# Renewables: Where to?

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Conference of EU-Jordan Networking in Renewable Energy
Amman – Jordan 27-28/2/2013

# What renewables

**Unlike hydrocarbon energies, renewable energy is developed from resources that are constantly replenished and will never run out.**

- **Solar power**
- **Wind power**
- **Biomass power**
- **Geothermal energy**
- **Ocean energy**
- **Hydropower**

# 2012 SELECTED INDICATORS

| | | 2009 | → | 2010 | → | 2011 |
|---|---|---|---|---|---|---|
| Investment in new renewable capacity (annual) | billion USD | 161 | → | 220 | → | 257 |
| Renewable power capacity (total, not including hydro) | GW * | 250 | → | 315 | → | 390 |
| Renewable power capacity (total, including hydro) | GW | 1,170 | → | 1,260 | → | 1,360 |
| Hydropower capacity (total) | GW | 915 | → | 945 | → | 970 |
| Solar PV** capacity (total) | GW | 23 | → | 40 | → | 70 |
| Concentrating solar thermal power (total) | GW | 0.7 | → | 1.3 | → | 1.8 |
| Wind power capacity (total) | GW | 159 | → | 198 | → | 238 |
| Solar hot water/heat capacity (total) | $GW_{th}$ | 153 | → | 182 | → | 232 |
| Ethanol production (annual) | billion litres | 73.1 | → | 86.5 | → | 86.1 |
| Biodiesel production (annual) | billion litres | 17.8 | → | 18.5 | → | 21.4 |
| Countries with policy targets | # | 89 | → | 109 | → | 118 |

*Source: Renewables 2012 Global Status Report p 17; www.ren21.net*

* *GW: gigawatt*

** *PV: solar photovoltaics*

# 2012| TOP FIVE COUNTRIES

| | New capacity investment | Hydropower capacity | Solar PV* Capacity | Wind power capacity | Solar hot water/heat capacity1 | Biodiesel production | Ethanol production |
|---|---|---|---|---|---|---|---|
| 1 | China | China | Italy | China | China | United States | United States |
| 2 | United States | Vietnam | Germany | United States | Turkey | Germany | Brazil |
| 3 | Germany | Brazil | China | India | Germany | Argentina | China |
| 4 | Italy | India | United States | Germany | India | Brazil | Canada |
| 5 | India | Canada | France | U.K./ Canada | Italy | France | France |

* *PV: solar photovoltaics*

*Source: Renewables 2012 Global Status Report p 19; www.ren21.net*

# 2012| TOP FIVE COUNTRIES

## Total Capacity as of End -2011

| | Renewable power capacity (incl. hydro | Renewable power capacity (not incl. Hydro) | Renewable power capacity per capita (not incl. hydro) | Biomass power capacity | Geothermal power capacity | Hydropower capacity |
|---|---|---|---|---|---|---|
| 1 | China | China | Germany | United States | United States | China |
| 2 | United States | United States | Spain | Brazil | Philippines | Brazil |
| 3 | Brazil | Germany | Italy | Germany | Indonesia | United States |
| 4 | Canada | Spain | United States | China | Mexico | Canada |
| 5 | Germany | Italy | Japan | Sweden | Italy | Russia |

| | Solar PV capacity | Solar PV capacity per capita | Wind power capacity | Solar hot water/heat capacity1 | Solar hot water/heat capacity per capita | Geothermal heat installed capacity | Geothermal direct heat use3 |
|---|---|---|---|---|---|---|---|
| 1 | Germany | Germany | China | China | Cyprus | United States | China |
| 2 | Italy | Italy | United States | Turkey | Israel | China | United States |
| 3 | Japan | Czech Rep. | Germany | Germany | Austria | Sweden | Sweden |
| 4 | Spain | Belgium | Spain | Japan | Barbados | Germany | Turkey |
| 5 | United States | Spain | India | Brazil | Greece | Japan | Japan |

*Source: Renewables 2012 Global Status Report p 19; www.ren21.net*

# Renewables Growth: Global

- **Renewables grown 16.7% of global energy consumption**
- **Modern renewables increased to 8.2%**
- **Biomass, declined to 8.5%.**

# Renewables Growth: Global

1. Renewables account for half of the 208 gigawatts (GW) of electric capacity added globally 2011.
2. Wind and solar photovoltaics (PV*) accounted for 40% (new renewables )of 30%.
3. Hydropower accounted for 25%.
4. By the end of 2011, total renewable power capacity worldwide exceeded 1,360 GW, up 8% over 2010.
5. Renewables comprised more than 25% of total global power-generating capacity estimated at 5,360 GW in 2011 and supplied 20.3% of global electricity.
6. Non-hydropower renewables exceeded 390 GW, a 24% capacity increase over 2010.

* *PV: solar photovoltaics*

# Renewables Grown: Pv*, CSP**, wind

1. **Solar PVs grew the fastest of all renewables 2006-2011.**
2. **PV capacity increased by 58% annually.**
3. **Followed by (CSP), which increased 37% annually**
4. **Followed by wind power which increased 26%.**

* *PV: solar photovoltaics*

** *CSP: concentrating solar photovoltaic's*

# Renewables Growth: Biofuels, biodiesel, Hydro, geothermal

**The development of liquid biofuels has been mixed in recent years, with biodiesel production expanding in 2011 and ethanol production stable or down slightly compared with 2010. Hydropower and geothermal power are growing globally at rates averaging 2–3% per year. In several countries, however, the growth in these and other renewable technologies far exceeds the global average..**

# Renewable Energy Growth in All End Use Sectors

**European Union**

1.Renewables accounted for more than 71% of total electric capacity additions in 2011, bringing renewable energy's share of total electric capacity to 31.1%.

2.Solar PVs* alone represented 47% of new capacity that came into operation.

3.In 2010, renewable share of total electricity consumption was 19.8% (up from 18.2% in 2009).

4.Renewables represented 12.4% of gross final energy consumption (compared to 11.5% in 2009).

* *PV: solar photovoltaics*

# Renewable Energy Growth in All End-Use Sector

**Germany** is a top among the top user of renewable technologies for power, heating, and transport. In 2011, renewables provided 12.2% of Germany's final energy consumption, 20% of electricity consumption (up from 11.6% in 2006), 10.4% of heating demand (up from 6.2%), and 5.6% of transport fuel (excluding air traffic).

# Renewable Energy Growth in All End-Use Sector

**United States**

1.Renewable energy made up 39% of national electric capacity additions in 2011.

2.The share of U.S. net electricity generation from non-hydropower renewables has increased from 3.7% in 2009 to 4.7% in 2011.

3.Nine states generated more than 10% of their electricity with non-hydro renewables in 2011, up from two states a decade ago.

4.All renewables accounted for 11.8% of U.S. primary energy production in 2011, up from 10.9% in 2010.

# Renewable Energy Growth in All End-Use Sectors

**China** ended 2011 with more renewable power capacity than any other nation, with an estimated 282 GW; one-quarter of this total (70 GW) was non-hydro. Of the 90 GW of electric capacity newly installed during the year, renewables accounted for more than one-third, and non-hydro renewables were more than one-fifth

# Renewable Energy Growth in All End-Use Sectors

## Wind

Several countries and states met higher shares of their electricity demand with wind power in 2011 than in 2010, including **Denmark**, where wind provided nearly **26%** of electricity demand, **Spain (15.9%),** and **Portugal (15.6%); four German states** met more than **46%** of their electricity needs with wind; **the state of South Australia** generated **20%** of its demand from wind; and the **U.S. states of South Dakota** and **Iowa** produced **22%** and **19%** of their power from wind, respectively.

# Top Countries of Renewables

1. The top seven countries for non-hydro renewable ele capacity- **China**, the **United States**, **Germany**, **Spain**, **Italy**, **India**, and **Japan** -accounted for about **70%** of total capacity worldwide.
2. The ranking was quite different on a per-person basis, with **Germany** in the lead followed by **Spain**, **Italy**, the **United States**, **Japan**, **China**, and **India**.
3. By region, the **EU** was home to nearly **44%** of global non-hydro renewable capacity at the end of 2011,
4. **The BRICS** nations accounted for almost **26%;** their share has been increasing in recent years, but virtually all of this capacity is in **China**, **India**, and **Brazil**

# Investment Trends in Renewables

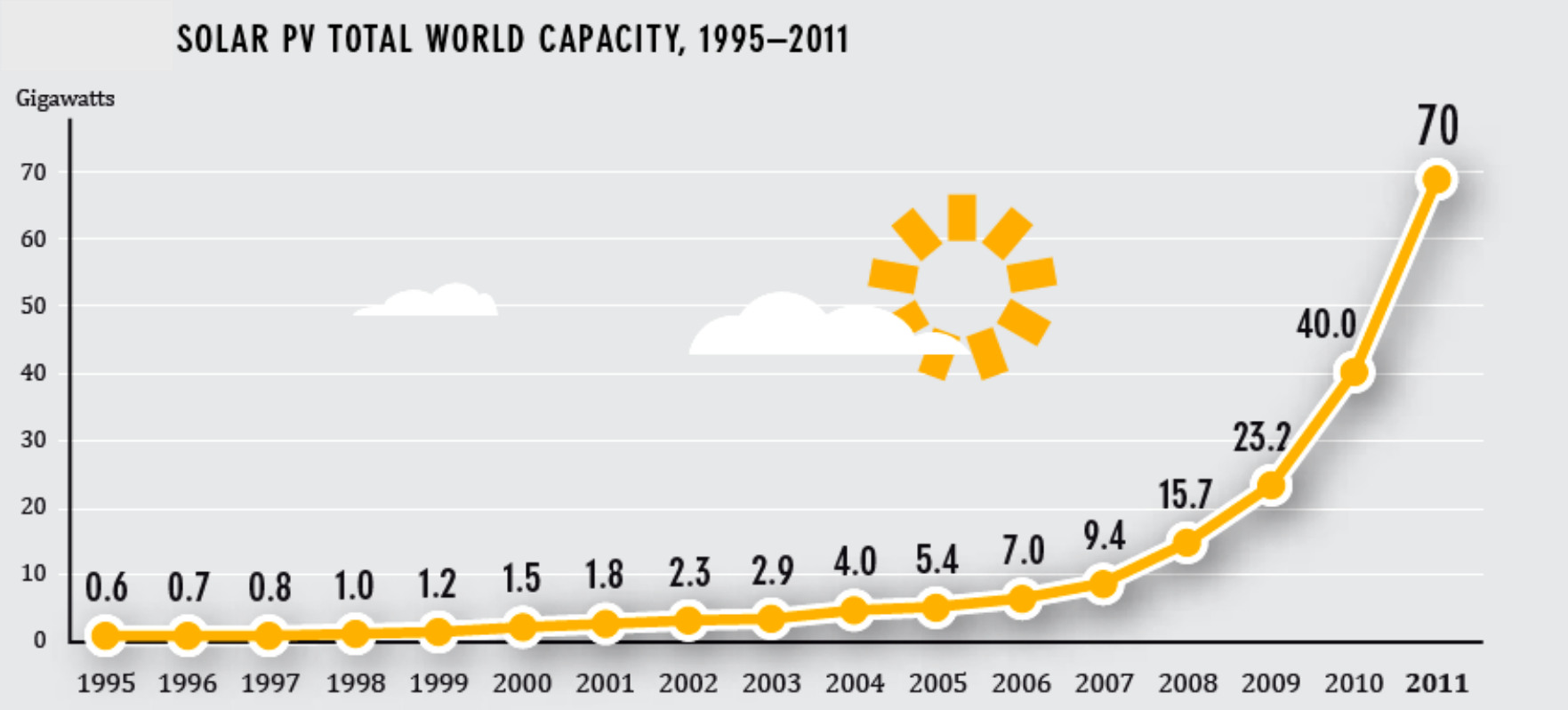
The top five countries for total investment were **China**, which led the world for the third year running, followed closely by the **United States**, and by **Germany**, **Italy**, and **India**. **India** displayed the fastest expansion in investment of any large renewables market in the world, with 62% growth. Developing countries accounted for **USD 89 billion** of new investment in 2011, compared with **USD 168 billion** in developed countries

# Solar Power

A Solar power plant the size of lake Nasser has the capacity of supplying the electricity needs of entire region

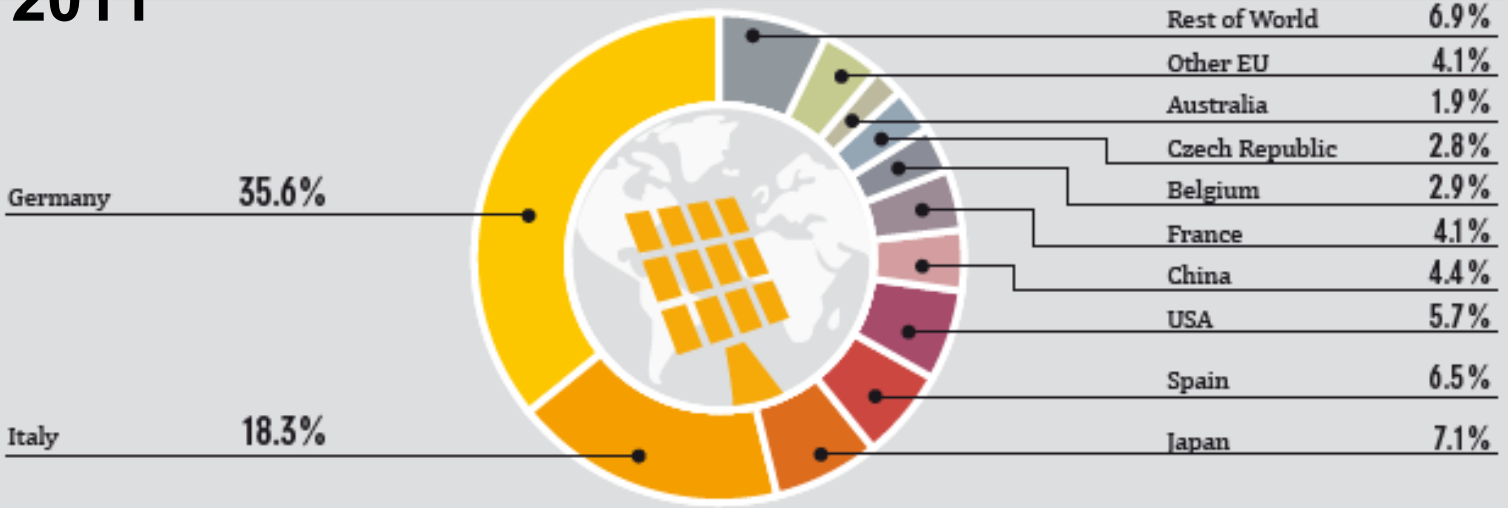
*Source: http://www.middleeastelectricity.com*

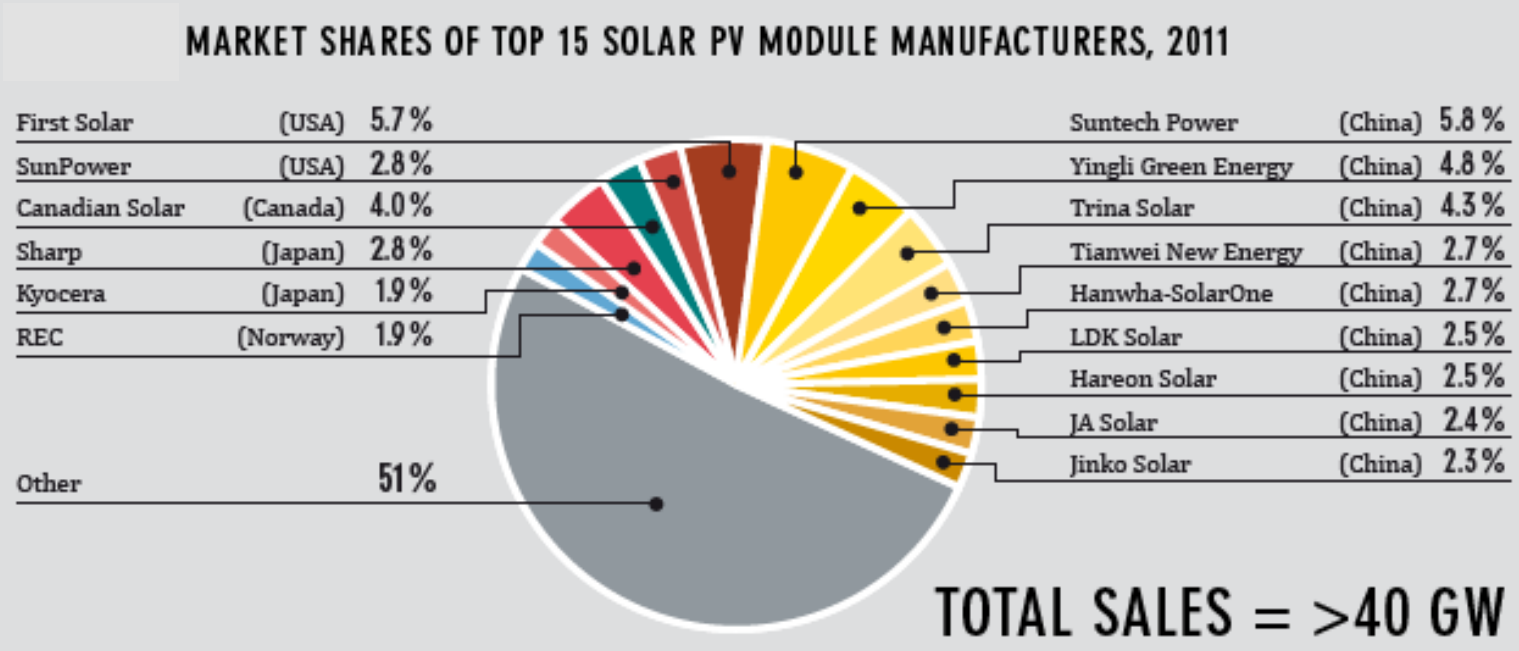
# SOLAR PV




*Source: Renewables 2012 Global Status Report p48; www.ren21.net*

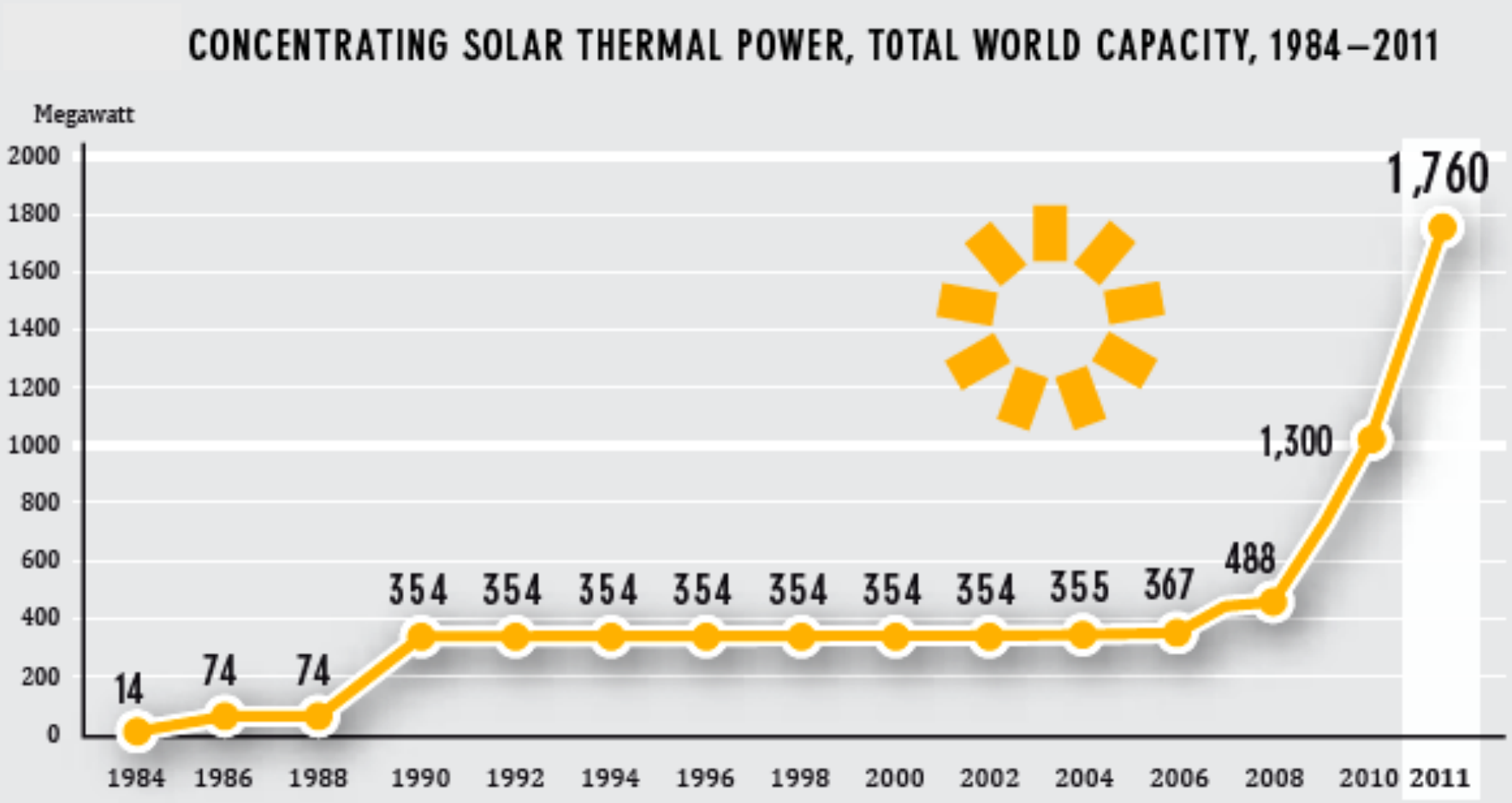
# Solar PV Operating Capacity, Top 10 Countries, 2011



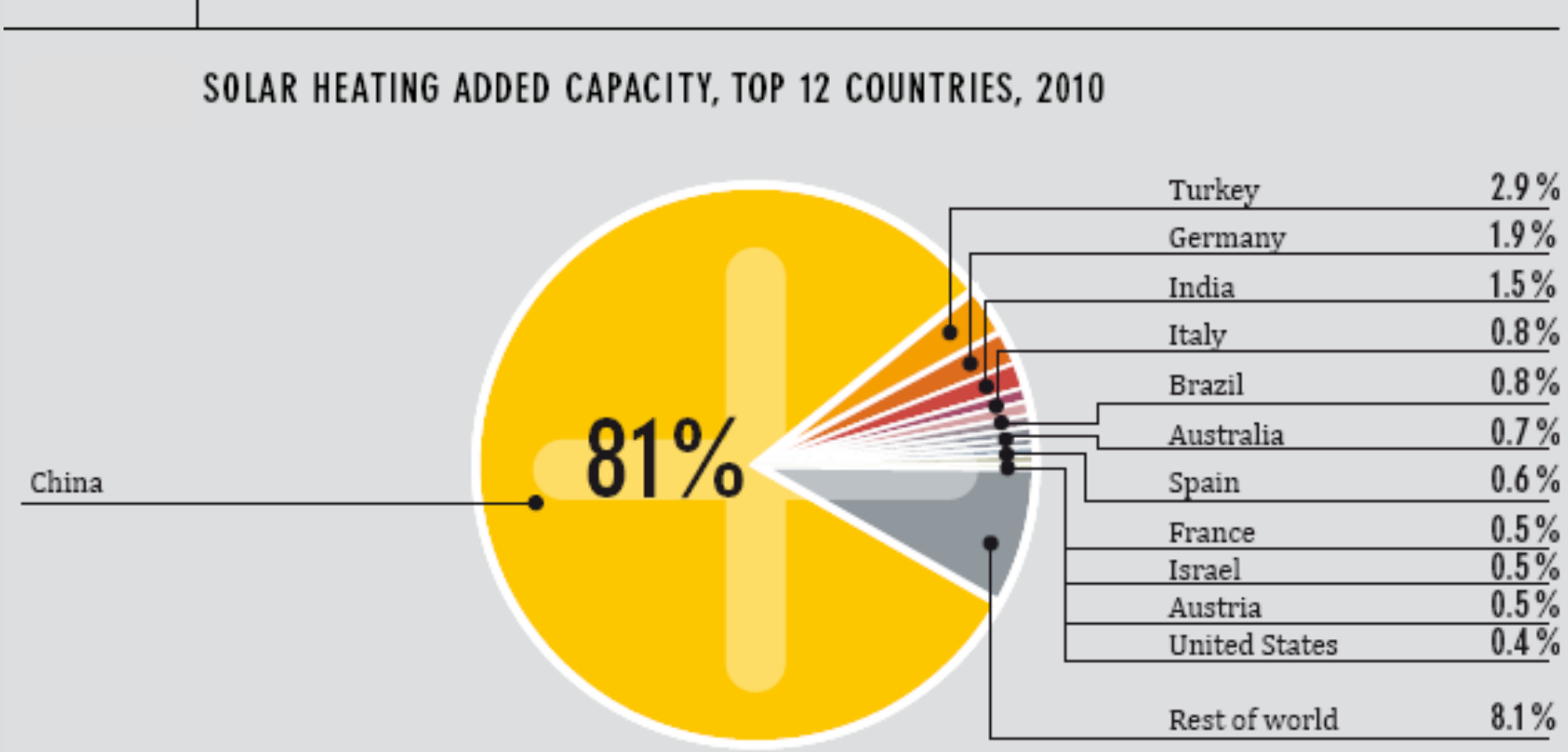



*Source: Renewables 2012 Global Status Report p48; www.*



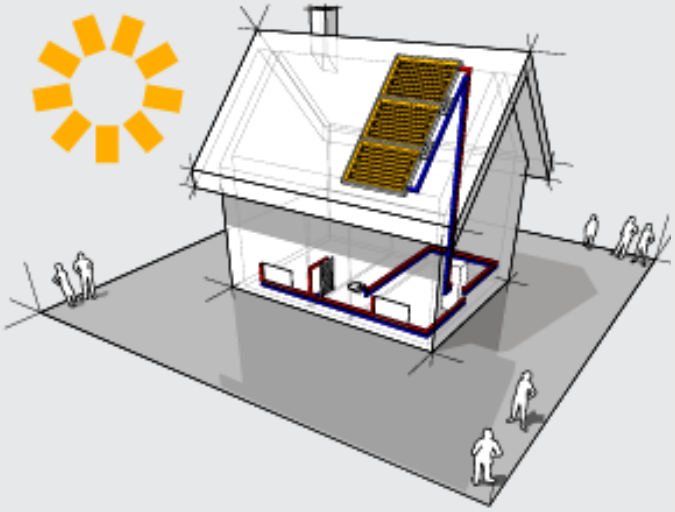

*Source: Renewables 2012 Global Status Report p51; www.ren21.net*

# SOLAR THERMAL HEATING AND COOLING

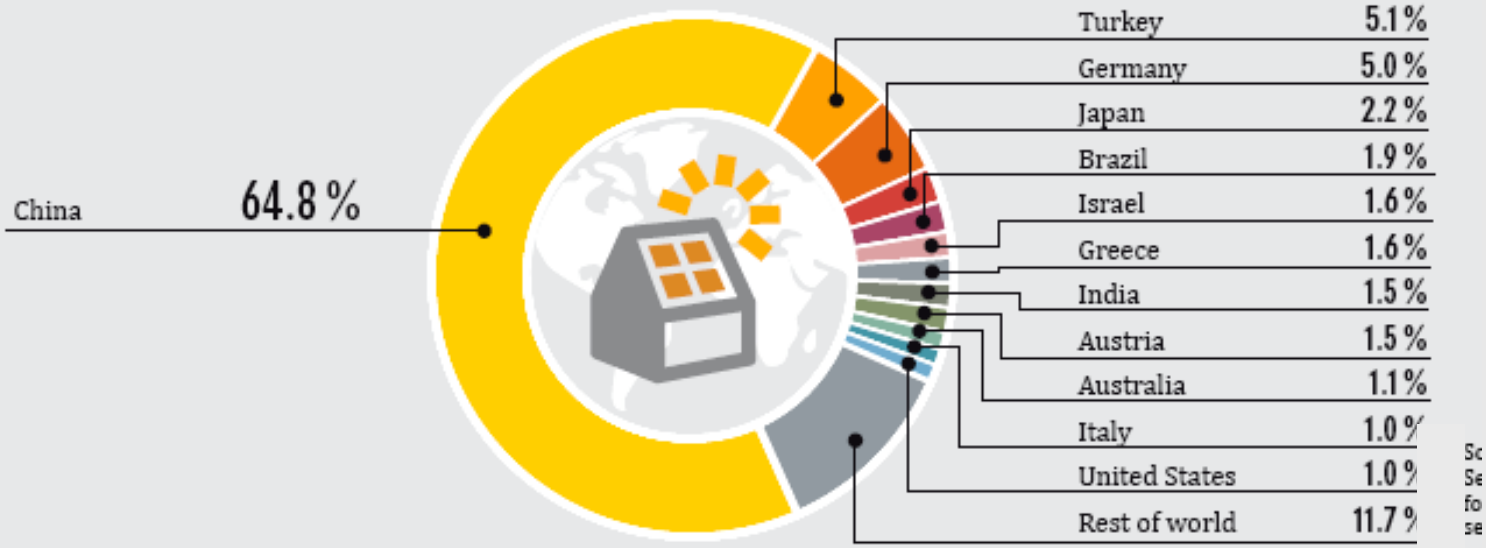



*Source: Renewables 2012 Global Status Report p 55; www.ren21.net*

# >200 MILLION HOUSEHOLDS USE SOLAR HOT WATER COLLECTORS



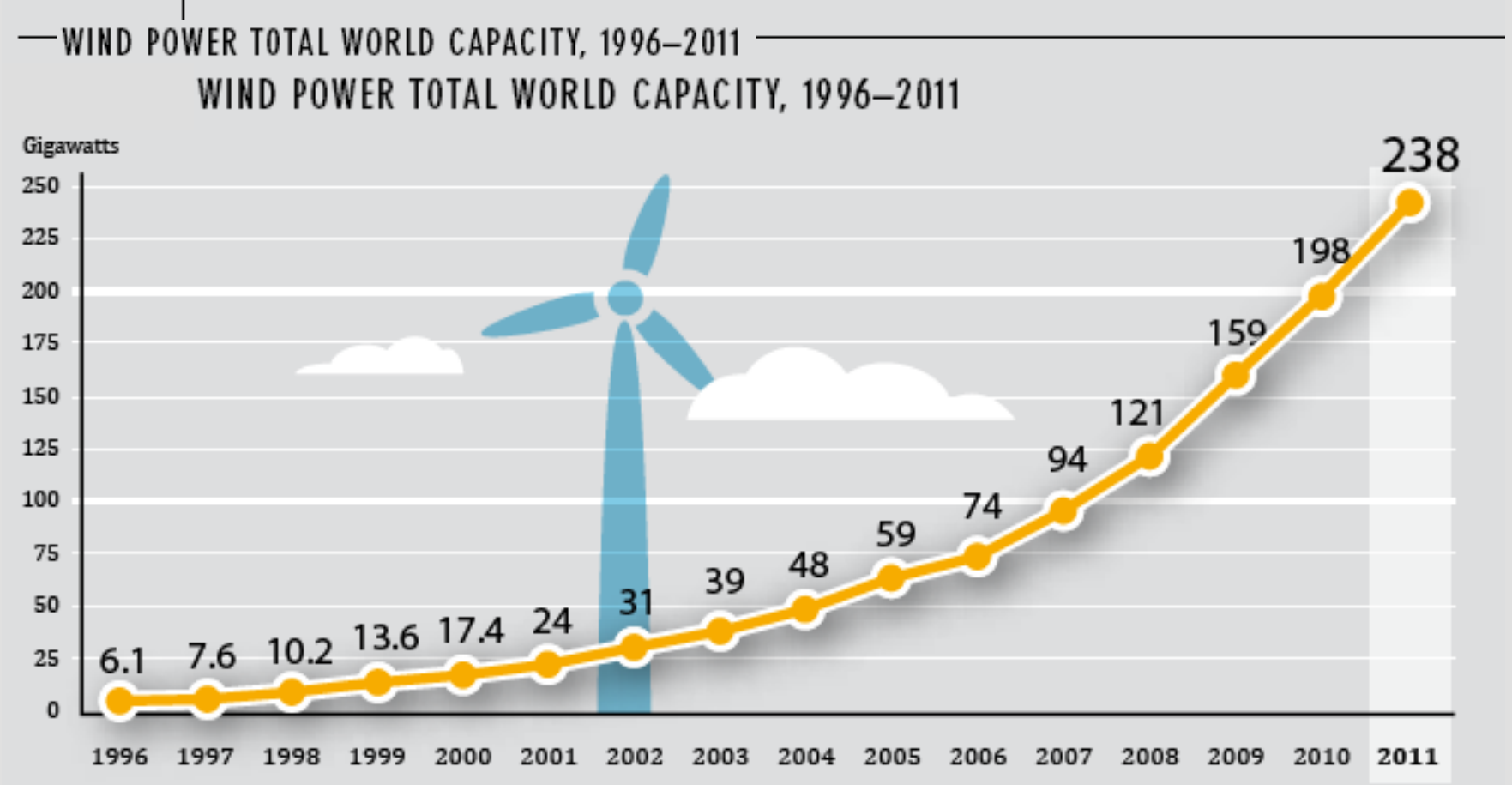
## SOLAR HEATING TOTAL WORLD CAPACITY, TOP 12 COUNTRIES, 2010




*Source: Renewables 2012 Global Status Report p 55; www.ren21.net*

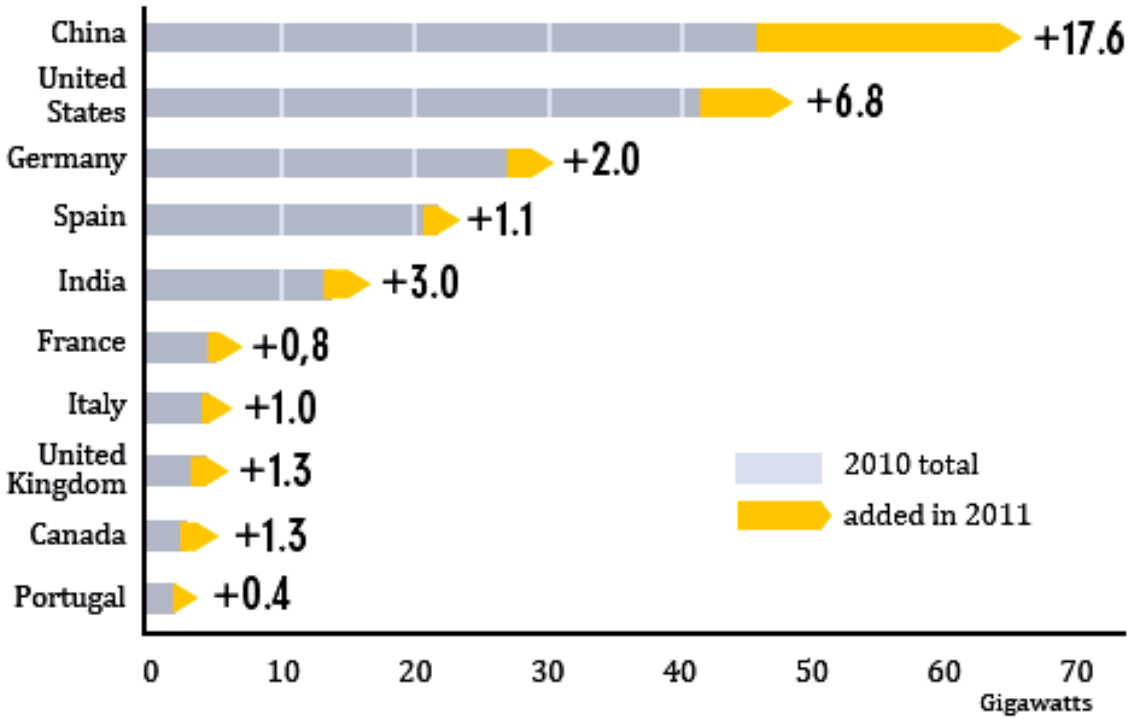
# Wind Power

# WIND POWER

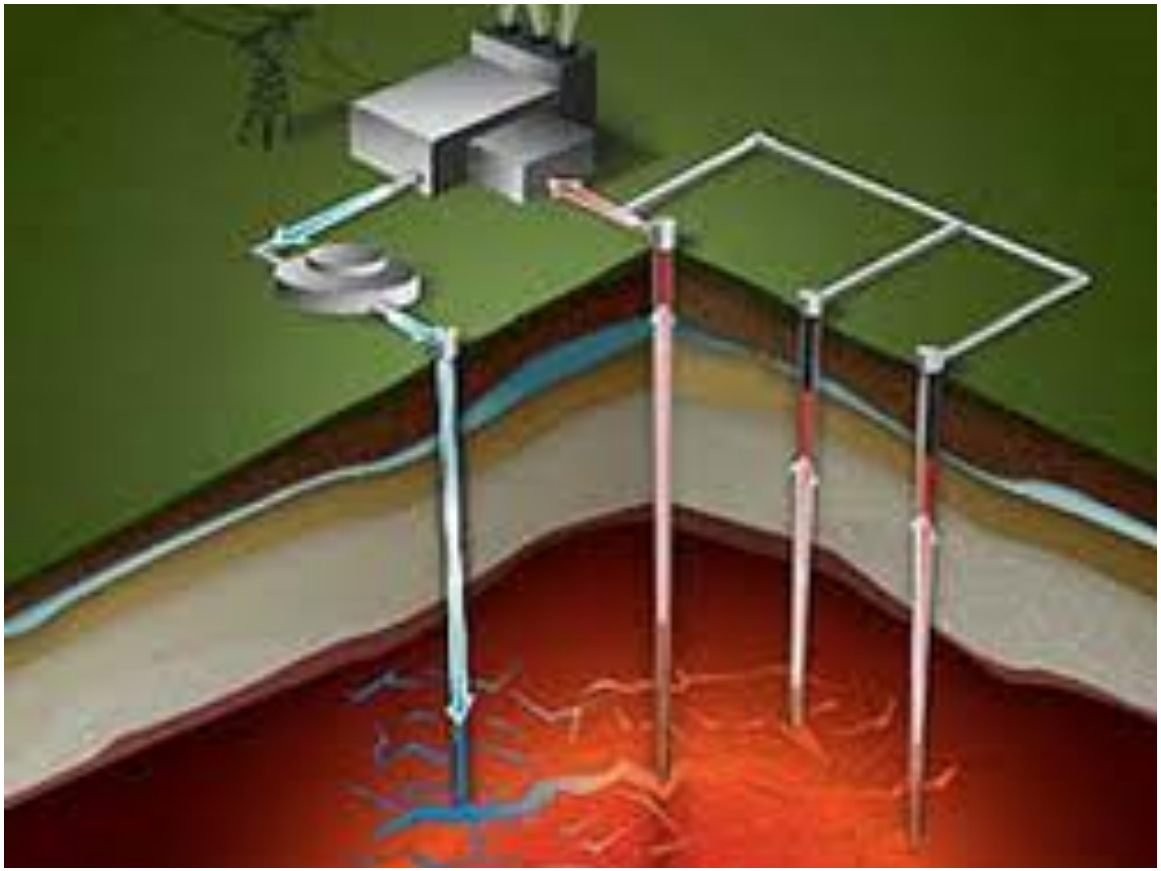



*Source: Renewables 2012 Global Status Report p 58; www.ren21.net*

# Wind Power Capacity, Top 10 Countries, 2011



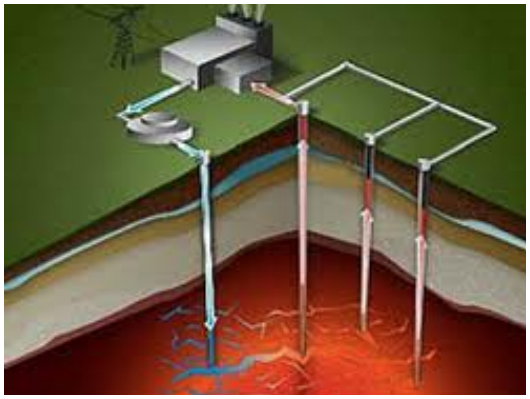

*Source: Renewables 2012 Global Status Report p 58; www.ren21.net*



# Geothermal Energy

# Geothermal Energy

Geothermal capacity grew by just 0.8% (88 MW) in 2011, to reach 11 GW. Geothermal capacity has now been overtaken by solar power capacity, but geothermal power runs at a much higher load factor solar (its source is continuous rather than intermittent), so geothermal still produces significantly more electricity than solar.



Only two major projects were completed in 2011, in **Iceland** (90 MW) and **Costa Rica** (42 MW), while **Mexico** shut down an old plant (78 MW). The US has the largest geothermal capacity, now just over 3.1 GW (28.3% of the world total), followed by the **Philippines** (2.0 GW), **Indonesia** (1.2 GW) and **Mexico** (0.9 GW).

*Source: http://www.bp.com/sectiongenericarticle800.do*

# Case of Geothermal Energy, Jordan

Two geothermal systems were designed and are currently being installed by MENA Geothermal at the American University of Madaba (AUM), Jordan , to meet the full heating and cooling demands of the university.

The geothermal heating and cooling systems at AUM, once completed, will be the largest in the Arab region

*Source: AFED, 2011*

# Geothermal System Features at American University of Madaba (AUM)

1. The **College of Science** 's geothermal system is designed to meet a
- cooling load of 1020 kW* (291 tons)
- heating load of 880 kW (251 tons)

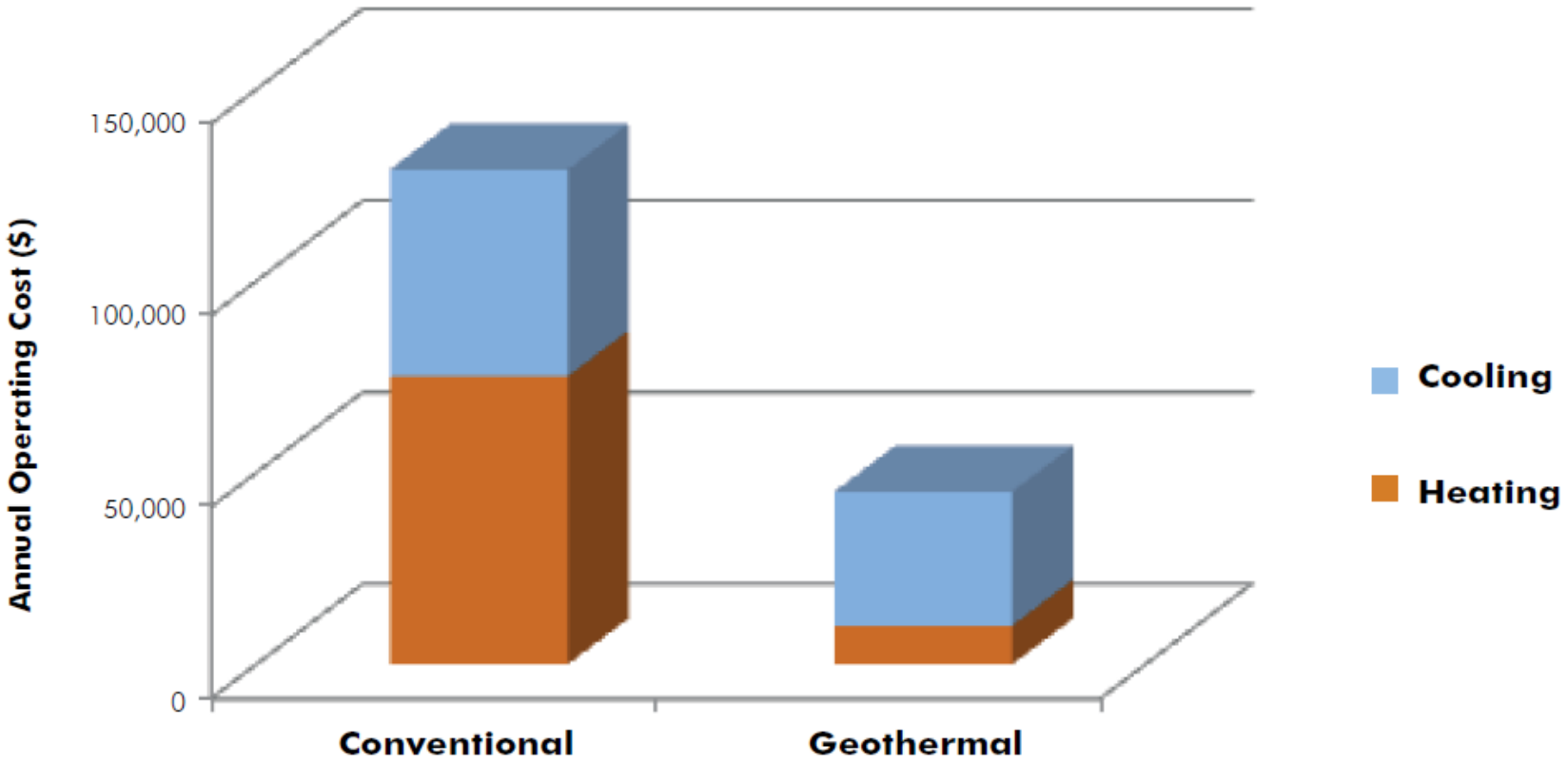
2. While the **College of Business** 's geothermal system is designed to meet a
- cooling load of 660 kW (189 tons
- and heating load of 470 kW (134 tons)

Annual Energy and CO2 Savings. Compared to conventional heating and cooling systems used in Jordan, AUM's geothermal heating and cooling system is expected to have annual savings of over 200,000 kWh of electricity in the summer months (cooling), and 90,000 liters of diesel fuel in the winter months (heating). In total, AUM will generate annual savings of <u>over $85,000</u>. Moreover, the geothermal system is expected <u>to eliminate 365 tons of CO2 emissions every year.</u>

*Source: AFED, 2011*

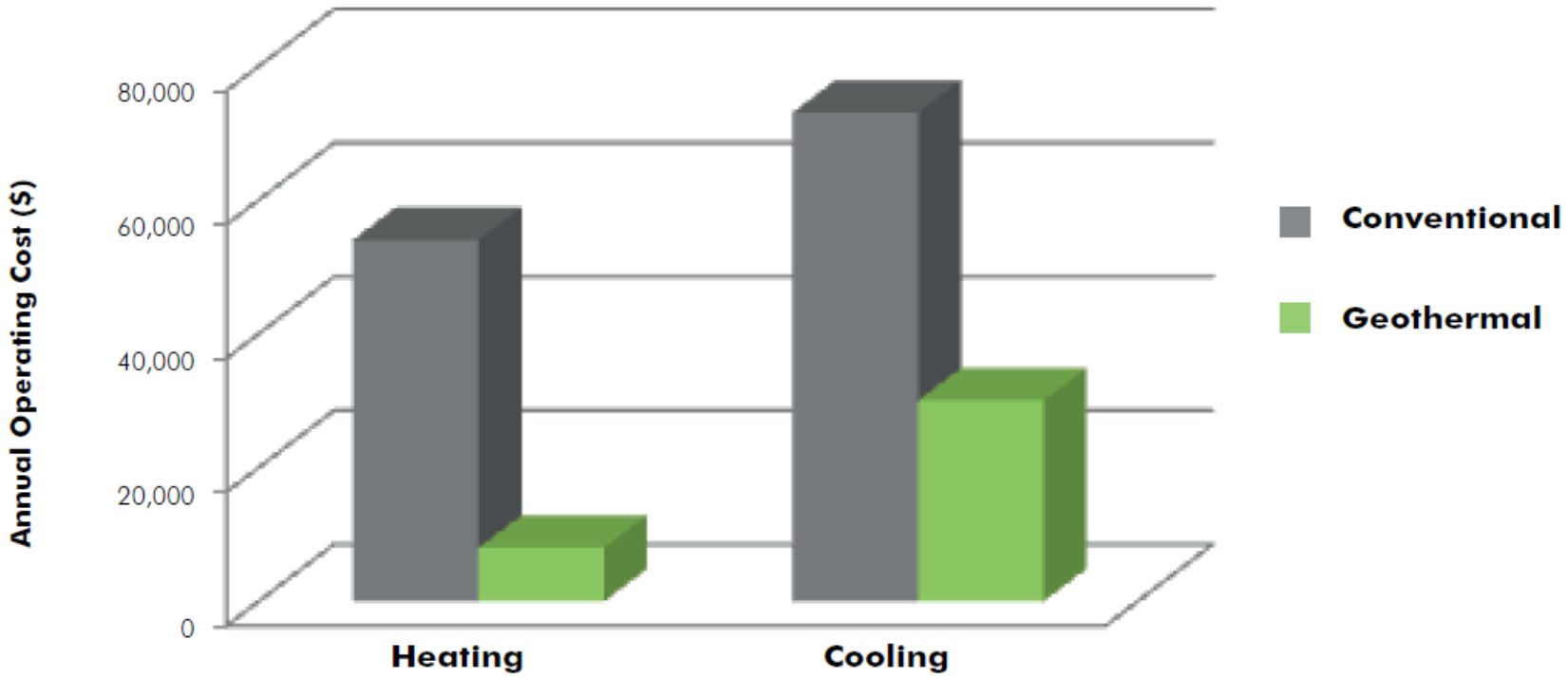
* *KW: Kilowatt*

# AUM's operating cost comparison conventional VS. Geothermal (Total)




*Source: AFED, 2011*

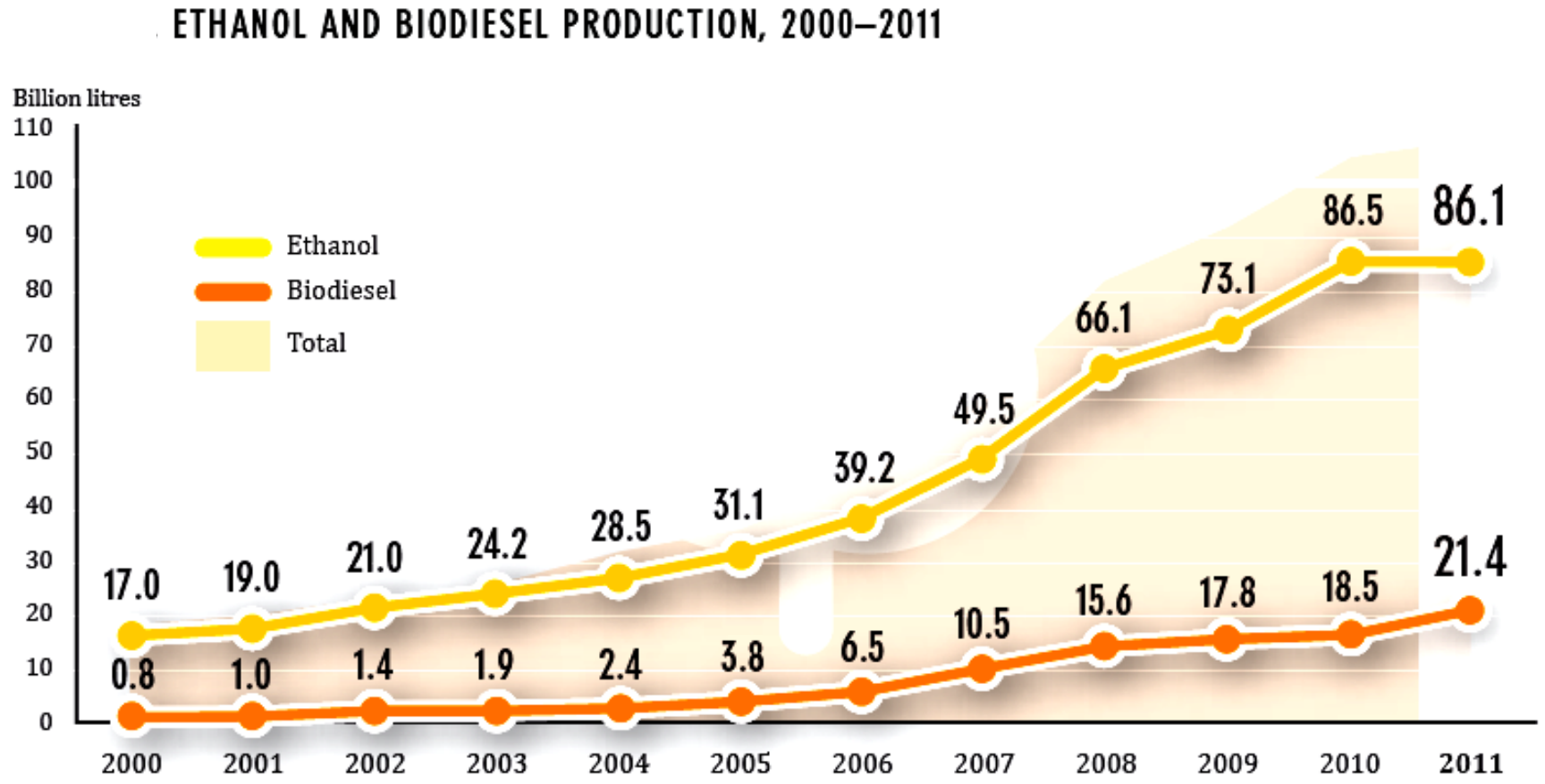
# AUM's operating cost comparison conventional VS. Geothermal (Heating Cooling)




*Source: AFED, 2011*

# Biomass energy

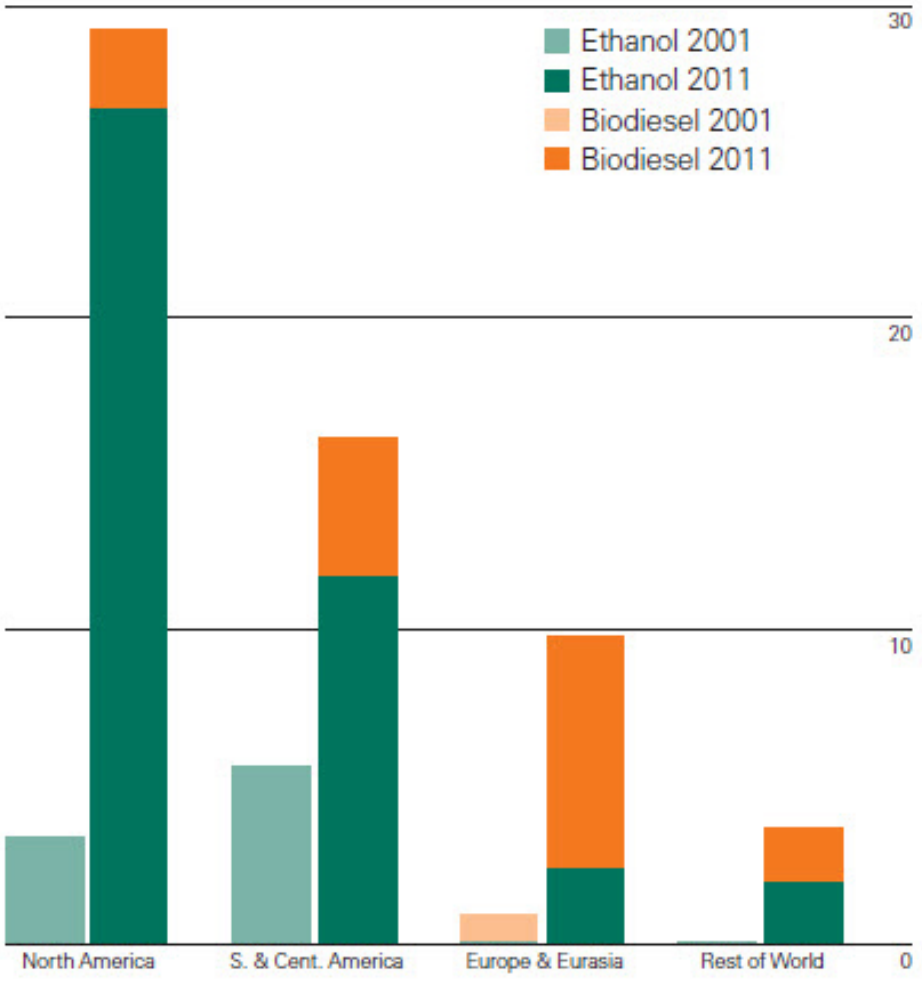
# BIOMASS ENERGY




*Source: Renewables 2012 Global Status Report p 37; www.ren21.net*

# World biofuels production

Million tonnes oil equivalent




World biofuels production grew by 0.7% in 2011, the smallest increase since 2000. Increased output in North America was offset by declines in South & Central America and Europe. Biodiesel accounts for just 27.5% of global biofuels output, but accounted for all of the growth in global biofuels output. Global ethanol output declined by 1.4%.

*Source: http://www.bp.com/sectiongenericarticle*

# Ocean Energy

Wave technology is the most exciting areas of untapped energy potential. Given fluctuating fuel prices and the impact of global warming, Ocean Energy is now in a very strong position to commercialize the vast body of research and development it has invested in over the past 10 years.

*Source: http://www.oceanenergy.ie*

# Hydropower Energy

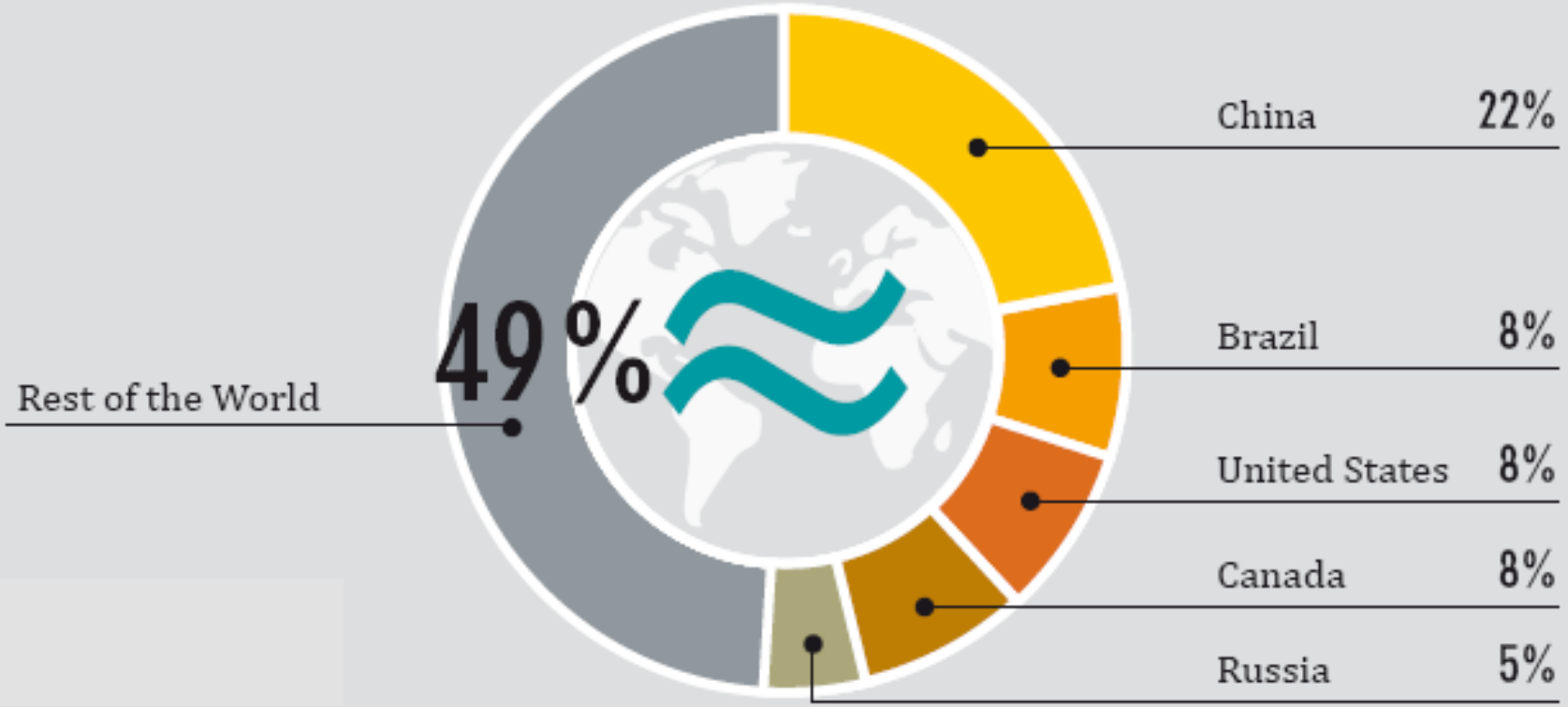
**Hydropower** or **water power** is power derived from the energy of falling water, which may be harnessed for useful purposes. Since ancient times, hydropower has been used for irrigation and the operation of various mechanical devices, such as watermills, sawmills, textile mills, dock cranes, domestic lifts and paint making.



*Source: http://en.wikipedia.org/wiki/Hydropower*

# HYDROPOWER

## HYDROPOWER TOTAL WORLD CAPACITY, TOP FIVE COUNTRIES, 2011

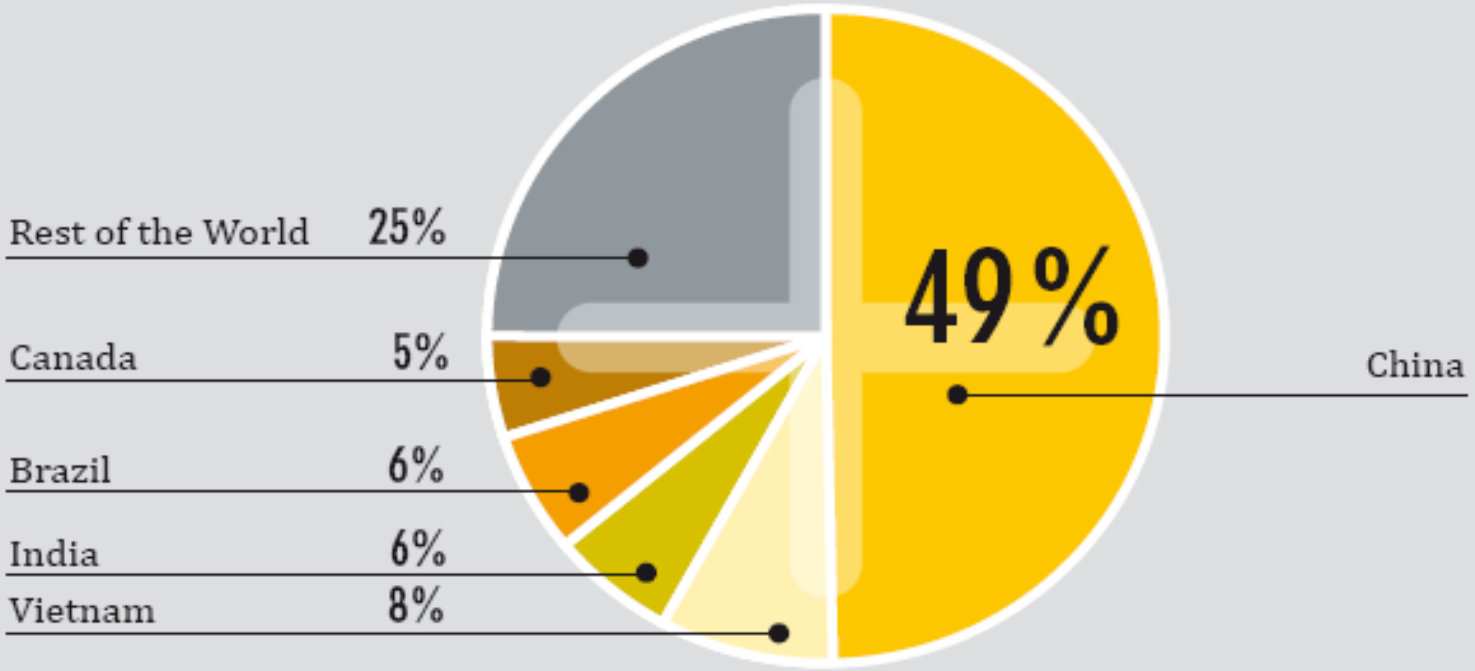



*Source: Renewables 2012 Global Status Report p 43; www.ren21.net*

TOTAL GLOBAL CAPACITY: ~970 GW

TOTAL CAPACITY ADDITIONS: ~25 GW

HYDROPOWER ADDED CAPACITY, TOP FIVE COUNTRIES, 2011

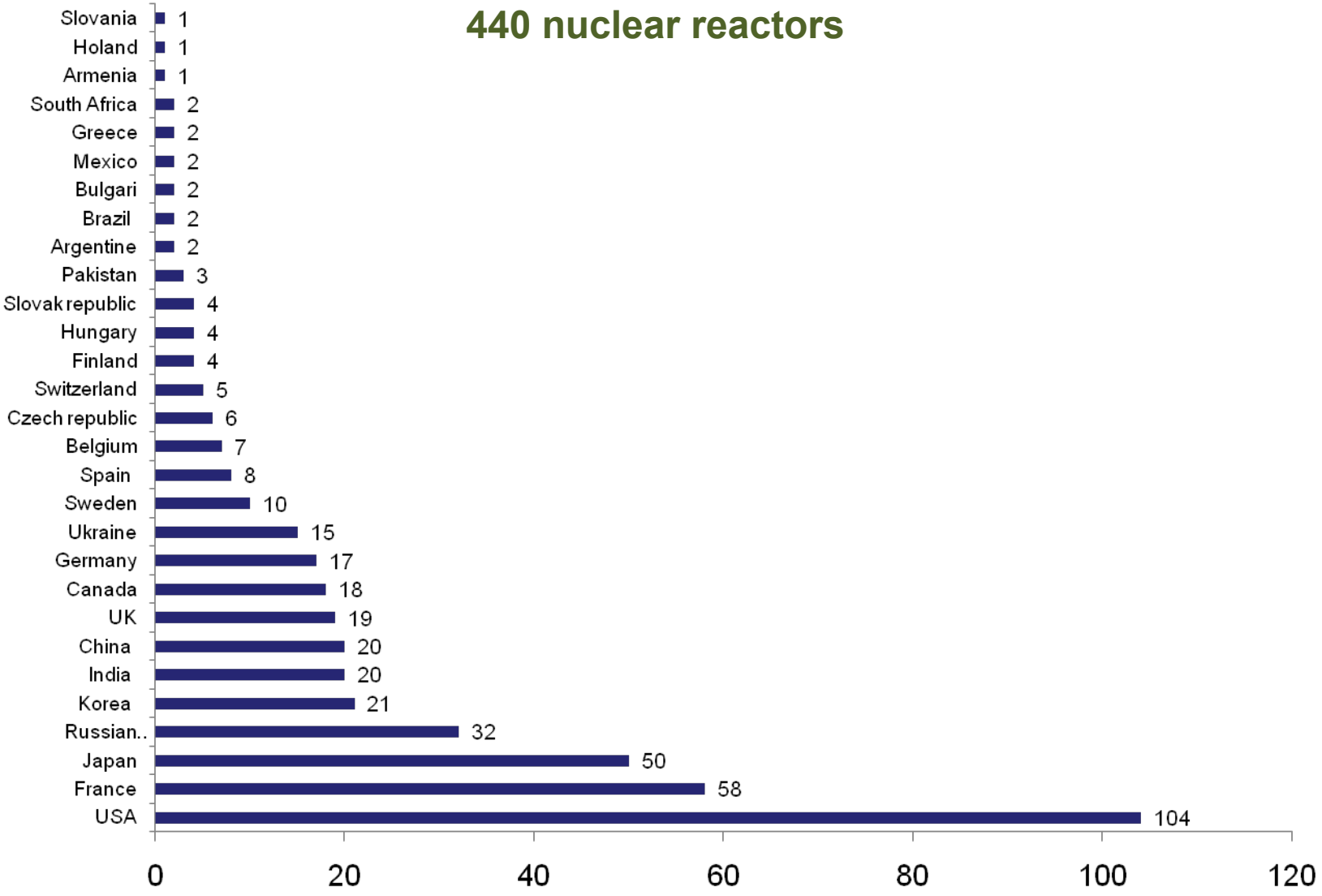



*Source: Renewables 2012 Global Status Report p 43; www.ren21.net*

# Nuclear Energy

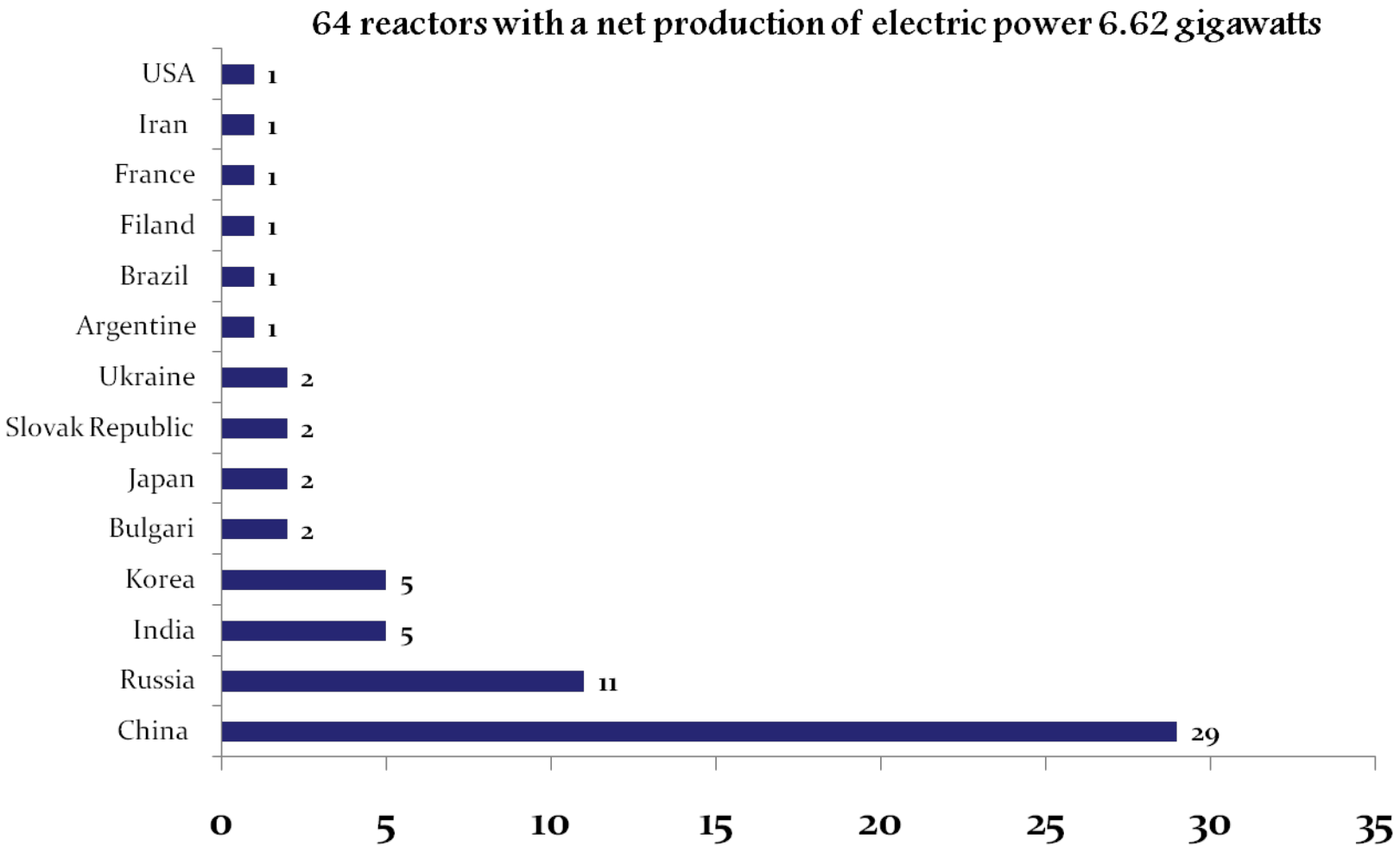
# Number of operating nuclear reactors all over the world

## 440 nuclear reactors




*Source: Jordan Atomic Energy* Commission

# Number of nuclear reactors under construction around the world



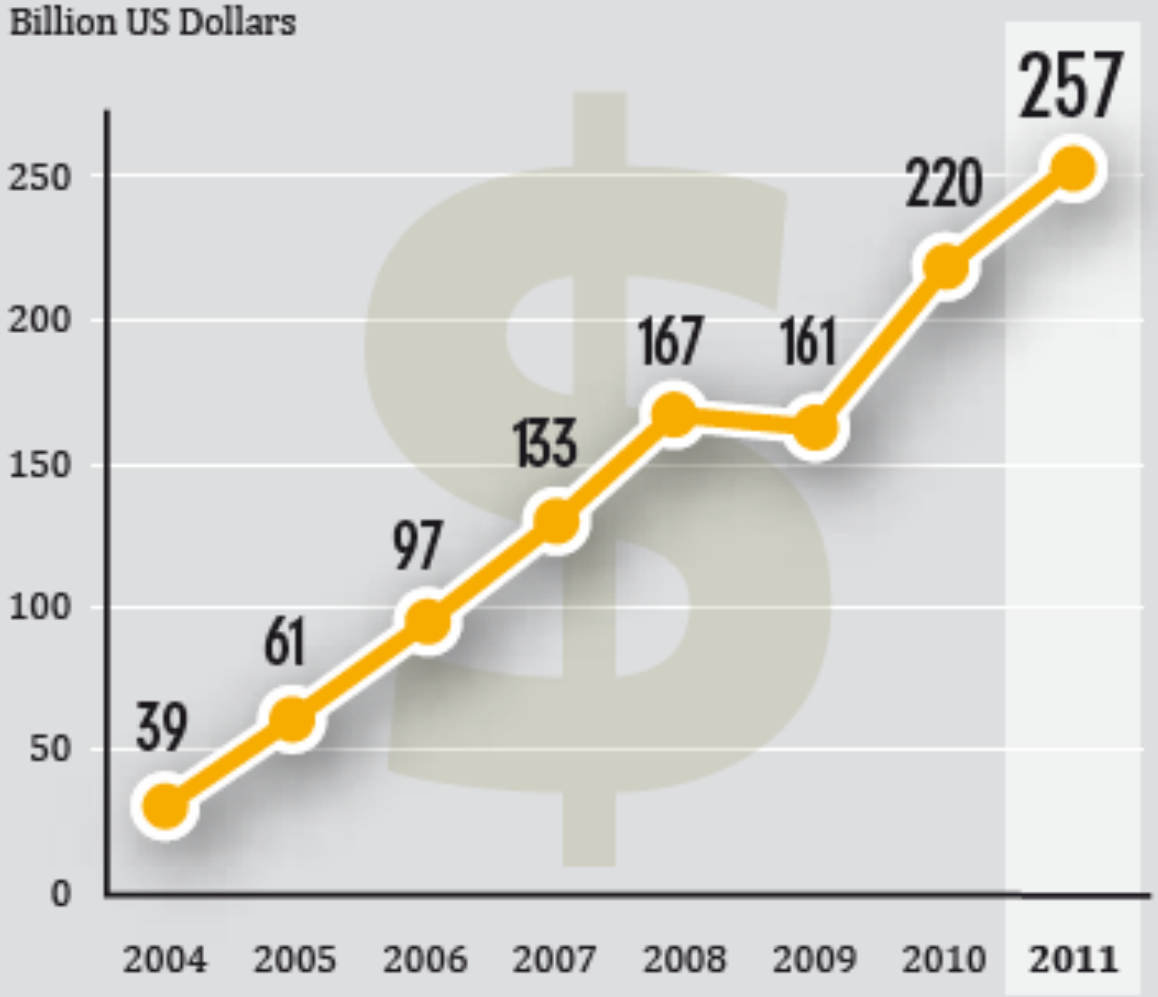

*Source: Jordan Atomic Energy* Commission

# Policy

# 2012 | POLICY MAPS


*Source: Renewables 2012 Global Status Report p 79; www.*

# GLOBAL NEW INVESTMENTS IN RENEWABLE ENERGY, 2004–2011




*Source: Renewables 2012 Global Status Report p 61; www.ren21.net*

# Energy subsidies in selected Arab countrie

| Country | Subsidy (%) as a percentage of fuel cost of |
|---|---|
| Algeria | 41.4 |
| Egypt | 56.3 |
| Iraq | 47.4 |
| Kuwait | 53.3 |
| Libya | 52.0 |
| Qatar | 63.2 |
| Saudi Arabia | 78.9 |
| UAE | 55.7 |

*Source: AFED, 2011*

# Arab renewable energy targets

| Country | Target |
|---|---|
| Algeria | Wind: 100 MW* by 2015; solar thermal: 170 MW by 2015; solar PV: 5.1 MW by 2015; cogeneration: 450 MW by 2015; solar CSP: 500 MW |
| Egypt | Renewable generation: 20 percent by 2020, including 12 percent from wind (about 7,200 MW) and 8 percent from hydro and solar PV |
| Jordan | Wind: 600–1,000 MW; solar PV: 300–600 MW; waste–to–energy: 20–50 MW |
| Kuwait | Renewable capacity: 5 percent by 2020 |
| Lebanon | Renewable capacity: 12 percent by 2020 |
| Libya | Wind: 280 MW and 1,500 MW by 2030; solar CSP**: 50 MW and 800 MW by 2030; solar PV: 150 MW by 2030 |
| Morocco | Solar hot water: 400.000 $m^2$ by 2012 and 1.7 million $m^2$ by 2020; wind: 1,440 MW by 2015; small hydro: 400 MW by 2015 |
| Palestine | Renewable capacity: 20 percent by 2020 |
| Saudi Arabia | Solar electricity: 41 GW by 2032 (25 GW SCP and 16 GW PV) |
| Tunisia | Wind: 330 MW by 2011; solar PV: 0.015 GW; solar hot water: 740,000 $m^2$ |

*Source: AFED, 2011*

* *MW: megawatt*
** *CSP: concentrating solar photovoltaic's*

# MASEN (Morocco Agency for solar energy) projects

**1.Ouarzazate Site:**

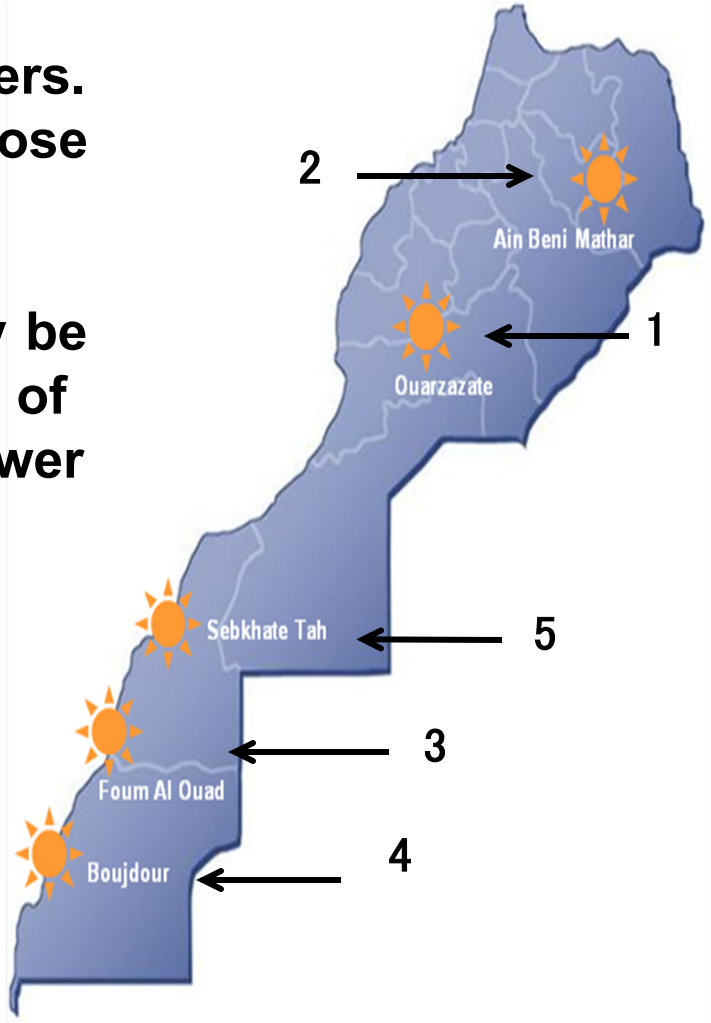
**with a surface of about 33 square kilometers. i.e. 3,300 Hectares. This site is located close to the Mansour Eddahbi dam whose storage capacity is 439 hm3. Energy produced by the power plant may be channeled to the 225/60 KV post of Ouarzazate which is close to the power plant.**

**2.Ain Beni Mathar Site.**

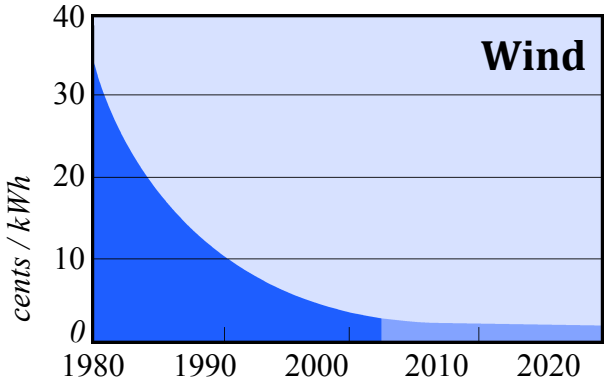
**3.The Foum El Oued Site.**

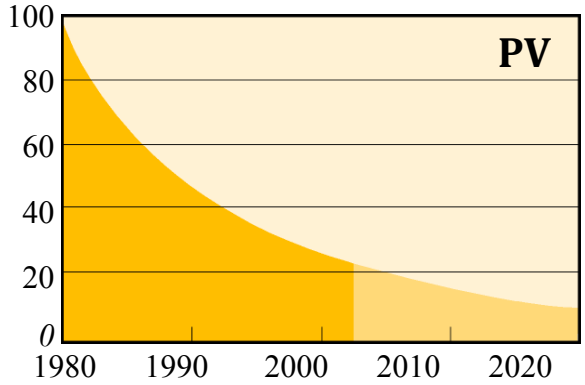
**4.Boujdour Site.**

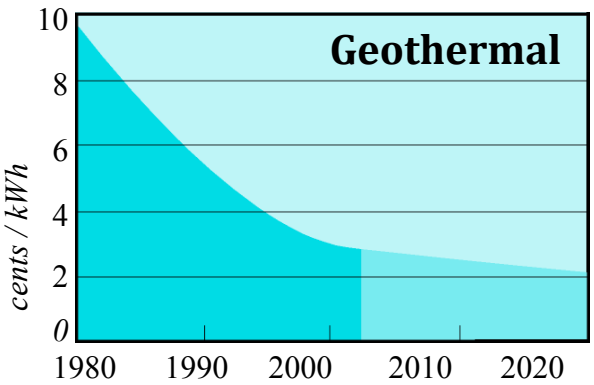
**5.Sebkhat Tah Site.**

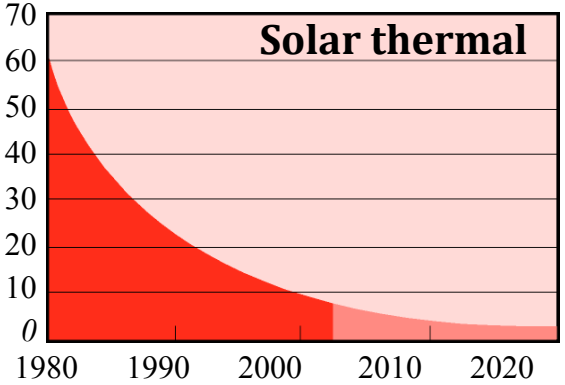


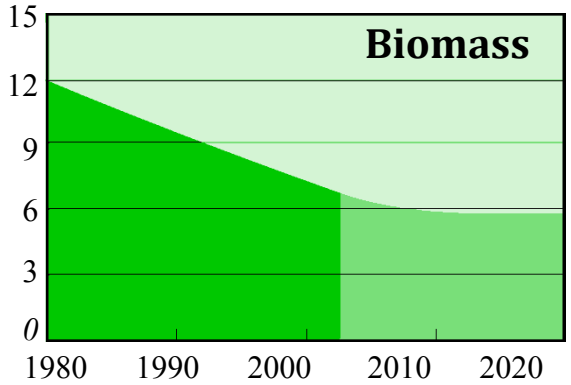
# Forecasted Renewable Costs




**All costs are levelized in constant year 2000**

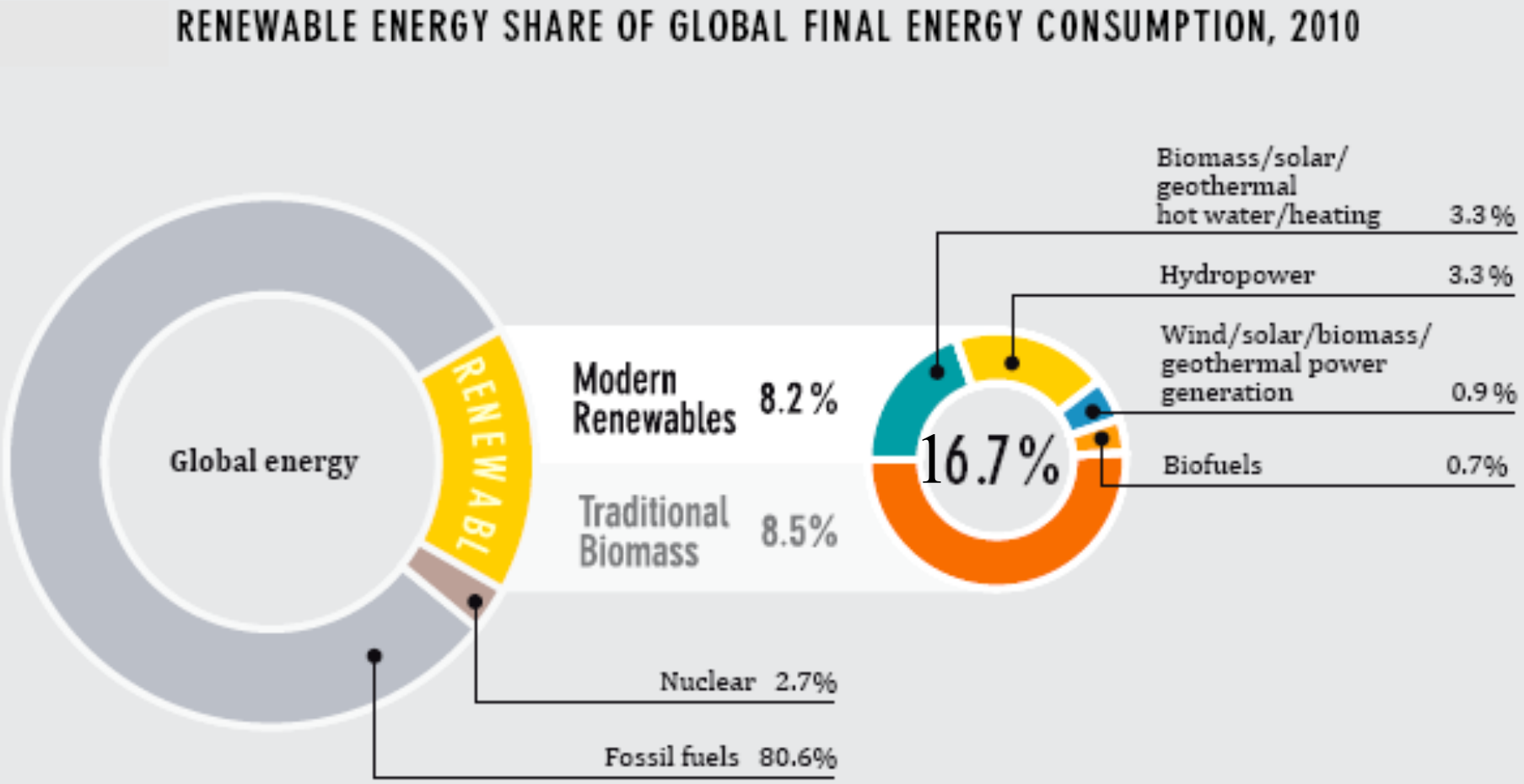
Source: NREL Energy Analysis Office (www.nrel.gov/analysis/docs/cost_curves_2002.ppt)

# Renewable Energy

**The key elements of this cost-benefit calculus appear to be:**

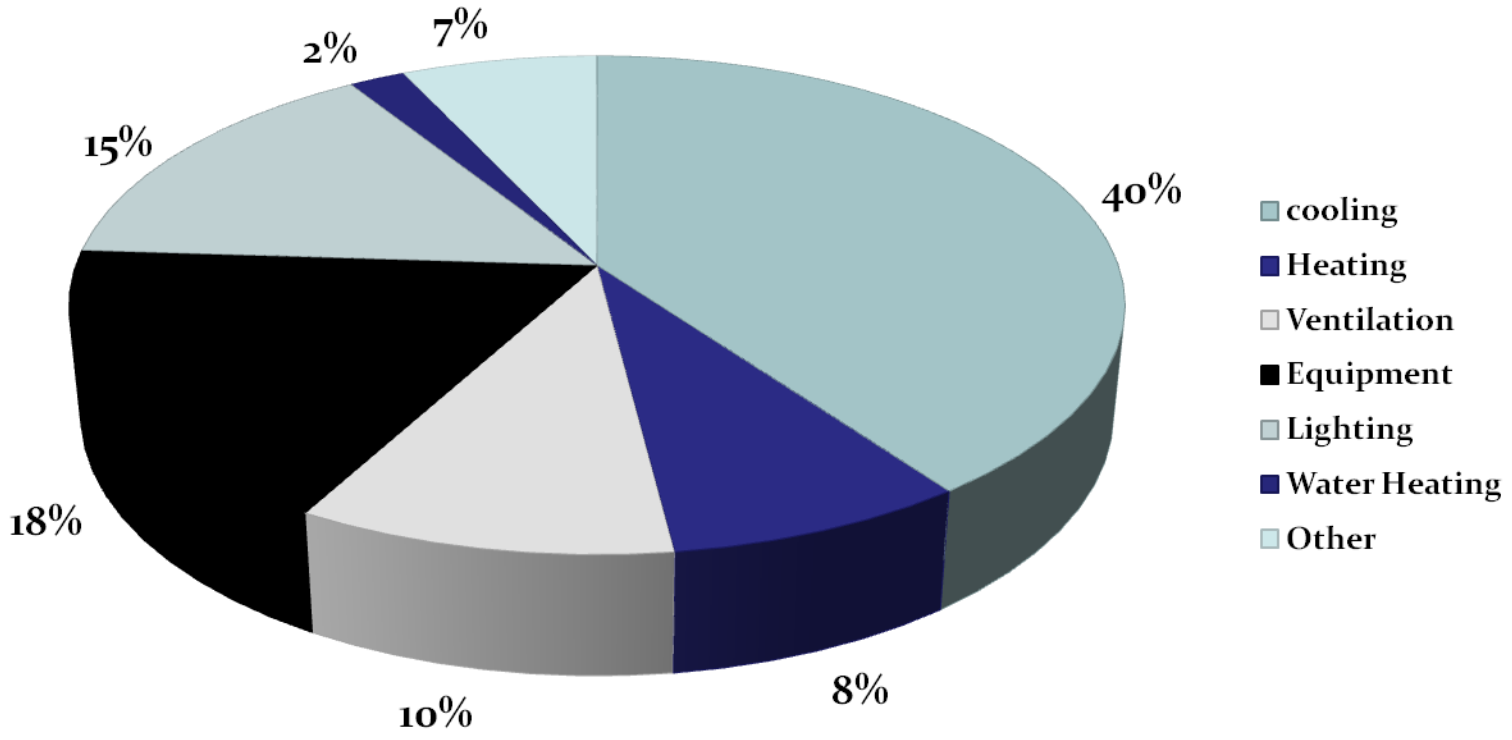
**1.Declining costs (and thus prices) of renewable energy and other sustainability products as technology improves and economies of scale arrive**

**2.Incentives that work in the favor of renewables: removal of subsidies for fossil fuels, tax credits for electric vehicles, etc.**




*Source: Renewables 2012 Global Status Report p 21; www.ren21.net*

# Hypothetical energy consumption breakdown in a large office building in a given Arab country



# Challenges

# Major Challenges In Ene

- **Energy security**: fuel supply resources for the future
- **Economic growth**: accommodation of the developing nations' needs
- **Environmental effects**: global warming and emission control
- **Electricity system reliability**: assurance of integrity of electric power infrastructure

# Key Challenges In Renewable Expans

- Integration into the grid
  - interconnection
  - grid capability
  - reliability issues
  - power quality
- Competitiveness of technology costs
- Environmental problems
- Development of storage technology
- Government policies.
- Back up power.
- Green power differential.

# Recommendations

- Remove the current obstacles that prevent the transition to green energy, which include the lack of investment in research and development, capacity building and integrated policy-making.
- To Reform the present legislative and institutional framework, to facilitate the transition to a green economy.
- To establish an incentive system that encourage investment in energy efficient technologies and renewable energy.
- To Adopt an energy efficiency plan and manage renewable energy issues as pillars of a new energy policy, built on a coordinated effort involving the government, the private sector, the financial sector and other stakeholders.
- Constant adjustment for energy prices to reflect the actual economic cost, scarcity, the long-term marginal cost, and environmental damage. Further , it is required to reform the energy prices as an effective tool to rationalize energy consumption and to transform to low-carbon emission, which will concurrently lead to a vast increases in government revenues. Re-allocation of these revenues is also a must to enhance energy-efficient technologies and renewable energy expansion .
- To Begin a political discussion on the formulation of a new institutional mechanism, to ensure the harmonization of energy policies and climate change in the Arab region.

# Renewable Energy

**Renewable energy will stabilize electricity costs, as ıt is not dependent upon depleting resources. Photovoltaic systems will also increase access to electricity in rural areas without the need of complex policy decision-making, thus balancing the socioeconomic infrastructure of the region. For heating and cooling systems, and water desalinization.**

**Thus, when considering these energy options on a larger scale, renewable energy is the most efficient choice in the long-run. The vast solar potential of the Middle East is waiting to be tapped.**

# Thank you