UNIVERSITY OF PATRAS
DEPARTMENT OF ECONOMICS

ENERGY ECONOMICS

Academic Year 2022-2023
Winter Semester
Lecture 7th
Economics of Renewable sources

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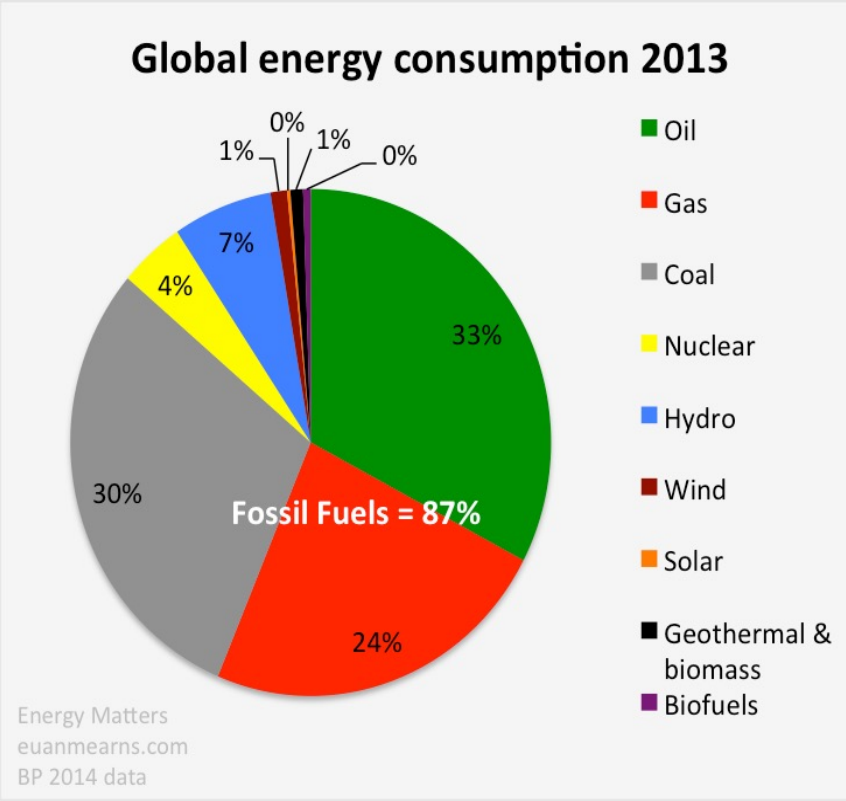
Energy Economics-Lecture 7th RES

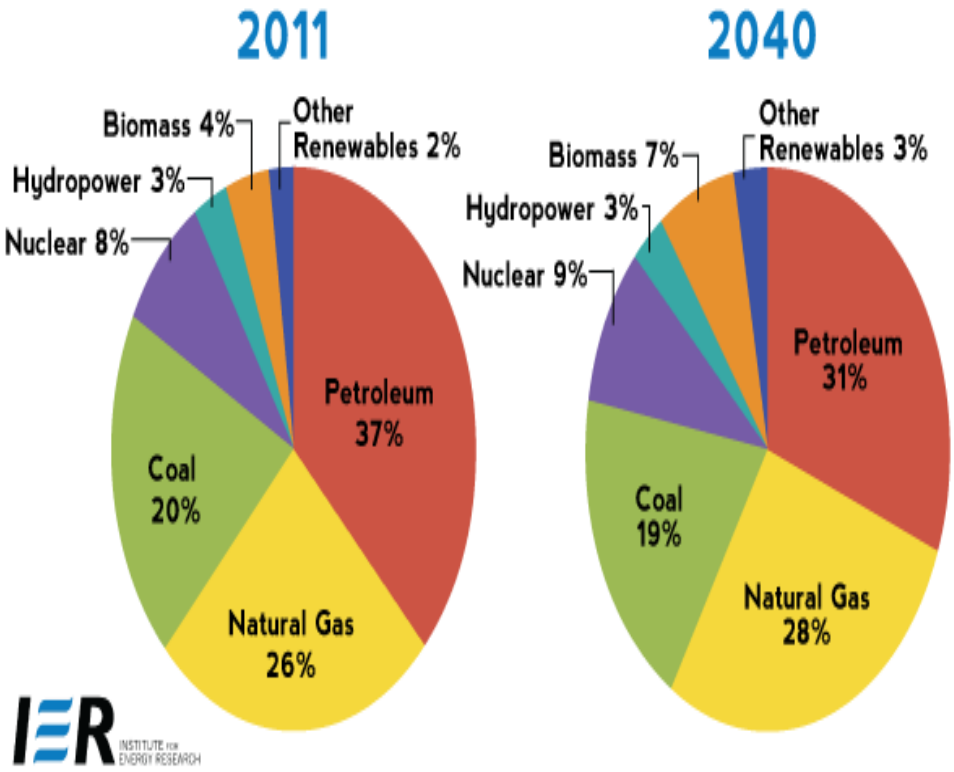
- The term "alternative forms of energy" refers to any form of energy that is outside the conventional forms of energy that we have examined so far.
- Although some of the traditional forms of energy can be renewed (such as hydropower) and may include both renewable and non-renewable energy sources (such as tar sands, shale gas, etc.), this lecture focuses on modern renewable energy sources.
- Most of these actions are available in abundance, and humanity is trying to find ways to use it, while direct costs to the consumer remain low in their traditional form of use.
- However, modern methods of exploitation that use these actions require specialized conversion processes, which in turn will increase the cost of procurement.
- Long-term oil price shocks in the 1970s and 1990s raised new interest in renewable energy, while global concern about climate change and sustainable development is giving more impetus to renewable energy.

Role of RES

Source: Energy Information Administration, Annual Energy Outlook 2013, http://www.eia.gov/forecasts/aeo/er/pdf/appa.pdf and

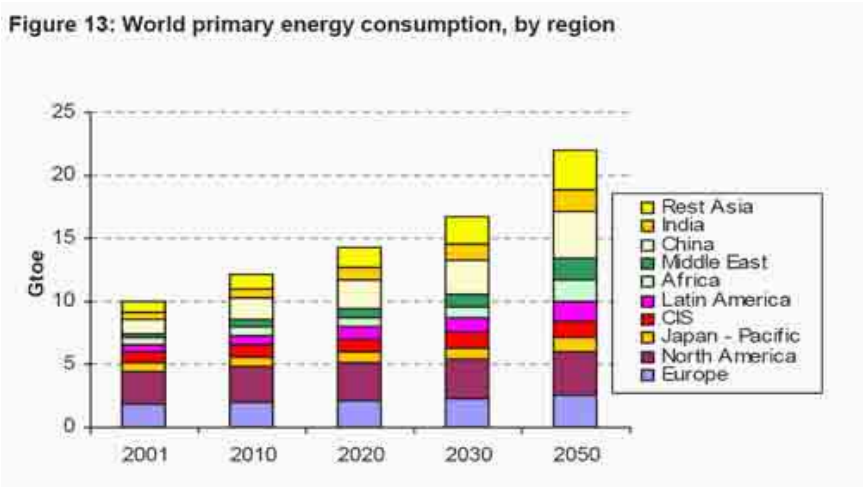
http://www.eia.gov/forecasts/aeo/er/pdf/tbla17.pdf

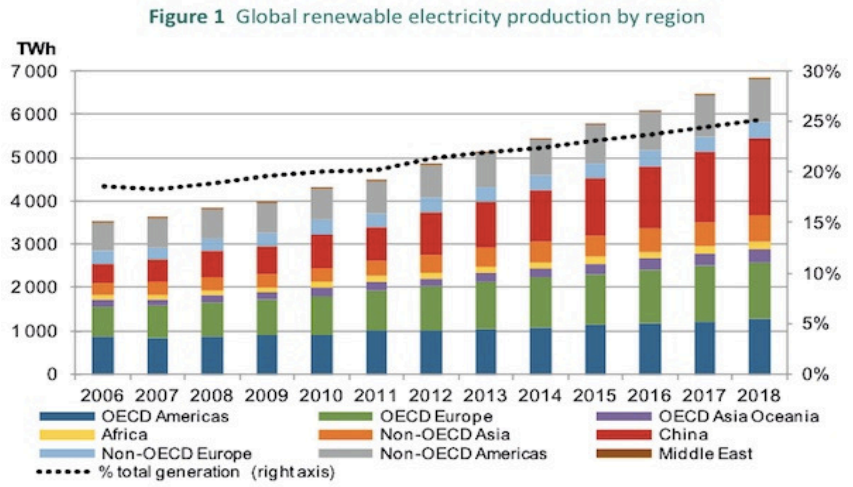


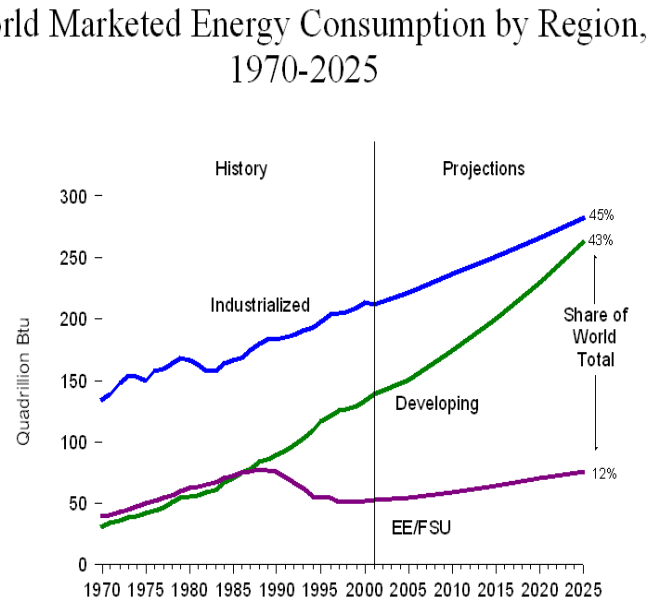


Source: International Energy Agency (IEA 2013)

RES in the world market I







Source: EIA, *International Energy Outlook 2004*

RES in the world market II

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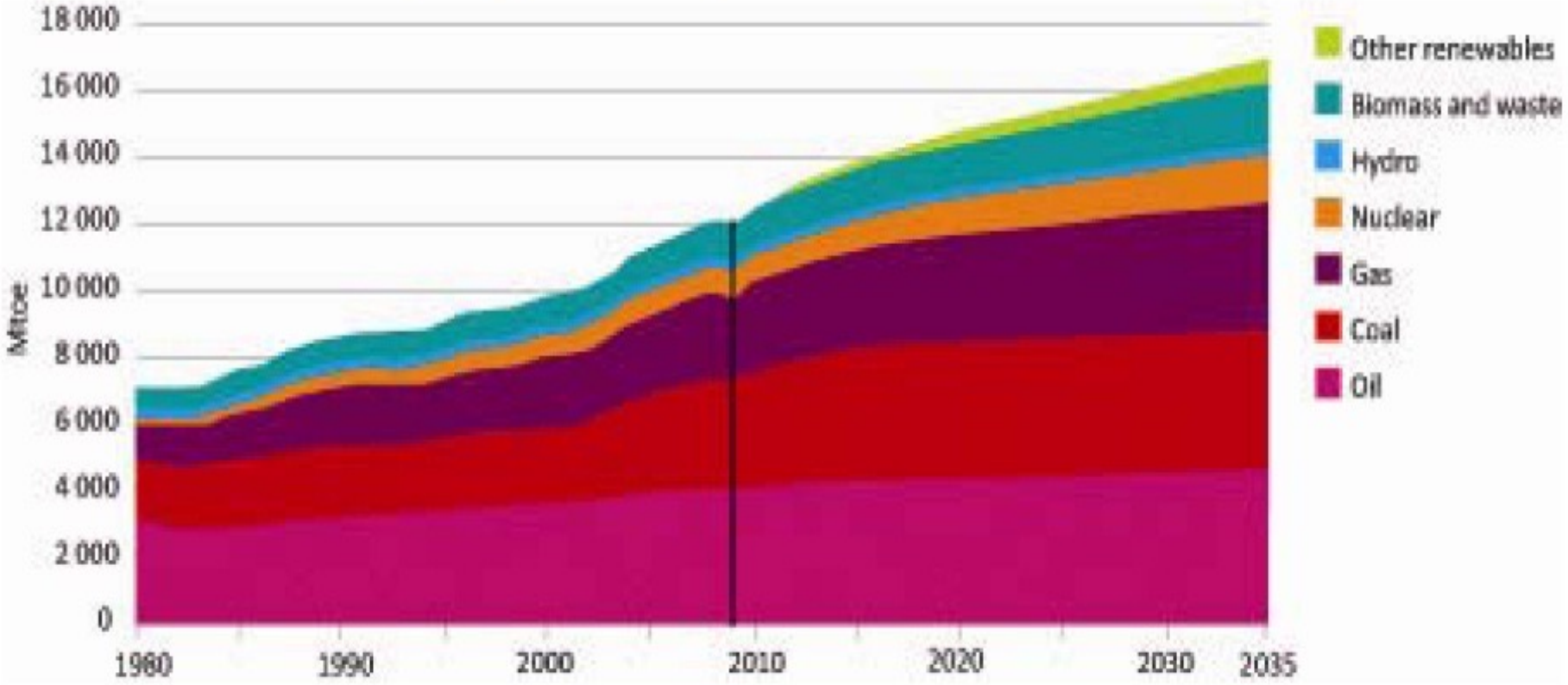
Figure 3.3: World primary energy demand by fuel in the New Policies Scenario, 1980 to 2035



Source: IEA, *World energy outlook 2011*, IEA, Paris, 2011, p. 76.

RES in EE

http://www.eea.europa.eu/data-and-maps/indicators/renewable-gross-final-energy-consumption
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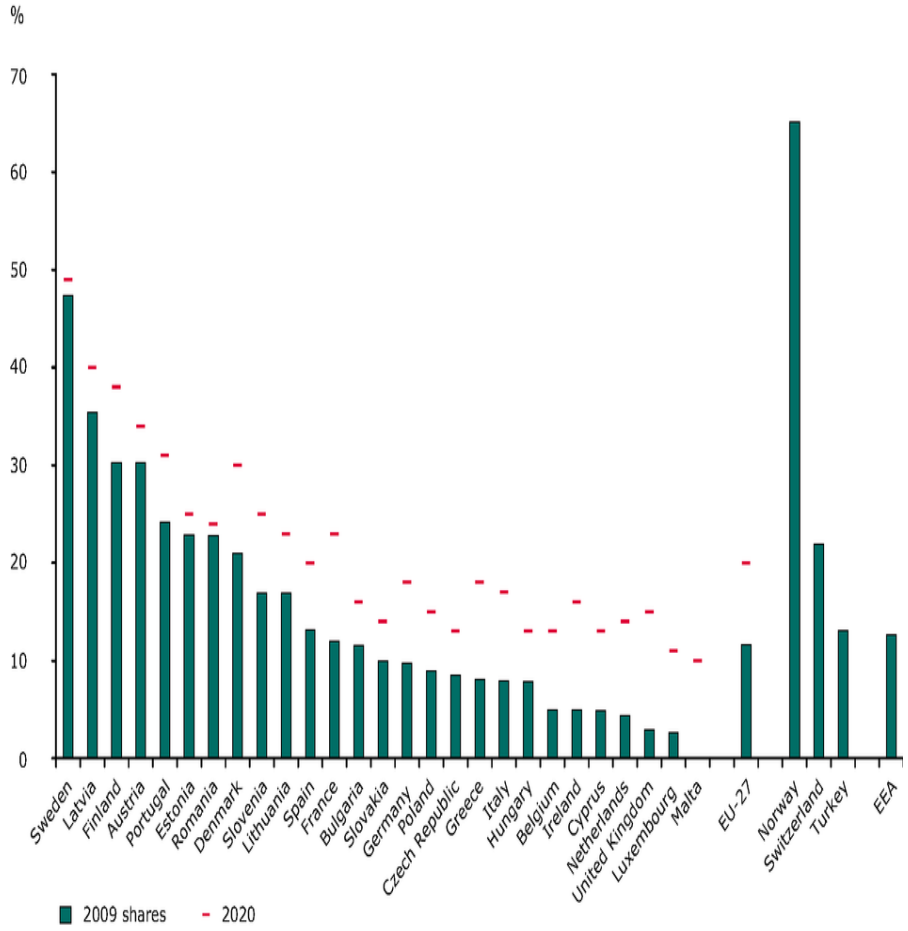
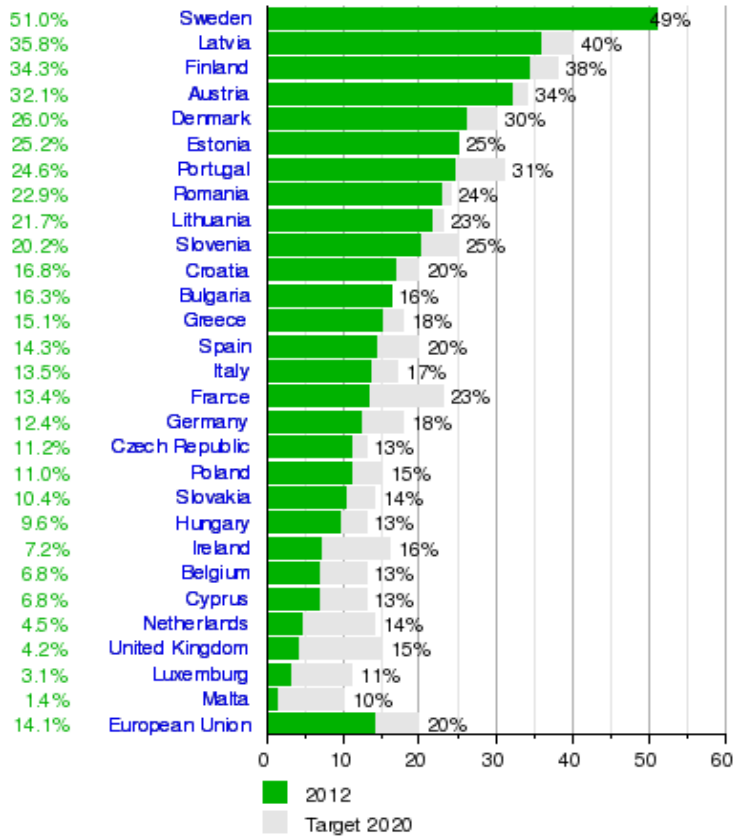




Share of renewable energies in gross final energy consumption in EU-28 countries in 2012 (in %). EEA

Can we make it?

Jacobson, M. Z. and M. A. Delucchi. 2011. "Providing all global energy with wind, water, and solar power, part I: technologies, energy resources, quantities and areas of infrastructure, and materials." *Energy Policy* 39: 1154-1169.	Total Global availability (trillion watts)	Availability in Possible - Buildable Locations (trillions watt)
Wind	1700	40-85
Wave	>2.7	0.5
Geothermal	45	0.07-0.14
Hydroelectric	1.9	1.6
Tidal	3.7	0.02
Solar Photovoltaic	6500	340
Concentrated solar power	4600	640

Can we make it?

Jacobson, M. Z. and M. A. Delucchi. 2011.	Global power supply (%) in 2030	Required number of plants / infrastructure
Wind Turbines	50	3800000
Wave power plants	1	720000
Geothermal plants	4	3500
Hydroelectric plants	4	900
Tidal Turbines	1	490000
Rooftop Solar Photovoltaic	6	1.7 bill
Solar PV power plants	14	40000
Concentrated solar power plants	20	49000
Σύνολο	100	

What are RES?

- Wind power. It was previously used for pumping water from wells as well as for mechanical applications (eg milling in windmills). It has begun to be widely used for power generation.
- Solar power. It is mostly used for thermal applications (solar water heaters and ovens) and its use for electricity generation has begun to gain ground with the help of the policy of promoting Renewable Energy Sources by the Greek state and the European Union.
- Hybrid autonomous power system, consisting of a photovoltaic array, a wind turbine, a backup power supply and accumulators
- Hydraulic energy. These are the well-known hydroelectric projects, which in the field of mild forms of energy are more specialized in small hydroelectric power plants. It is the most widespread form of renewable energy.
- Biomass. It uses plant carbohydrates (mainly waste from the wood, food and feed industries and the sugar industry) to release energy captured by the plant by photosynthesis. Urban waste and scrap can still be used. It can give bioethanol and biogas, which are fuel more environmentally friendly than traditional ones. It is a source of power with many capabilities and applications that will be used extensively in the future.
- Geothermal energy. It comes from the heat generated by the radioactive decay of the earth's rocks. It is exploitable where this heat goes naturally to the surface, e.g. hotplates or hot water sources. It can be used either directly for thermal applications or for the production of electricity. Iceland covers 80-90% of its energy needs for heating and 20% for electricity with geothermal energy.
- Energy from the sea
- Energy from tides. It exploits the gravity of the Sun and the Moon, which causes a rise in water. The water is stored as it goes up and is forced to pass through a turbine to produce electricity. It has been implemented in England, France, Russia and elsewhere.
- Wave energy. It exploits the kinetic energy of the waves of the sea.
- Energy from the oceans. It exploits the temperature difference between the ocean layers, using thermal cycles. It is under investigation.
- Osmotic energy. Mixing sweet and seawater releases large amounts of energy, as happens when a river flows into the ocean. This energy is called osmotic energy (or blue energy) and is recovered when the river water and seawater are separated from a semi-permeable membrane and the fresh water passes through it.

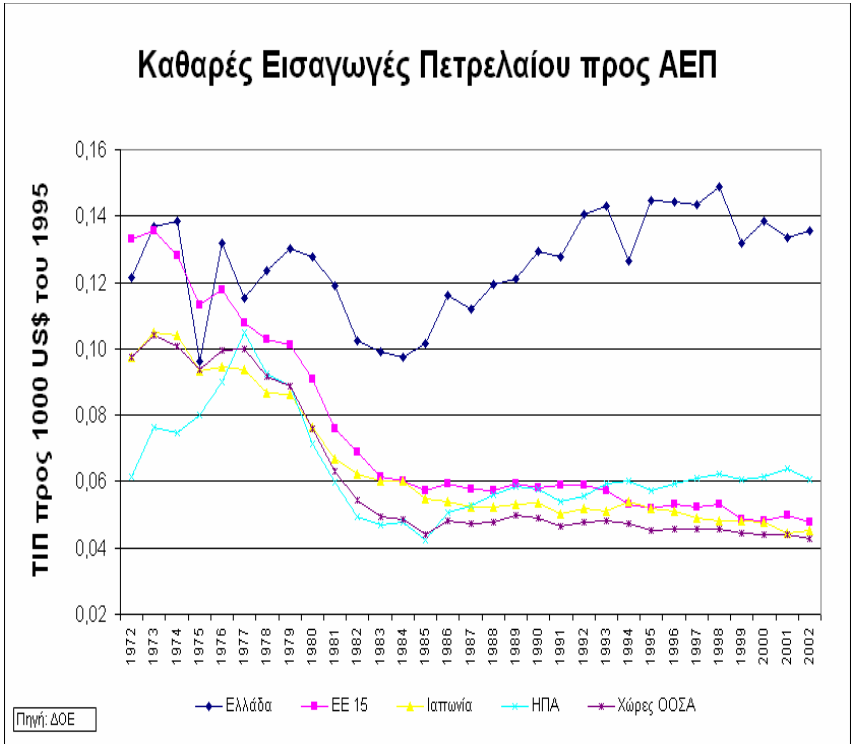
http://el.wikipedia.org/wiki

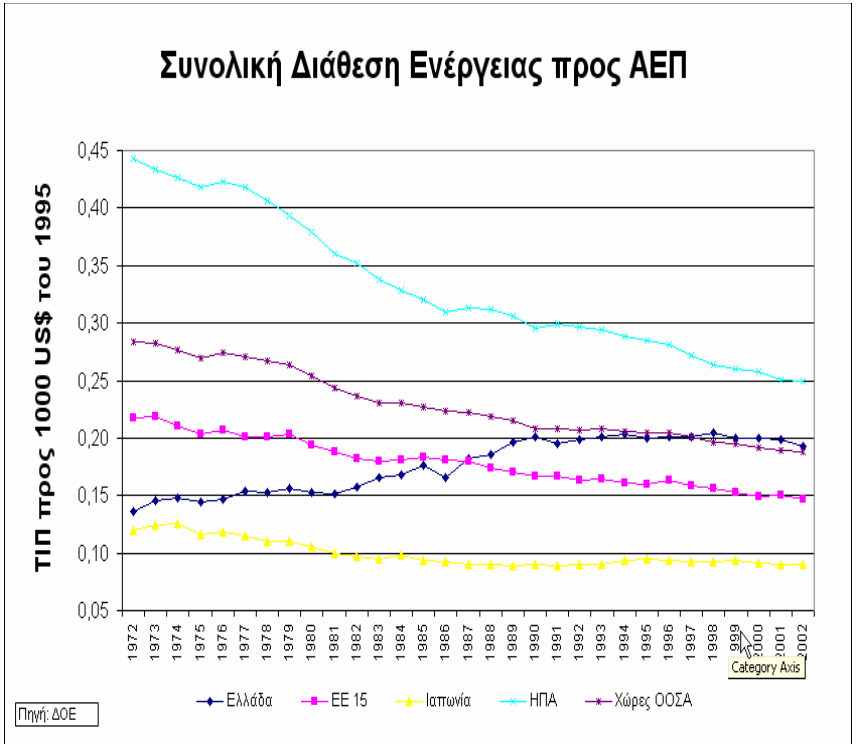
Adv (+) and disadv (-)

http://el.wikipedia.org/wiki

- They are very environmentally friendly, having virtually zero residues and waste.
- They will never be exhausted, unlike fossil fuels.
- They can help the energy self-sufficiency of small and developing countries, as well as be the alternative proposal in relation to theoil economy.
- They are flexible applications that can produce energy commensurate with the needs of the local population, eliminating the need for enormous power plants (in principle for the countryside) and also for long-distance energy transfer.
- The equipment is simple in construction and maintenance and has a long life span.
  They are subsidized by most governments.
- They have a fairly low rate of return of 30% or lower.
- Therefore, a fairly large initial cost of application to a large surface of the earth is required. For this reason, so far they have been used as complementary sources of energy.
- For the above reason at present, they can not be used to meet the needs of large urban centers.
- The supply and output of wind, hydropower and solar power depend on the season, but also on the latitude and the climate of the area in which they are installed.
- For windmills, there is the view that they are not elegant in terms of aesthetics and that they cause noise and bird deaths. However, with the development of their technology and the more careful selection of installation sites (eg platforms on the open sea), these problems have almost been solved.
- Hydroelectric plants are said to cause methane release from the decomposition of plants under the water and thus contribute to the greenhouse effect.

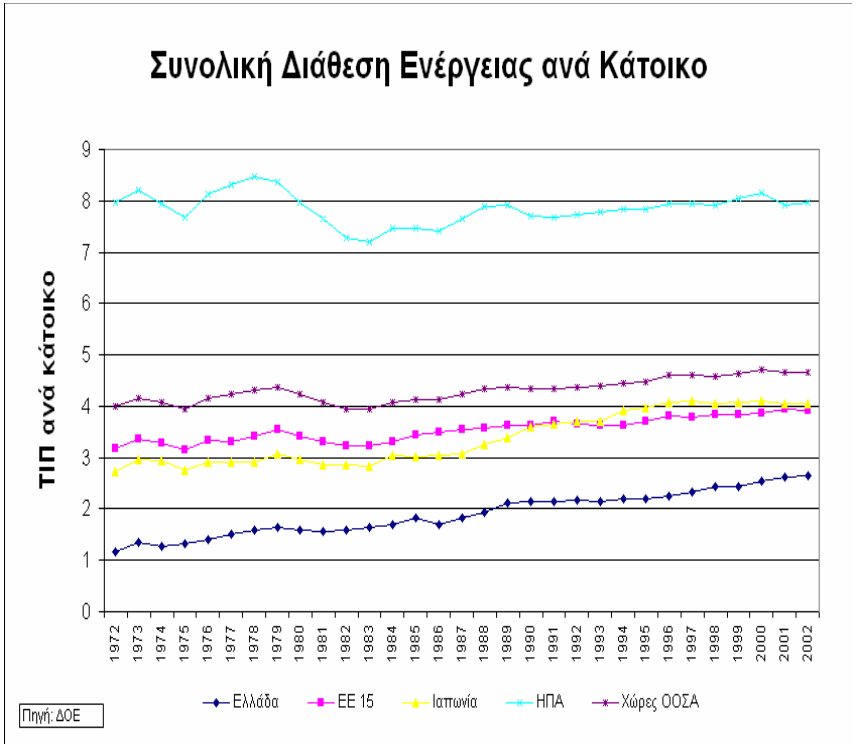
The Greek dimension I

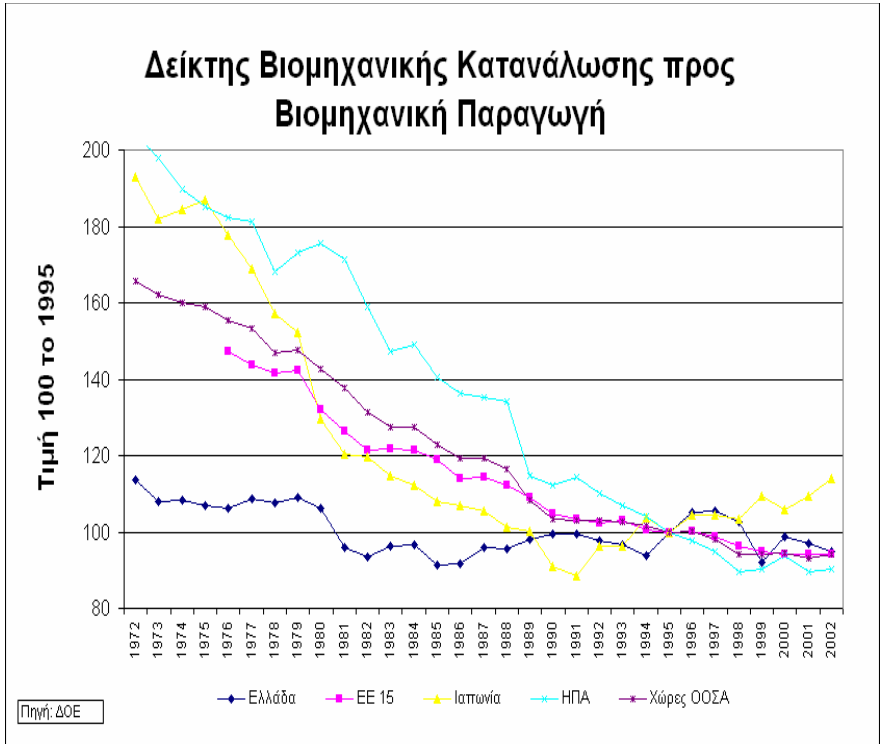




http://www.cres.gr/kape/datainfo/indicators.htm

The Greek dimension II





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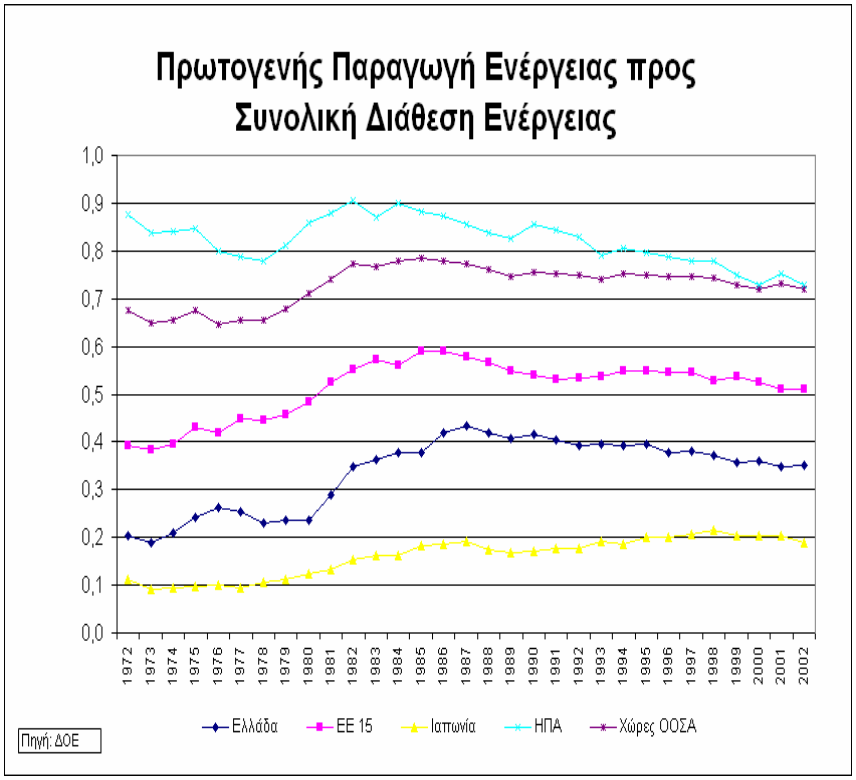
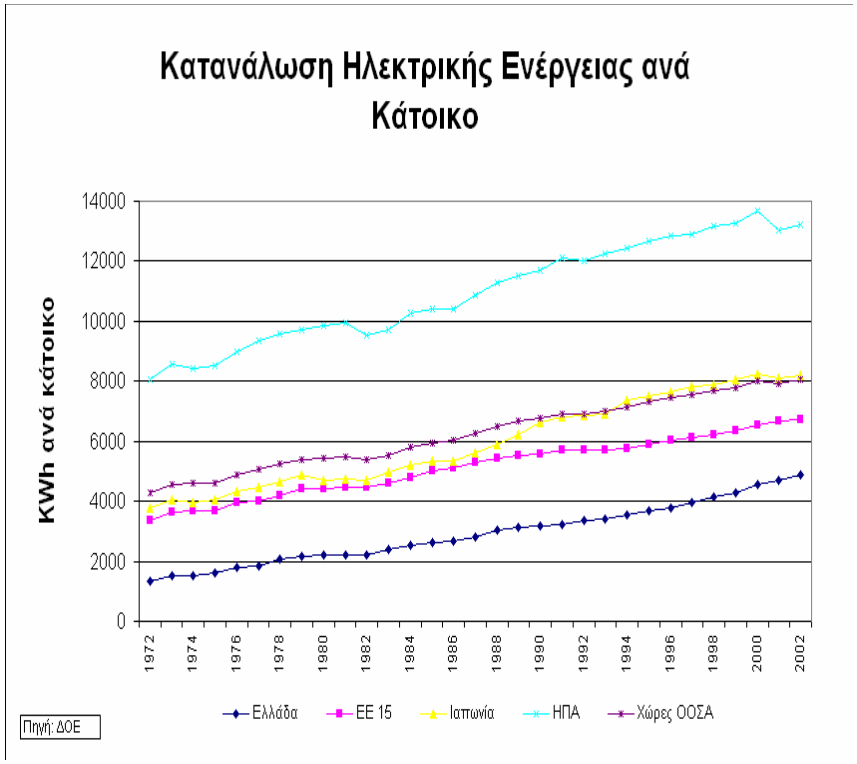
The Greek dimension III





http://www.cres.gr/kape/datainfo/indicators.htm

Factors enhancing RES I

- Reducing CO2 emissions and mitigating climate change and is the main driving force of RES for the time being. Greenhouse gas (GHG) concentration is increasing due to the dependence on fossil fuels of modern economies. It is believed that increasing the concentration of greenhouse gases will lead to a dramatic increase in temperature. In particular, the concentration of CO2 in the atmosphere will double from the current levels by 2050.
- Security of energy supply has reappeared in recent years. This is due to the recent increases in fossil fuel prices in general and oil prices and worries about global exhaustion of fossil fuels, the imminent fall in production, the consequent increase in import dependency, increasing competition for supply from emerging countries, political instability in the source of hydrocarbons and the economic impact of the disruption of energy supply in developed and rapidly developing countries.

Factors enhancing RES II

- Improving access to energy: Today it is believed that over 2 billion inhabitants around the world do not have access to clean forms of energy. The problem is more acute in rural areas in poor countries, where the supply system may be non-existent. In order to ensure sustainable development, it is necessary to provide clean energy to these people. Renewable energy obviously contributes to this.
- Job Opportunities. RESs have the potential to create jobs directly due to their decentralized structure, the same structure of technologies and the level of operation of the systems.
- Other impacts: Renewable energy dependency will help improve macroeconomic stability by reducing energy dependence and reducing the trade balance.

Technical difficulties I

- Electricity produced from these sources can not be distributed following the regulatory plan of other forms and should be used whenever electricity is available. However, by better weather forecasting, an accurate estimate of production at local level can be made.
- As a consequence of this, capacity is only used for a limited time, leading to a low capacity utilization rate (solar energy in photovoltaic systems is less than 10% in Europe, while the average capacity utilization of the wind is about 20 %).
- Consequently, these systems can not provide reliable supplies and will require back-up capacities.

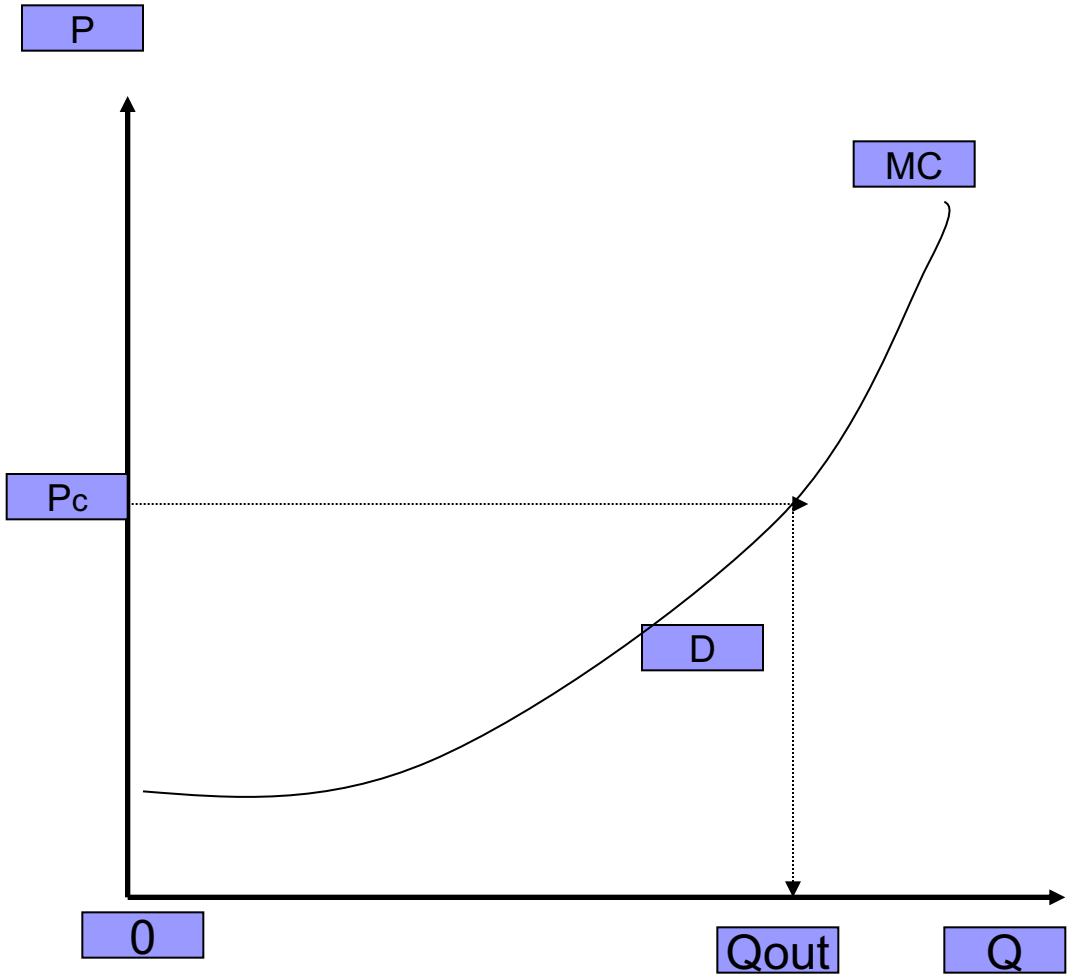
Technical difficulties II

- Inappropriate valuation: The price of electricity usually varies depending on whether it is used during off-peak or peak hours. Power supply during the peak season yields a higher price to the supplier, which is problematic with RES.
- Inappropriate pricing signals: Often, these units are integrated into the distribution system and are based on a clean measurement (ie it considers that the energy supplied means less energy consumed by the unit).
- Non-internalization of externalities: Renewable energies have environmental advantages compared to electricity compared to fossil fuels.
- Risk fuel benefits: RES does not face the same risk compared to fossil fuel prices. In fact, the cost of running renewable energy sources is "minimal" in most cases.

The role of costs

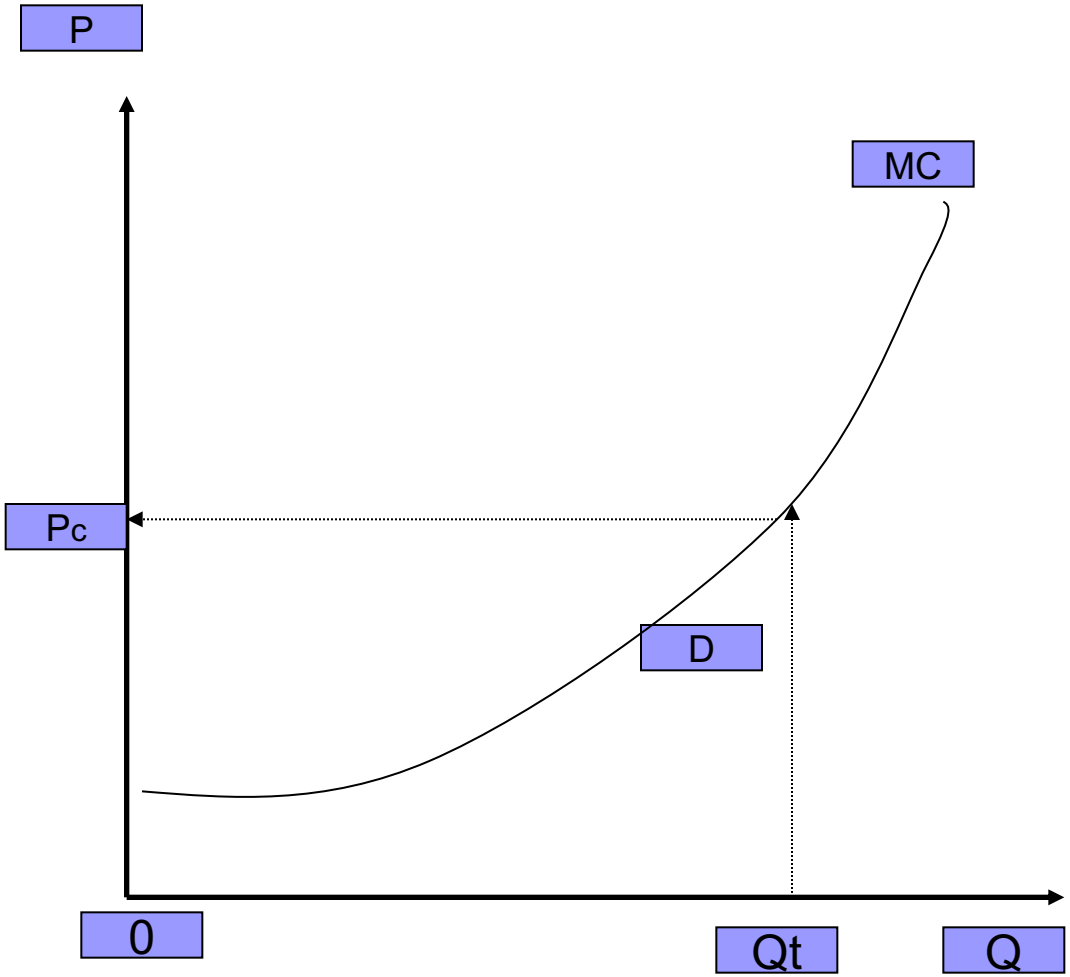
- Energy costs associated with energy and includes the costs associated with power generation, maintenance, etc. Normally, these costs are much lower compared to fossil fuels.
- Costs Capacity: These include installation costs and stable operation and maintenance (labor costs, inventory, etc.). For RES based on electricity, this is the most important element of the cost and could be between 50% and 80% of the total cost of the supply.
- Other related costs
  a. Environmental costs are higher for fossil fuels and almost non-existent for renewable energy sources.
- On the other hand, in standby capacity costs could be important for some types of RES.
- c. Similarly, the fuel price risk (or safety risk) could be high for certain fossil fuels and should be considered here.

Support mechanism-feed in tariffs



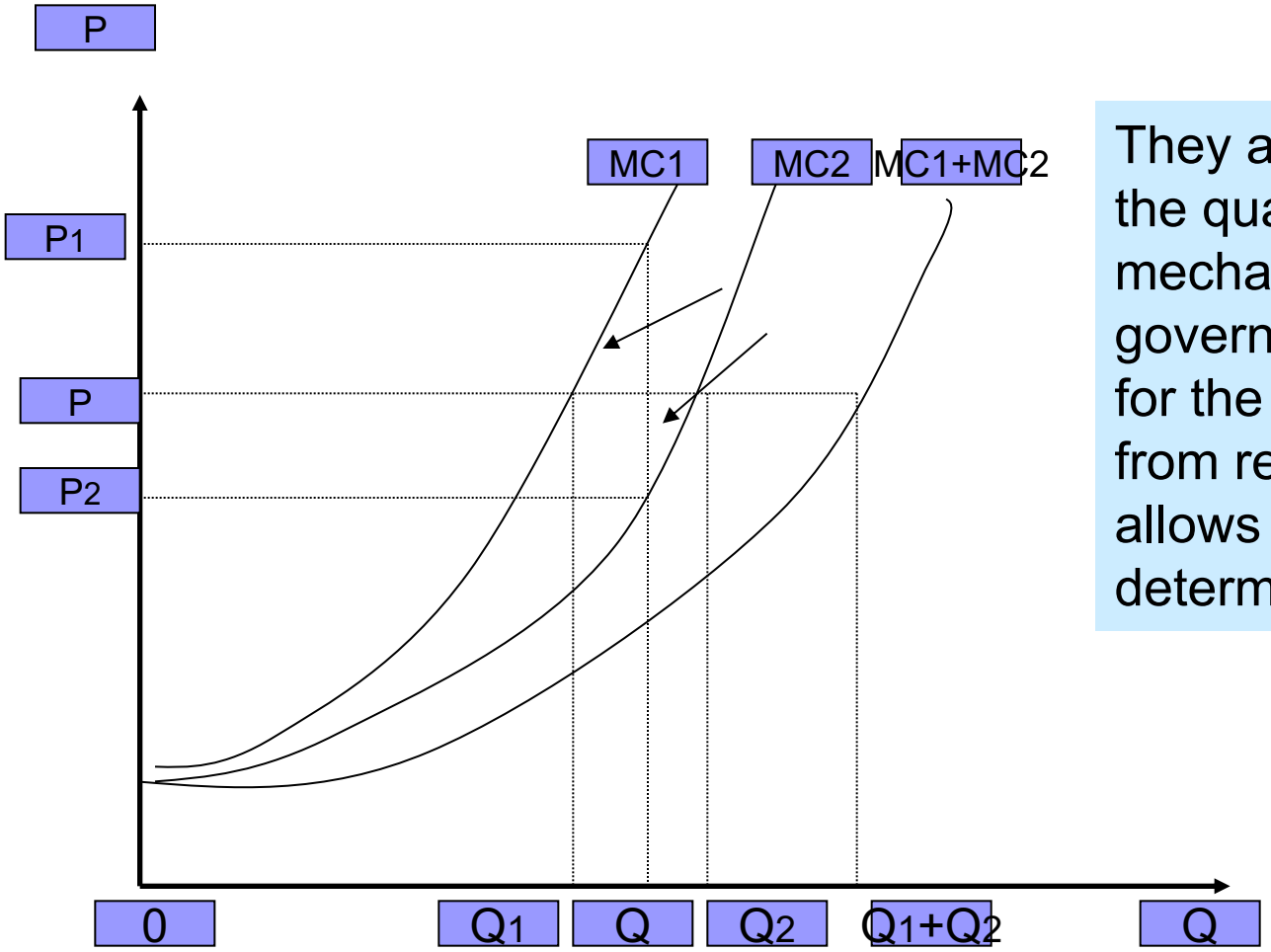
Producers with a lower price will enter the market by producing Qout. The grant cost is equal to Pcx Qout.

Support mechanism-competitive binding processes



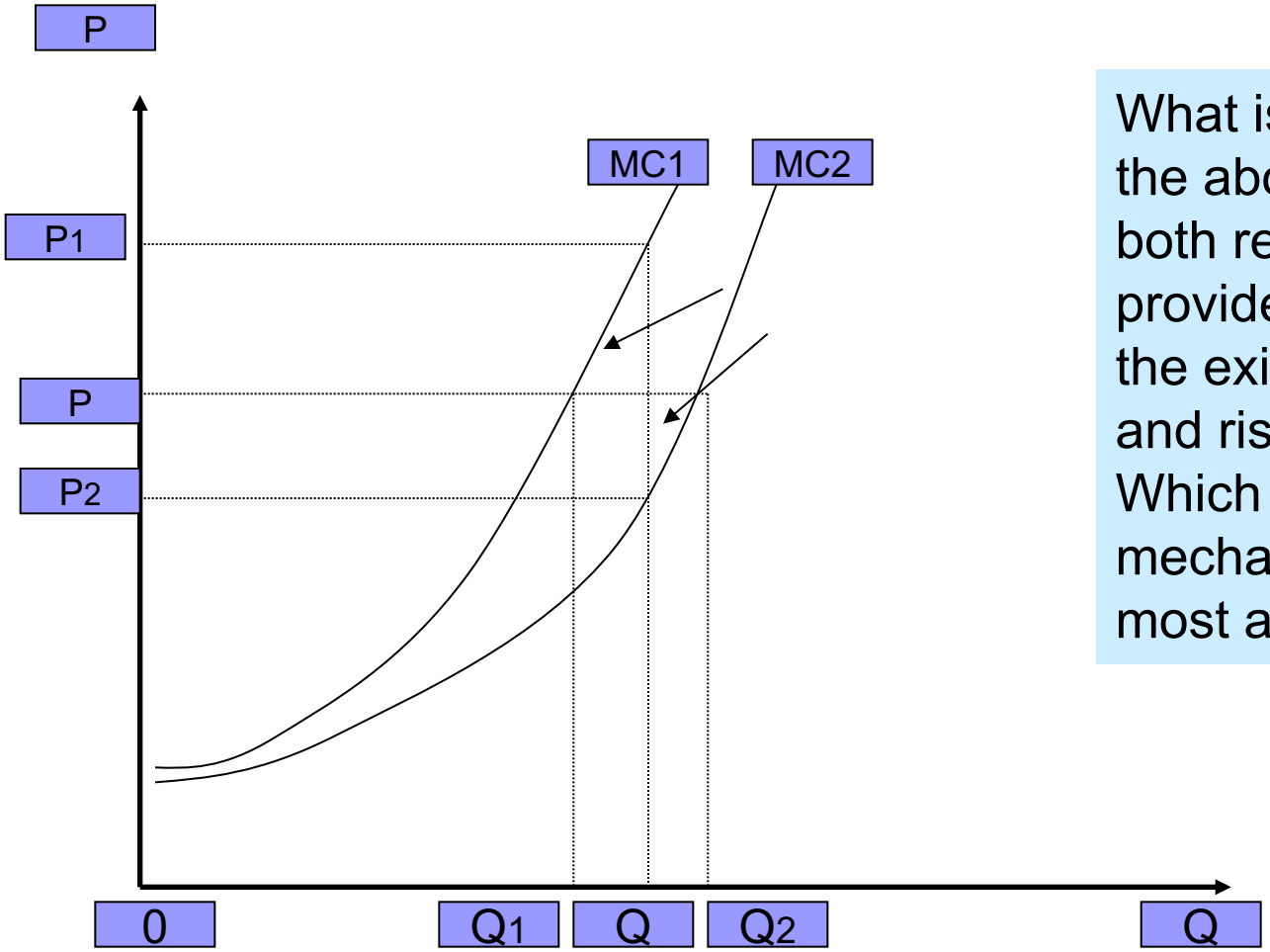
This is a competitive bidding process. This particular mechanism is therefore an attempt to discover the supply curve through bids. As the bidding system decides on the quantity to be purchased, there is no certainty as to the maximum bid volume (whether or not the target will be achieved).

Support mechanism- renewable obligations



They also operate through the quantity limitation mechanism in which the government sets the target for the supply of electricity from renewable sources and allows the price to be determined by the market.

Support mechanisms under uncertainty and risk



What is the performance of the above mechanisms if both regulators and energy providers take into account the existence of uncertainty and risk?
Which of the two mechanisms seems the most appealing?

Economic incentives

RISK TYPE	FEED-IN-TARIFF	ROC
Price Risk	No price risk for generators	Great deal for price risk
Volume Risk	No volume risk	Exists
Balancing Risk	Side-stepped and no penalty for intermittent generation	Balancing risks exists

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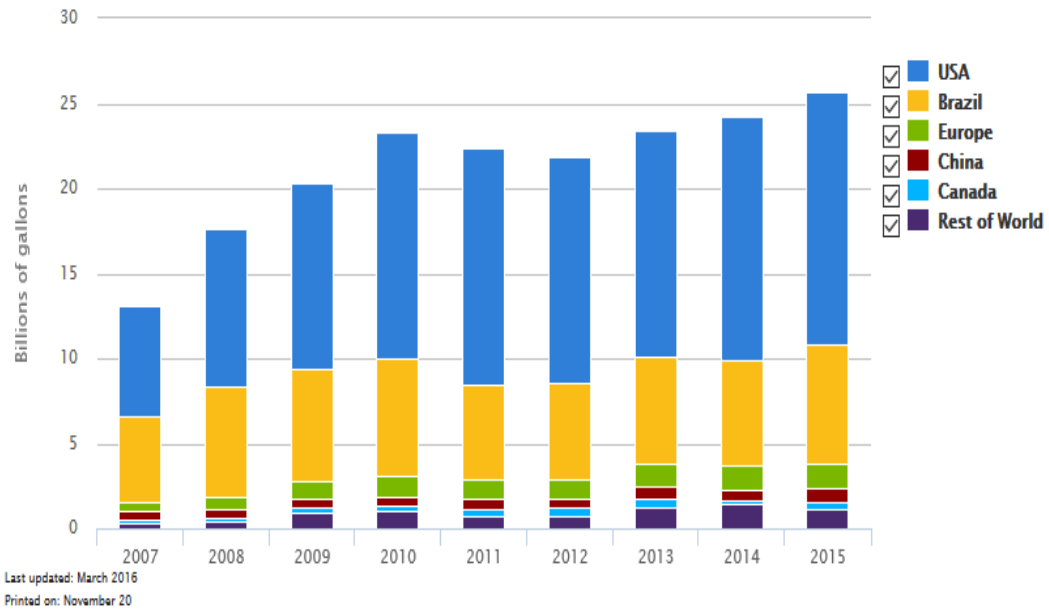

Source: Renewable Fuels Association

Notes: A more detailed breakdown of fuel ethanol production by country for 2000-2012 can be viewed at the EIA's International Energy Statistics: Biofuels Production.

This chart shows global ethanol production by country or region, from 2007 to 2015. Global production peaked in 2015 after a dip in 2012 and 2013. The United States is the world's largest producer of ethanol, having produced nearly 15 billion gallons in 2015 alone. Together, the U.S. and Brazil produce 85% of the world's ethanol. The vast majority of U.S. ethanol is produced from corn, while Brazil primarily uses sugar.

ARRA Electrification Projects

View Map

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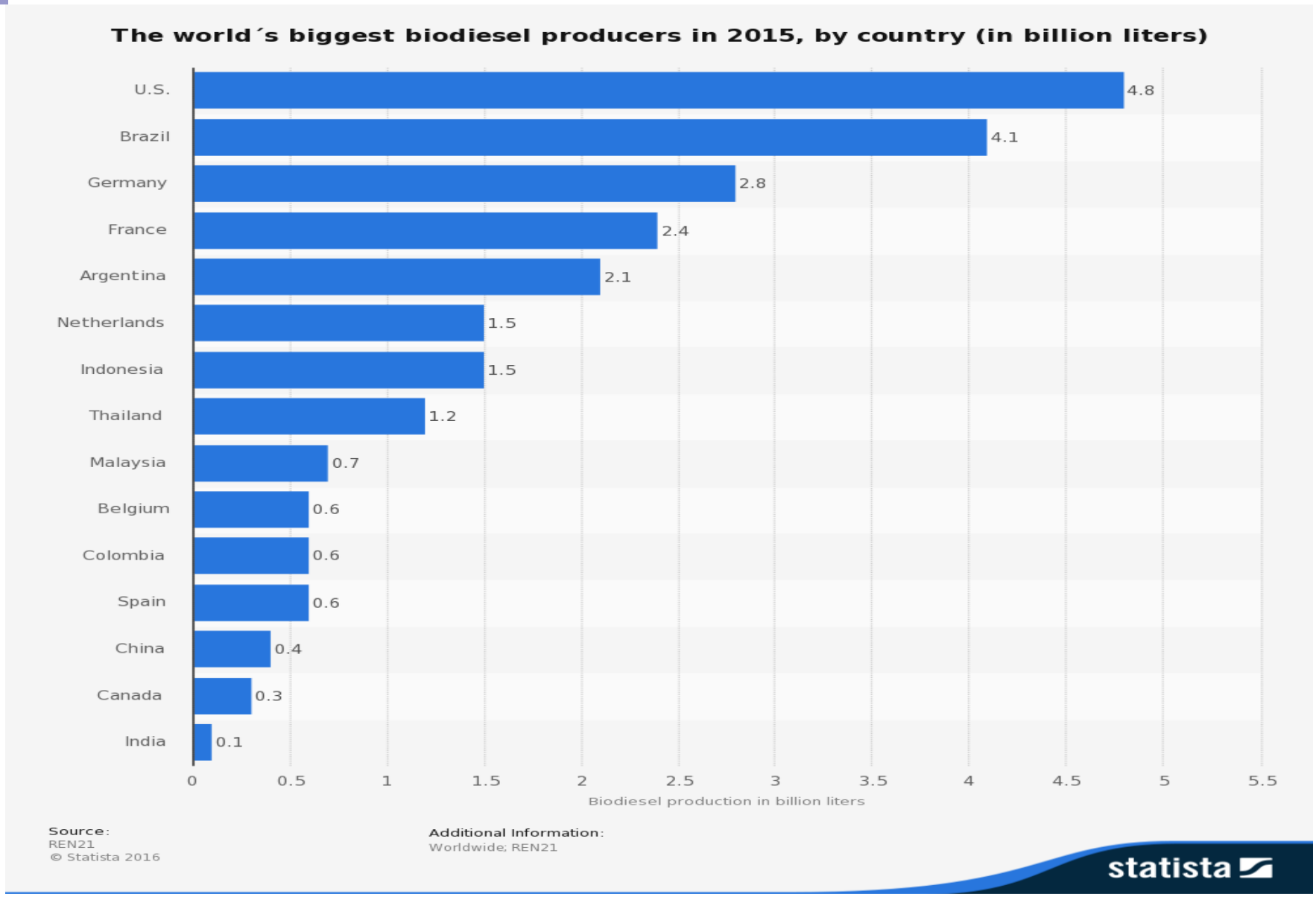
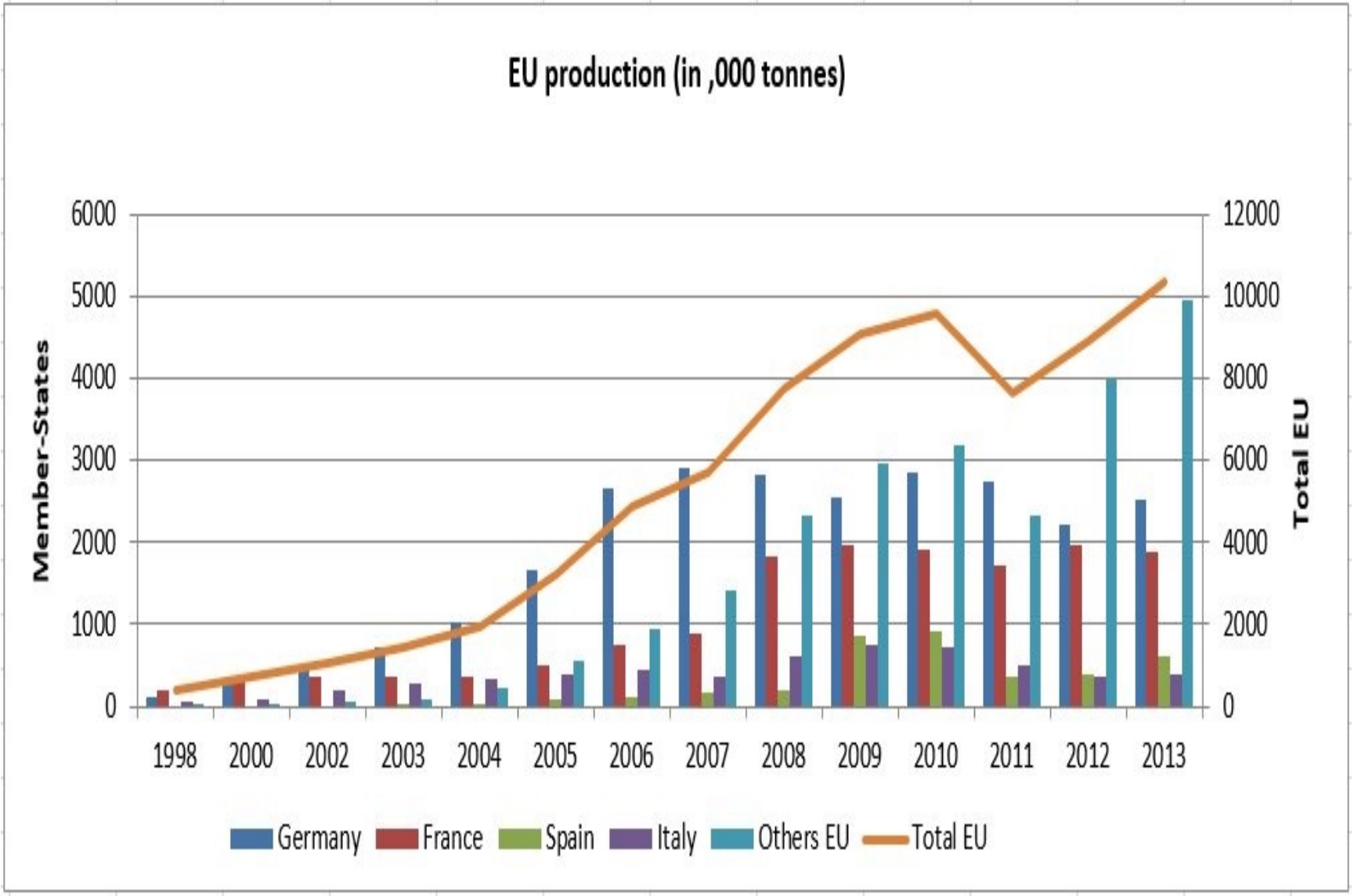

The world´s biggest biodiesel producers in 2015, by country (in billion liters)
U.S.
Brazil
Germany
France
Argentina
Netherlands
Indonesia
Thailand
Malaysia
Belgium
Colombia
Spain
China
Canada
India
4.8
4.1
2.8
2.4
2.1
1.5
1.5
1.2
0.7
0.6
0.6
0.6
0.4
0.3
0.1
0
0.5
1
1.5
2
2.5
3
3.5
4
4.5
5
5.5
Biodiesel production in billion liters
Source:
REN21
© Statista 2016
Additional Information:
Worldwide; REN21
statista


EU production (in ,000 tonnes)
Member-States
Total EU
6000
5000
4000
3000
2000
1000
0
12000
10000
8000
6000
4000
2000
0
1998
2000
2002
2003
2004
2005
2006
2007
2008
2009
2010
2011
2012
2013
Germany
France
Spain
Italy
Others EU
Total EU

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