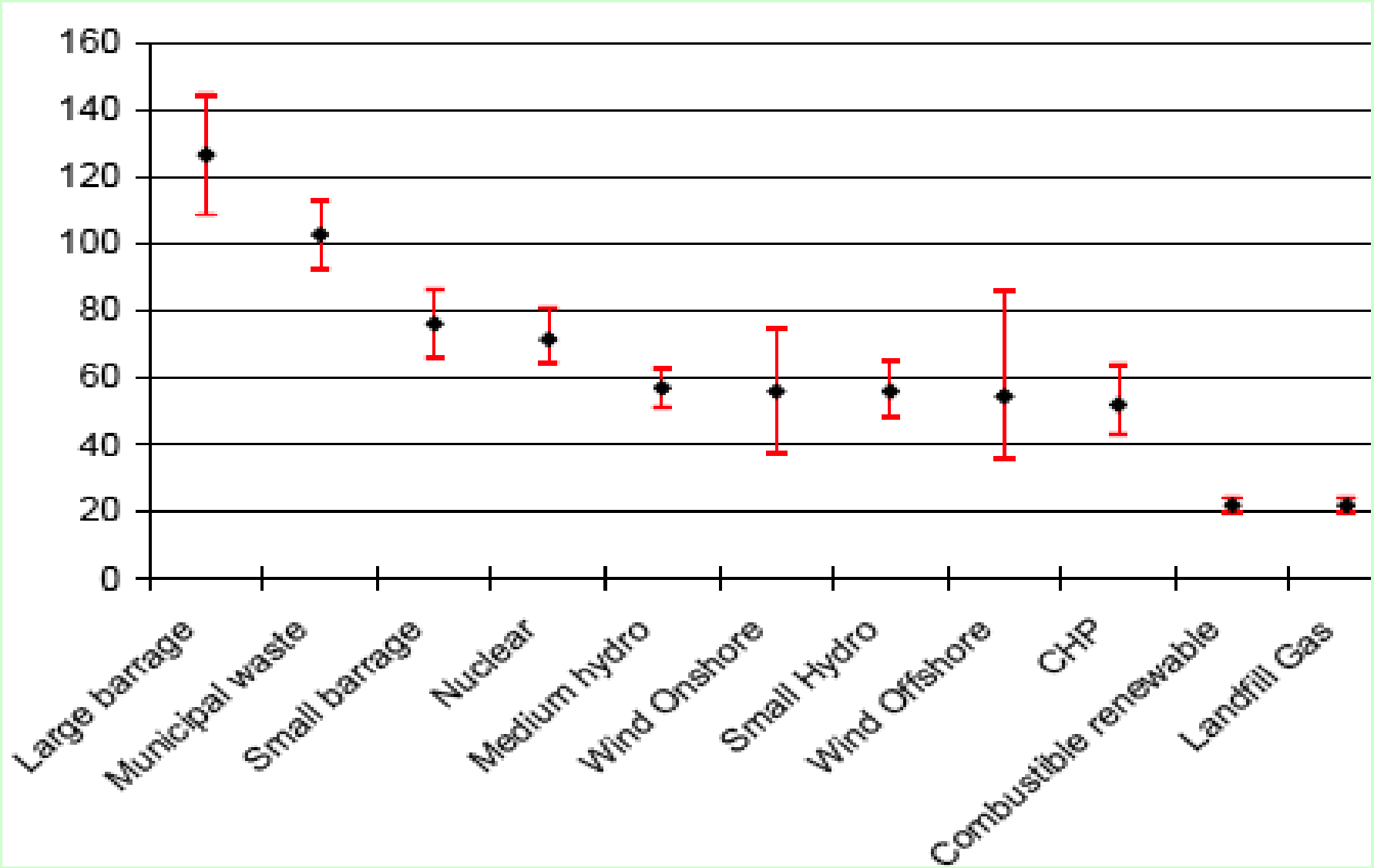
£/MWh

Frontier Economics 2008



Do we need Nuclear?

* Can't contribute short term: ~10 years to plan/build

* or long term: reserves of high grade uranium limited

In the meantime, creates further problems with:

* Accidental leaks and emissions

* Long term disposal of active wastes

* Proliferation of bomb making capacity and materials

* Potential Terrorist attacks

The accident at Chernobyl plant in the Ukraine led to many EU countries backing off from nuclear power

Renewables - mostly faster, cleaner, safer, cheaper, with no emissions or wastes,no proliferation or terrorist threats, and no fuel resource depletion worries

Nuclear Fusion

Plasma at 200 million degrees

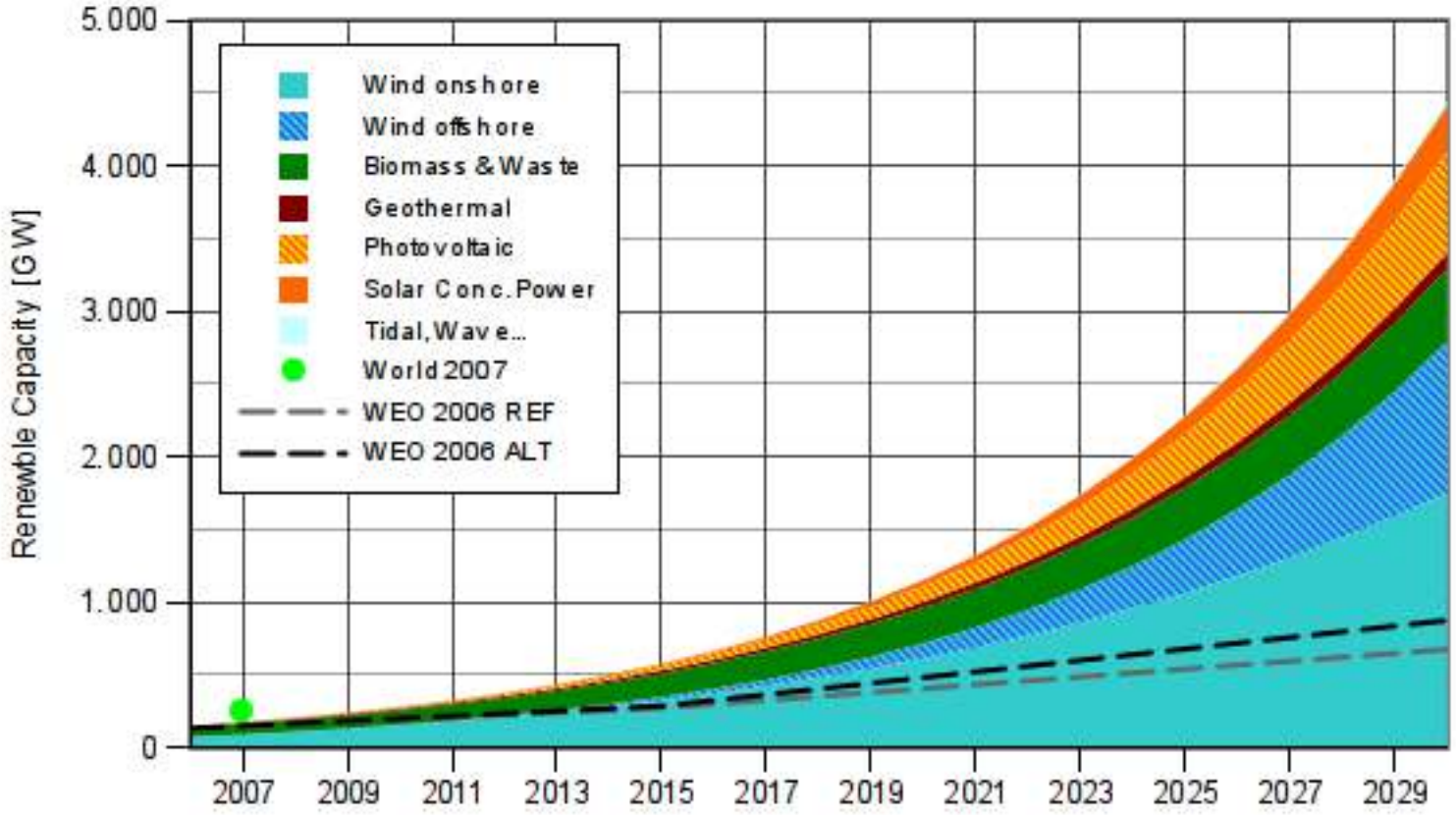
No wastes?

Intense radiation means that components become radioactive- and have to be striped out and stored

No fuel limitations?

Reserves of lithium (for making tritium) are limited

JET at Culham

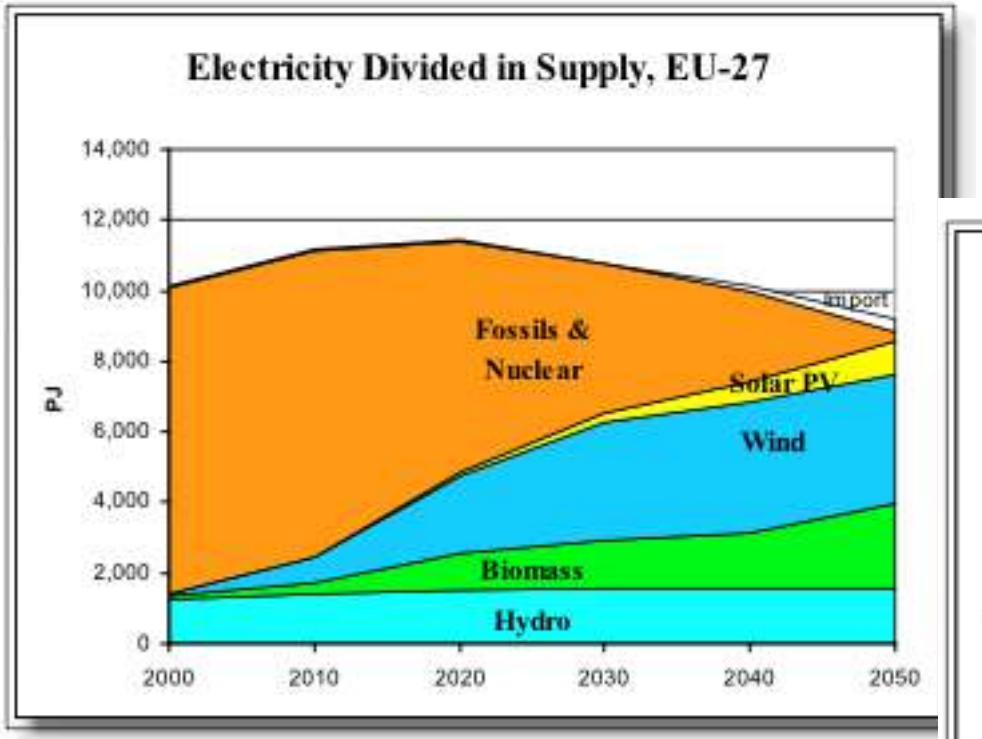


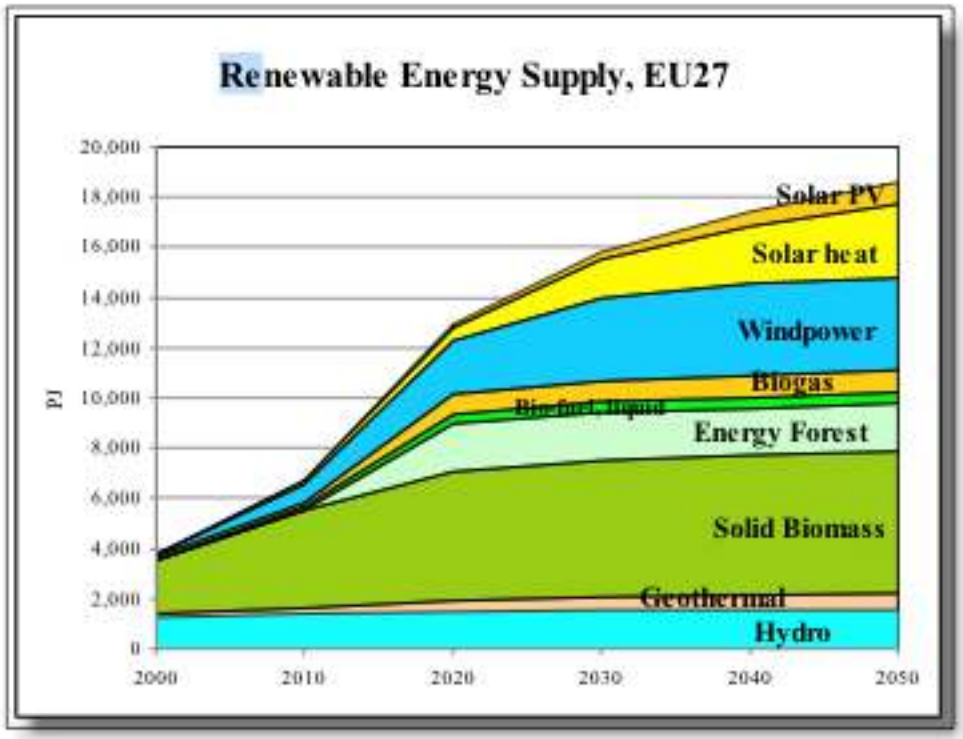
Energy Watch 'high' scenario- 4,45GW of (non hydro) renewables globally by 2030-

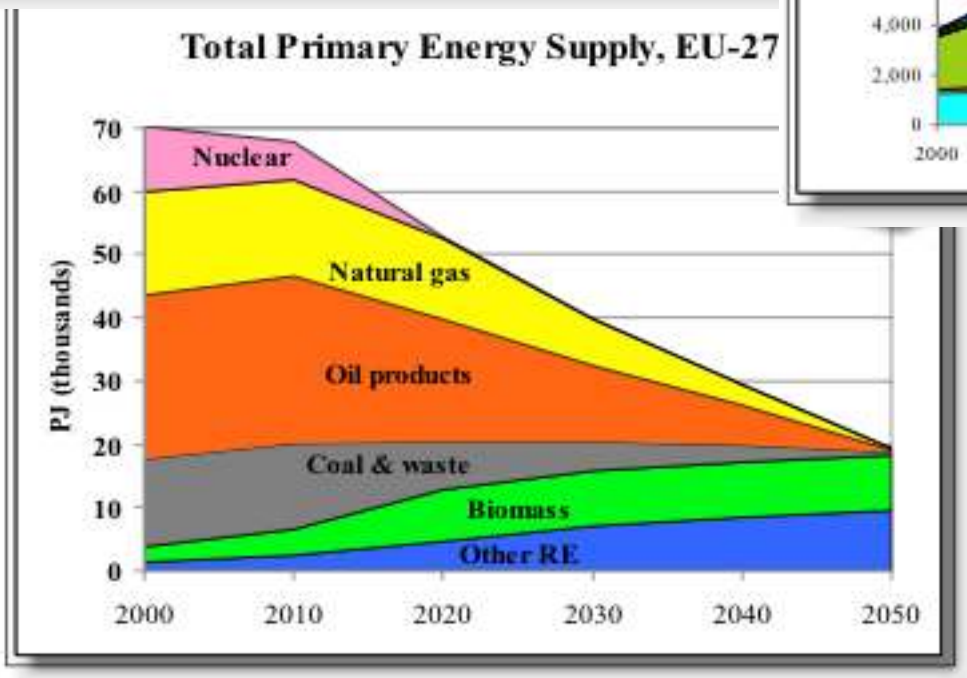
30% share of final total energy demand,

62% of global electricity (Energy Watch 2008)

INforSE visions







Phase-out of fossil fuels by 2050 and nuclear power by 2025, leading to 33% reductions of greenhouse gases by 2020 and 100% by 2050.

Germany- 23 GW of wind, 2GW PV

In 2008 it got 14.2% of its electricity, and 8.6% of its final energy from renewables.

Target: 30% of electricity by 2020

USA- 20 GW of wind

In 2008, 29 GW(e) of (non-hydro) renewables+77GW hydro- ~10% of total US energy generation capacity.

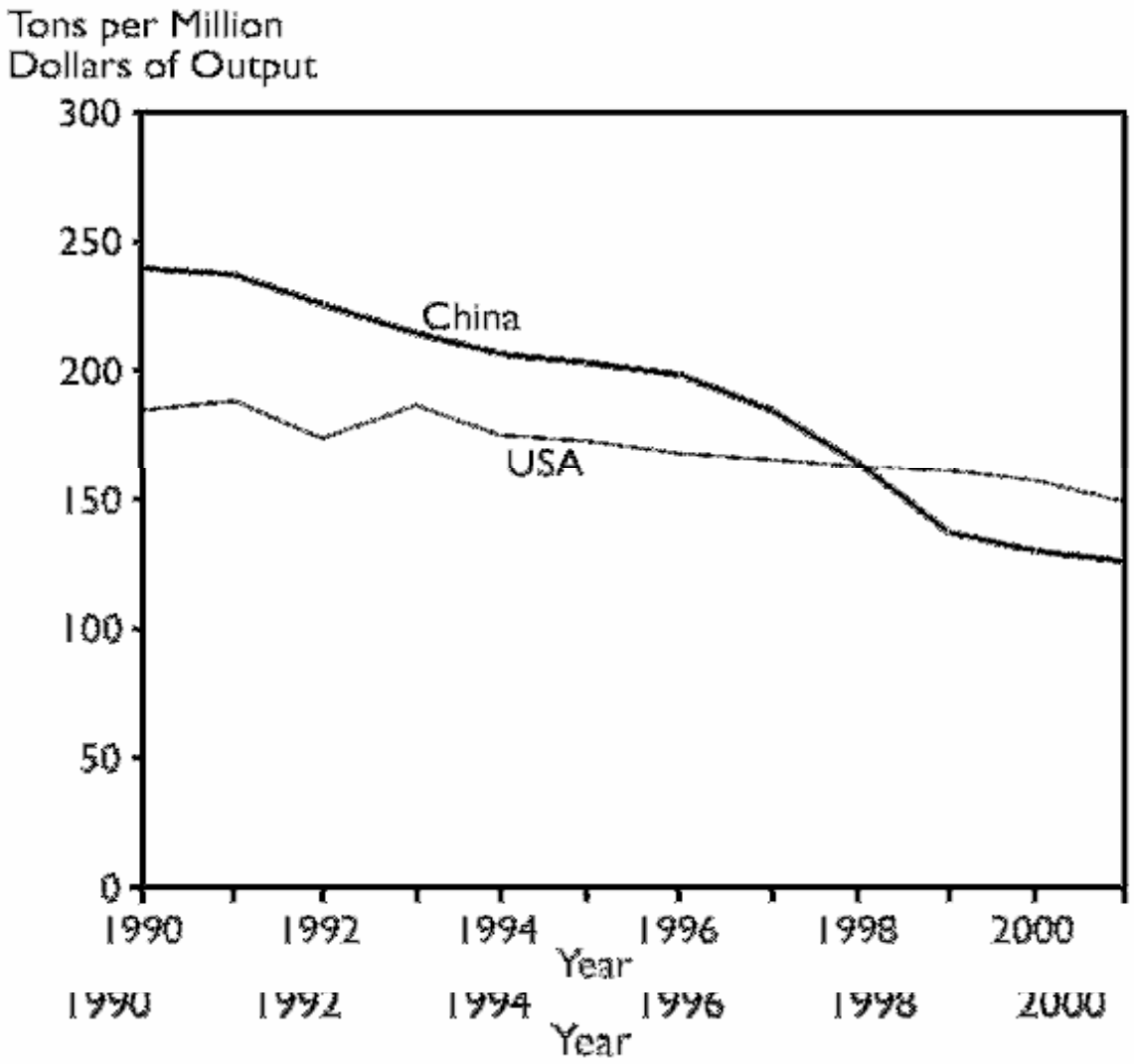
Target: 10% of electricity by 2010. 25% by 2025.

China- **7.7%** of energy from renewables in 2005.

Targets: 10% by 2010, 15% by 2020

Wind target- 20GW by 2020, possibly more (100GW?)

Carbon Intensity trends- Carbon /GNP



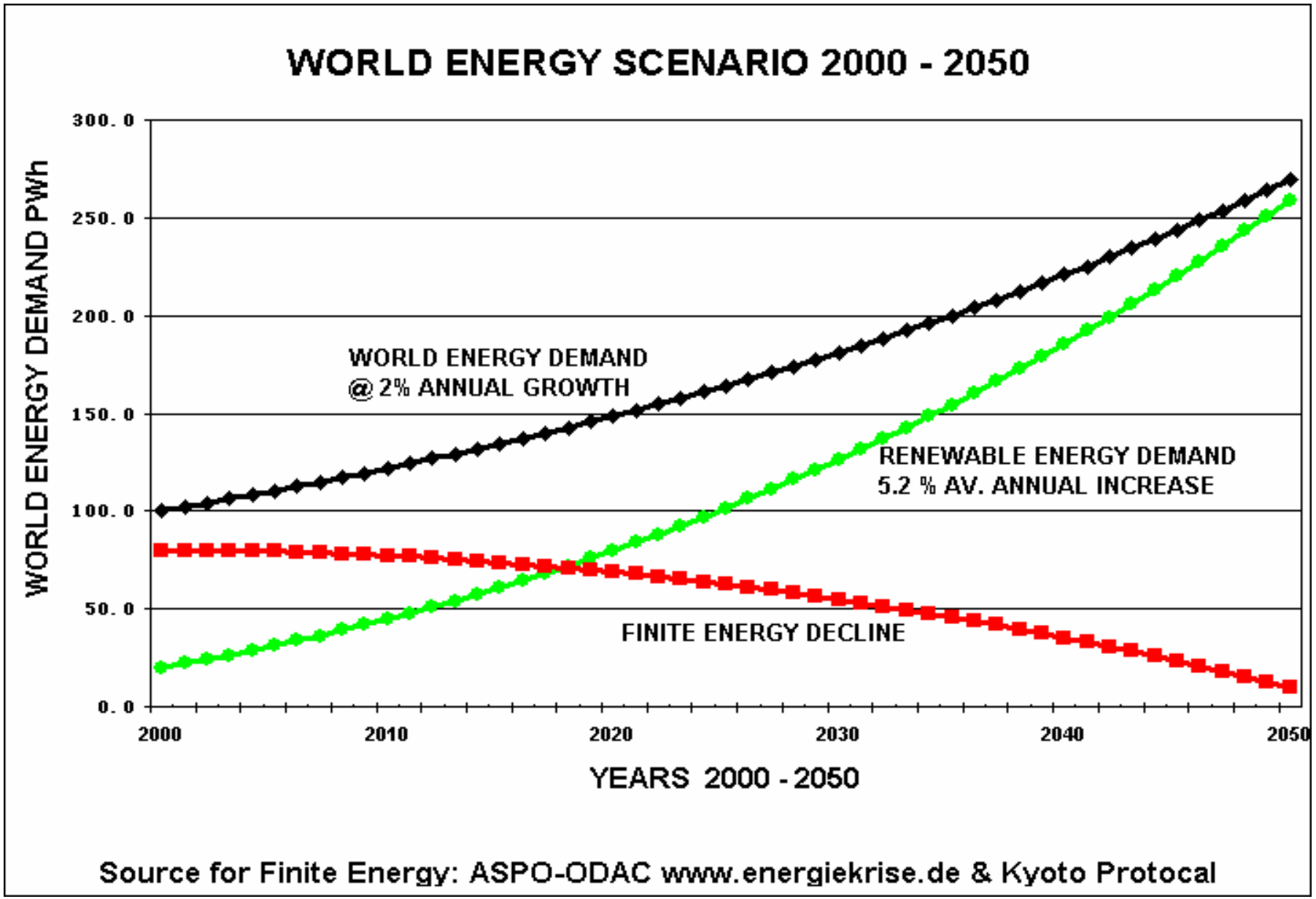
Ocean Current Power Farm Projects in S.Korea

Uldolmog 100MW by 2010

Others:
Shiwah area,
254MW
planned
for 2010

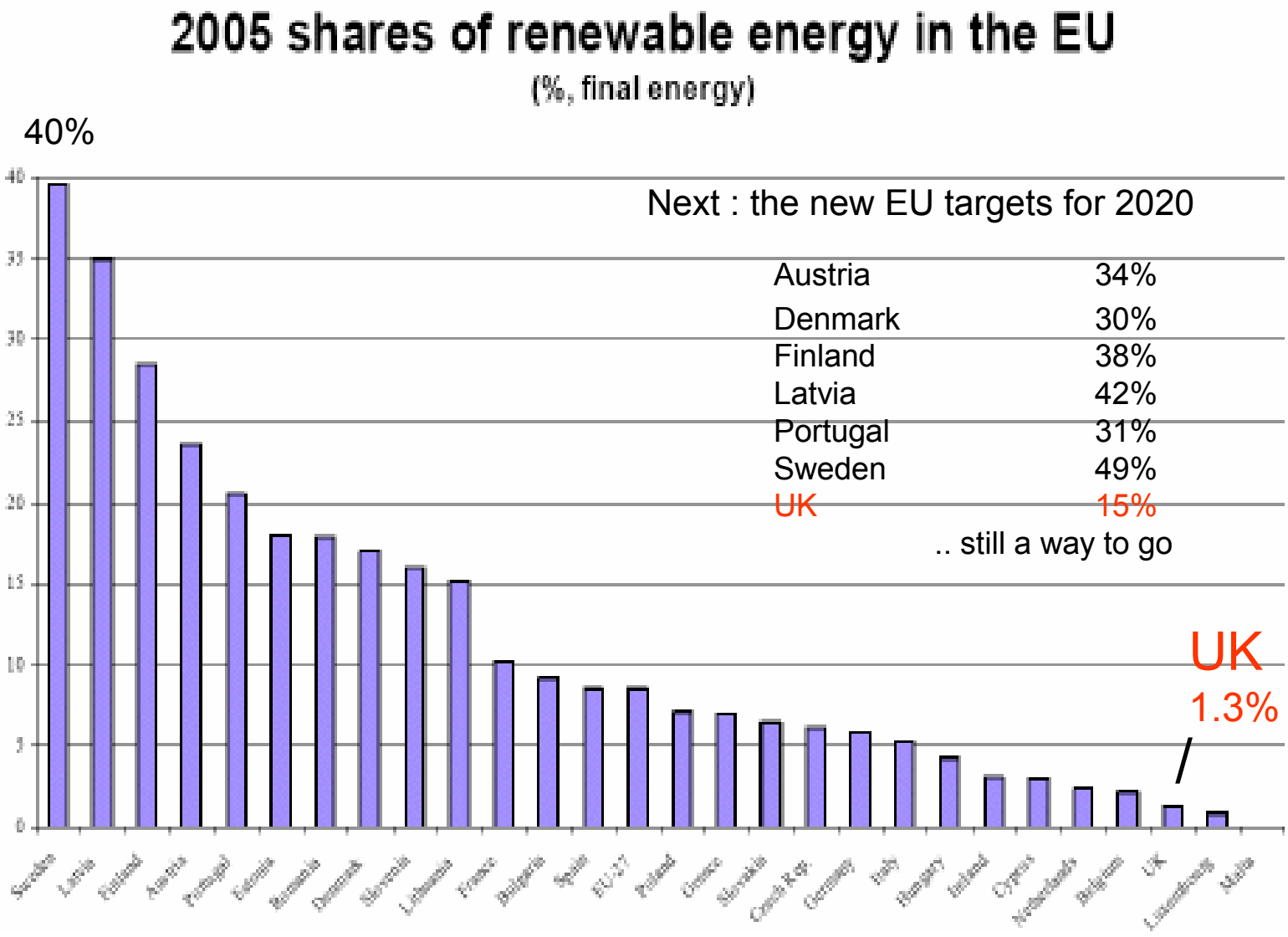
Wando 300MW by
2015

Target: 11% of energy from renewables by 2030

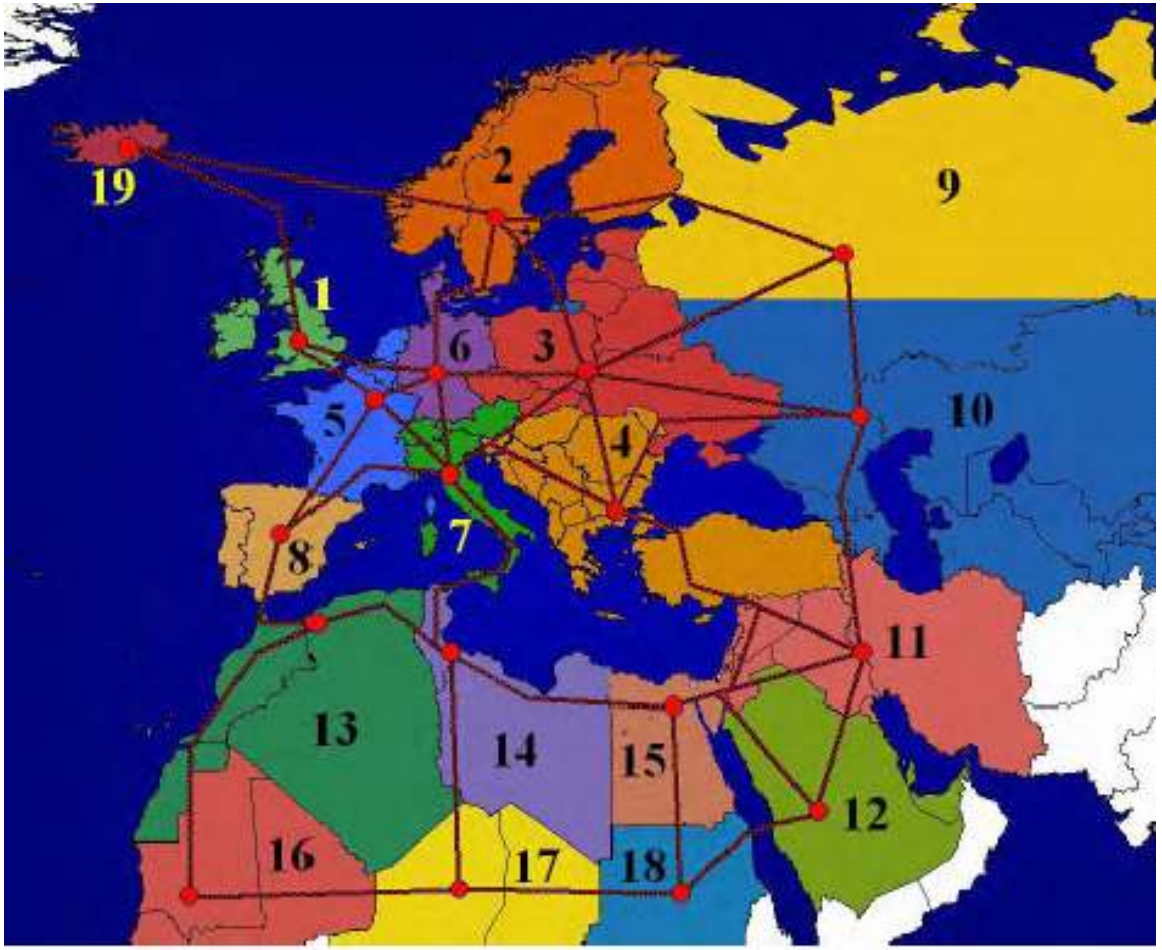


International Sustainable Energy Organisation (ISE□O)

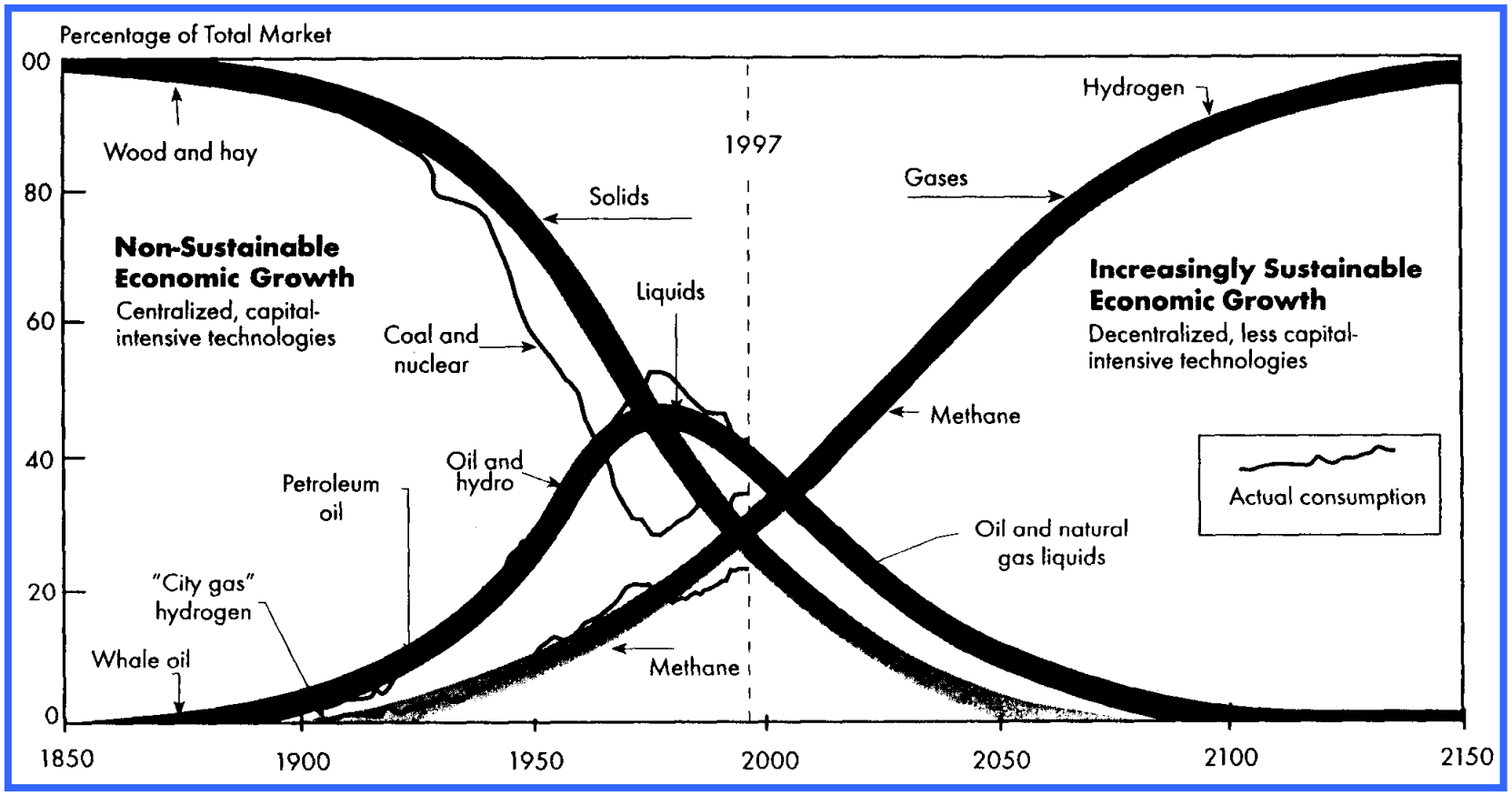
New EU target - 20% of energy from renewables by 2020



Integration- electricity supergrid or hydrogen grid?



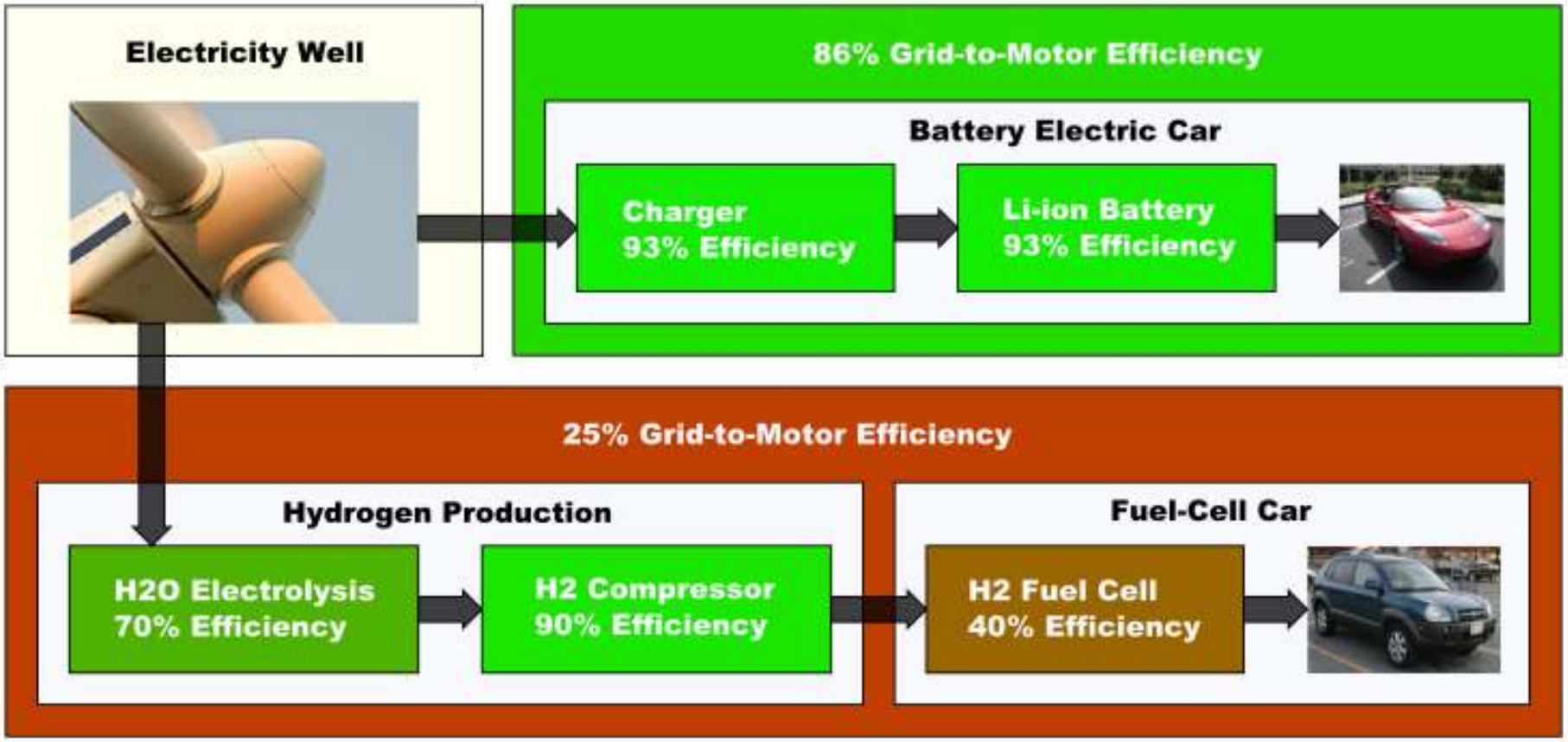
Global Energy Systems Transitions, 1850-2150



Some see hydrogen as the future

Source: LTI Research Group 1998

Overall conversion efficiency is low…

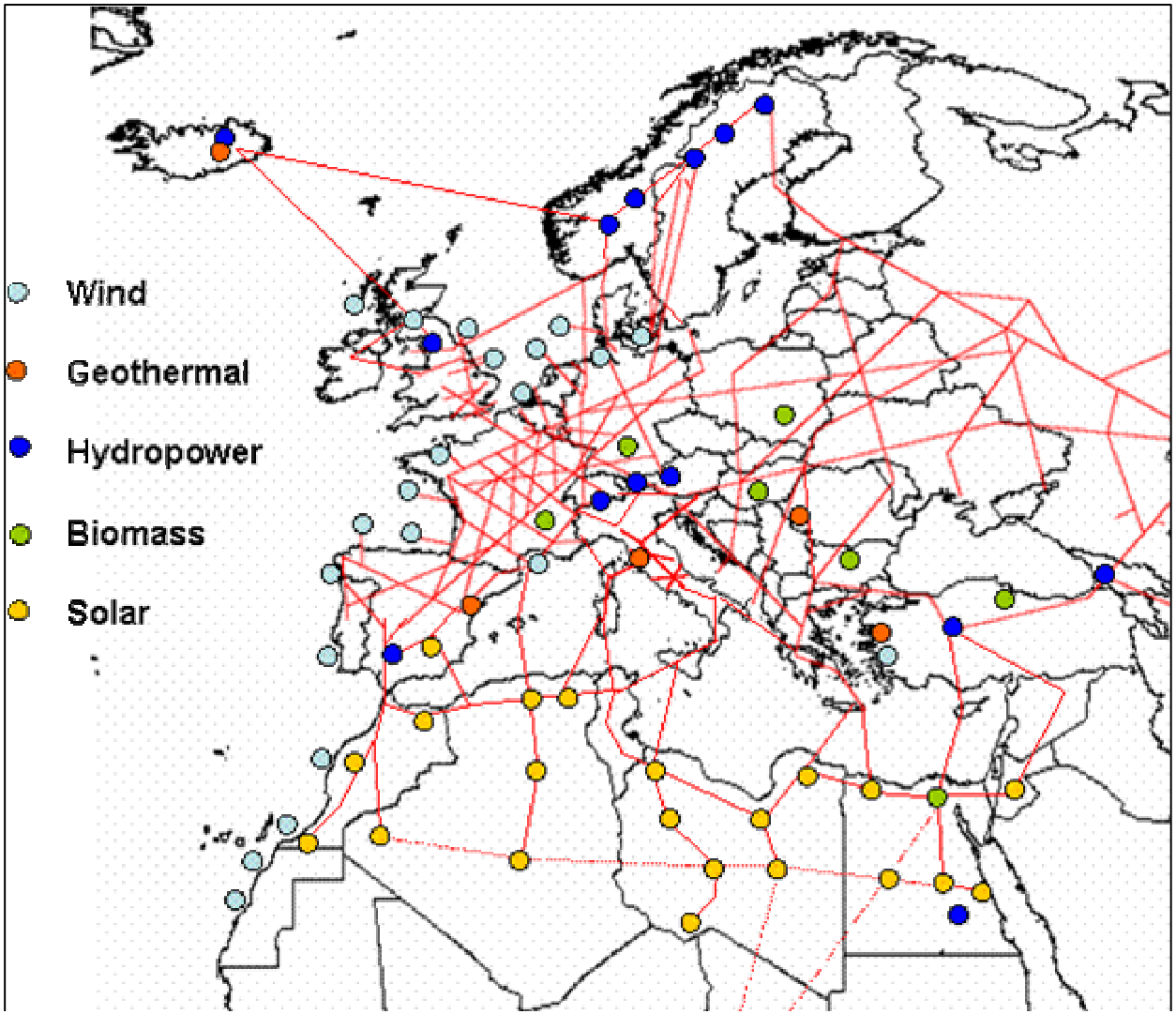


..but hydrogen has the big advantage that it can be stored

Electricity is probably more likely

High Voltage Direct Current supergrids-

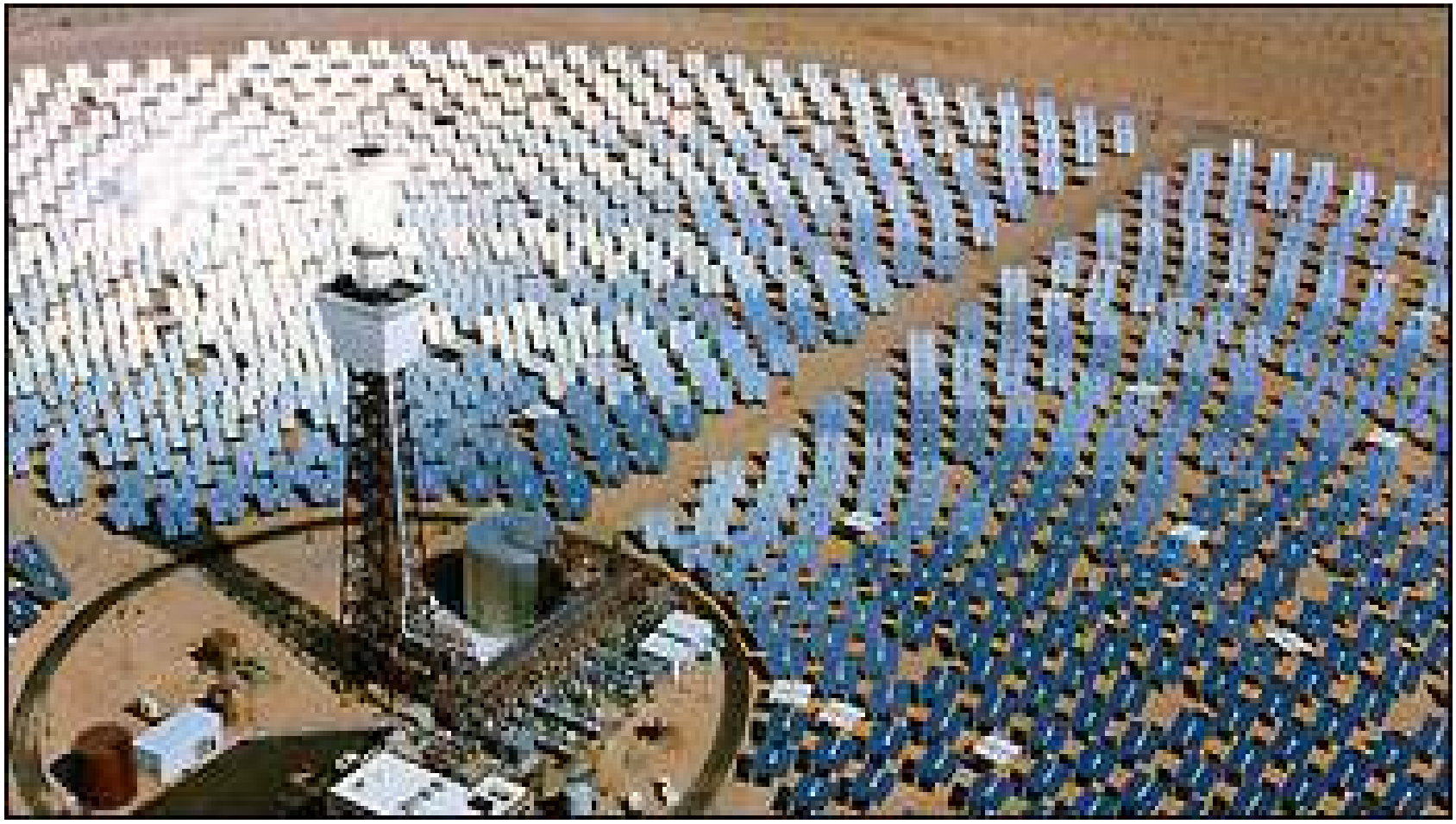
Energy losses1-2%/1000km



EU-ME-NA grid network

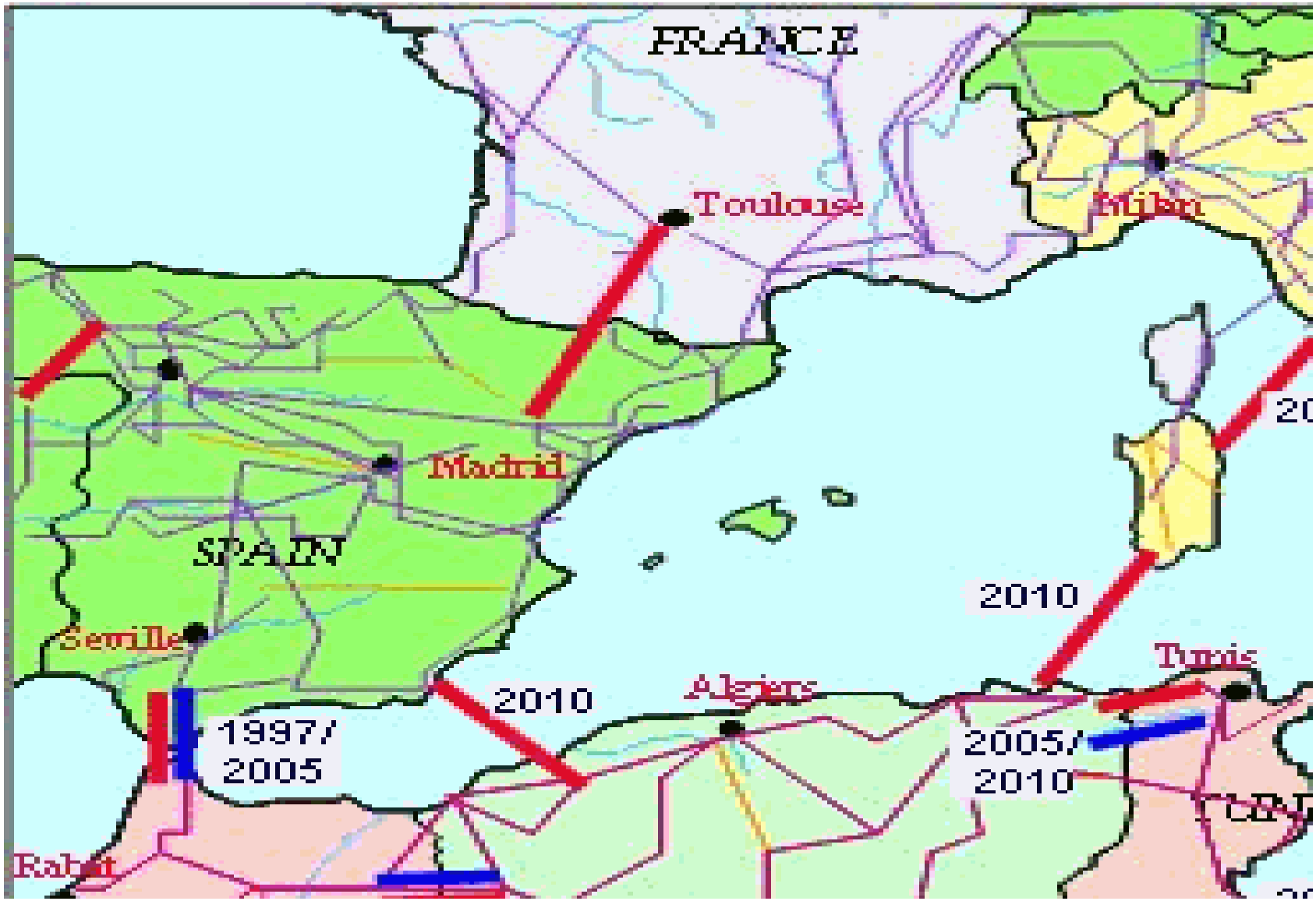
with CSP solar in desert areas proving 15 % of energy via HVDC links and wind from the north sea also feeding in- plus hydro

Concentrating Solar Power (CSP)
Focused solar 'Power Tower'



Can have molten salt heat storage for continuous power production overnight

HVDC grid links already planned for CSP from Africa



CSP/HVDC EU links

Pros

Why not make use of solar where it is most intense- with molten salt heat stores for overnight

Transmission losses low with HVDC links- 2% per 1000km

Builds positive trading links with poor areas

Cons

Expensive and invasive- new grid links across the EU. Which might attract terrorists

Solar energy available on your roof- why collect it from far away?

Could be an exploitative relation with desert countries

Just swopping reliance on imported oil and gas for imported solar electricity- North could be held to ransom by the South!

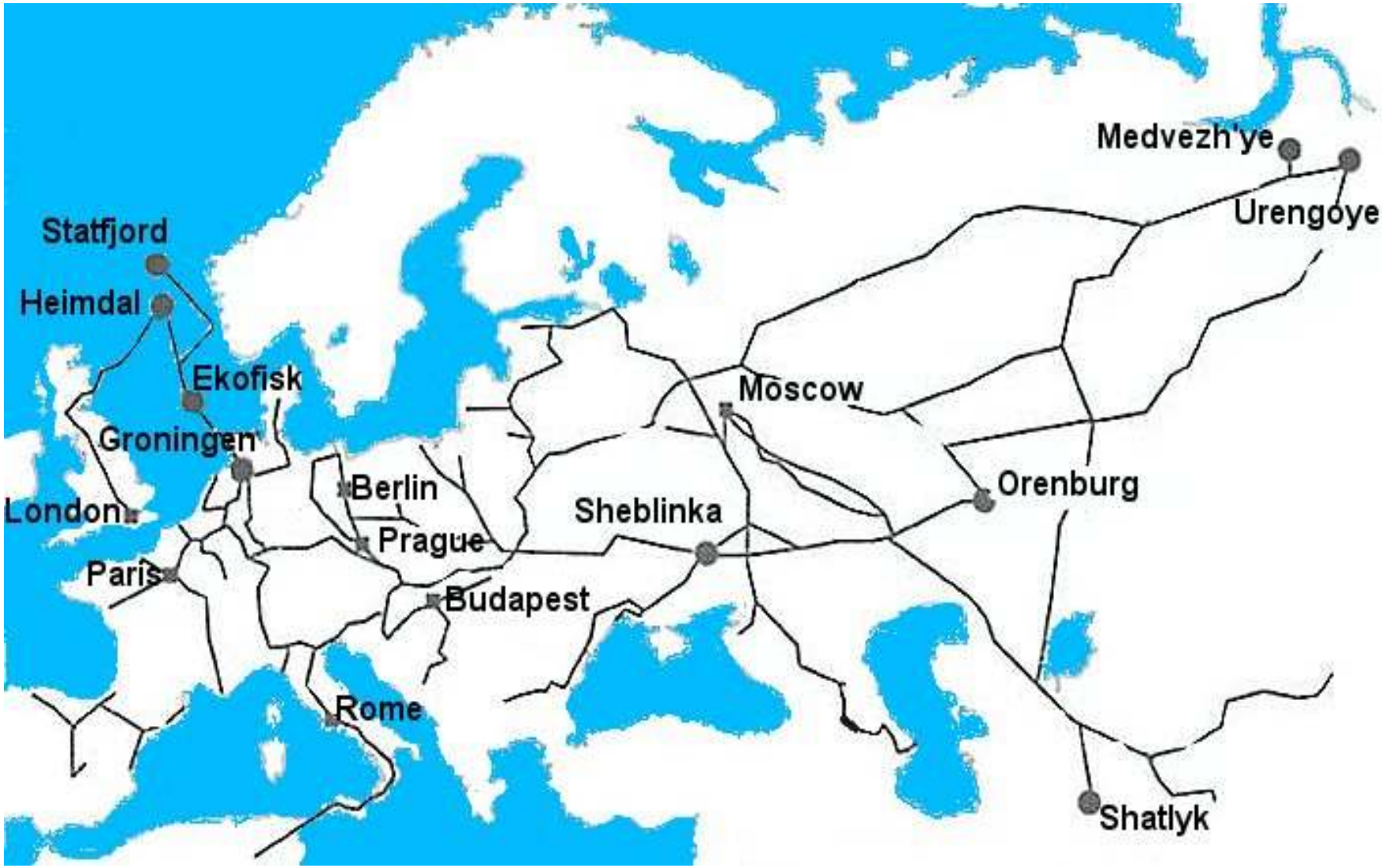
Shouldn't we sort our own house out first? Won't this be used an excuse not to do so?

Wind may be better

Airtricity North Sea Supergird - linking in off-shore wind farms

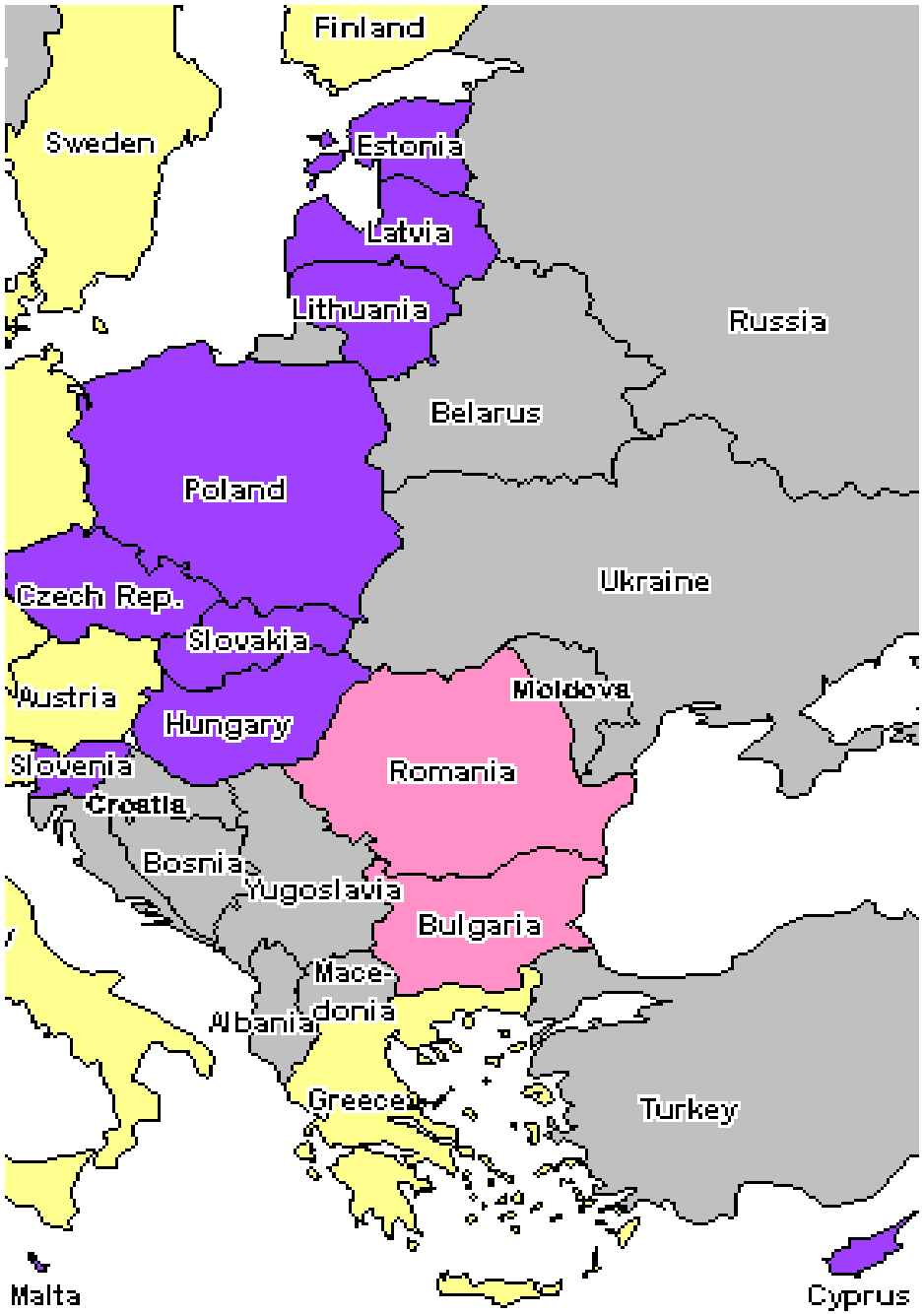
10GW initial stage now planned

Airtricity Supergrid



The EU is desperate to get Russia's gas. But so is China

New Europe


Finland
Sweden
Estonia
Latvia
Lithuania
Russia
Belarus
Poland
Ukraine
Czech Rep.
Slovakia
Austria
Hungary
Moldova
Slovenia
Romania
Croatia
Bosnia
Yugoslavia
Bulgaria
Mace-
donia
Albania
Greece
Turkey
Malta
Cyprus

New Europe: Renewable shares in emerging countries

Share of RES as % of the consumption of primary energy (PES)

Country	PES (PJ)	RES (PJ)	% share
Bosnia and Herzegovina (2003)	176.1	26.8	15.2
Croatia (2004)	412.1	69	16.7
Macedonia (2003)	123.3	13.2	10.7

The renewable energy is mostly from large hydro plants and heat from traditional biomass.

Source: 'Incentives for and barriers to the development of renewable energy sources in five Balkan countries' report by **Martin Mikeska, Petr Holub** , Hnutí DUHA in co-operation with Agree.net, January 2007

Central and Eastern Europe: *Renewable Potentials in the EU*

MW(e) ***by 2020***	**Wind**	**Geothermal**	**Biomass**	**Hydro**	**Total**
Bulgaria	3,400	200	3,371	1,070	8,041
Czech Rep.	2,200	0	819	285	3,304
Estonia	500	0	248	0	748
Hungary	500	0	983	357	1,840
Latvia	550	0	325	428	1,303
Lithuania	500	0	318	214	1,032
Poland	4,000	0	4,160	999	9,159
Romania	3,000	15	1,919	2,568	7,502
Slovakia	250	0	273	499	1,023
Slovenia	100	10	135	642	887

From Black and Veatch survey for **EBRD** reported in *Renewable Energy 2007-08* WREN

Central and Eastern Europe: *Renewable Potentials outside the EU*

MW(e) ***by 2020***	**Wind**	**Geothermal**	**Biomass**	**Hydro**	**Total**
Albania	50	0	625	1,070	1,745
Armenia	400	0	89	571	1,060
Azerbaijan	1,500	0	218	1,142	2,860
Belarus	200	0	996	214	1,410
Bosnia/Herzegovina	50	1	79	1,712	1,843
Croatia	1,000	48	575	642	2,265
Georgia	2,300	15	149	4,852	7,315
Kazakhstan	8,000	12	1,149	4,424	13,585
Kyrgyzstan	1,500	0	166	7,063	8,729
Macedonia	50	0	89	428	567
Moldova	500	0	154	71	725
Russia	60,000	400	14,687	119,150	194,236
Tajikistan	1,000	0	109	18,836	19,945
Turkmenistan	10,000	0	139	357	10,495
Ukraine	5,000	3	1,660	1,712	8,375
Uzbekistan	1,000	0	555	1,926	3,481
FR Yugoslavia	100	0	108	923	1,131

From Black and Veatch survey for **EBRD** reported in *Renewable Energy 2007-08* WREN

Not on their list- Turkey, with reportedly a 10GW wind potential and large geothermal potential

Expected turbine output for wide-area wind energy deployment in distant regions of high wind yield

Country	Potential rated Power [GW]	Potential production [TWh/a]
Northern Russia and North-western Siberia	350	1100
North-western Africa		
Southern Morrocco	120	400
Mauritinia	105	320
Kazakhstan	210	550

Source: Dr Gregor Czisch, University of Kassel
www.iset.uni-kassel.de/abt/w3-w/projekte/LowCostEuropElSup_revised_for_AKE_2006.pdf

EU Renewables Directive 2008

A new Guarantees of Origin trading system can be used to trade electricity and heat/cooling -in 1MWh units - between EU countries, for projects over 5MW.

Imported electricity, produced from renewable energy sources outside the Community, may also count towards EU Member States' targets, again using a system of guarantees of origin.

But limits may be imposed on how much can be imported- this is still being negotiated .

JI and CDM **Renewables & energy efficiency projects**

EU Member States may also use emission credits generated by projects outside the EU, via either:

* The Joint Implementation (JI) mechanism - covering projects carried out in countries with an emissions reduction target under the Kyoto Protocol

* The Clean Development Mechanism (CDM) - for projects undertaken in developing countries.

Under EU 2008 ETS Directive, the credits from CDM projects can only make up 3% of 2005 emissions of any importing EU country.

National and international issues

Should we in the UK/EU import power from overseas to set against of national renewables/emission targets?

It might help them earn money, but lets us off the hook.

Surely they should use it and reduce emissions, themselves.

But then it may be easier to generate green power in sunny/windy countries- and the planet doesn't care *where* the emissions come from

World by Carbon Emissions

>> Size of a country equals emissions in million metric tons

WORLDWATCH INSTITUTE

Displayed data: US Department of Energy

Map created by Mapping Worlds

Technology Conclusions

Small can be beautiful, but so can large- we need both, in a supergrid network

It's a bit like IT: we moved from large centralised mainframes to decentral independent PCs, and then linked them up on the web.

Emergent behaviour

The supergrid would allow local energy supply and demand variations to be better balanced across a wide area.

It could have a high degree of interactive links between users and suppliers - a ‘smart grid’ allowing generation and consumer demand to be better managed

As with the world wide web/internet, we can expect many new opportunities, capacities and functions to emerge, once the smart supergrid system is established

European Commission Second Strategic Energy Review 2008

The EC's Green Paper on energy networks identifies six strategic initiatives as essential for the EU's energy security including a Baltic Interconnection Plan, a Mediterranean Energy Ring, adequate North-South gas and electricity interconnections with Central and South-East Europe, a North Sea Offshore Grid.

Euro Grid

The European Commissions new Economic Recovery Plan (Feb. 2009) includes 100 million euros (£93m) for a grid link between the Republic of Ireland and Wales to help renewables generators in Ireland access the UK energy market.

And around 150 million euros (£139m) for early work on a possible North Sea grid.

Europa Grid

Norwegian owned Transmission company *Imera Power* has announced plans to build undersea electricity grids in both the Atlantic and the North Sea.

The Dublin-based company said its plan for a large grid of subsea AC and DC cables could become the "foundation" for a pan-European offshore electricity network.

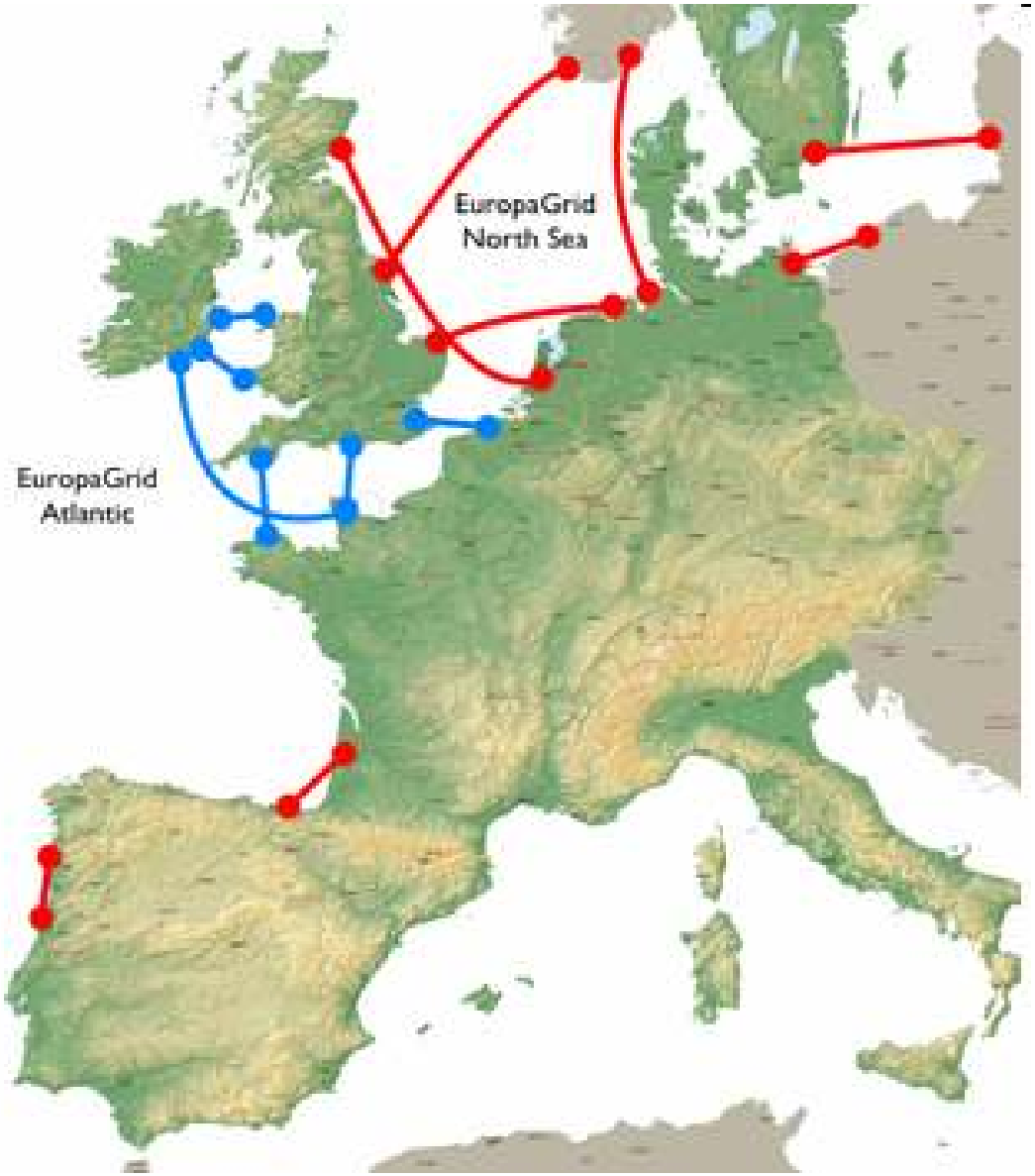
It is looking for 100m euros for the first stage.

Source: NewEnergyFocus.com 3/2/09

IMERA

EUROPAGRID

PHASE ONE



Imera Projects Already Under Development

Suitable for Offshore Windfarm Connection

The recently formed British company *Mainstream Renewables*, plans to create a Supernode, consisting of two interconnected offshore wind farms one British, one German, with a backup connection supplying Norwegian hydro, which it hopes to complete in 2015.

This demonstration project would then expand, and link to similar schemes elsewhere e.g in the Mediterranean.

New Scientist, 12 March 2009

The US is going to do it too…

"One of, I think, the most important infrastructure projects that we need is a whole new electricity grid. Because if we're going to be serious about renewable energy, I want to be able to get wind power from North Dakota to population centers, like Chicago. And we're going to have to have a smart grid if we want to use plug-in hybrids then we want to be able to have ordinary consumers sell back the electricity that's generated from those car batteries, back into the grid. That can create 5 million new jobs, just in new energy."

Barak Obama, Nov. 2008

Limiting climate change and avoiding energy security crises

Sustainable energy: key issues

- What scale?
- Which generation technologies?
- How to link up- supergrids?
- Is electricity the best vector?
- How to accelerate deployment?
- How to improve end-use efficiency?
- How much time have we got?
- What are the other options- adaptation?