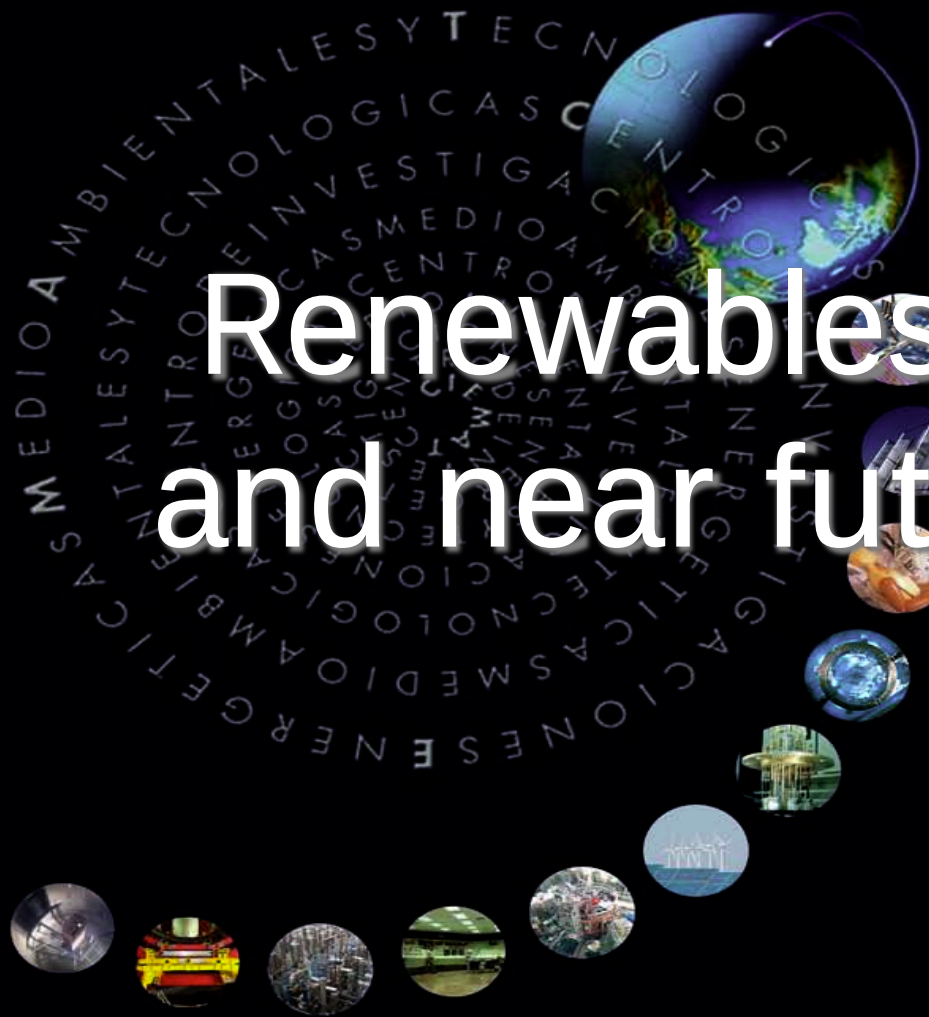
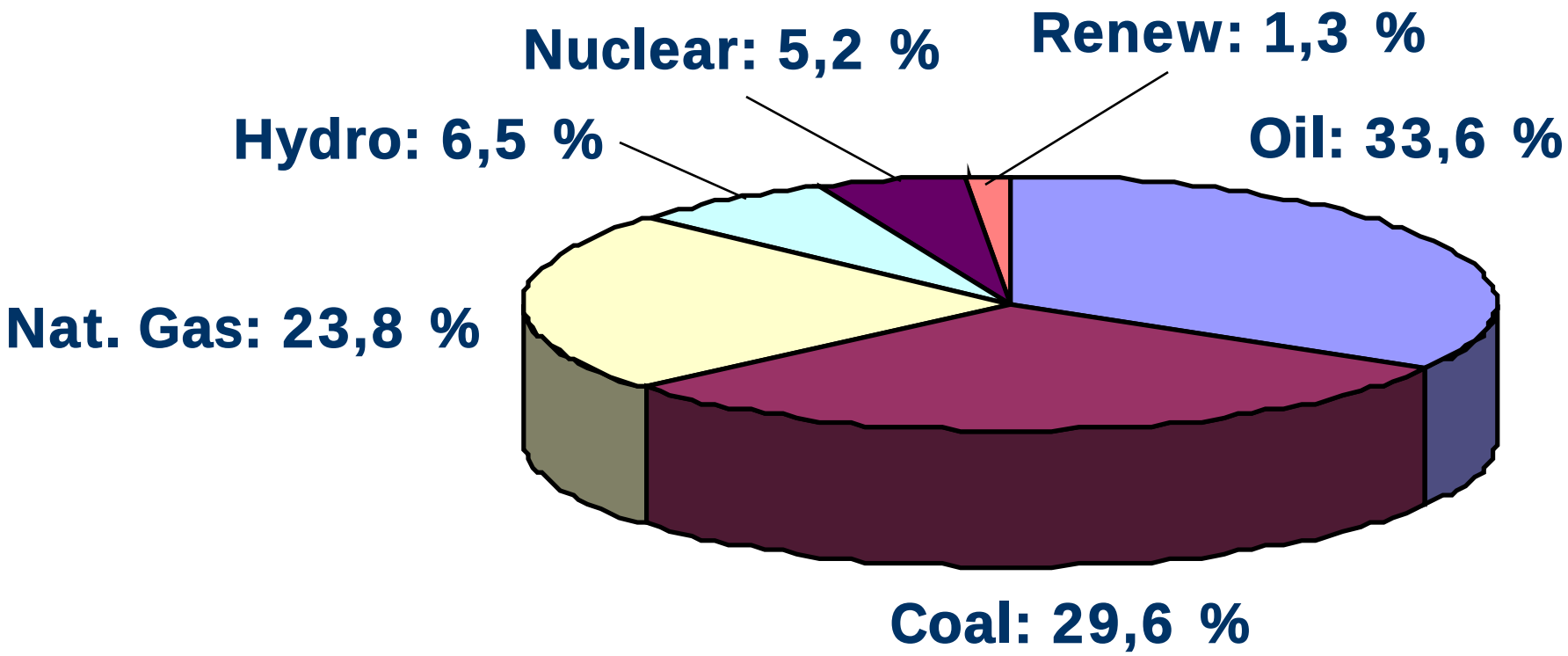


Renewables: present and near future status

Cayetano López
CIEMAT
Director General
November 2011

World primary energy consumption by source, 2010



Overwhelming dependence on fossil fuels (World: 87%. Spain: 79%)

Problems of geographical distribution, resource scarcity, price volatility and environment damages.

This scheme is not sustainable

The elements of change

The serious drawbacks of the existing energy supply scheme
Imply a change whose main vector is:

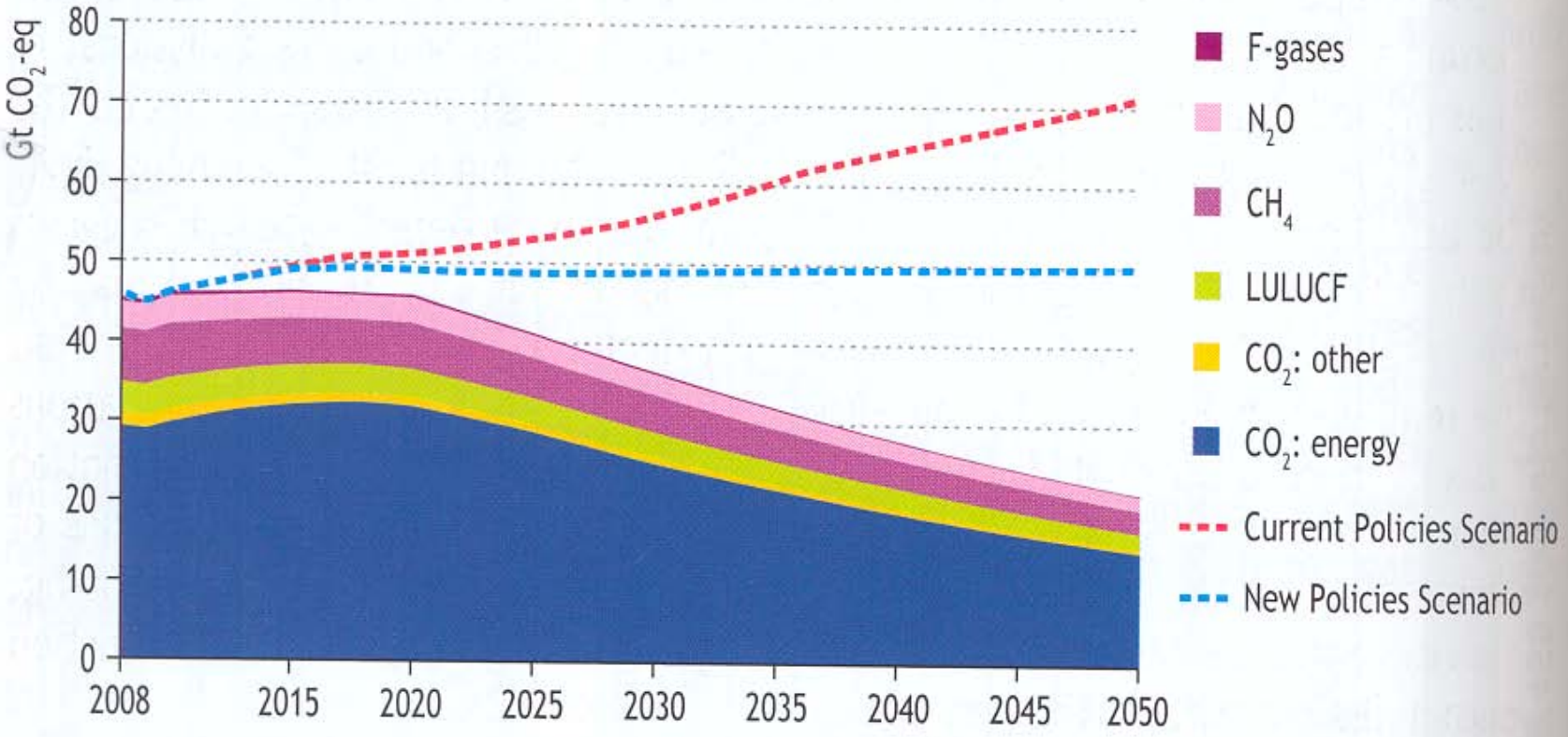
Reduce the carbon content of the primary energy sources

Energy saving and efficiency increase
Less fossil fuels
More renewables
More (at least keep) nuclear (Fukushima accident?, Gen IV?)
Possible clean use of coal (CO_2 capture and sequestration)
Fusion (not available in the short term)

None of these alternatives are free of problems. To implement them, a big effort in technology development and political support is necessary.

Prospects on CO_2 emissions

Figure 13.4 • World anthropogenic greenhouse-gas emissions by type in the 450 Scenario



Note: F-gases include hydrofluorocarbons (HFCs), perfluorocarbons (PFCs) and sulphur hexafluoride (SF_6) from several sectors, mainly industry.

Sources: IEA-OECD analysis using MAGICC (version 5.3v2) and OECD Env-Linkages models.

Renewable Energies

Problem 1: High Cost

Possible solutions:

Increasing size of the plants

Advances in R + D

Improvements in component manufacture

Series production (market expansion)

Experience in O & M

Problem 2: Intermitency

Possible solutions:

Hybridation

Energy storage (electricity, heat, H_2)

Wind energy, a story of success

1979: 40 c€/kWh

- Increased Turbine Size
- R&D Advances
- Manufacturing Improvements
- Operating Experience

Wind park in Carnota (A Coruña)

2010: 4 - 7 c€/kWh

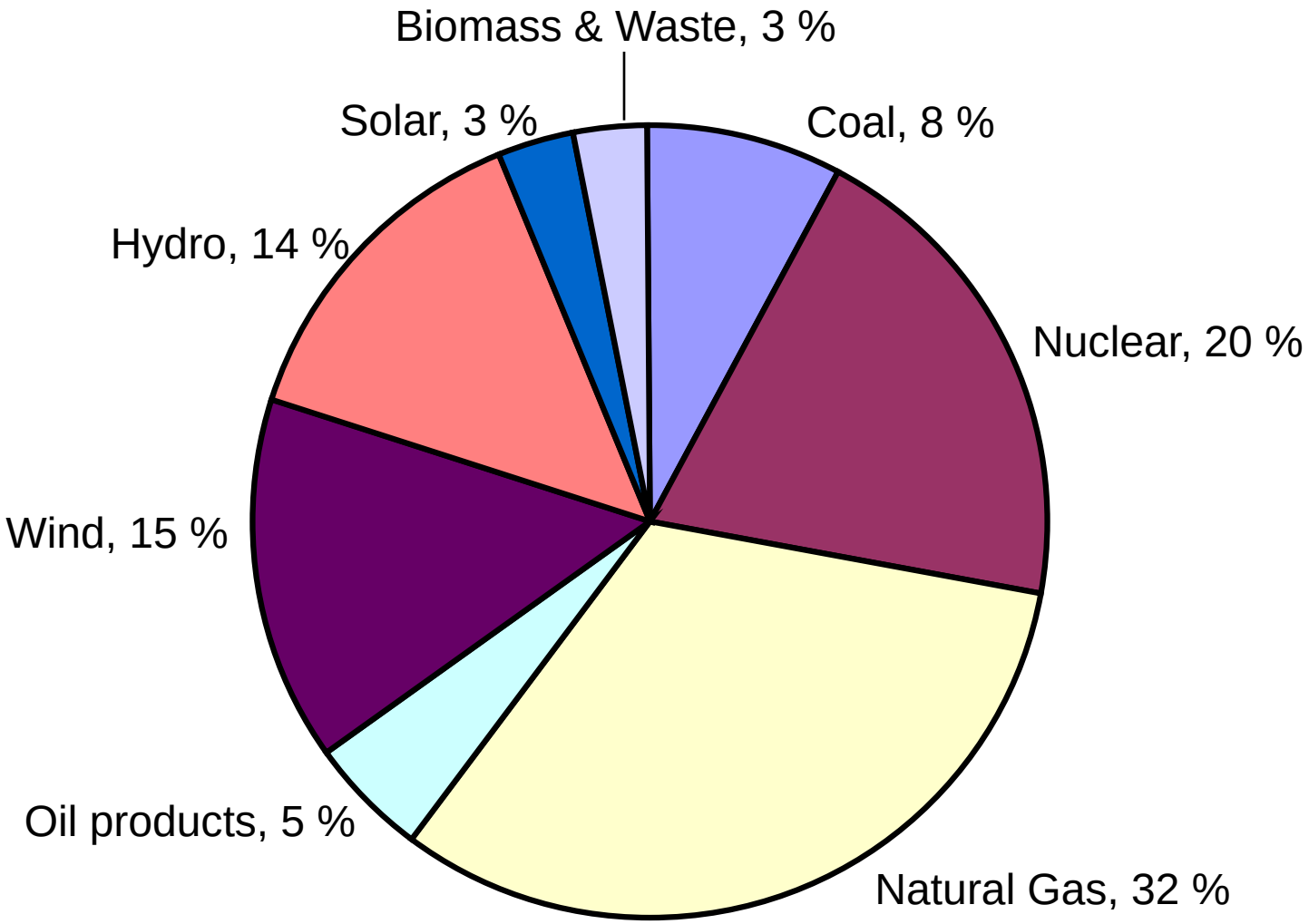
The wind energy market, Dec 2010

Country	MW	%
China	42,287	21.8
USA	40,180	20.7
Germany	27,214	14.0
Spain	20,676	10.6
India	13,065	6.7
Italy	5,797	3.0
France	5,660	2.9
UK	5,204	2.7
Canada	4,009	2.1
Denmark	3,752	1.9
Rest of the world	26,546	13.7
Total TOP 10	**167,844**	**86.3**
World Total	**194,390**	**100**

In Spain, around 15% of the electricity in 2010 was generated by wind turbines.

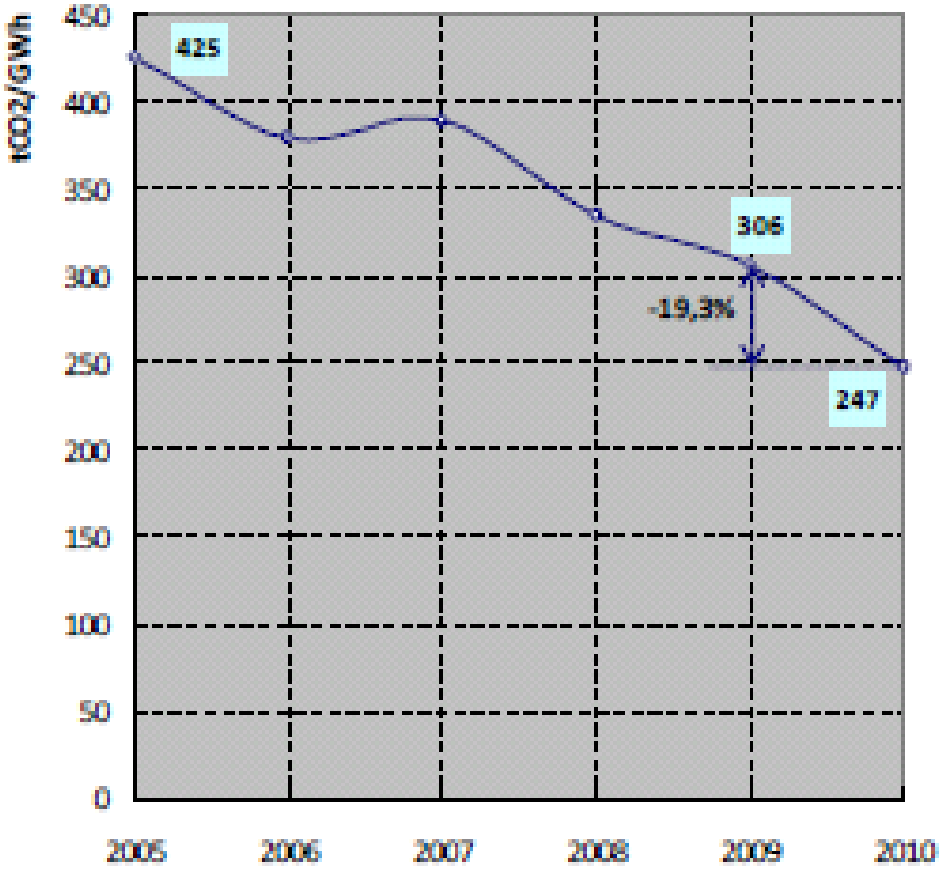
The goal for 2020 is to reach 25%

Electricity Generation in Spain, 2010



Renewables: 35 %

Renewables in the Spain energy supply



CO2 emissions by unit of electricity produced

Renewables in 2010:

11,3% in Primary Energy

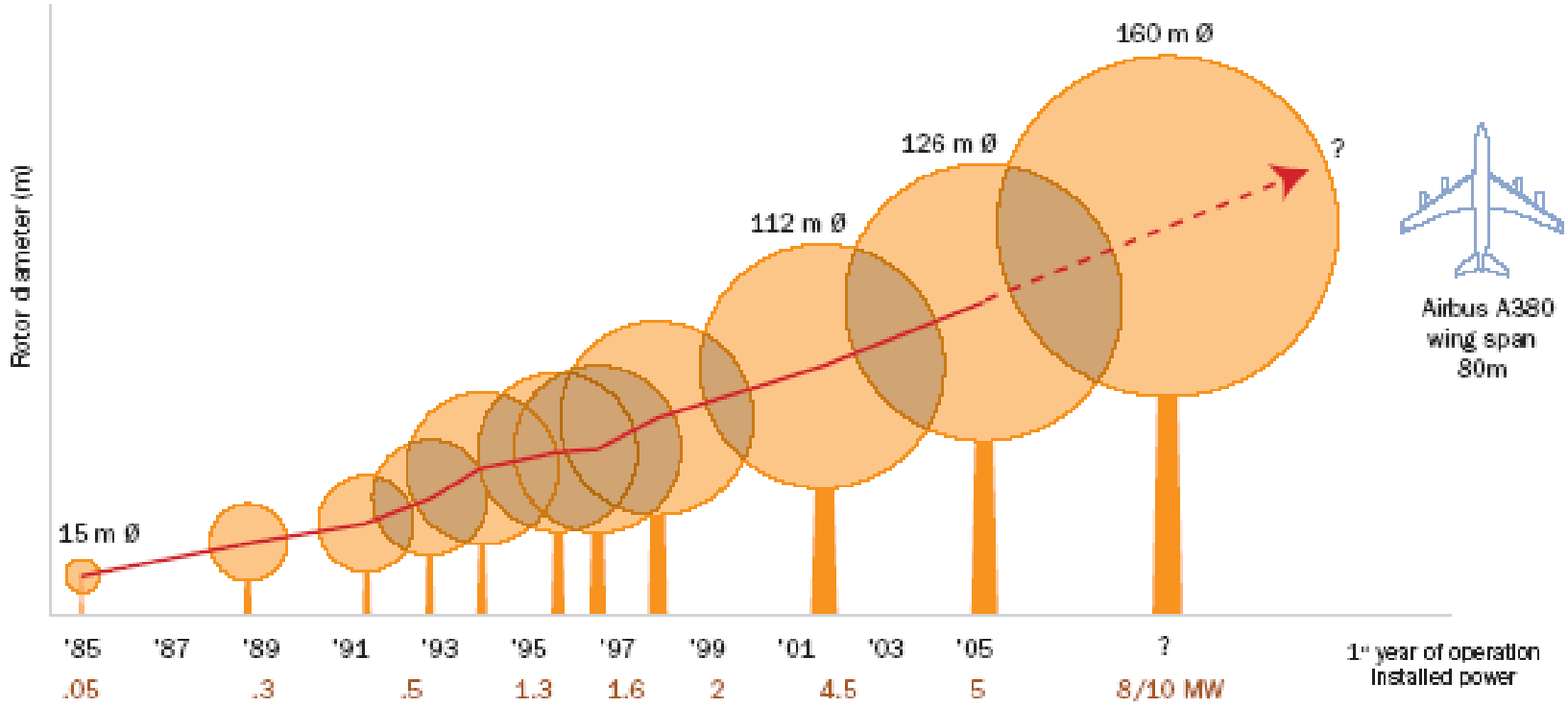
13,2 % in Final Energy

35 % in Electricity

5 % biofuels

Increasing size of the turbines

¿Is there a limit in turbine power?



A dynamic industrial sector in Spain

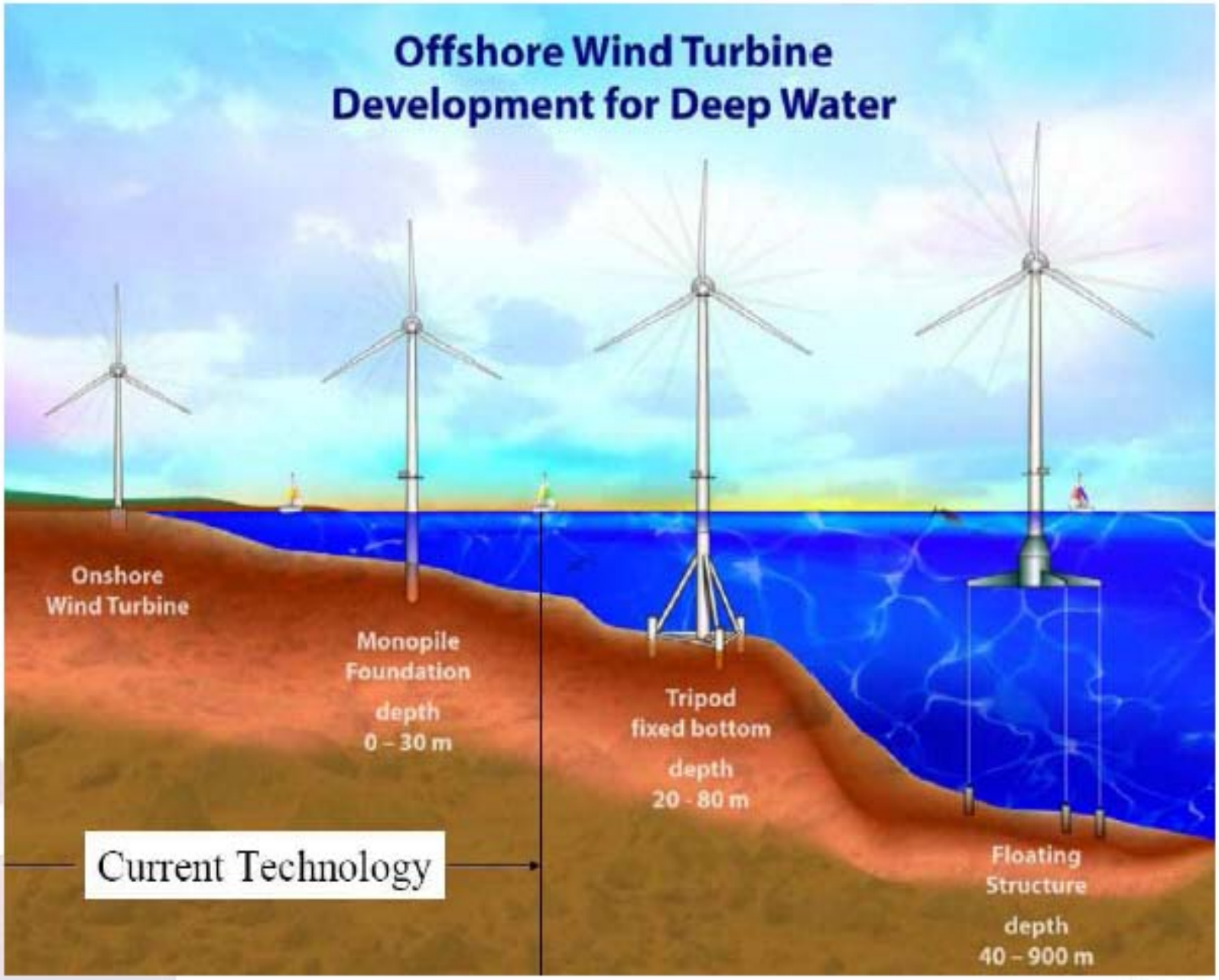
Table 1. Largest Wind Markets and Domestic Wind Companies[2]

Country	Cumulative Wind Capacity (2006) (MW)	Leading Domestic Wind Companies (Global rank in 2006)	Percent of Installed Turbines Made by a Domestic Company (2006)
1. Germany	20,652	Enercon (#4), REpower (#8), Nordex (#7), Fuhrlander (#14), Siemens (formerly Bonus) (#6)[3]	55%
2. Spain	11,614	Gamesa (#2), Ecotecnia (#12), EHN/Ingetur (#11)	76%
3. US	11,575	GE Wind (#3)	37%
4. India	6,228	Suzlon (#5)	52%
5. Denmark	3,101	Vestas (#1)	100%
6. China	2,588	Goldwind (#10)	39%
7. Italy	2,118	None	0%
8. UK	1,967	None	0%
9. Portugal	1,716	None	0%
10. France	1,585	None	0%

Source: BTM, 2007; Wiser and Bolinger, 2007; company financial reports, and authors' calculations.

Iberdrola is the first company in the world to own and manage wind plants (more than 13.000 MW, around 7% of the cumulated wind power)

New developments: Off-Shore technology



Small wind

Integration in residential environments and in isolated locations.

Small wind: pros and conts

Lack of technological maturity

Lack of quality and certification standards

A robust technology is required: almost no O & M

A very low level of noise and vibrations is required

High specific cost

Turbulent flux and low annual average wind speed

It works in places without grid connexion

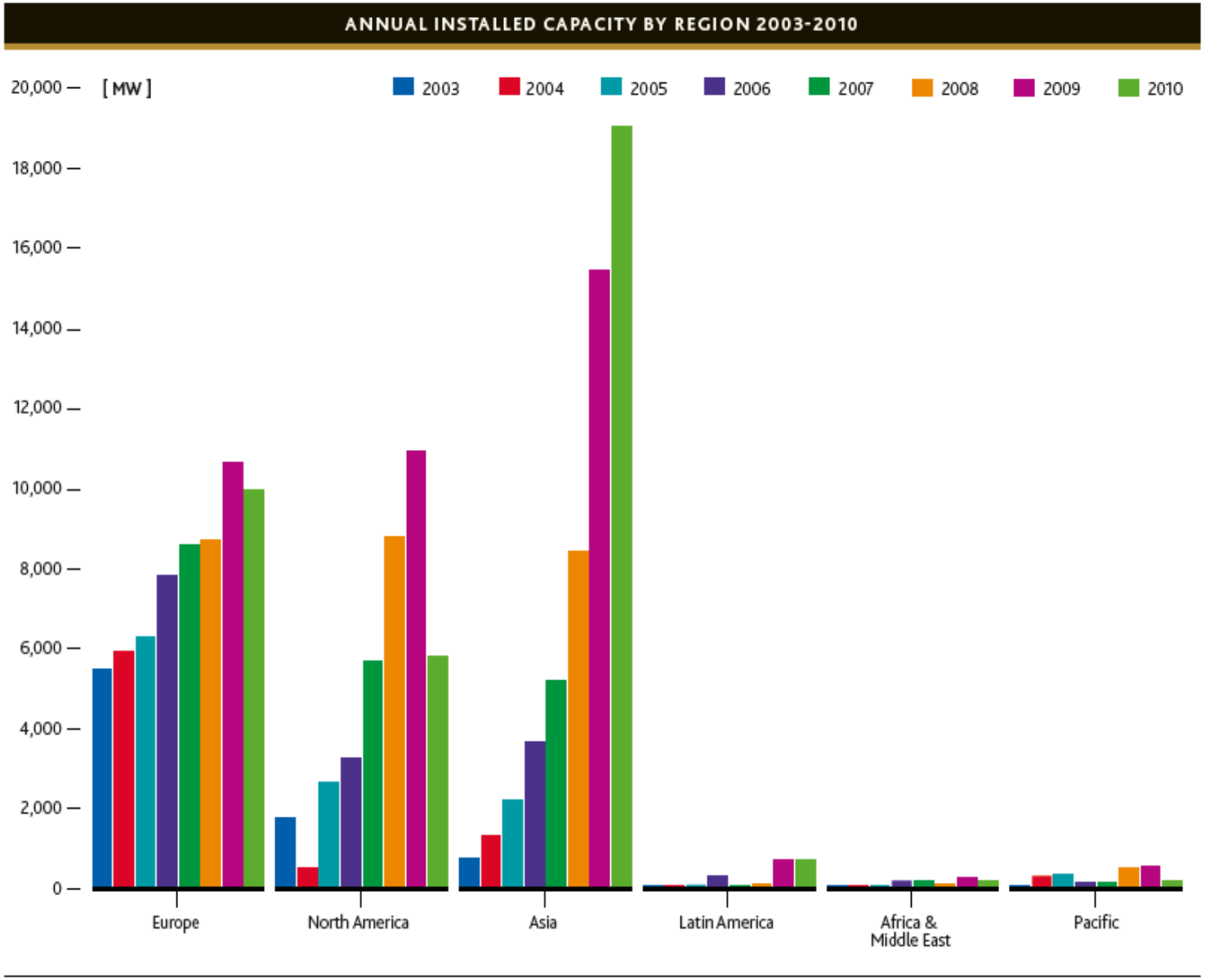
Lower visual impact

Reduced transportation losses

Easy installation, reduced civil works

It works with moderate winds

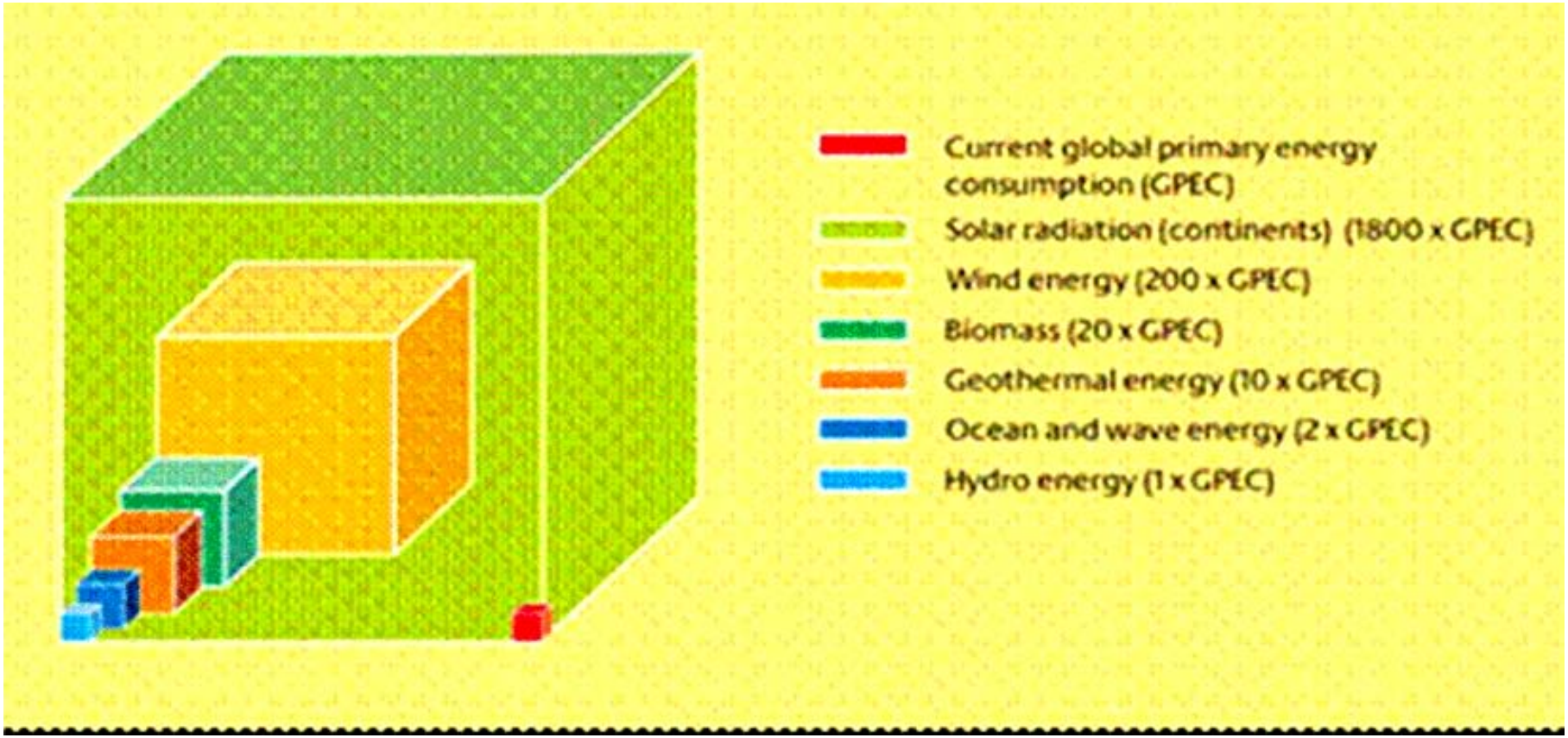
The wind energy deployment in Asia



Global Wind Statistics 2010, GWEC

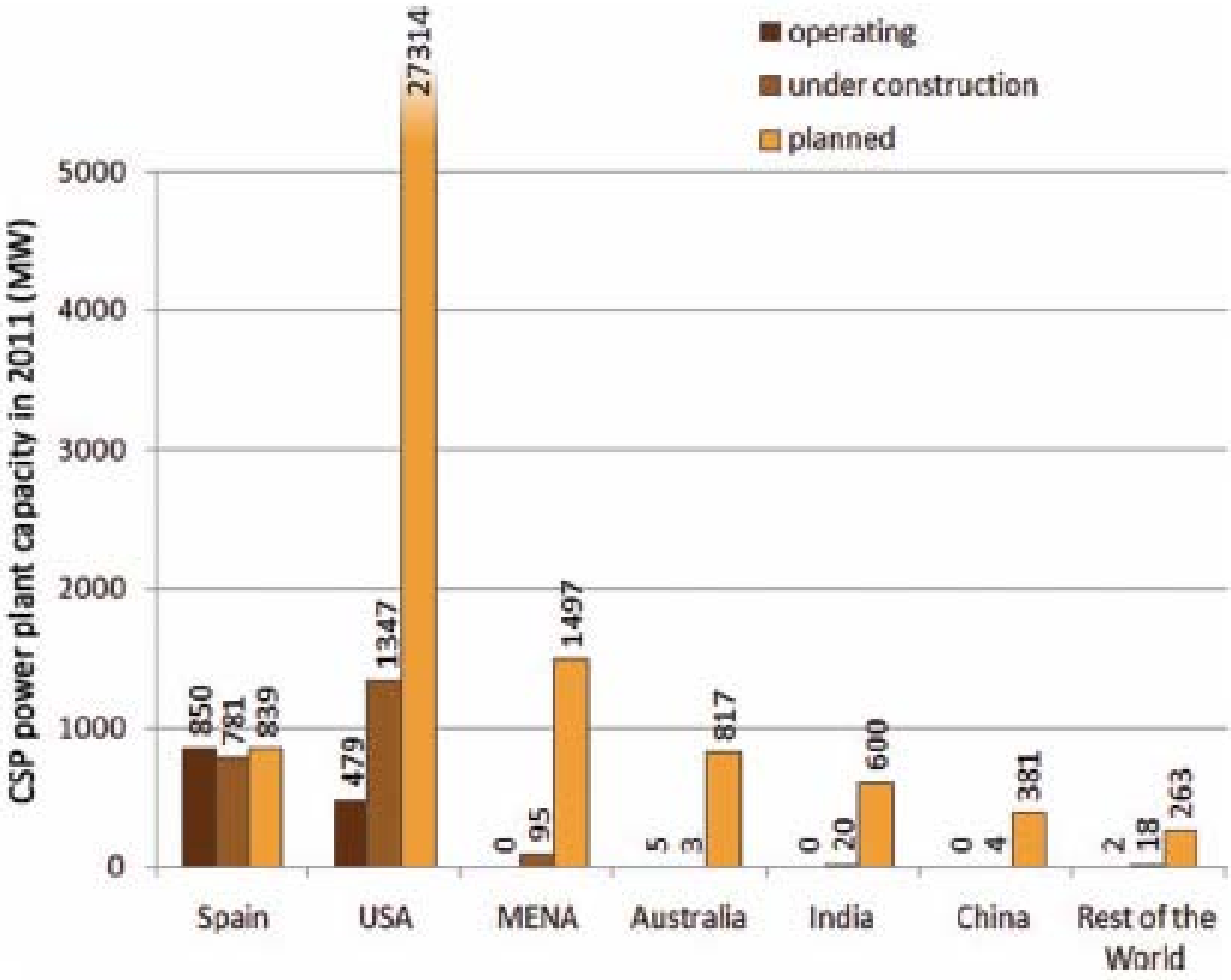
The solar resource

In good conditions, the daily averaged incoming solar flux is around 220 – 250 W / m2 which, integrated, gives a yearly primary energy of around 2000 – 2200 kWh / m2. This is equivalent to a “rain” of about 20 cm of oil per annum and m2. 1,2 barrel/(year x m2)

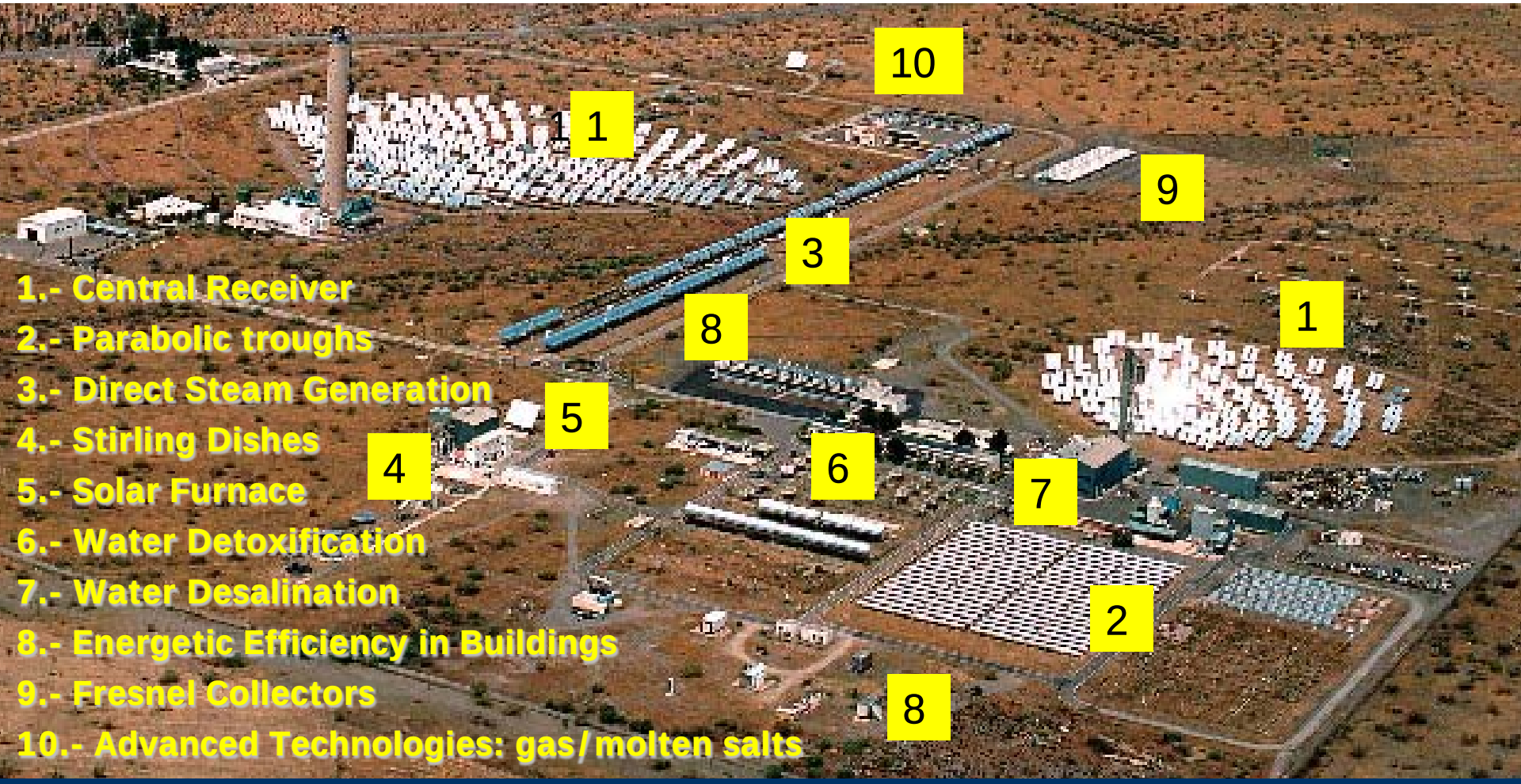


Solar energy is plentiful but diffuse

CSP in Spain (July 2011)



Solar Platform in Almeria (PSA)



The Plataforma Solar de Almería is the world most complete experimental installation in concentration solar energy

Andasol, 2 x 50MWe

Andasol 1: Power Block and Storage

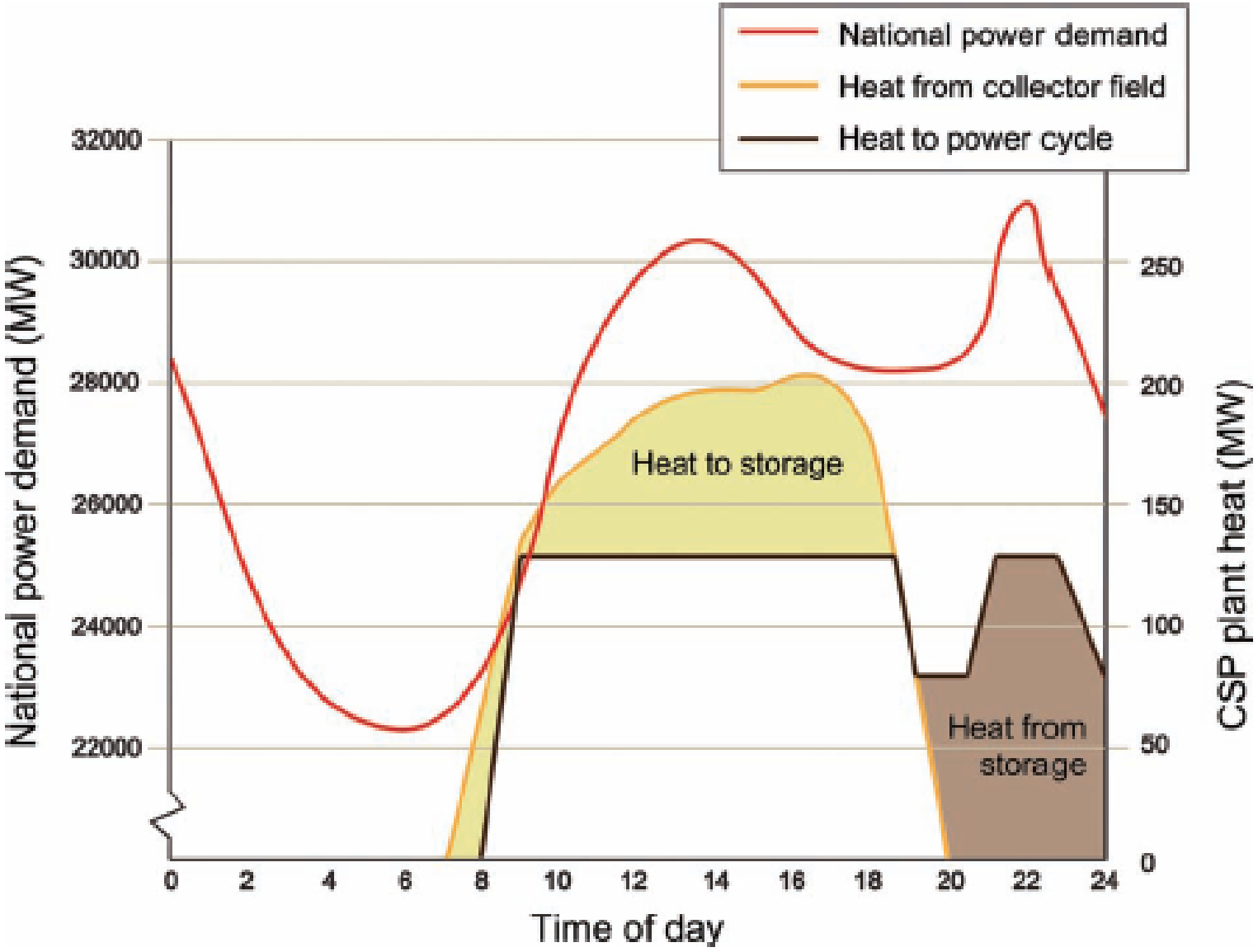
2 tanks: Ø = 36 m; h = 14 m

28.500 tm of molten salts

7,5 h storage at 50 MW

CSP and dispatchability

Figure 4.2 Extending operating hours of a 50 MWe CSP plant with thermal storage, to follow the demand curve of a normal mid-summer day in Spain. Demand curve derived from RED Electrica de España (2011) and CSP load from computer simulation (https://demanda.ree.es/demandaEng.html)



Central Receiver: Gemasolar

Power: 20 MWe. Storage: 15h at full power

A technological breakthrough: Direct Steam Generation

Environment friendly

Cost reduction (20 %)

Máx. temperature and pressure: 400 ºC and 120 bar.

11 troughs. Opening: 5.76 m; total length: 550 m; Power: 1.8 MW_t

3 Mwe prototype in order to check this technology (CIEMAT, Iberdrola, IDAE, AGECAM, Navarro-Piquer)

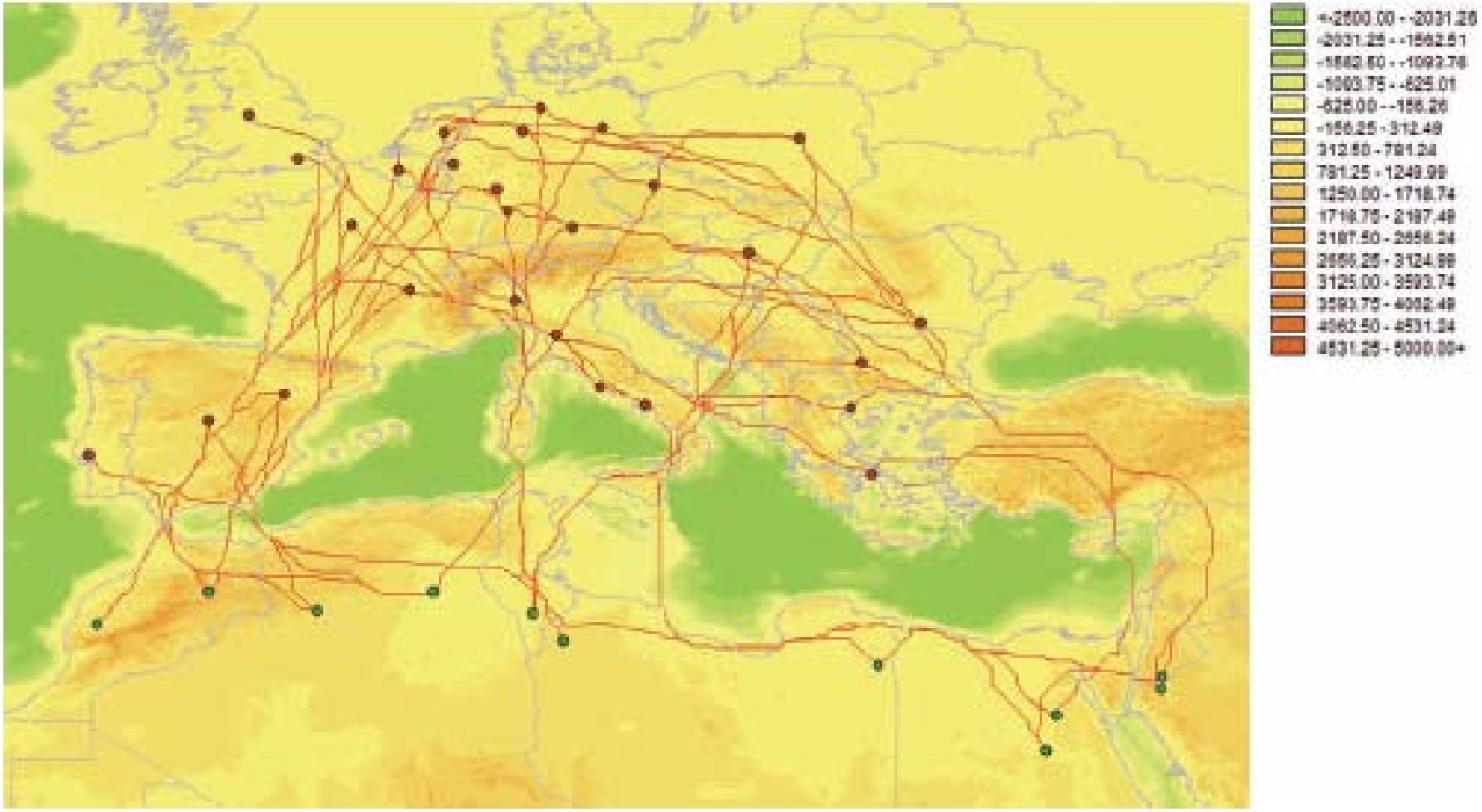
Hopefully completed in 2012

Environmental Applications

- Detoxification plant for pesticide polluted waters in the Almeria greenhouse fields. In operation since June 2004 (ALBAIDA)
- CONSOLIDER Project: TRAGUA (Solar Energy for water treatment)
- AQUACAT: Egypt, Tunisia, Morocco
- VII FP projects: SOLWATERGY (Integration of CSP and Desalination at the Mediterranean Area), Spain, France, Germany, Switzerland, Egypt, Algeria

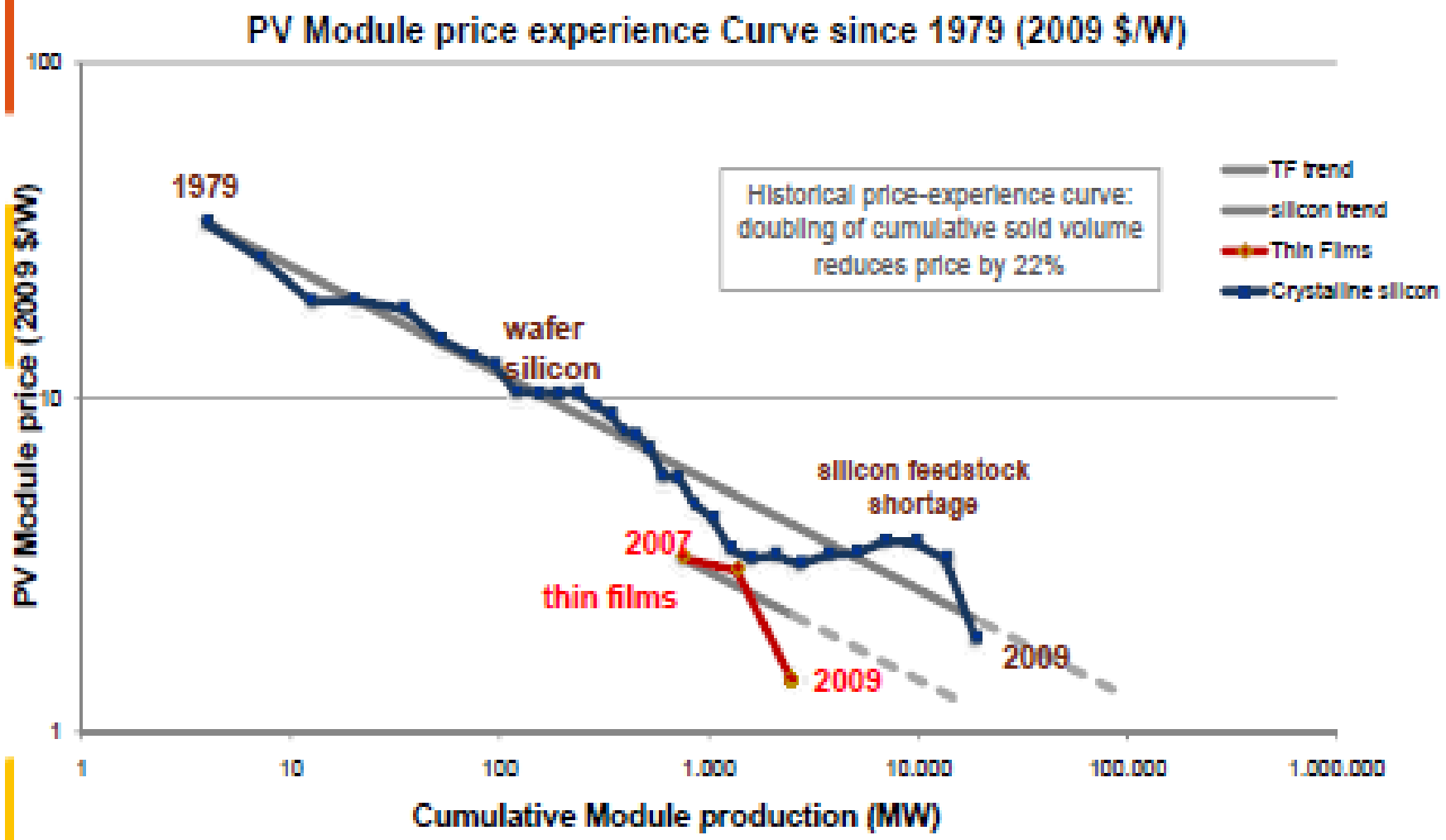
MENA-Europe Complementarity

Figure 7.3 Exploration of potential transmission routes for HVDC lines connecting CSP plants in the MENA region to demand centres in Europe (DLR, 2009). The background map shows the elevation in metres above/below sea level.



The Desertec and the Mediterranean Solar Projects

PV: the learning curve



The global PV market

All these elements tend to estimate the global market to be most likely between 14.3 and 16.5 GW in 2010, with a reasonable probability of a market size around 15.5 GW based on recent mid-February information.

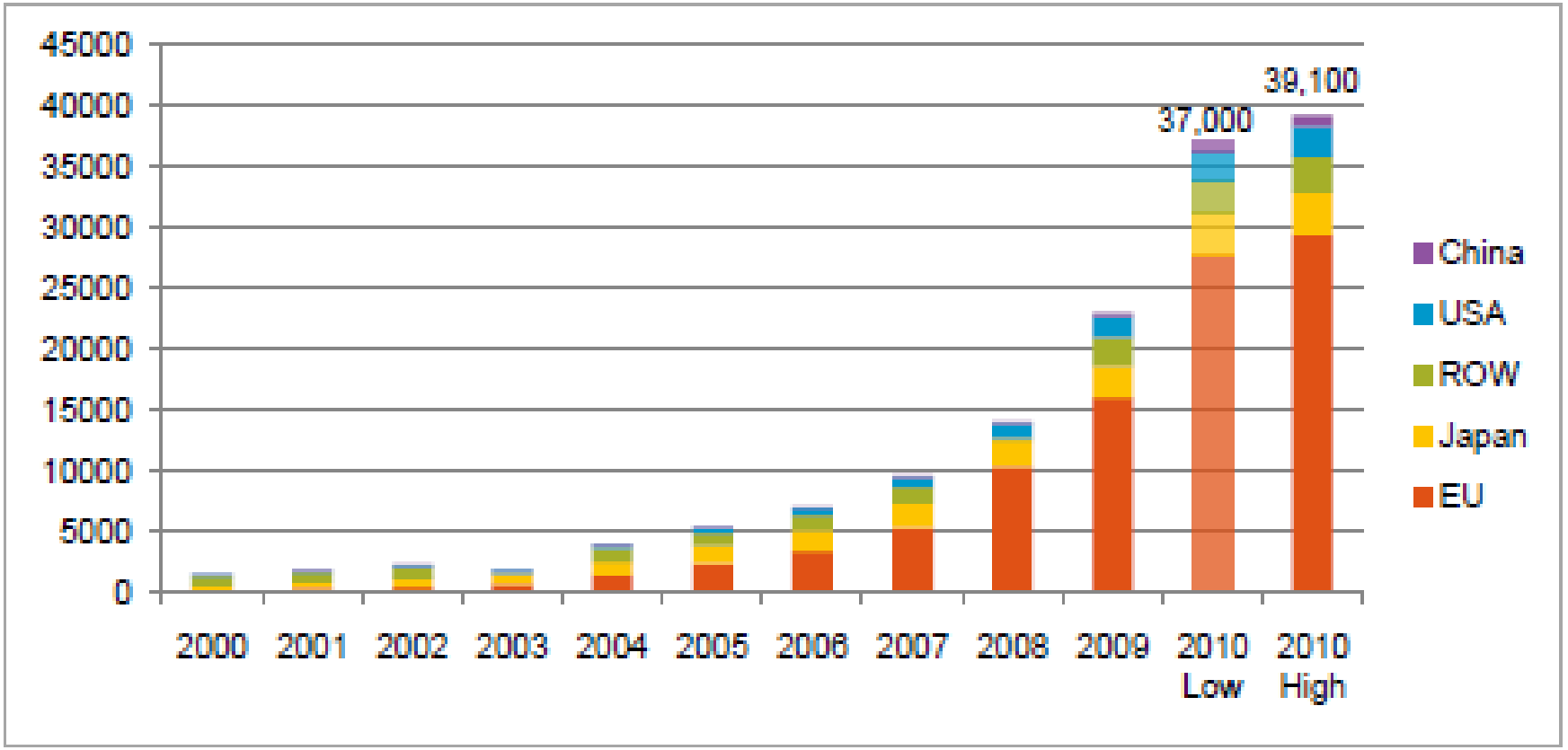
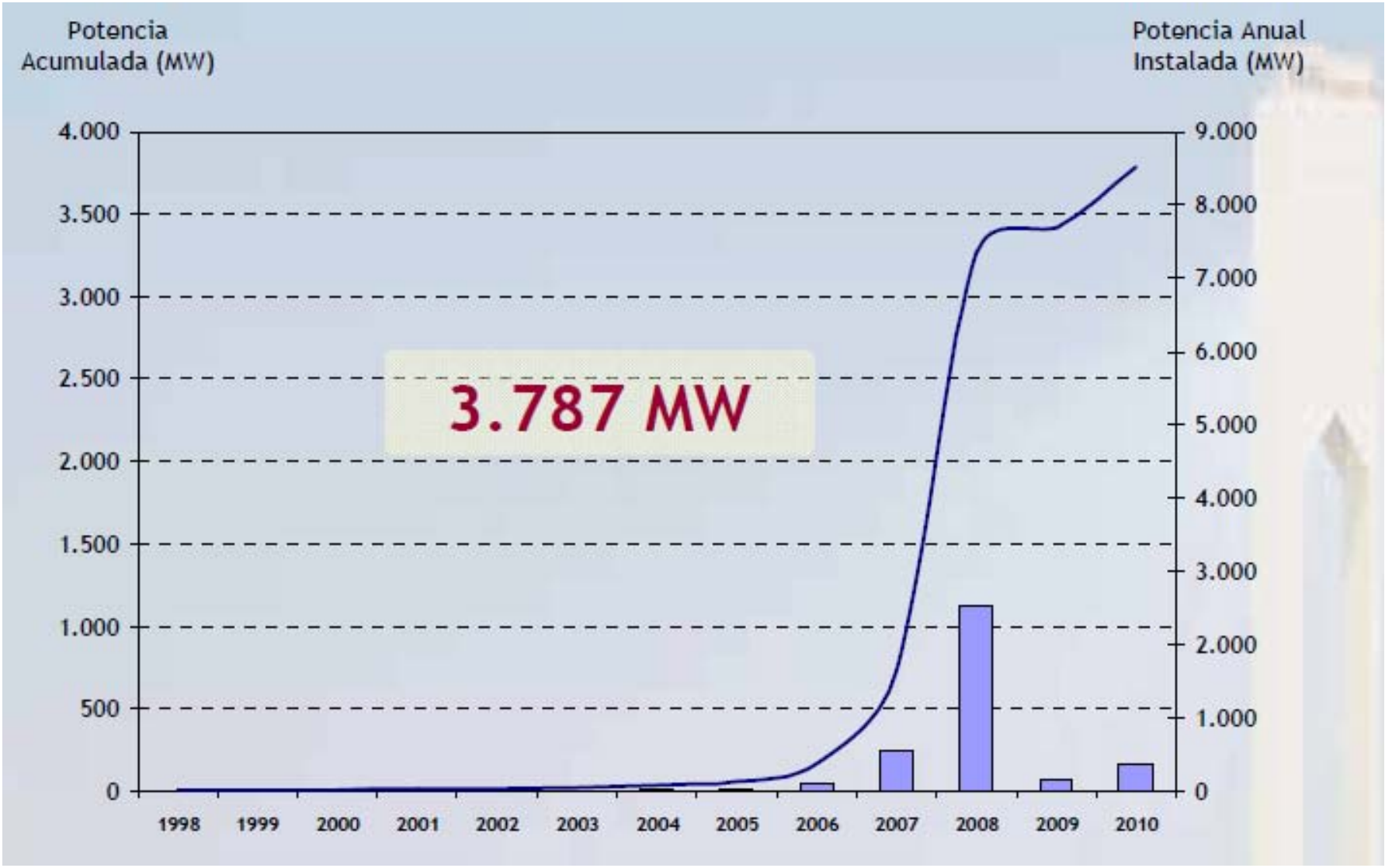


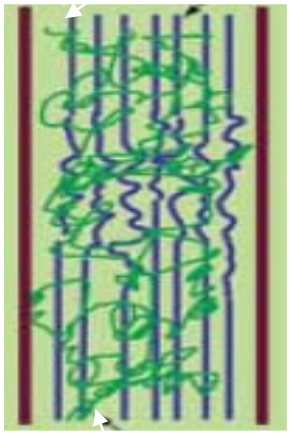
Figure 2: Evolution of global cumulative installed capacity worldwide (in MW)

EPIA, Market Outlook, 2010

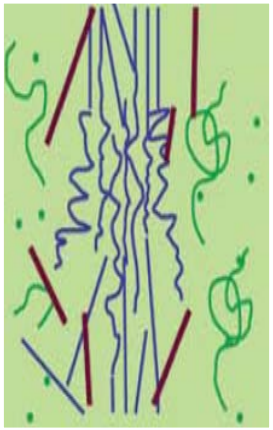
The PV installed power



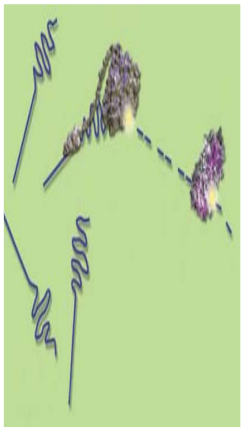
Ethanol from cellulosic biomass



Pretreatment

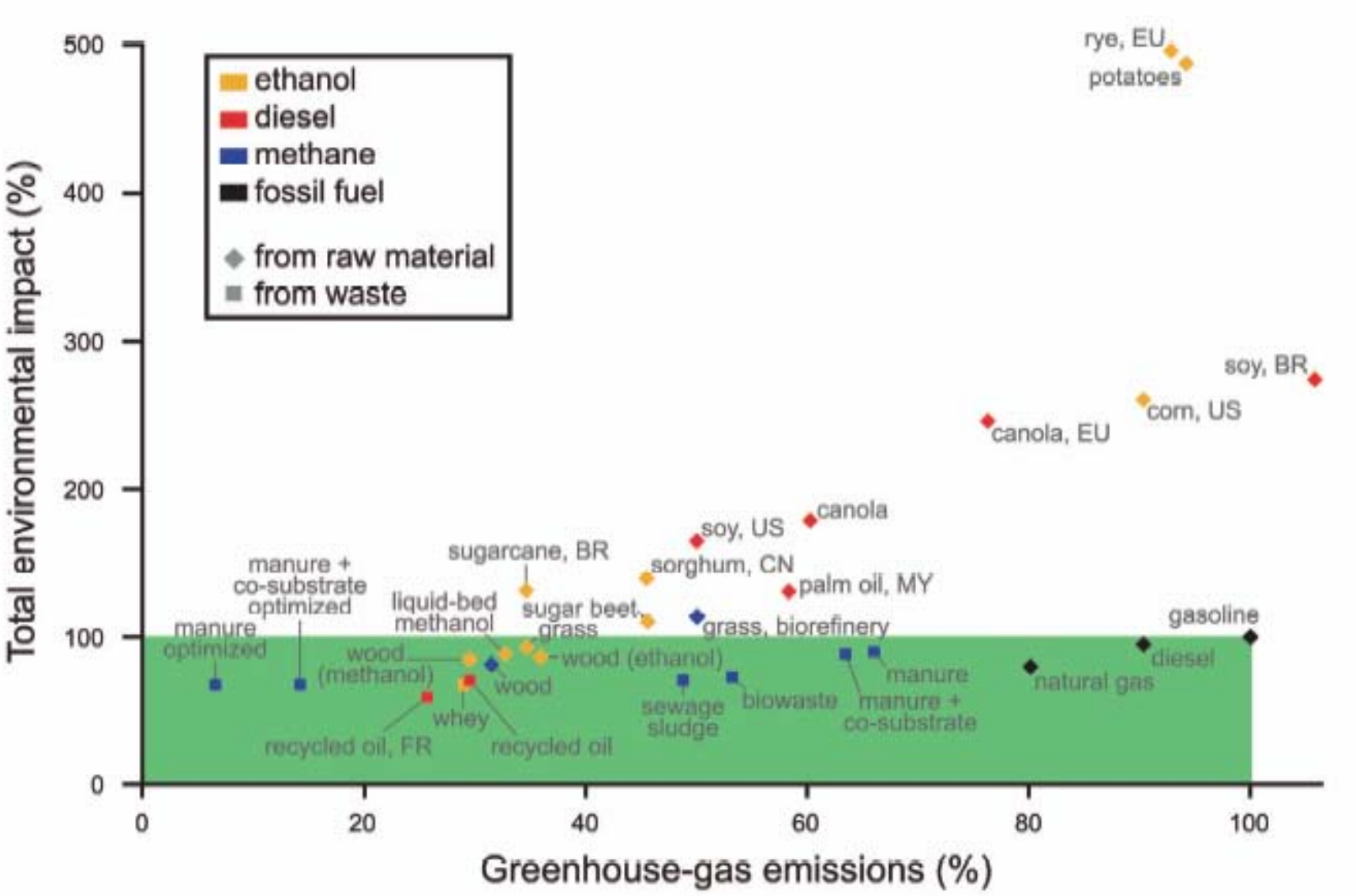


Enzymatic Hydrolisis



Fermentation

Biofuels vs. Fossil fuels



R. Zah *et al*., *Ökobilanz von Energieprodukten: Ökologische Bewertung von Biotreibstoffen* (Empa, St. Gallen, Switzerland, 2007).

Pilot Plant at L'Alcudia (Valencia)

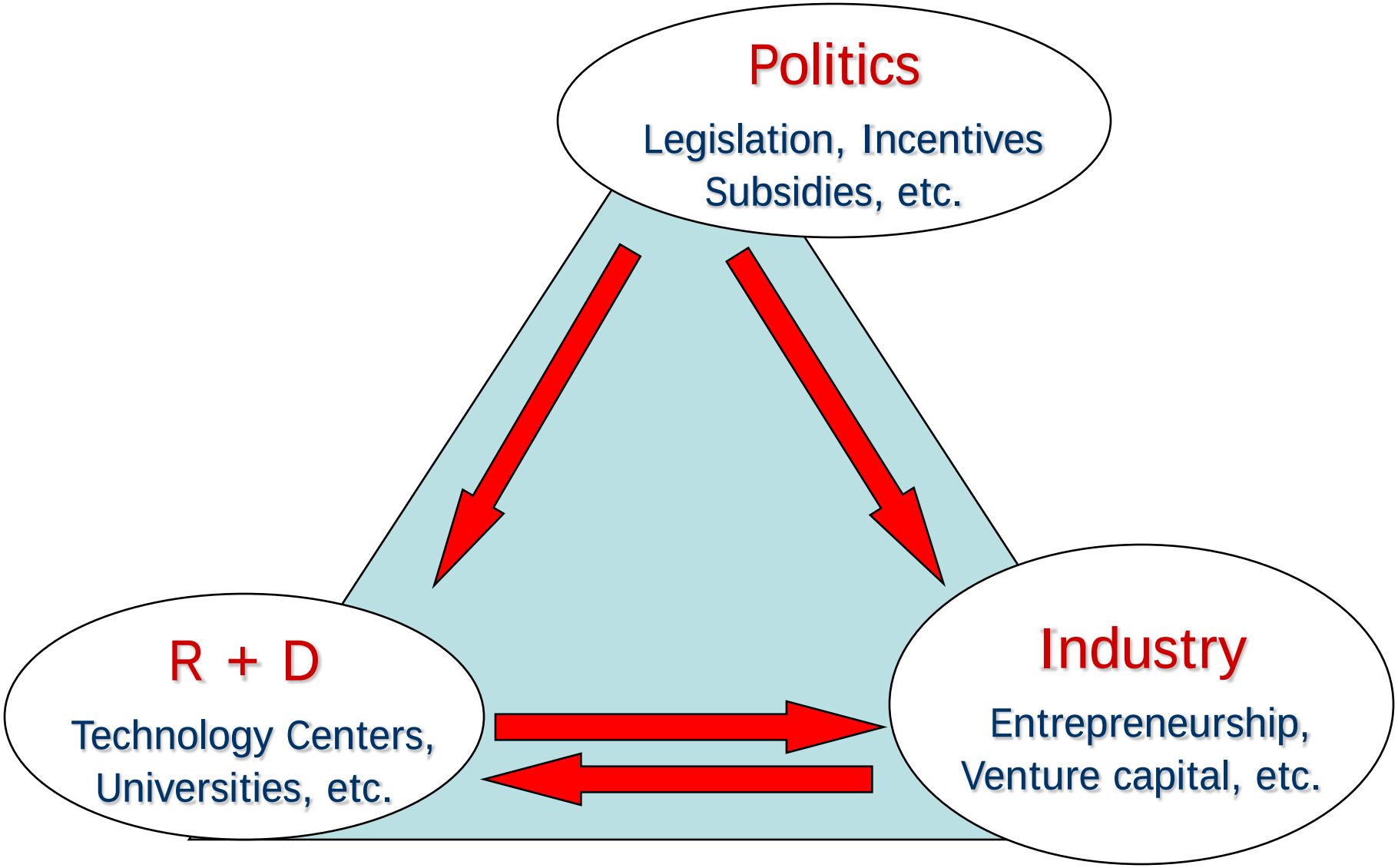
Agreement with IMECAL and Ford to explore the CIEMAT technology

Diluted Acidic Hydrolisis

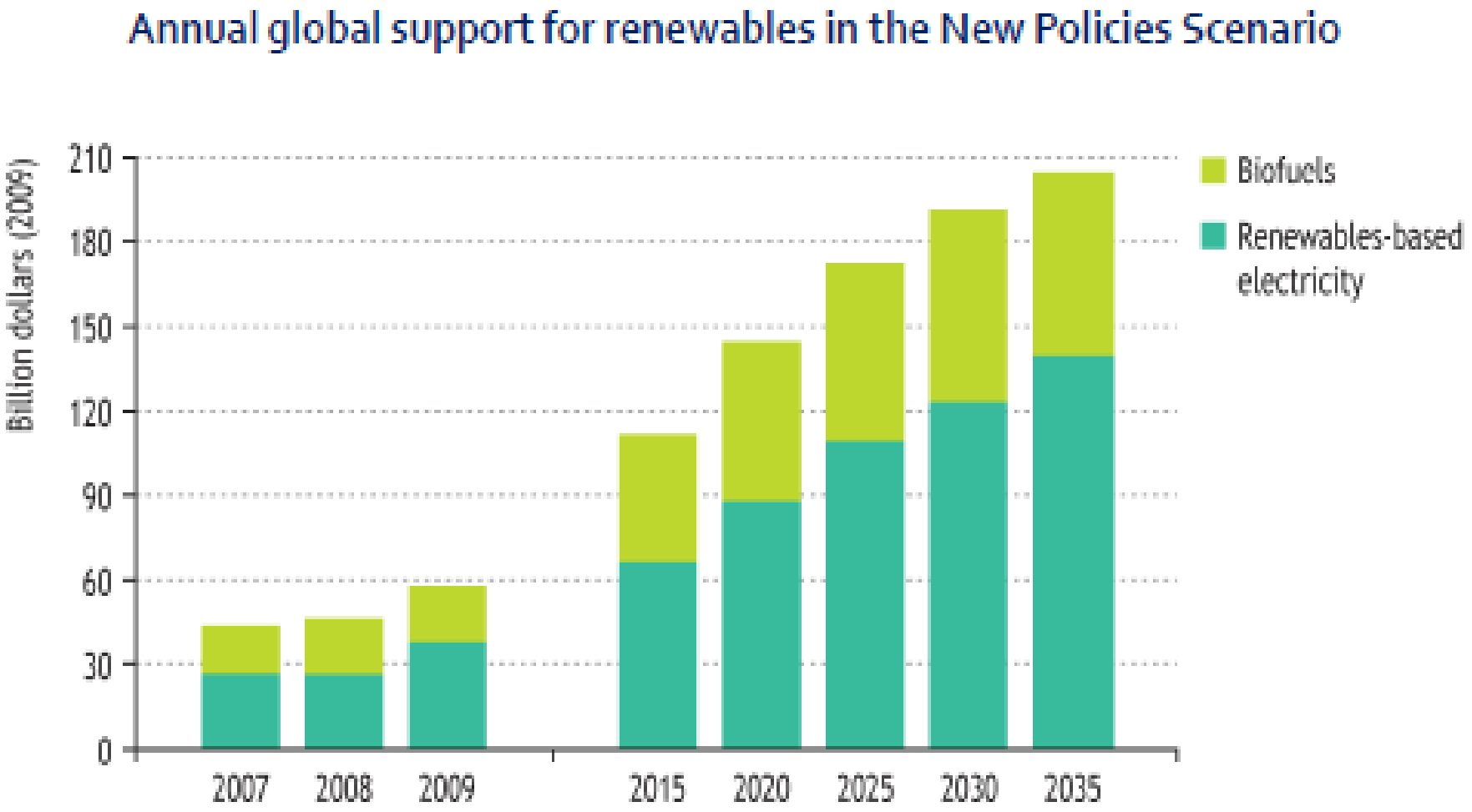
Urban and Agriculture Organic Waste

70 Tons/day

Conditions for the renewables deployment



Support for renewables



Some conclusions

We have to face a (near) future of energetic and environmental difficulties

The main goal has to be:

Decrease the dependency on carbon based energy sources

Increase renewables and (keep?) nuclear

Trigger a drastic change in our energy use habits

In the short term, clean energy is more expensive. So, public support and public education are needed

Move towards common regulation, a more extended and stronger grid in Europe. Increase the transnational connexions. An european grid manager?

Deal with the other side of unsustainability: the public attitude in energy matters. Conflict between energy demand requirements and social response to energy related installations, HV lines, etc.


CENTRO DE INVESTIGACIONES ENERGETICAS MEDIOAMBIENTALES Y TECNOLOGICAS

Thank you !!!