The changing role of electricity

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World population evolution

By 2050, the world population is expected to reach 9.1 billion, an increase of 2.6 billions over 2005.

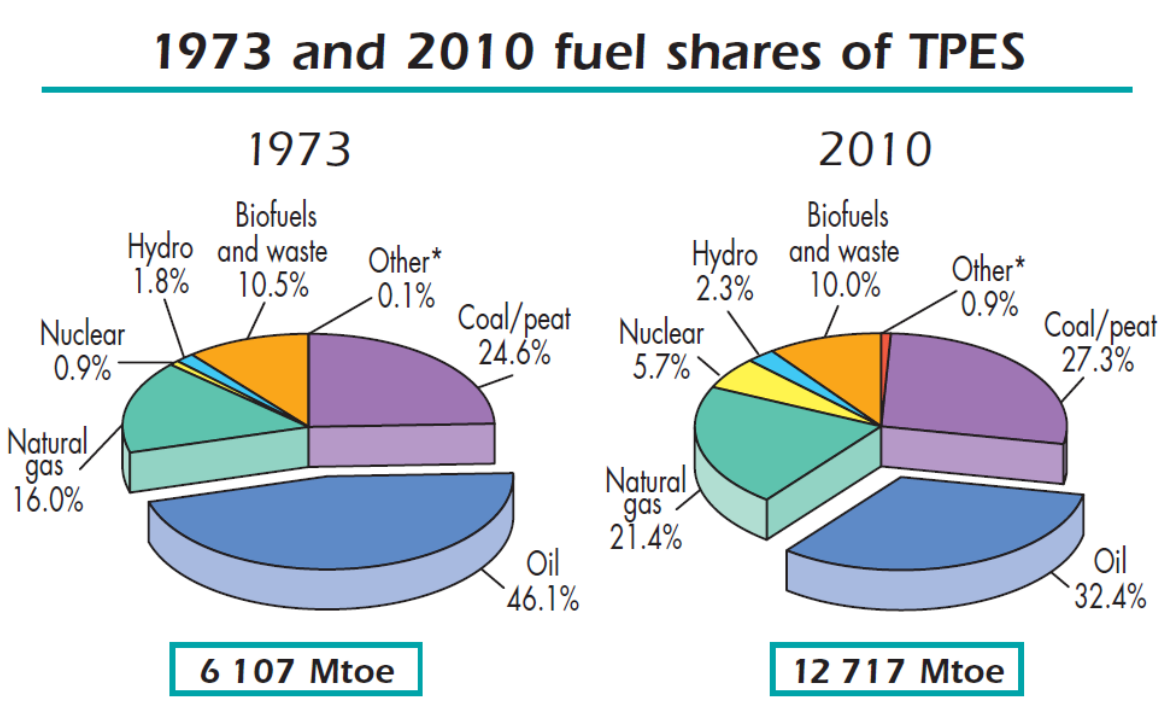
By 2050, we will have :

- 3 billion people who already live in «energy affluent» regions of the world with plentiful, probably more and more expensive, energy.
- 4 billion people who live in «energy poor» regions of the world where energy is only sparsely available.
- 2.1 new inhabitants who will primarily live in «energy poor» regions.

1.5 billion inhabitants of our planet have NO access to electricity

A few unavoidable energy facts

Primary energy – by sources



The total doubles.

The fossil fuel share decreases from 86.7% to 81.1%.

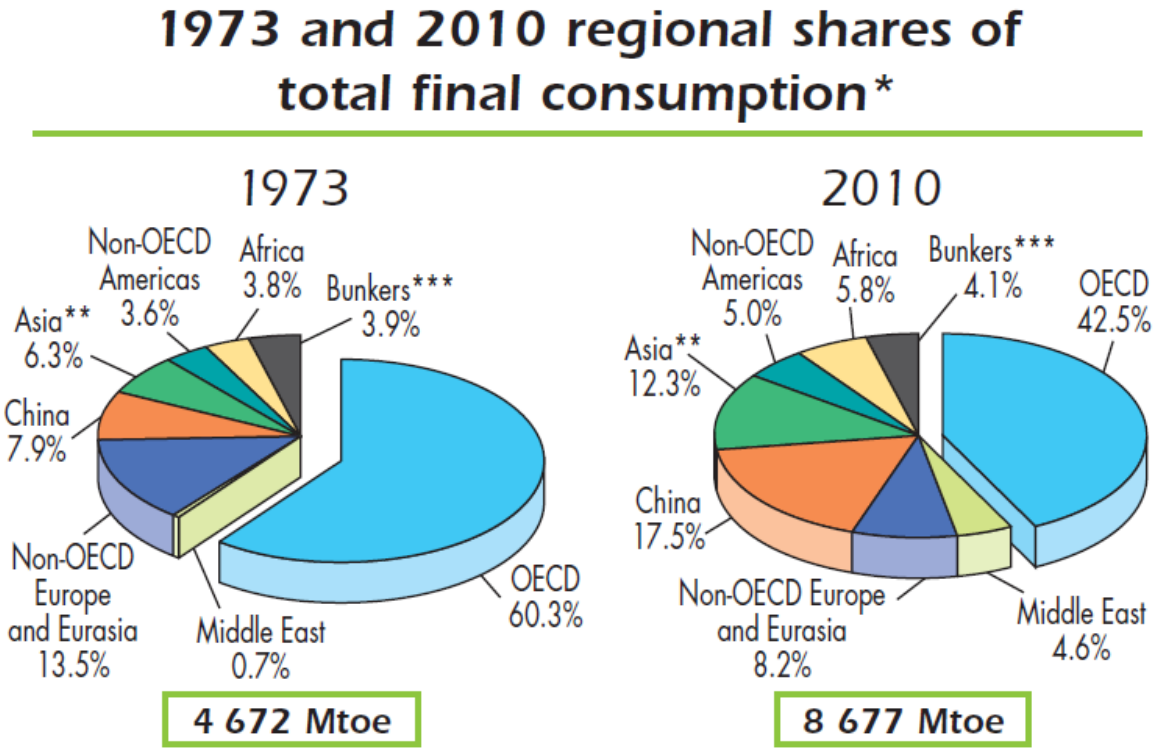
- **Coal: More**
- **Natural gas: More**
- **Oil: Less**

The combined part of nuclear & hydro increases from 2.7% to 8.0%.

Increase of natural gas: 279%
Increase of coal: 231%
Increase of oil: 146%

Source: IEA Key statistics 2012

Consumption - by regions



Cons. / primary

1973: 76.5%

2009: 68.2%

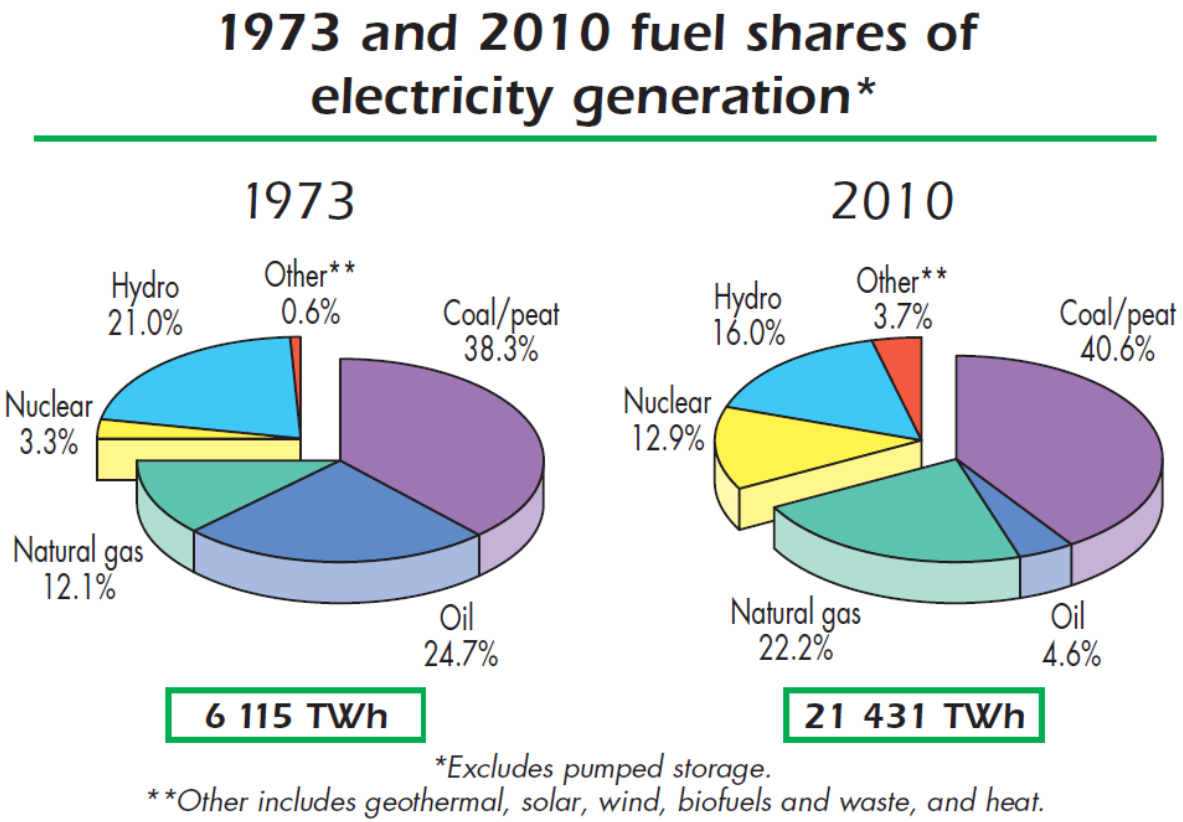
Growth within OECD: 131% **Growth outside of OECD: 269%**

The part of Asia, without China, goes from 6.3% to 12.3%.

The part of China goes from 7.9% to 17.5%.

Source: IEA Key statistics 2012

Electric energy production



Increase of coal consumption to produce electricity: 372%

The production of electricity grew by 350% while the total «only» doubled.

The world is rapidly becoming electric.

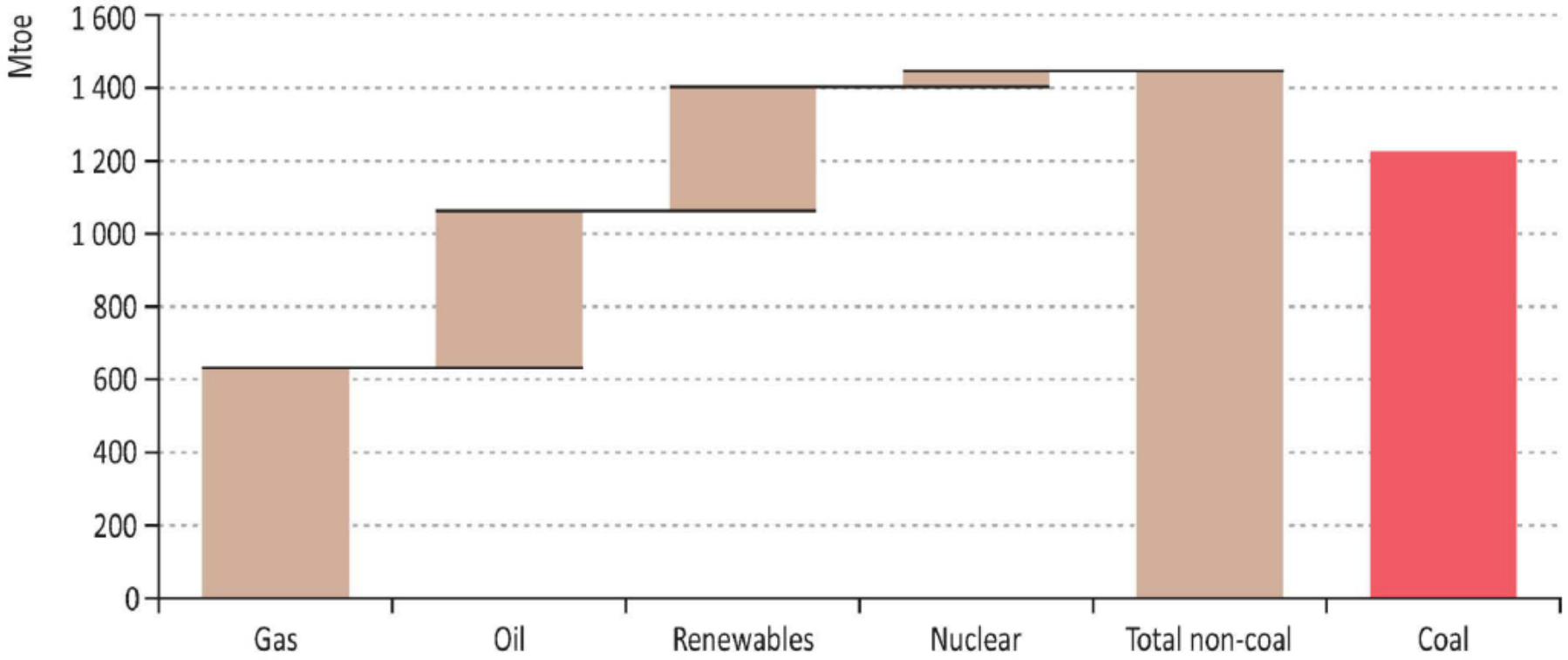
The hydrocarbon part decreased from 75.1% to 67.4%.

The CO_2 free part increased from 24.9% to 32.6%.

Source: IEA Key statistics 2012

Increase of primary energy demand

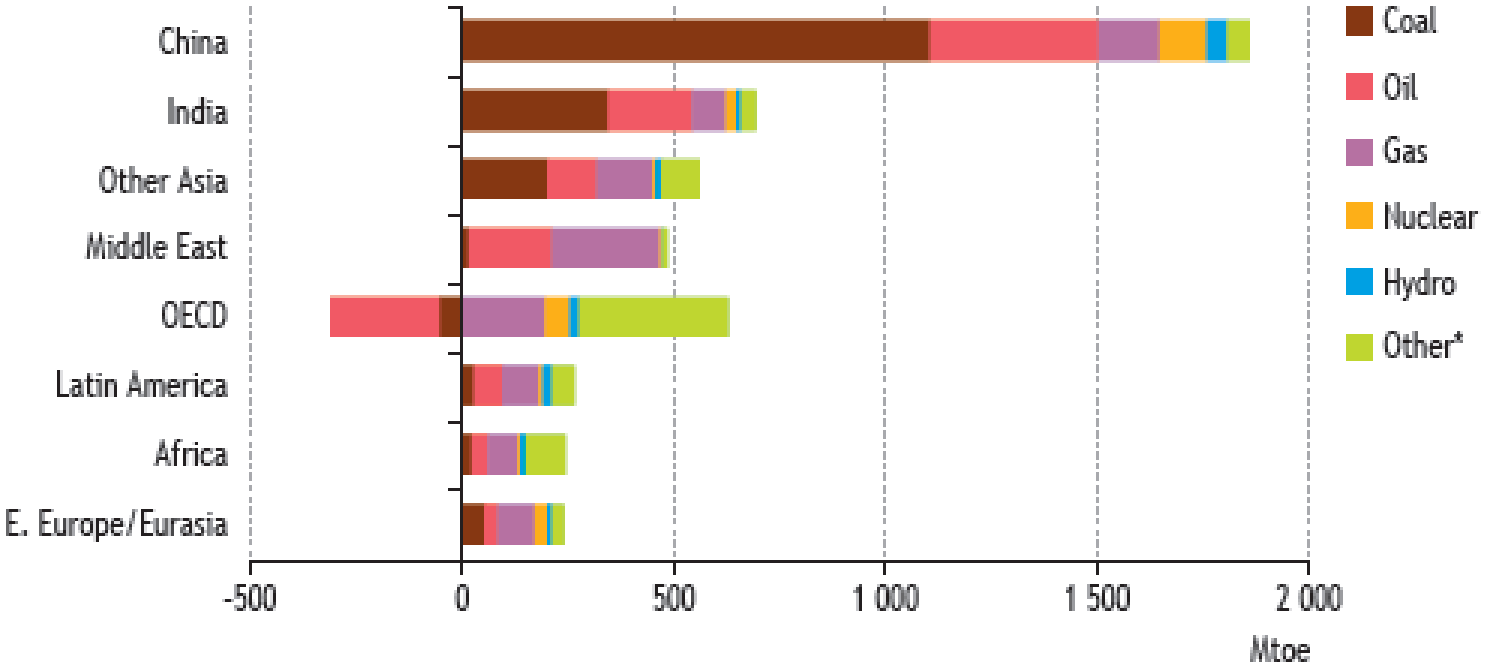
2000 - 2010



Source : AIE 2011

The increase of primary energy demand worldwide

Figure 1.2 • Incremental primary energy demand by fuel and region in the Reference Scenario, 2007-2030



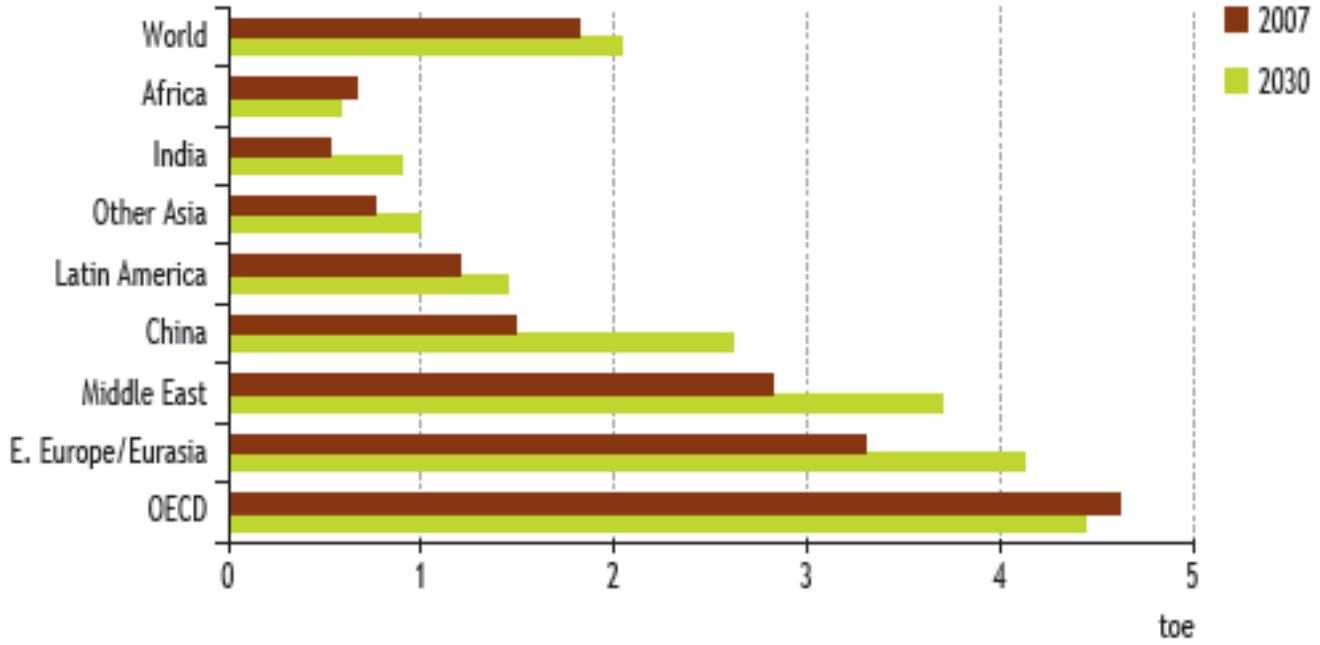
- **Coal and oil dominate outside of the OECD**
- **Within the OECD, renewables represent the greatest increase.**

The 21st century will, unfortunately, be that of coal

Source : IEA

Evolution of the demand per capita

Figure 1.3 • Per-capita primary energy demand by region in the Reference Scenario



OECD decreases

Africa decreases!

Source : IEA

Bifurcation of challenges

From the data given above, one should come to the conclusion that there are two types of challenges:

- In industrialized countries, the challenge is the rational – sober - utilization of energy.
  - Energy efficiency
  - Expensive technologies for rich countries

- In emerging countries, the challenge is a massive increase in energy consumption while avoiding a catastrophic impact on the environment.
  - Environmental impact
  - Affordable and **well-suited** technologies for developing countries

The nuclear energy bifurcation

Europe: moves toward the exit

World: moves on

Nuclear energy – worldwide situation - 1

August2012

- 435 nuclear reactors were in operation world wide.
  - 104 in the United States
  - 70 reactors in the United States had already seen their operational licenses extended to 60 years.
- 30 countries

2010

Nuclear energy : 13% of the world wide electricity production

Nuclear energy – worldwide situation - 2

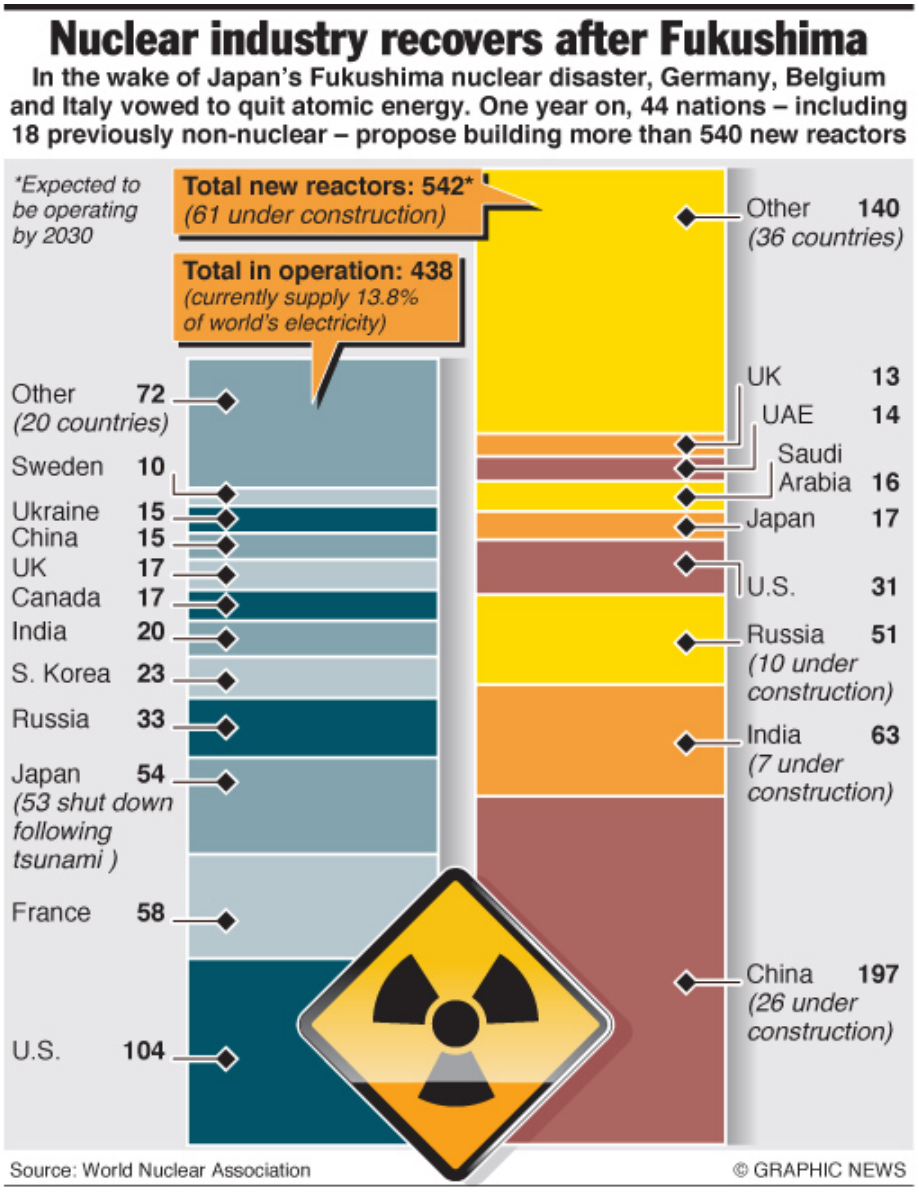
Nuclear energy contributes more than 30% of the total electricty production in 13 countries

2010 : % of nuclear energy in the electricity production

France	78%
Slovaquia	54%
Belgium	54%
Ukraine	47%
…….	
Switzerland	**40%**
Sweden	40%
…..	
Japan	**27%**
Germany	**22%**

The nuclear energy exit challenge in Switzerland is very ambitious

Construction & planification of new nuclear power plants



In construction : 61

- 26 in China
- 10 in Russia
- 7 in India
- 4 in Korea
- 14 elsewhere

Proposed: > 400

- 44 countries
- Of which 18 do yet use nuclear energy

Europe: the race to exit nuclear energy - 1

As late as 2010, several countries, including Germany and Sweden, had decided to renounce their earlier renouncement of nuclear energy.

The «nuclear renaissance» was in full swing driven by the European 20 – 20 – 20 target for 2020:

- 20% decrease of CO_2 emissions
- 20% decrease of overall energy consumption
- 20% share of renewable energy

The Fukushima accident changed all of that.

The political race to exit nuclear energy is on!

Europe: the race to exit nuclear energy - 2

Switzerland – decided May 25 - 40% nuclear

2020	Decommission of 3 of the 5 operational reactors 1'000 MW
2029	Decommission of 1 more operational reactor additional 1'000 MW
2034	Decommission of the last operational reactor additional 1'000 MW

2035 Total for Switzerland: 3'000 MW to be replaced.

Germany – decided a few days later than Switzereland - 22% nuclear

August 2011	Decommission of 8 of the 17 operational reactors. 8'400 MW
2022	Decommissioning of the remaining 9 operational reactors. additional 12'100 MW

2022 Total for Germany: 20'500 MW to be replaced

Europe: the race to exit nuclear energy -

Belgium – decided in October - 55% nuclear

2015	Decommissioning of 3 of the 7 operational reactors 1'400 MW
2025	Decommissioning of the remaining 4 operational reactors additionall 4'100 MW

2025 Total for Belgium: 5'500 MW to be replaced

France

President François Hollande has decided that the two nuclear reactors at Fessenheim – 2 * 900 MW – will be shut down in 2016.

The socialist – green coalition in France has committed to reduce the nuclear energy contribution down to 50%, from 75 % at present, by 2025.

We may well have a supply issue by 2025 – 2030
unless the political outlook changes – again…….

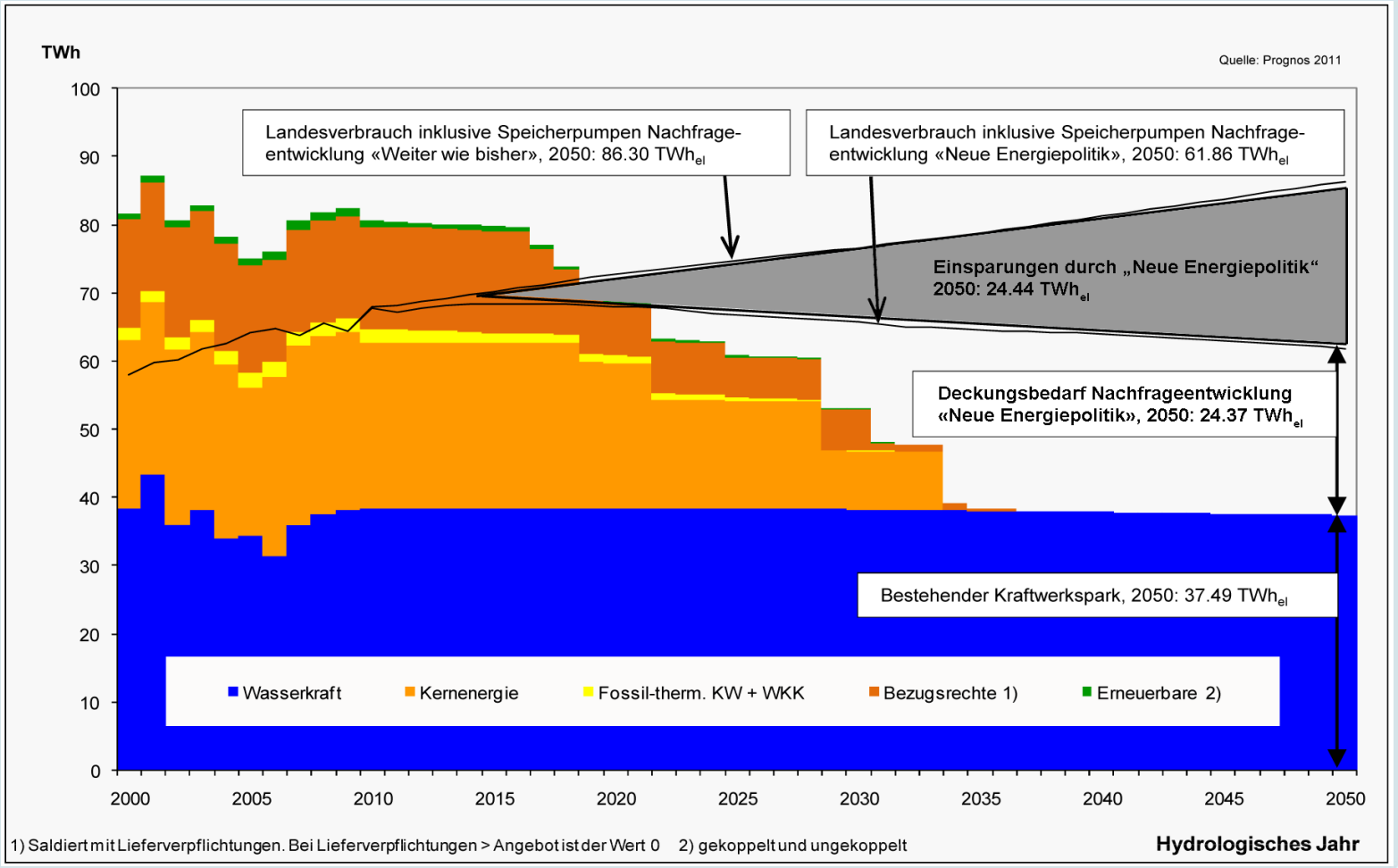
The on-going economic crisis will not be resolved quickly -
it will most probably mean less investments in renewable energies

What climate???

Switzerland:

an interesting case study

Sinkender Deckungsbedarf bis 2050 mit „neuer Energiepolitik“



Quelle: Prognos 2011

2050 energy strategy in Switzerland round numbers

2010:

- Domestic electric energy consumption: 60 TWh
- Domestic production & consumption balanced over the year.
- Domestic production:

	56.5% hydro	34 TWh
	38.1% nuclear	23 TWh
	5.4% other	3 TWh

2050 assumptions:

- «Business as usual» - consumption: 84 TWh
- Economies: 24 TWh => consumption: 60 TWh
- Hydro: 36 TWh
- New renewable energies: 24 TWh (predominantly PV and wind)

Shale gas

Massive shale gas reserves in many countries

Assumption: The total electricity generation by CCGTs with a net conversion efficiency of 55%.

Country/region	Technically recoverable resources [trillion m^3]	Net calorific value/heat value [PWh]	Total electricity generation 2009 [PWh p.a.]	Reserve life time [years]
USA	24.4	244	4.19	32
Canada	11.0	110	0.60	101
Mexico	19.3	193	0.26	406
China	36	360	3.70	54
Poland	5.3	53	0.15	194
France	5.1	51	0.54	52
Norway	2.3	23	0.13	97
Argentinia	22.0	220	0.12	992
South Africa	14.0	140	0.25	308

Rule of thumb: m^3 natural gas = 10kWh

Shale gas could be the «game changer» during the next decades

Conclusions

Energy challenges – energy affluent regions

Maintain standards of living – preserve potential for economic development.

Decrease the total energy demand **but using more electricity**

- Switzerland: 2 000 Watt society
- France: «*par 4*»
- Germany: «*Energiewende*»

Decarbonize production and consumption

- More hydro – more solar (PV & thermal) – more wind
- More heat pumps – more electric transportation

Bidirectional electric networks – **multi-energy** networks

Broad deployment of storage: multi-level and multi-technology

Distributed electrical systems

Energy challenges – energy poor regions

Provide for aspirations toward better living conditions – increased overall energy consumption per capita.

Accelerate the direct transition toward **electricity.**

Implement broad-based clean coal technologies for electricity production.

Ensure that major energy production systems will provide benefit for the local populations.

Enable the development of electric energy transmission and distribution infrastructures.

Develop specific end-use technologies suitable for local deployment conditions.

Support the local education and training of well-qualified professionals to build and then operate modern energy supply and utilization systems.

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