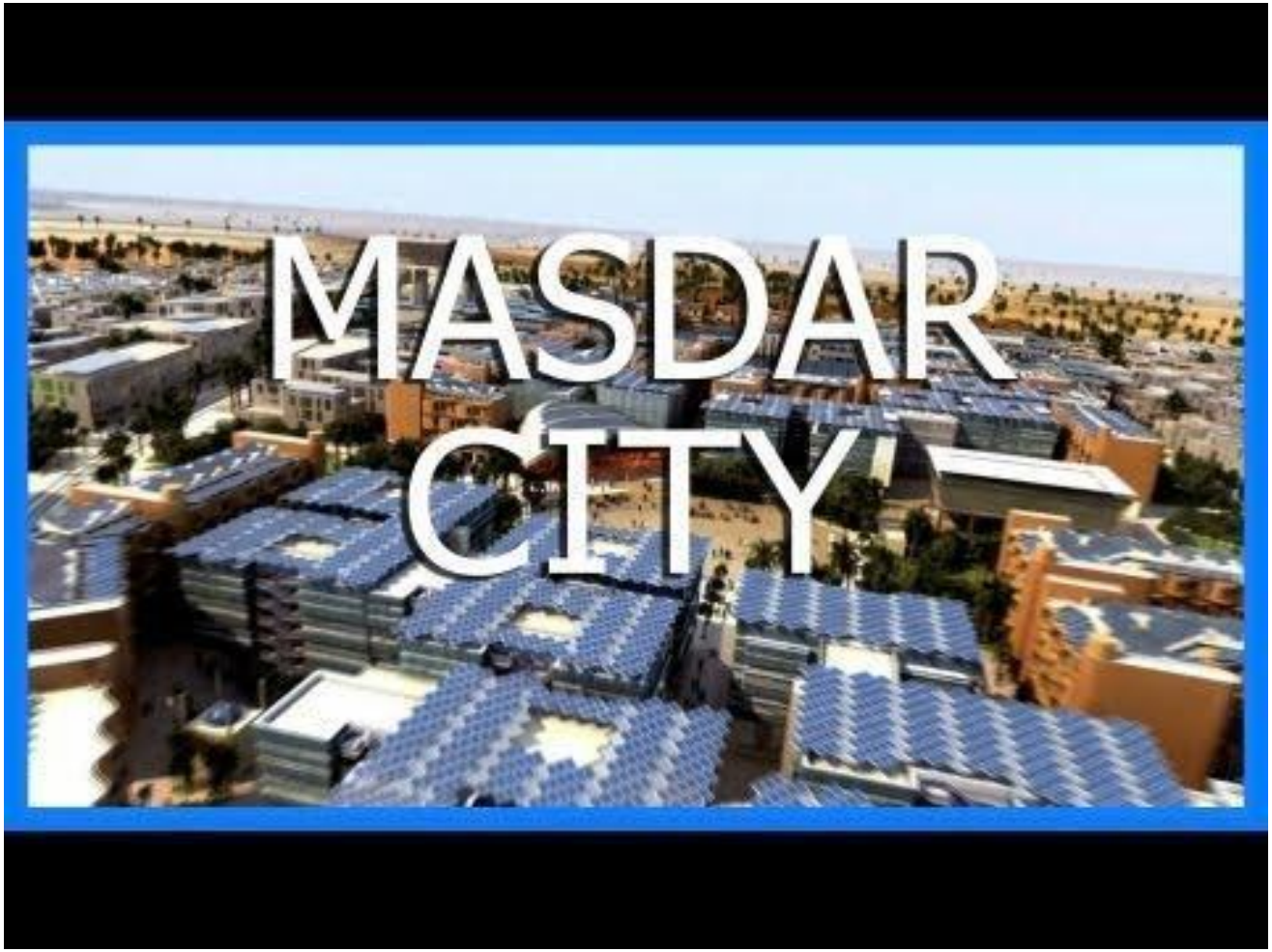
Source: C2ES

Cogeneration - Combined Heat and Power



This technology is very important for both
- fossil fuels, such as Gas Turbines
- and renewable Resources

Masdar city



"To truly transform our economy, protect our security, and save our planet from the ravages of climate change, we need to ultimately make clean, renewable energy the profitable kind of energy."

- President Barack Obama

Schedule of presentations: 5:30 pm - 7:30 pm

Date:Thursday	Topics
June 20	Selling our Future
June 27	Population Pressure: Land & Water
July 11	Climate Change & the Energy Transition
July 18	Stabilizing Climate:An Energy Efficiency Revolution
July 25	Stabilizing Climate:Shifting to Renewable Energy
August 1	Designing Cities for People
August 8	Eradicating Poverty & Stabilizing Population
August 15	Restoring the Earth
August 22	Feeding Eight billion People Well
August 29	Can We Mobilize Fast Enough
September 5	Summary & Priorities

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