

Seminar on the Hydrocarbon Age

May 8th., 2006.

Energy in Spain: Renewables, opportunities and threats

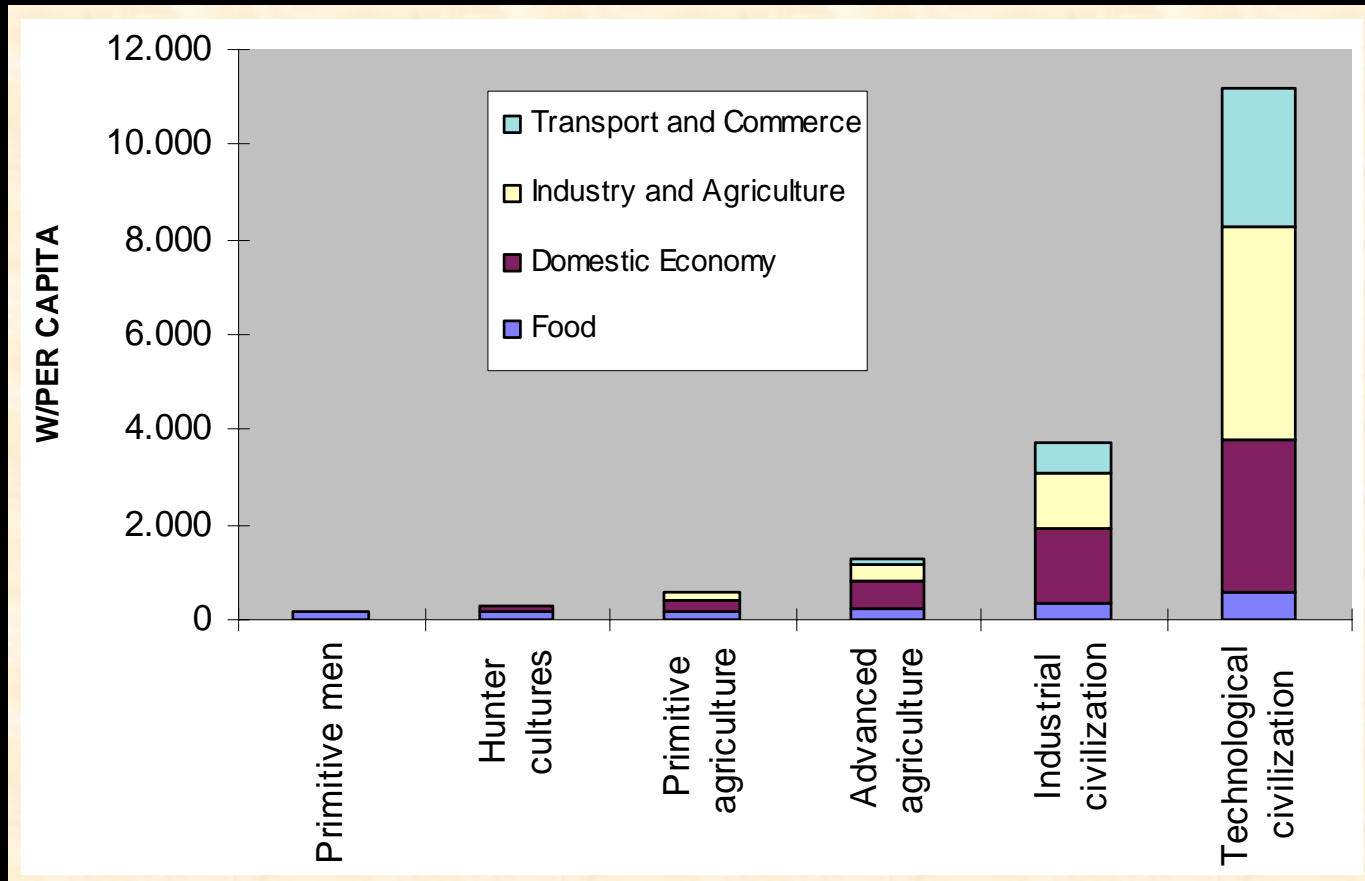
Pedro A. Prieto
ASPO-Spain/Crisis Energética
Vicepresident AEREN



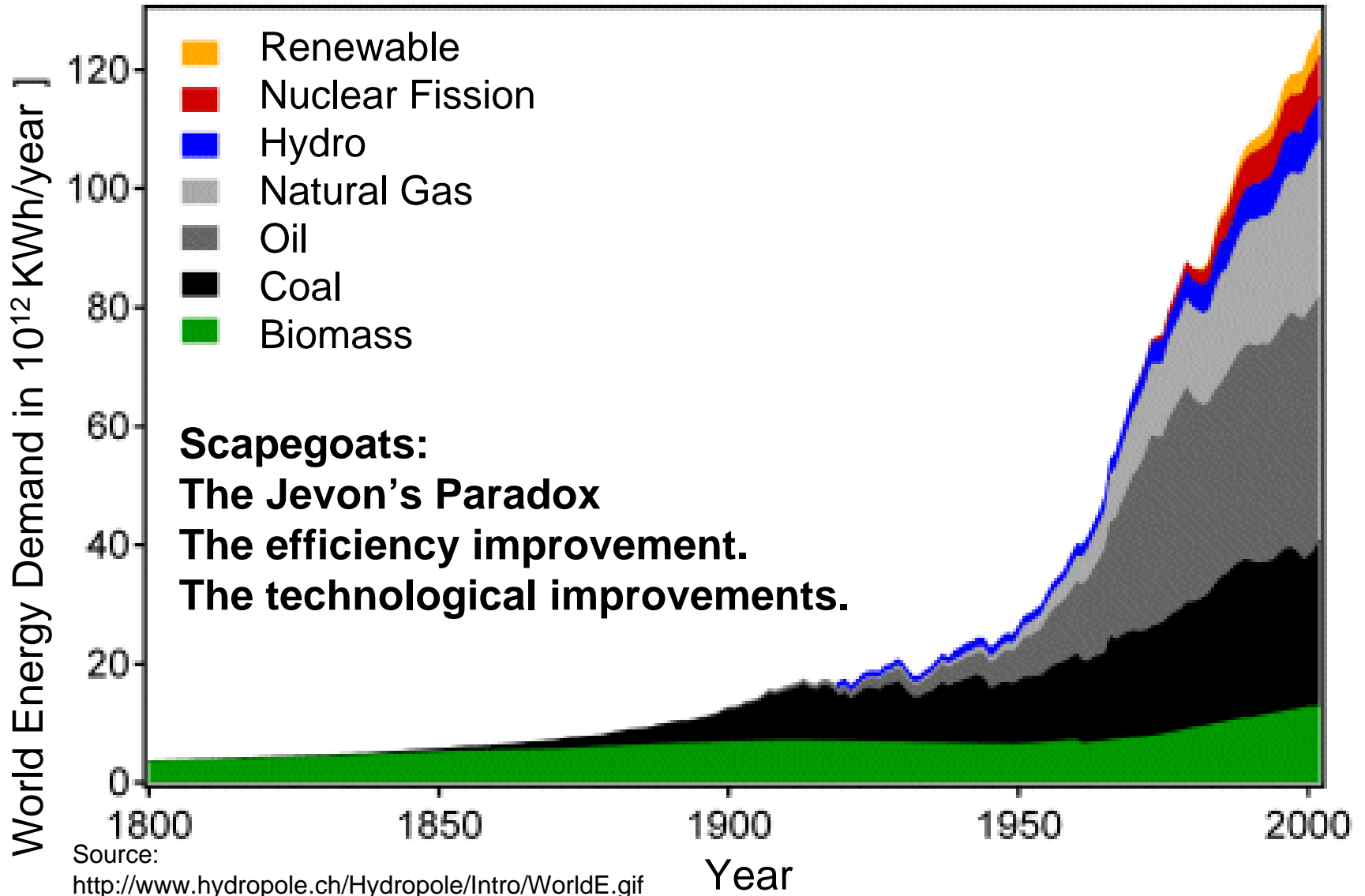


A general overview of basic energy concepts frequently missed

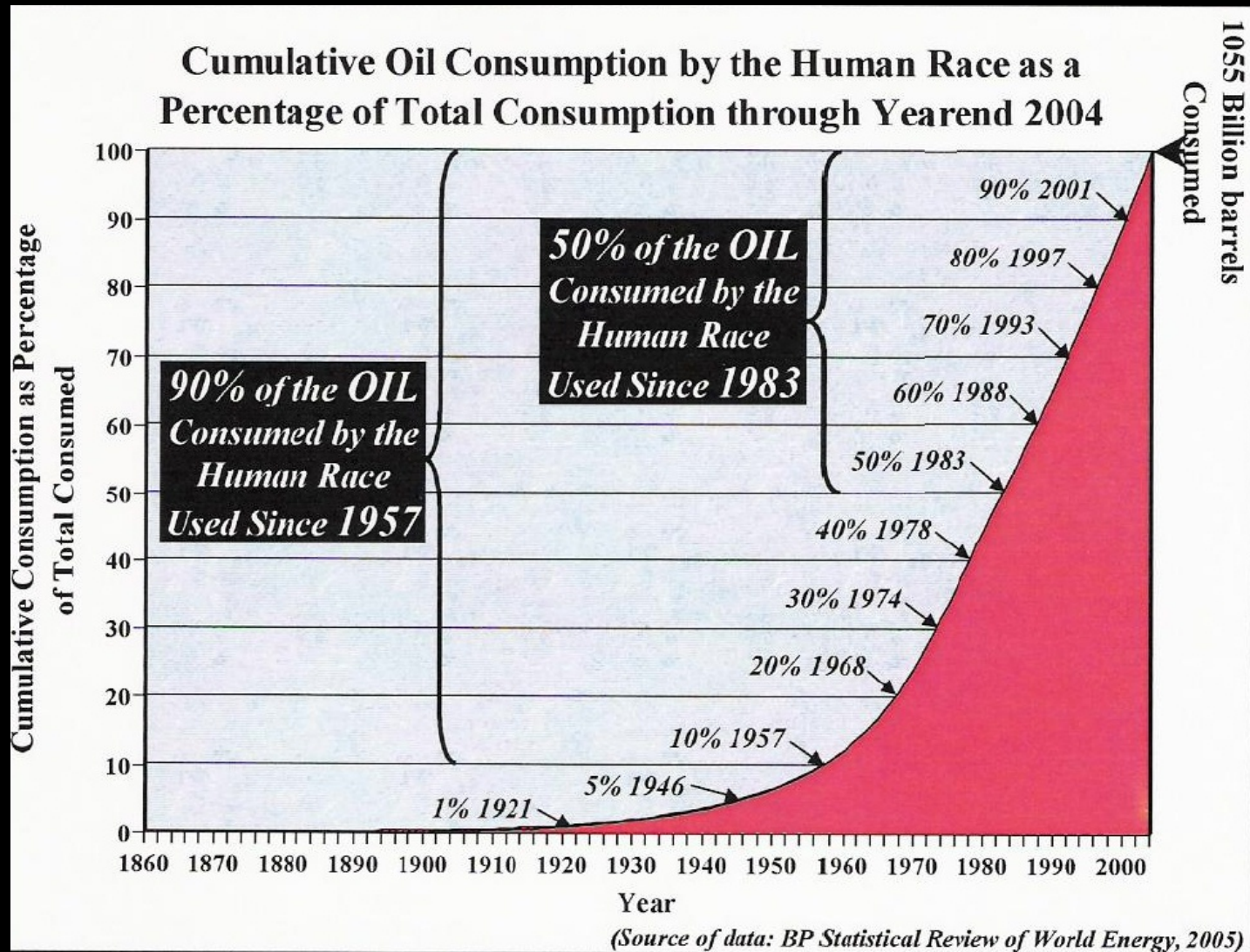
The Energy Consumption in the Different Cultures



The unstoppable growth of energy consumption...



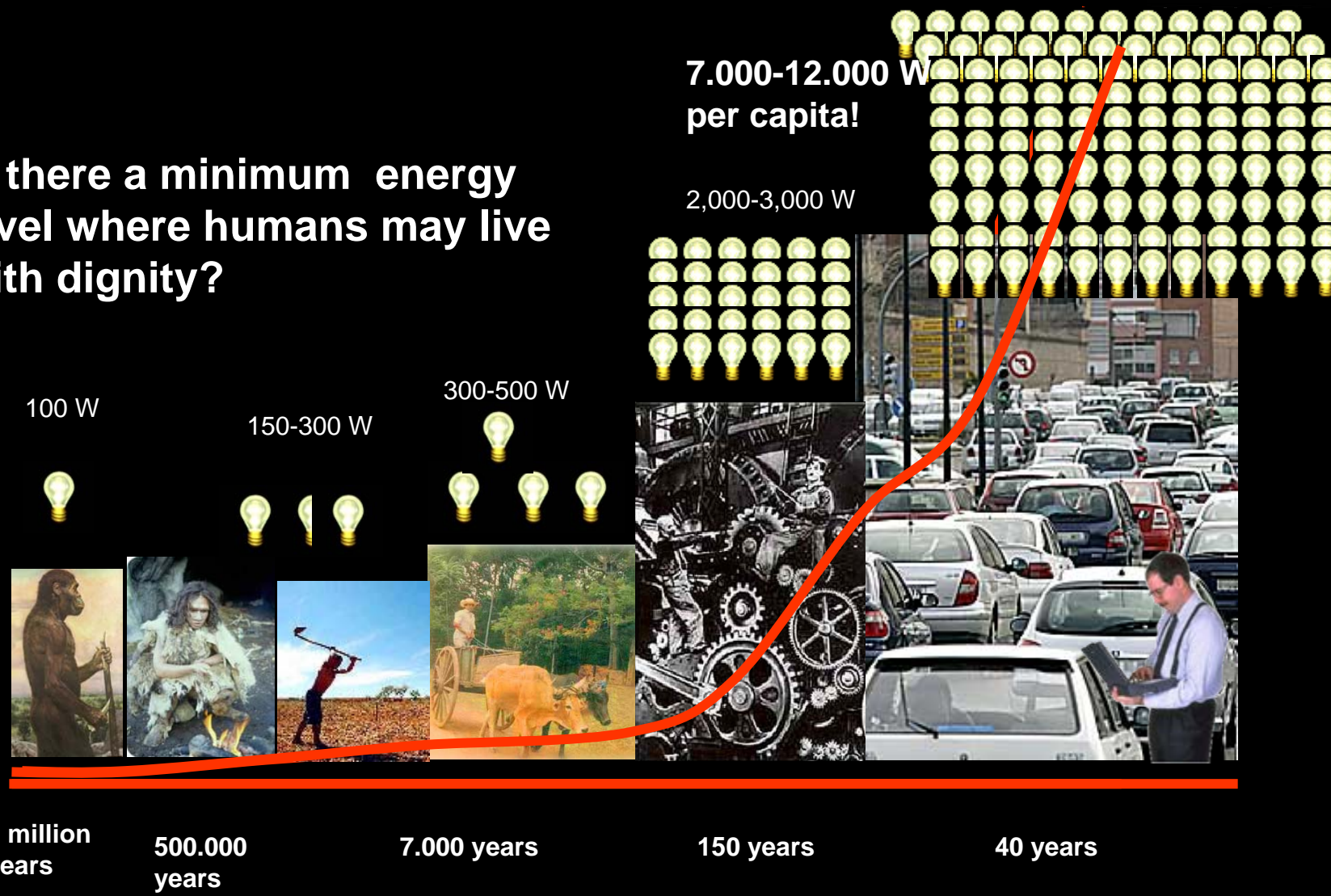
An unsustainable pattern...



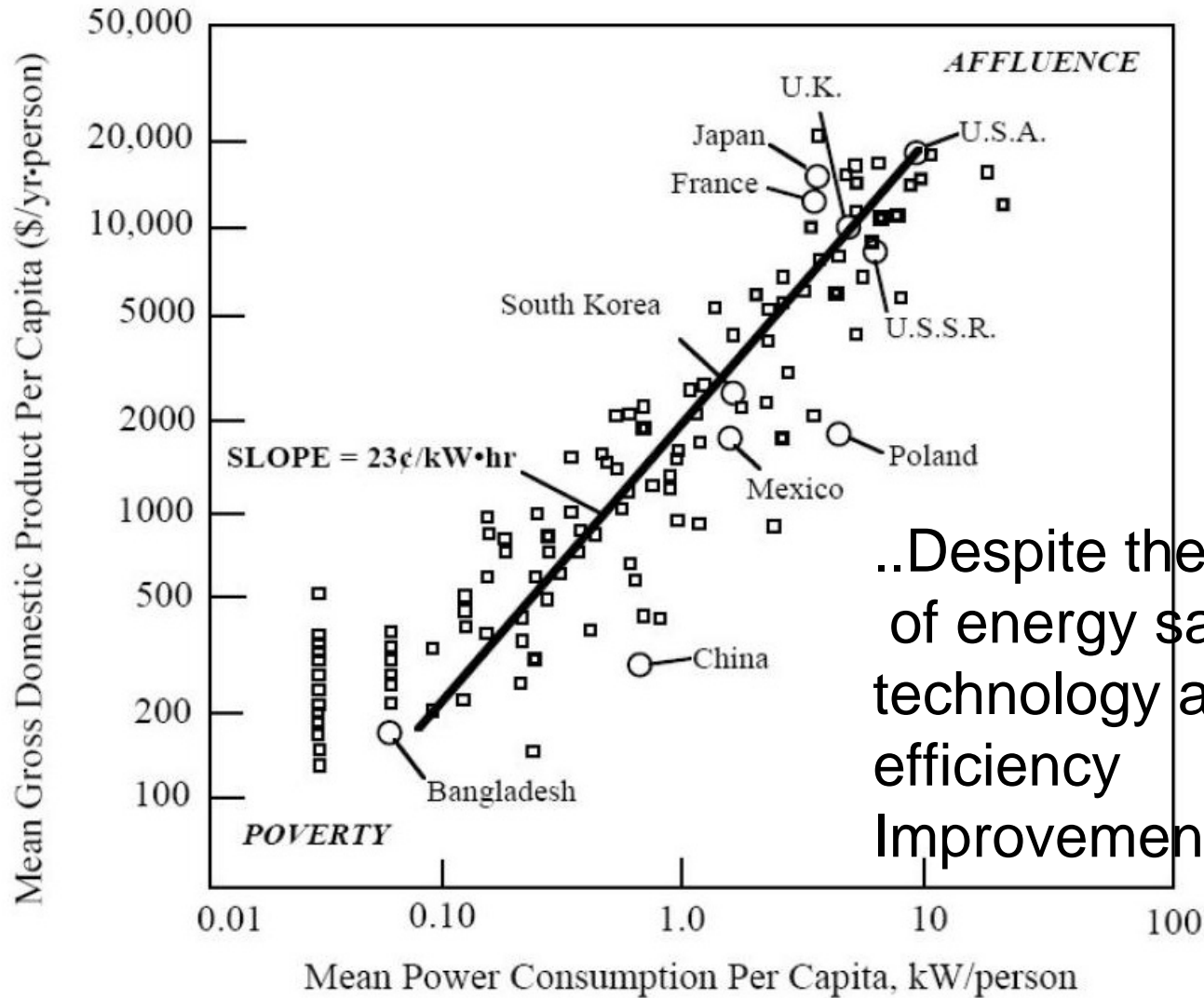
Speeding up



Is there a minimum energy level where humans may live with dignity?



Direct Relation between energy and economic growth

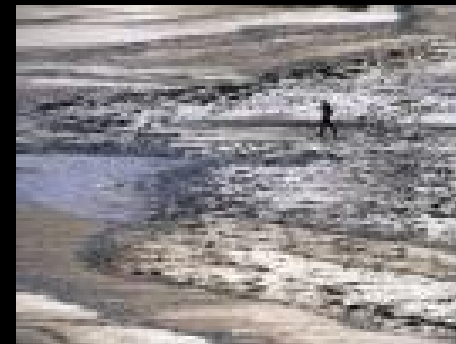


..Despite the myths of energy savings, technology and efficiency Improvements.

The Global Oil Production and Consumption



- Every year 4,500 king-sized football stadiums (1 Hm³) of oil are burnt. Or 50,000 Prestiges



The Global Coal Production and Consumption



- Every year 2,300 football stadiums of coal are burnt.
Unas 5.538 Mtons



The Global Gas Production and Consumption



- Every year 2.4 million football stadiums at atmospheric pressure are burnt



The Global Nuclear Production and Consumption

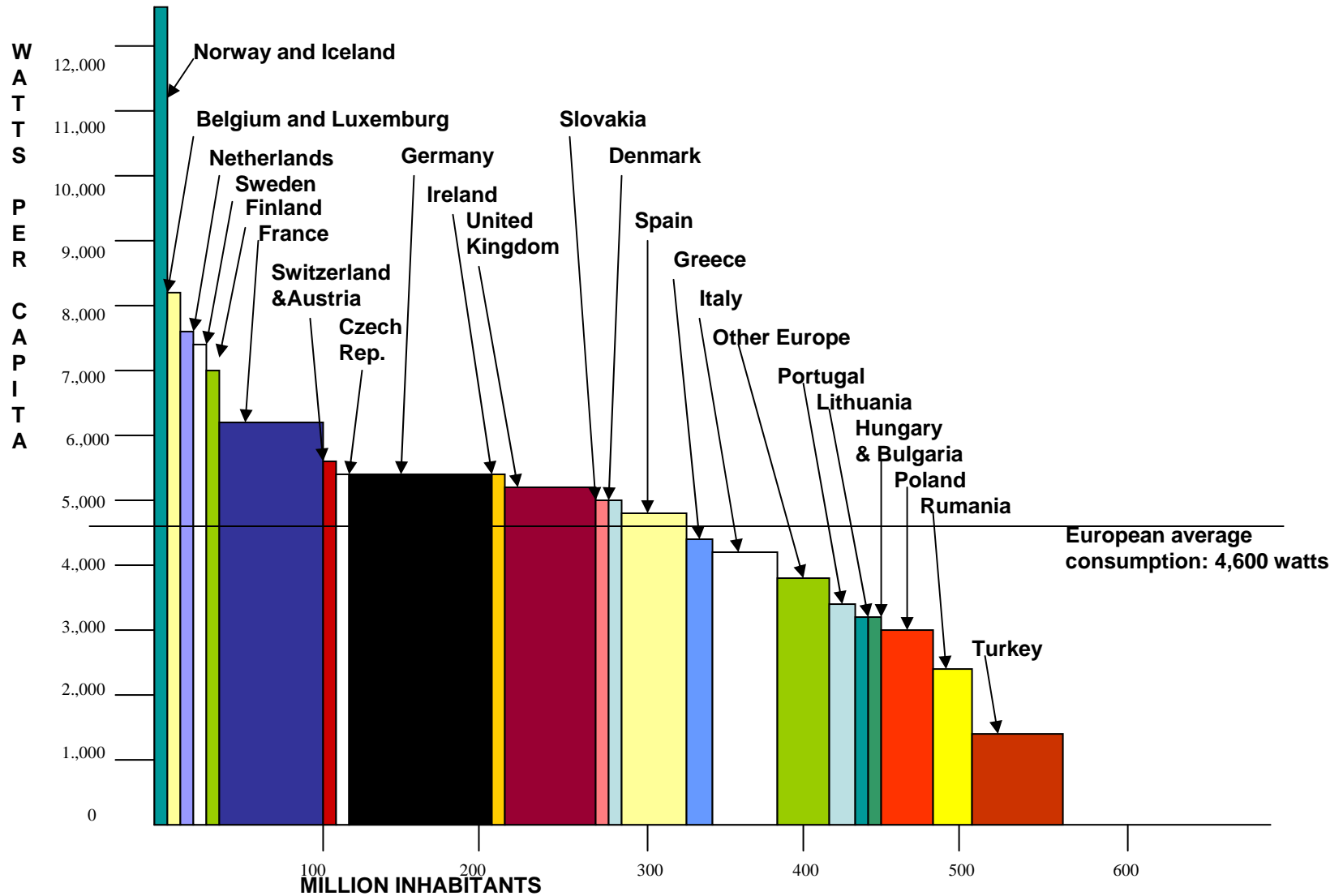


- 440 nuclear power plants in operation
 - Uranium yearly production: 32,000 Tons
 - 6% contribution to the primary energy consumption
 - 88,000 tons of radioactive waste/year (2% high level)
 - R/P ratio is now about 60 years at 130 US\$/kg
 - 3.3 Million tons of reasonably assured reserves
- THE PLAN OF PATRICK MOORE, FOUNDER OF GREENPEACE**
- 1.700 nuclear power plants in 30 years
 - 1 new 1 GW nuclear power plant per week
 - 400 human groups in the build up
 - 238,000 tons of uranium required
 - 48 Yucca Mountains required
 - Proven reserves to last less than the construction time
 - CO2 emissions bigger than what created with gas, if mining of less than 0.02% is to be practiced



**Loyola de Palacio
mentions 4,000
new plants!!**

Uneven distribution of European primary energy

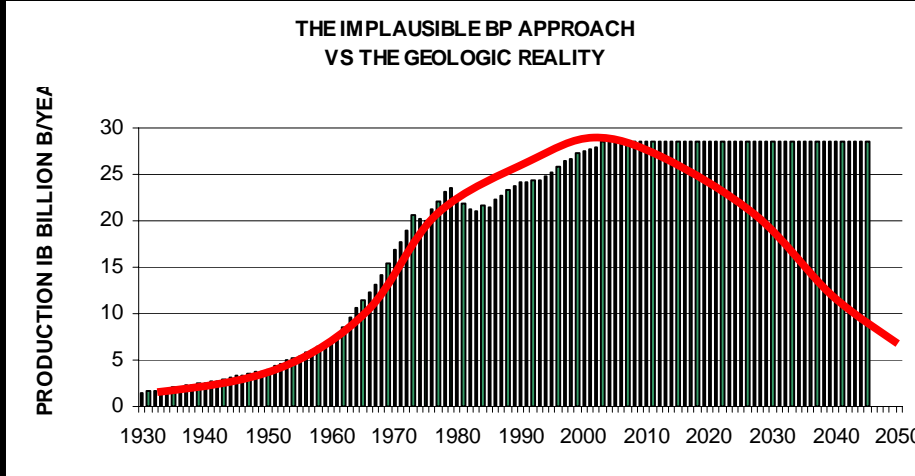


Source: British Petroleum. Statistics 2003.

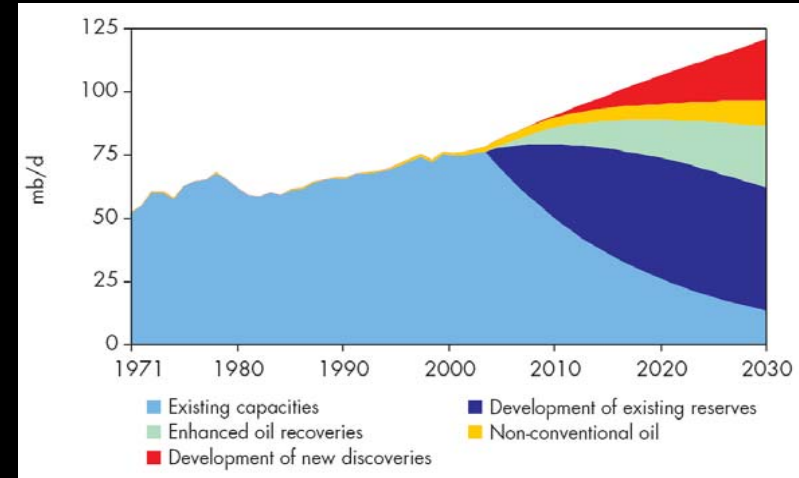
The Growing Gap as per the Big Entities



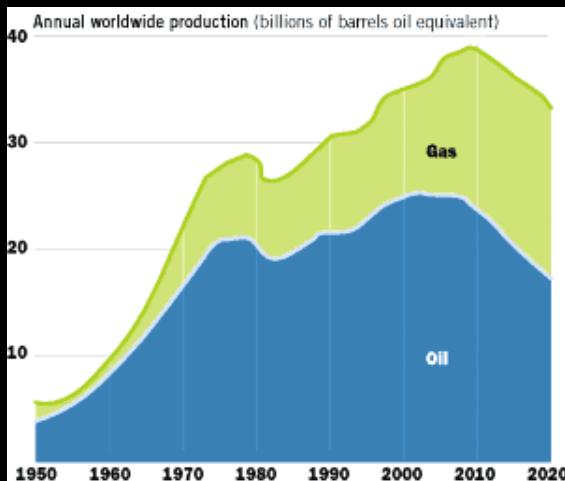
The BP R/P Concept



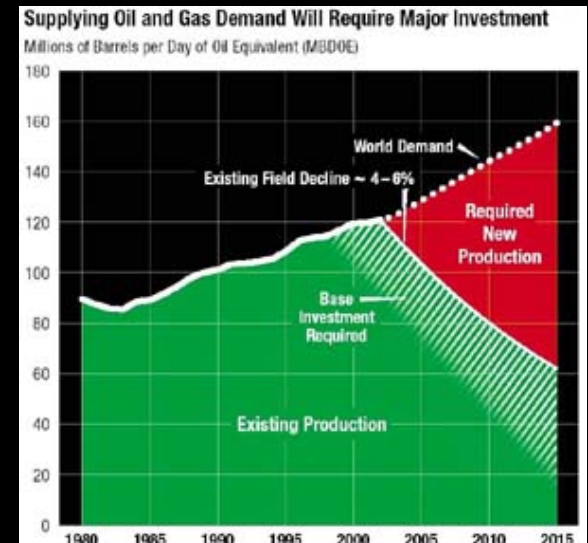
The IEA routes



The ENI vision



The Exxon Mobil "Reds"



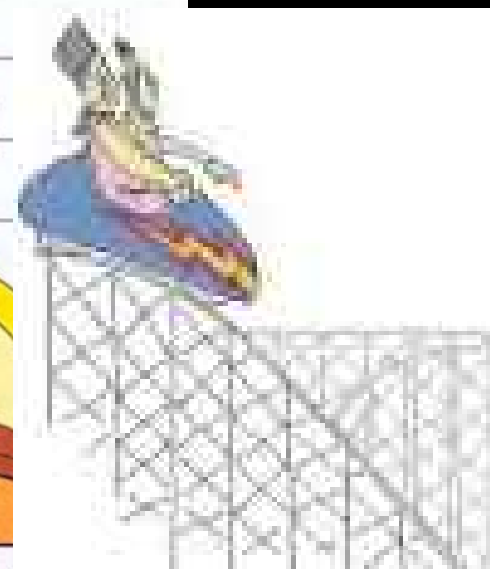
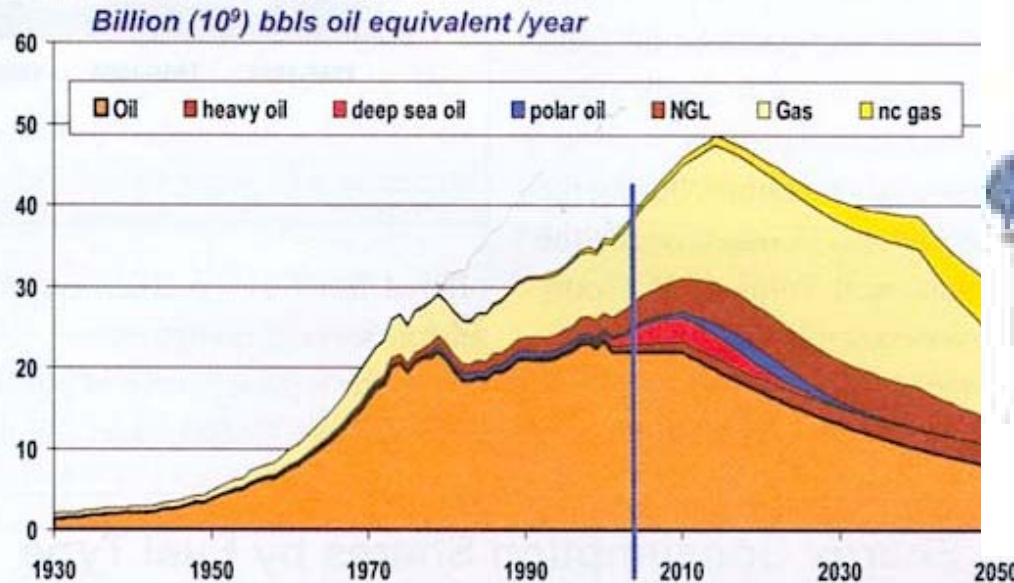
How to tackle the “prosperous way down”?



Repsol YPF

World Total Annual Oil & Gas Production 1930 to 2050(e)

With today's traditional oil declining, future growth in production relies on non conventional oils, oil from difficult areas as deep waters or the Artic, and, significantly on higher gas production



Source: History: BP Statistical Review, BGR. Forecast: Petroconsultants, Petrodata, BGR, Petroleum Economist

June 13th 2005



Basic Energy Questions for Mankind...



- **Where are we?**
- Where do we want to go?
- How to reach there?
- What Time Frame?
- What is sustainability?
- What does it mean minimum energy level, with human dignity?



Where are we?

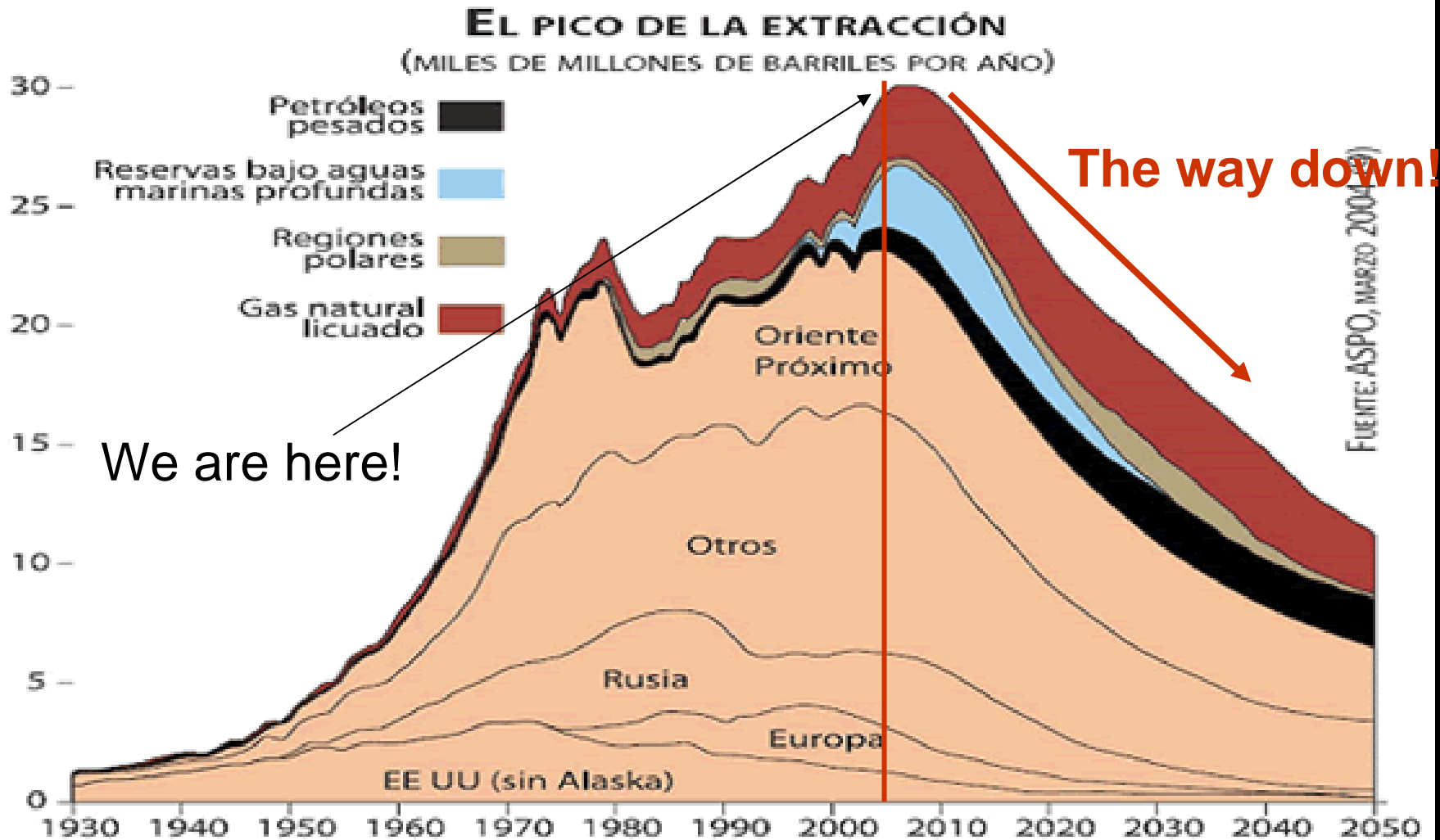
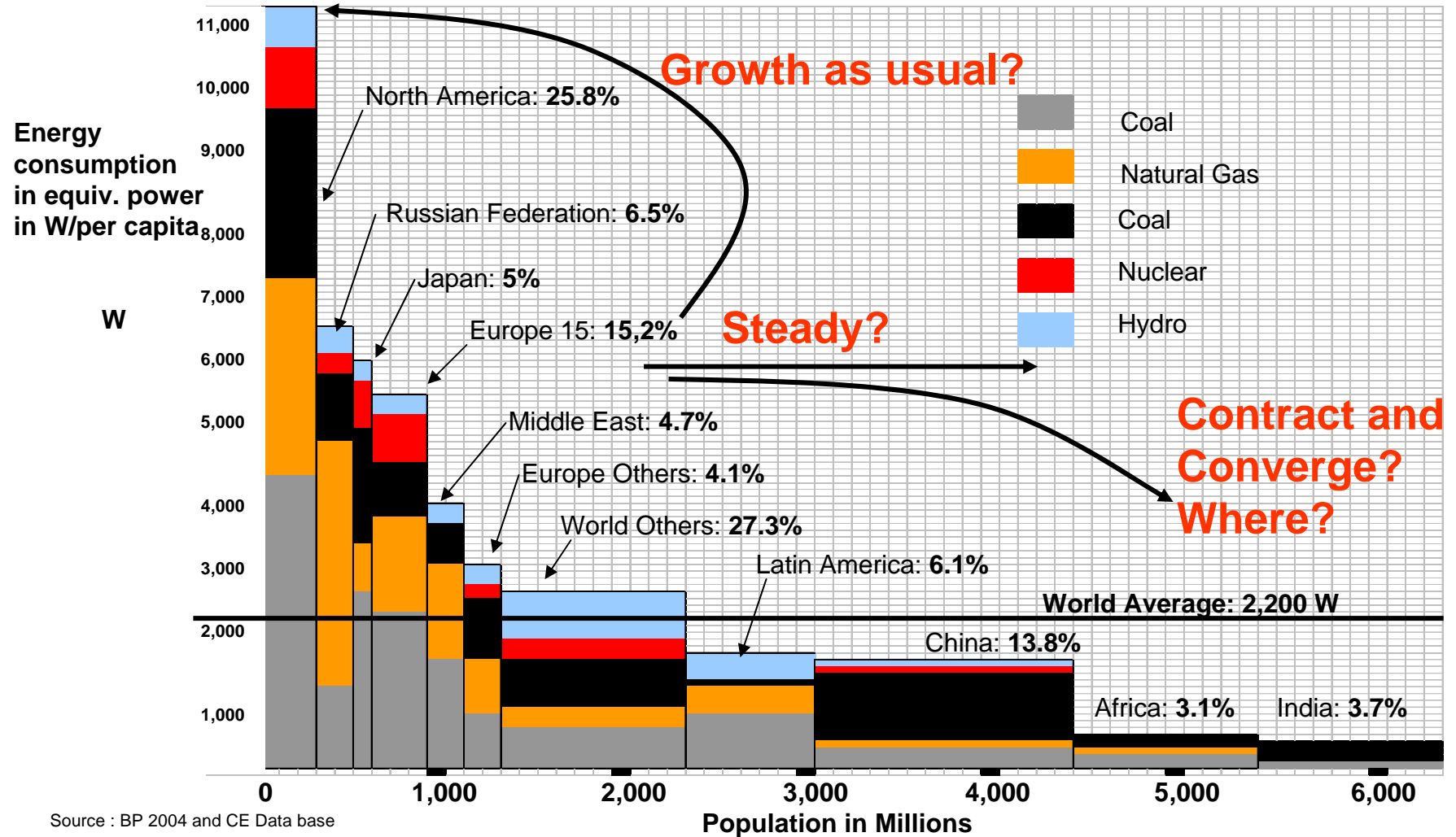


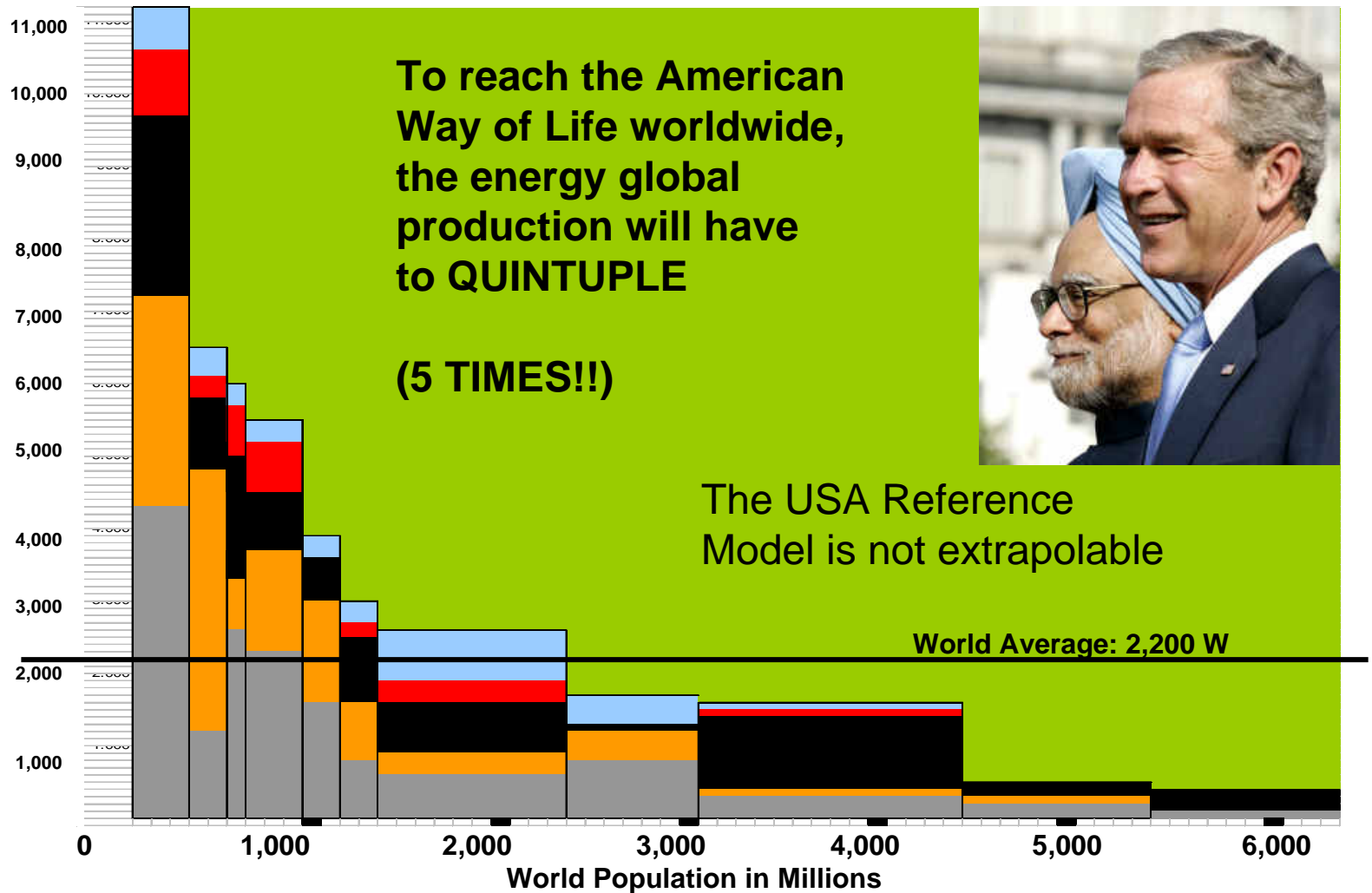
Figura 3: Gráfico de la producción mundial de petróleo según la Asociación para el Estudio del Cenit del Petróleo (ASPO).

Where do we want to go?





Where do we want to go?





Renewable energies:

What can they do
to replace fossil
and nuclear?

Renewability



The sun and the wind are
renewable



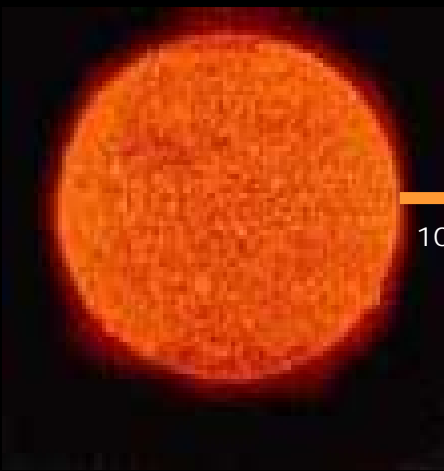
The photovoltaic modules
and the wind generators,
ARE NOT



The energy cycles in Planet Earth



Tines the global consumption
 oOf primary energy
 in % on total solar radiation
 on Earth



10.000/100%

Short wave emmitted
 Long wave refelcted

On seas and oceans
 3.600/36%

On continents
 900/9%

To biomass
 100/1%

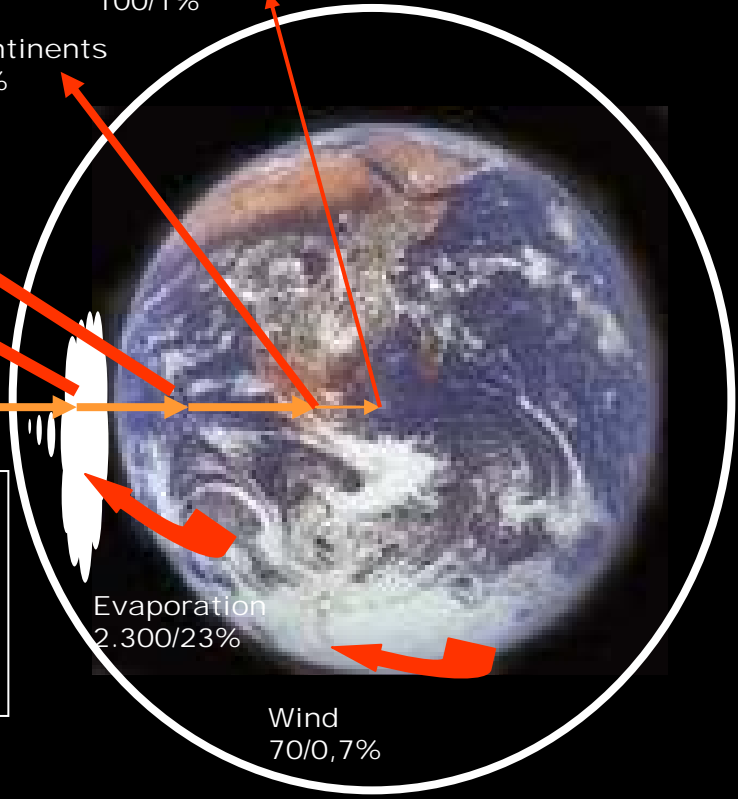
In clouds
 2.300/23%

Atmosphere
 3.100/31%

Waves	10
Tides	10
Rivers	8
Streams	5
Temperature differential	
In oceans	1

Evaporation
 2.300/23%

Wind
 70/0,7%

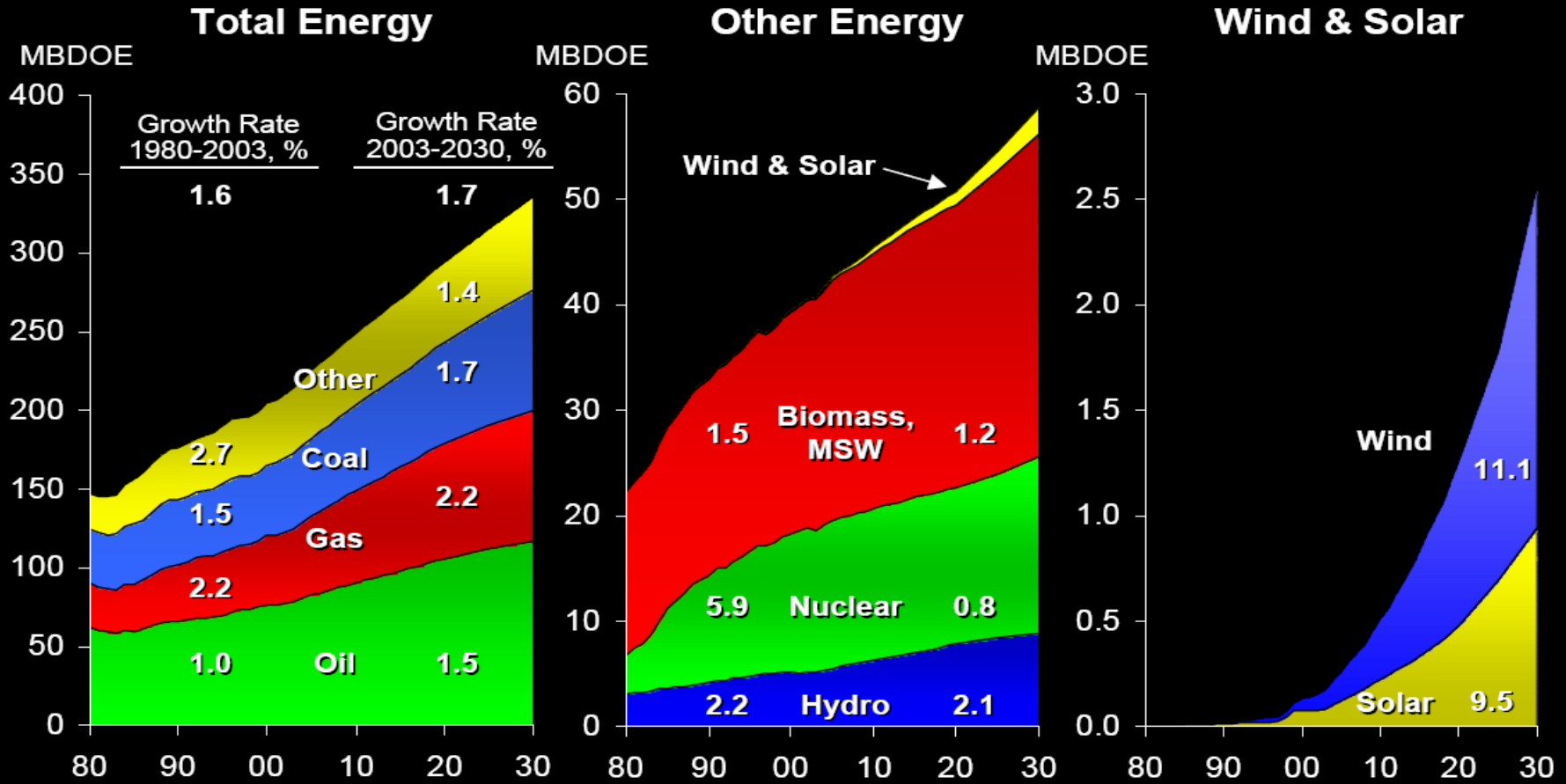


Sources: *The New Enciclopedia Britannica*. Volume 16 Pags. 436-437. 15th Ed. Chicago 1992
 Josep Puig y Joaquim Corominas. "La ruta de la energía" Ed. Anthropos Pag 166 y sig.
 Hermann Scheer "Estrategia solar". Plaza y Janés. 1993. Pags. 123 y sig. British Petroleum. World Statistics 2003

Renewable energies in a global context



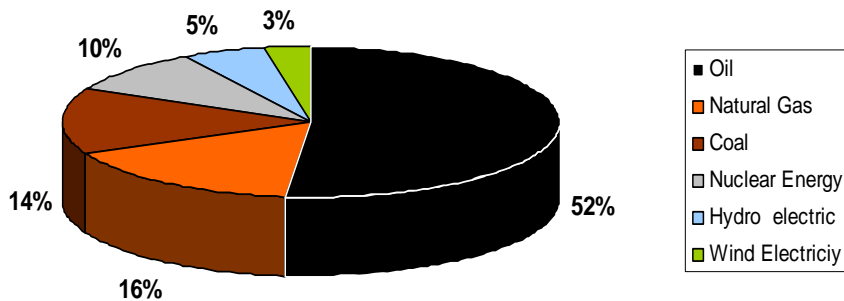
Oil & Gas Remain as Primary Energy Sources



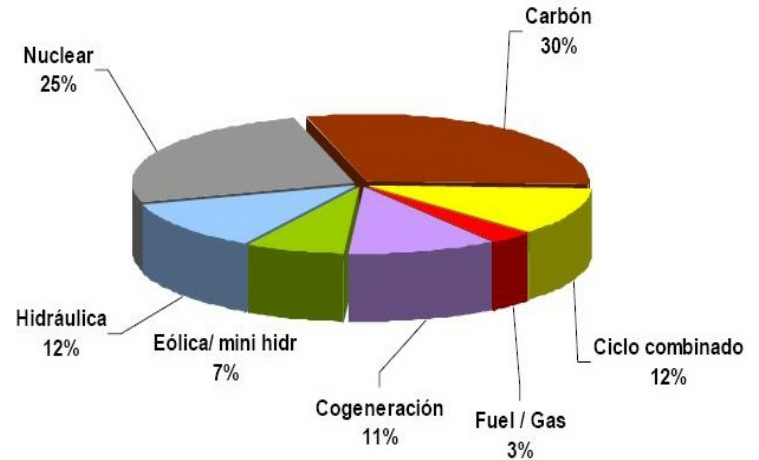


A Case Study for Spain

Primary Energy Consumption in Spain 2004
146 MToes



Estructura de generación por tecnologías. Energía. Año 2004
Electricity Consumption: 250 TWh ~ 20 Mtoes
~14% of Primary Energy at output and ~ 40% at input



The present energy dependence in Spain is 82%, or 92% as uranium is also imported and technologies, spares and enrichment are beyond the national control

Photovoltaic in Spain: Govt. Plans and Support



- **400 MWp (2010). 40 MWp installed base**
- 575% of the prevailing electric tariff, guaranteed for 25 years. Then onwards, 460 %
-
- IDAE non refundable aid 10 for installations up to 100 KWp (limited to 6 M€) (Closed)
- ICO financial aid of up to 80% total project value. 6-7 €/KWp
 - 10- 12 year amortization period (Mid South Spain)
 - Insurance: 1-2 c€/KWh (2-4 % of income)
 - O&M: 3-5 c€/KWh (5-7 % of income)
 - Security: 1 c€/KWh (2% of income)

4th. World producer
4th. world installed base

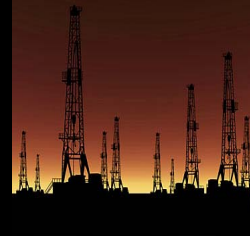
Wind energy in Spain: Govt. Plans and Support



- **Up to 12 GW installed power**
- 90% of electric prevailing tariff for 15 years and 80% onwards
- Premium: 40%
- Incentive: 10%
- About 1,000 €/Kw of installed power
- Decommissioning: 3.5% of total investment
- Load Factor: 27%
- Operating costs: 22%
- Amortization of 3 to 5 years (class 6 wind fields)

2nd. World producer
2nd. world installed base

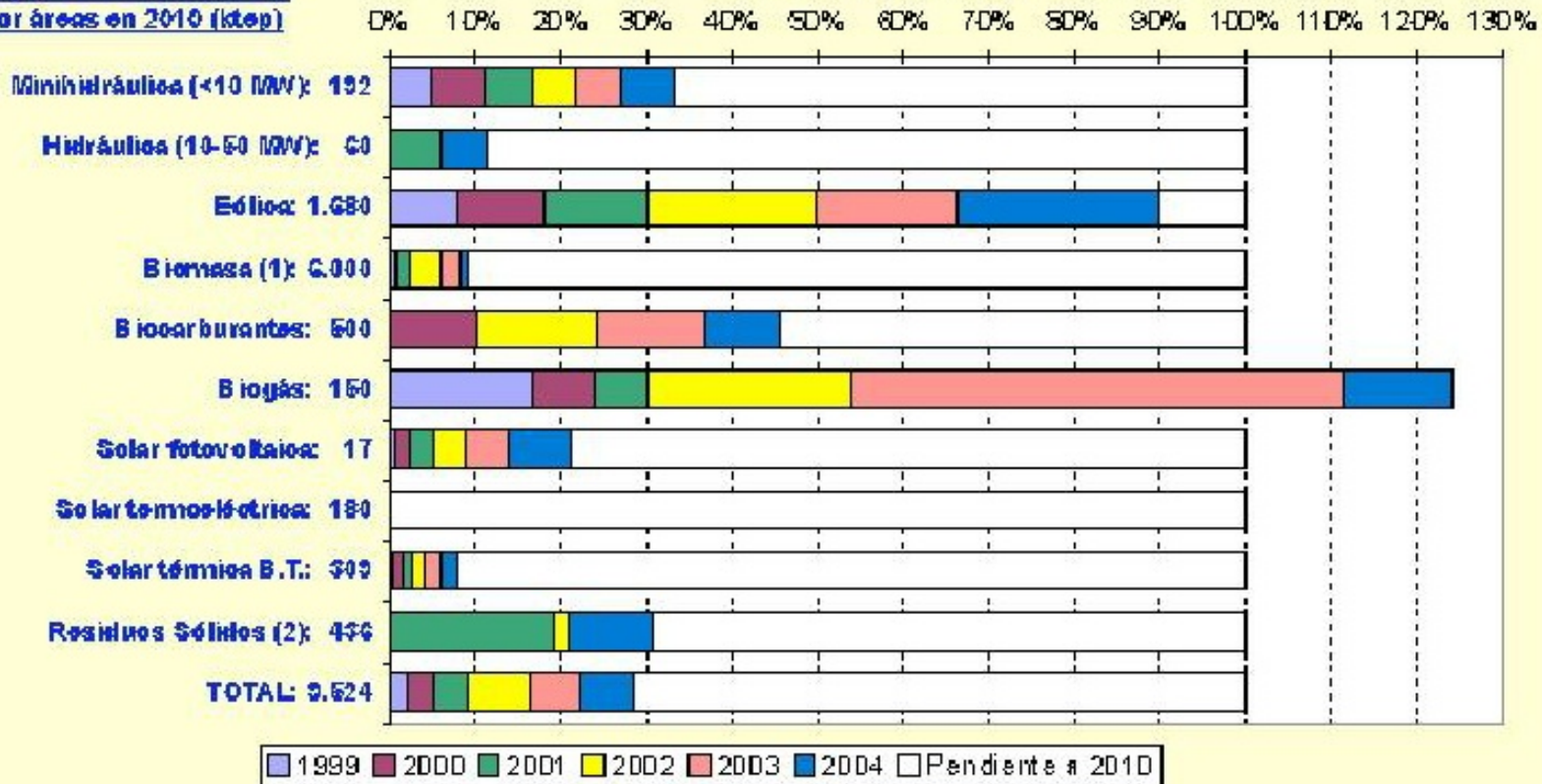
The plans of the Spanish Govt. On Renewable energies (2010)



Seguimiento Plan de Fomento de las Energías Renovables.
 Evolución Datos Energéticos (1999-2004)

Objetivos de incremento
 por áreas en 2010 (ktep)

Sobre objetivos a 2010



Basic Assumptions 1



Let us please almost everybody:

- **Peak oil (Conventional) at 80 Mb/Day in 2010**
- **Peak Gas at 40 Equiv. Mb/Day in 2020**
- **Depletion goes then onwards at geological path (~4%/year for oil and 5%/year for gas) with 25% combined residual base at the end of the period**
- **Economic Growth continues at 2%/Year (BAU)**
- **No big Wars, Conflicts or Disruptions within the period**
- **The considered period is 2006 -2050 as per the last Greenpeace Report Assumptions (Renewables, Spain)**

Basic Assumptions/2



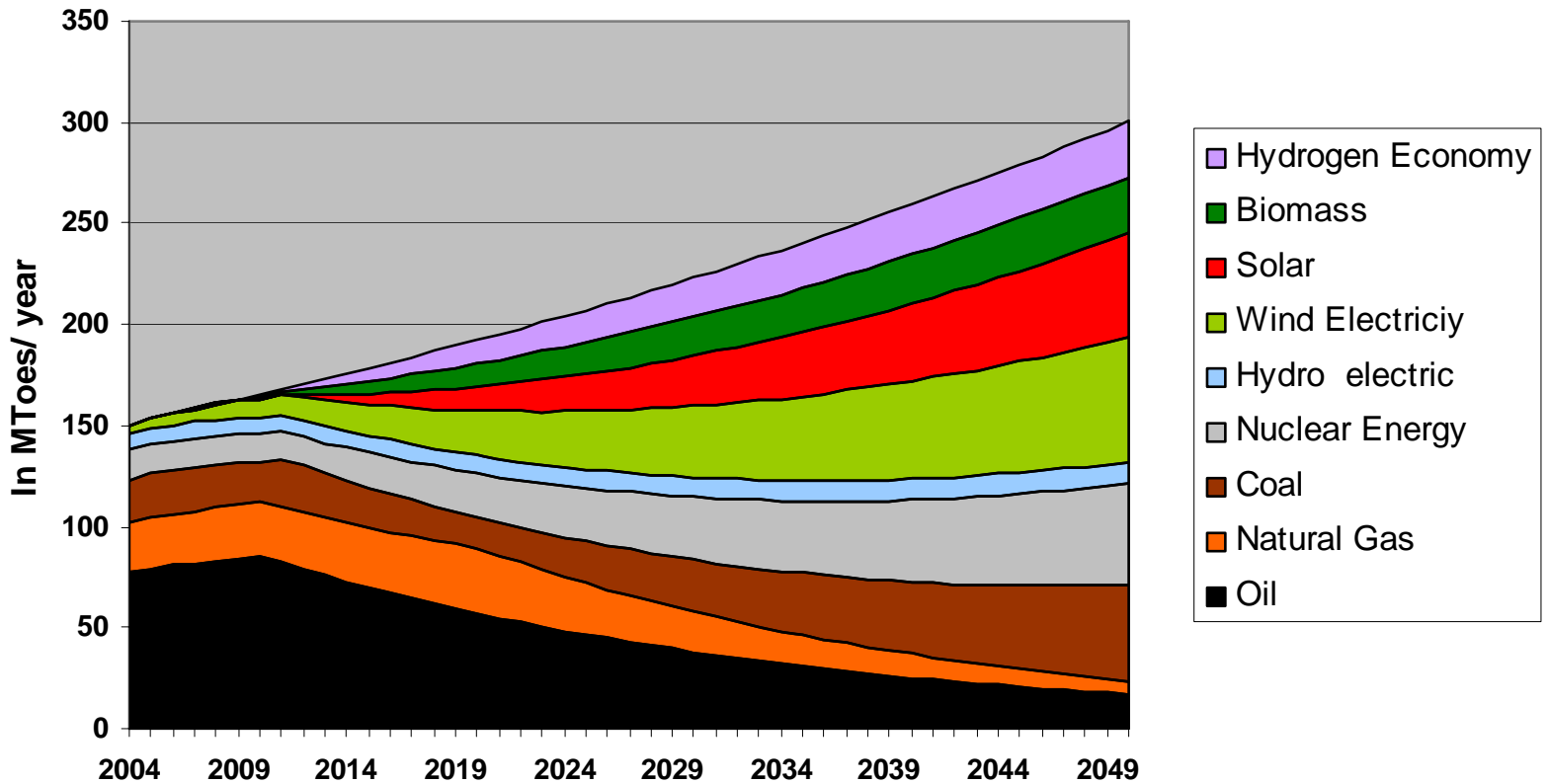
The Growing Gap is filled with the following Mix:

- Arithmetic (rather than Gaussian) approach for simplicity
- **Coal keeps stable or slightly enter into liquefaction (Kyoto surpassed 52%)**
- **Present incentive plans for renewable are kept throughout the period**
- **Nuclear stays during the considered period (extensions granted) and even grows even more than the French Model pace: 200% in 45 years**
- **Oil and gas gaps to be filled by renewables with the following mix:**
 - Energy savings through technology improvements get an overall 20% reduct.
 - Transport to be replaced by biofuels (50%) and hydrogen economy (50%)
 - All electricity becomes renewable by 2050, with
 - 50% wind at the end of the period
 - 50% solar photovoltaic or thermoelectric at the end of the period
 - Hydro and mmini-microhydro grow a 25% throughout the period
 - Storage systems (Pumping up) may grow

The Outcome



Energy Mix for a BAU Approach with Renewables in Spain



What does imply for Spain? Orders of Magnitude



- **30 new nuclear power plants of 1 GW throughout the period. (almost 1 per year)**
- **100% occupation of the fertile remaining valleys by new dams (today is about 85% of the big valleys)**
- **25 times 750 (TWh) the present electric wind generation (~30 TWh/y) throughout the period (Provided there are enough Class 6 windfields)**

What does imply for Spain? Orders of Magnitude



- **Solar panels for more than 1,000 times (40 GWp) the present installed park (40 MWp, with some 60 GWh/year, or 250 Km² of modules or 150-280 Billion €, or more than 20 times the present world total production, throughout the period**
- **Biomass for 30 Mtoes/year at the end of the period. Using half of the remaining forests and prairies would yield 6 Mtoes/year. 80% will have to be imported.**
- **The hydrogen economy considered (28 Mtoes at the end of the period) will need to almost double the wind and solar sources, or the above considered nuclear power park. Infrastructures excluded.**

Conclusions



1. The present way of living is not sustainable at all
2. The foreseeable global depletion rates of oil and gas can not be replaced at present consumption rates and with the present economic model
3. A real sustainable society is well below the 5,000 W of average power per capita of the present European standard of living, if to sustain 6.5 billion people.
4. Life with dignity for humans may be found from 150 W of average power per capita to 15,000 W. The minimum level is to be discussed

Conclusions/2



5. Even one of the most advanced countries in the world in promoting the use of renewable energies, can not fill the growing gap of depleting fossil fuels.
6. The proportion of renewables used today in the world is negligible, exception for the hydroelectricity.
7. The proportion of renewable energies in the consumption pie of Spain is also almost negligible. Hydroelectric resources are almost used up.
8. Renewable energies have good opportunities, but rather to minimize the impact than to replace the gigantic present consumption levels, even less the programmed continuous growths.

Conclusions/3



- 9. The governments and big energy corporations are all aware of the impending fossil fuel depletion, specially of oil first and gas later, but are doing nothing to counter it.**
- 10. The efforts towards renewable energies have to increase in several orders of magnitude, to cover minimum basic need of present population**
- 11. Renewable energies may have some type of impact on environment, but may have a real net yield lower than expected and may have also limits to growth.**
- 12. ACT NOW AND ASK GOVERNMENTS TO REACT!**

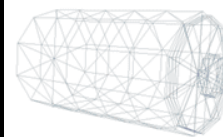


Thanks for your attention

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