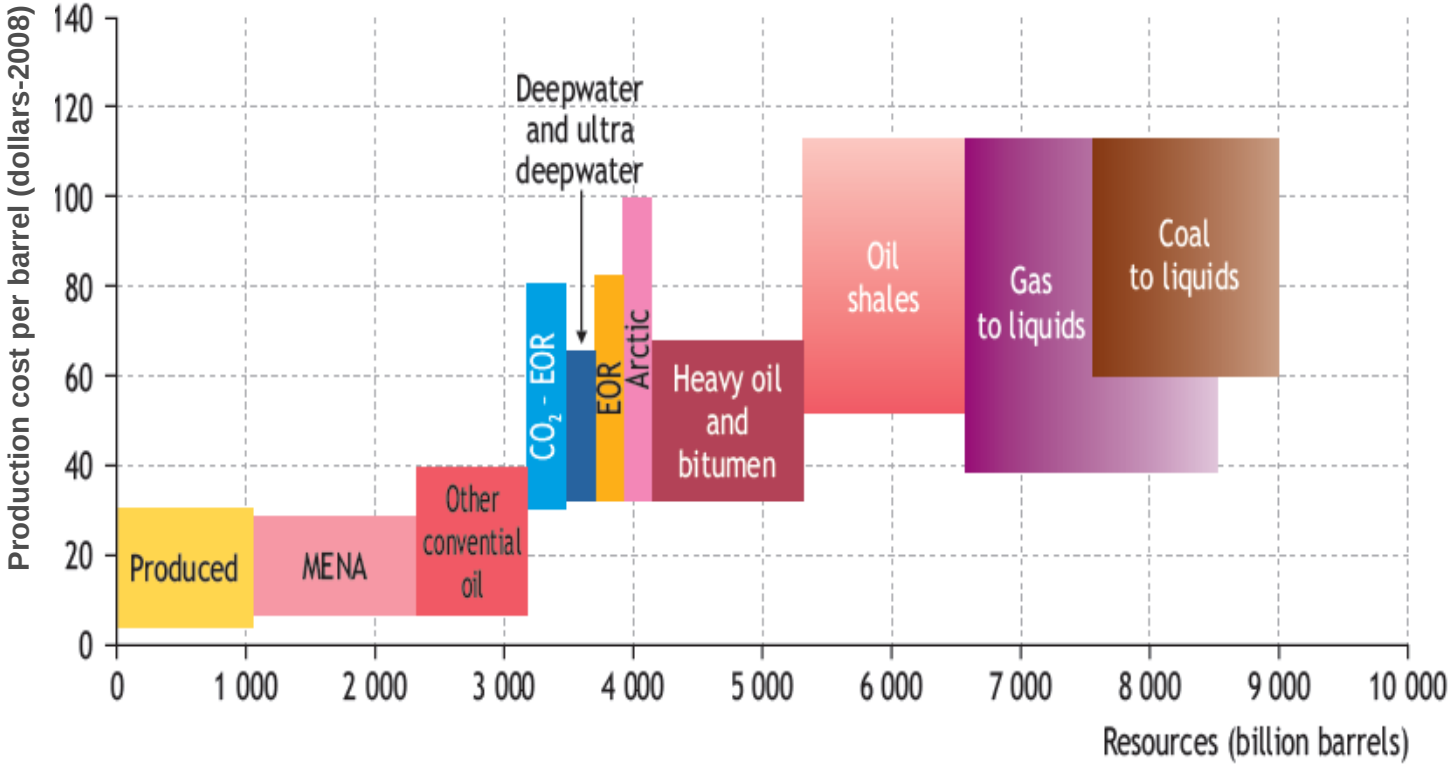
The foreseeable energy supply for the coming decades and its water demand. “Water for energy”.

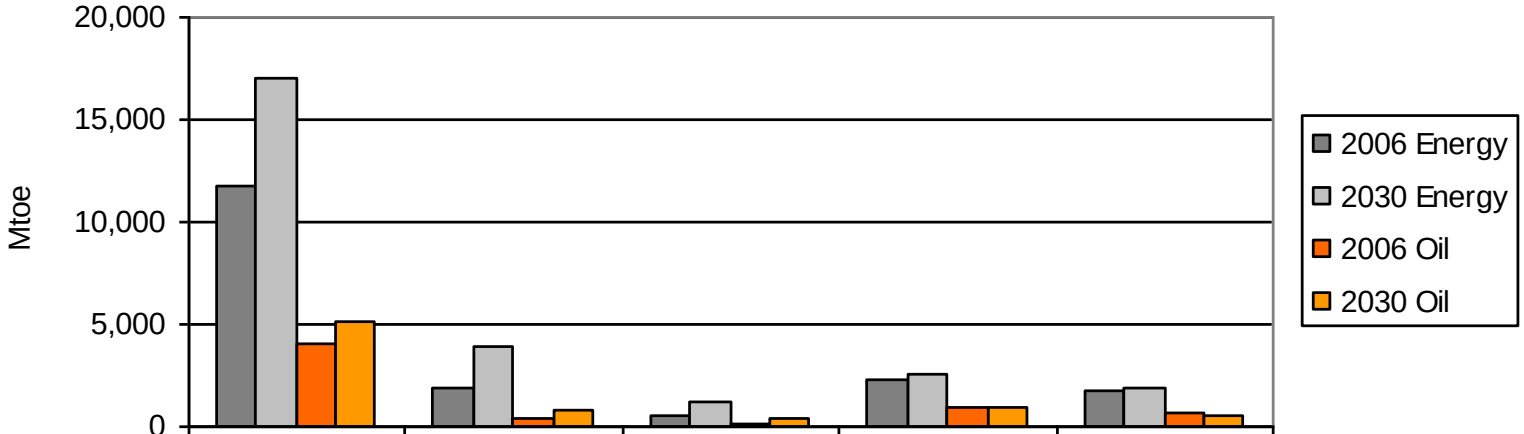
IGNASI NIETO MAGALDI

Santander, 22-24 Septiembre 2009

Long-term oil-supply cost curve. Ultimately recoverable oil resources

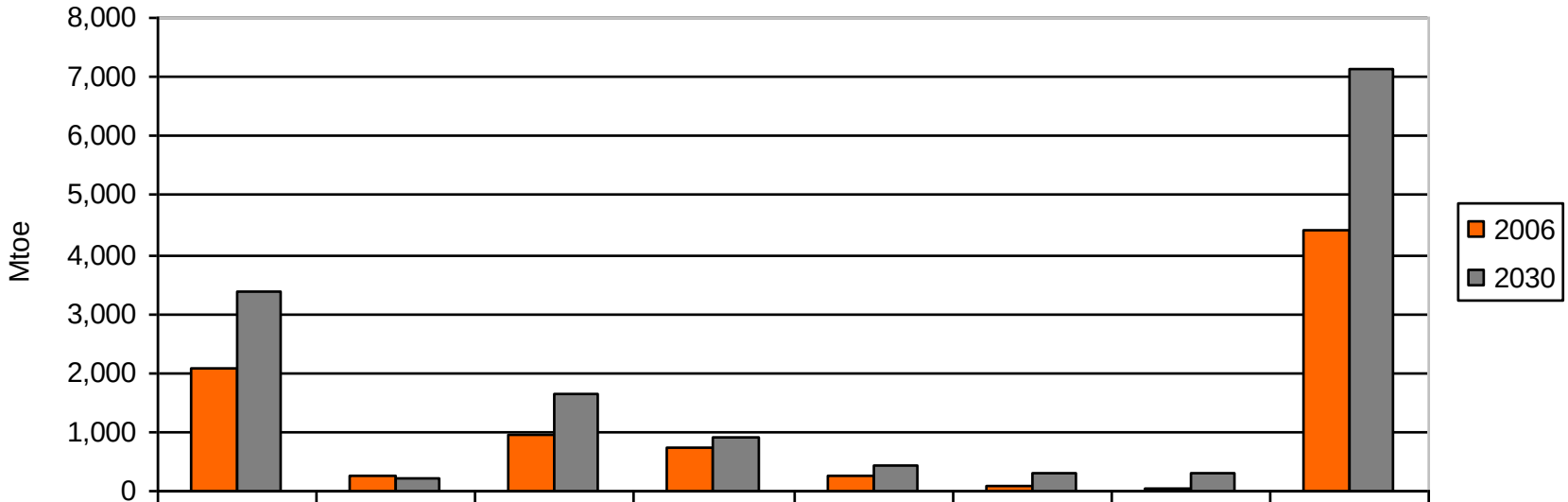


Foreseeable total energy primary demand and oil demand



	World	China	India	USA	EU
2006 Energy	11,730	1,898	566	2,319	1,821
2030 Energy	17,014	3,885	1,280	2,566	1,903
2006 Oil	4,029	352	136	937	668
2030 Oil	5,109	814	346	881	602

Expected current and future (2030) power generation (electricity) in the world



	Coal	Oil	Gas	Nuclear	Hydro	Biomass and Waste	Other renew able	TOTAL
2006	2,075	277	947	728	261	81	55	4,424
2030	3,375	204	1,664	901	414	286	287	7,130

Water withdrawal and consumption for electric power generation

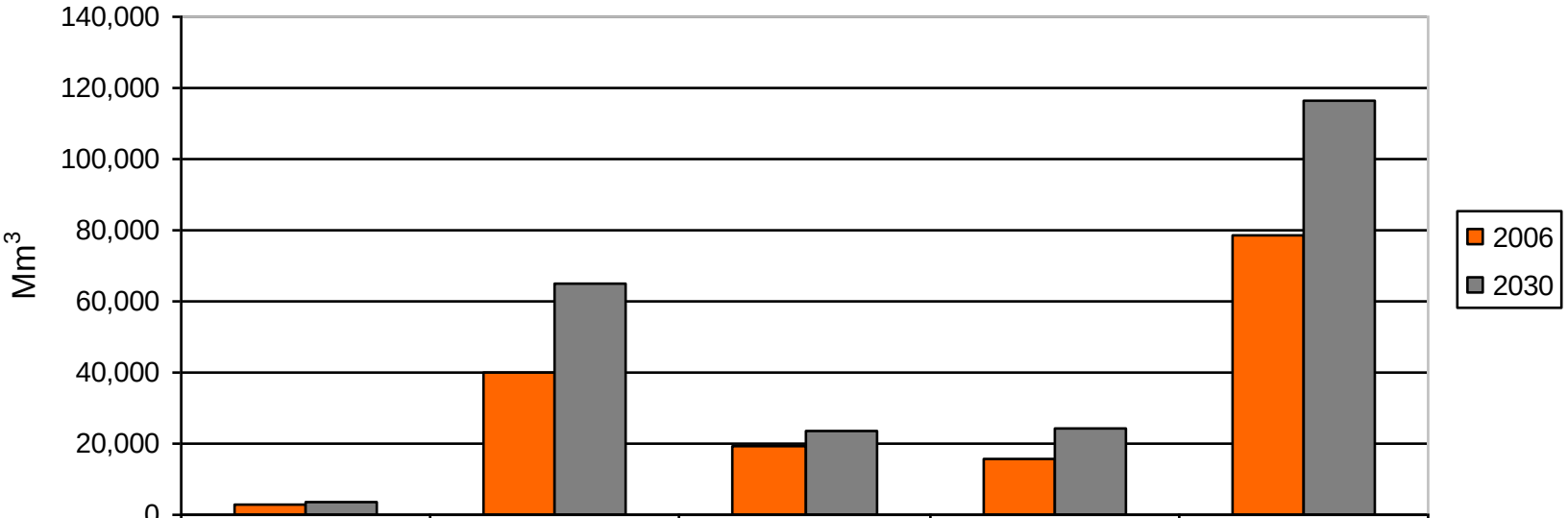
Water Use and Consumption for Electric Power Generation			
Plant-type	Cooling Process	Water Use Intensity (m^3/MWh)	
		Steam Condensing	
		Withdrawal	Consumption
Fossil / biomass steam turbine	Open-loop	75 - 190	0.75 - 1.14
	Closed-loop	1.14 - 2.28	1.14 - 1.82
Nuclear steam turbine	Open-loop	95 - 227	1.51
	Closed-loop	1.90 - 4.16	1.51 - 2.72
Natural Gas Conbined-Cycle	Open-loop	28.4 - 76	0.38
	Closed-loop	0.87	0.68
Concentrating Solar	Closed-loop	2.83	2.80

Water consumption for hydrocarbons and its substitutes

Fuel Type and Process	Relationship to water Quantity	Water Consumption per-unit-energy l/MWh *
Conventional Oil & Gas - Oil Refining	Water needed to extract and refine; Water produced from extraction	90.4 - 258.4
- NG Extraction Processing		25.8 - 28.7
Biofuels - Grain Ethanol Processing	Water needed for growing feedstock and for fuel processing	155.04 -2,067.2
- Corn Irrigation for EtOH		32,300 - 408,272
- Biodiesel Processiong		51.7 - 64.6
- Soy Irrigation for Biodiesel		178,296 - 775,220
- Lignocellulosic Ethanol and other synthesized Biomass to Liquid (BTL) fuels	Water for procession; energy crop impacts on hydrologic flows	310 - 1,938 ψЬ (etanol) 180.9 - 1,162.8 ψЬ (diesel)
Oil Shale - In situ retort	Water need to Extract / Refine	12.9 - 116.3 ψ
- Ex situ retort		193.8 - 516.8 ψ
Oil Sands	Water need to Extract / Refine	258.4 - 646

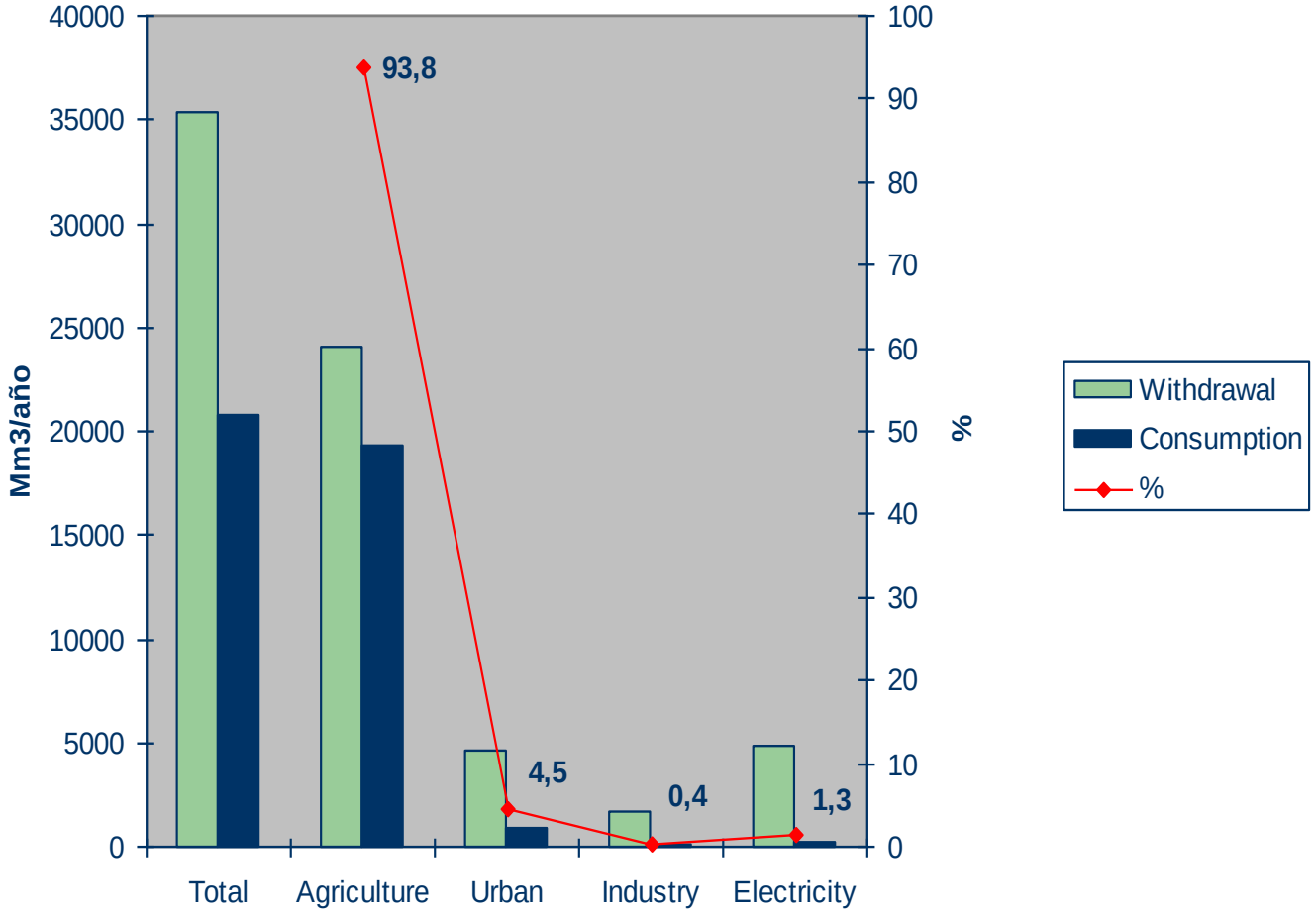
* Ranges of water use per unit energy largely based on data taken from the Energy-Water Report to Congress (DOE, 2007)
ψ Estimates based on unvalidated projections for commercial processing
Ь Assuming rain-fed biomass feedstock production

Water consumption for energy in the main electricity production technologies



	Oil	Coal	Nuclear	Nat. Gas (CCGT)	TOTAL
2006	2,982	40,322	19,230	15,894	78,428
2030	3,781	64,822	23,800	24,240	116,642

Water withdrawal and consumption. The case of Spain



Conclusions

•Energy availability at affordable prices is key to allow countries to grow and achieve a good level of wealth or standard of living. Although oil and gas can be traded internationally, electricity must be produced near the consumption site due to technical reasons. So, the concept of virtual water as a solution cannot be applied, in general, to the case of electricity. Besides, among all energy fuels and technologies, electricity is the one with more water consumption per output.

•However, from a global point of view, if we take a look on the figures, the total water consumed to produce the electricity we need is very small compared to other uses (mainly agriculture). So, the issue “water for energy” is not a problem for the water consumption sustainability. Still, under the foresseable future consumption assumptions, there will not be a problem of water to produce the electricity we need. Instead, from a local point of view, there could be areas where the most water intensive technologies should be avoided.

•The faster electricity production mix will shift towards technologies using less water, the less water will be consumed overall. However, some technologies like biofuels or concentrating solar thermoelectric will have to improve in their perfomance.

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