

The Coming Energy Market

Economic and business implications of technological, geopolitical, and regulatory factors



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PART 1: The Coming Energy Market

Economic and business implications of technological, geopolitical, and regulatory factors

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On November 14 and 15 in Madrid, ESADEgeo co-sponsored – together with KIC-InnoEnergy, Boston Consulting Group, and the Aspen Institute España – a dialogue to discuss how energy technologies, geopolitics, and regulation will impact in the medium-term on business and society. We focused on the overall energy market and distilled the major implications for general business, energy-consuming and energy-supplying industries, and public policies. The dialogue was attended by over 70 top global business leaders and policy-makers, and included leading experts, businessmen, and policy-makers as speakers.

The meeting built on the following premises: energy is central for humanity and at the same time is complex, global, and multidimensional. Policy-makers must therefore ensure the appropriate integrated and global governance of energy. At the same time, business must try to make sense and foresee the near future by taking into account very different dimensions. There is, thus, a clear need to combine cutting-edge knowledge on the state of energy-related technology, regulation and policy, and geopolitics.

The relevance of energy

Poor progress towards the 2° C target

The *World Energy Outlook 2011* confirmed that we are not on track to reduce global warming. If the current trend in energy production continues, the Earth's average temperature will be more than 2° C higher in 2100 than before industrialisation, irreversibly harming the planet and conditions for human life.

Other and more immediate crises are almost completely occupying world attention, distracting governments and citizens alike from the energy challenges ahead. In the United States, there has been no energy debate at the federal level for many years; the European Union is in the eye of a financial hurricane; and the emerging countries want to maintain rapid economic growth and lift millions out of poverty.

In this context, the last meeting of the United Nations Framework Convention on Climate Change (UNFCCC), held at the end of November in Durban, South Africa, produced no advances on climate change prevention. Fortunately, the parties decided to continue negotiating an international agreement.

Energy-related GDP amounts to 10%-30%

Energy is fundamental for humanity, not only because of its potentially negative externalities, but also because of its economic relevance: western countries spend 8-10% of their GDP on energy, and developing countries spend double or triple that amount. For this reason, we need a system to govern energy.

Governing energy: incorporating all the dimensions

Energy must be governed globally and holistically

Owing mainly to its environmentally negative externalities, an unregulated energy market is not a useful governing mechanism because it is unable to internalise environmental costs. It has been calculated that the most contaminating energy sources would have to bear a 70% tax to reflect their negative externalities.

A substantial lack of information in this field is another reason why the free market does not work. Often, as with the properties of a gas reserve, for example, information is technically difficult to obtain. In addition, governments consider natural resources to be strategic and so do not release relevant information. Finally, time frames related to energy are usually long: centuries for environmental effects or decades for returns on investments. Thus, energy must be governed through a system of cooperation and regulation.

This will be a complicated task. Managing energy requires simultaneously taking into account technical and political dimensions.

The state of energy technology

We need to integrate the different disciplines regarding energy-related technology and reject the idea that technology has the answer to all our woes.

The need to evaluate energy technologies integrally and realistically

Energy exploration and production requires many different disciplines and technologies – such as wind, photovoltaic, nuclear, and coal. This variety undermines an integral vision of energy. We need to realistically evaluate the short/medium-term potential, in terms of cost and capacity, of the various technologies: including renewable energy, electricity storage, nuclear power, and shale gas.

Technology as a magic silver bullet is unrealistic

Moreover, technology as a magic silver bullet is unrealistic¹. Let us take carbon dioxide capture and storage (known as CCS) as an example. After being hailed as the ultimate solution, carbon capture has been found to have unpleasant consequences: processes are less efficient than expected; plant capital costs are higher, and more coal is consumed. Other problems include the fact that pipeline systems to transport the CO₂ would have to be huge; existing plants cannot be retrofitted; and the fact that there is no large-scale coal plant in existence using CCS². Similar uncertainties and doubts affect other new energy technologies, such as shale gas.

Moreover, uncertainty increases as one follows the climate change causal chain³: emission; atmospheric concentrations; global warming; climate change; and impacts on human welfare.

¹ John M. Deutch, *The Crisis in Energy Policy* (2010), Harvard University Press.

² (Deutch, 2010)

³ (Deutch, 2010)

Policy & regulation

Energy must be governed via regulations and policies. We therefore need to understand the latest projects and tendencies of energy regulatory policies. We need to identify specific policies that advance and influence the energy market in different ways.

Political interests and public attitudes are fragmented and contradictory

Fragmentation also exists in the political sphere, where industrial and economic sectors are organised – but divided.

Deutch⁴ considers that the US failed its energy policy because of:

- Adoption of unrealistic goals
- Public attitudes and dilemmas
- Competing national and international interests
- Absence of quantitative analysis and planning

Rigorous analysis and planning are necessary for energy policy

Spanish regulation of solar energy is unfortunately infamous in this respect. Indeed, a group of foreign energy investors is seeking arbitration in a dispute with the Spanish government over Madrid's unexpected cuts last year in solar energy tariffs. Arbitration is being made under the terms of the Energy Charter Treaty.

⁴ (Deutch, 2010)

European-level energy policies are particularly challenging

In the case of the EU, energy policy becomes particularly complex due to limited sovereignty. The European Commission unveiled its proposed 'Guidelines for Trans-European Energy Infrastructure' on 19 October 2011. This proposal aims to ensure that strategic energy networks and storage facilities are completed by 2020. To this end, the Commission has identified 12 priority corridors and areas covering electricity, gas, oil and carbon dioxide transport networks.

Geopolitics

Geopolitics in the energy field is notoriously important. We need to better understand the worldwide economic and business implications of a dynamic geopolitical landscape.

Important dynamics unfolding: Russia and China

Beyond the transfer of power from west to east, other interesting dynamics are unfolding:

- The Nord Stream gas-pipe has recently been opened and this will affect the European energy dependency landscape.
- 'Energy is an instrument of geopolitical competition, like nuclear weapons or large armies were during the Cold War. For Russia, possession of vast oil and gas resources fulfils a function similar to its nuclear weapons in the Soviet era⁵'.

⁵ Russia, China and the geopolitics of energy in Central Asia. 2011. Center for European Reform.

- 'China's modernisation and rise as a superpower depends on securing reliable access to natural resources. Beijing has responded to this imperative by making the worldwide search for energy one of foreign policy priorities,'⁶.
- Other interesting geopolitical dynamics include: China is attracting investment to its unruly western and Muslim rural regions from the Gulf Cooperation Council (GCC) in order to diversify energy sources but also to avoid unrest.

Inadequate multilateral institutions for global market and global externalities

The energy sector exemplifies the inadequacy of our multilateral institutions. Energy policy is national, but the sector's externalities are global. A radioactive leak, the rupture of an undersea oil well and, above all, CO₂ emissions threaten many nations. However, energy's benefits adhere to specific agents, be they consumers, producers, or sellers. This imbalance creates a clear incentive for free riders who benefit while costs are covered by others.

Moreover, global governance is necessary because energy supply and demand around the world are disconnected. Few countries have a neutral energy balance. Oil, the world's main source of energy, is indicative in this regard. The Middle East has a 266% commercial surplus of oil, and the US a 65% deficit. This geographical imbalance requires an ordered system of trade, clear regulations, and a well-regulated global market. Today, however, opaque bilateral agreements abound, and very different environmental requirements and contradictory subsidies coexist.

⁶ (CER11)

As a result, our global energy institutions are woefully inadequate. The International Energy Agency admits only OECD countries, which excludes China, the largest energy consumer. The intergovernmental Energy Charter Treaty, which obliges signatories to apply impartial market rules to energy products and services, has not been signed by the US, the world's second largest energy consumer, and has not been ratified by Russia, the world's largest oil producer. World Trade Organization agreements apply to energy only tangentially, because energy is considered an exhaustible natural resource, and is often exempt from the rules.

Current multilateral system has a Western imprint

Moreover, non-Western countries – which include big consumers such as China and India, and the largest producers (the Gulf States and Russia) – do not trust an institutional system created mainly by the West. The emerging countries rightly argue that the West is responsible for today's climate-change problem. Until very recently, Western development following the industrial revolution was free of any environmental restrictions, and the emerging countries believe that they should not have to bear the adjustment cost. Likewise, producing countries oppose giving up one of their few power bases.

The solution must include a new institution. Perhaps, it would be a good idea for the world's largest emitters to initially negotiate through the G-20, or a similar body for energy. Negotiations could then be opened to all states, placing them under the ambit of the UNFCCC, for example.

The focus of the negotiations must be comprehensive, aiming at emission limits and financial and technological support for energy sources that are less harmful to the environment. Limiting emissions would impose costs disproportionately on oil-exporting countries, and on consumers in emerging countries, where technology is less sophisticated.

Coal is a key issue in climate change negotiations

A key issue in these conversations is coal – since it is cheap and widely available⁷. Coal is expected to remain a proportionally constant source of primary energy (26%) until 2035. During this period, US coal emissions will grow by 0.7% and 3% for China.

As reviewed here, energy governance is a complex, multi-dimensional endeavour that must be dealt with in a systemic manner. In the following section, we drill into some of these energy governance's key dimensions, providing the reader with the state-of-the-art in this field.

⁷ (Deutch, 2010)

PART 2: Technological, geopolitical, and regulatory factors

The following is based on the conversations held during the forum “The Coming Energy Market: Economic and business implications of technological, geopolitical, and regulatory factors” held in Madrid on November 14 and 15, 2012. All possible errors and omissions are ESADEgeo’s sole responsibility. The speakers’ presentation materials are available at www.esadegeo.com.

The role of innovation and technology in the energy sector⁸

A 1% decrease in the cost of energy could save Europe some €20 billion per year. This would increase the welfare and competitiveness of the European economy. Technology can make such a drop in costs possible. KIC InnoEnergy was constituted in 2010 and aims to develop technology that lowers costs, lowers green gas emissions, while increasing operability.

Designated as a one of the first three Knowledge and Innovation Communities (KICs) by the European Institute of Technology, KIC InnoEnergy is a world class alliance of top European players with a proven track record. The alliance consists of 30+ shareholders and additional 50+ partners - companies, research institutes, universities and business schools covering the whole energy mix. The alliance are organised around

⁸ Based on a talk by Diego Pavía, CEO, KIC InnoEnergy

six regional units, the Co-Location Centres (CC): Alps Valleys, Benelux, Germany, Iberia, Poland Plus and Sweden. KIC InnoEnergy currently has €1 billion of capital to invest in energy technology research and innovation.

However, energy technologies are extremely dependent on adequate regulation. As an illustration, the current development of renewable energy would not exist without appropriate climate change regulations. Other examples of policy and regulatory impacts in the energy sector include France's freeze on shale gas exploration, or the announcement by presidential candidate Mr. Francois Hollande (on November 15 2011) that he intends to phase out 24 of the 58 nuclear plants in France. Technology and policy are extremely intertwined in the energy sector.

Renewable energy sources⁹

Energy, with water and food, is one of the basic ingredients for human life and development. Currently, the predominant global source of primary energy is fossil fuel (oil, gas, coal) and it represents 87% of primary energy consumption. There are serious consequences of such a context, in particular the non-sustainability of a system that generates environmental problems, remains highly price volatile, and is based on scarce resources. There is, therefore, an urgent need for change. The new mantra is to reduce the carbon content of our primary energy mix. This can be achieved through several complementary approaches: (i) more efficient transformation of energy; (ii) less use of fossil fuels; (iii) increased use of renewable energy and nuclear; and (iv) a cleaner use of coal.

However, the use of renewables presents two main problems. Firstly, the cost of renewable energy is still higher than the current cost of competitive sources. The roadmap for a decrease in costs of renewable technologies consists in scaling the plants, finding cheaper components and materials to produce the plants, reaching a level of mass production for the components, and improving operations and maintenance, which is currently on a high-speed learning curve.

The second problem relates to the intermittence of electricity production from renewable sources. Both dimensions of the problems can be tackled by intelligently

⁹ Based on a talk by Cayetano López, Director General, CIEMAT

combining technology and policy. The current global market in renewable energy is an example of such a smart combination.

Technologies

Wind power has currently 200GW of installed capacity worldwide, the equivalent of half the installed nuclear capacity. The costs of wind power are falling with improved designs for blades and materials that have dramatically increased the size of the turbines.

There are two main technologies for solar energy generation – photovoltaic and concentrated solar power (CSP). In traditional photovoltaic approaches, plants do not necessarily produce at peak demand. Concentrated solar photovoltaic techniques enable production with ‘differed’ timing that mimics production during peak hours.

Despite suffering difficulties for storage, photovoltaic (PV) techniques have benefited from an amazing learning curve and costs are collapsing. The sharp learning curve relies on support from public administrations. Solar feed-in tariffs create distortions in market supply and demand curves while changing the equilibrium. Large-scale experimental projects such as DESERTEC and MENA in North Africa are especially important, and only make sense when combined with the means to transport the electricity to Europe.

Biofuels can substitute fossil fuels such as ethanol and diesel for vehicles. However, energy is needed to produce the biomass, reducing the overall balance of

energy produced in the life cycle. The increased use and production of biofuel needs political will, R&D, investment, and the creation of an industry.

Costs

In the Spanish case, forecasts predict that market-competitive costs will be reached for wind energy in 2017, for solar photovoltaic energy in 2023, and for concentrated solar energy in 2026. Obviously, if fossil fuel prices fall then the market-competitiveness of renewable energy would be delayed.

Currently 87% of our primary energy comes from fossil fuels. With R&D efforts and adequate feed-in tariffs up to 50% of primary energy could come from renewables. R&D subsidies for nuclear power are currently four times higher than for renewable energy. Subsidies need to swing from nuclear to renewable energy to make the plan sustainable.

Spain and Europe as frontrunners

Spain scores comparatively high when compared to other countries for usage of renewable energy. It ranks second in percentage of power generated by wind, and fourth for installed capacity. The development of wind has had the collateral effect of creating a new and dynamic industrial sector. Currently, the Spanish utility firm Iberdrola ranks first as a worldwide operator of wind power. The current challenges faced by the wind industry include mastering offshore generation with costly and complicated civil engineering; as well as mastering 'small wind' generation – that is,

small turbines installed directly at the residential and consumer level. The latter is of particular interest for electricity supply in areas isolated from the grid.

Europe pioneered wind power generation in 2004. The US followed and Asia has been the late-comer. However, Asia has experienced the steepest slope.

Solar is starting to be visible on the Spanish generation mix, reducing significantly the emissions per unit of electricity produced. Of the 20% of energy mix targets, 13% has already been achieved. Spain has been the frontrunner in concentrated solar plants, with the '*Plataforma Solar de Almeria*', a 25-year old project that has recently gained increased importance.

To sum up, the near future of energy and environment challenges are clean energies. The latter will only be developed with the support of investments, common EU regulations, and the creation of extended and reliable interconnections.

The development of technology for unconventional gas¹⁰

Gas is an important element for the future of energy as it is the cleanest fossil fuel. The production of unconventional gas since 2007 has experienced a notable growth. Unconventional gas and oil have potentially large reserves. However, it is difficult to estimate these reserves precisely due to the lack of technology and continuing exploration efforts. Current figures estimate a total of 190 tcm, with 26 tcm in China, 25 tcm in the US, 22 tcm in Argentina, 19 tcm in Mexico, and 14 tcm in the RSA. In Europe, the countries with the most potential are Poland, France, and the UK. In comparison, the countries with most conventional gas are Russia, Qatar, Iran, and Iraq.

It is estimated that unconventional gas will represent 7% of the total share of energy sources by the year 2026. Without the development of these unconventional reserves, there will be a shortfall in gas supply. Current gas prices are around \$4/tcf in the US and have risen from \$12 to \$18/tcf in Japan after the nuclear crisis.

Technology & environment

Unconventional gas relies on very different technologies to conventional gas. Gas extraction depends on factors such as geology, geochemistry, and structure – as well as complex technological and screening criteria. The technology was developed in the early 1980s in the US and horizontal drilling techniques played a prominent role.

¹⁰ Based on a talk by Professor Stanislaw Nagy, AGH University of Science and Technology

The common wisdom for unconventional gas emphasises its negative environmental and health impacts. The most important impacts being surface management, chemical disposal, fracturing, water and emissions, and the fact that energy is needed to produce gas. These difficulties are underpinned by regulatory uncertainties. However, it is argued that the number of production incidents reported in the US (as represented in 42 US Environmental Protection Agency reports) is small relative to the scale of operations.

The public perception of unconventional gas greatly differs from area to area, with 70% of the Polish population championing its use.

However, analyses of the costs, impacts, and benefits of unconventional gas still lack data. For example, total carbon emissions – including energy use for production and direct emissions of methane and CO₂ – are still unclear. Many see gas as the bridge from coal and oil to renewables; and as a key element in the foreseeable future with lower CO₂ costs and geopolitical complexities than oil.

Nuclear energy¹¹

Nuclear is still of interest for the future of energy. It is mature, reliable, and carbon free with generating costs that are stable compared to electricity generation that relies on fossil fuels with volatile prices. Moreover, nuclear generation has significant synergies with renewable energy. In particular, the latter can work at peak and nuclear can act as a baseload. Nuclear power may also be the key for self-sufficiency with little fuel needing importation.

Nuclear energy greatly reduces need for using or importing fossil fuels. In France, for example, 25% of total income generated by all exports is spent on importing fossil fuels. For Spain, that figure raises to 66%.

However, there are major difficulties in gaining public acceptance.

Safety and waste management

Nuclear power has drawbacks in the safety of reactors, the risk of proliferation, and the challenge of long-term waste management. The accidents in Chernobyl and Three Mile Island led to the so-called nuclear winter, a period with little knowledge transfer to new engineers and no new developments of plants. The result at the end of that period was a network of aging plants (27 years old on average with most plants designed for a maximum life of 40 years).

While, current technology has reached a high standard of safety – especially the III EPR generation of plants – there are three improvements possible to further raising

¹¹ Based on a talk by Bernard Boullis, Director of Nuclear Energy Division, CEA

the safety of nuclear plants: (1) creating complementary, comprehensive safety assessments; (2) sharing at an international level the lessons drawn from the Fukushima accident, notably under the IAEA; and (3) strengthening the organisational aspects in case of a severe emergency.

Generation IV power plants will use recycled fuel, lower the volumes of waste, and bring about a major reduction in the toxicity of fuels. This is a major improvement, as currently there is not a single final repository in the world for waste management.

For new generation nuclear plants, the international fusion research project ITER will be an important source of information and research on waste management. In addition, European regulatory agencies are currently cooperating to share knowledge and develop common best practices in waste management.

Fuel-reprocessing plants imply nuclear proliferation risk. Particular attention must be paid to: access to material at sensitive points of the reprocessing cycle; inspections of plants; and the strategic value of the material by mixing other products.

Nuclear power may be the energy of the future with potential for significant improvements in safety and waste management. However, a great effort will be needed to explain nuclear power issues to gain public acceptance. This social legitimacy issue remains one of the main challenges for nuclear development.

Electricity storage¹²

Energy storage has developed mostly in relation to the following areas: (i) consumer electronics; (ii) vehicles; and (iii) electricity grid. R&D efforts tackle such issues as energy density, safety, storage lifetime, cost, and power efficiency. Each area directs its R&D differently. For example, consumer electronics focuses on energy density, while consumer cars on safety. Regarding the grid, increasing lifetime, reducing cost, and reaching higher levels of scalability are the pressing needs.

Currently, grid-related research is mostly concentrated on how to efficiently integrate renewables. Due to their nature, most renewable sources of energy generate intermittent electricity (e.g. solar, wind), with high variations of production and limited capacity to control these variations. In the absence of storage, renewable sources need back-up generation capacity, often from coal or gas, to fill-in the irregular supply. Batteries can be a partial solution, since they smooth the impact of intermittence on generation and price volatility.

Batteries for vehicles are part of a strategy to diversify sources of energy in the transport sector. Together with liquid fuels, gas fuels, and hydrogen cells, electric batteries can reduce significantly the dependence on oil for transportation. Immediate challenges for the development of batteries for vehicles include safety, cost, environmental impact (on disposal of batteries as well as the source of electricity), and availability of raw materials for large-scale production. The current autonomy of electric vehicles (200km) and charging times are sufficient, according to studies, for the use

¹² Based on a talk by Torbjörn Gustafsson, Professor at Uppsala University

made by the average car driver. However, this autonomy is still quite limited and might not be suitable for all users. If all vehicles were to become electric in a country such as Sweden, electric energy demand would increase by 15%, if charging took place during off-peak moments of electricity demand—this, however, must yet be further explored since the study of electric car users' charging patterns is yet inconclusive.

Another crucial research concern regards the exploration of new materials for the positive electron of batteries. Current materials used are manganese and lithium, while researchers are testing silicium, lithium, and ferrous fluorine. Noteworthy for the search of new materials is that batteries are non-fungible and can be recycled (unlike fossil fuels). This property reduces greatly the need for newly extracted raw materials. In addition, some of the new materials considered are widely available.

India and energy¹³

India's energy and international affairs nexus can be broken down into five dimensions: access, technology, demand, horizons, and cooperation.

India's five global energy dimensions

(1) Access – in India, promises of electricity access, with road and water access, can win local elections. Access to water is key to survival, while road access is key to equality. Access to water in many cases is heavily reliant on access to electricity for electrical pumps. However, 55% of electricity is generated by coal, which is both imported and mined domestically. Only half of Indians are connected to the grid.

(2) Energy technology development, in particular for clean technologies, greatly depends on access to finance and investors. Such investors and finance are difficult to reach and design is quite complex.

(3) Oil demand is rising, but India has good refining capacity and has just developed a strategic oil reserve. Coal production is down. Thus, demand for imports from both crude oil and coal have risen. Moreover, despite the existence of some coal reserves, India is unlikely to become self-reliant.

(4) Horizon: India has great potential to develop renewable energy, a potential that is currently under-utilised. This is due to the lack of political will and investment, which has slowed since 2008. Some of the investments have an international component and begun a descent even before the global recession, most likely due to

¹³ Based on a talk by Arunabha Ghosh, CEO of the Council of Energy, Environment and Water

the lack of stable policy signals needed by investors. The need for heavy investments to develop clean technologies makes the case for cooperation between India and other countries.

(5) Cooperation: India is still not an active member of the 'energy clubs', nor is China. However, both are needed in order to build an active and regulated energy regime. And Both China and India need to get involved in the international energy governance institutions. For example, as China has no strategic oil reserves, bilateral agreements and secured equities in oil production will not be enough to secure its supply in time of crisis.

Four future global energy scenarios

Four future global energy scenarios are identifiable by combining two dimensions: (i) fragmented or integrated governance; (ii) different institutions with conflicting or consistent set of rules. Currently, the regime is fragmented and involves conflicting rules. For example, WTO rules conflict with OPEC and with the current climate change regime of subsidising renewable energy. The global aim must be to achieve a regime with integrated institutions and complementary rules. such a regime would involve coordinating the Energy Charter Treaty, the International Energy Agency, and the WTO, and where Russia, India, and China are active in all these institutions.

The view from a major oil and gas company¹⁴

Emerging countries will drive markets in the near future. These countries will increase in population and GDP per person and drive a major increase in demand. Moreover, the share of energy-intensive industries increases as countries develop. Thus the energy/GDP ratio increases as countries develop and diminishes as countries move to white collar and value added sectors such as finance and services. This has been the path followed by the currently developed nations, where the energy/GDP slope has been negative since the 1970s. This is the same as saying that there will be an increase of 'productivity of GDP per BTU'.

Increasing demand for all energy sources

In the next 20 years we will see a significant role for renewables in the growth of energy supply. However, all sources of energy are projected to increase in supply and demand. Oil will suffer from a lack of capital investment for new capacity during this decade. For example, OPEC countries will be using all their current spare capacity by 2020. OPEC countries will cover 75% of the increase in oil demand by 2030, and represent a hefty 36% of the global oil supply.

Gas demand will increase. Despite a new and growing supply from unconventional gas, it will not be enough to match demand in Europe and Asia, especially when taking into account the decrease in production from conventional gas

¹⁴ Based on a talk by David Peattie, Head of BP Russia

sources. LNG (liquefied gas) transportation will therefore be crucial for meeting the increase in demand.

This scenario described depends strongly on: projections of economic and population growth, in particular for China; the current global regime for climate change; the predicted energy security strategies in particular for the US, EU, and China; and most importantly, expected technological breakthroughs.

China and global energy¹⁵

China is playing a leading role in the global energy market.

Central Asia has become an important supplier for China. An important change occurred in the wake of the fall in Central Asia of the former Soviet Union. Central Asia was previously an internal supplier of the former Soviet Union, but is now turning to new markets, in particular China. A promising project is the gas pipeline linking Turkmenistan with China, which has been recently inaugurated and has great potential to expand to new countries, for example Kazakhstan.

The Middle East obviously continues to retain its importance for China. It has also been building important oil and coal reserves. And nuclear power is gaining a significant role in the Chinese energy mix – with several plants currently commissioned.

Chinese demand of natural gas will increase dramatically, with important levels of imports from liquid natural gas (LNG). However, it has proven more difficult for China to secure access to gas reserves abroad than it has been for oil: host countries (particularly Russia and Central Asian nations) avoid production sharing agreements.

The sustainability of its current strategy to tackle increasing energy demand is a growing concern for China. For the rest of the world, a concern is the lack of transparency and understanding of Chinese markets, making predictions for global markets unreliable. A key issue for the future is how both questions will be tackled:

¹⁵ Based on a talk by Professor Xiaojie Xu, Professor for the International Energy Program, Institute of World Economics and Politics, China Academy of Social Sciences

increase in China's needs of supply and the world's lack of understanding of China's energy market.

An adequate energy regime

There remains the need for a new global regime that works on a bilateral or multilateral level. The reform of current institutions (WTO, IEA, G-20) and/or the creation of new ones is necessary. Key areas in need of consensus include: changing North-South relations, abolishing the nowadays impractical Washington consensus, changing the infamous Chinese-African resource-centred relationships; and climate change talks.

Europe's energy policy¹⁶

Europe is the largest regional consumer and importer of energy products. Its objectives are to create a market that is efficient, open, sustainable, and secure for investment. More precisely, Europe is working to achieve its commitments in the 20-20-20 plan, with a reduction of 20% in carbon emissions, an increase of 20% in renewables in the energy mix; and a 20% increase in efficiency by 2020.

Interconnecting Europe

Europe is moving towards a well functioning internal market target by 2014. To reach this goal it will need further transport infrastructure investment: increased interconnections between members; and connections with external countries to increase the security of supply. Europe cannot secure energy for the future by itself and an aim of complete self-reliance is unrealistic. There is now a need to change external energy policy and develop a coherent internal policy – with unity among member states. Such a policy is necessary for successful external relations and sustainability.

External relation policies will be successful if combined with a coherent increase in physical interconnections. These interconnections will only be developed in a context of secure predictability for investments.

¹⁶ Based on a talk by Günther Oettinger, Commissioner for Energy, European Commission

Renewables and the European grid

The share of renewables could increase from 19% to 35%. For this sharp increase to be successful, investments need to be made in the fields of offshore grids, and the above-mentioned interconnections and smart-grids. The introduction of tariffs systems can provide vital support to investors. But even when incentives are put in place, the lack of public support might jeopardise investments. For example, the French-Spanish interconnection, the North-South German connection, and the Austrian electricity ring, have all experienced important delays.

These delays in capital injection in infrastructure are starting to become critical. Europe needs to be faster if its members want to have access to secure energy. Studies show that the barriers are at the granting of permits and public perceptions. The processes need to be more transparent and early communication is needed to increase trust.

In the current economic context, the EU must combine efficient energy policies and the competitiveness of European industries. Policies must be specifically sensitive to energy intensive industries.

A European external common energy policy

EU members need to focus on acting coherently in external relations – and achieving the internal objectives of 20-20-20 while increasing the capacity of the grid. The EU has not yet capitalised on the benefits of acting with one voice, although it has

been very successful when it has acted with a united front – for example in the resolution of the Russia-Ukraine dispute.

Despite the fact that Europe does not have a specific bureau of international energy affairs – unlike the Bureau of Energy Resources within the US Department of State – the European Commission’s internal relations are strong, for example between the directorates of external relations and energy.

The EU needs clear and common priorities with partner countries. This includes support for neighbouring countries to exploit energy efficiently with initiatives similar to DESERTEC for the North African development of wind and solar power (where 60% of the population still does not have access to electricity). For this to be successful, interconnections from Africa to Spain and France are needed. Currently, a 3-to-8 year scope of investments is being settled under the memorandum of understanding for Medgrid and DESERTEC.

A united voice could also enable more access to central Asia and the Caspian region. The EU’s aim for central Asia is to achieve a fair playing field with global open markets – and European diplomacy is already very active in the area.

As far as EU-Russia energy relations are concerned, the EU and Russia should partner only for Russian gas, while the EU should deal directly and without intermediaries with other producing countries.

A united voice could play an important role when cooperating with other consumer and importing countries. The EU should focus on R&D development, increased efficiency, and the creation of a stable global energy market. For renewable

energy, a common R&D effort with US, China, EU, and India is needed. Moreover, a binding global agreement increasing the limits for carbon emissions is possible – providing that the EU is not left standing alone.

Lastly, a united voice in energy could support EU tasks on international poverty alleviation by allocating energy-related investments as part of the EU's international aid development effort.

In conclusion, the road to 2025 and 2050 needs new perspectives. These new policies will require increased intensity in subjects such as greenhouse gas regulations, energy efficiency policies, and larger and smarter infrastructures.

European regulatory efforts¹⁷

How is the EU proceeding towards its 20-20-20 objectives by 2020, now that we are half way through the process?

20% renewables

It seems very likely that the target of reaching 20% of energy from renewables will be achieved as there has been a serious public push and support, especially with the introduction of feed-in tariffs. However, feed-in tariffs are also seen as a counter-productive mechanism because the costs are passed to customers in a similar way to consumption taxes. However, such a tax works regressively, since the poorest spend the highest percentage of their income on energy.

Another caveat of the renewable energy capacity increase via feed-in tariffs is that the technologies developed are ‘hand-picked’ – meaning that they have not been selected through open market competition. Unsupported technologies, such as carbon dioxide capture and storage or increased efficiency for coal and gas power plants, may prove more beneficial in reducing carbon emissions.

However, integrating renewable sources to the grid remains complex due to the intermittent nature of production. This production needs a grid that is resilient to changes and a power mix that allows for flexibility – depending on how much is being generated by renewables at a given time.

¹⁷ Based on a talk by Jean-Michel Glachant, Director of the Florence School of Regulation

20% efficiency

A 20% increase in efficiency gains is much less likely to succeed, as it has less public push. Mechanisms to support efficiency increases are more difficult to implement than feed-in tariffs. However, the goal is not impossible. For example, by introducing costs on the production of energy inefficient elements – such as light bulbs – the costs of reductions are passed to the final consumer. Another alternative is that utility companies are given the responsibility of reducing consumption by their customers in an approach similar to that taken in the UK.

20% reduction in greenhouse gases

Finally, a 20% reduction in greenhouse gas emissions is feasible and this is mostly thanks to the introduction of renewable energy rather than carbon emission caps. Interestingly, the introduction of renewable capacity has killed the price for carbon, therefore reducing the incentive to reduce emissions from other sources.

Ultimately, even if the 20-20-20 policy is successful, it may leave Europe in a dead-lock when negotiating objectives for 2050, both internally and at international levels. Tightening reductions may be difficult internally, especially if no other countries commit to a binding agreement. Moreover, even a 50% reduction in European emissions is insignificant when compared to the growth of emissions from big polluters such as China and India. Europe might be more able to impact on global emissions if it invests heavily in cleaner technologies in these countries and develops clean technologies that are adapted to their needs (clean coal for example). Moreover, the success of the 20-20-

20 target is highly uncertain because it is very sensitive to the development of the European economy.

Integrating European regulators¹⁸

The regulatory framework in Europe is changing. Europe's third energy package requires cross-border network rules (framework guidelines and network codes) to make a clearer and more level playing field for competition. ACER (Agency for the Cooperation of Energy Regulators) was created to reach that goal. The agency creates a framework for cooperation between national regulatory agencies (NRAs) and all European regulatory agencies must participate.

Another regulation change addresses energy trading: so far as financial authorities are responsible for the access and supervision of information from traders. Regulation on market integrity and transparency (REMIT) will transfer monitoring and oversight responsibilities to the energy NRAs and ACER. Another novelty under REMIT is the levelling of the regulatory regime for trading by introducing a European-wide passport for wholesale trading in electricity and gas. This will allow companies registered in one country to operate in all European markets. To do so, companies need equivalent regulations for accessing operations throughout the EU. Finally, an EC regulatory proposal will deal with the financial instruments to fund cross-border infrastructure.

In early 2011, the European Council established 2014 as a deadline to achieve a complete liberalisation of the internal gas and electricity market. So far, gas lags behind electricity in terms of liberalisation: it is a less transparent market, the unbundling of

¹⁸ Based on a talk by Tomás Gómez, Counselor for the National Commission for Energy

product and capacity is more difficult to achieve, and domestic consumers suffer from a lack of transparency and protection. For electricity, the path also remains unfinished and one main source of market distortion is the introduction of renewable energies.

Besides the cross-border regulatory issues, ACER is in charge of initiatives that integrate the market at a regional level as a first step to European integration. There are six regions for electricity and three regions for gas. The other main task of ACER is drafting network rules, more precisely, the framework guidelines and network codes.

CEER, the organisation that preceded ACER for cooperation among NRAs is still functioning and has new responsibilities in the analysis of sustainable development, financial services, security of supply, but most importantly, in improving customer care.

The addition of capacity can open the market, independently of how players respond. In any event, there are huge opportunities for trading.

The actual role of ACER is the first step towards enforcement. However, the institutions that have to act and issue sanctions are either the member states, or the European Commission and the European Court of Justice.

Currently, the most important issues are the harmonisation of the balancing rules and the unbundling of gas markets.

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Renewables: present and near future status

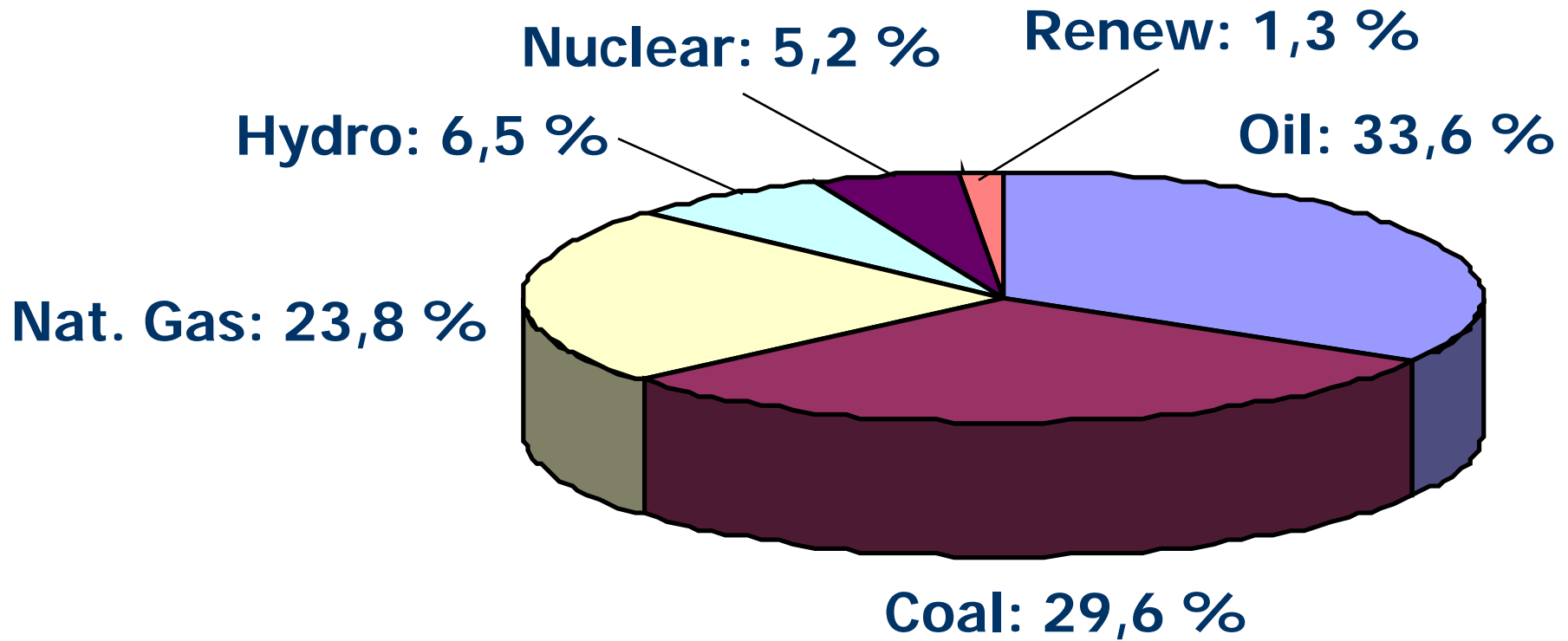
Cayetano López

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?)

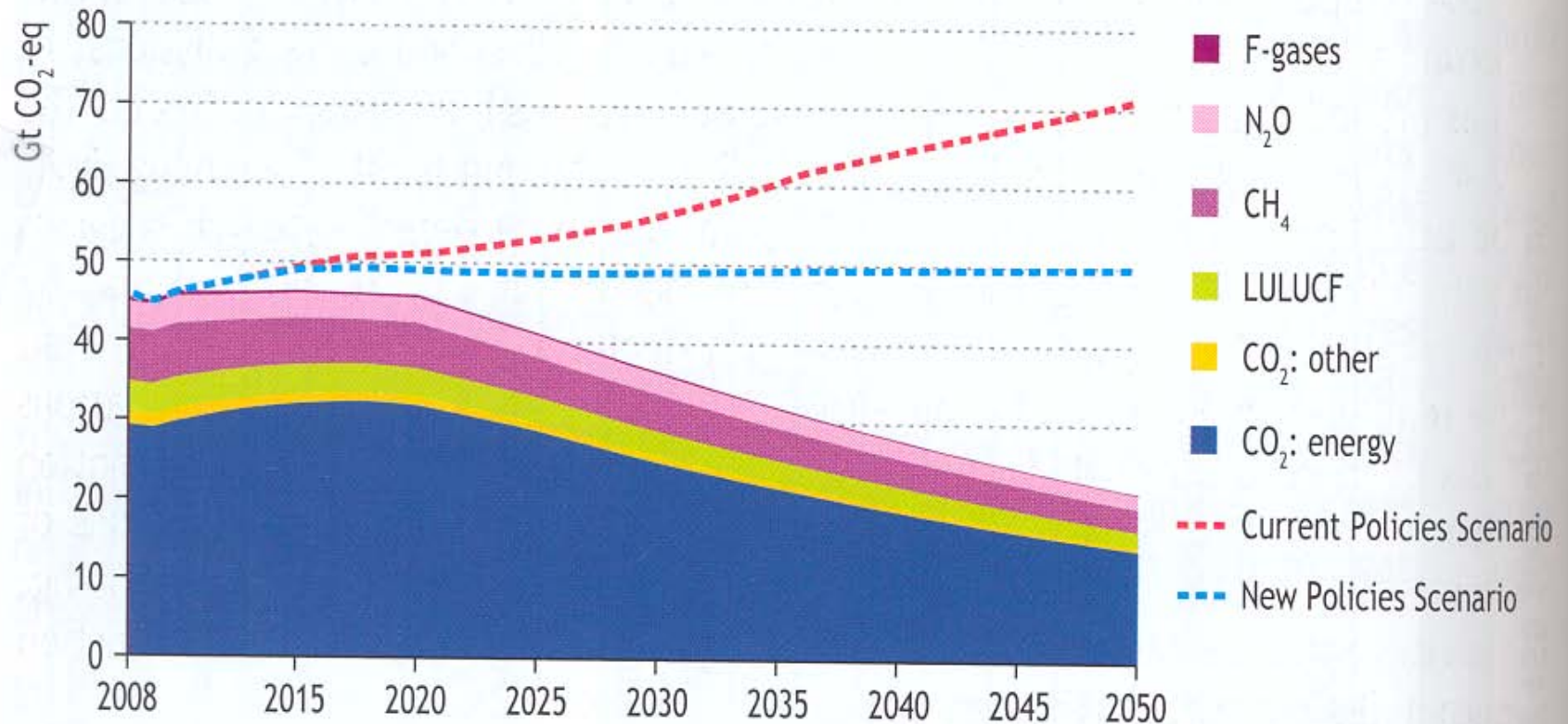
Possible clean use of coal (CO₂ capture and sequestration)

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 CO₂ 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 (SF₆) 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: Intermittency

Possible solutions:

Hybridation

Energy storage (electricity, heat, H₂)

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

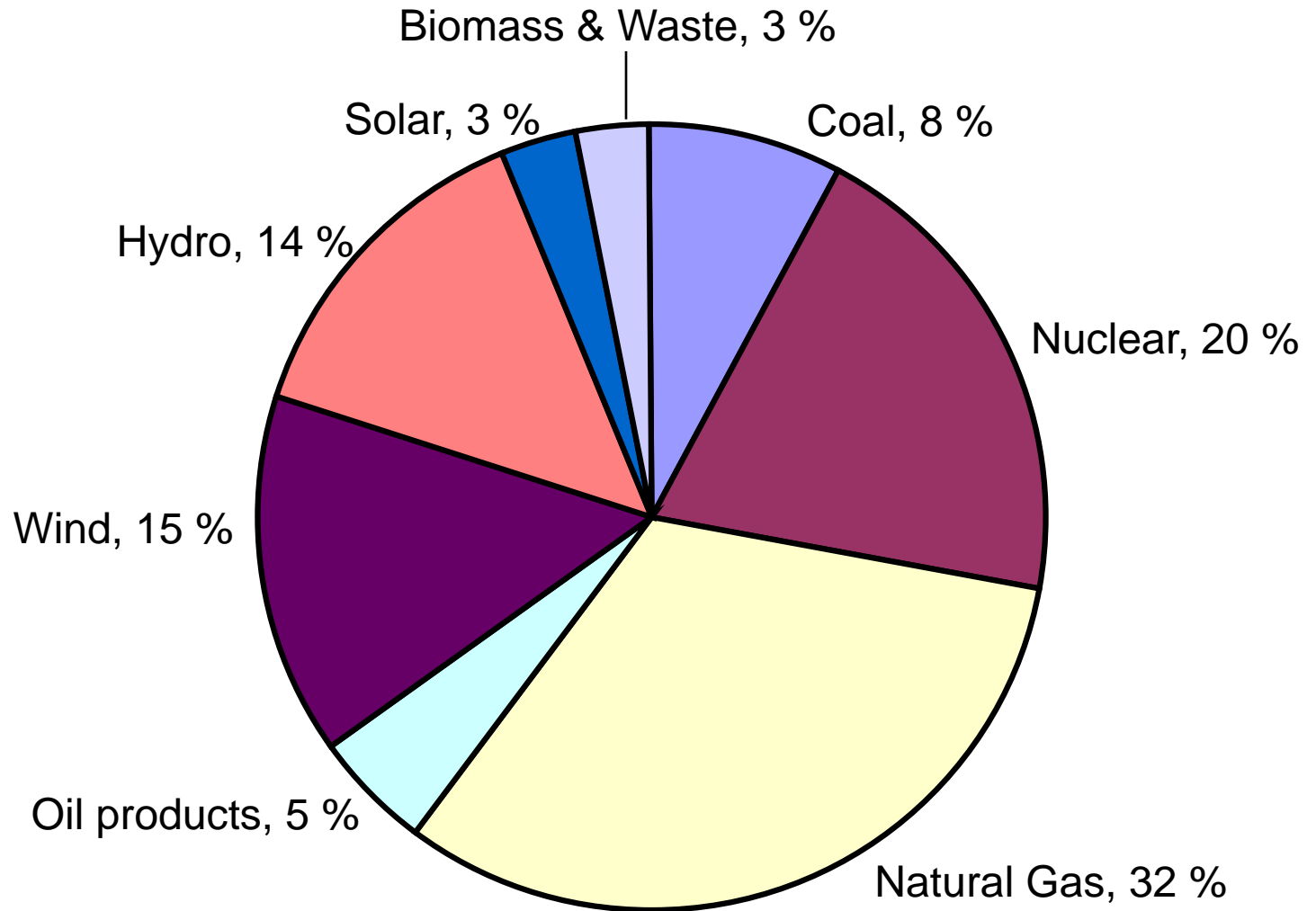
The wind energy market, Dec 2010

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.

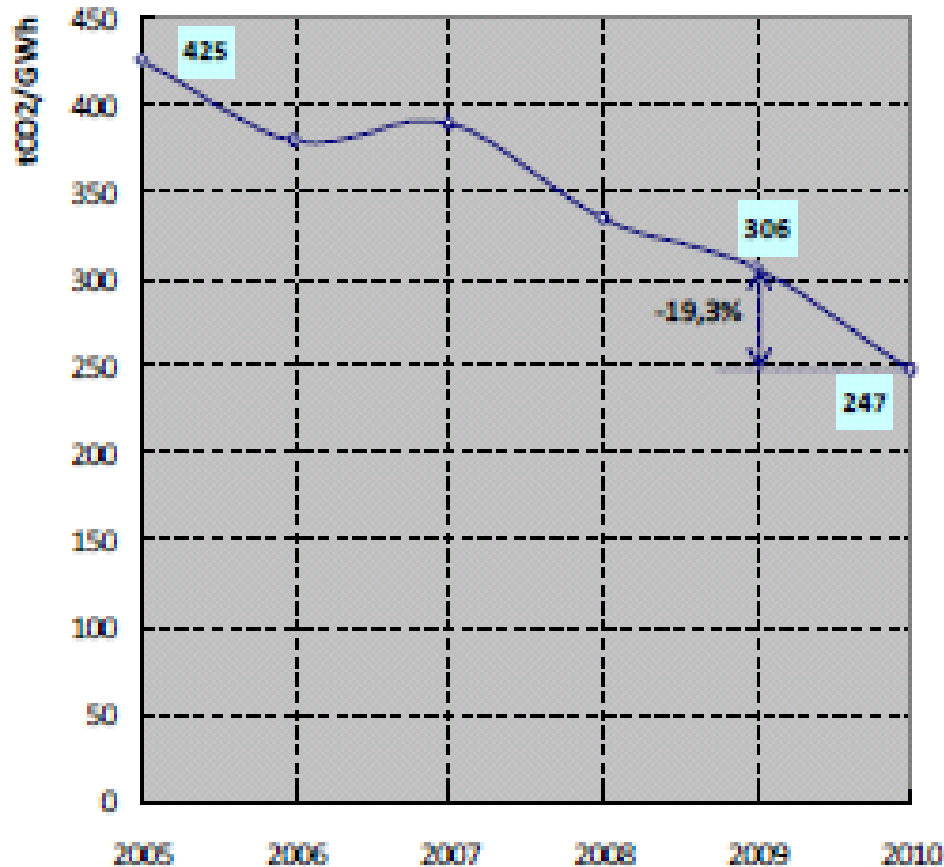
The goal for 2020 is to reach 25%

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

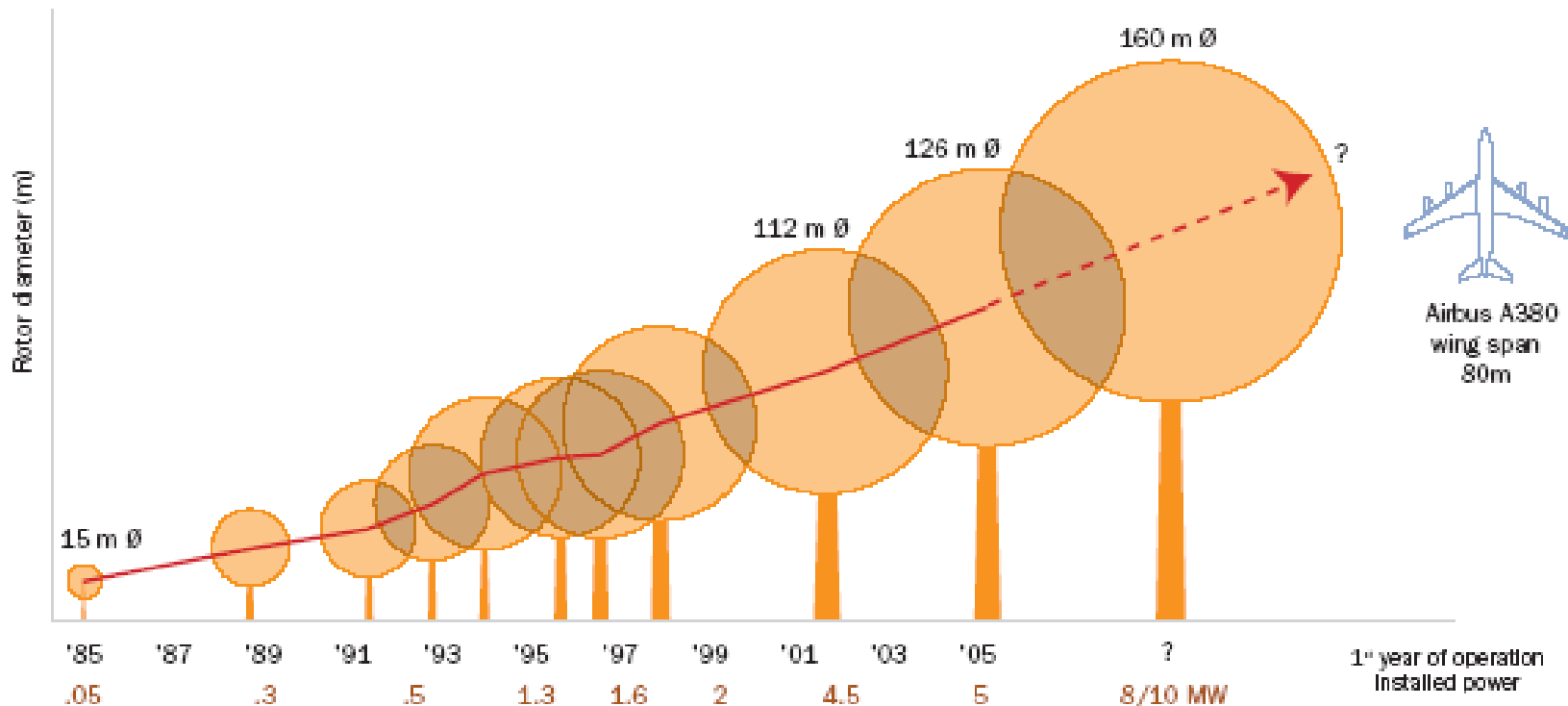
13,2 % in Final Energy

35 % in Electricity

5 % biofuels

Increasing size of the turbines

¿Is there a limit in turbine power?



A dynamic industrial sector in Spain

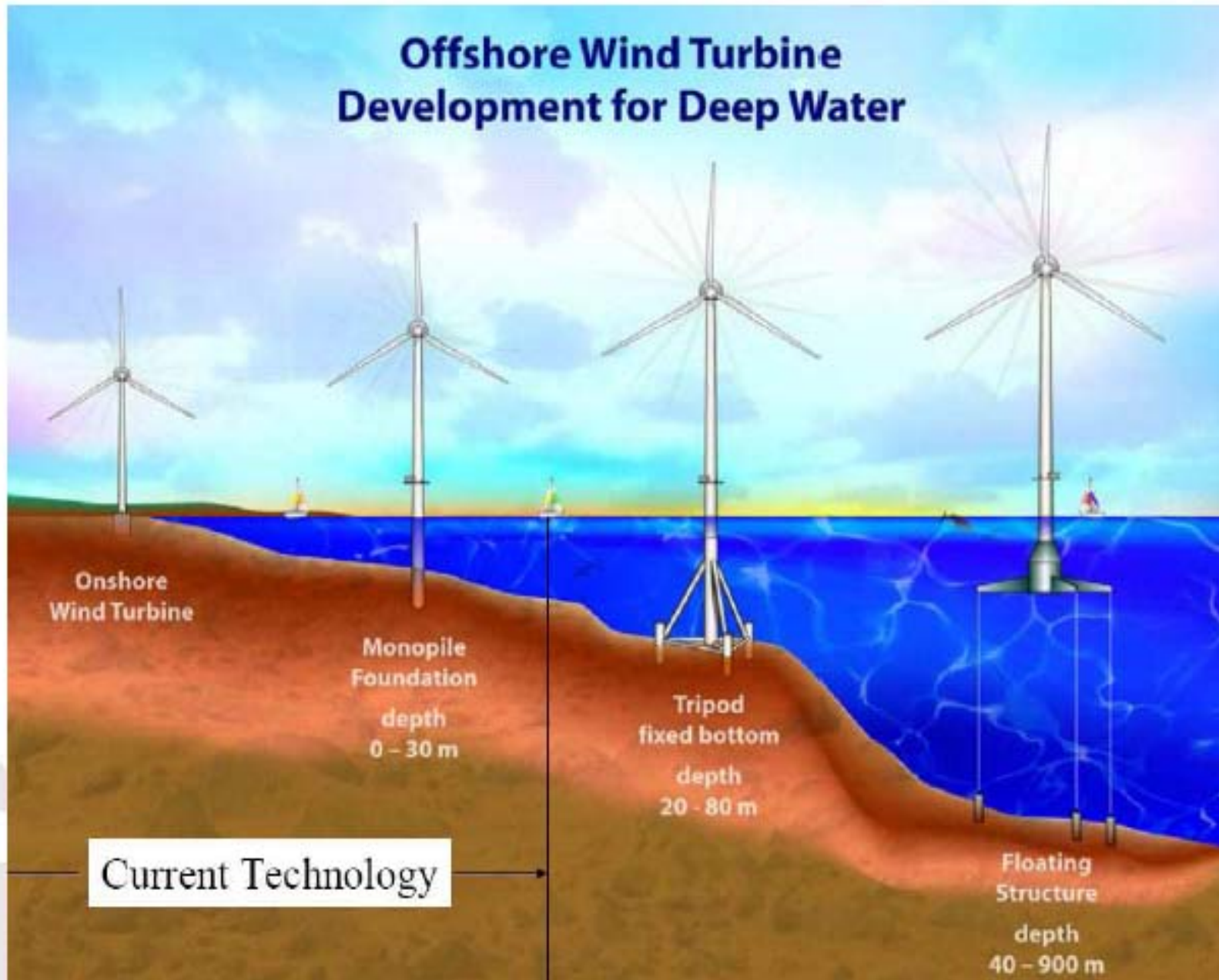
Table 1. Largest Wind Markets and Domestic Wind Companies²

Country	Cumulative Wind Capacity (2006)	Leading Domestic Wind Companies	Percent of Installed Turbines Made by a Domestic Company (2006)
	(MW)	(Global rank in 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), Ecotecnica (#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 cons

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

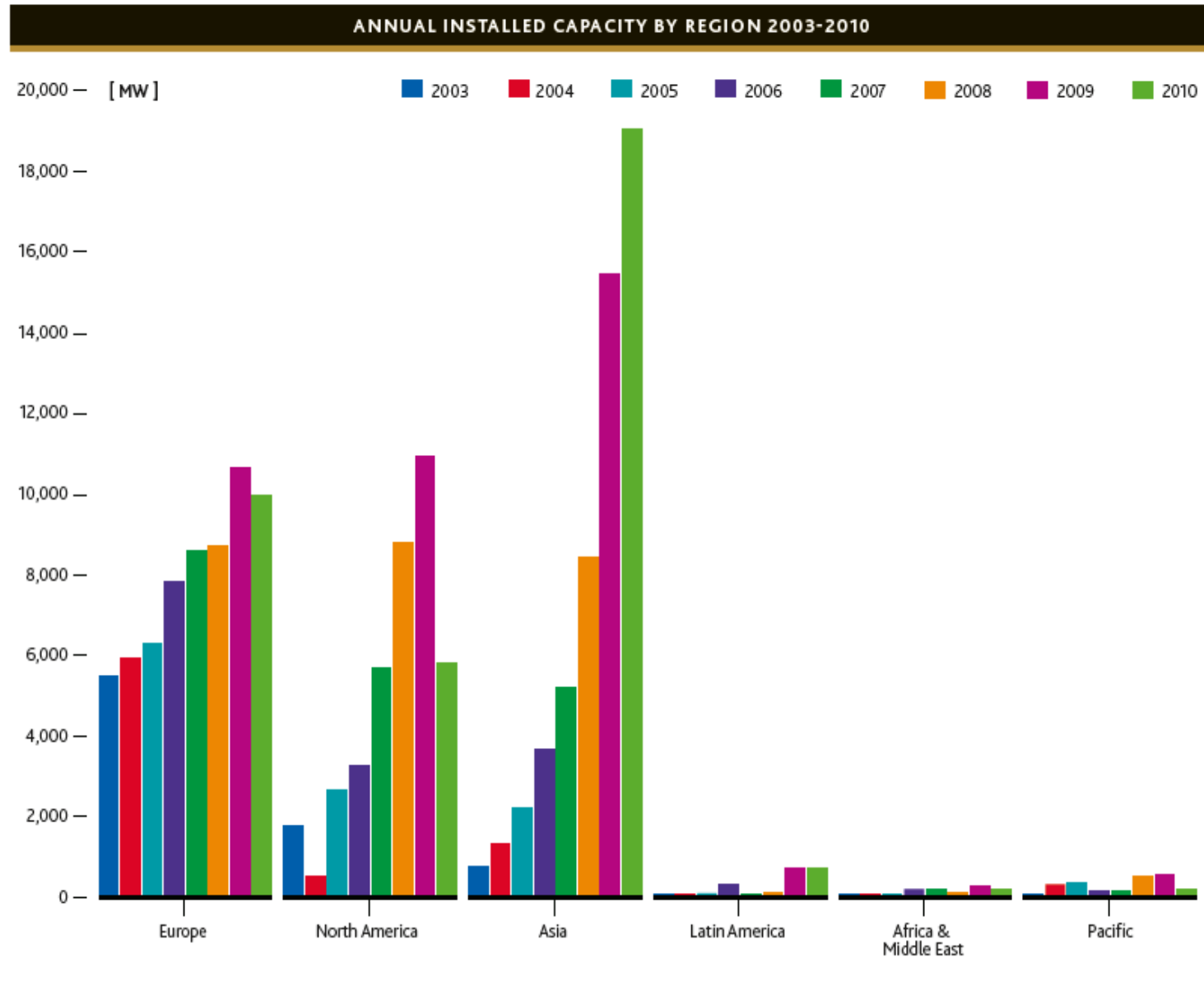
Lower visual impact

Reduced transportation losses

Easy installation, reduced civil works

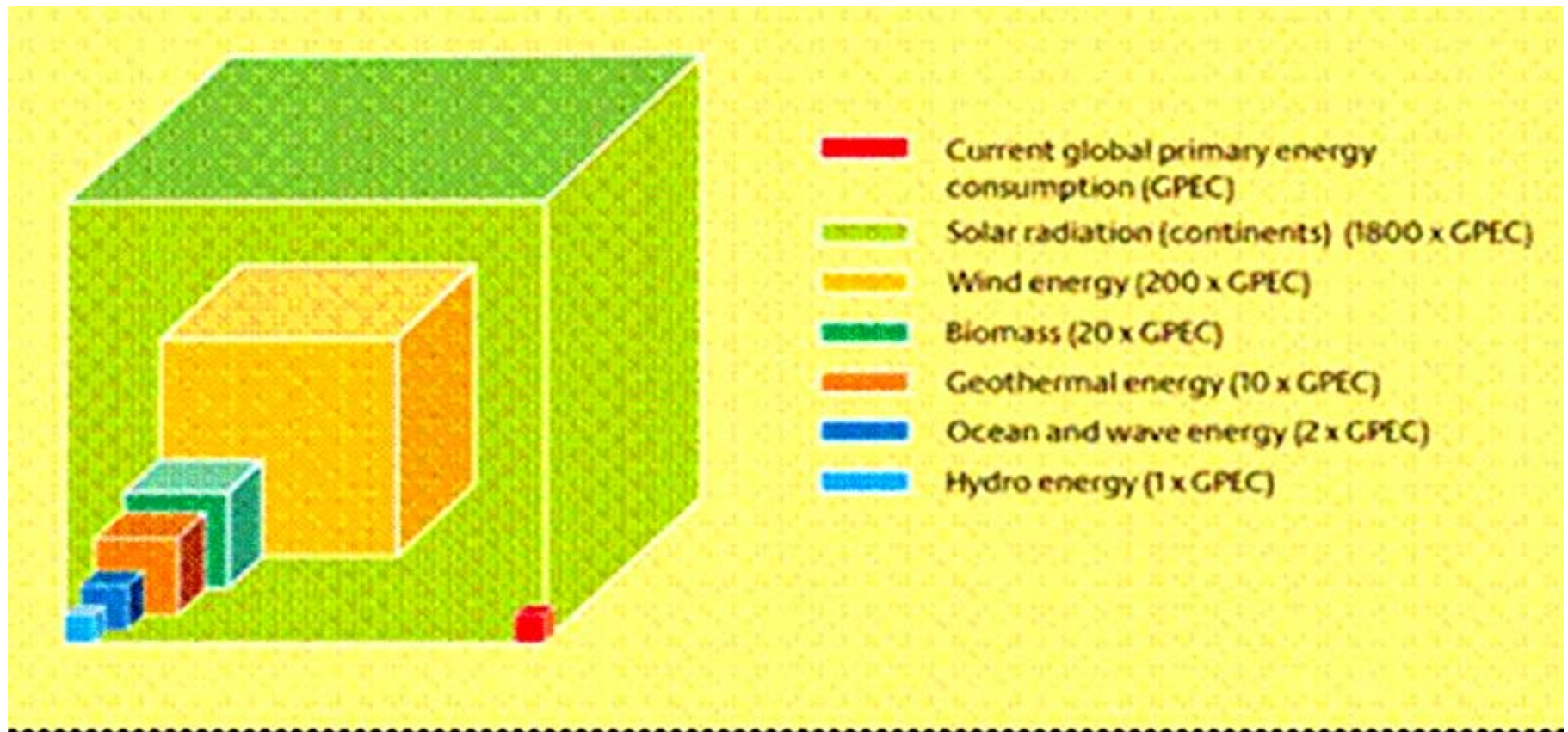
It works with moderate winds

The wind energy deployment in Asia



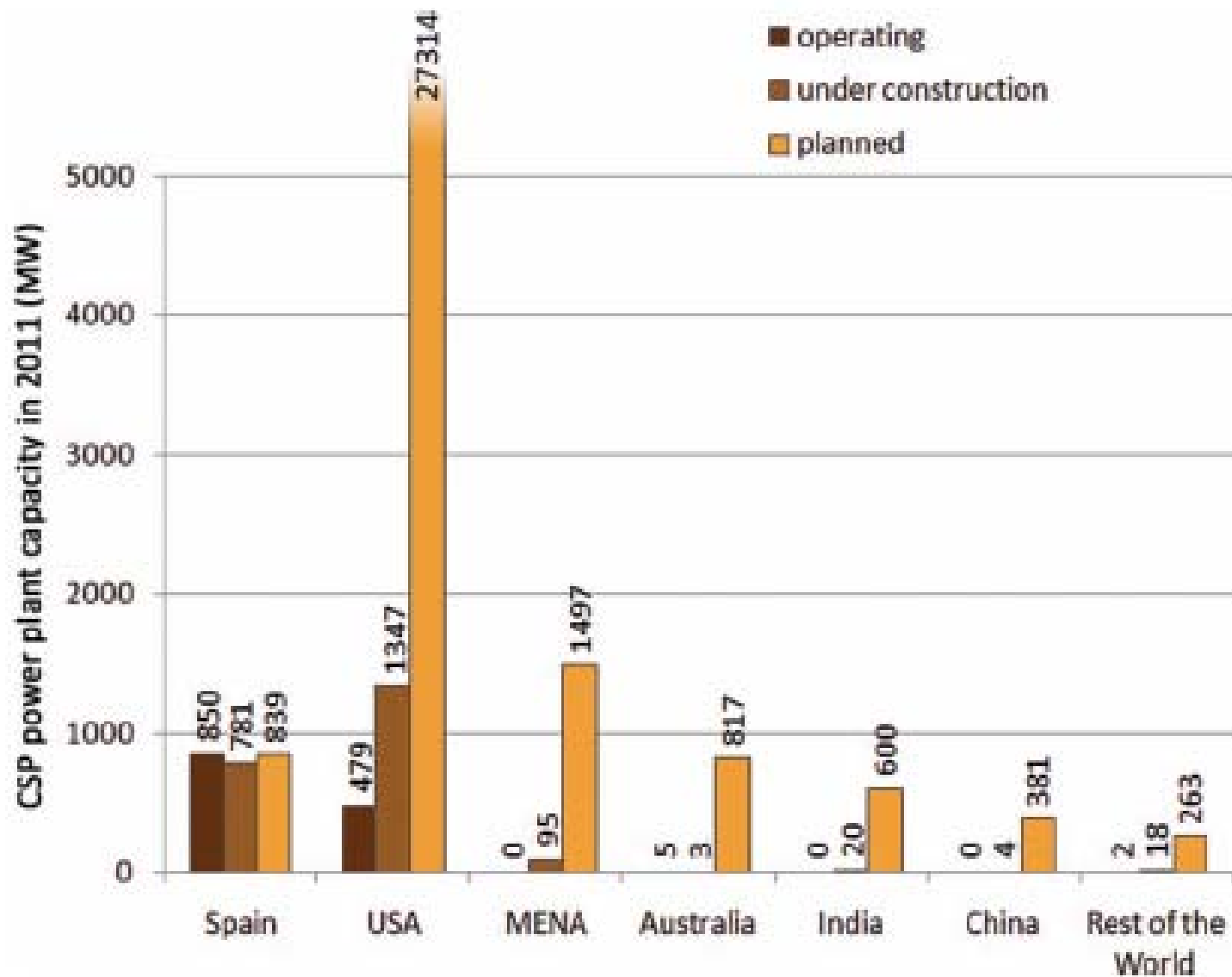
The solar resource

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)

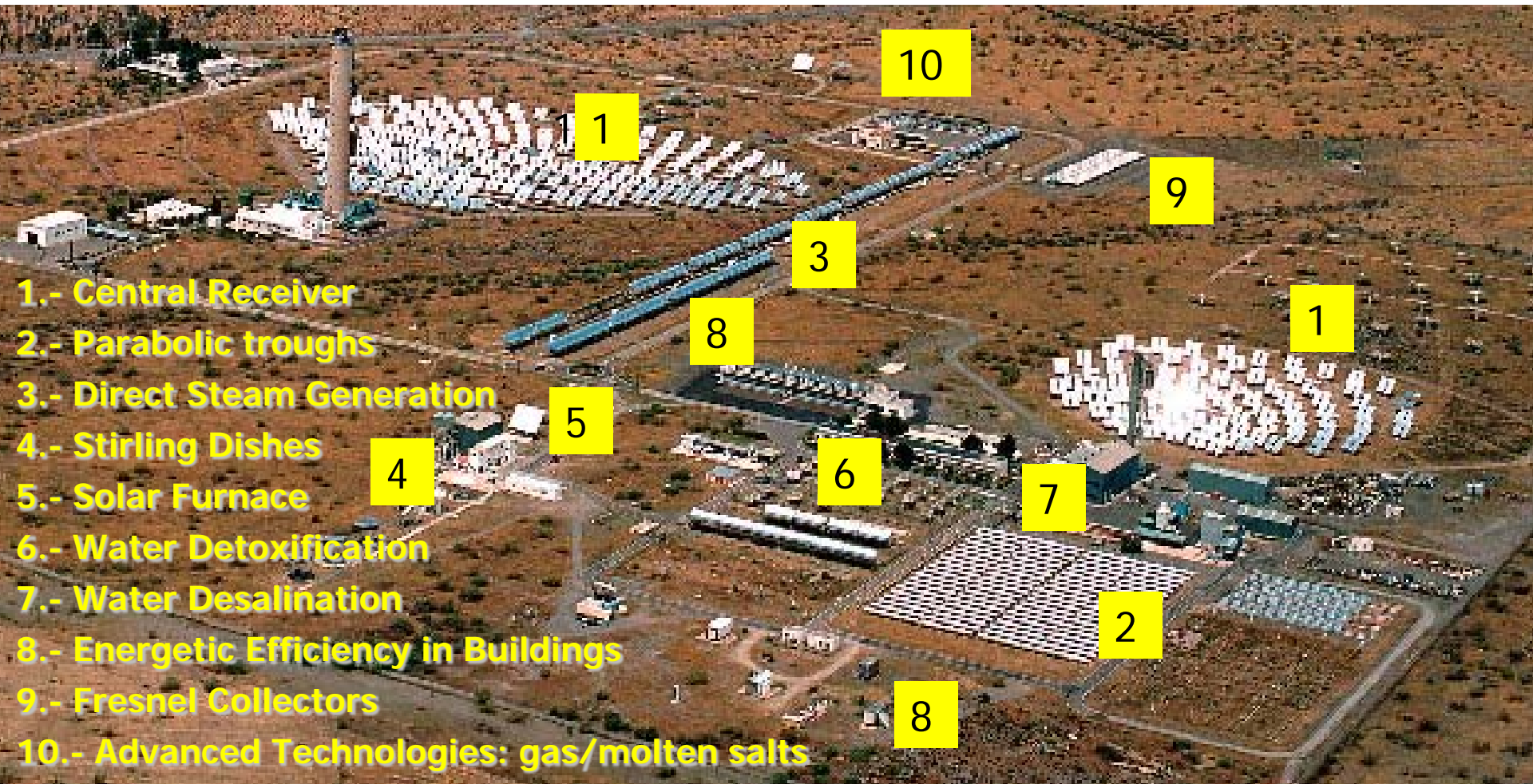


Solar energy is plentiful but diffuse

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



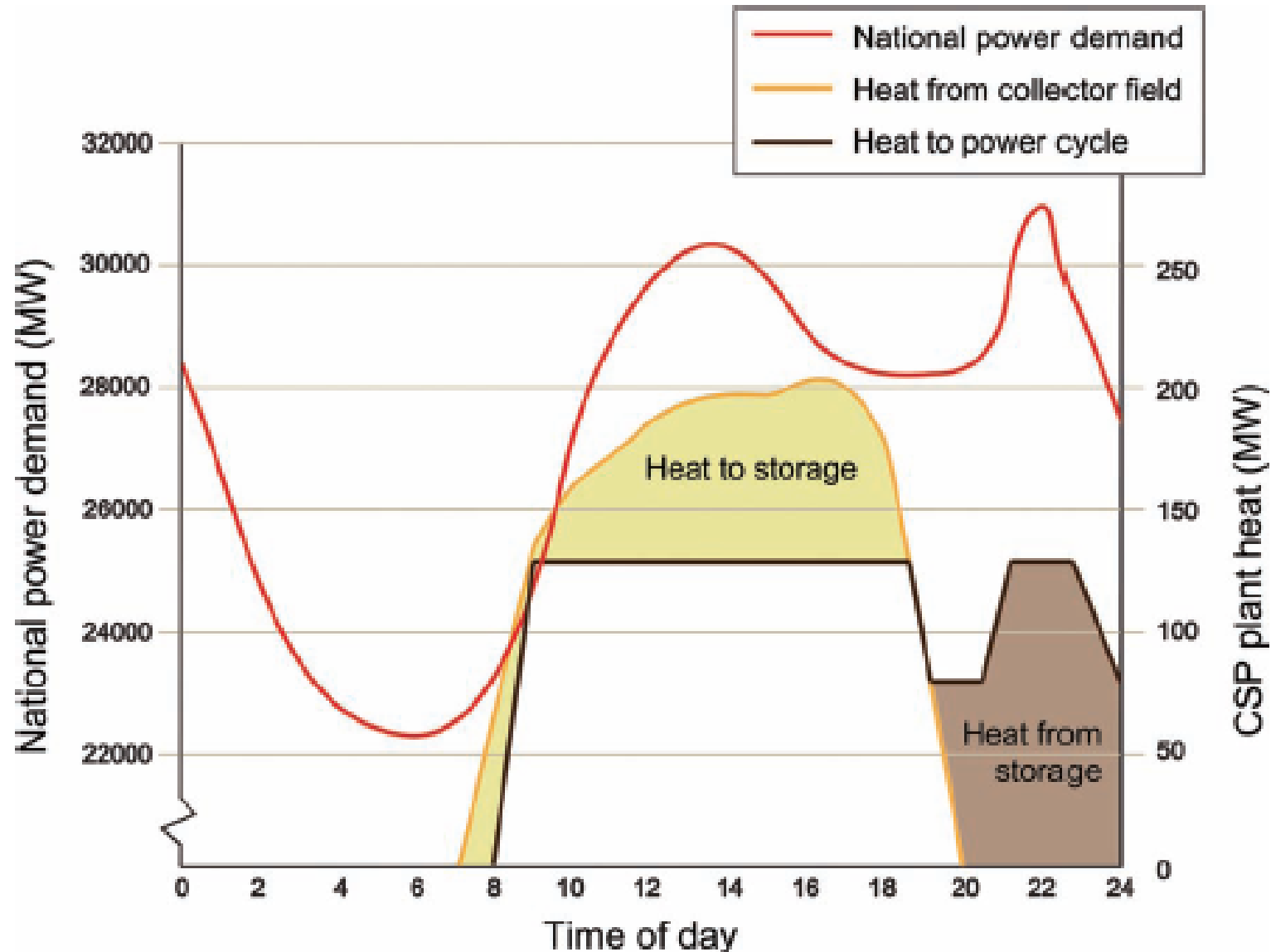
2 tanks: $\emptyset = 36 \text{ m}$; $h = 14 \text{ m}$

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 Eléctrica 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 °C 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, AGE CAM, Navarro-Piquer)

Hopefully completed in 2012

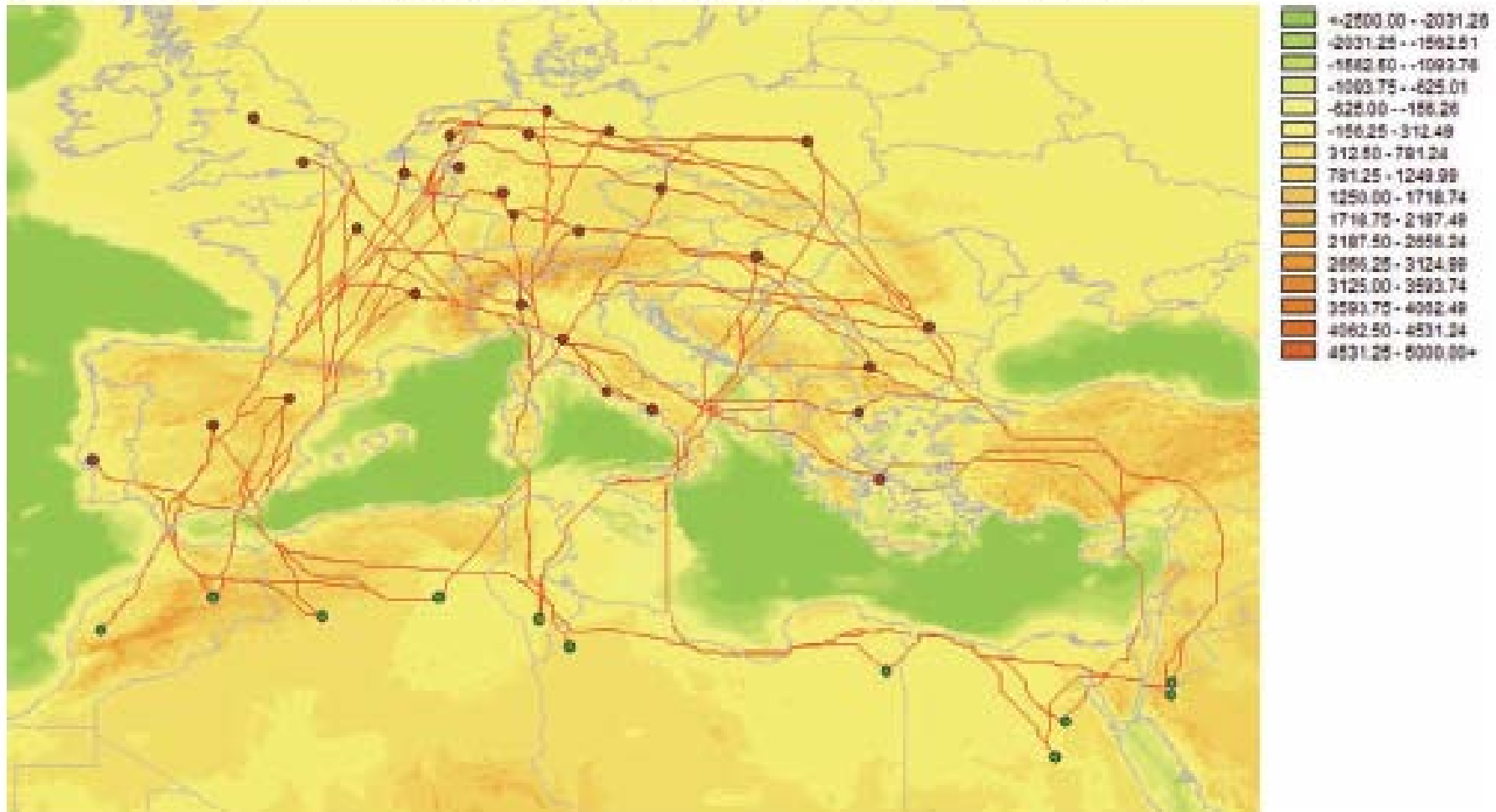
Environmental Applications



- 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

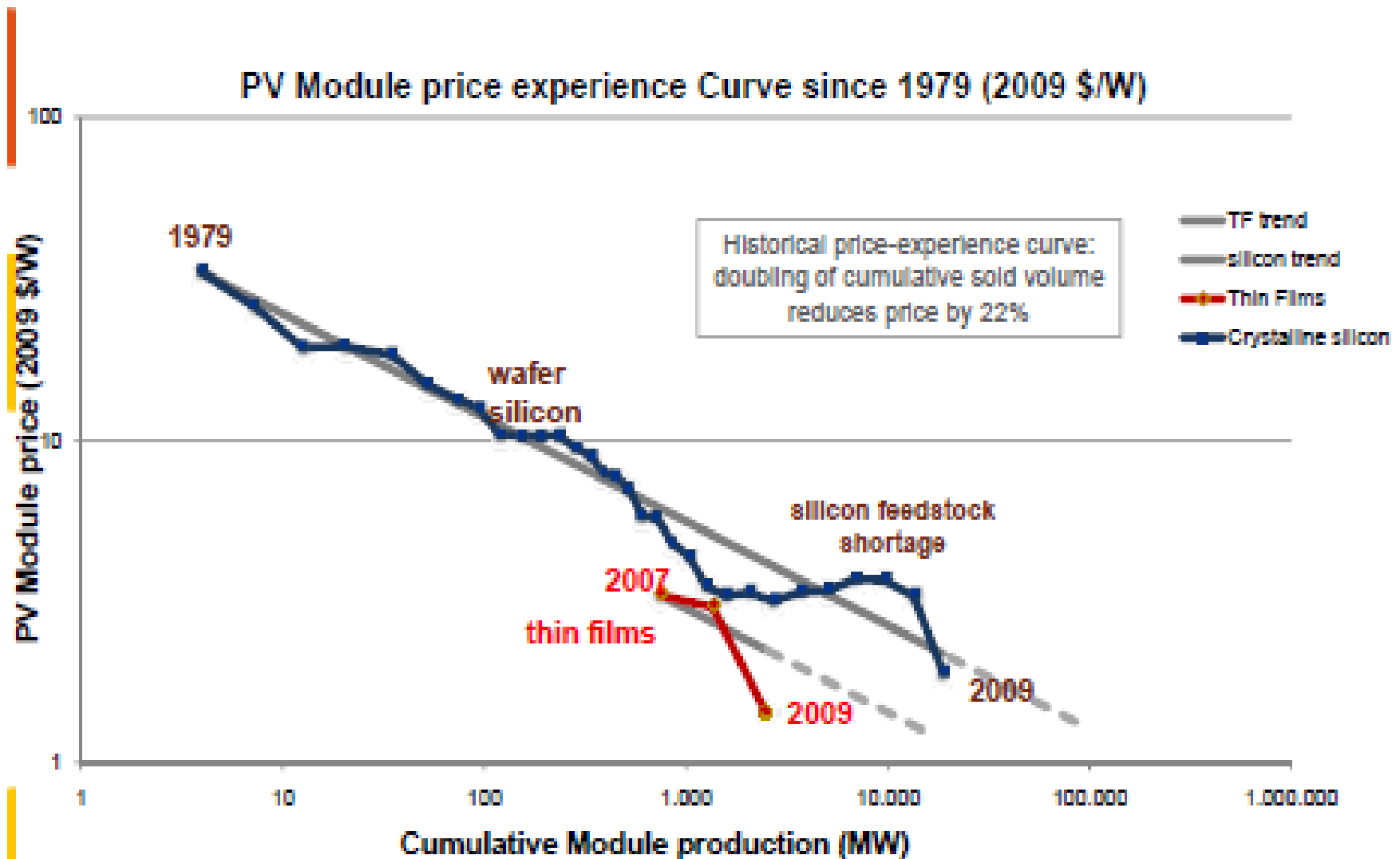
MENA-Europe Complementarity

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.

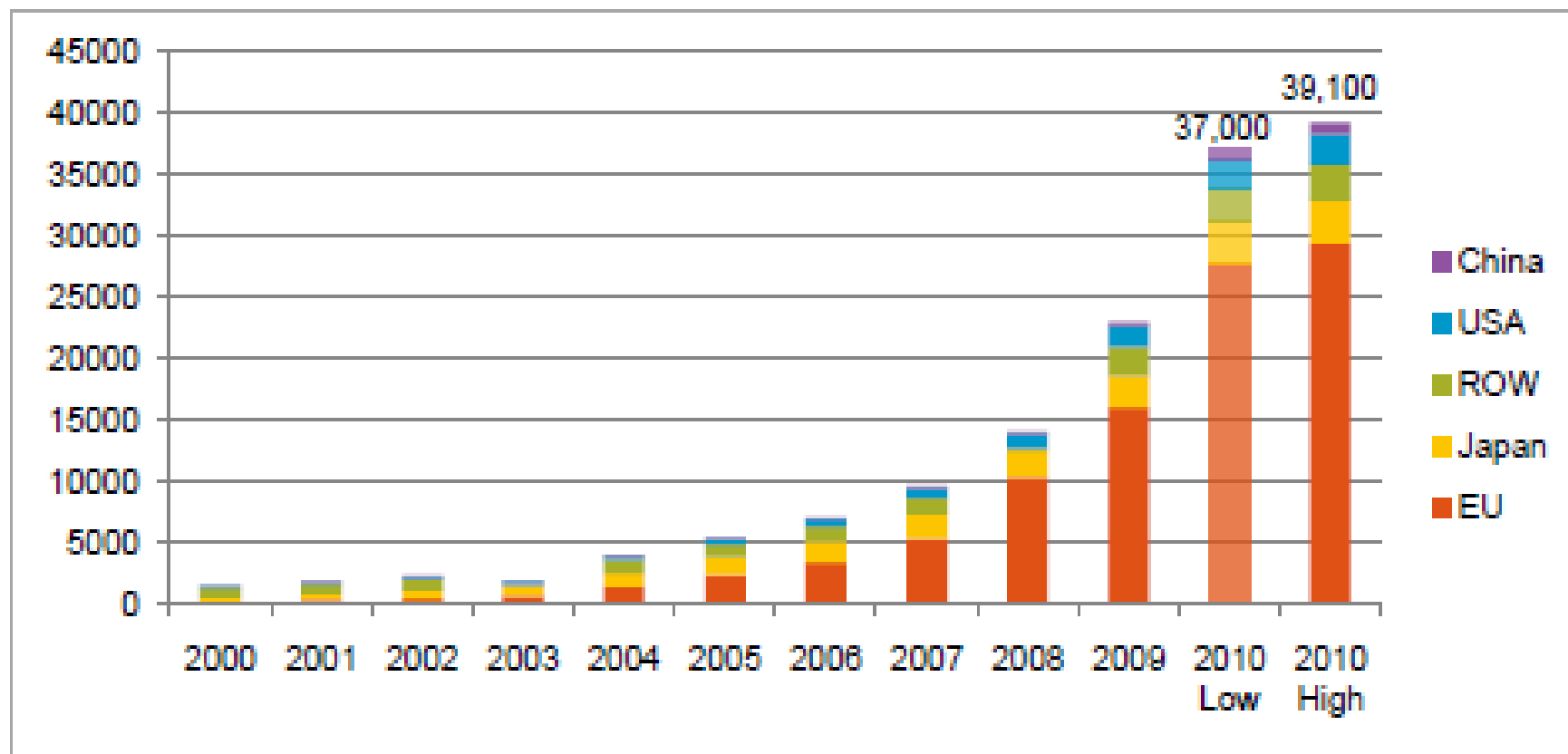
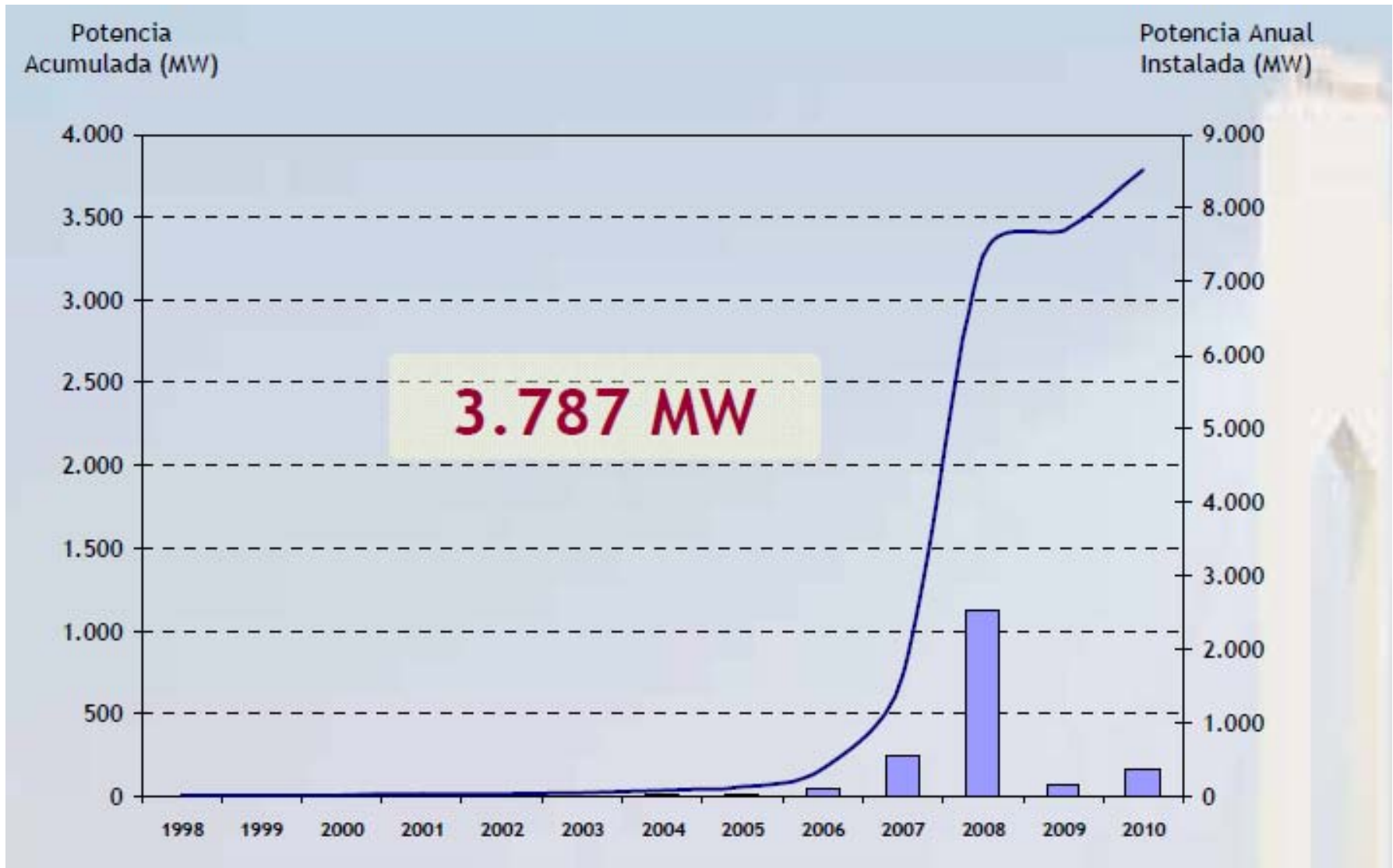


Figure 2: Evolution of global cumulative installed capacity worldwide (in MW)

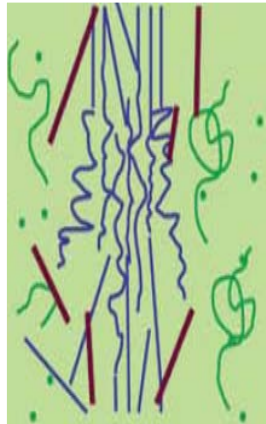
The PV installed power



Ethanol from cellulosic biomass



Pretreatment



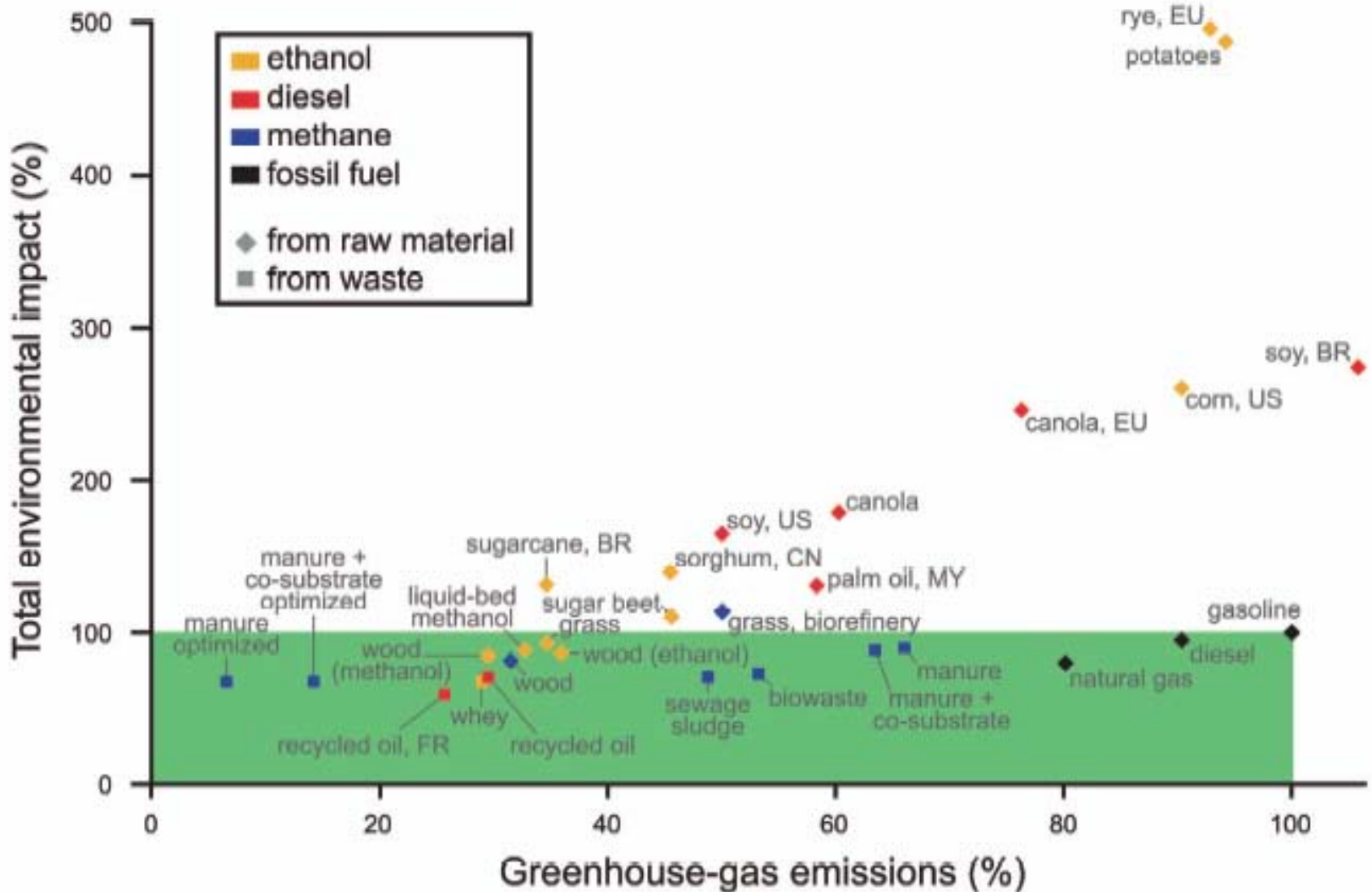
Enzymatic
Hydrolysis



Fermentation



Biofuels vs. Fossil fuels



Pilot Plant at L'Alcudia (Valencia)

Agreement with IMECAL and Ford to explore the CIEMAT technology

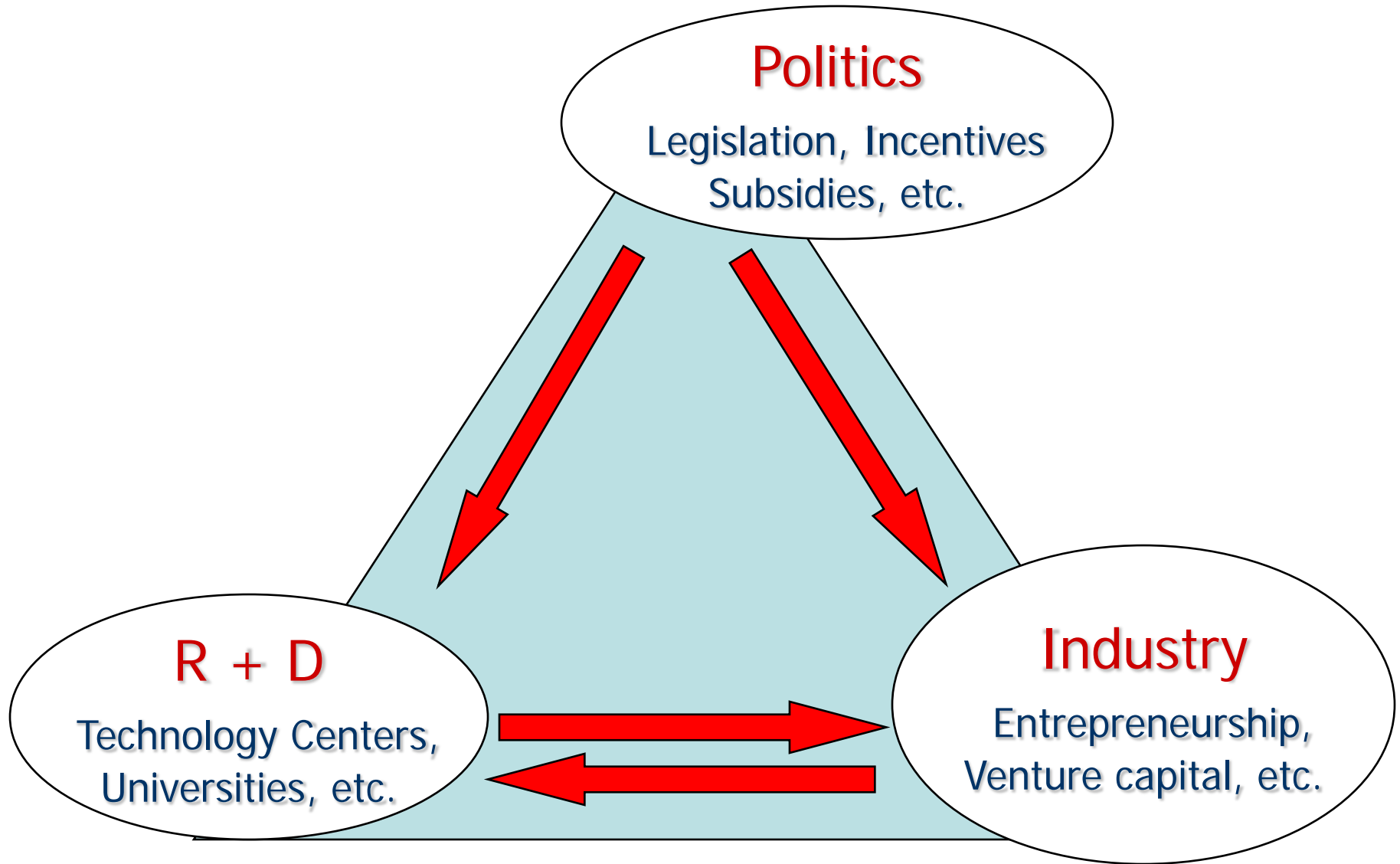


Diluted Acidic Hydrolysis

Urban and Agriculture Organic Waste

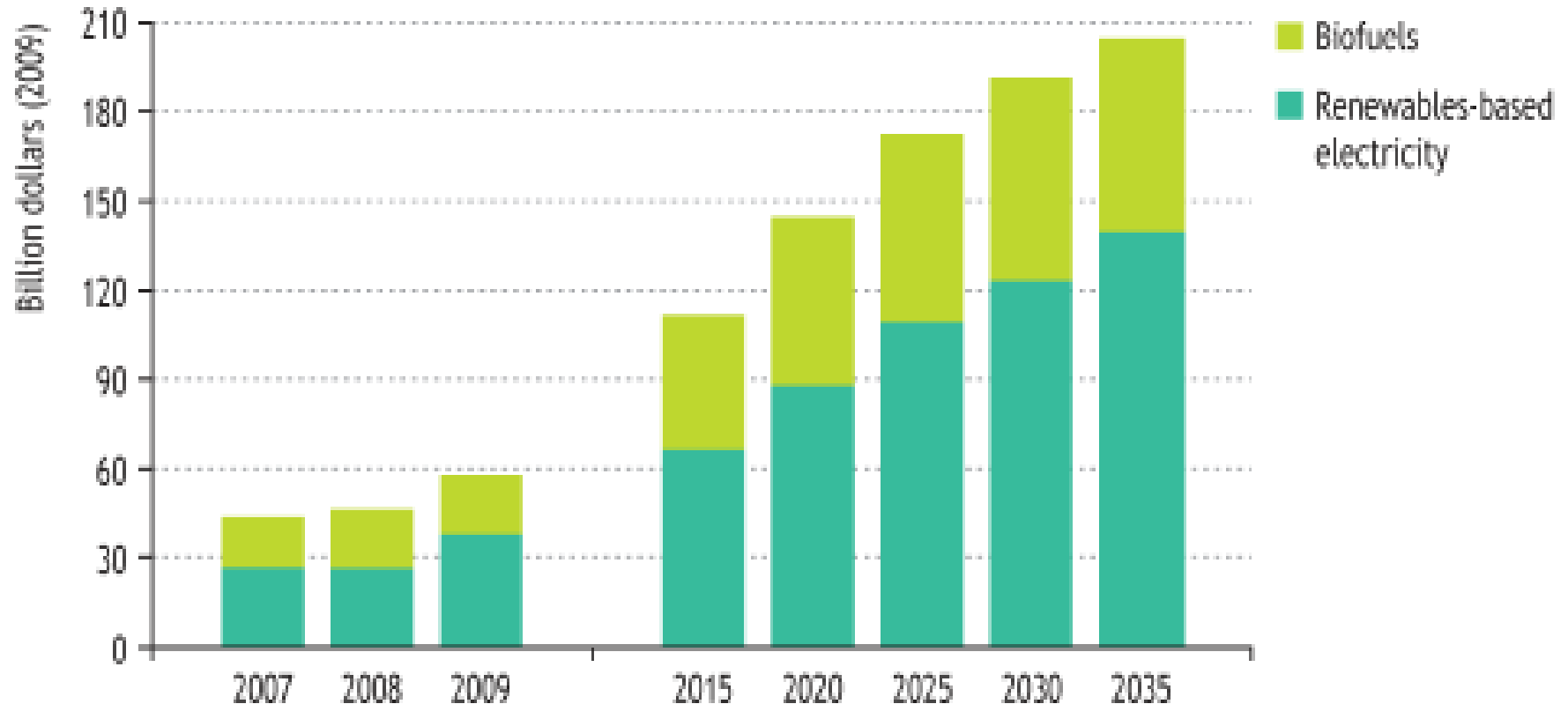
70 Tons/day

Conditions for the renewables deployment



Support for renewables

Annual global support for renewables in the New Policies Scenario



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.

ESADE – MADRID, 24-25 november, 2011



cea

energie atomique • energies alternatives

WHAT CHALLENGES FOR NUCLEAR ENERGY ?

Bernard BOULLIS
Director, Fuel Cycle Programs

Alternative Energies and Atomic Energy Commission

- 1 - NUCLEAR ENERGY TODAY**
- 2 - DRIVERS & CHALLENGES**
- 3 - GUIDELINES FOR FUTURE NUCLEAR SYSTEMS**

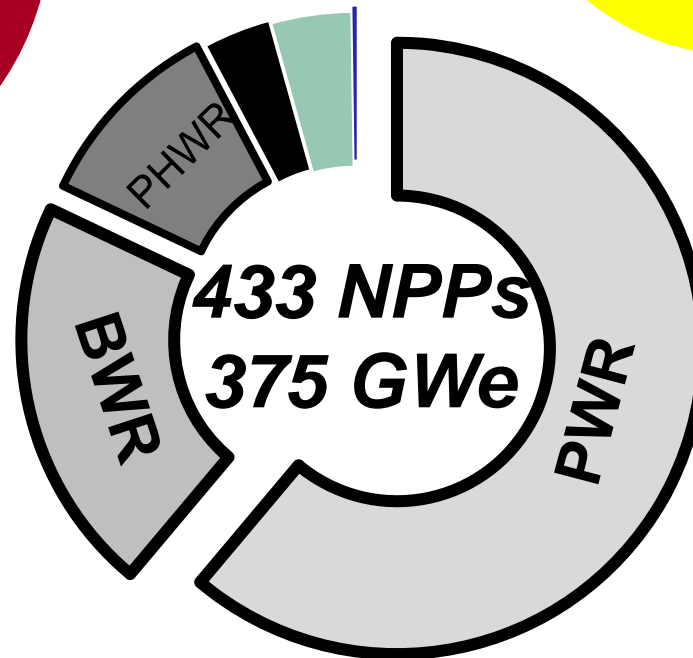
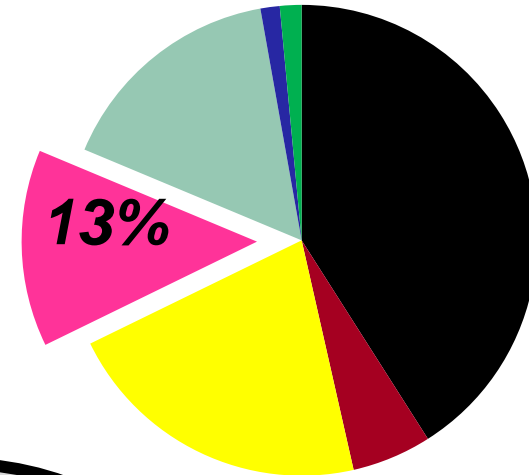
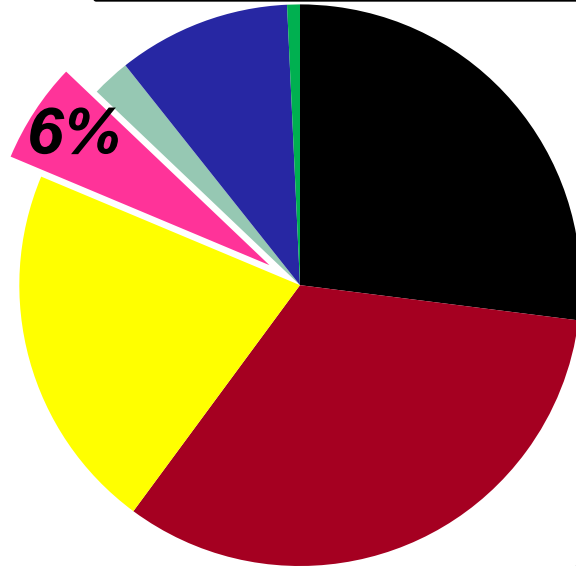


NUCLEAR ENERGY TODAY...

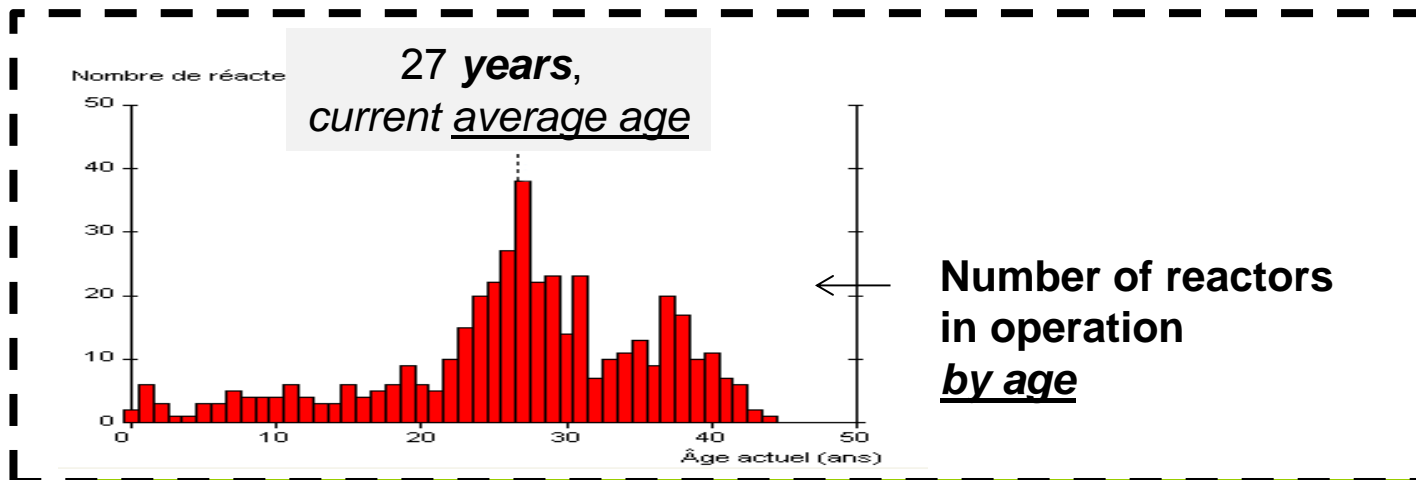
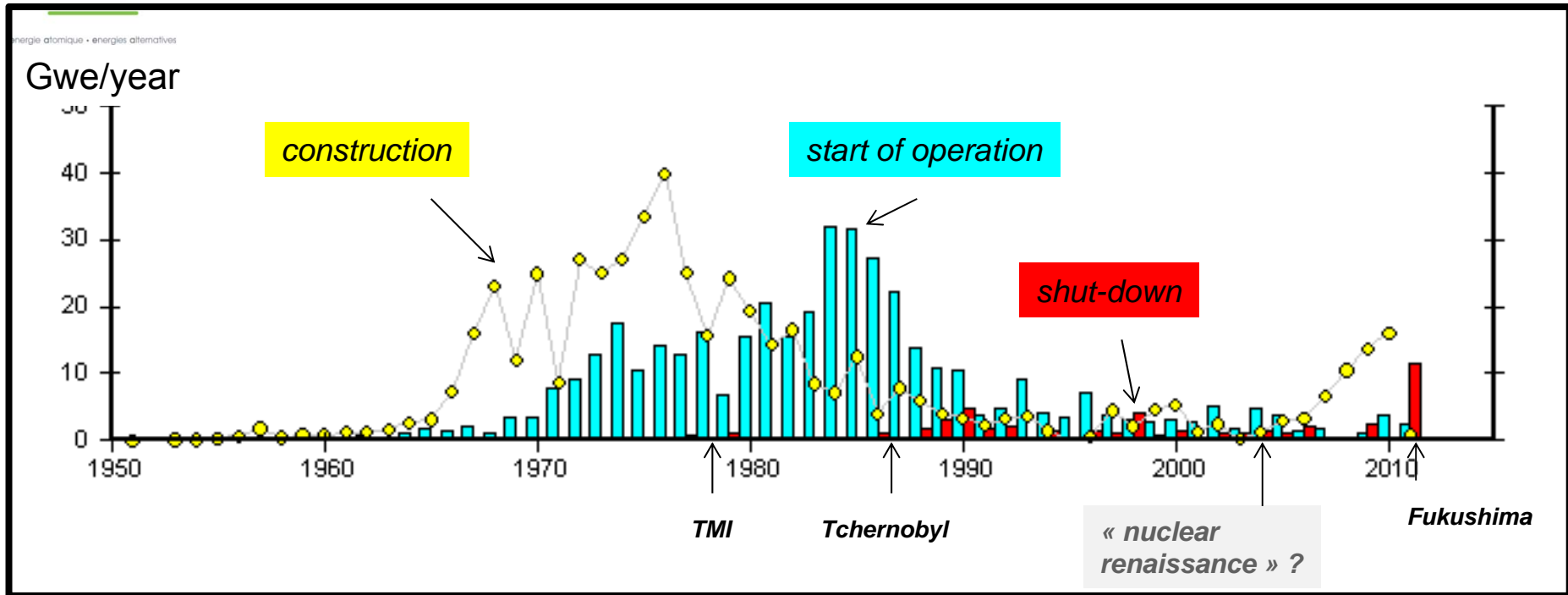
**world primary energy
(12 Gtoe)** (IEA, 2008 records)

world electricity (20 000 TWh)

- COAL
- OIL
- GAS
- NUCLEAR
- HYDRO
- BIOMASS
- OTHER RNW

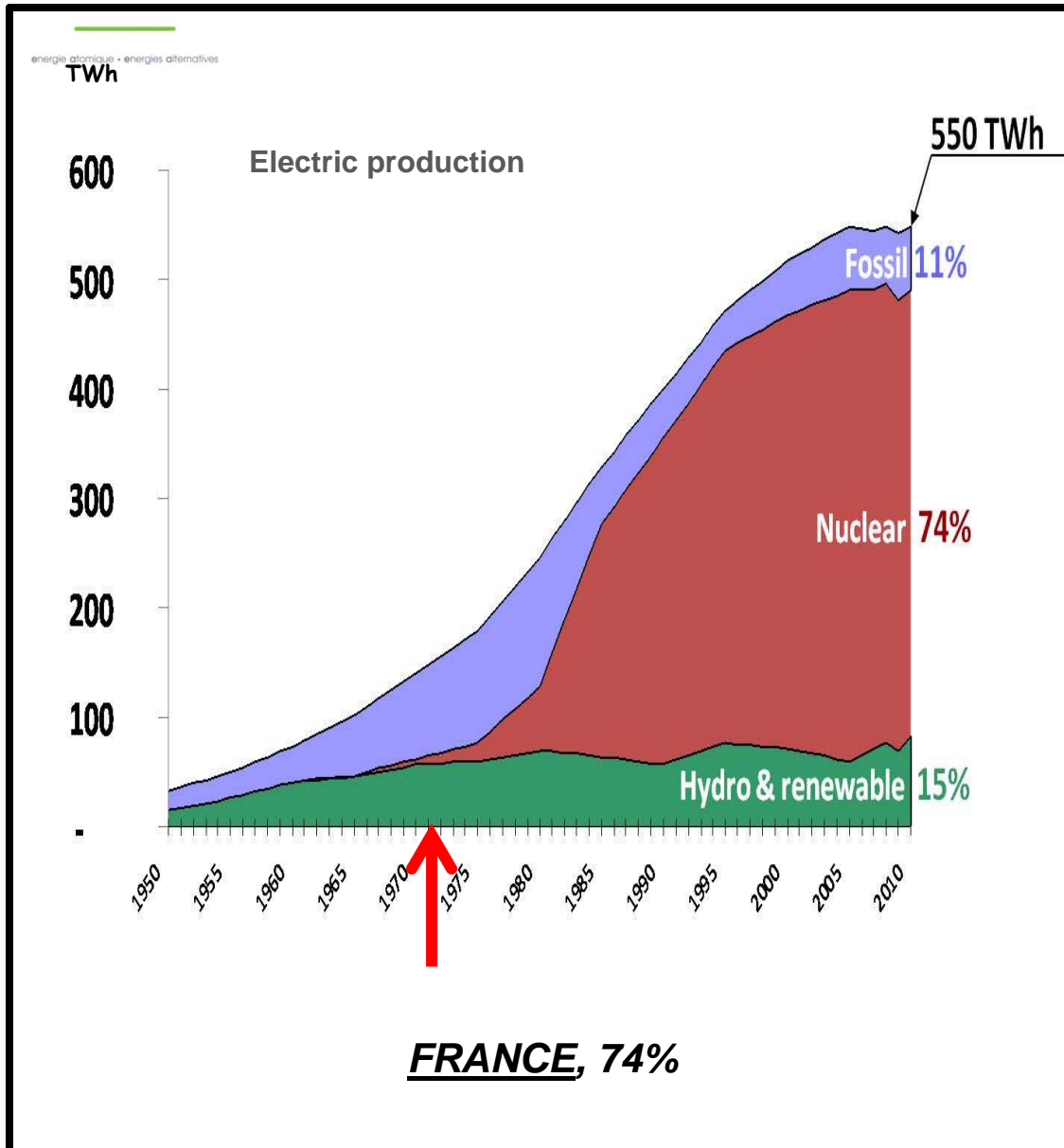


THE CURRENT NUCLEAR WORLD FLEET



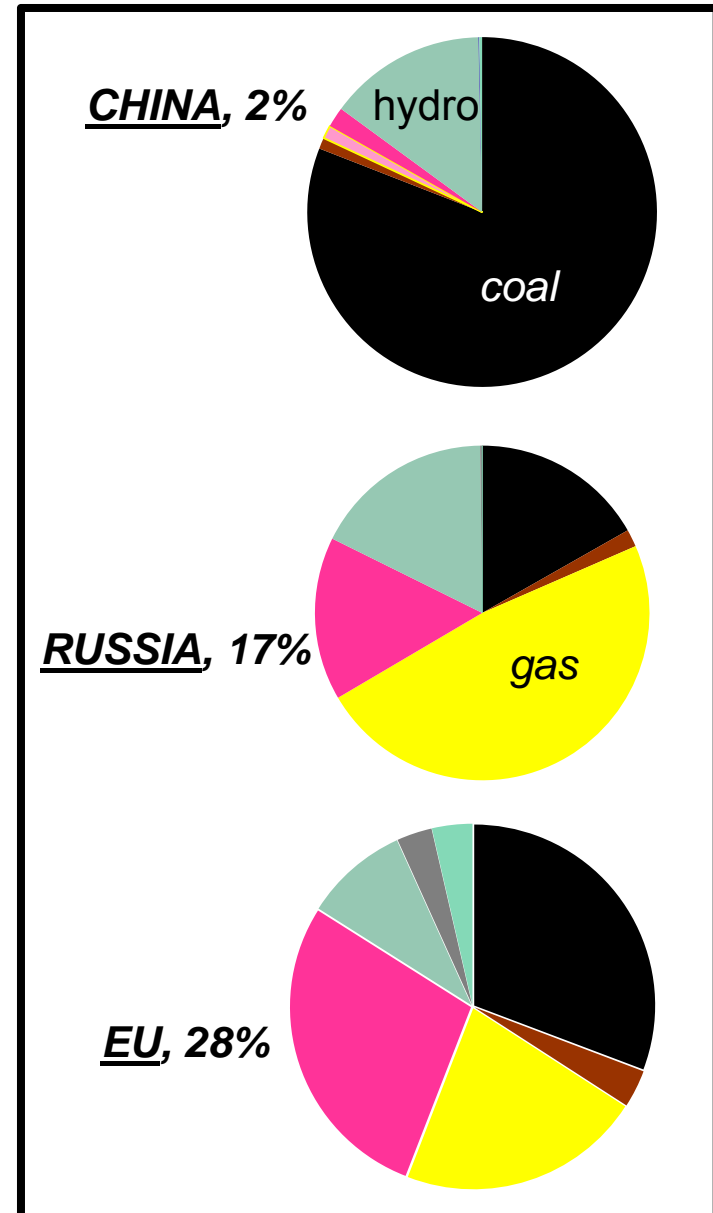


NUCLEAR ELECTRICITY TODAY...



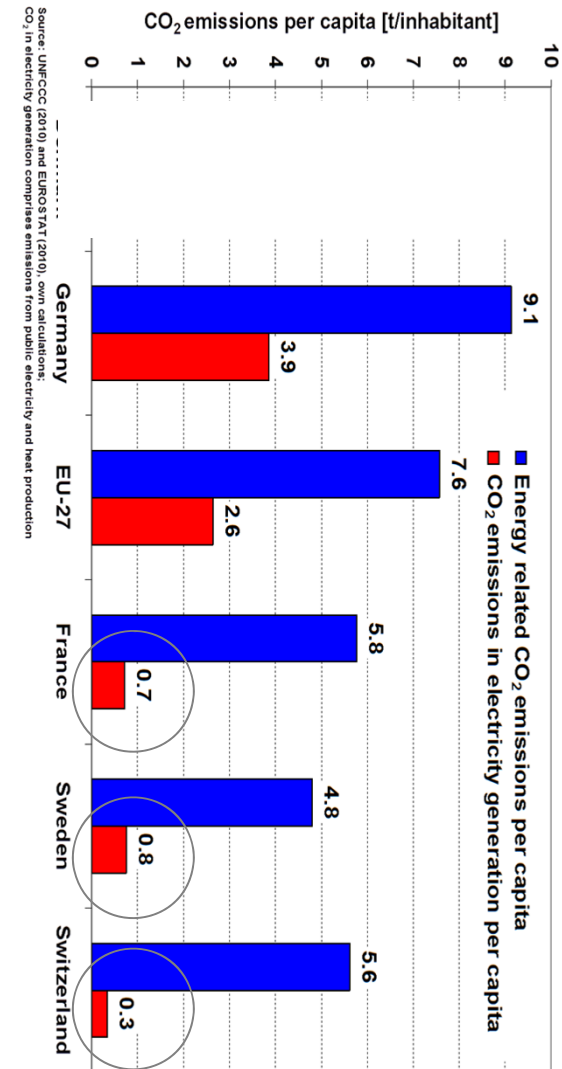
Pr. Bernard Boullis

What Challenges for Nuclear Energy?



IAE, WEO, 2010 (2007 records)

- **a mature technology**
(>14 000 reactor.years cumulated)
- **reliable**
(NPPs availability > 82%)
- **a (almost) carbon-free electricity**
- **a mastered cost:**
low dependance vs. fuel cost

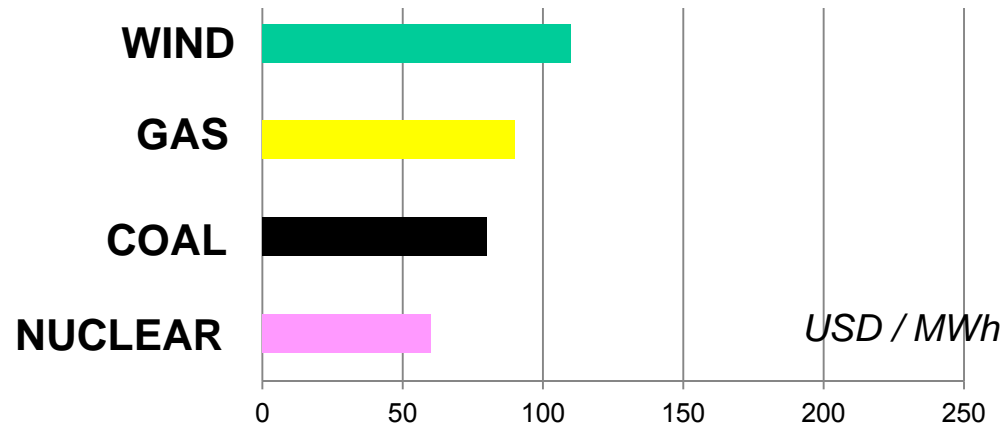




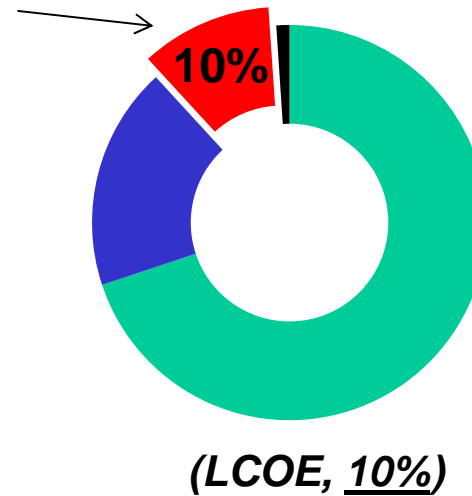
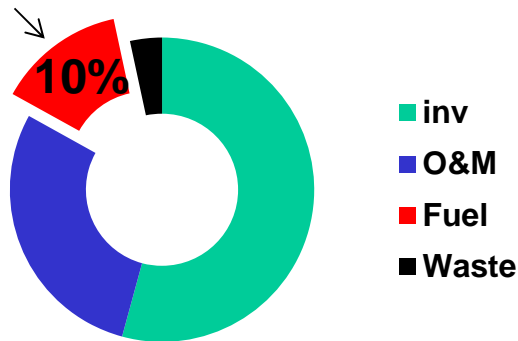
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NUCLEAR ENERGY COSTS...

IEA & OECD-NEA 2010
(LCOE, Europe region, 5%)



FUEL SHARE in LCOE (french study)



stability / predictability
of nuclear (hydro)
electricity prices

vs.

volatility
of fossil fuels prices

– **NUCLEAR ENERGY TODAY... QUESTIONS TOO!**



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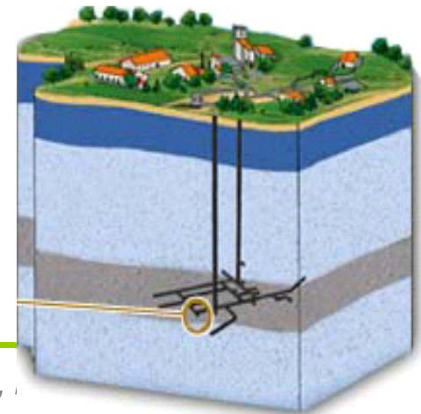
• **NUCLEAR REACTORS SAFETY**



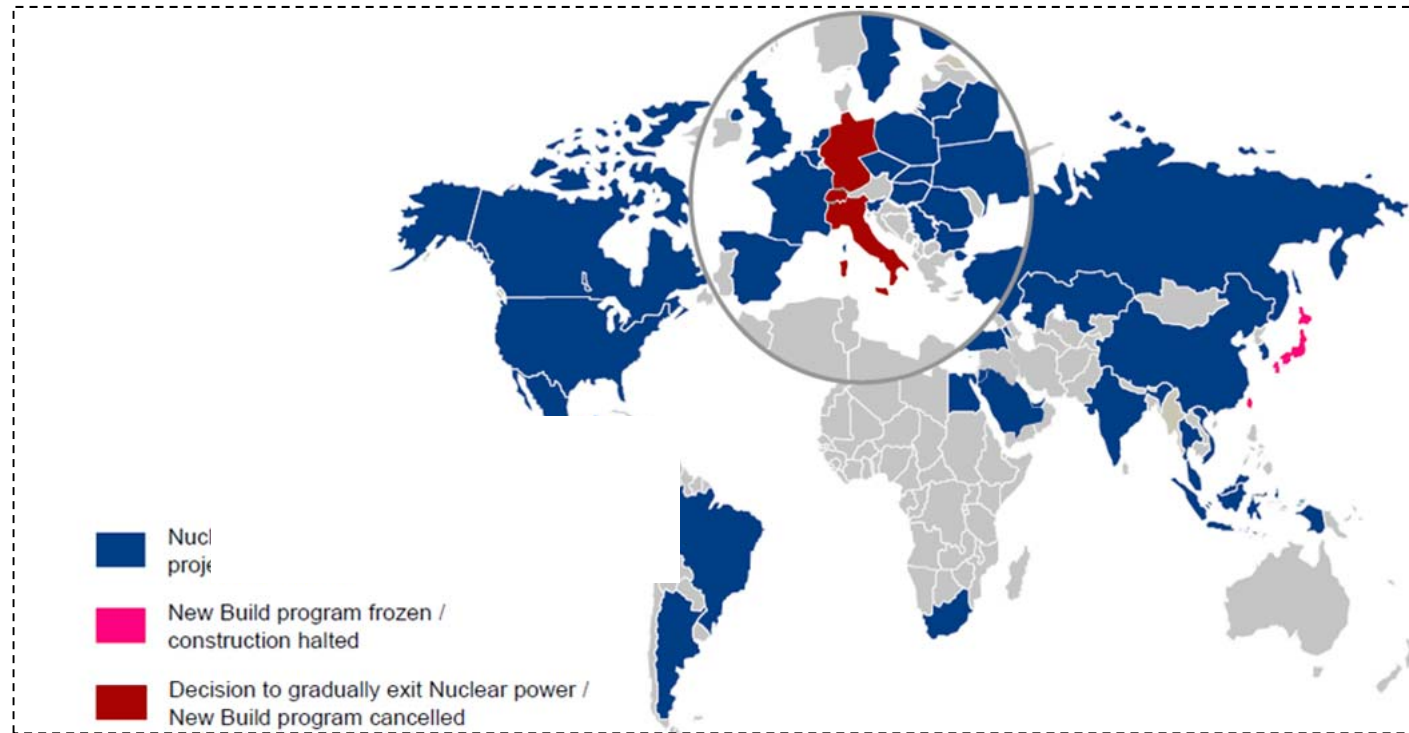
• **PROLIFERATION RISKS**



• **WASTE LONG-TERM HAZARDS**



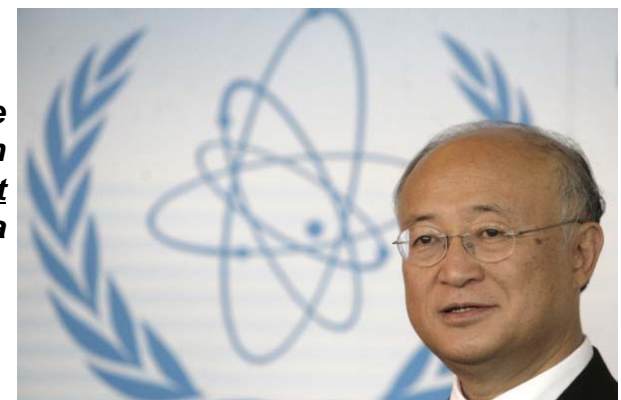
NUCLEAR TOMORROW ?



M. AMANO, Director General of the IAEA, Vienna(September 2011)

“ Following the Fukushima Daiichi accident, there was speculation that the expansion in interest in nuclear power seen in recent years could come to an end. However, it is clear that there will, in fact, be continuous and significant growth in the use of nuclear power in the next two decades, although at a slower rate than in our previous projections.

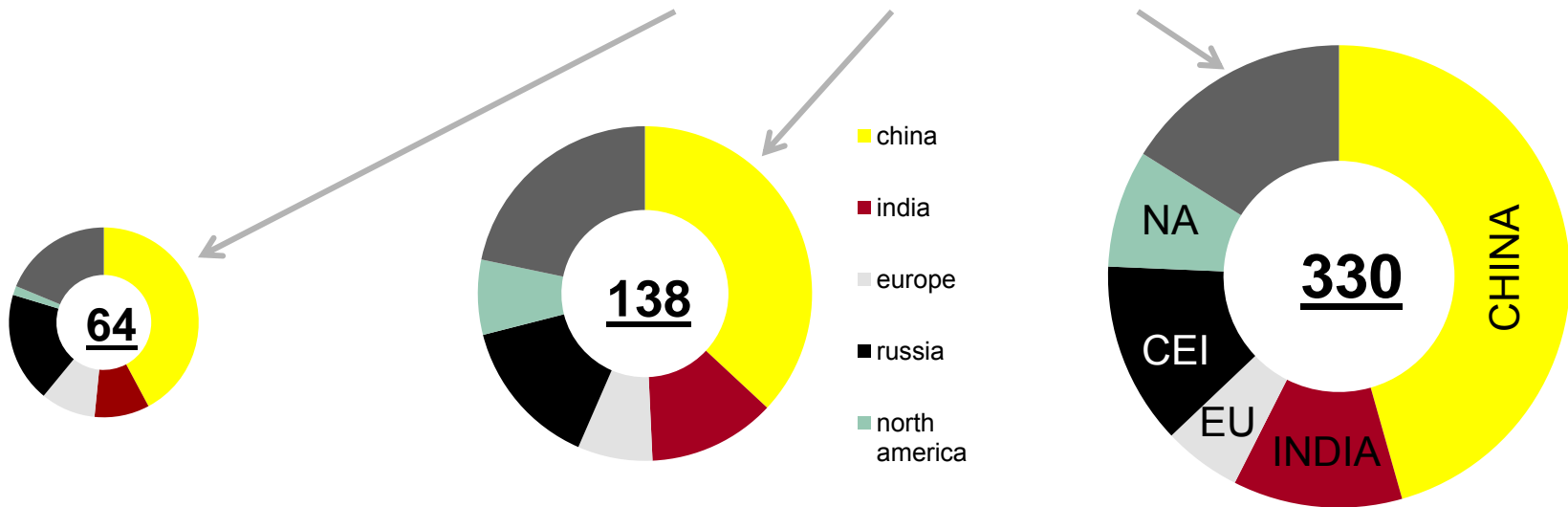
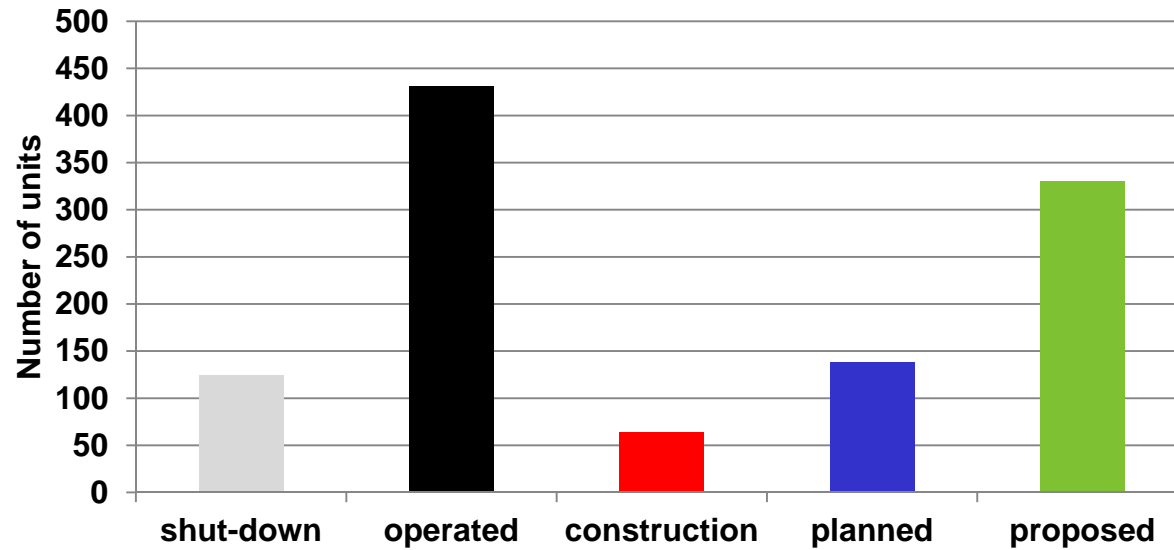
And we expect the number of operating nuclear reactors in the world to increase by about 90 to 350 by 2030, in our low to high projections. ”



— NUCLEAR ENERGY , AN ENERGY FOR THE FUTURE...



energie atomique • énergies alternatives

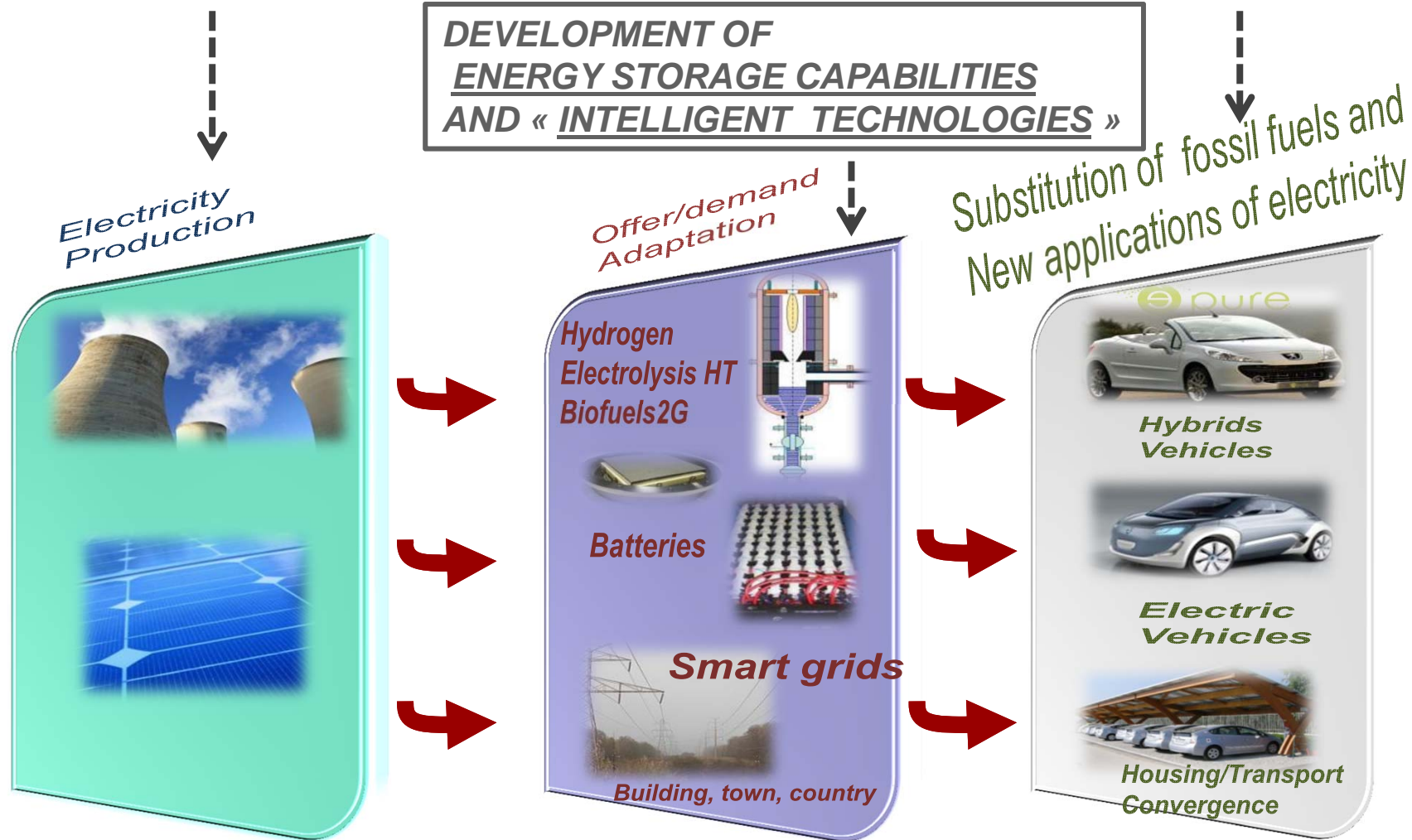


(IAEA and other diverse sources)

NUCLEAR ENERGY, AN ENERGY FOR FUTURE...

A POSSIBLE SYNERGISTIC DEVELOPMENT
OF NUCLEAR (BASE LOAD) & RENEWABLES

NEW APPROACHES,
NEW APPLICATIONS...



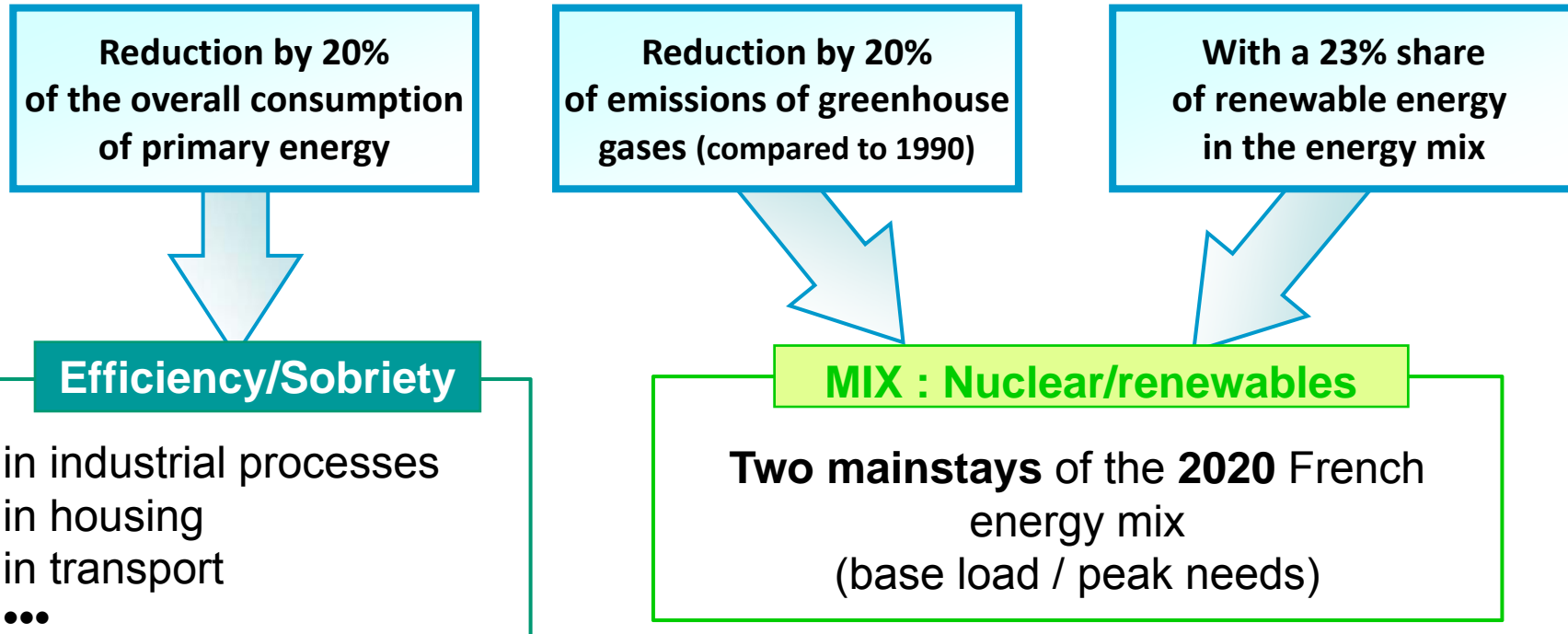


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FRENCH ENERGY POLICY

France keeps heading fixed by the European Climate-Energy Package

2020



50% of the primary energy consumption still rely on fossil fuels

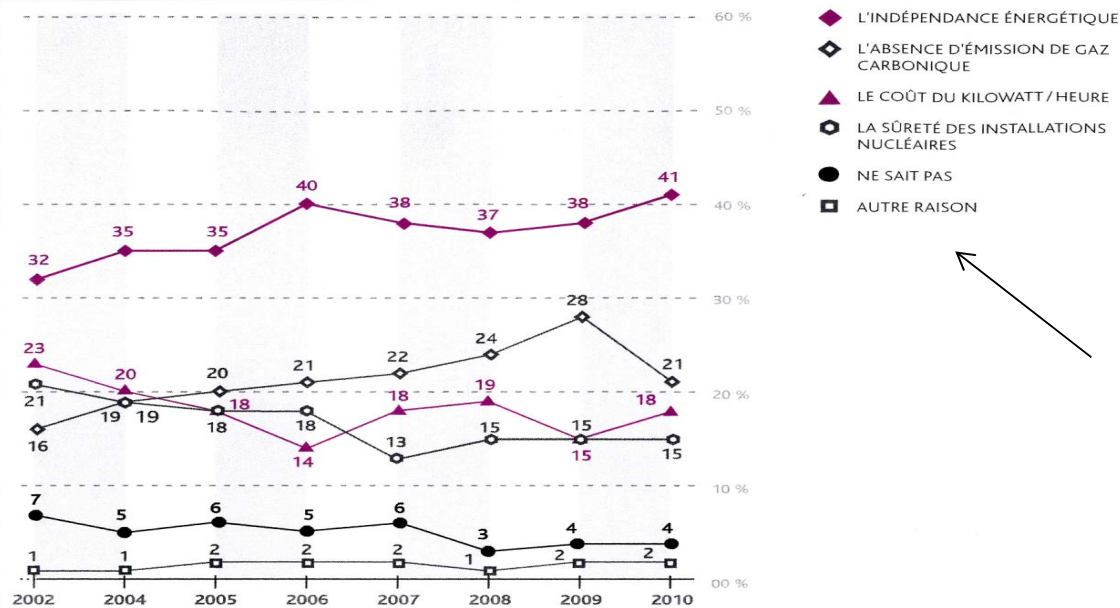
(French 2010 fossil fuels import = 25% of total export incomes)

_____ 2011 _____ = 35% _____

WHAT ARE THE CHALLENGES ?

- ATTRACTIVE DRIVERS FOR NUCLEAR ENERGY!

(CONTRIBUTOR TO A CARBON-FREE RELIABLE ENERGY MIX!)
(A MASTERED COST)
(SECURITY OF SUPPLY, SELF-SUFFICIENCY!)



NUCLEAR ENERGY:
WHY ?
(IRSN, 2010 barometer)

WHAT ARE THE CHALLENGES ?

- ATTRACTIVE DRIVERS FOR NUCLEAR ENERGY!

(CONTRIBUTOR TO A CARBON-FREE RELIABLE ENERGY MIX!)

(A MASTERED COST)

(SECURITY OF SUPPLY, INDEPENDENCE!)

- A KEY-CONDITION FOR DEVELOPMENT: PUBLIC ACCEPTANCE!

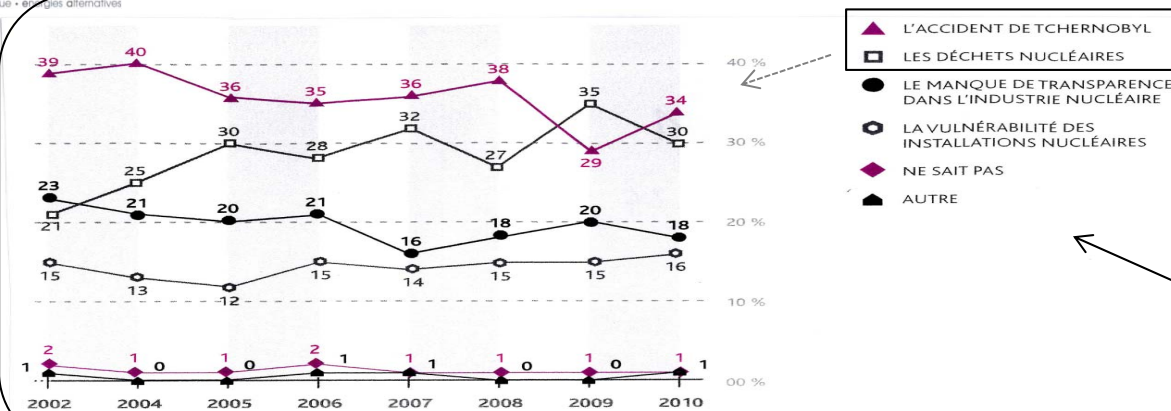
(SAFETY HIGHEST REQUIREMENTS!)

(SECURITY HIGHEST GUARANTEES !)

(WASTE MANAGEMENT ABSOLUTELY SAFE IN THE LONG TERM !)

→ THE ROUTE FOR NEXT GENERATION NUCLEAR SYSTEMS

WHAT ARE THE CHALLENGES ?



**NUCLEAR ENERGY:
WHY NO?**

(IRSN, 2010 barometer)

-A KEY-CONDITION FOR DEVELOPMENT: **PUBLIC ACCEPTANCE!**

(**SAFETY HIGHEST REQUIREMENTS!**)

(**SECURITY HIGHEST GARANTIES !**)

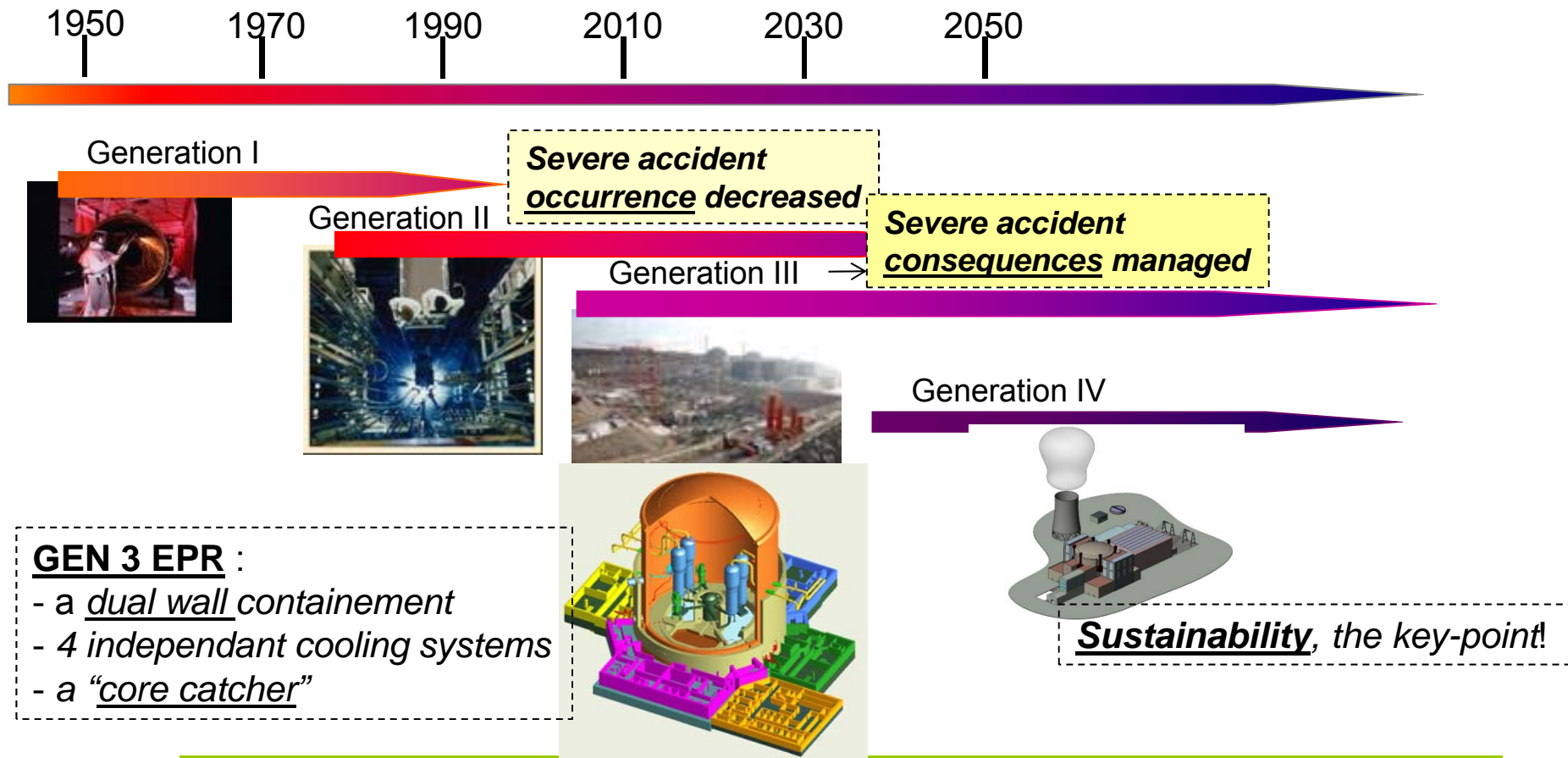
(**WASTE MANAGEMENT ABSOLUTELY SAFE IN THE LONG TERM !**)

.... AND CONVINCE!

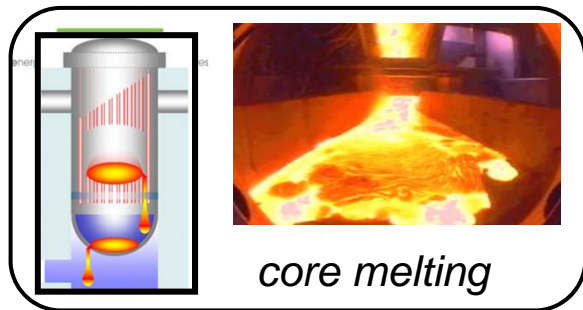
→ **THE ROUTE FOR NEXT GENERATION NUCLEAR SYSTEMS**

NUCLEAR SYSTEMS GENERATIONS...

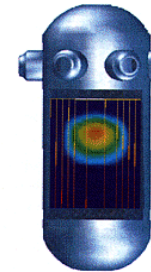
TODAY : GEN 1 under DISMANTLING, GEN 2 OPERATED, GEN 3 under CONSTRUCTION, PROSPECTS for GEN 4 [EACH GENERATION: A STEP FOR SAFETY IMPROVEMENT]



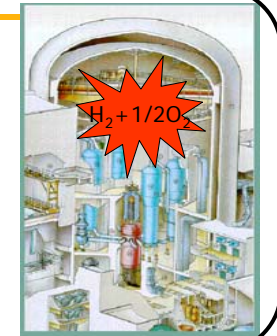
« POST-FUKUSHIMA » SAFETY APPROACH



core melting



H2 generation



- COMPLEMENTARY COMPREHENSIVE RISK & SAFETY ASSESSMENTS

(« stress tests », EU peer reviews)

(French Nuclear Safety Regulator: conclusions to be issued early 2012)

(Up-grade of the safety level of the current fleet)

- IMPORTANCE OF SHARING, AT INTERNATIONAL LEVEL (IAEA), THE LESSONS DRAWN FROM FUKUSHIMA DAI ICHI ACCIDENT,

(impact on safety standards, safety margins)

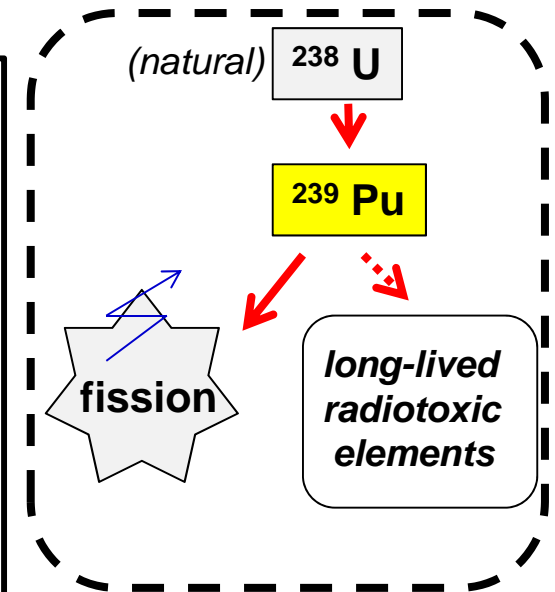
- IMPORTANCE OF ORGANIZATIONAL ASPECTS IN CASE OF EMERGENCY SEVERE SITUATIONS !

(eventuality of simultaneous agressions)

(reliable sources for power, for cooling, ...)

THE DRIVERS FOR 4th GENERATION SYSTEM:

- *plutonium more effective (complete) burning*
- *drastic extension of uranium natural resource*
(by a factor of # 100!)
- *drastic reduction of waste long-term toxicity*
(by effective burning of long-lived radiotoxic actinides)



TWO MAIN GUIDELINES:

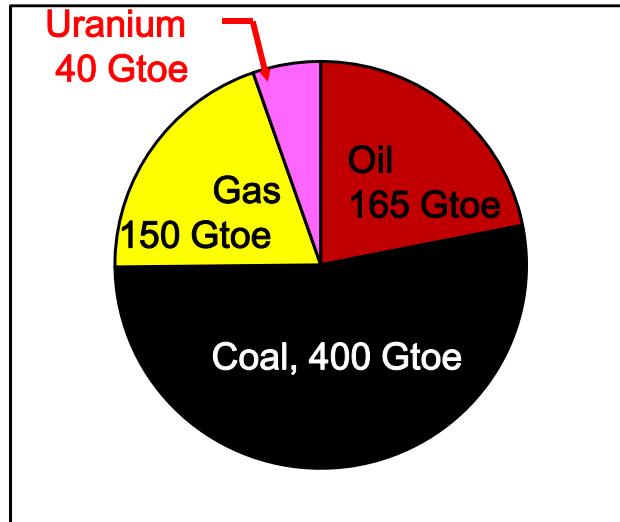
1- RECYCLE!

*(both decrease final waste,
and take advantage of valuable contents)*
(# 95% re-usable!)

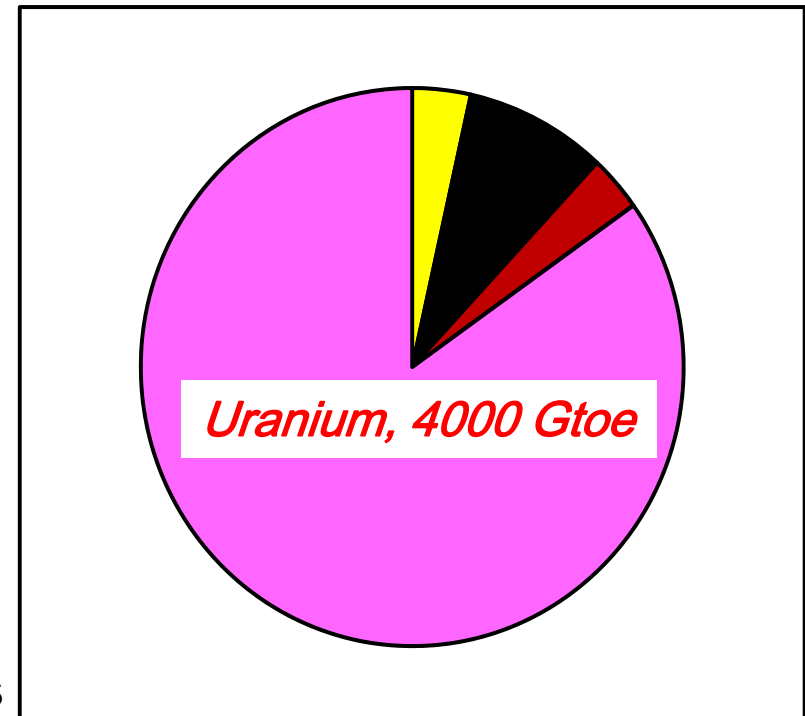
2 - FAST NEUTRON REACTORS

(the best-suited for efficient burning of recycled materials)

FOSSIL FUELS POTENTIAL RESERVES



Uranium use
in thermal neutrons (*current*) reactors



Uranium use
in fast neutrons reactors

Identified conventional resources (WEC, 2010):
(OIL 165 Gt, COAL 826Gt, GAS 180 Tm³, URANIUM 3,3Mt)

RADIOACTIVE WASTE MANAGEMENT: THE FRENCH 2006 ACT

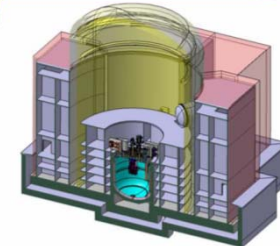
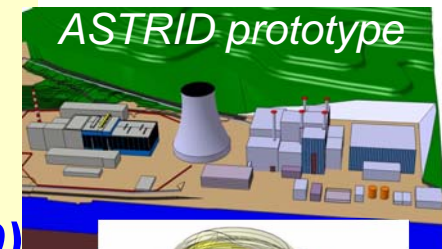
➔ TWO MAIN PRINCIPLES :

- RECYCLE (reprocess)
to decrease waste amount & toxicity
- RETRIEVABLE GEOLOGICAL REPOSITORY,
for ultimate waste



➔ A « ROADMAP » :

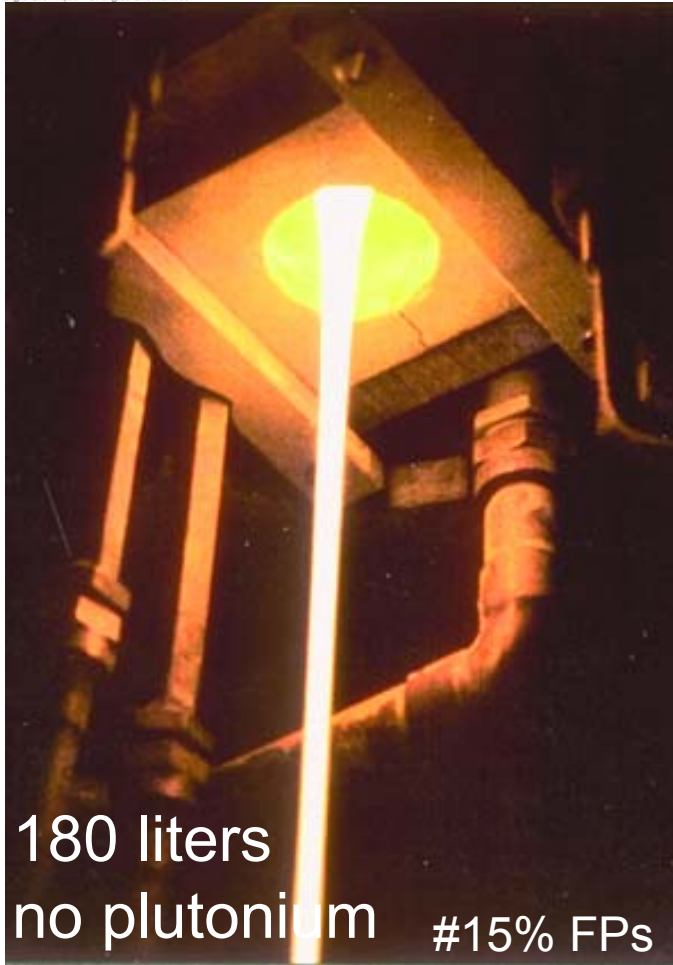
- 2012 : assess the industrial potentialities of long-lived elements transmutation (prototype fast neutron reactor 2020)
- 2015 : licence application for repository (operation by 2025)



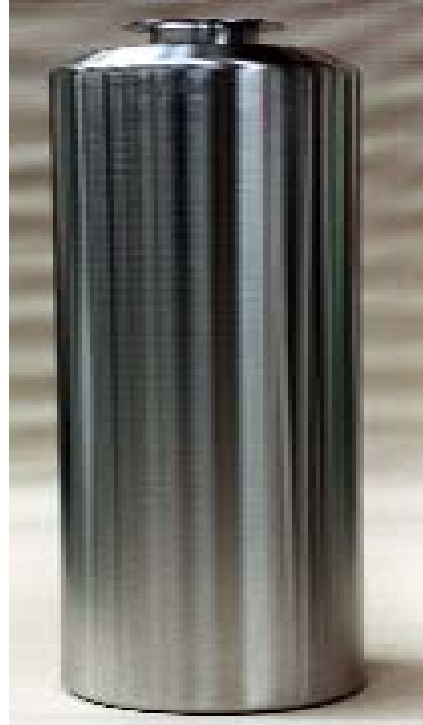


FINAL WASTE VITRIFICATION

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180 liters
no plutonium #15% FPs



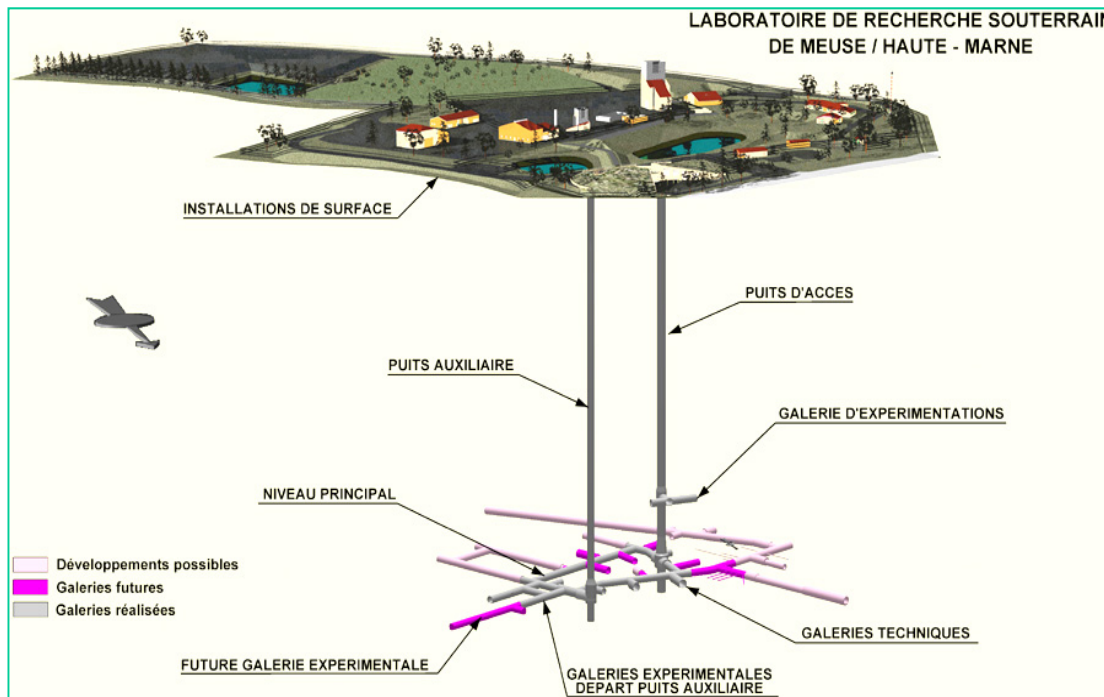
10-15 glass canisters /reactor /per year



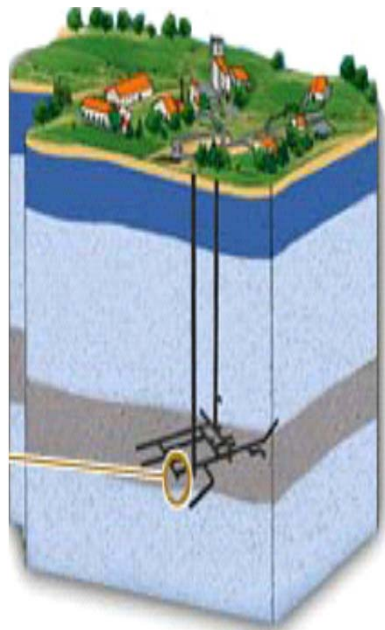
FINAL WASTE LONG TERM MANAGEMENT...



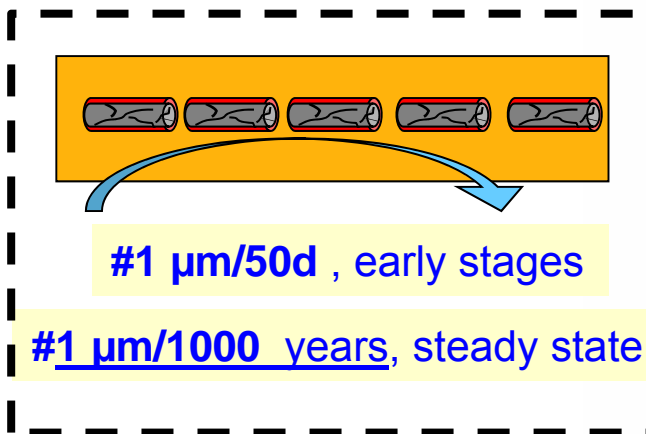
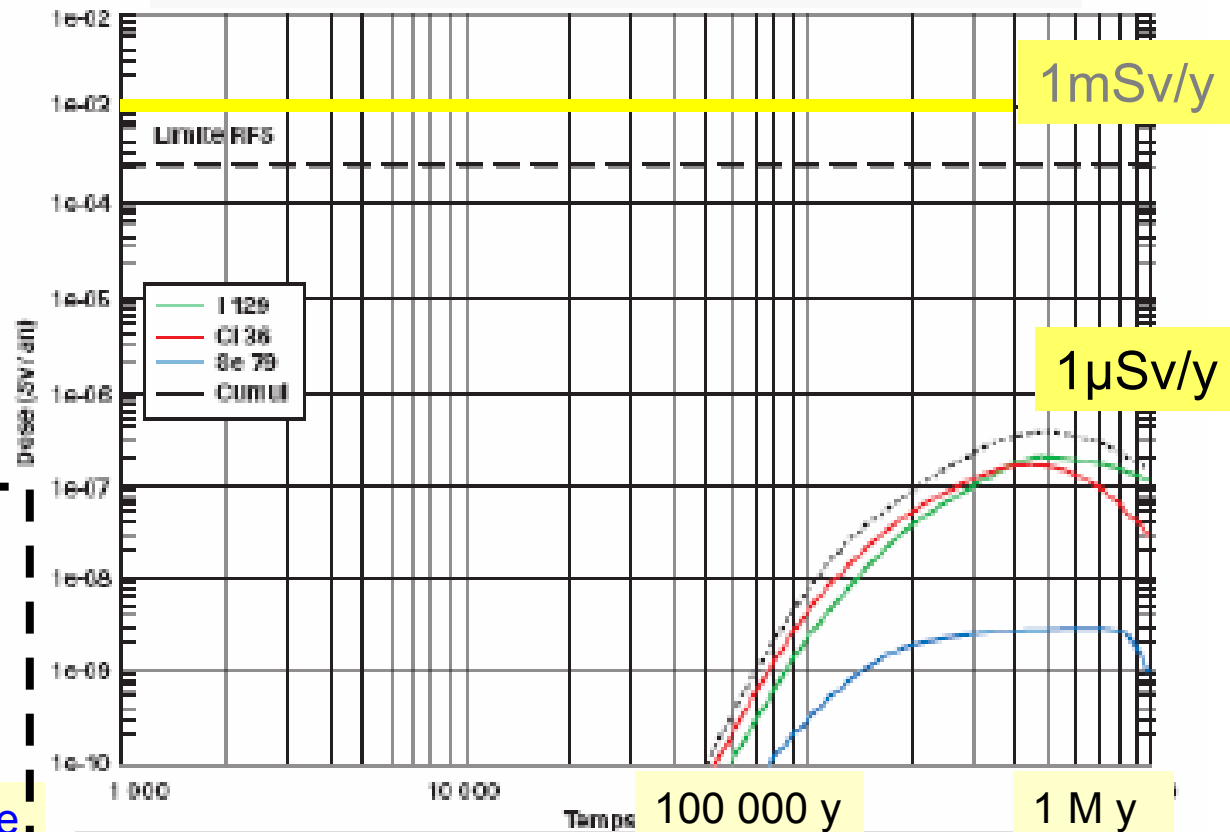
- Underground research laboratory East France (CIGEO Project)



GLASS CANISTERS DISPOSAL

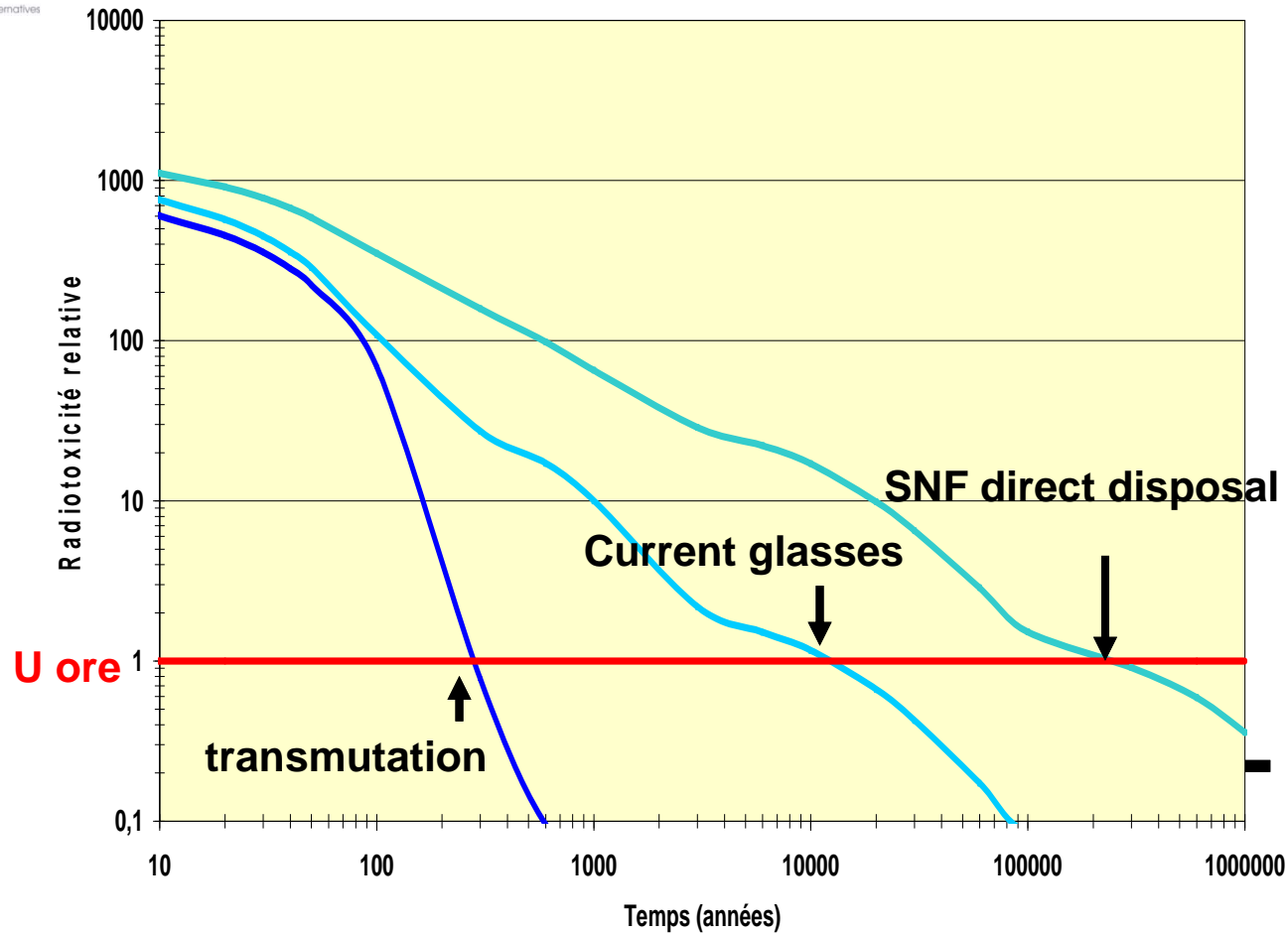


(ANDRA, « CLAY REPORT », 2005)

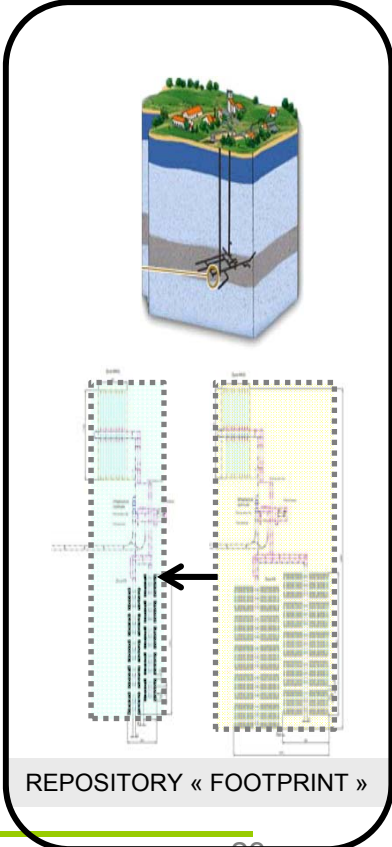


DOSE DELIVERED (*most exposed*)

FINAL WASTE LONG TERM MANAGEMENT...



**Final waste radio- toxicity:
from over 200 000 years ... to centuries ??**



en résumé...

- NUCLEAR ENERGY , A SIGNIFICANT SHARE TODAY!
 - NUCLEAR ENERGY, ATTRACTIVE FOR THE TOMORROW'S « MIX »
HIGH POTENTIALITIES,
HIGH POSSIBLE FURTHER IMPROVEMENTS,
AN ENERGY FOR THE FUTURE...
 - BUT ITS DEPLOYMENT NEEDS NUCLEAR ENERGY TO BE ACCEPTED!
- AND THIS IS AN IMPORTANT CHALLENGE!*
...WORTH TO BE TAKEN UP !

Energy policy : MIX ...



... and compromises !

Pr. Bernard Boullis

RESEARCH IS ESSENTIAL!!!!

*« The scale and the breadth of energy challenge is enormous, far greater than many people realize!
But it can and must be met! » (IEA, 2010)*

« Young people mobilization is crucial! » (WEC)

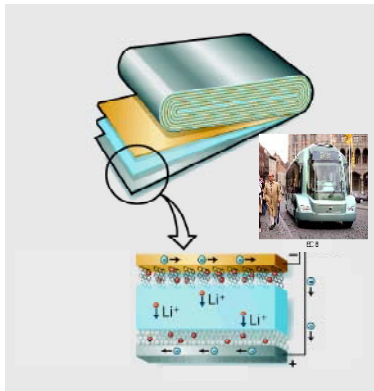
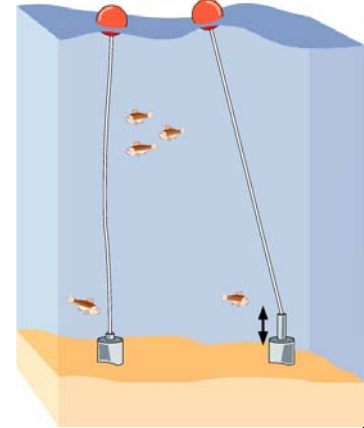
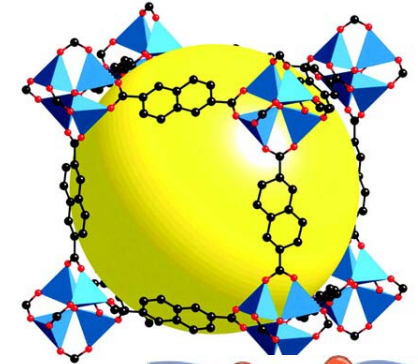
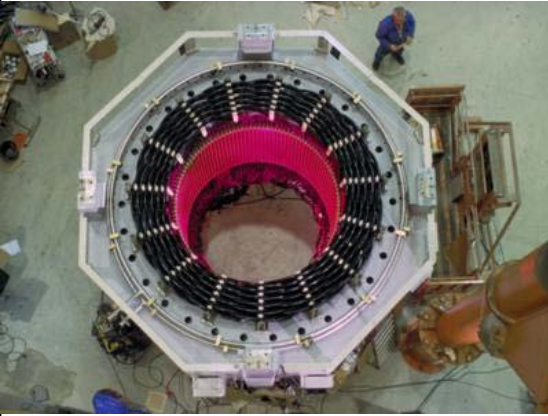


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Storage: the state of the technology

Torbjörn Gustafsson

**Ångström Advanced Battery Centre
Department of Materials Chemistry
Uppsala University**



28/02/2012

The Coming Energy Market



Acknowledgements



Ångström Advanced Battery Centre



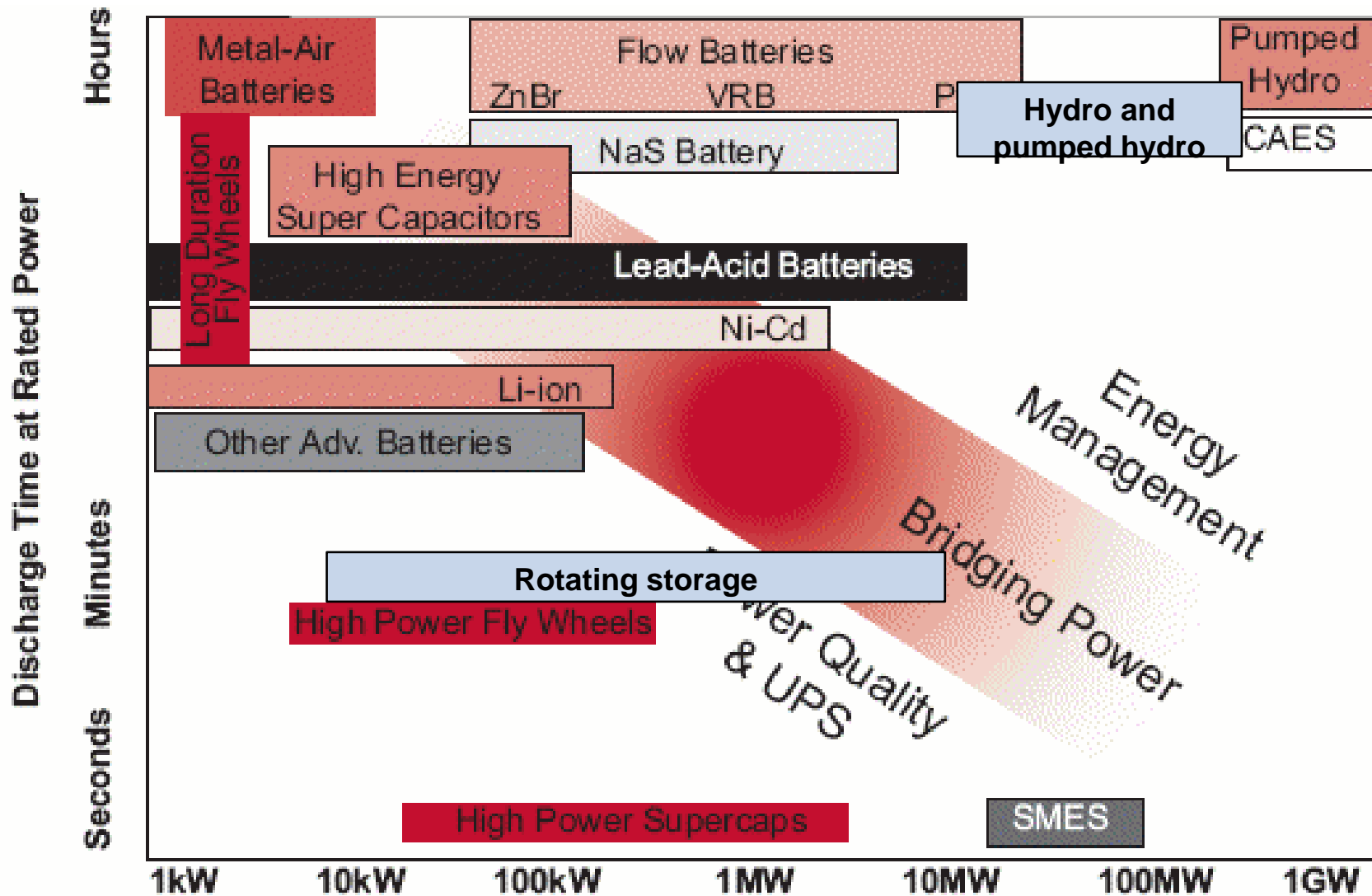
Welcome to
**EIT KIC InnoEnergy
CC Sweden**



Over the last century electricity has developed from being a scientific curiosity to one of the major energy carriers in our society. Why?

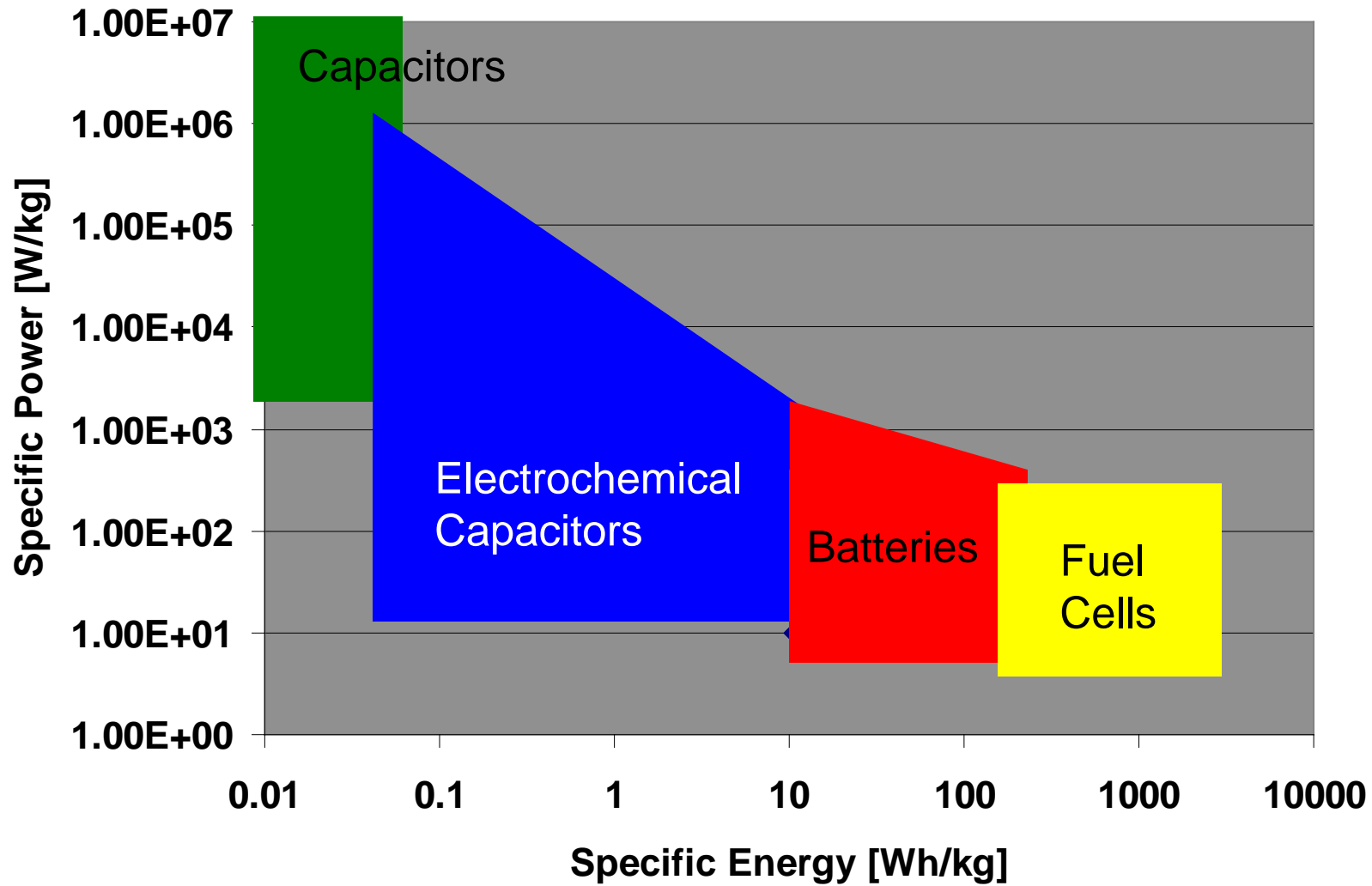


Electrical storage





Power and Energy





Where are the batteries today – after two centuries?

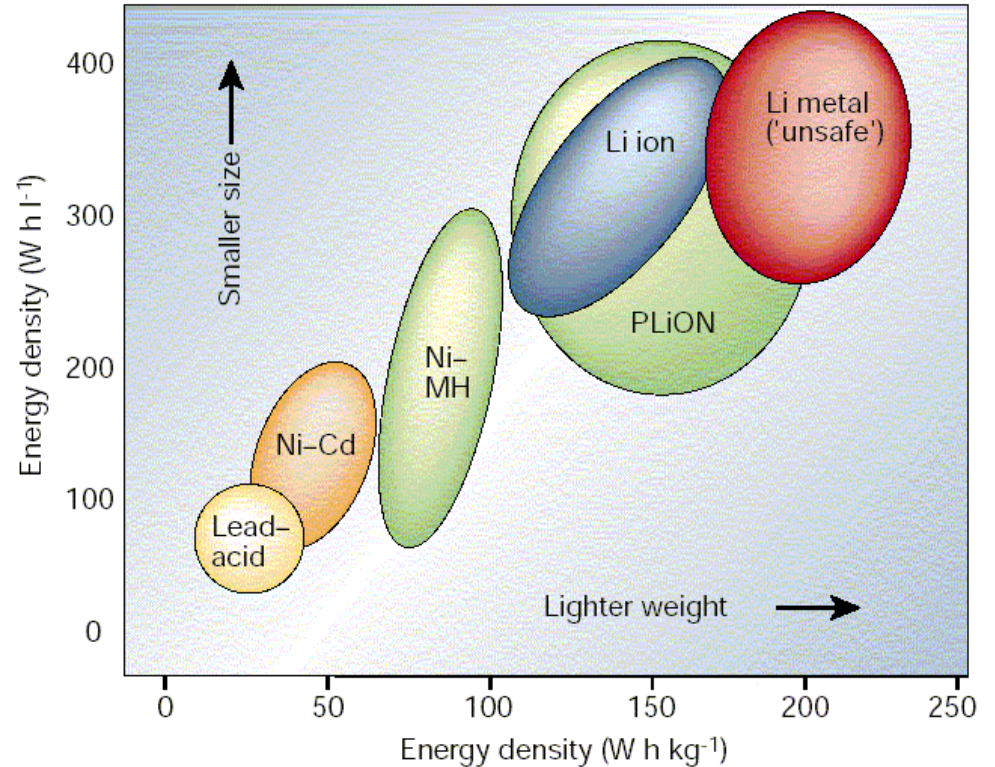


Alessandro Volta, 1799
(Cu/Zn)

- 1839 Fuel cell
- 1859 Pb-acid
- 1899 Ni-Cd (Swedish)
- 1973 Li-metall
- 1975 Ni-MH
- 1979 Li-polymer (Armand)**



1990: Li-jon (Sony)





Different types of storage

Increasing size



Energy density
Safety
Life time, Cost
Power efficiency



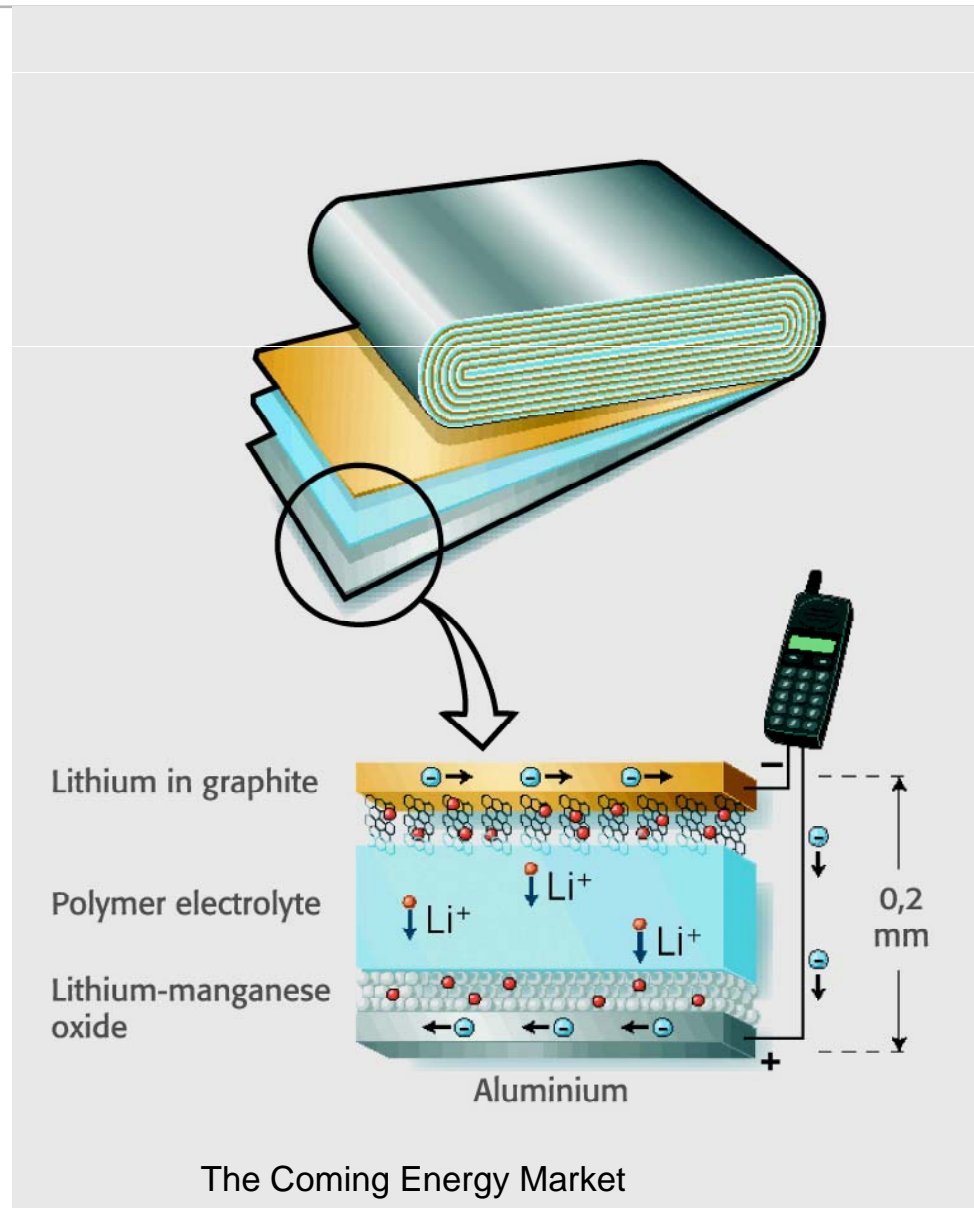
Safety
Power/Energy density
Life time, Cost



Life time, Cost
Up scalability
Power/Energy density
Safety



The lithium-ion battery in portable electronics





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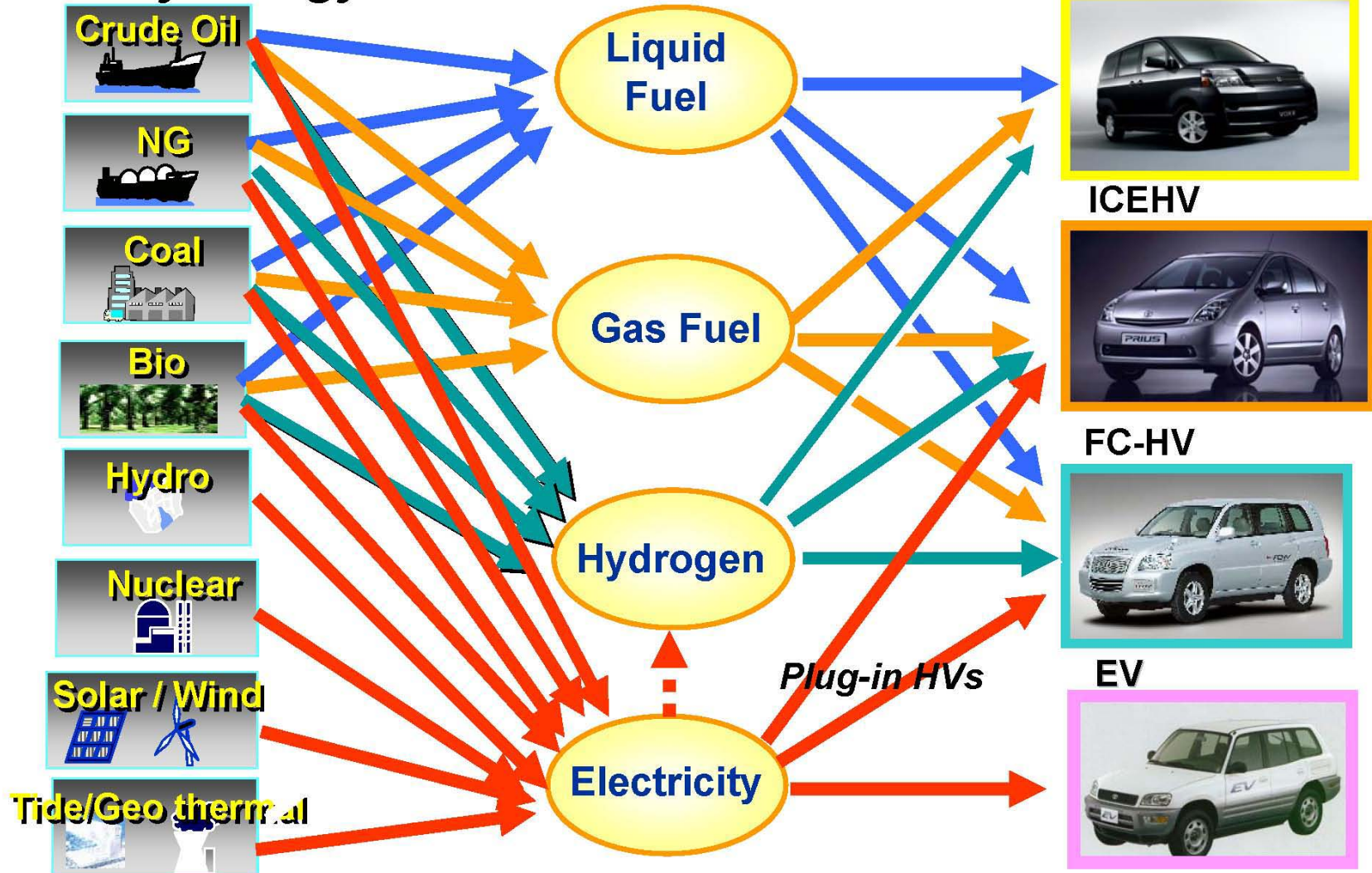
Vehicles





Energy Diversification for future automobiles

Primary Energy



From Toyota



The electrical vehicle

National goals...

- Germany 1.000.000 EVs 2020
- USA 1.000.000 EVs 2015
- France 2.000.000 EVs 2020
- Denmark 600.000 EVs 2025



Will this happen?



The EV battery

- Energy content: 30kWh
- Weight: 200 kg
- Cathode material: 70 kg
- Anode material: 35 kg

**One EV battery corresponds to 10 000
mobile phone batteries!**

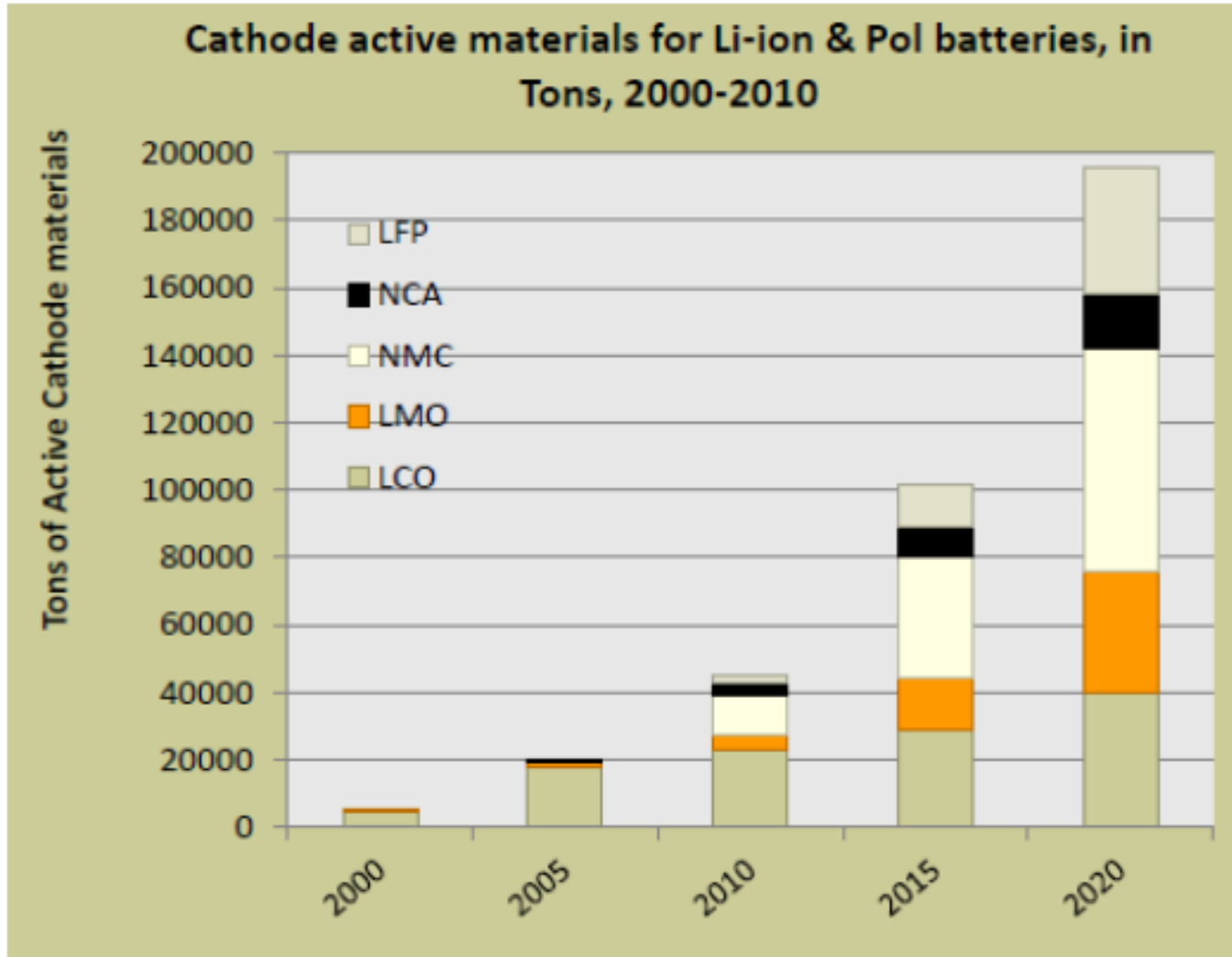


Challenges for the future EV battery market

- Safety
- Cost
- Environmental impact
- Availability of raw materials
- Transport of new batteries



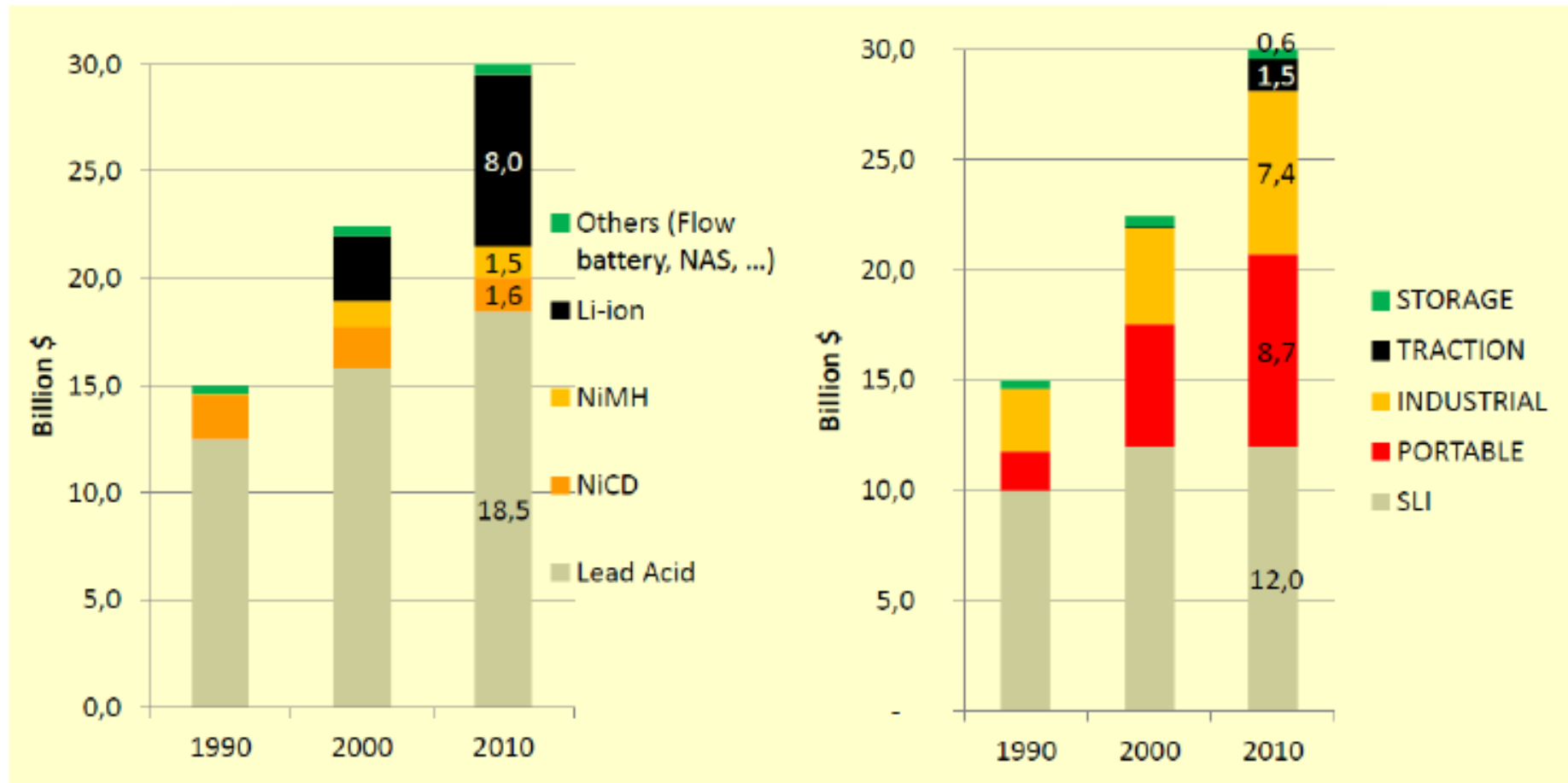
Cathode materials for Li-ion batteries



Source: Christophe Pillot, Avicenne Energy, "The rechargeable battery market – past and future", Batteries 2011.



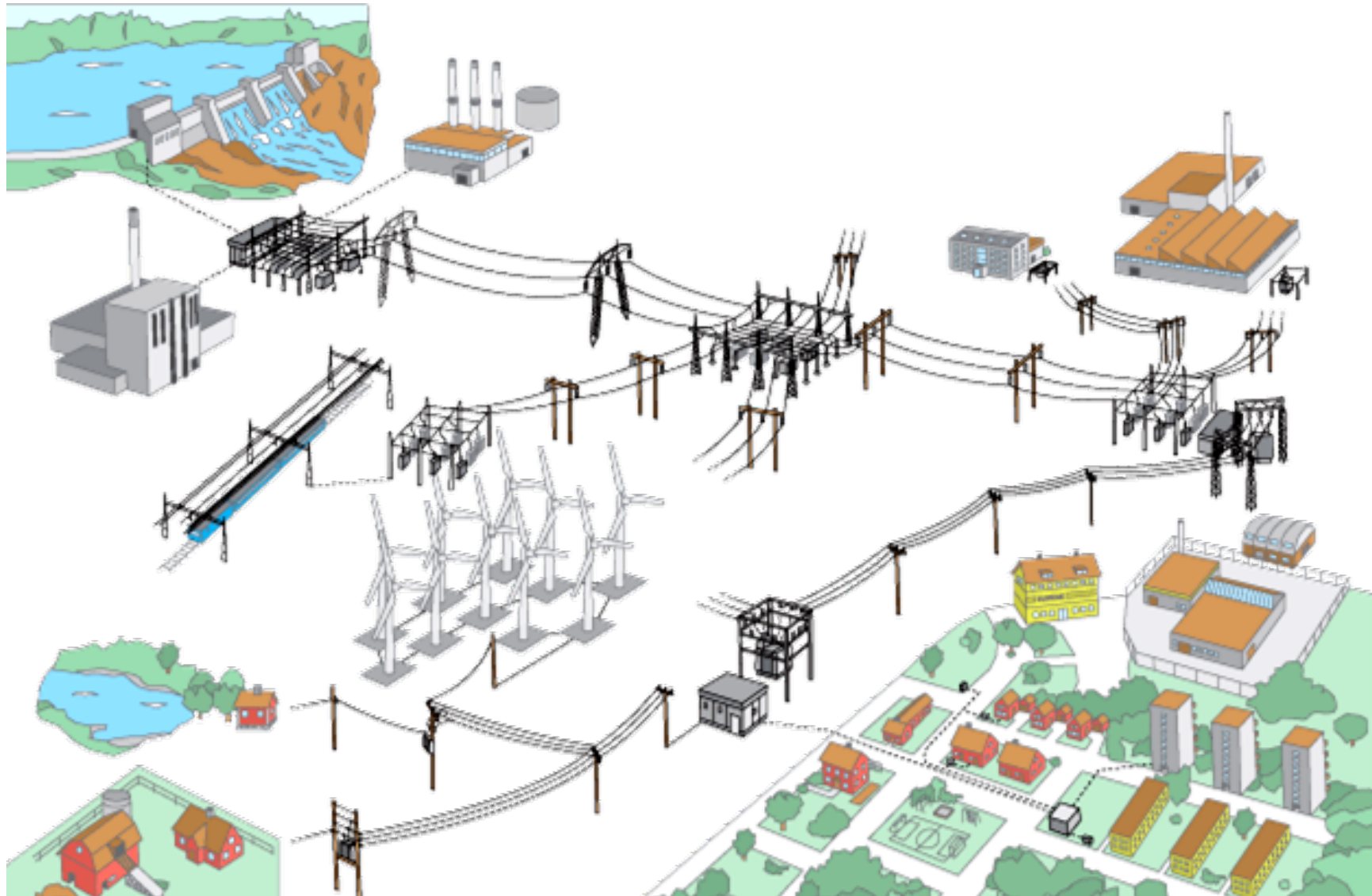
World wide battery market



Source: Christophe Pillot, Avicenne Energy, "The rechargeable battery market – past and future", Batteries 2011



The grid



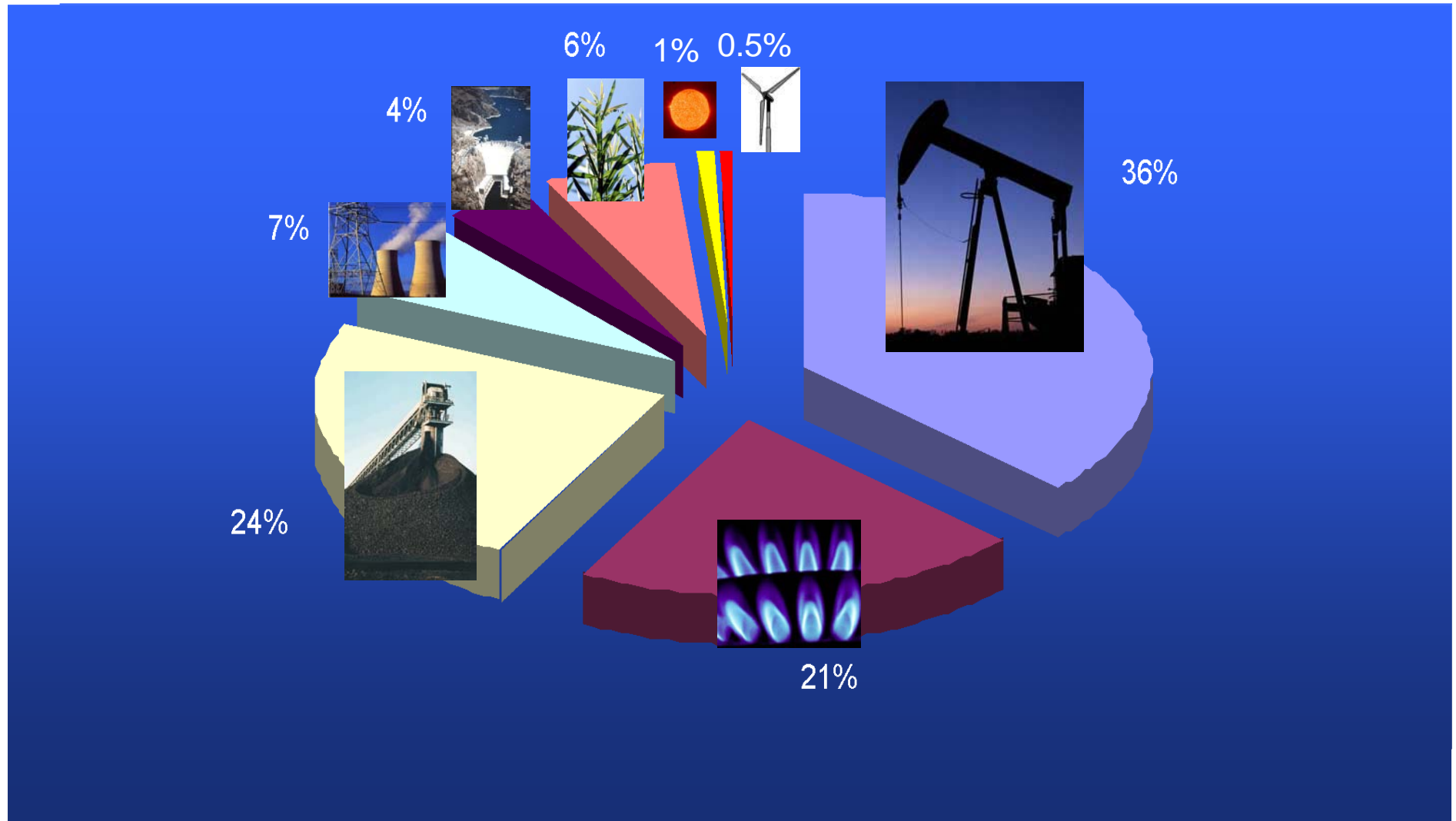


The Grid

Energy production = Energy consumption

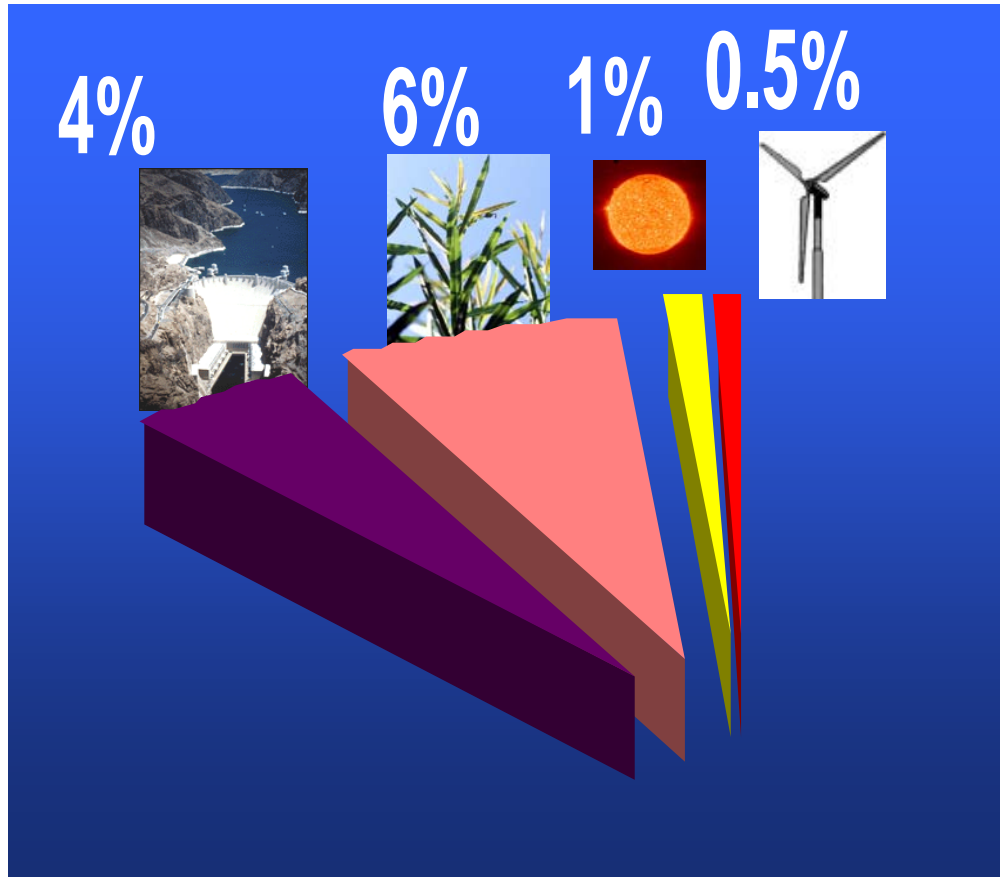


Energy sources used today





Renewable energy sources



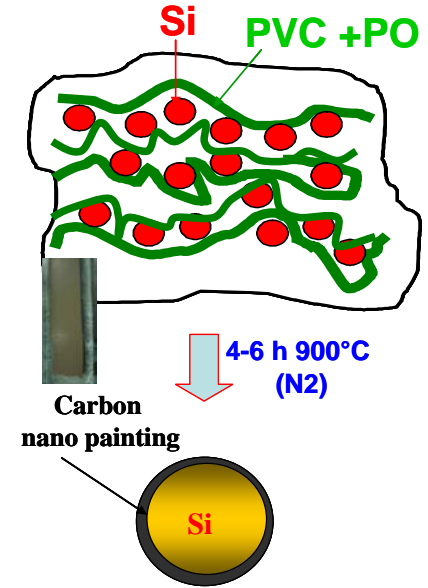
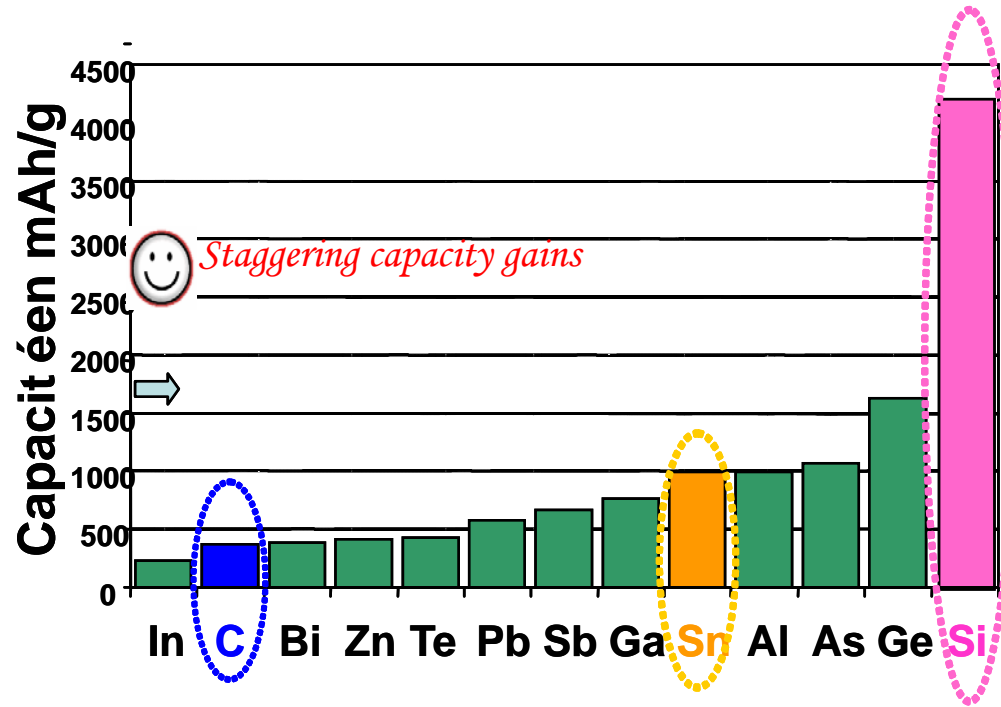
How to increase the utilisation of the renewable energy sources?



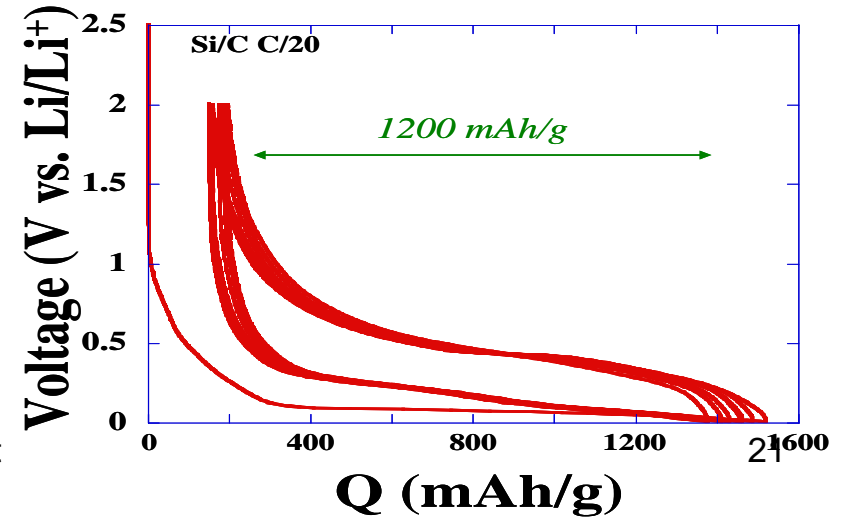
New battery concepts



Nano silicon



↙
**Si based Li-ion batteries
soon on the market**





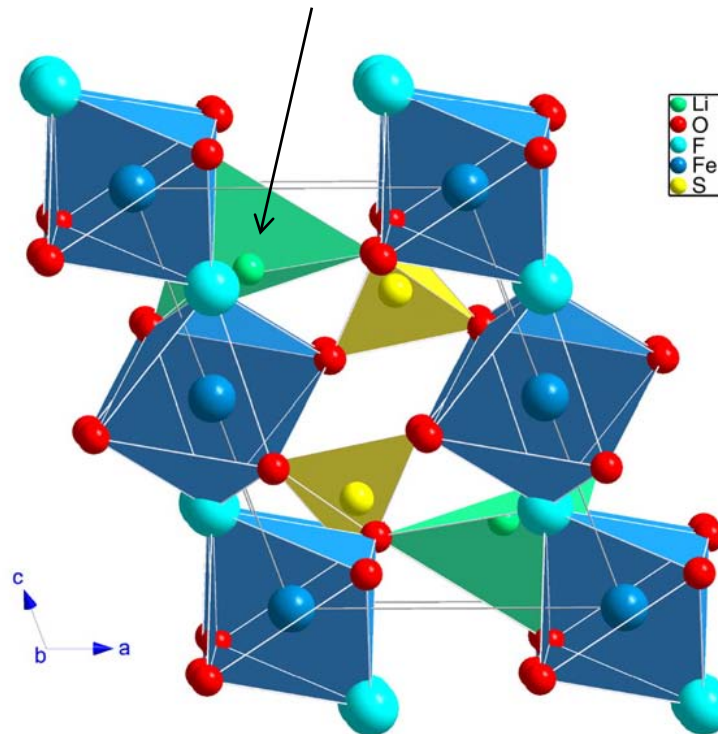
LiFeSO₄F

Synthesis

Electrochemistry
- charge/discharge

Electrolyte
- ion transfer

Li⁺



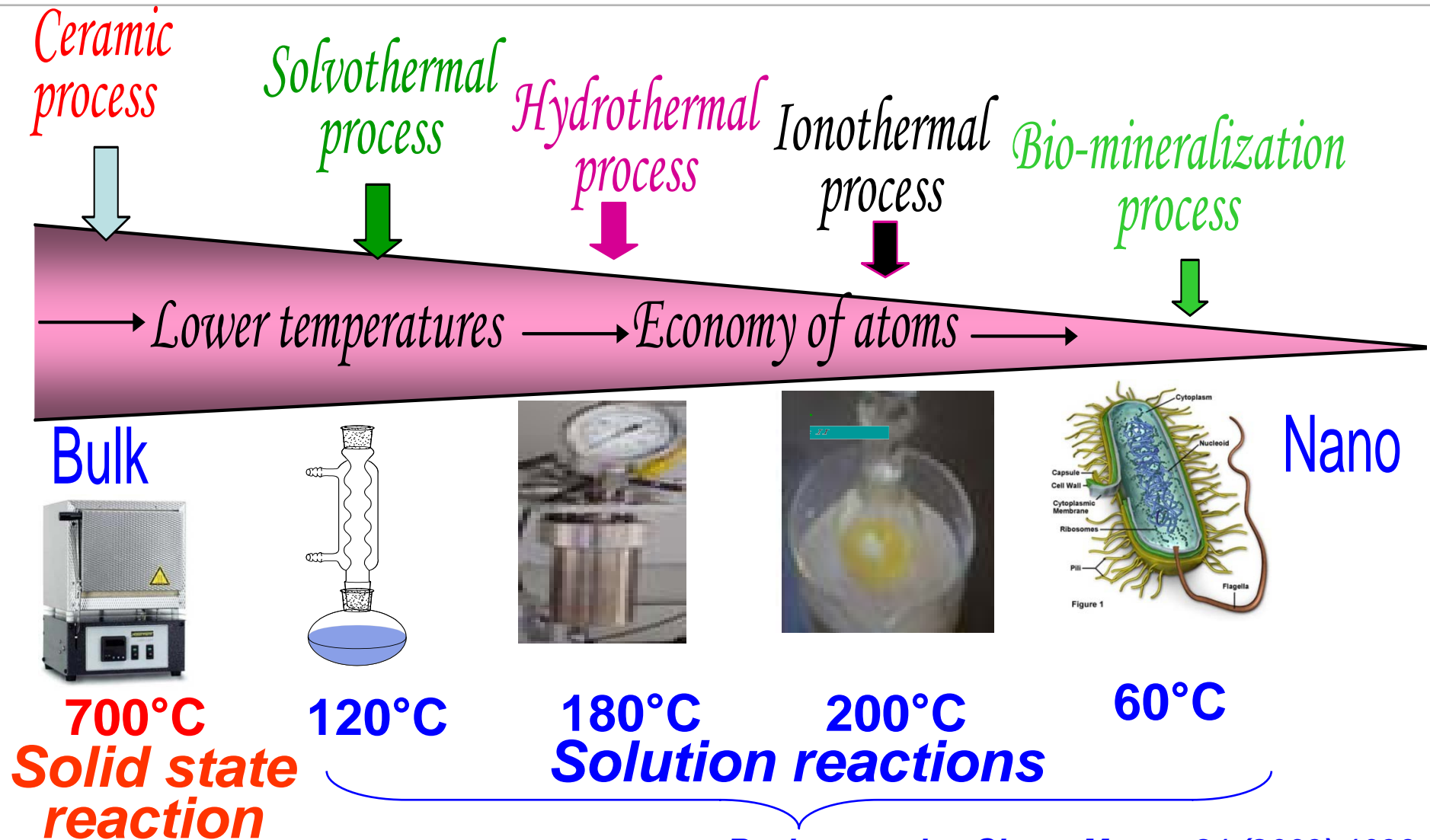
Structural changes
- diffraction

Surface chemistry
- x-rays

Cathode material: LiFeSO₄F



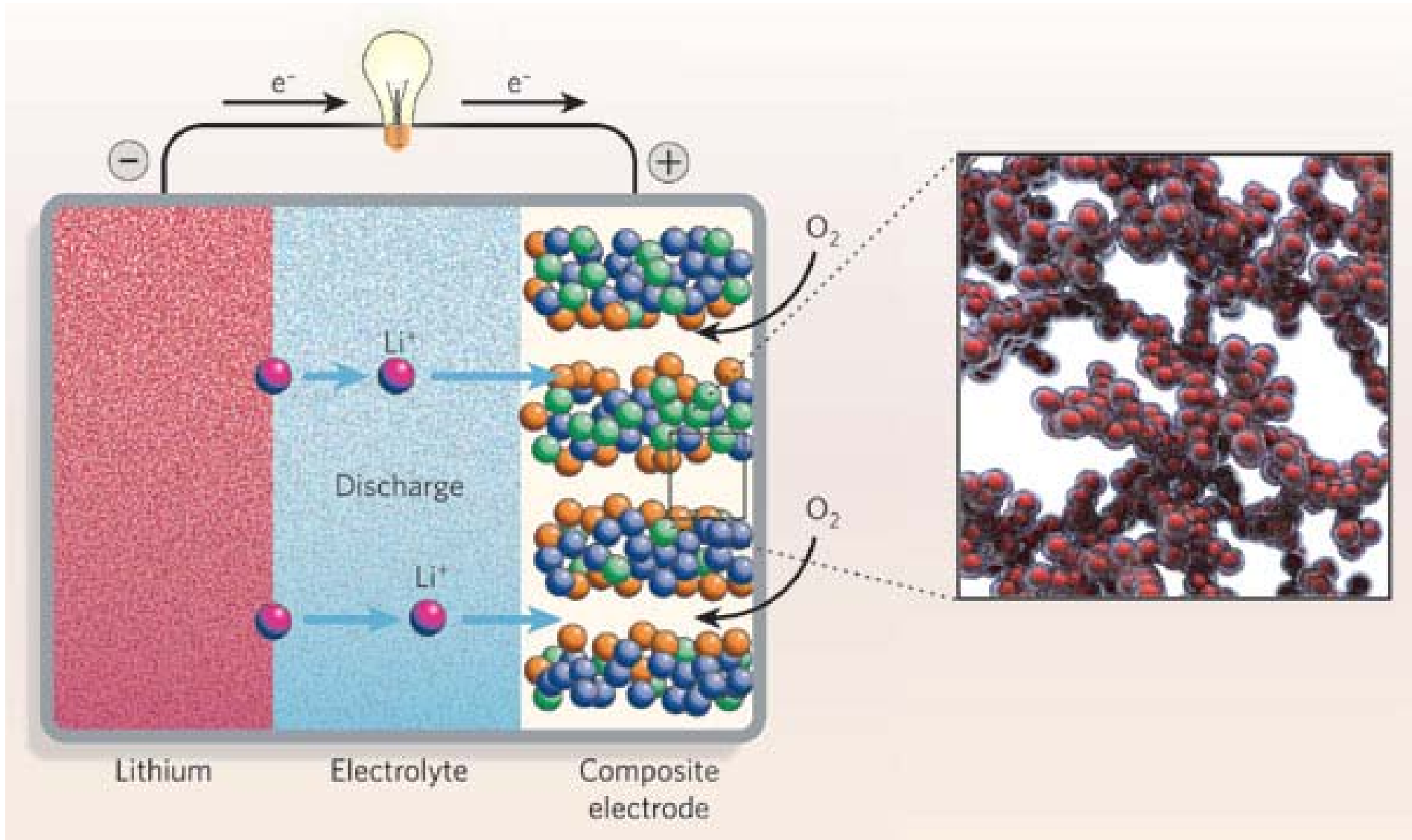
Minimising carbon dioxide footprint



Recham et al., *Chem. Mater.*, 21 (2009) 1096.

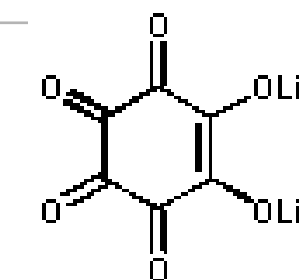


The Lithium-air battery

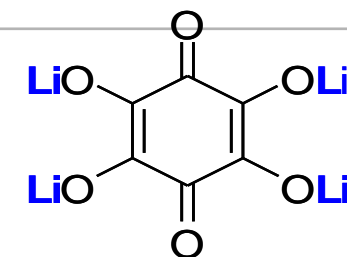




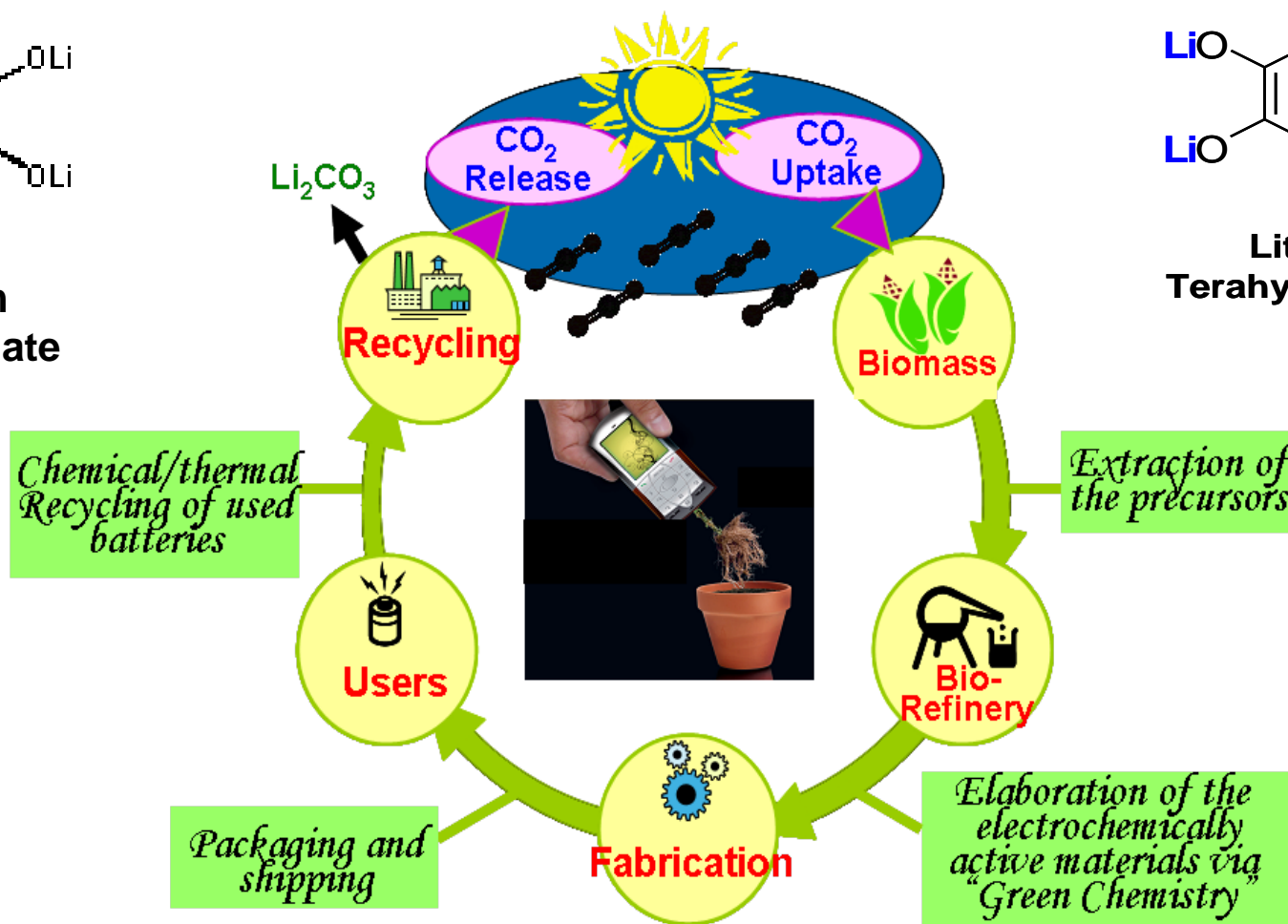
A new generation of “green” Li-ion batteries



Dilithium dirhodizonate

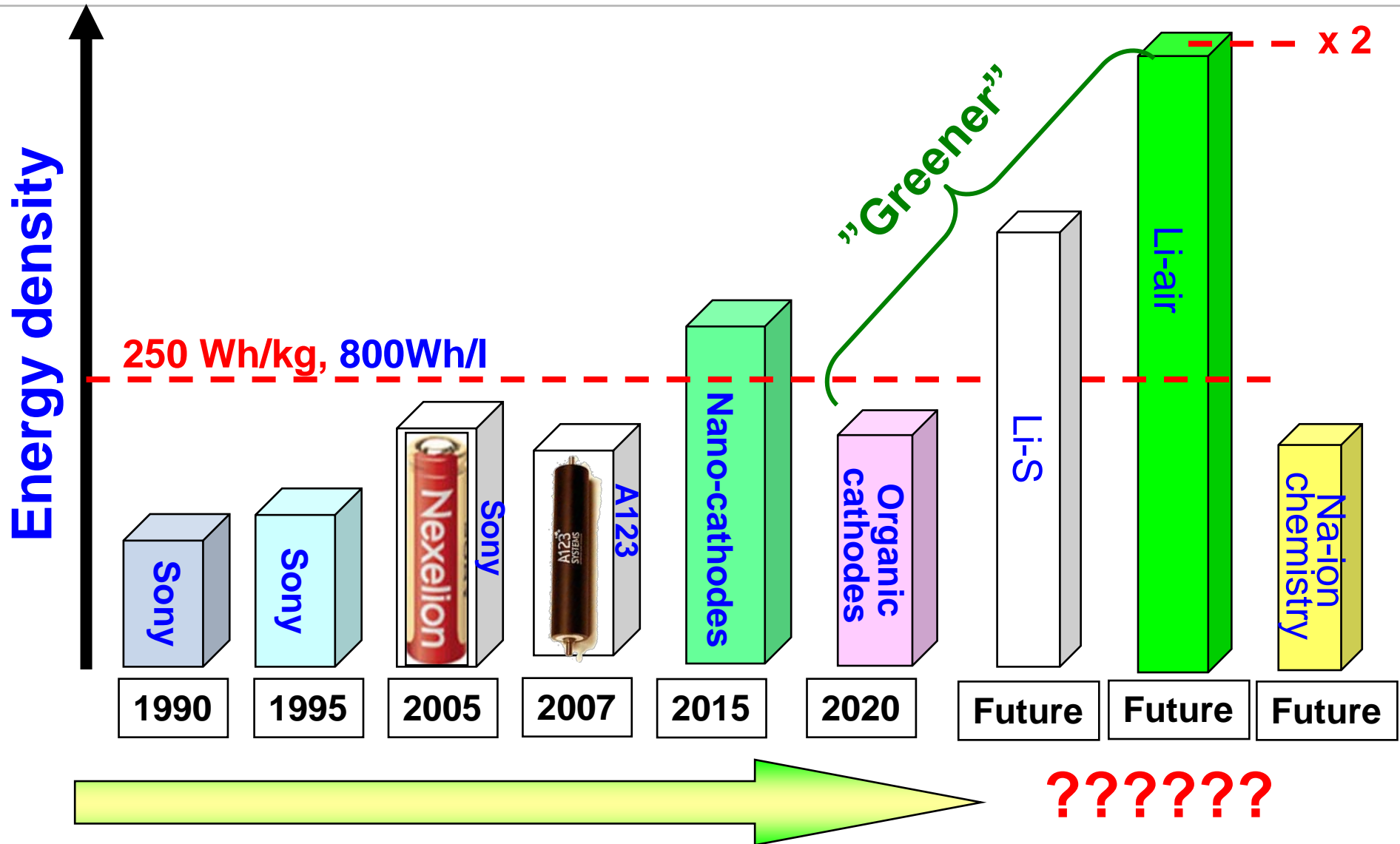


Lithiated Terahydroquinone



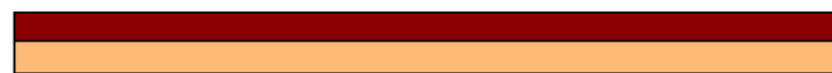


Li-ion batteries the next 20 to 30 years



Micro batteries

Same foot-print area (base):



2D – thin film

Short Li transport path

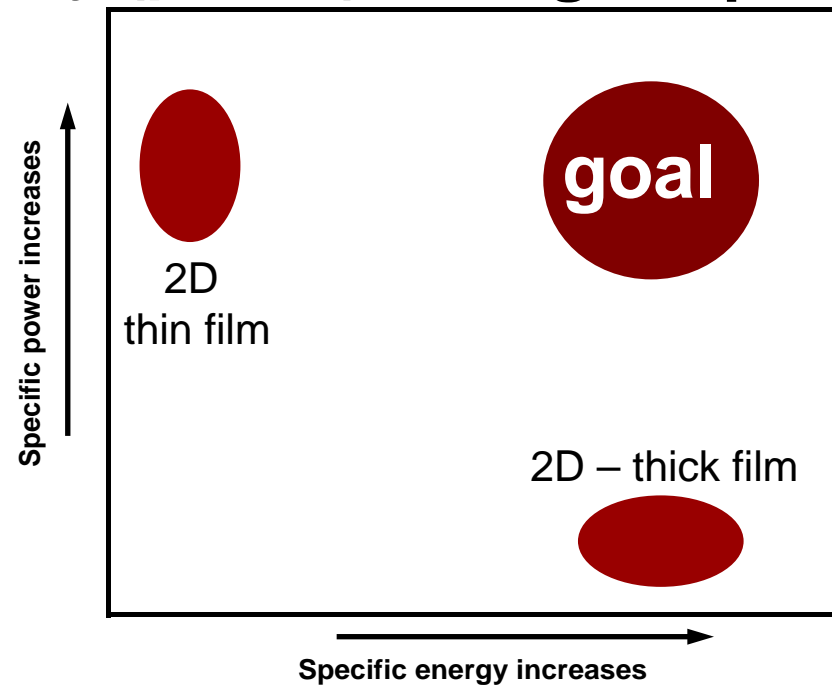
➔ high rate capability (power)



2D – thick film

Large amount of active material

high capacity (energy density)

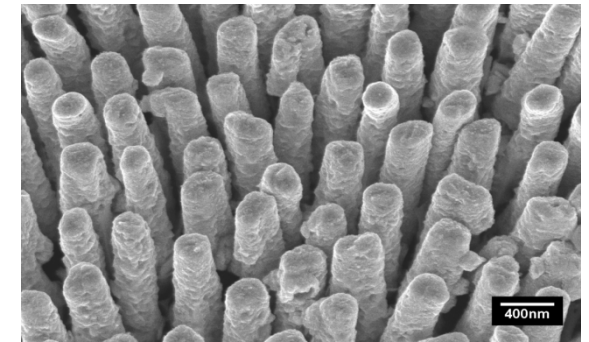
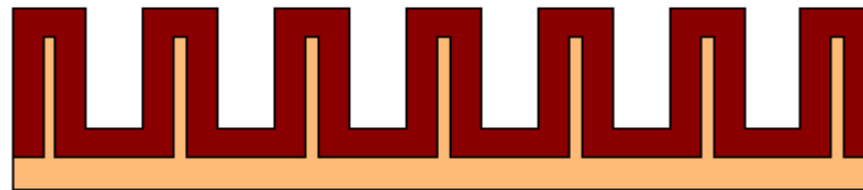




Why moving from 2D to 3D battery design?

Same foot-print area (base):

3D – thin film



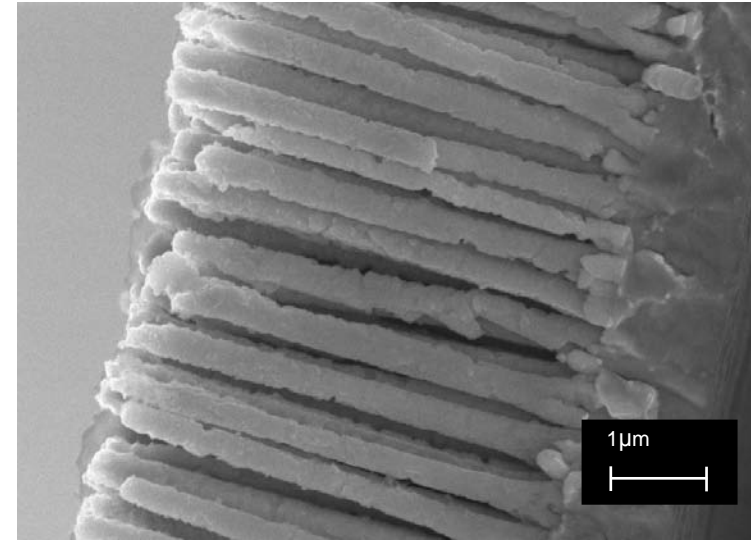
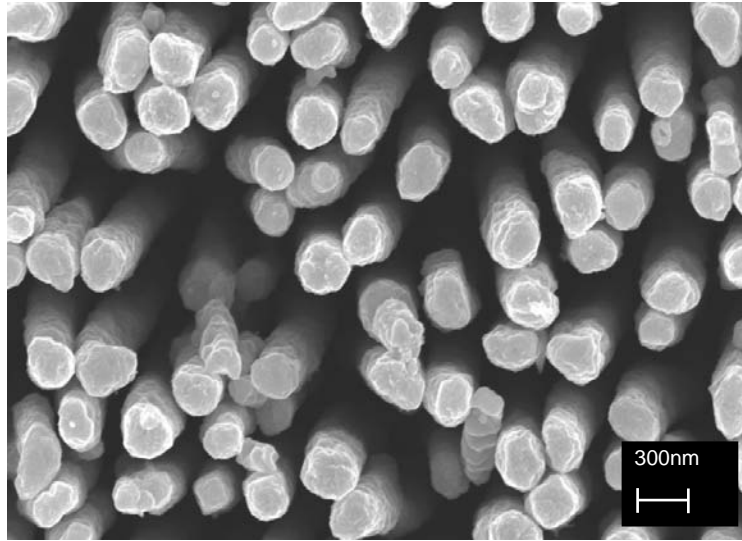
Short Li transport path AND Large amount of active material

→ No need to compromise between energy density and power density

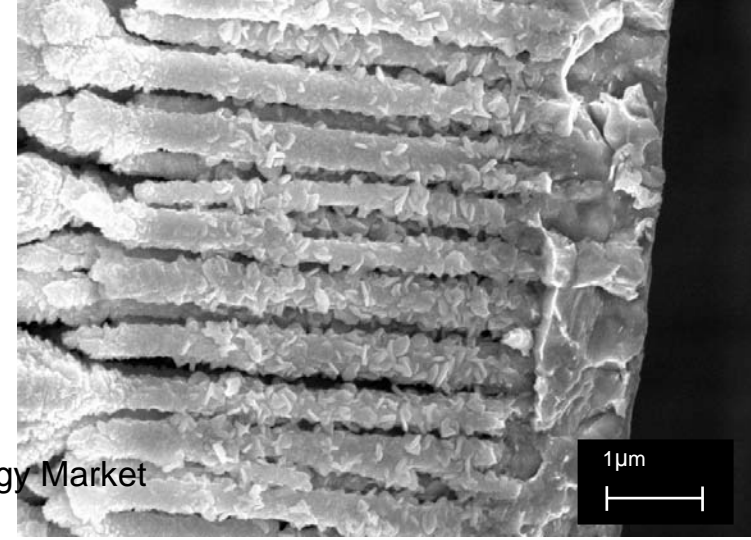
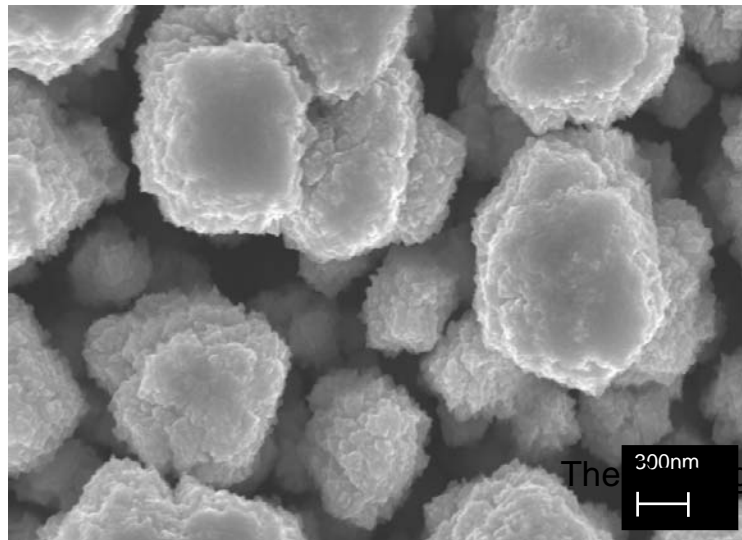


3D-microbatteries

Current collector of copper



Current collector of copper deposited with Sb





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Thank You!



Geopolitics of Energy Security:

Five framings from a global Indian perspective

Dr Arunabha Ghosh

CEO

Council on Energy, Environment and Water

New Delhi

The Coming Energy Market

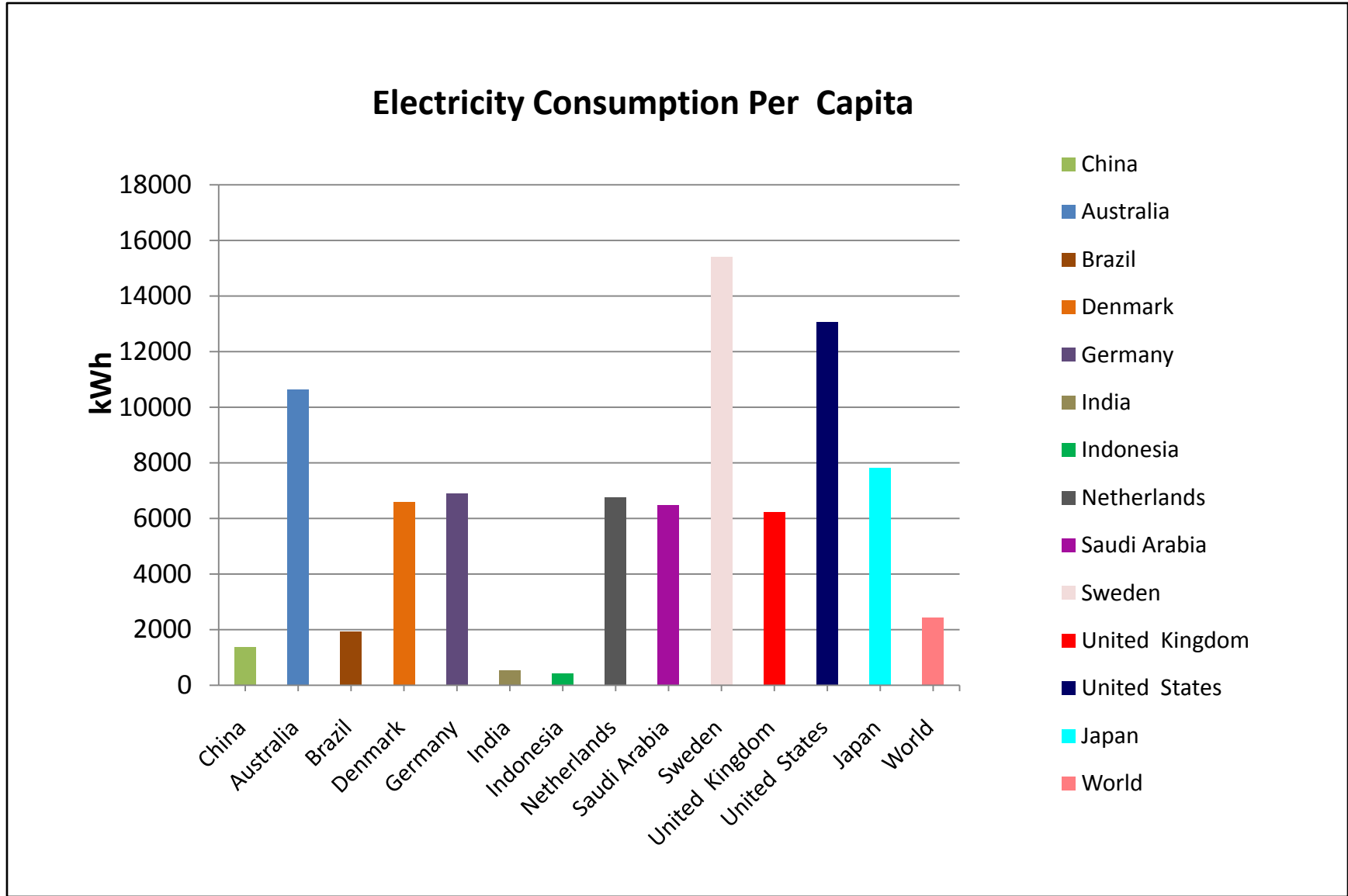
ESADEgeo and Aspen España

Madrid, 24 November 2011

Five ways to frame the energy security debate

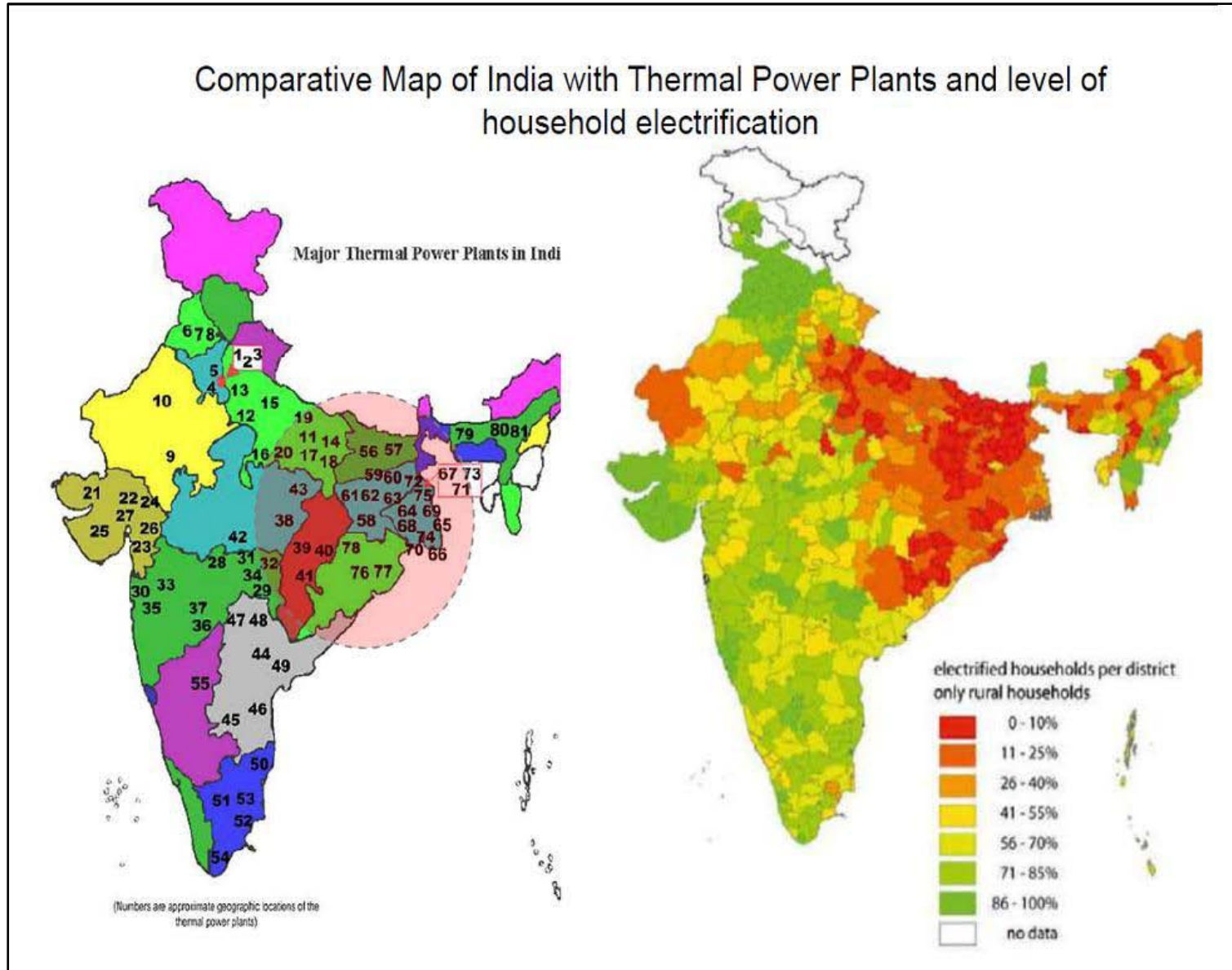
- Energy access: or how to lose (or win) an election
- Energy technology: or how to upscale efficiency
- Energy demand: or how to confront supply constraints
- Energy horizons: or how to promote renewable energy
- Energy cooperation: or how to avoid disputes and conflict

Per capita energy consumption is small for India

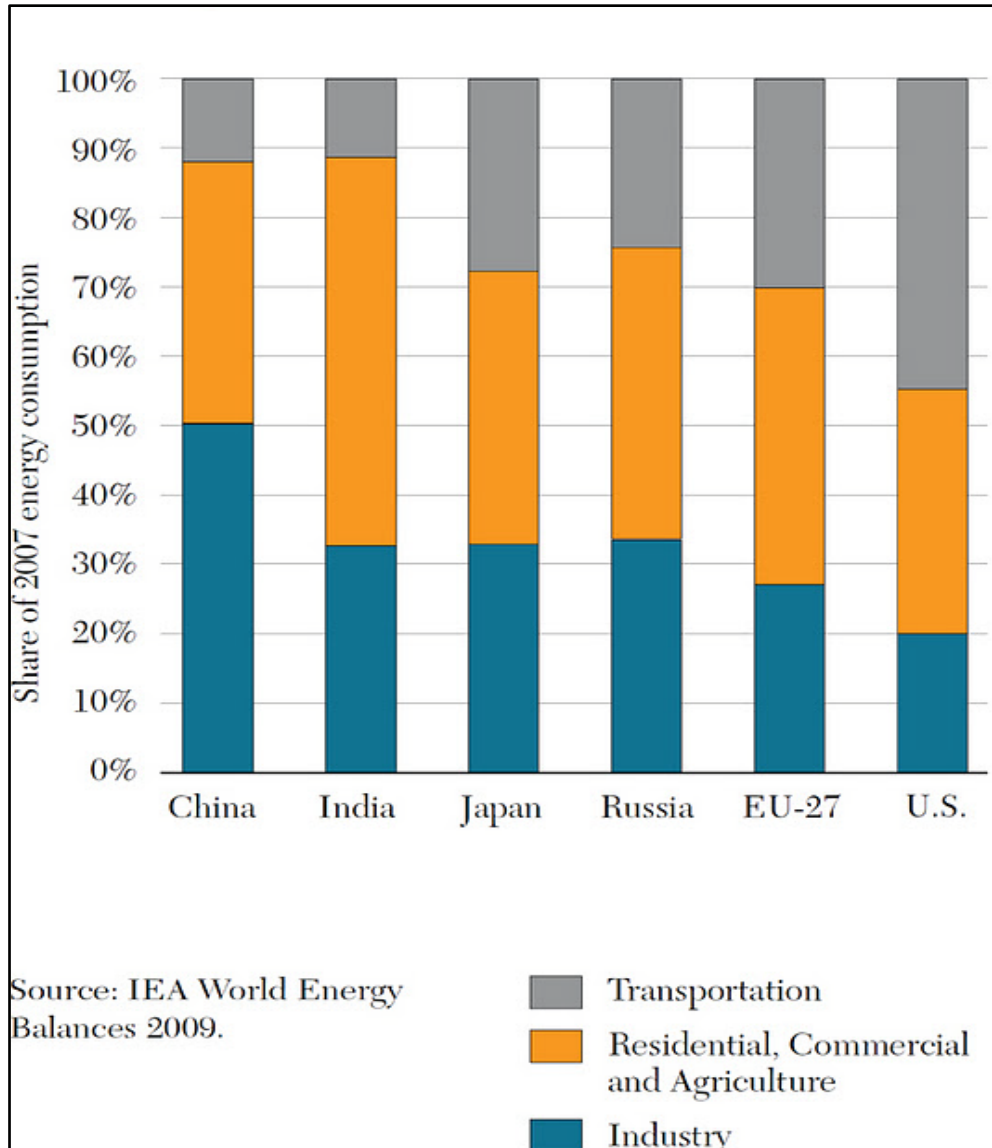


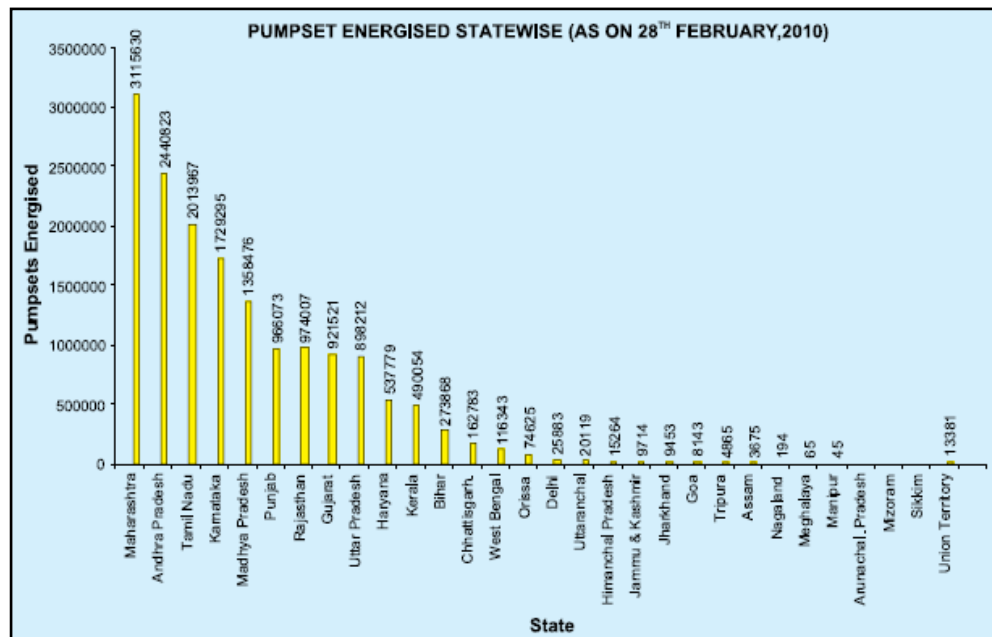
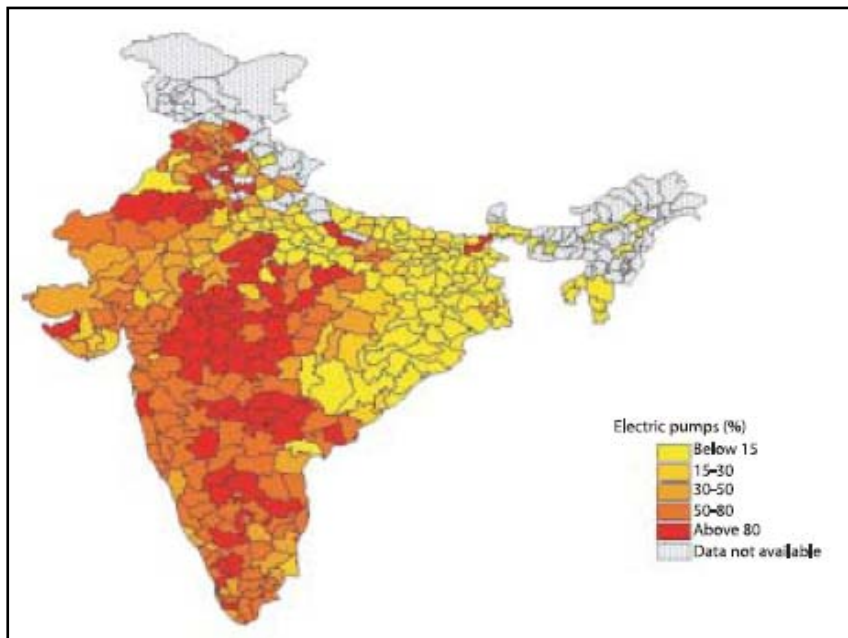
SOURCE: IEA (2005), Key World Energy Statistics 2005, International Energy Agency, Paris, 2005

Energy inequality in India



Agriculture still a major consumer of energy

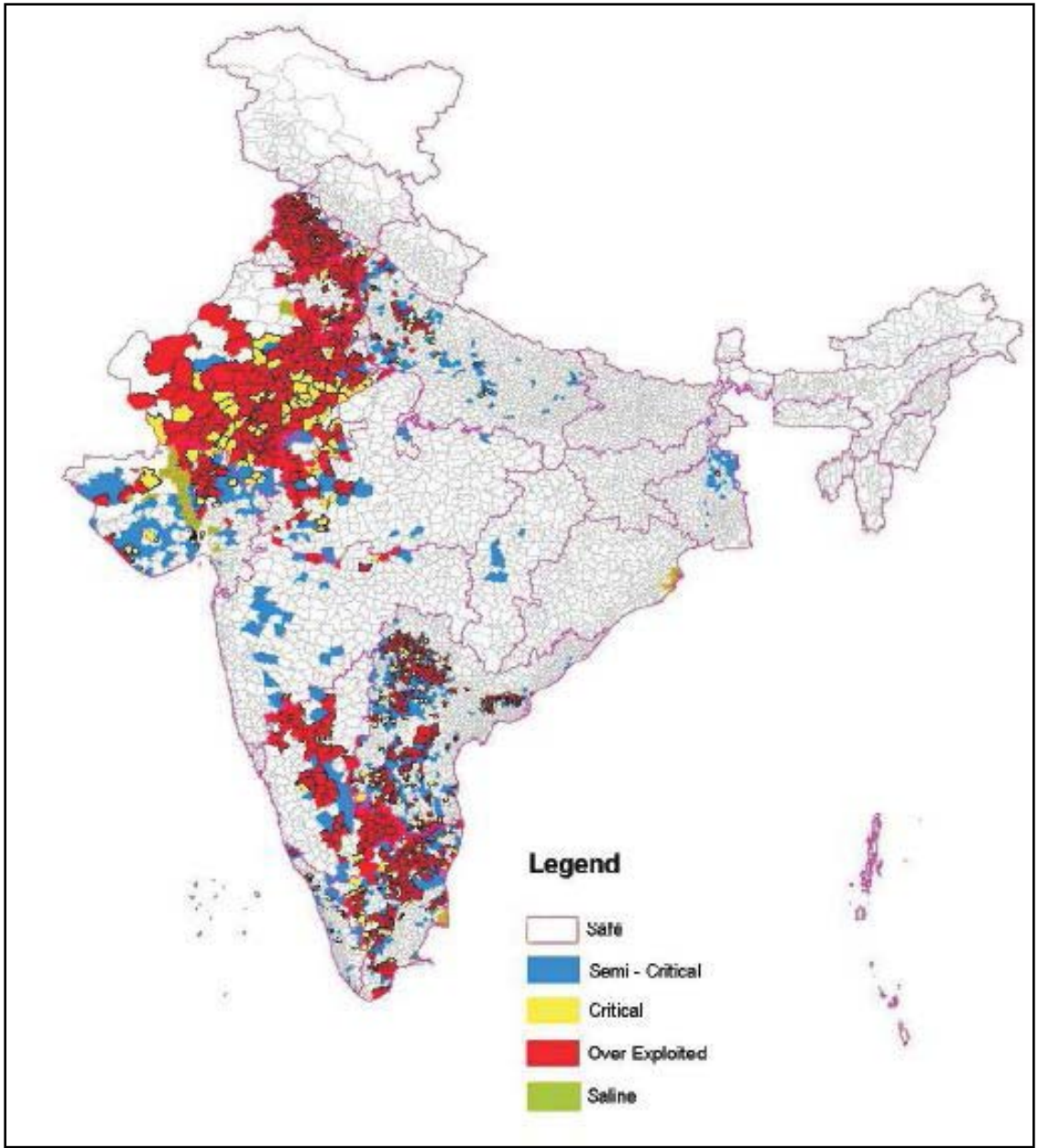




Geographical distribution of electric agricultural pump sets



Energy-groundwater nexus: deepening crisis

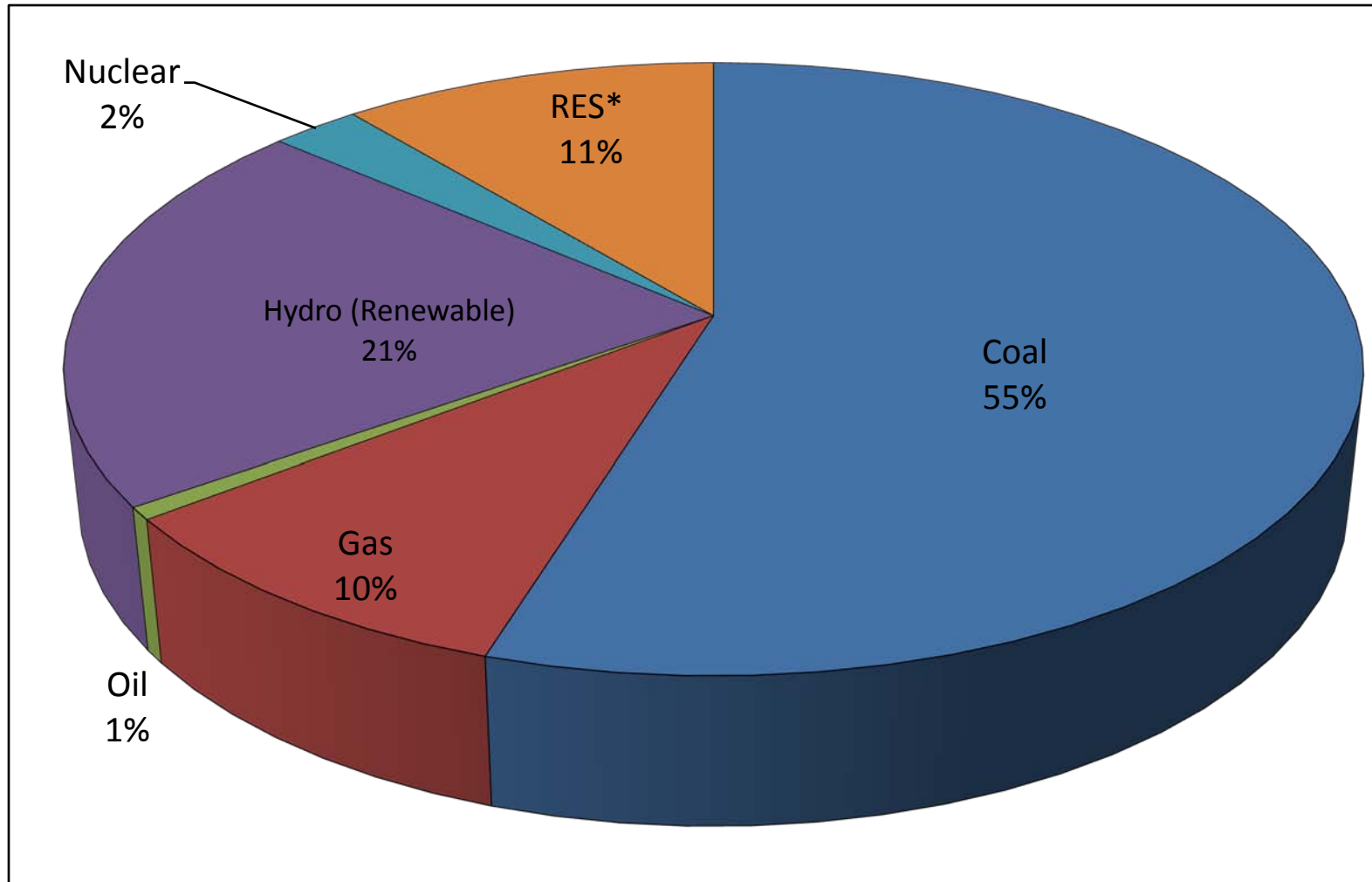


SOURCE: CEEW (2011)

Five ways to frame the energy security debate

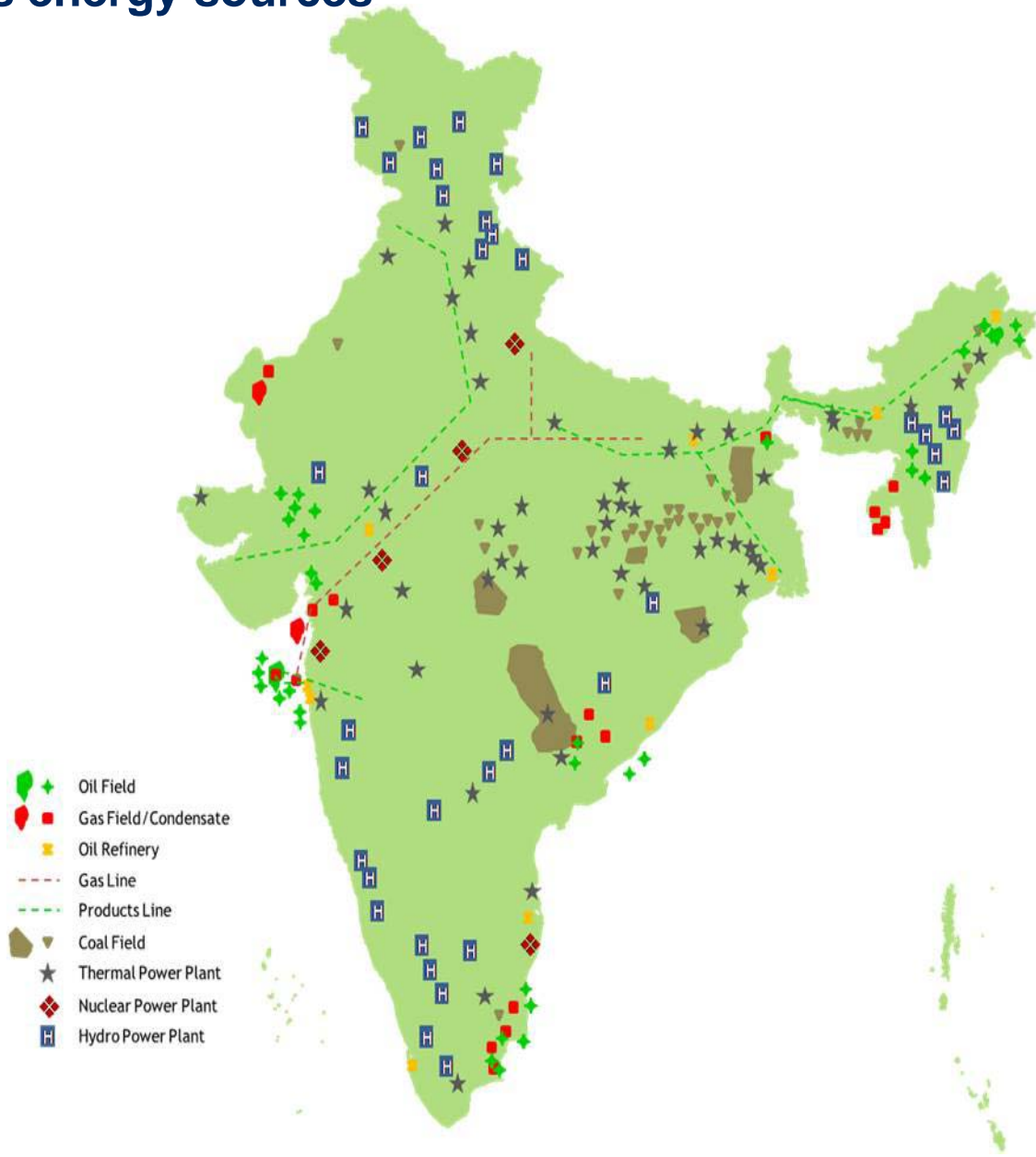
- Energy access: or how to lose (or win) an election
- Energy technology: or how to upscale efficiency
- Energy demand: or how to confront supply constraints
- Energy horizons: or how to promote renewable energy
- Energy cooperation: or how to avoid disputes and conflict

Fossil fuels dominate the power capacity for now



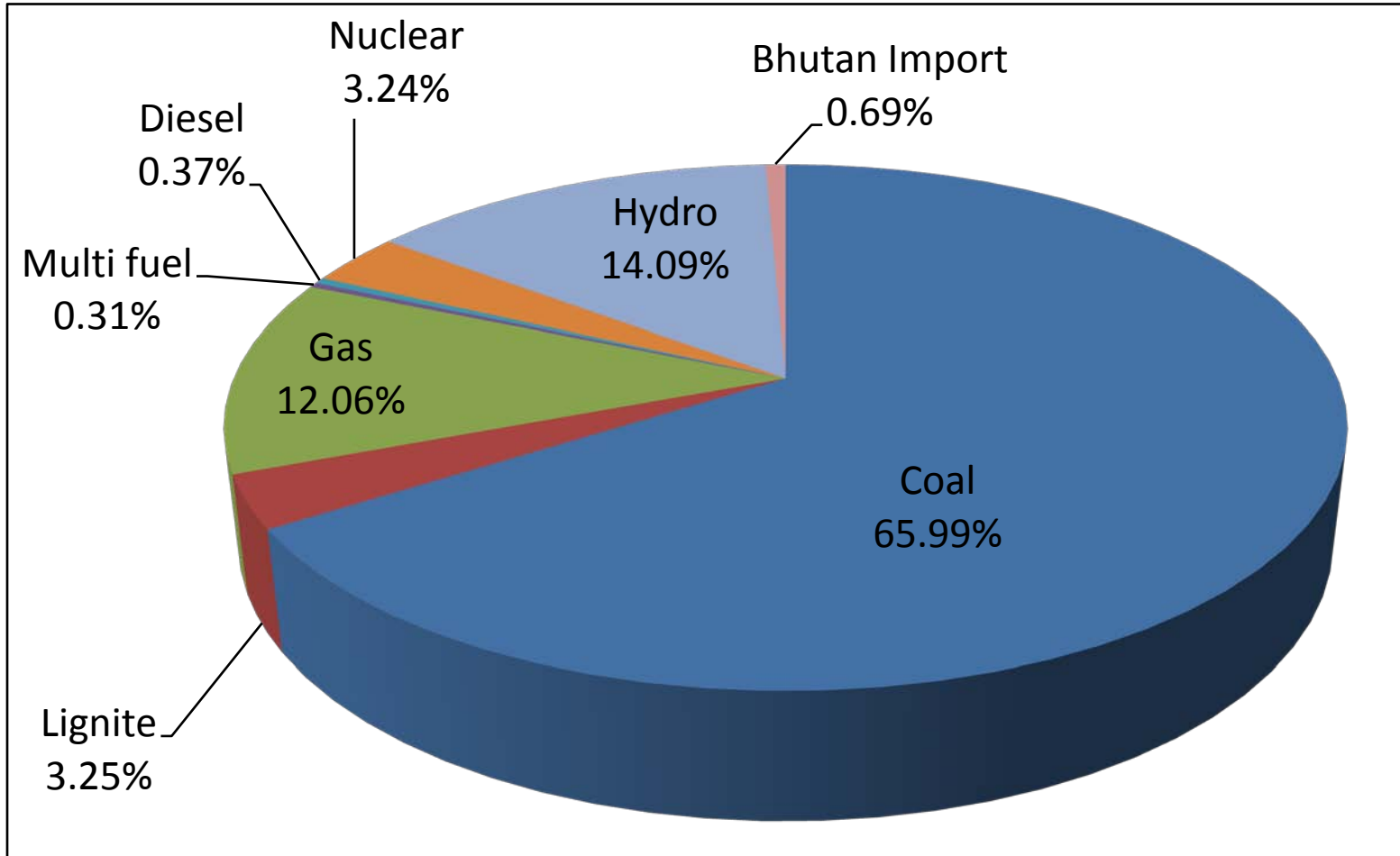
*Renewable Energy Sources(RES) include SHP, BG, BP, U&I and Wind Energy, SHP= Small Hydro Project , BG= Biomass Gasifier ,BP= Biomass Power,, U & I=Urban & Industrial Waste Power, RES=Renewable Energy Sources

Mapping India's energy sources

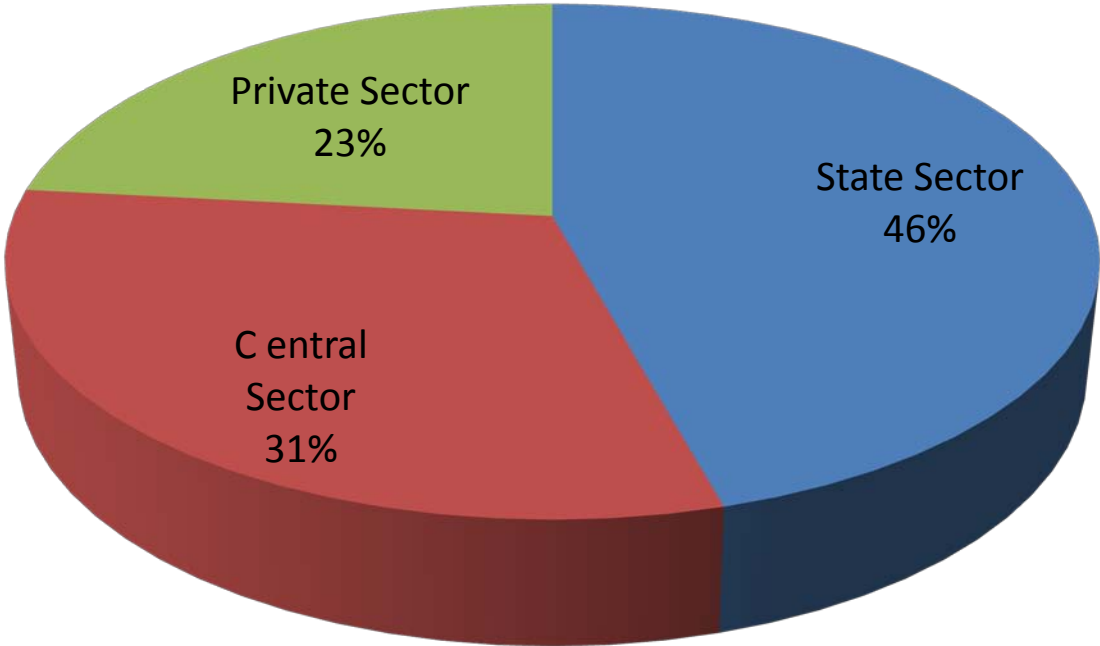


And coal dominates electricity generation

Percentage share of fuel in power generation during 2010-11



Private sector's share in electricity generation is gradually increasing

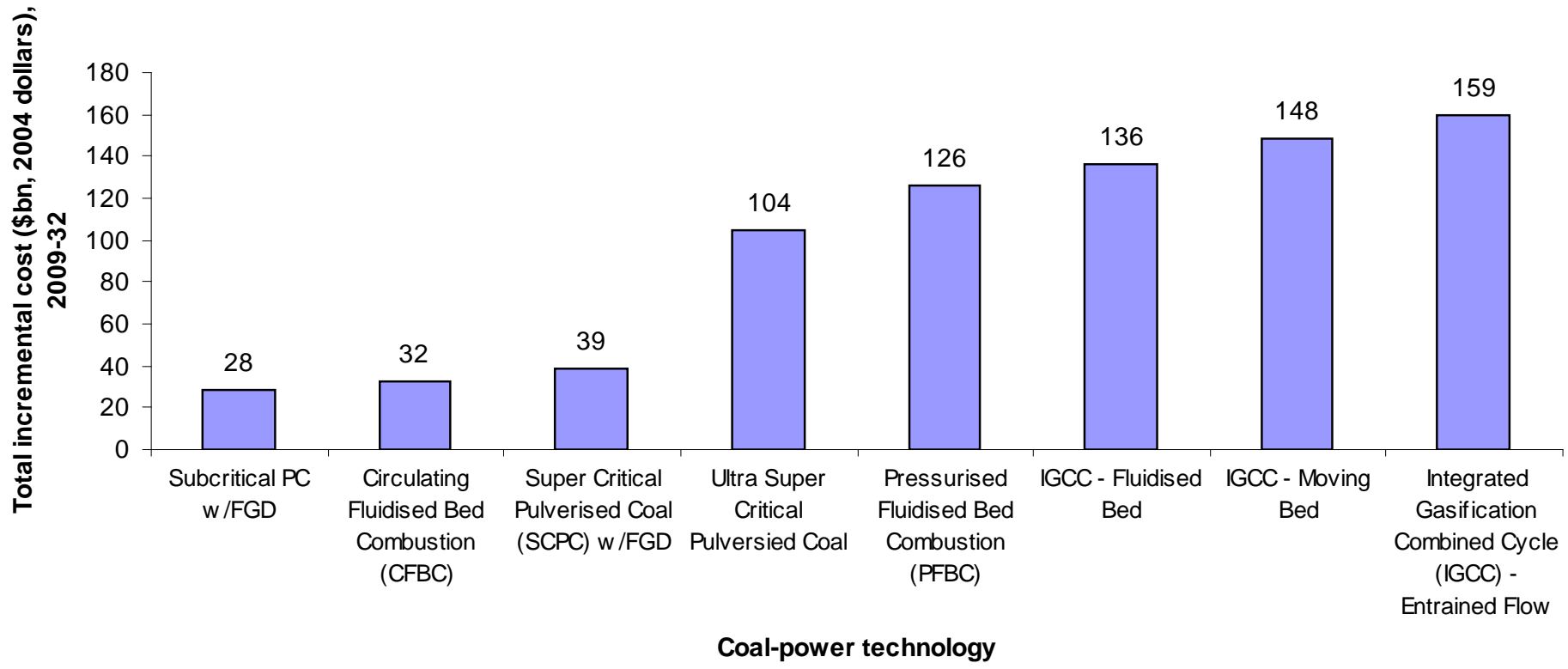


Sector	MW
State Sector	83563.65
Central Sector	56572.63
Private Sector	42553.34
Total	182689.62



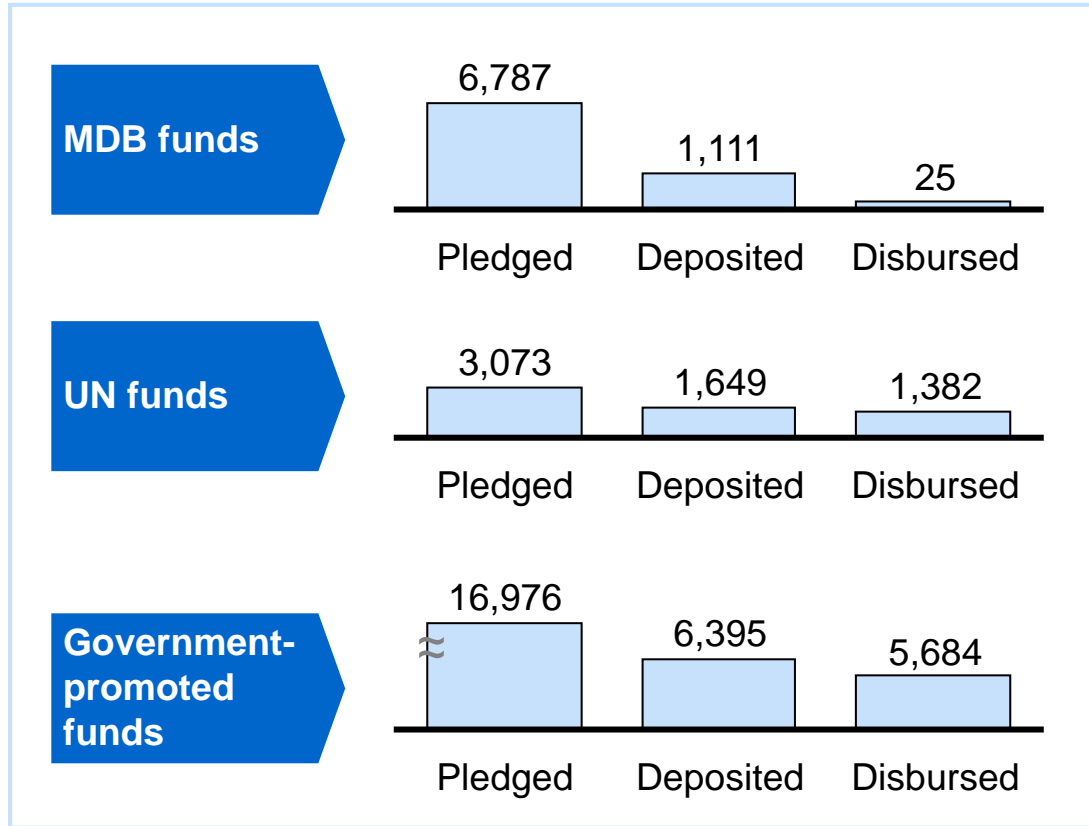
Efficient technologies cost money

Incremental costs for higher efficiency, lower emissions technologies



Many recent initiatives for climate financing but low ambitions so far

\$ million, figures updated as of August 2010



Note 1: UK Environmental Transformation Fund – International Window: Funds channelled through CIFs, FCPF, and CBFF, hence not included separately.

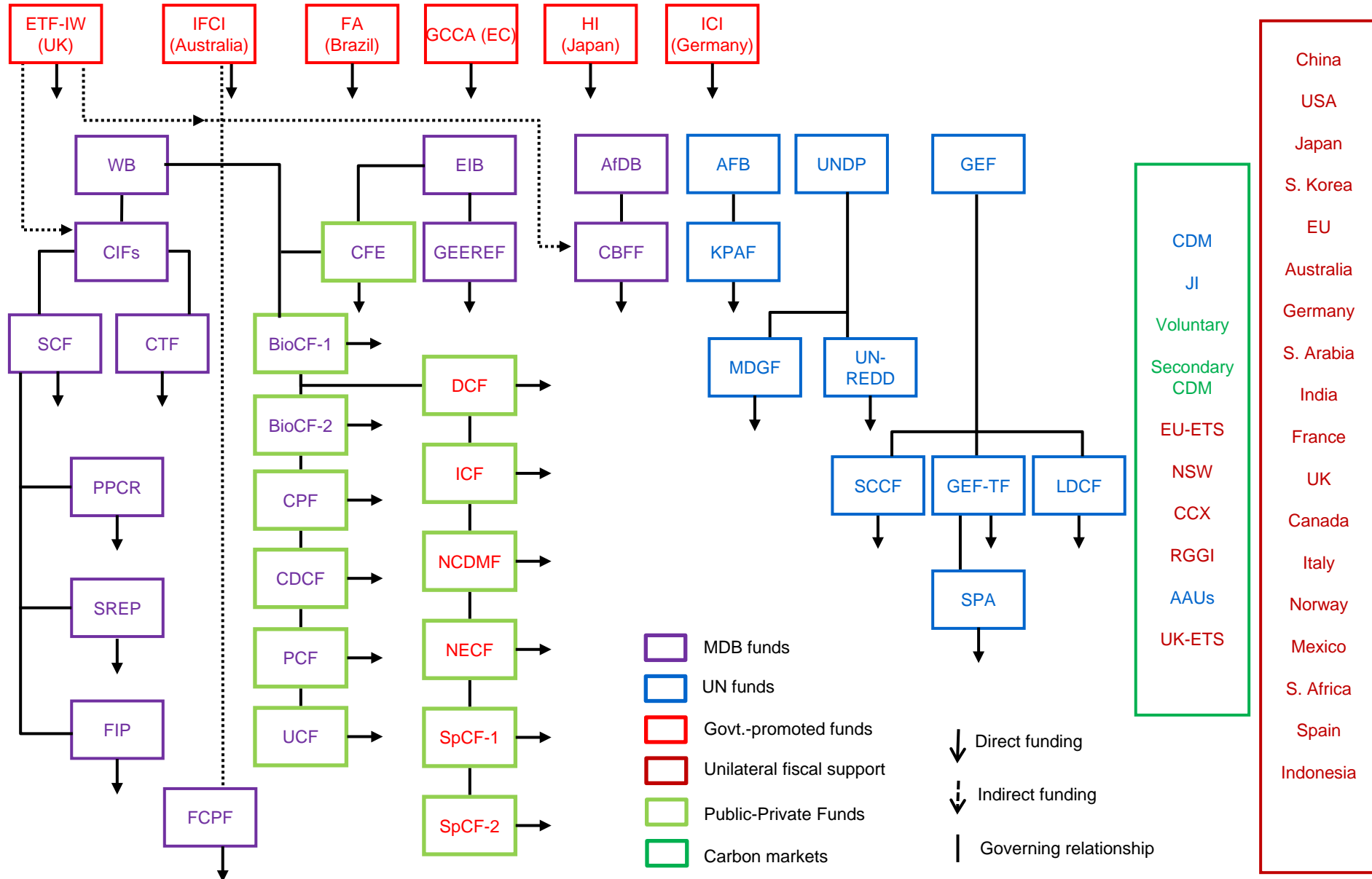
Note 2: Strategic Climate Fund (MDB): Funds channelled through PPCR, FIP, and SREP, hence not included separately.

Note 3: For the Adaptation Fund (UN), the money raised from the monetisation of CERs is included under pledges.

Note 4: Funds for the Strategic Priority on Adaptation (SPA) are sourced from the GEF Trust Fund.

Note 5: For the GEF Trust Fund, only pledges/deposits under the climate change focal area for the fourth and fifth funding replenishments are included.

Climate funding sources are many but governance is often interlinked



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Meanwhile, energy demand is rapidly rising

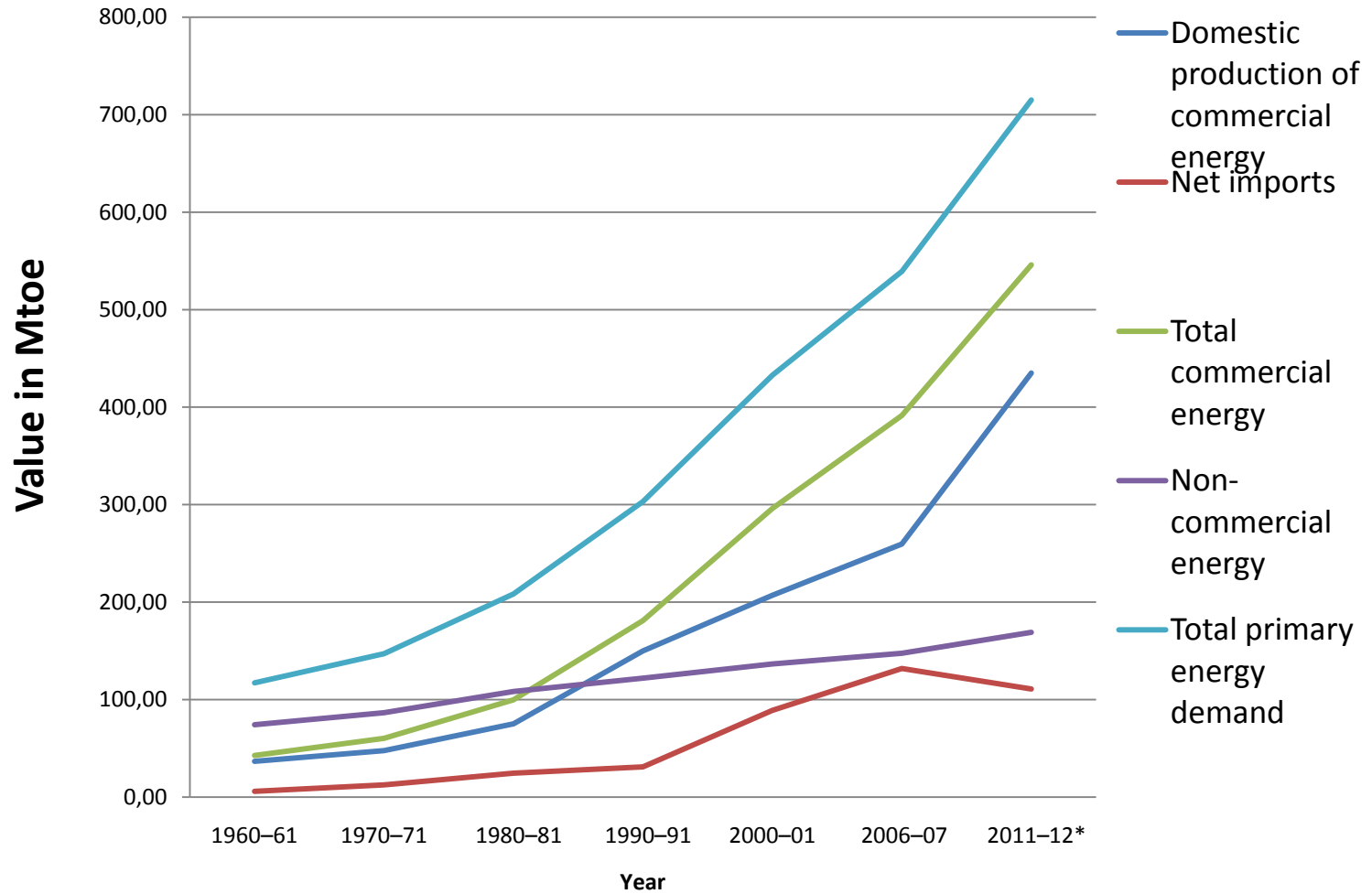
- Presently, over 84% of the villages are electrified; but **only 43.5% of the rural households have access to electricity**
- **Demand for power has been growing at the rate of 5.74% in recent years**
- **Demand for oil doubled in a decade to 2.9 mbpd in 2008**; projected to reach 7 mbpd by 2030
- India imported 17.8% of its commercial energy in 1991; today, it **imports more than 30%**
- **Indian Strategic Petroleum Reserves**: 36.7 mb or 10 days of consumption by 2012; plan for 90 days of reserves

India's energy demand

	Trends in Demand and Supply of Primary Energy (All in Mtoe)						
	1960–61	1970–71	1980–81	1990–91	2000–01	2006–07	2011–12*
Domestic production of commercial energy	36.78	47.67	75.19	150.01	207.08	259.56	435
Net imports	6.04	12.66	24.63	31.07	89.03	131.97	111
Total commercial energy	42.82	60.33	99.82	181.08	296.11	391.53	546
Non-commercial energy	74.38	86.72	108.48	122.07	136.64	147.56	169
Total primary energy demand	117.20	147.05	208.30	303.15	432.75	539.09	715

* Projected requirement at the end of the Eleventh Plan as per the IEPC report.

India's energy demand



Hydrocarbon reserves: coal is king

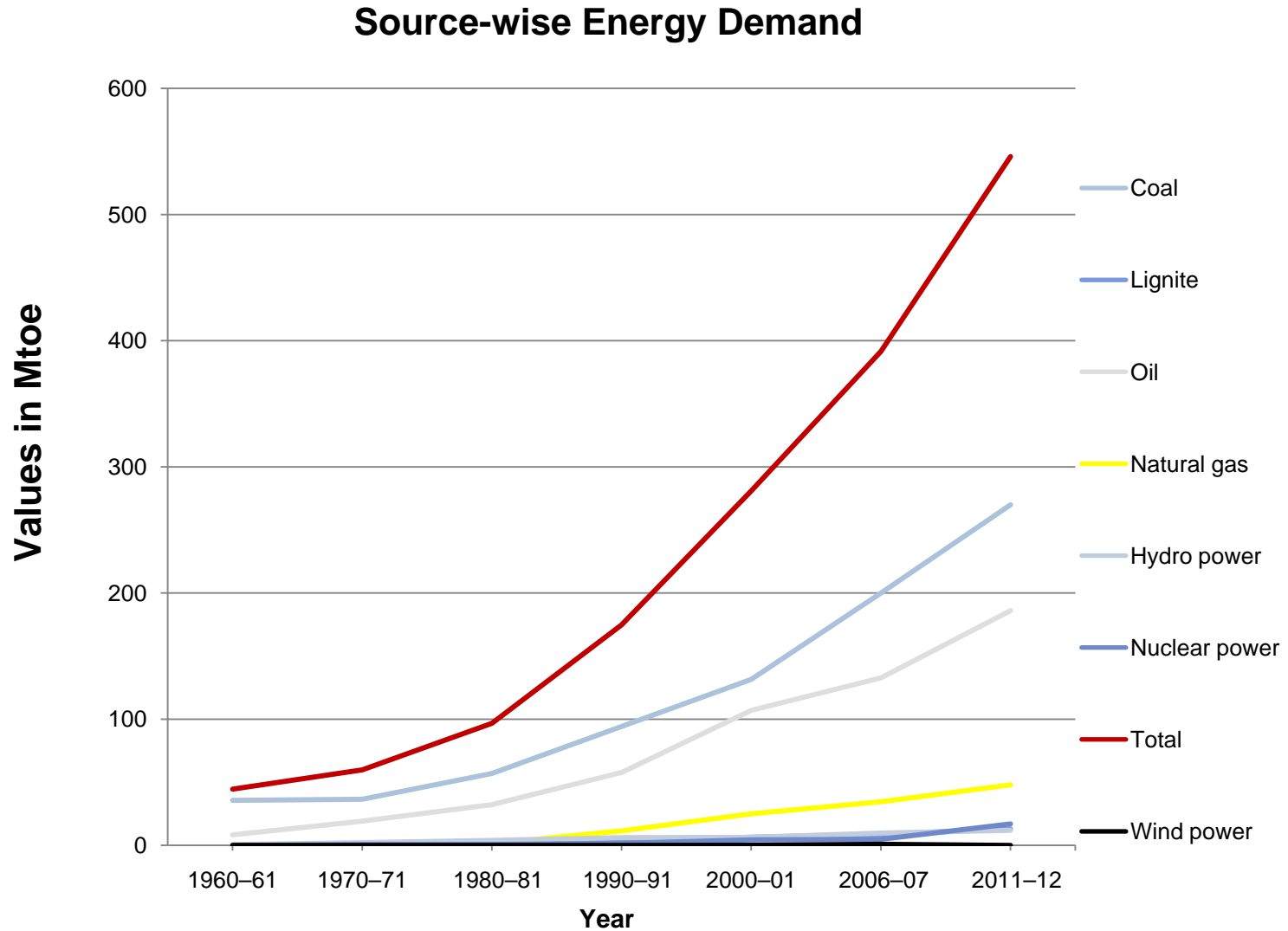
Resources	Unit	Proved	Inferred	Indicated	Production in 2004-05	Net imports in 2004-05	Reserve/Production ratio	
		P	I		Q	M	P/Q	(P+I)/Q
Coal (as on 1.1.2005)	Mtoe	38114	48007	15497				
Extractable Coal**	Mtoe	13489	9600-15650		157	16	86	147-186
Lignite (as on 1.1.2005)	Mtoe	1220	3652	5772				
Extractable Lignite	Mtoe	1220			9		136	136
Oil (2005)	Mtoe	786*			34	87	23	23
Gas (2005)	Mtoe	1101*			29	3(LNG)	38	38
Coal Bed Methane	Mtoe	765		1260-2340				
In-situ Coal Gasification***								
Total		56695			229	106	283	344-383

* Balance Recoverable Reserves, ** Extractable coal from proved reserves has been calculated by considering 90% of geological reserve as mineable and dividing mineable reserve by Reserve to Production ratio (2.543 has been used in 'Coal Vision 2025' for CIL blocks); and range for extractable coal from prognosticated reserves has been arrived at by taking 70% of indicated and 40% of Inferred reserve as mineable and dividing mineable reserve by R:P ratios (2.543 for CIL blocks and 4.7 for non-CIL blocks as per 'Coal Vision 2025'). *** From deep seated coal (not included in extractable coal reserves) Note: Indicated Gas resource includes 320 Mtoe claimed by Reliance Energy but excludes the 360 Mtoe of reserves indicated by GSPCL as the same have not yet been certified by DGH.

Hydropower potential in India

Region	Principal Hydro			Pumped Storage Feasible Installed Capacity in MW	Small Hydro (up to 15 MW) Potential in MW
	Potential at 60 % Load Factor	Feasible Installed Capacity in MW	Potential in billion kWh per year		
Northern	30155	53405	225	13065	3180
Western	5679	8928	31.4	39684	661
Southern	10768	16446	61.8	17750	801
Eastern	5590	10965	42.5	9125	530
North Eastern	31857	58956	239.3	16900	1610
Total	84044	148700	600	95524	6782

India's energy demand, by source

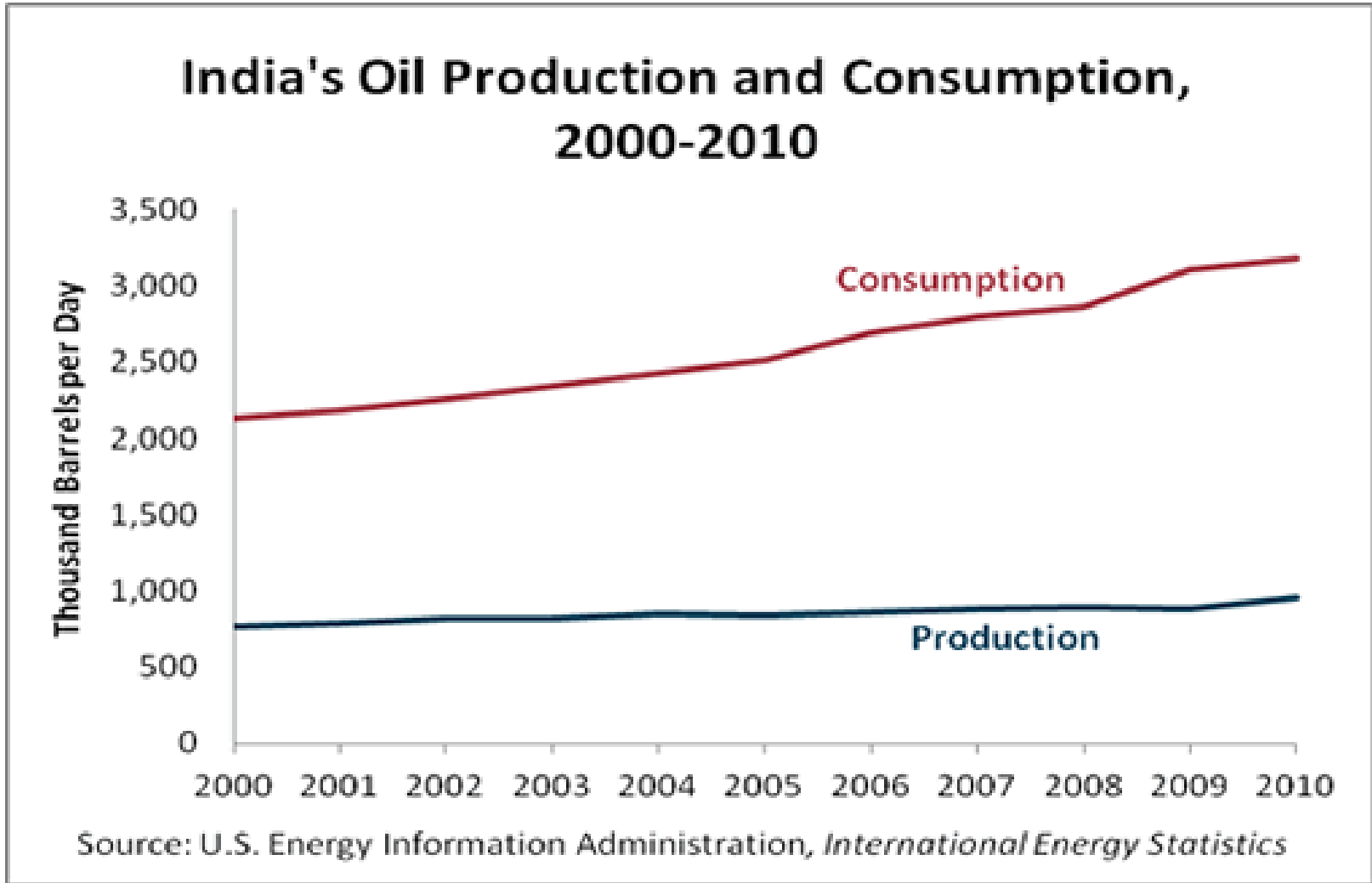


But growth in coal production is slow

Coal Production (in million tonnes)

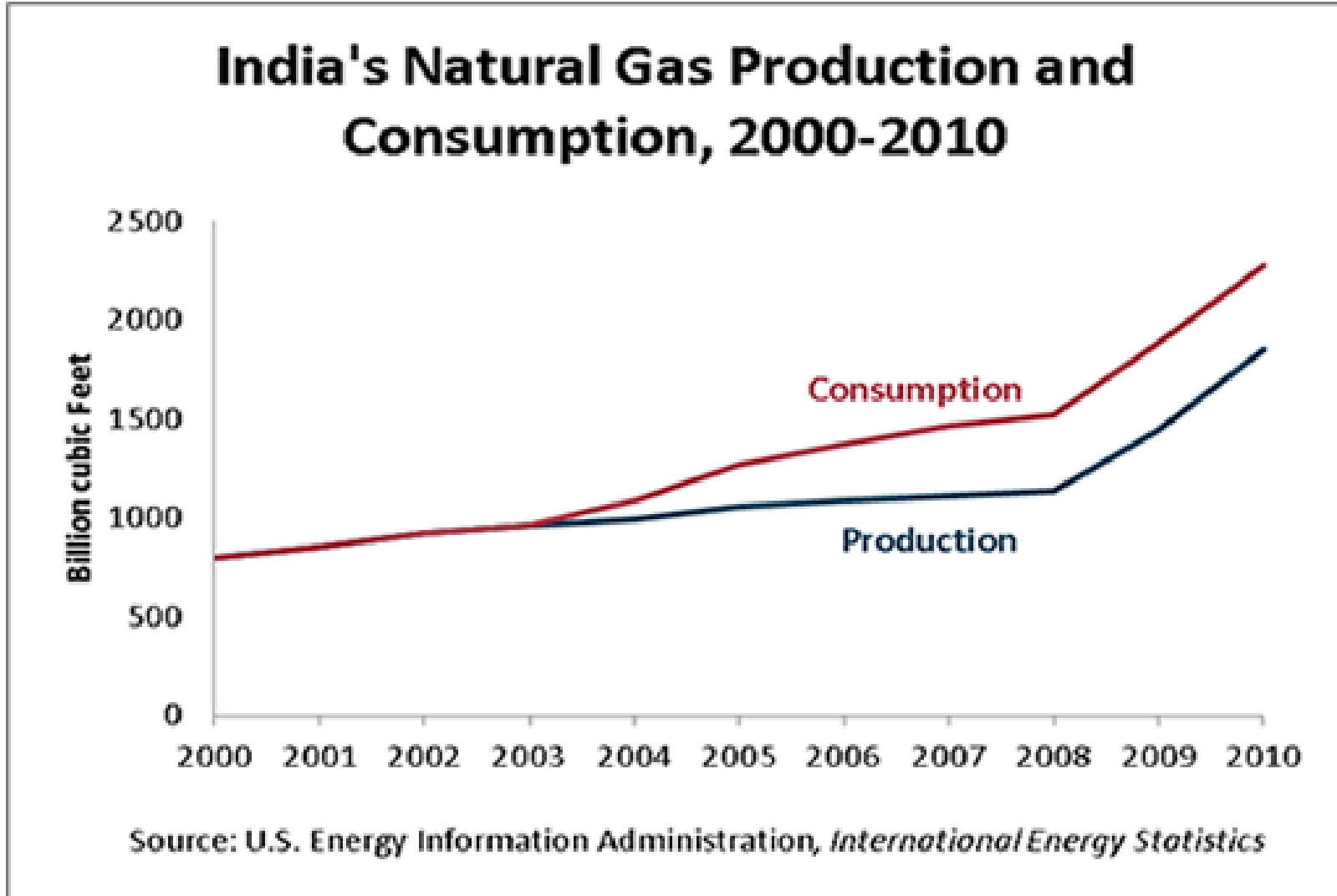
Company	Target 2010-11	Actual upto Dec. 2010	Achievement (%)	2009-10 Actual up to Dec. 2009	Growth (%)
CIL	460.50	299.52	65.04	295.51	1.36
SCCL	46.00	36.33	78.98	36.55	-0.60
Others	65.87	33.56	50.94	33.60	-0.12
Total	572.37	369.41	64.54	365.66	1.02

Oil production has not kept pace with consumption



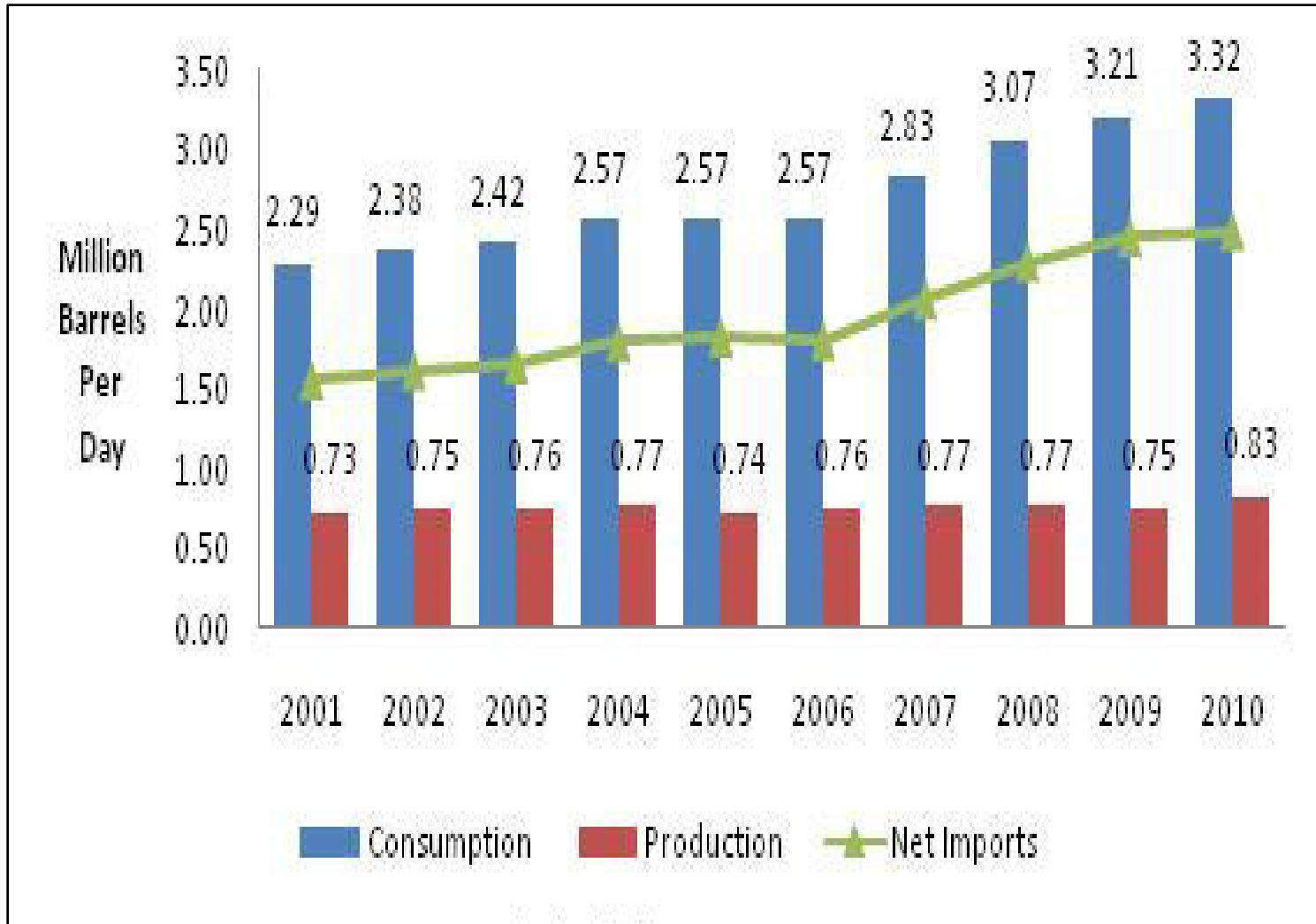
But refining capacity trebled from 51 mmtpa in 1991 to 148 mmtpa in 2007

Natural gas has struggled with finding new sources



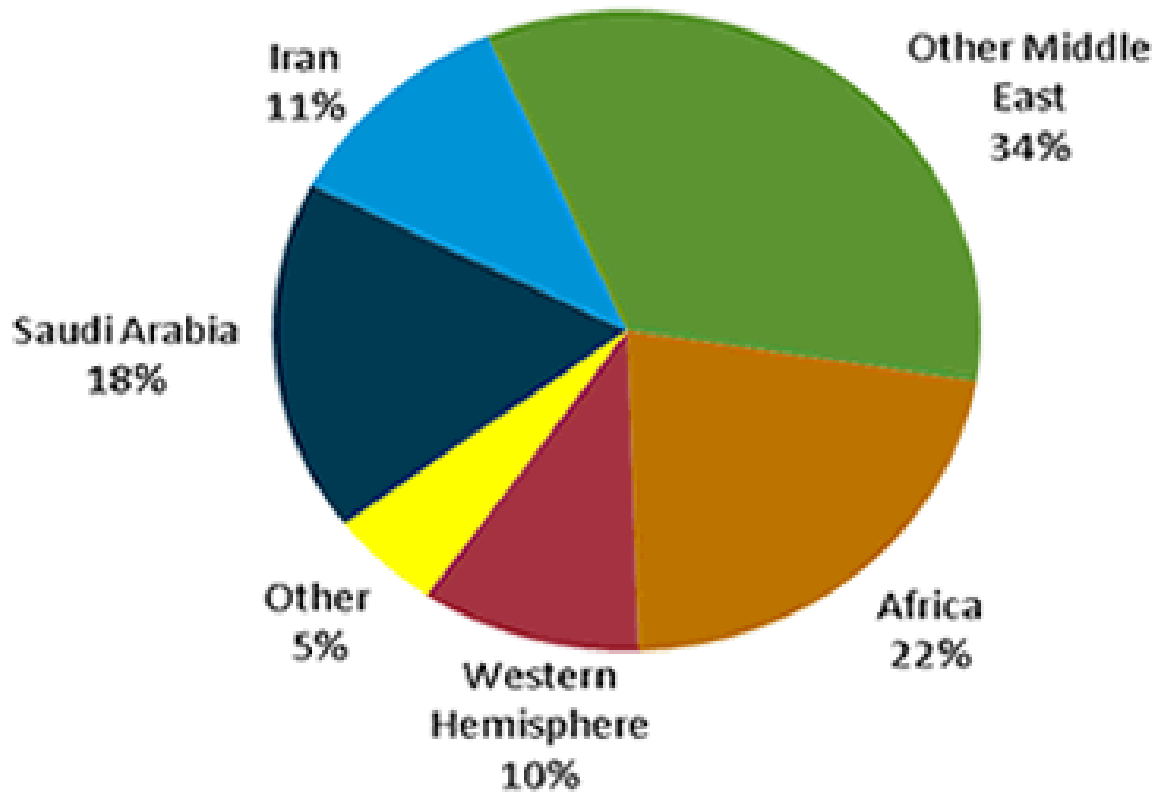
30% of gas produced is feedstock for urea; 40% is for power generation;
 Late entrant: first LNG terminals only in 2004

Oil imports already meet about 80% of demand



India is heavily reliant on West Asia

India's Oil Imports by Source, 2010



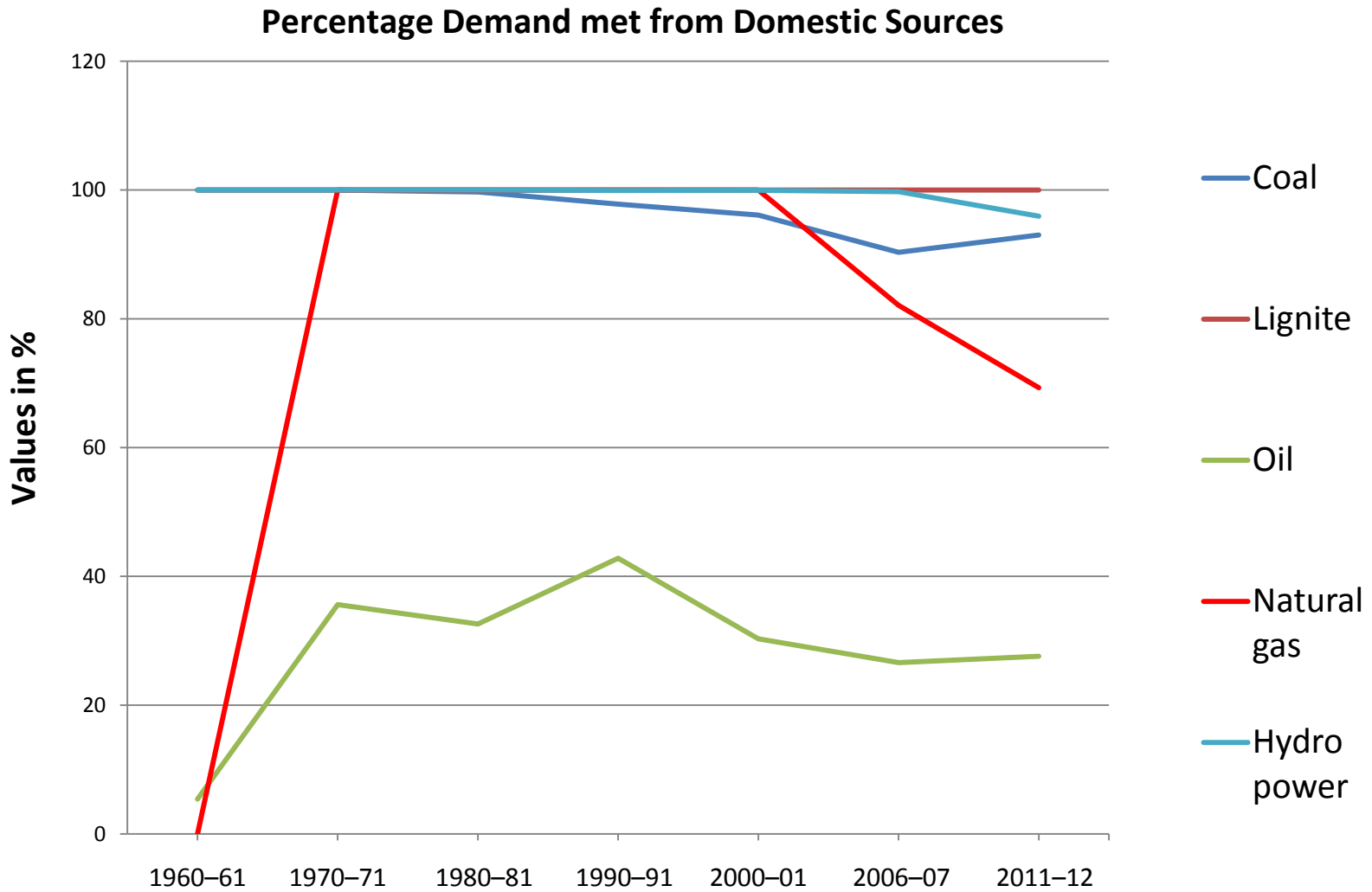
Source: Global Trade Atlas

Self-reliance no longer feasible for India

Percentage Demand met from Domestic Sources (All in %)							
	1960–61	1970–71	1980–81	1990–91	2000–01	2006–07	2011–12*
Coal	100	100	99.7	97.8	96.1	90.33	93.02
Lignite	100	100	100	100	100	100	100
Oil	5.4	35.6	32.6	42.8	30.3	26.6	27.59
Natural gas	–	100	100	100	100	82.08	69.3
Hydro power	100	100	100	99.93	99.96	99.74	95.94

* Projected requirement at the end of the Eleventh Plan as per the IEPC report.

Self-reliance no longer feasible for India



Fuel imports are expected to keep rising

Projected Primary Energy Requirement for India, 2030 (All in Mtoe)				
Fuel	Range of Requirements	Assumed Domestic Production	Range of Imports	Import (%)
Coal including lignite	632–1022	560	72–462	11–45
Oil	350–486	35	315–451	90–93
Natural gas including coal bed methane (CBM)	100–197	100	0–97	0–49
Total commercial primary energy	1351–1702	–	387–1010	29–59

Note: Range of imports is calculated across all scenarios by taking the minimum requirement and maximum domestic production as the lower bound and maximum requirement and minimum domestic production as the upper bound

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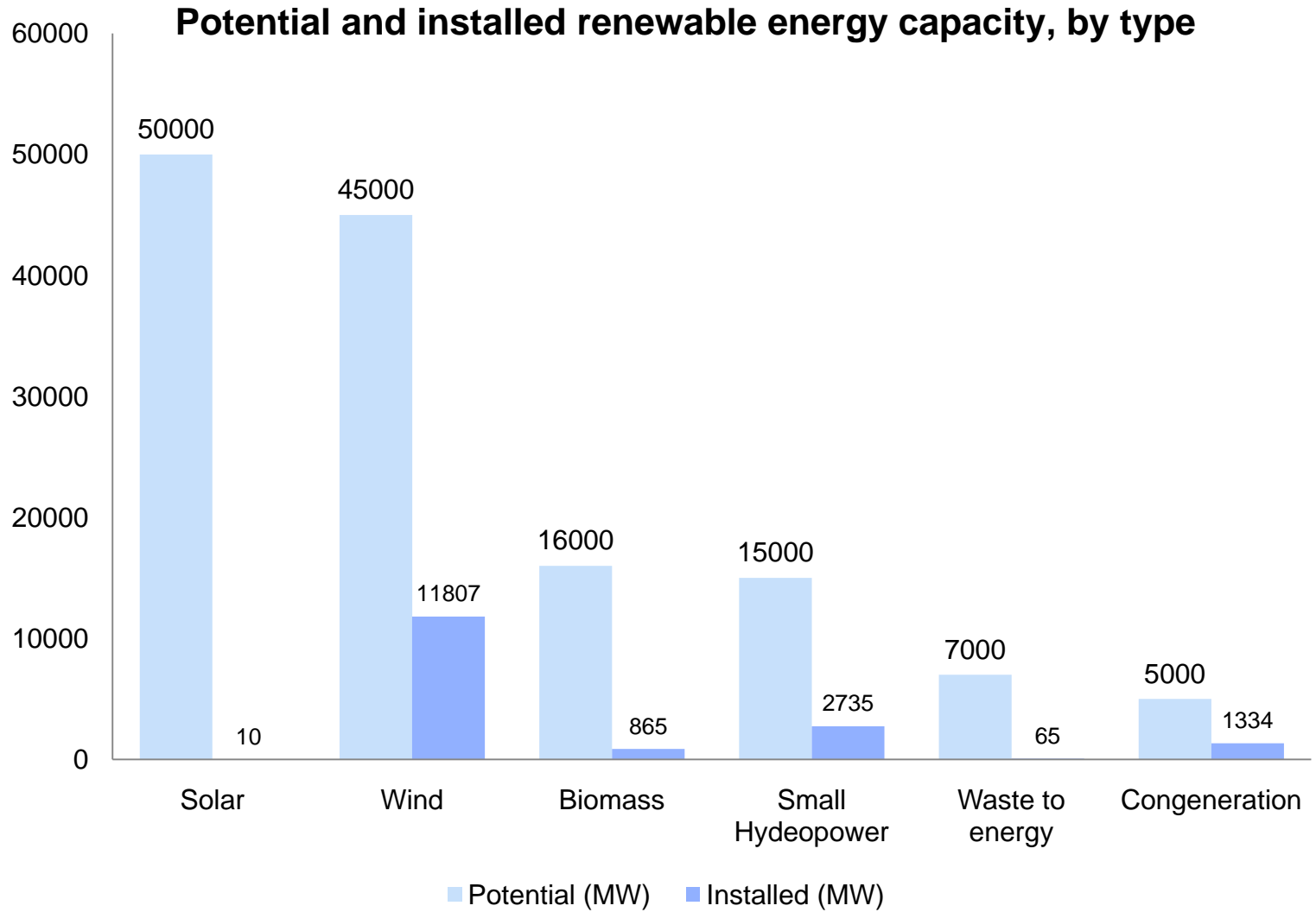
India's renewable energy potential

Resources	Unit	Present	Potential	Basis of Accessing Potential
Hydro-power	MW	32,326	1,50,000	Total potential assessed is 84,000 MW ^{****} at 60% load factor or 1,50,000 MW at lower load factors
Biomass				
Wood	Mtoe/year	140	620	Using 60 million Ha wasteland yielding (20) MT/Halyear
Biogas	Mtoe/year	0.6	4	In 12 million family sized plants
		0.1	15	In community based plants if most of the dung is put through them.
Bio-Fuels				
Bio-diesel	Mtoe/year	-	20	Through plantation of 20'million hectares o wasteland or 7'million hectares of intensive cultivation
Ethanol	Mtoe/year	<1	10	From 1.2 million hectares of intensive cultivation with required inputs.
Solar				
Photovoltaic	Mtoe/year	-	1,200	Expected by utilising 5 million hectares wasteland at an efficiency level of 15 percent for Solar Photovoltaic Cells
Thermal	Mtoe/year		1,200	MWe scale power plants using 5 million hectares
Wind Energy	Mtoe/year	<1	10	Onshore potential of 65,000 MWe at 20 percent load factor
Small Hydro-powe	Mtoe/year	<1	5	

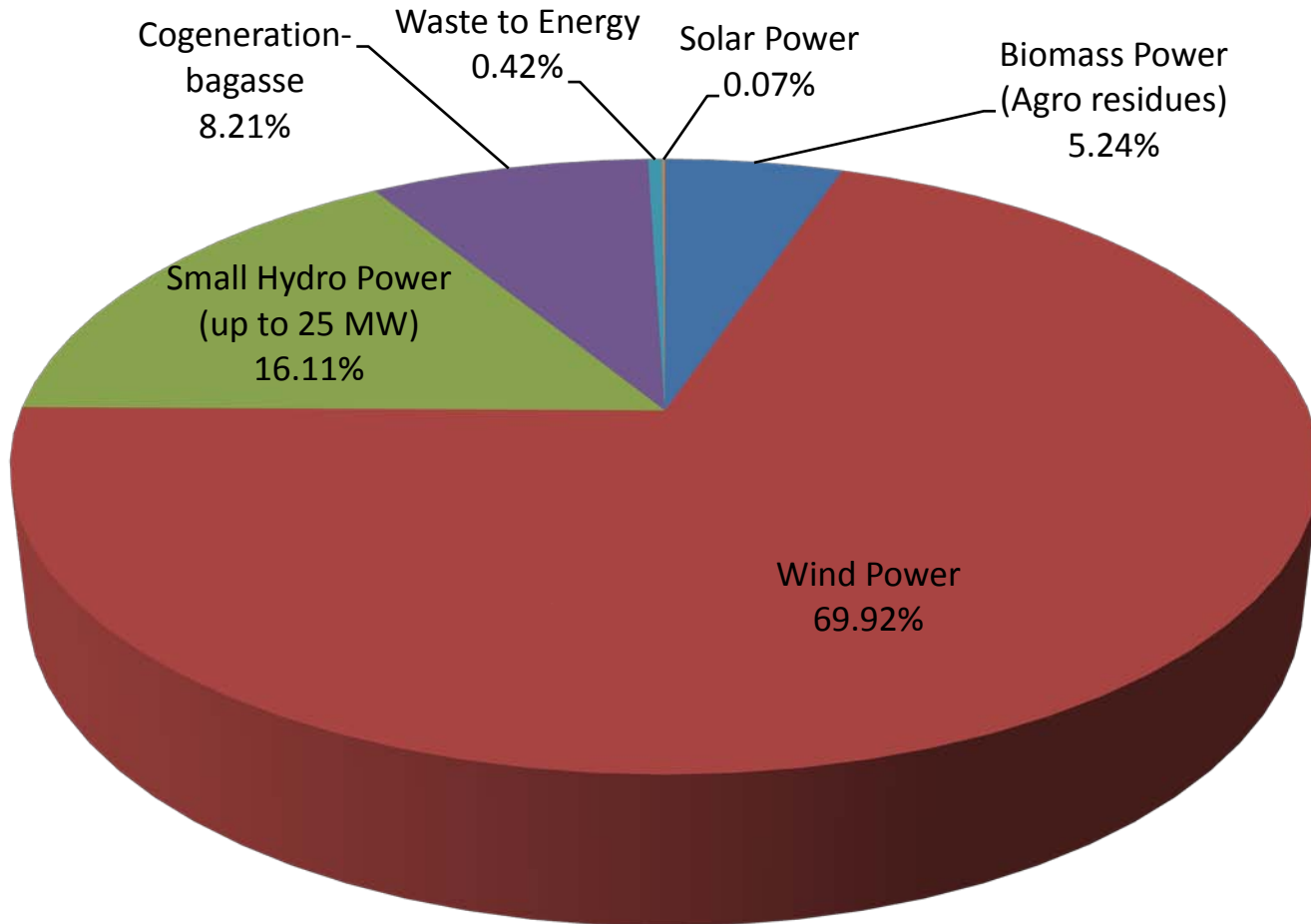
Small but growing share of renewables

Annual Achievement 2010-11 and Cumulative Achievement by June 2010			
No.	Source/System	Achievements during 2010-11 (up to 30.6.2010)	Cumulative achievements (up to 30.6.2010)
A Grid-interactive renewable power			
1	Biomass Power (Agro residues)	45.5 MW	901.1 MW
2	Wind Power	202.73MW	12009.48 MW
3	Small Hydro Power (up to 25 MW)	31.64 MW	2767.05 MW
4	Cogeneration-bagasse	67.5 MW	1411.53 MW
5	Waste to Energy	7.5 MW	72.46 MW
6	Solar Power	2.0 MW	12.28 MW
	Total (in MW)	356.87 MW	17173.9 MW
B Off-Grid/ Distributed Renewable Power (including Captive/ CHP plants)			
7	Biomass Power/Cogen.(non-b a gasse)	6.0 MW	238.17 MW
8	Biomass Gasifier	4.0 MWeq.	125.44 Mweq
9	Waste-to-Energy	6.0 MWeq.	52.72 MWeq
10	Solar PV Power Plants	0.0 MWp	2.92 MWp
11	Aero- Generators/ Hybrid System	0.0 MW	1.07 MW
	Total (in MW)	16.00MWeq	420.32 MWeq

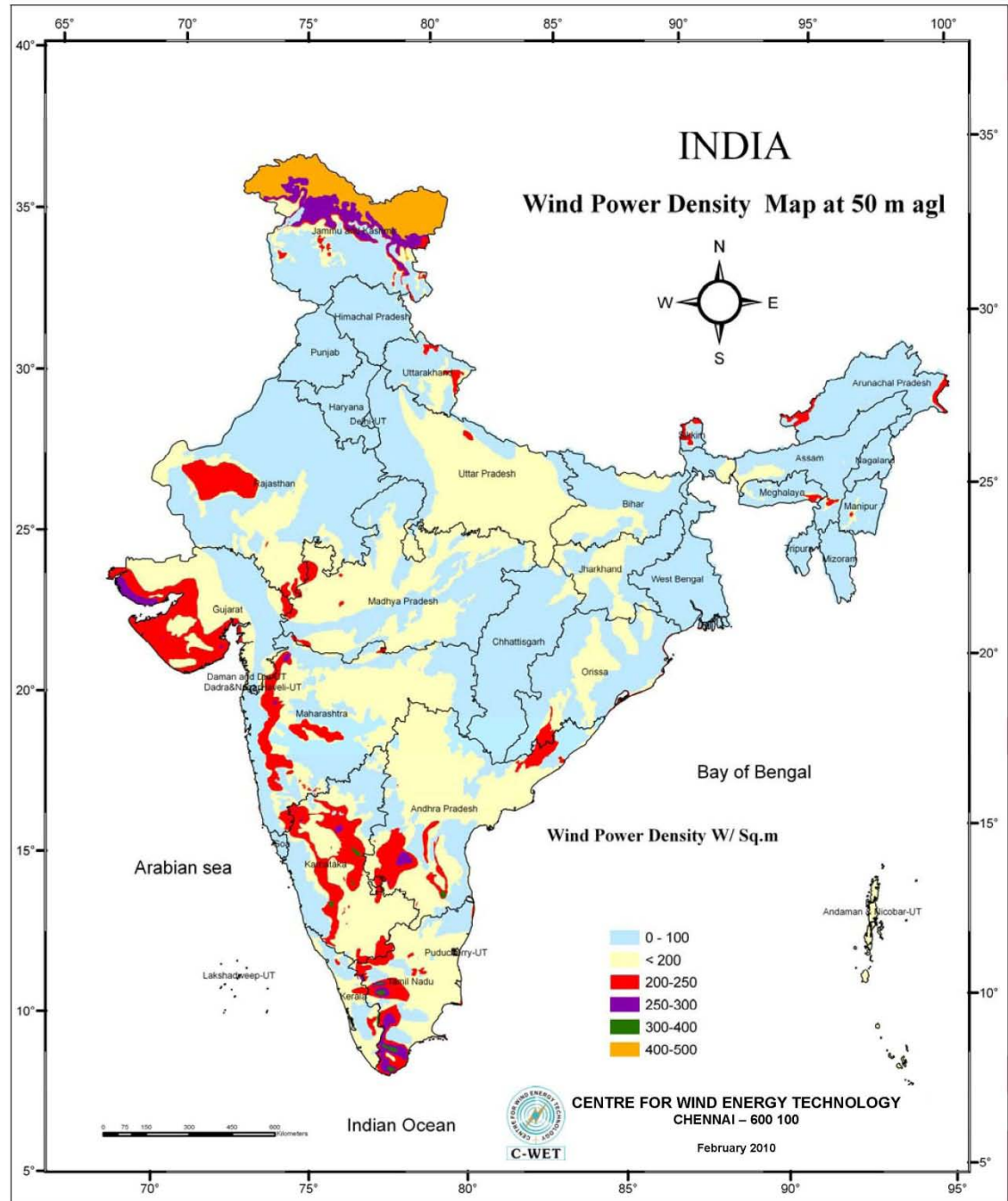
But renewable energy potential largely under-utilised



Grid-interactive renewable power: wind dominates so far



Wind energy potential



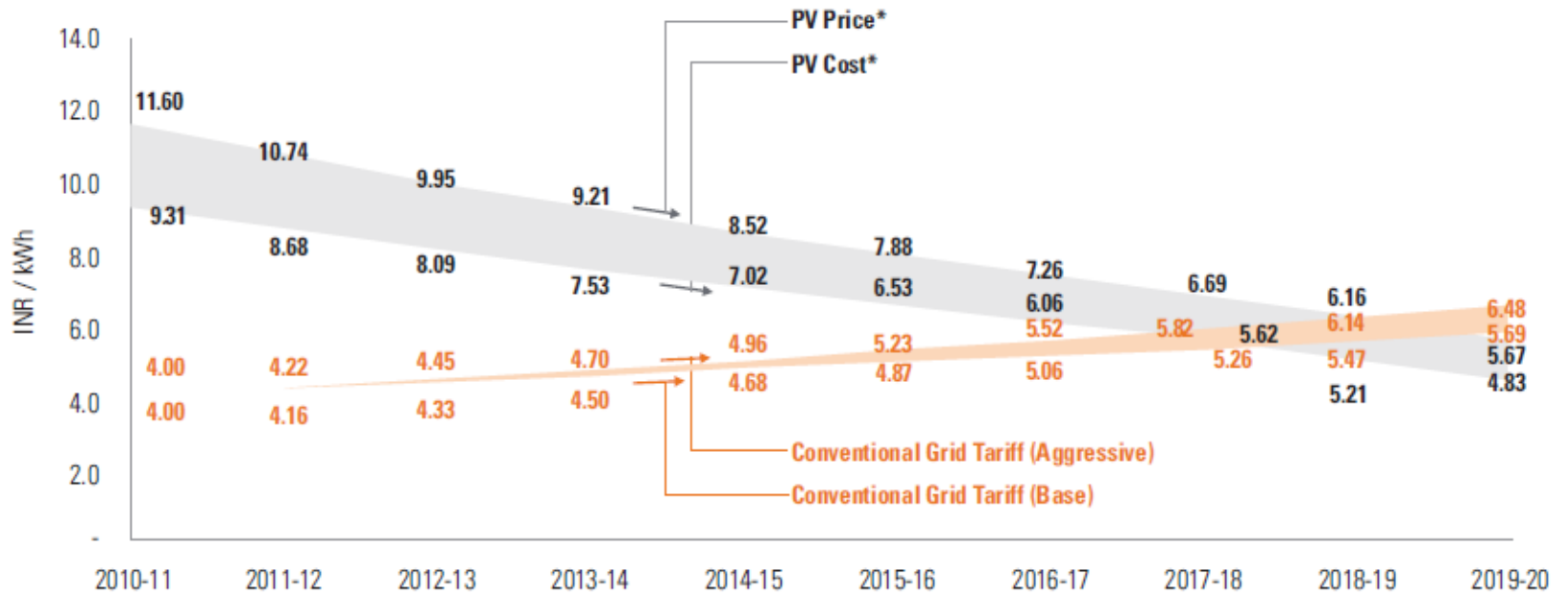
SOURCE: http://www.cwet.tn.nic.in/html/departments_wpdmap.html, 2010

Solar energy potential



Need for policies to match the real with the potential

Levelized Cost Comparison of Utility-scale PV and Conventional Power at Grid

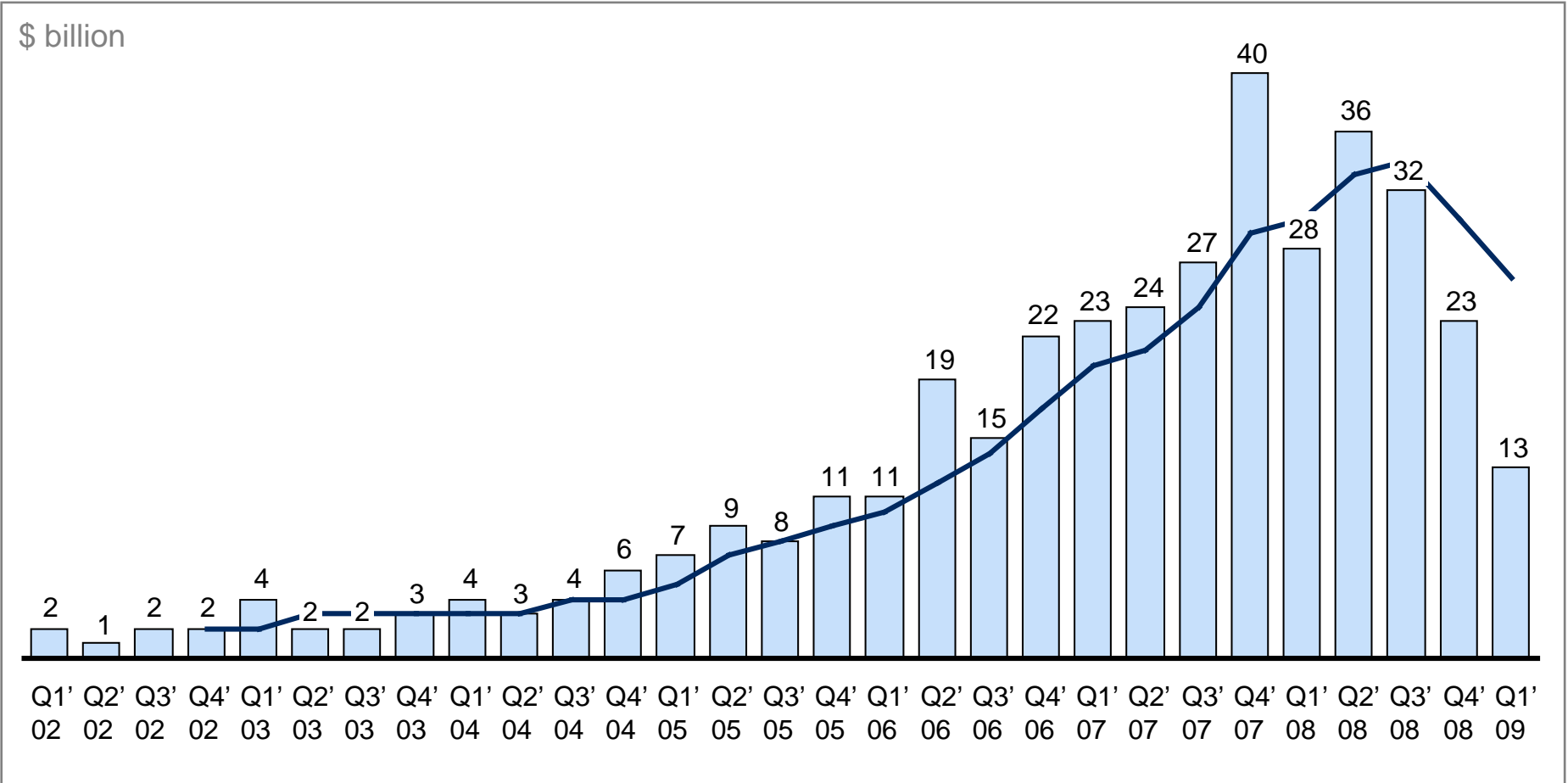


Grid Parity Year	Aggressive Case	Base-Case
Utility PV Price	2017-18	2019-20

Slowdown in sustainable energy investments began in early 2008

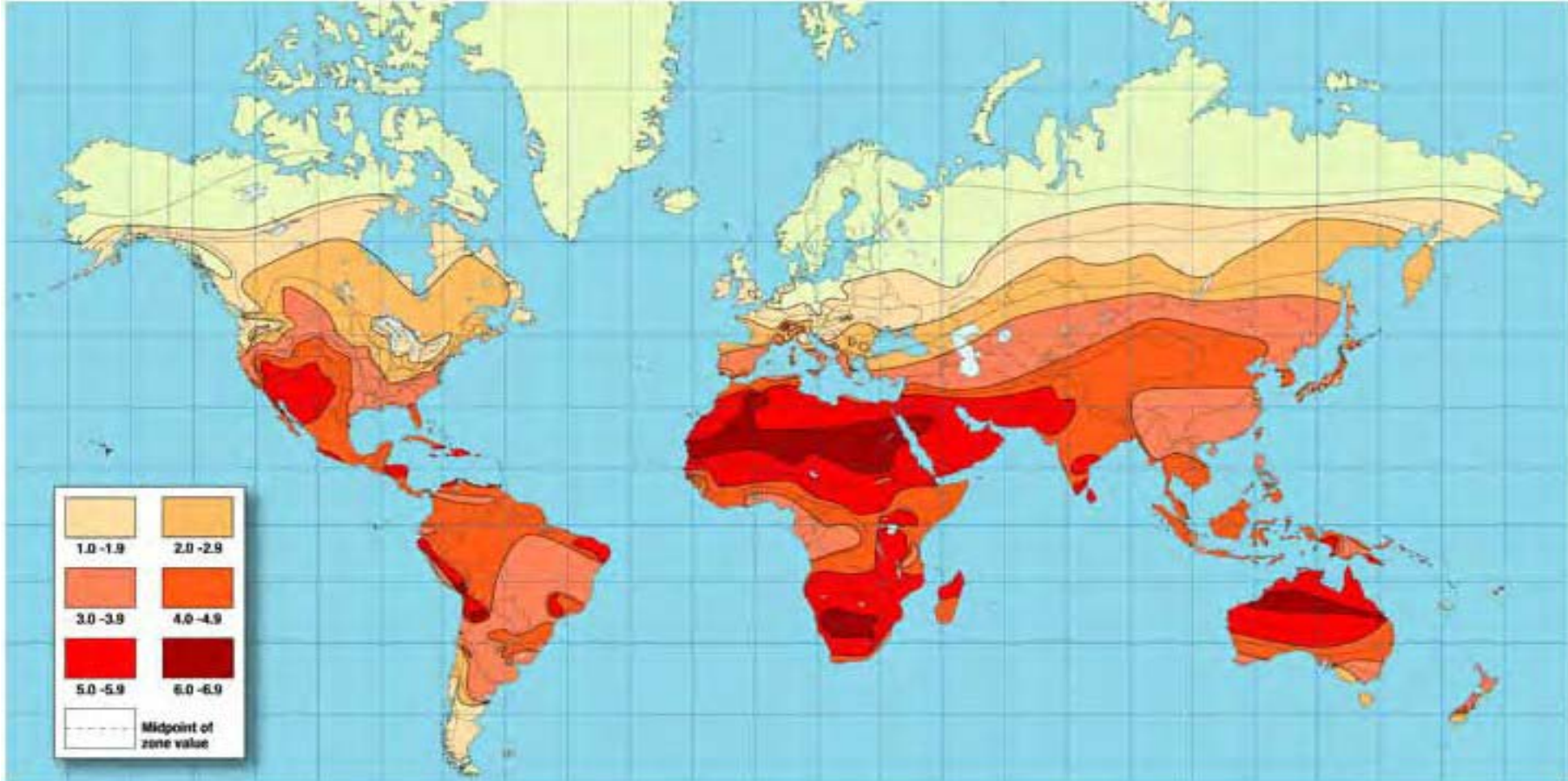


■ Total new investment in sustainable energy, \$bn
— 4Q running average



SOURCE: UNEP, Sustainable Energy Finance Initiative, New Energy Finance (2009)

Case for global cooperation?



SOURCE: OKSolar.com

NOTE: Based on yearly averages of daily hours of sunlight and ambient temperature; chart prepared on 16 July 2011

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Key actors in global energy trade

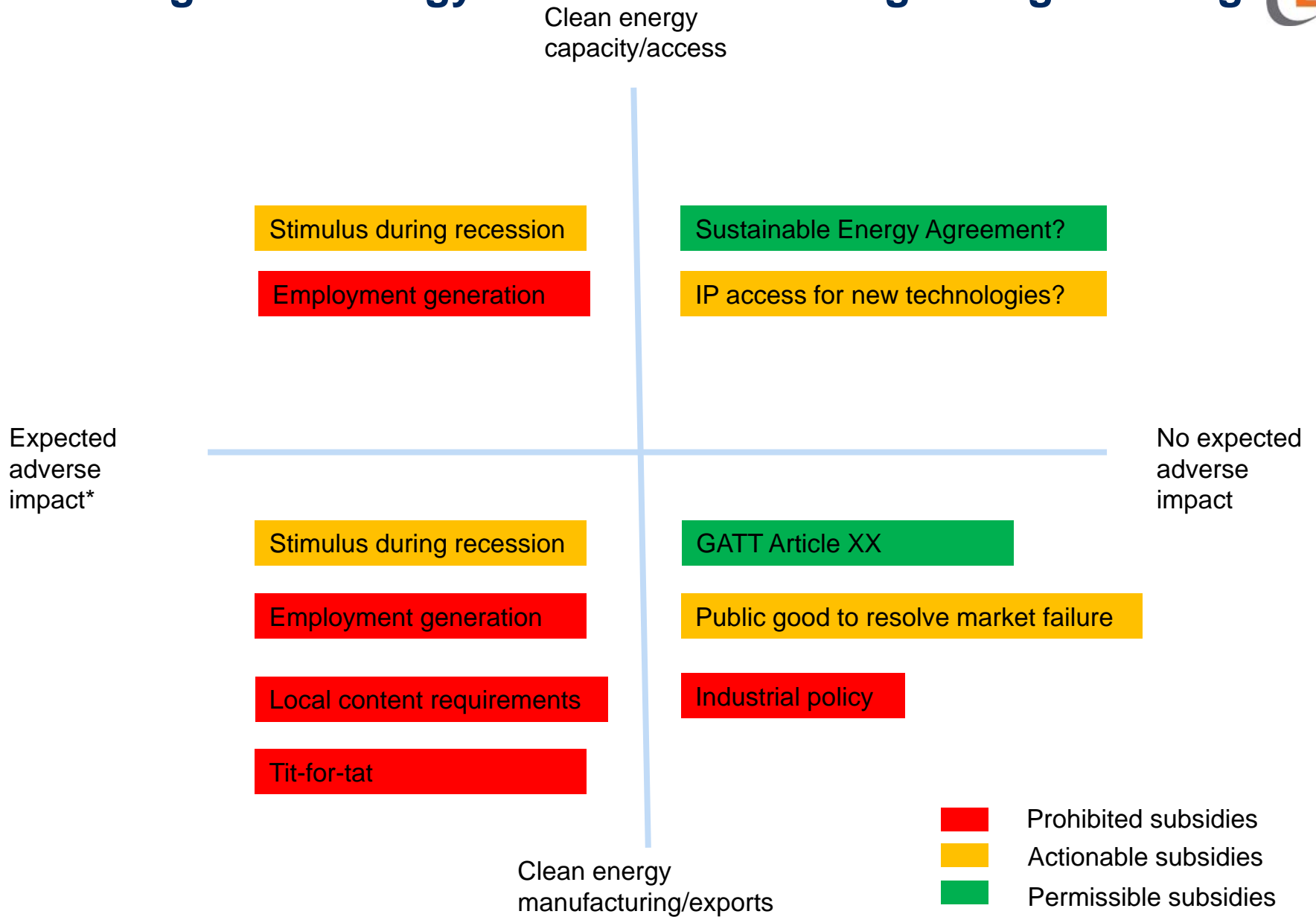
	1965–73	1974–81	1982–90	1991–2002	2003–10
Oil importers	United States Japan France Germany United Kingdom	United States Japan France Germany Italy	United States Japan France Germany Italy	United States Japan France Germany Italy	United States Japan China France Germany
Oil exporters	Venezuela Iran Saudi Arabia Kuwait USSR	Saudi Arabia Iran USSR Kuwait Venezuela	Saudi Arabia USSR Venezuela Iraq Iran	Saudi Arabia Russia Venezuela Iran Norway	Saudi Arabia Russia Iran Norway UAE

ECT membership has broadened beyond EU and Europe

Country	EU member	ECT member	WTO member
Albania		•	•
Armenia		•	•
Australia*		•	•
Austria	•	•	•
Azerbaijan		•	
Belarus*		•	
Belgium	•	•	•
Bosnia & Herzegovina		•	
Bulgaria	•	•	•
Croatia		•	•
Cyprus	•	•	•
Czech Republic	•	•	•
Denmark	•	•	•
Estonia	•	•	•
European Communities	•	•	•
Finland	•	•	•
France	•	•	•
Georgia		•	•
Germany	•	•	•
Greece	•	•	•
Hungary	•	•	•
Iceland*		•	•
Ireland	•	•	•
Italy	•	•	•
Japan		•	•

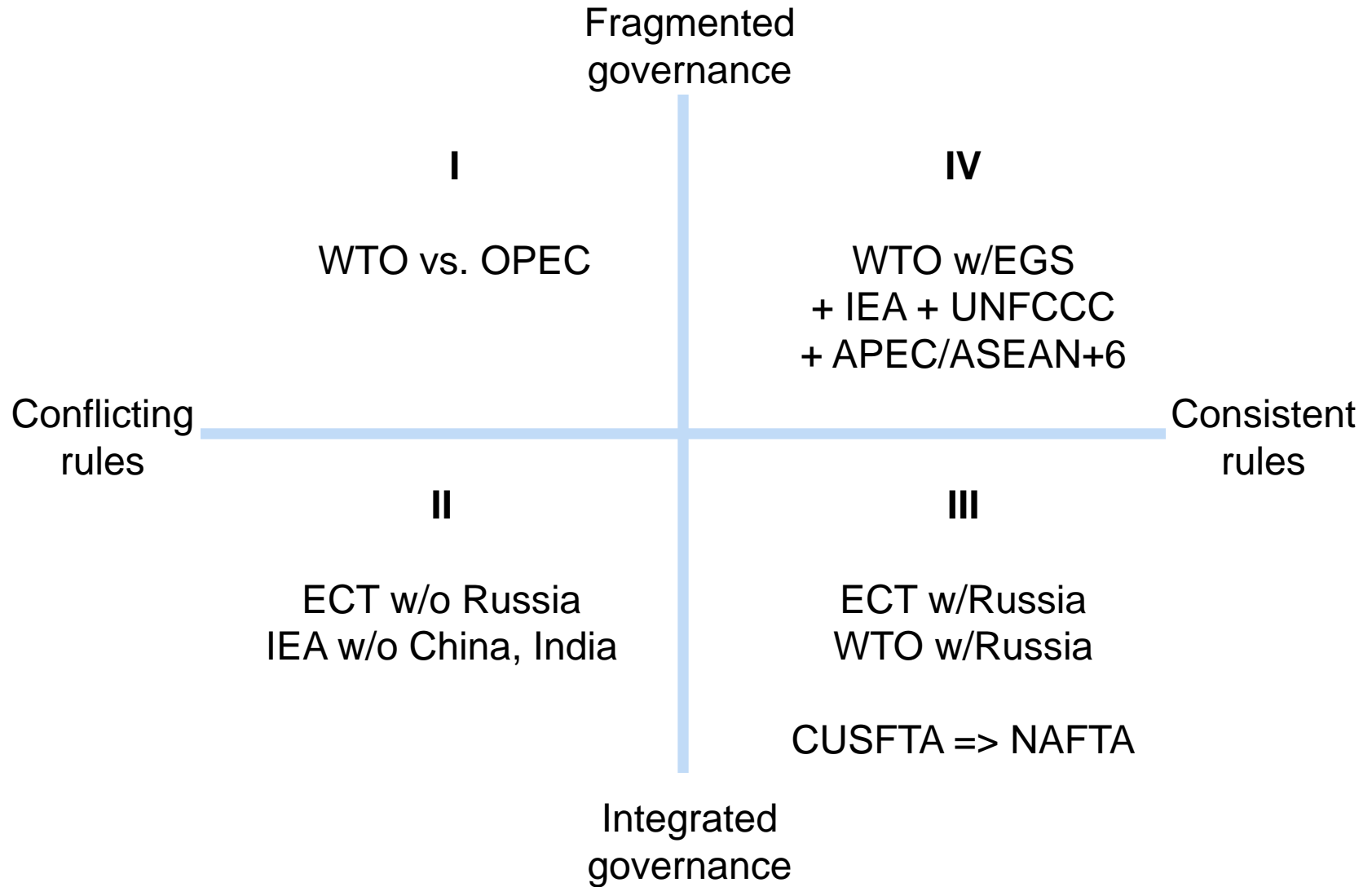
Country	EU member	ECT member	WTO member
Latvia	•	•	•
Liechtenstein		•	•
Lithuania	•	•	•
Luxembourg	•	•	•
Macedonia		•	•
Malta	•	•	•
Moldova		•	•
Mongolia		•	•
Netherlands	•	•	•
Norway*		•	•
Poland	•	•	•
Portugal	•	•	•
Romania	•	•	•
Russian Federation*		•	
Slovakia	•	•	•
Slovenia	•	•	•
Spain	•	•	•
Sweden	•	•	•
Tajikistan		•	
Turkey		•	•
Turkmenistan		•	
Ukraine		•	•
United Kingdom	•	•	•
Uzbekistan		•	

Governing clean energy subsidies will be a growing challenge



* As per WTO rules, adverse impacts could result from: injury; serious prejudice; or nullification of benefits

Alternative energy regimes for alternative priorities



Key takeaways

- Energy access will remain a political issue in India for decades to come
- Climate change has introduced complications in the energy security equation: India will seek out technology to increase fossil fuel efficiency
- India's fossil fuel infrastructure is increasingly dependent on foreign sources of supply: but without domestic reform, investments are unlikely to increase domestic capacity
- Renewable energy potential in India is under-utilised and is a tremendous market opportunity: India could take the lead in regional or plurilateral cooperation
- India is not party to any major energy governance regime: rules governing trade, climate and energy will need more coherence for investments and trade to increase

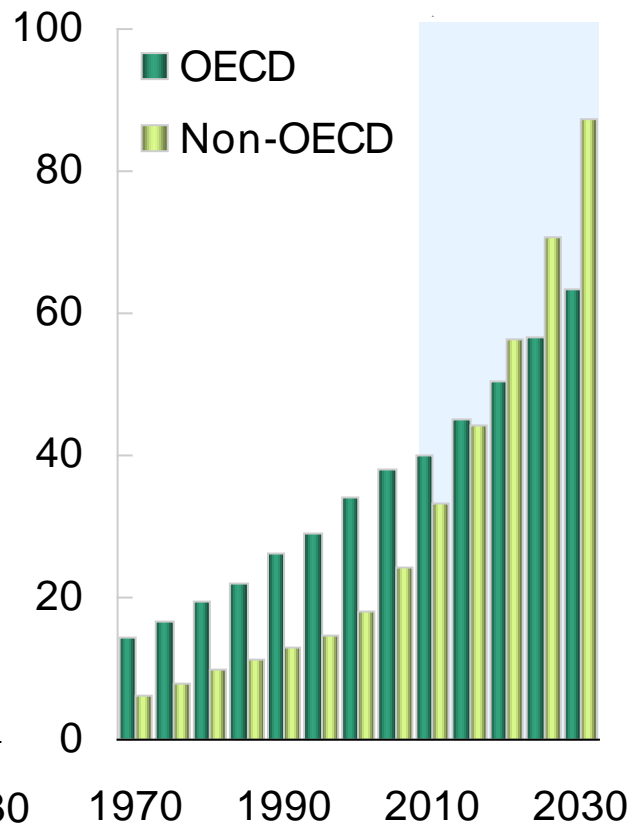
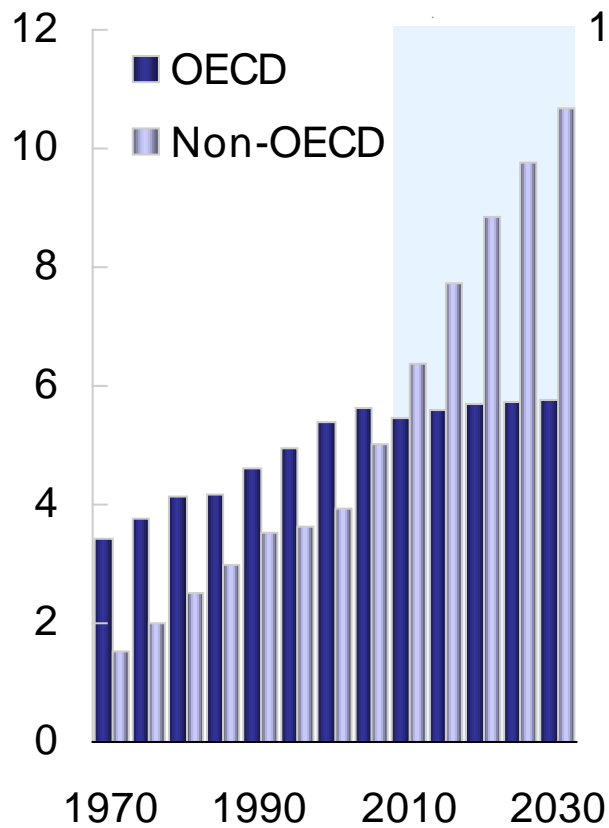
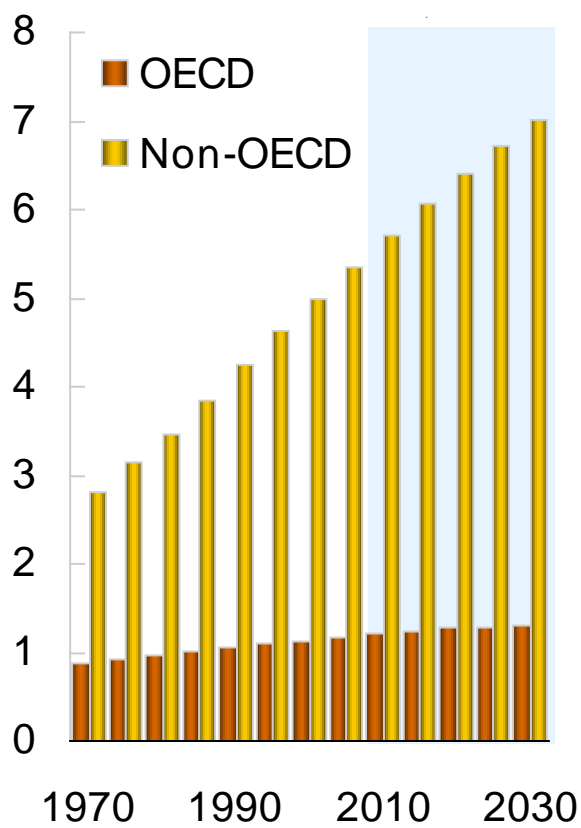
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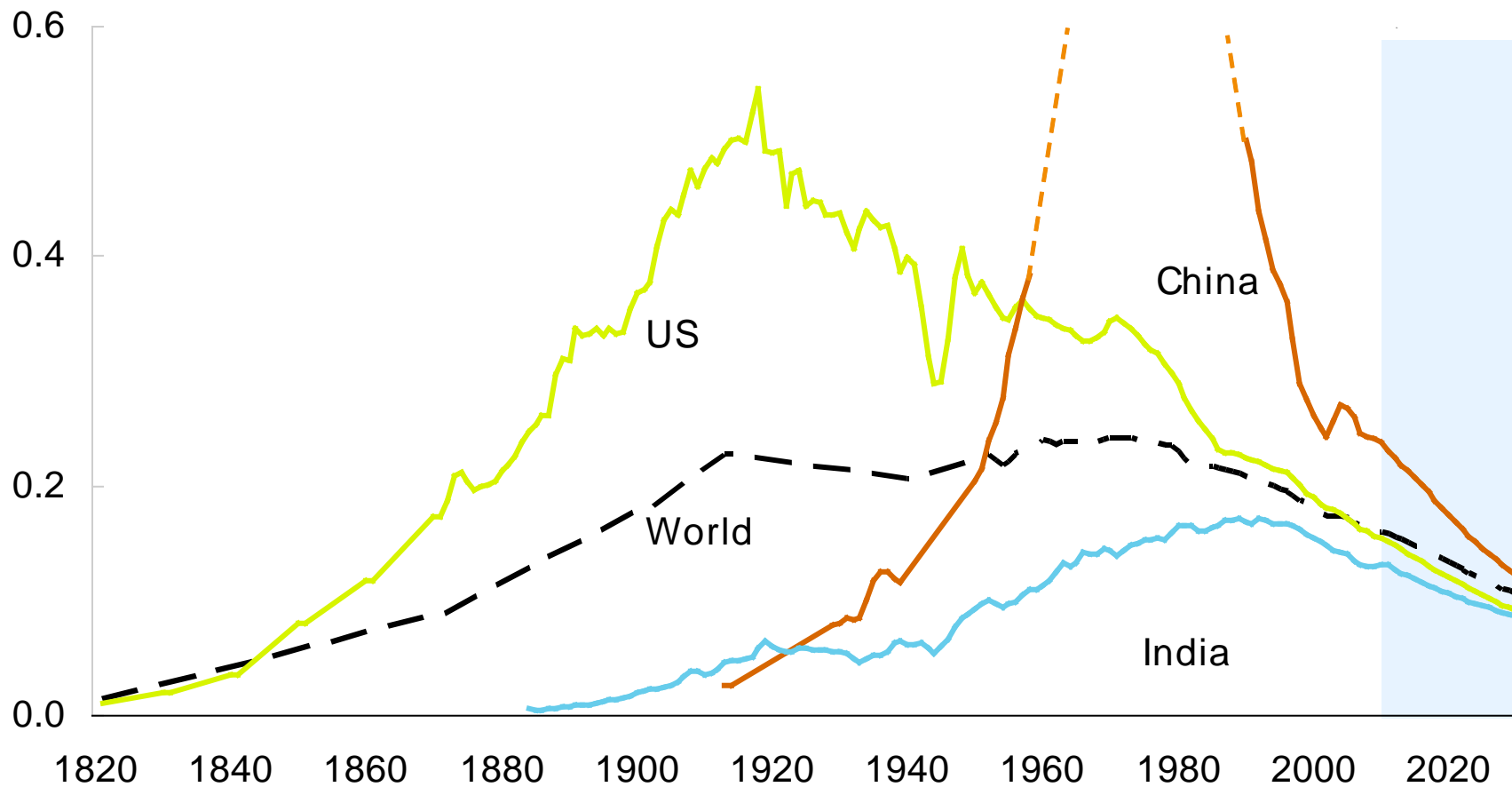
<http://ceew.in>

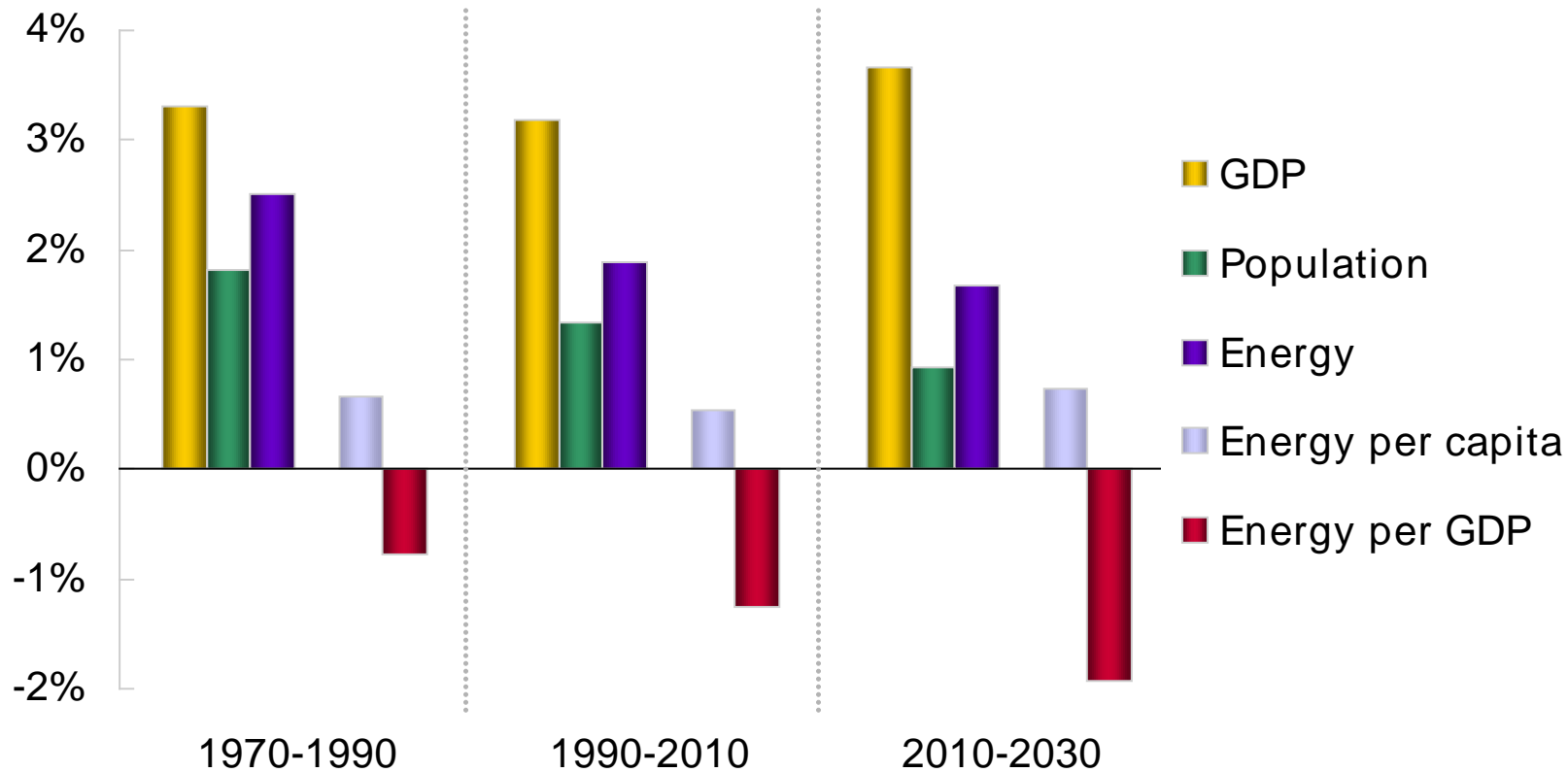
60 years
BP Statistical Review

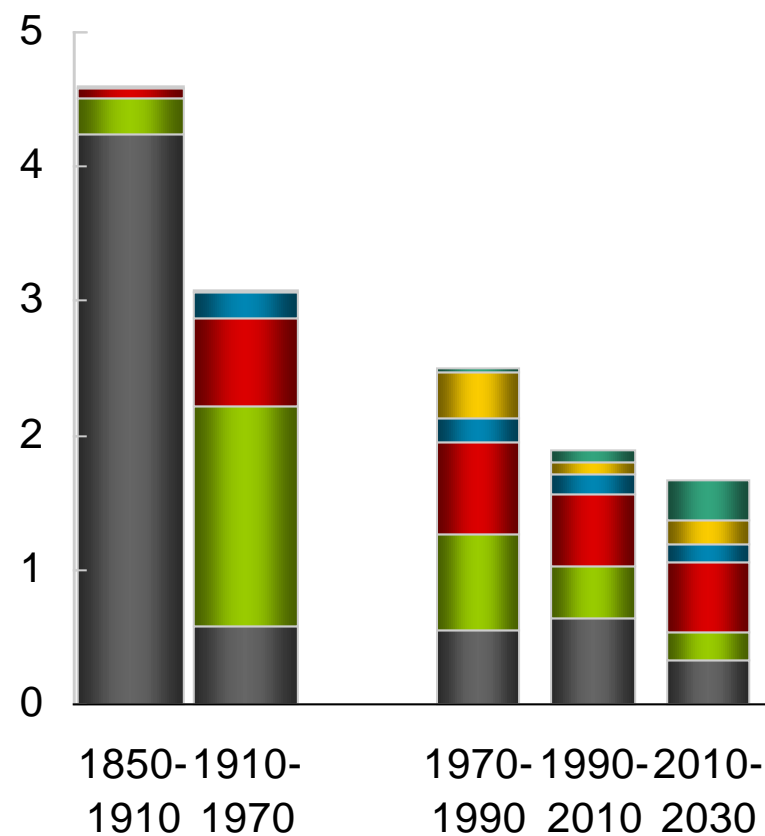
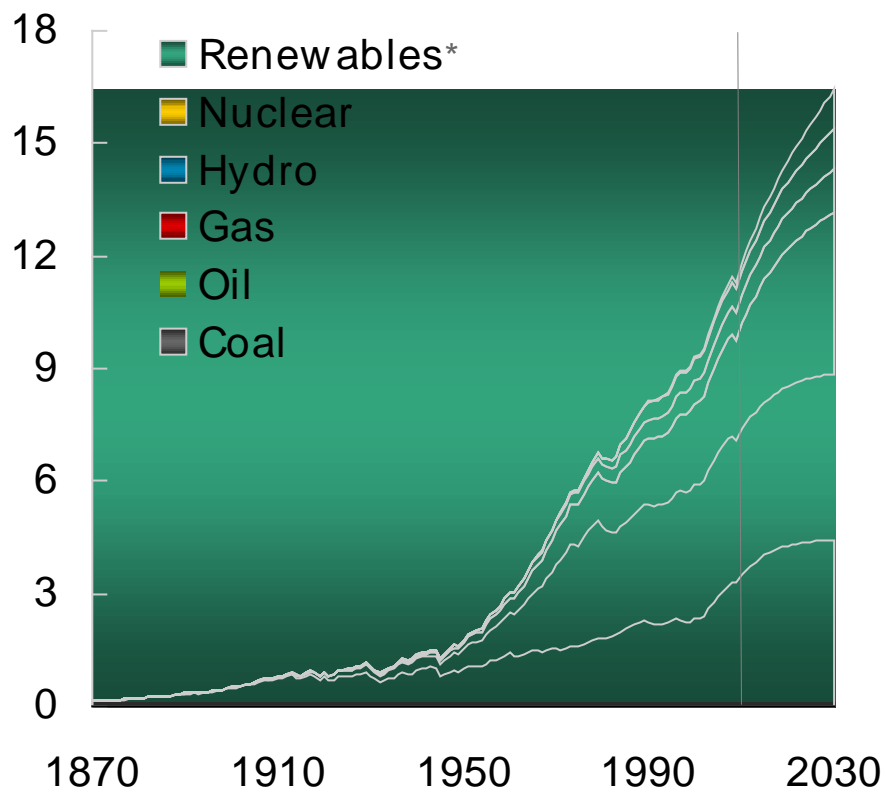




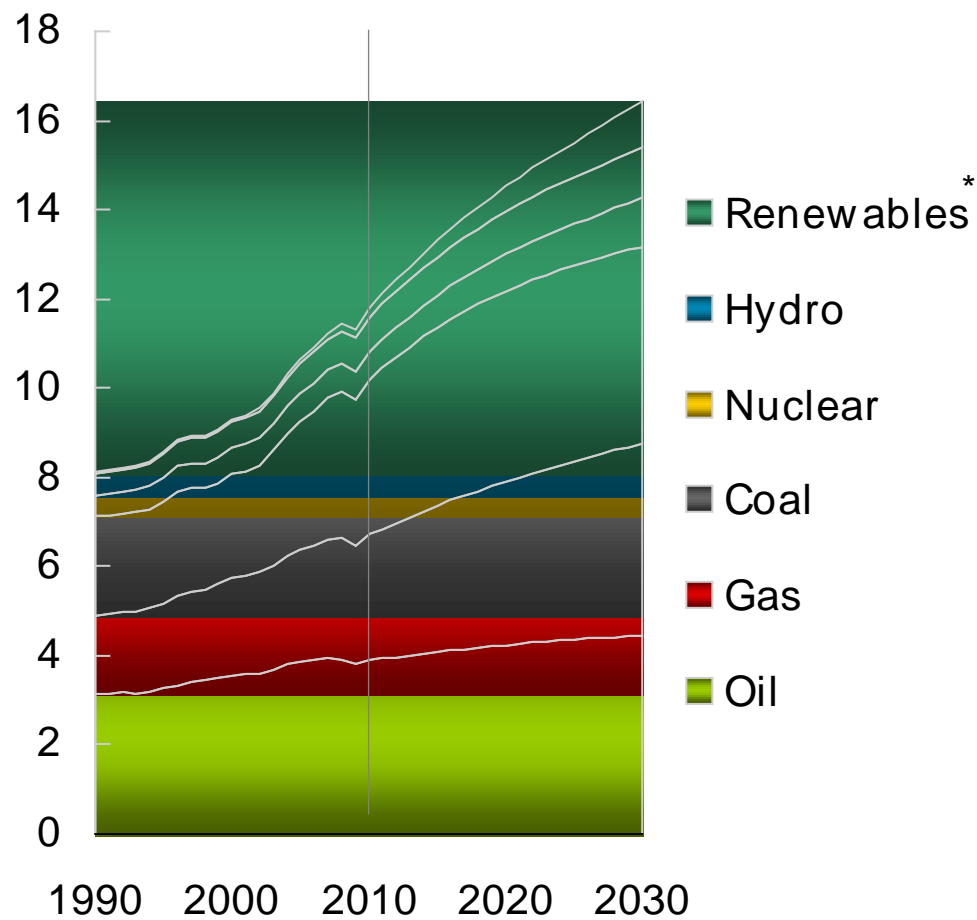
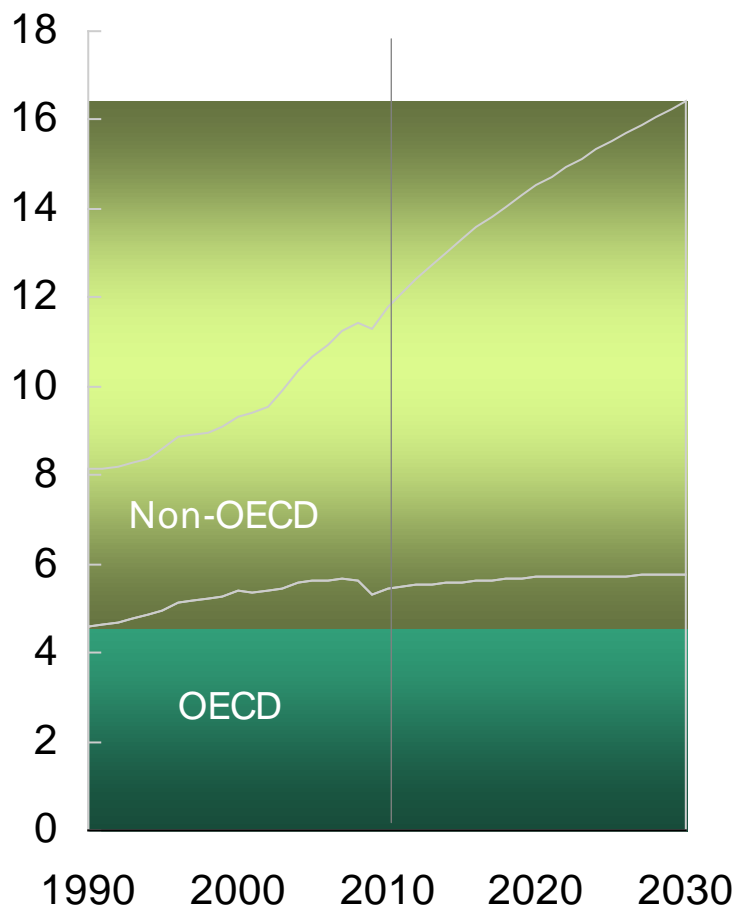




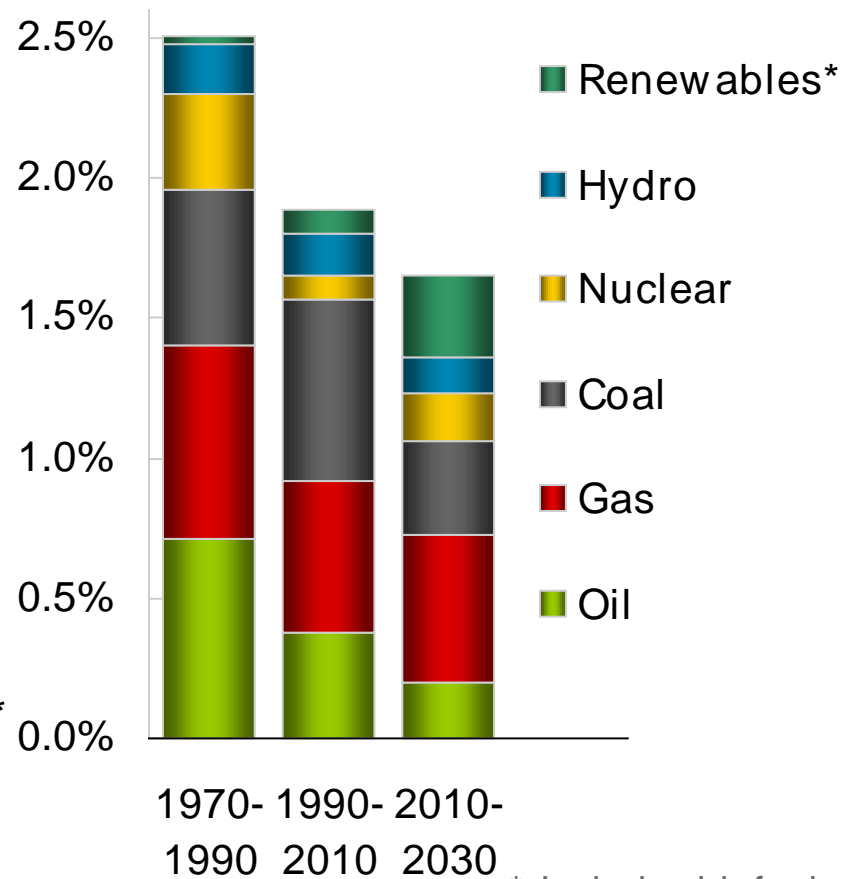
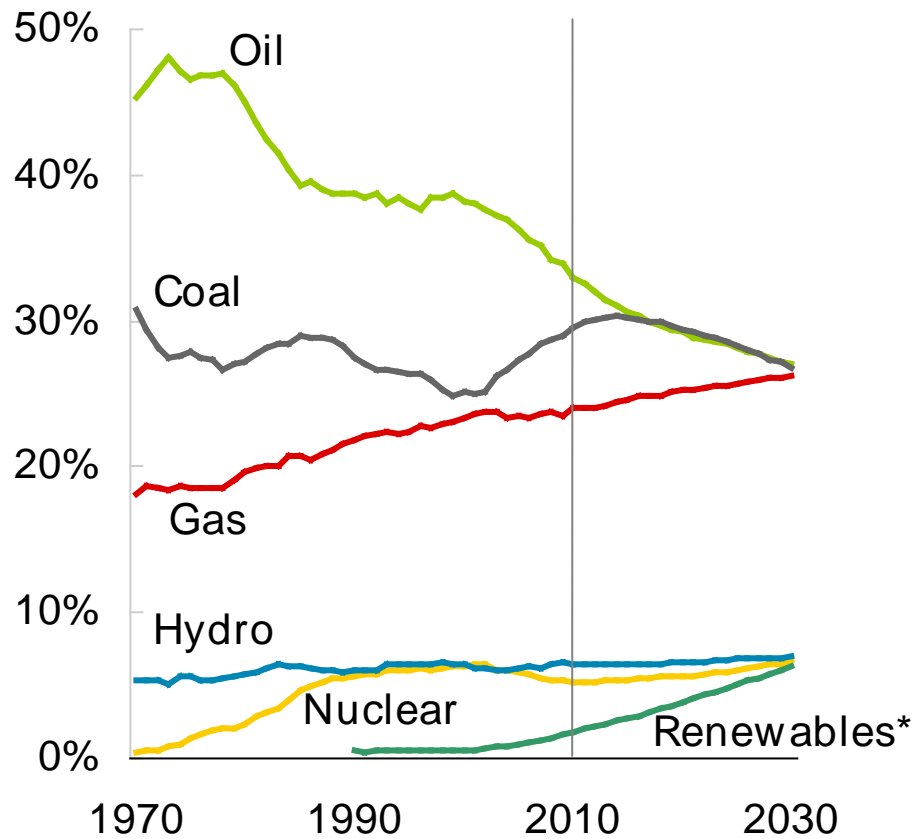




* Includes biofuels



* Includes biofuels

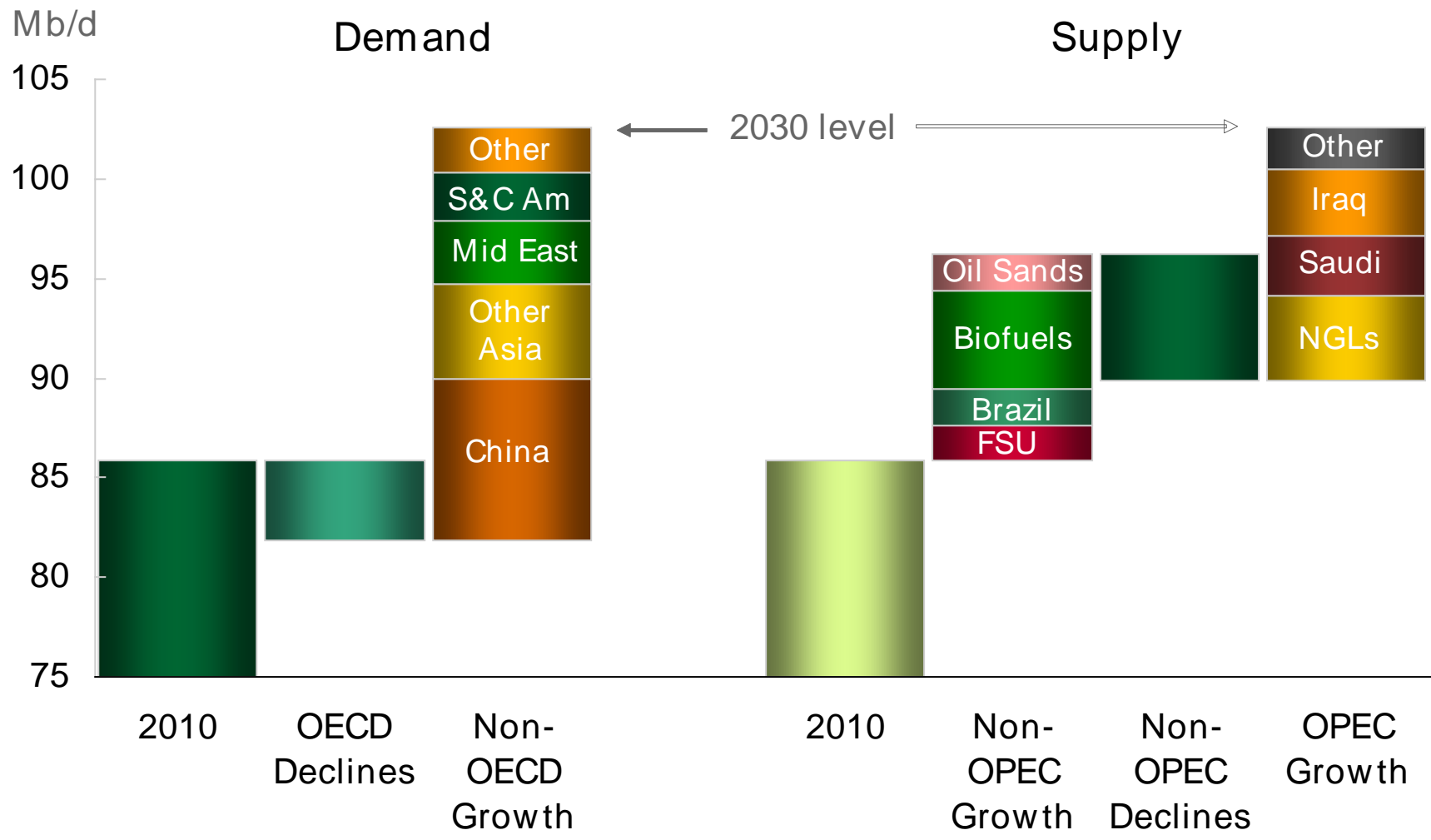


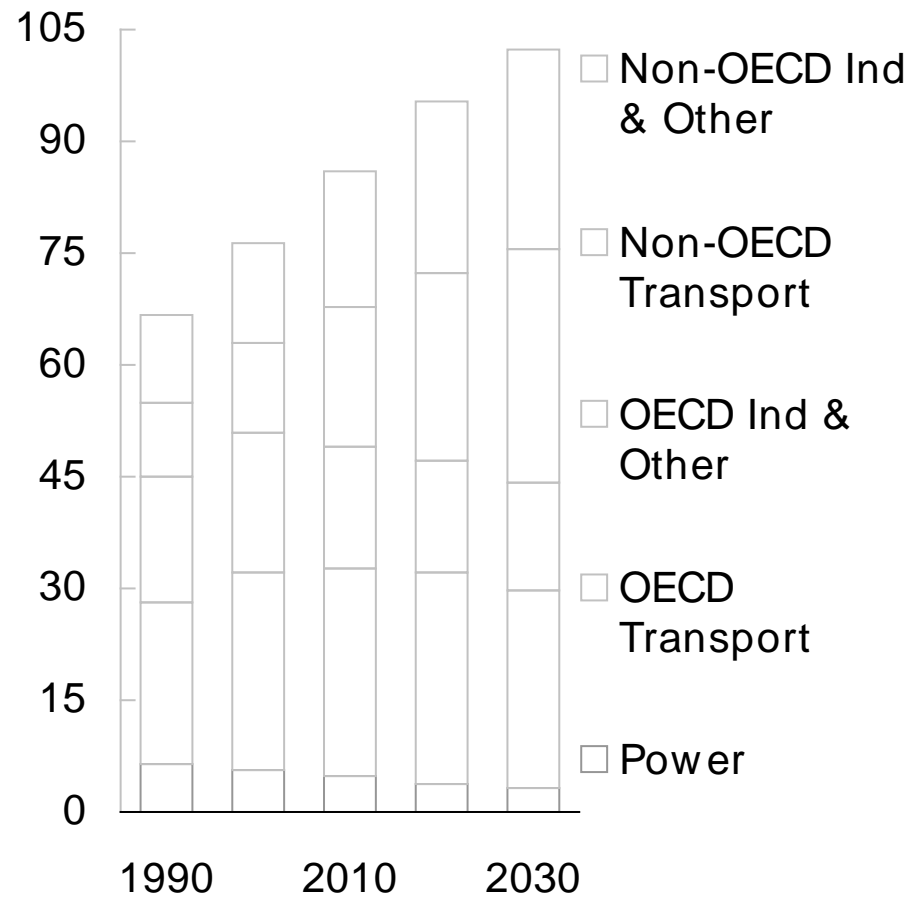
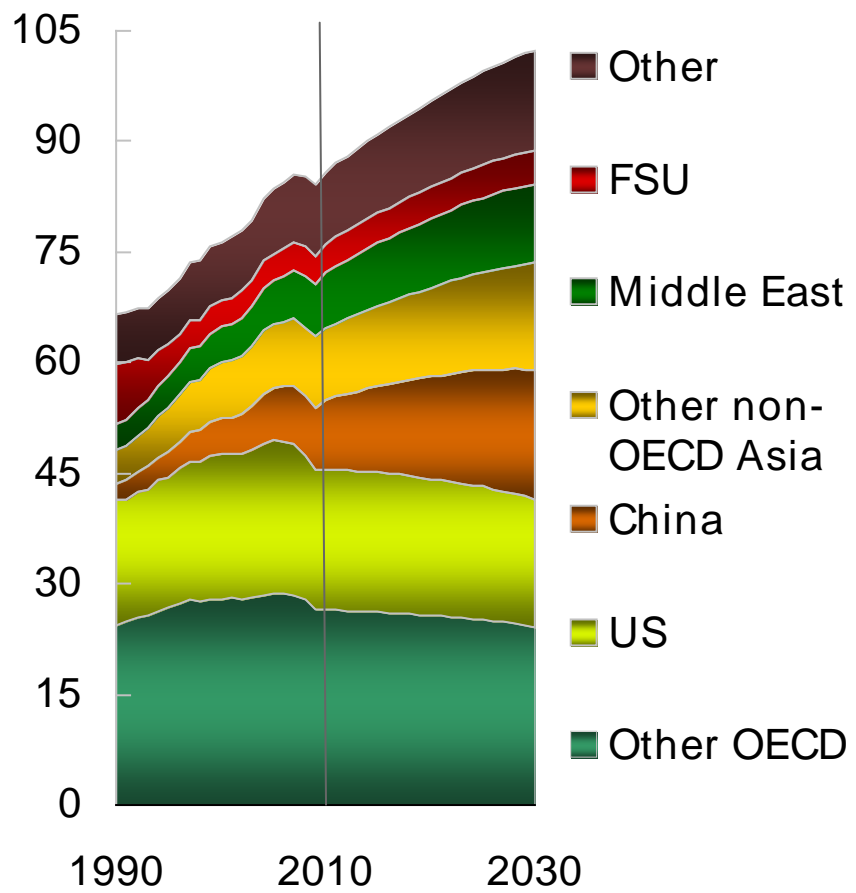
* Includes biofuels

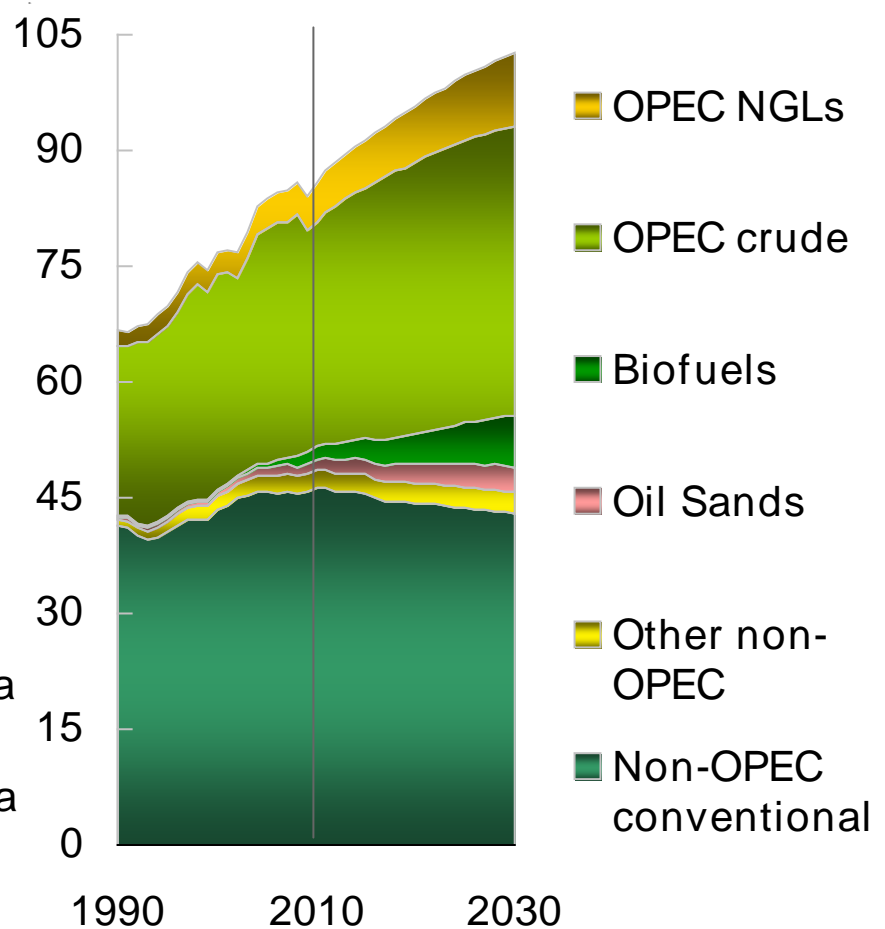
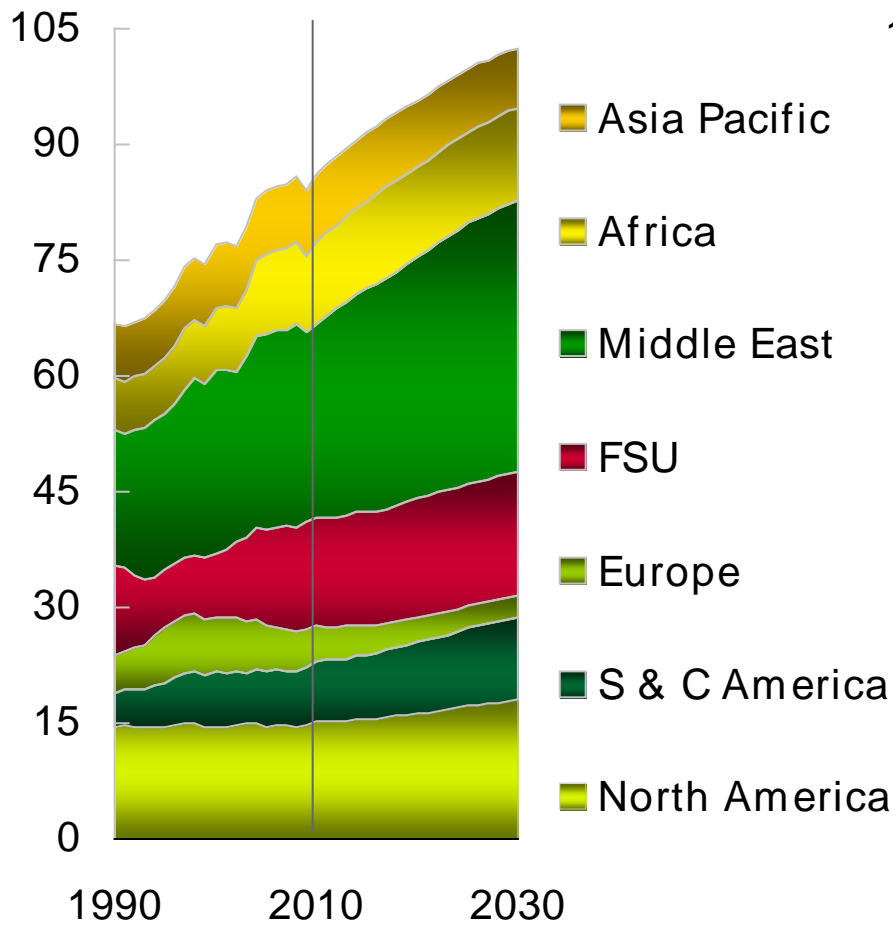




Liquids balance –

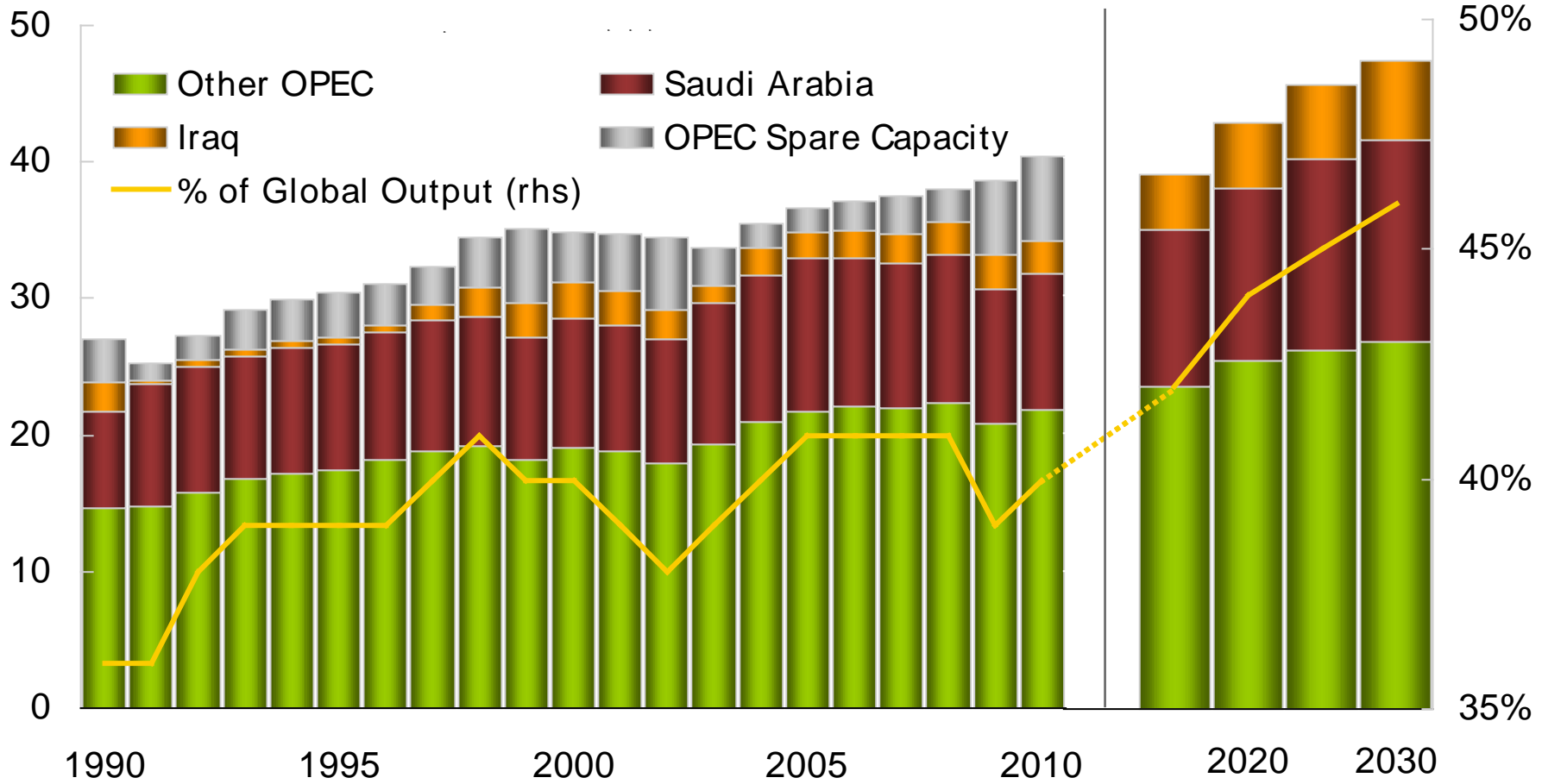




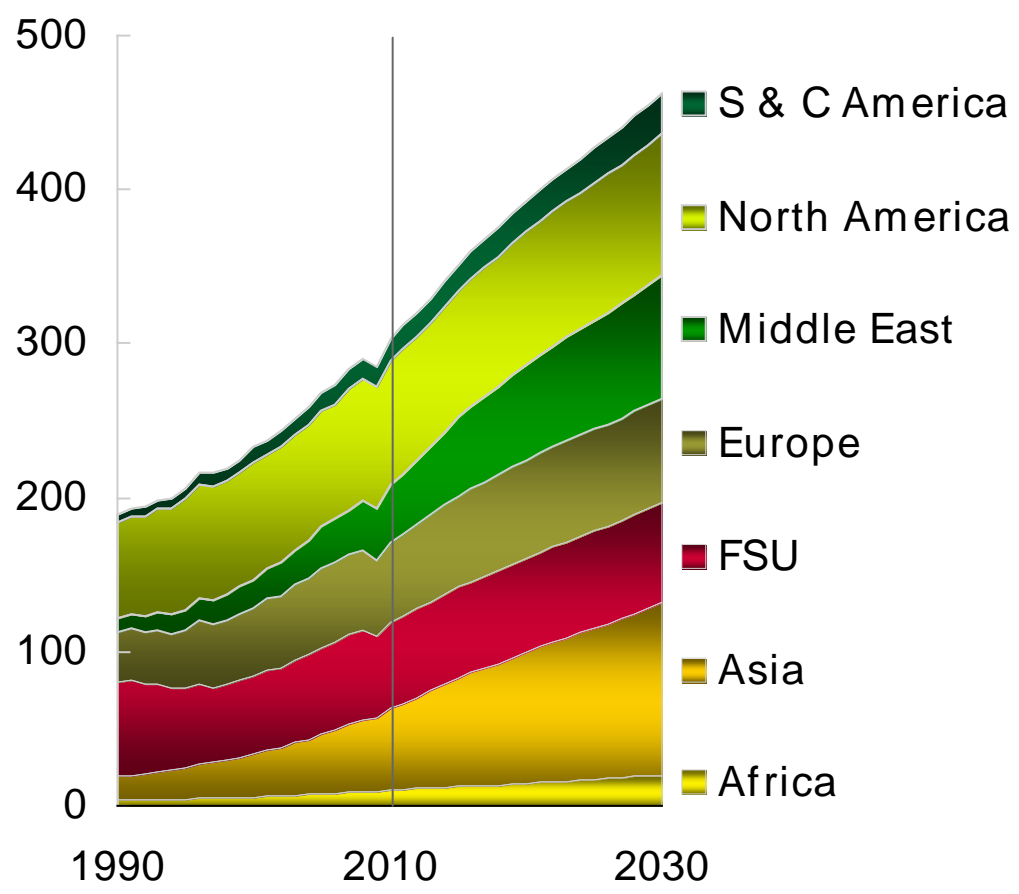
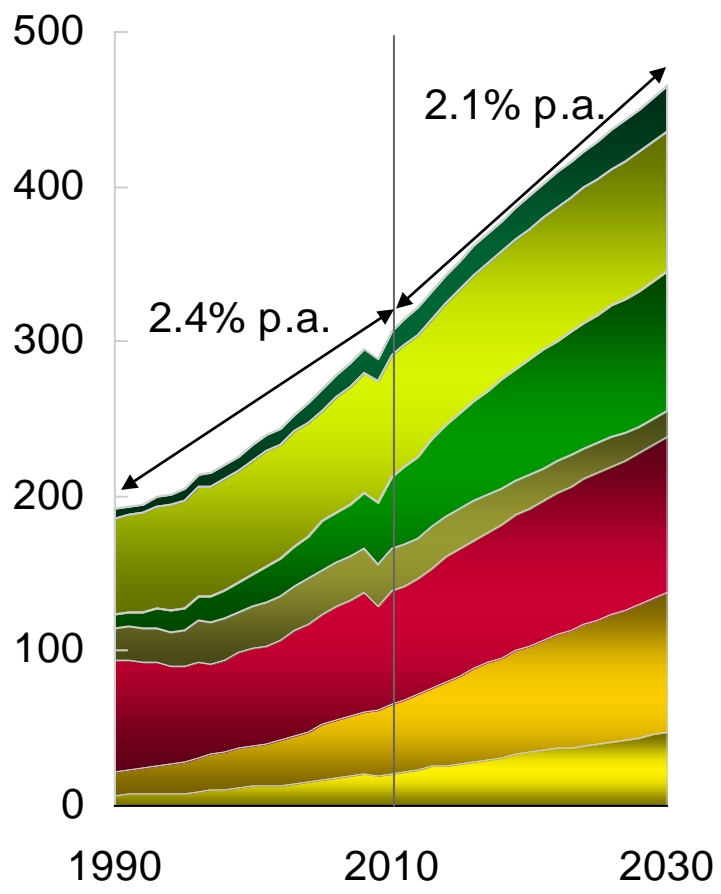


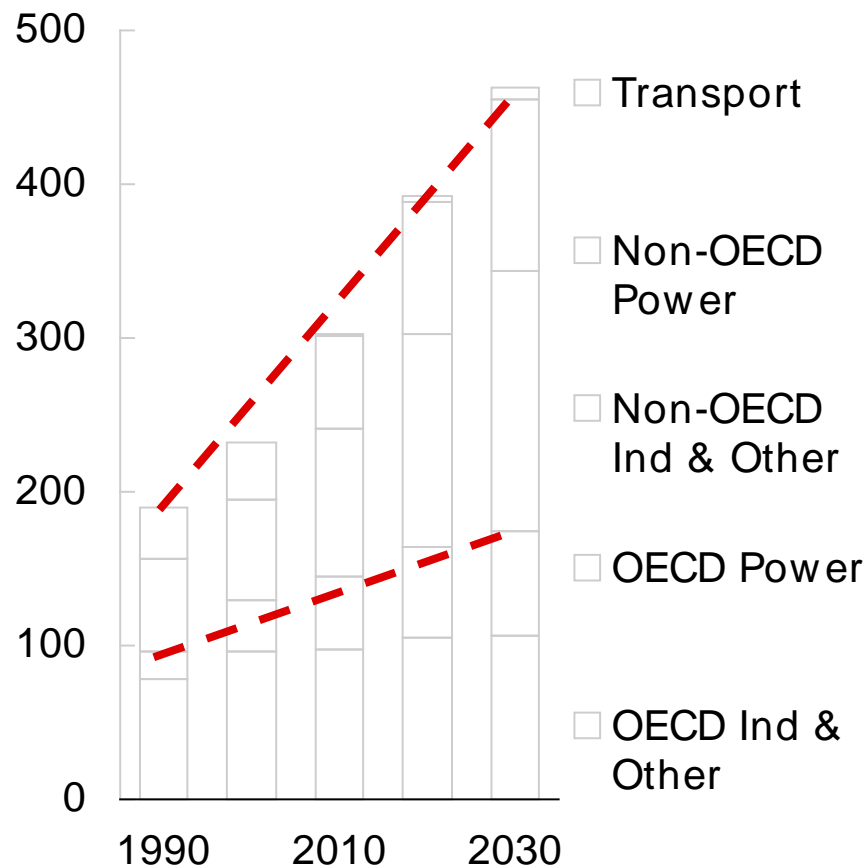
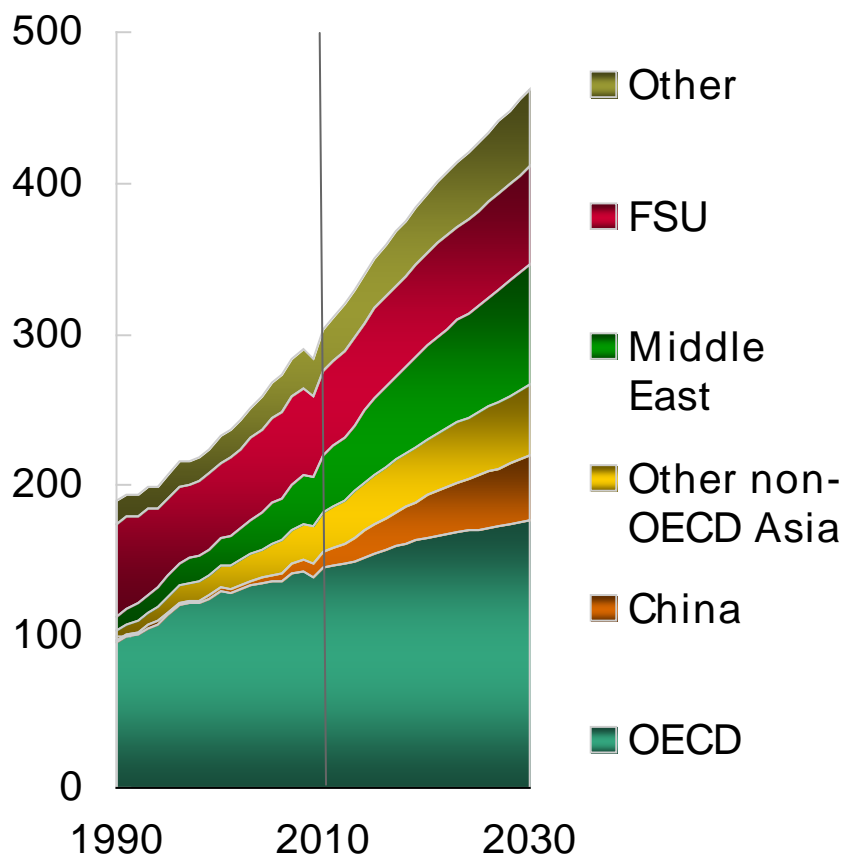


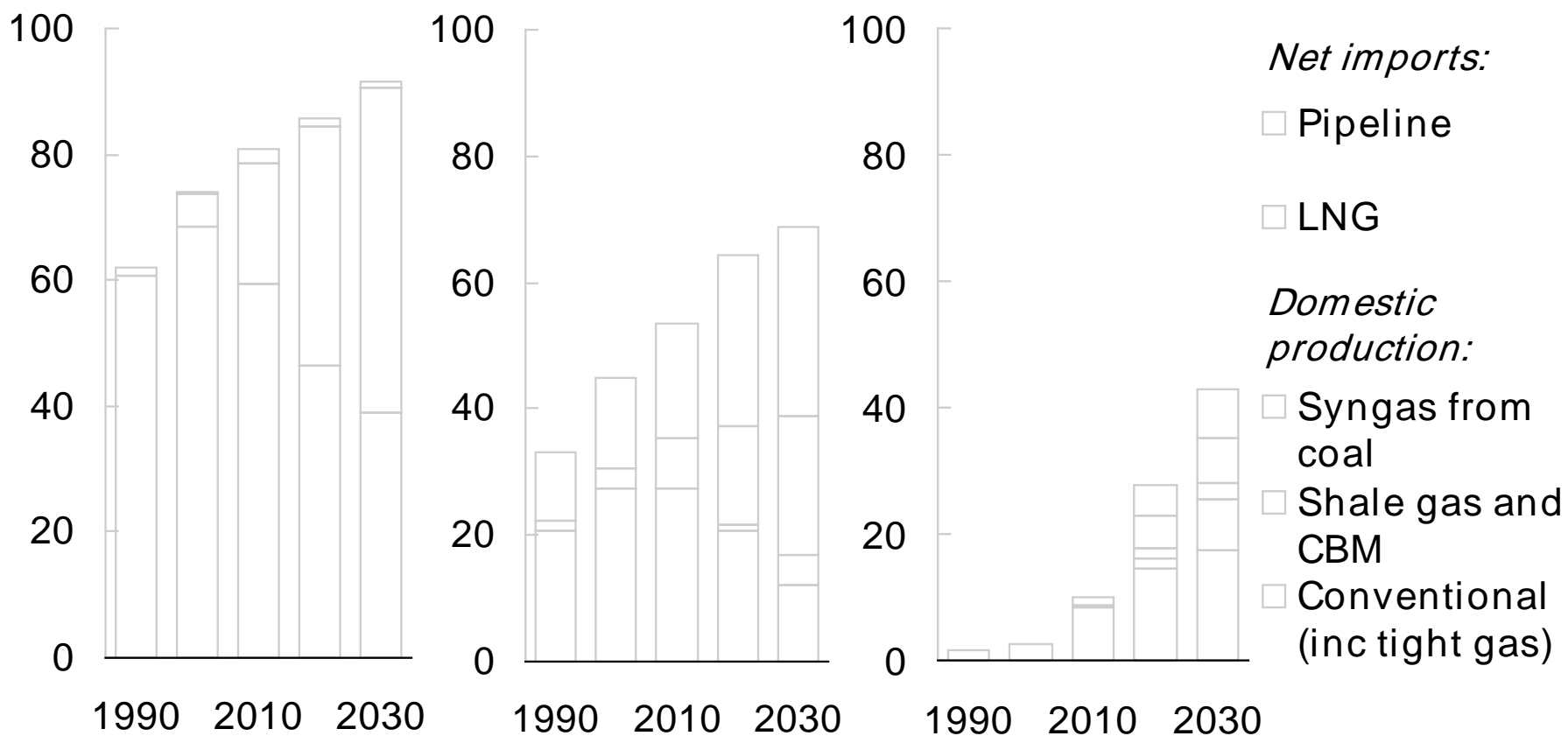
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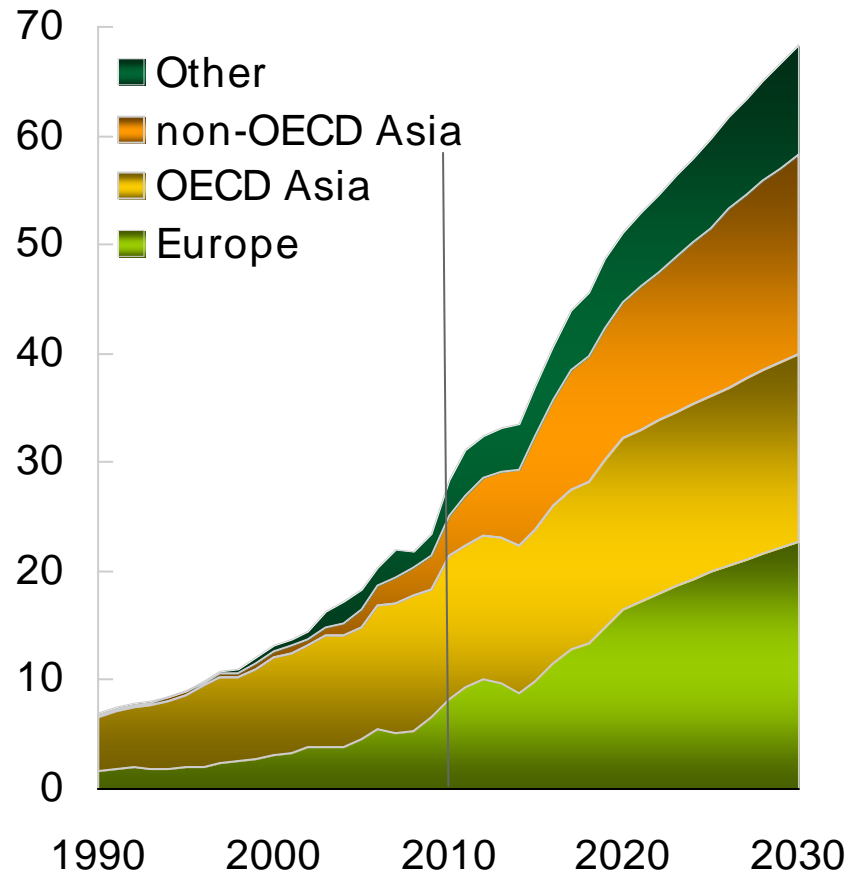
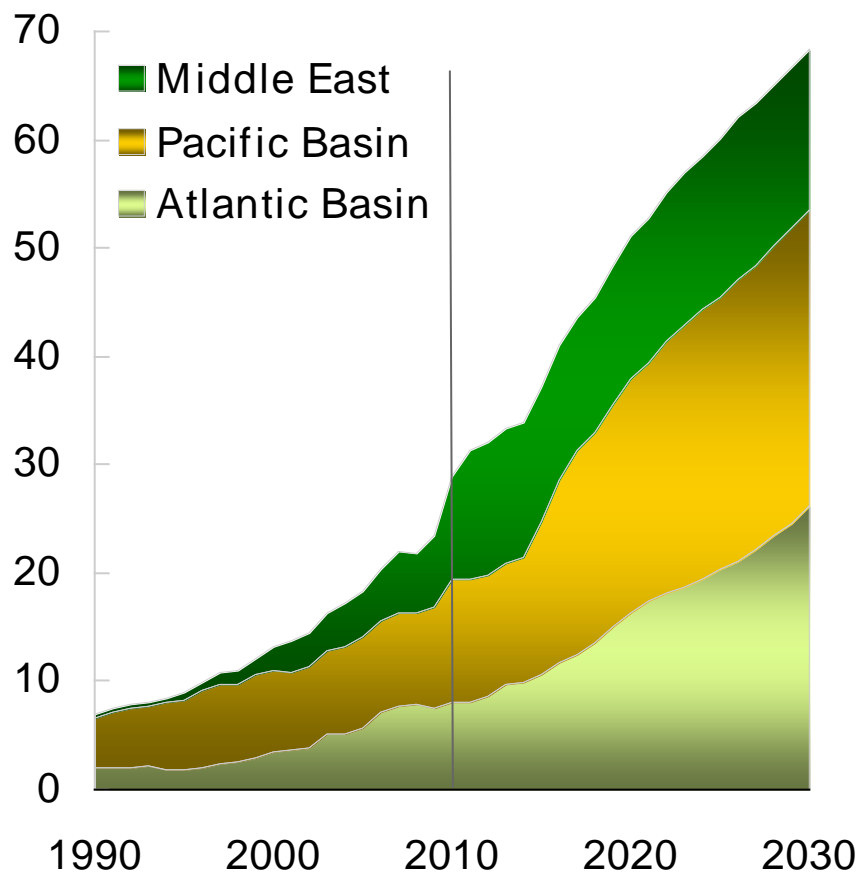


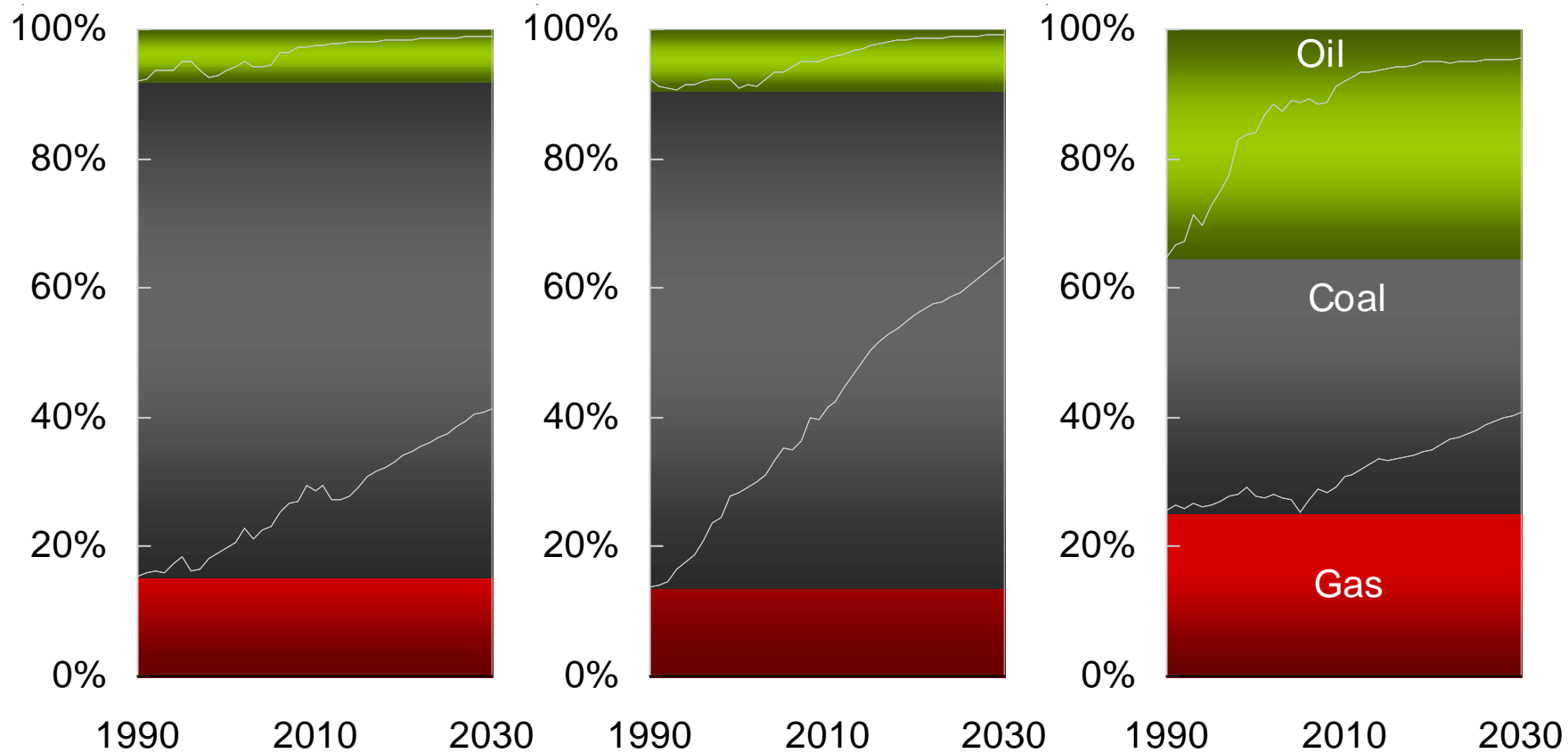














future pace of global economic growth

stronger policy action on climate change

China's



Geopolitics of Energy Security

From Imbalance to Re-balance:
a Chinese perspective

Xiaojie Xu

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Topics

- Imbalance of energy supply in the wake of the fall of the FSU
- Imbalance of demand growth in the wake of China's rise
- Chinese scenario: from Petro-Dragon to a Black Energy Swan
- Chinese options and roles: how to shift from black swan to white one for enhancement of energy security

Imbalance of supply

- Imbalance of energy supply in the wake of the fall of the FSU
- Greater Middle East or Greater Central Asia as a game changer
- Competition between Opec and non-Opec supplies
- Questions for Russia: competing with Opec
- Questions for the US: unconventional revolution and changes, both internally and externally

Imbalance of demand

- China's rise and a looming larger demands for substantial energy sources
- An insatiable pattern: Petro-Dragon scenario
- Questions for China: its demand trend is sustainable into the future? ready to tackle? A set of unexpected questions yet to be answered
- Questions for the world: Be aware of China's rise beforehand? Understandable due to lack of transparency? How to cooperate with China? G2 or not? G20! TPP? Yet to find a way to work together with China

Questions for re-balance

- New Energy Security Concepts: consumer-producer's views, country, regional and global ones (climate change)
- FDI policy and resources (re)nationalism: a shift resource sovereignty from rule taker to rule maker
- PSA or SC: contractual transition and EITI Practices.
- North-South cooperation: Washington consensus or Beijing one on development
- Global agenda and responsibilities on global energy security
- Good governance: inside out responsibilities

Chinese Options

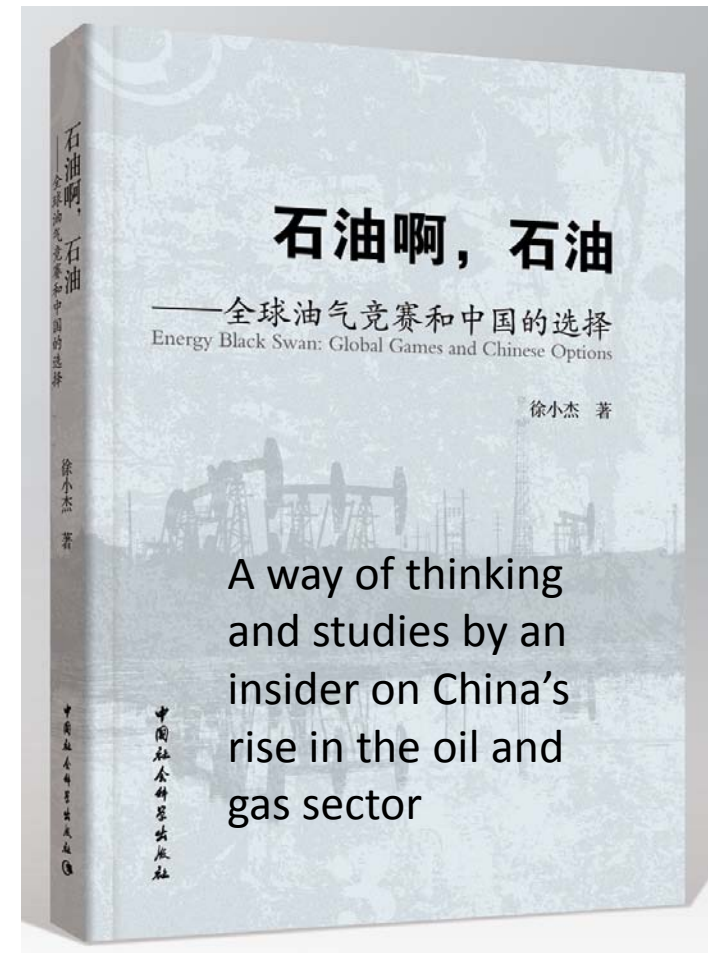
- Energy Security in China: from self-sufficient to balanced pattern
- Be either a competitor or partners, both regionally and globally? African case
- Shift from bilateral to multilateral approach. Chinese proposed energy club under SCO; Sino-EU dialogue, etc.
- Either join or co-building the new global platforms, WTO, IEA, ECT and G20 and BRICS

Chinese Roles

- A rising geopolitical power with balance of strength
- A leading economic player or performer as the largest developing country in the world
- A white energy swan and partner to the world with several possible scenarios and impacts
- Results mentioned above will depend on if China can make a historic shift from black swan to white one within a span of a decade or two.

Thanks

- Xiaojie Xu
- Senior Fellow at CASS; Advisor to CNPC and State Energy Administration
- xiaojie_xu@yahoo.com
- New flagship book: Energy Black Swan: Global Games and Chinese Options





*European 20-20-20 Energy Policy
at the cross-road?
A very provocative and pro-business view...*

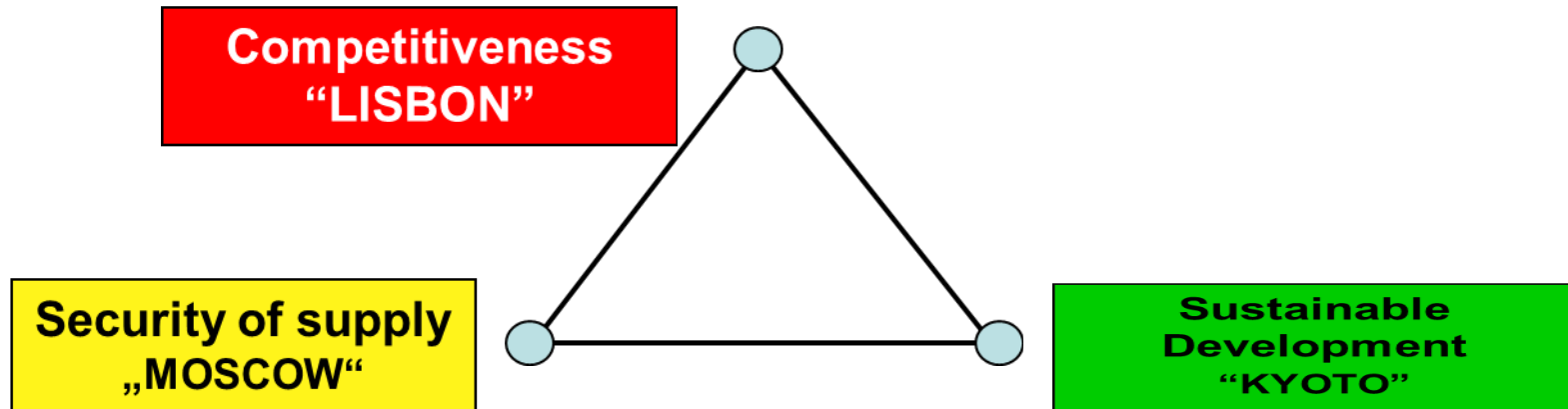
Jean-Michel Glachant

Florence School of Regulation

& Loyola de Palacio EU Energy Chair

Madrid, 25 November 2011

The EU energy policy triangle



- **Lisbon:** to obtain enough energy at competitive prices in effective Internal Market
- **Kyoto:** to combat climate change
- **Moscow:** to guarantee security of supply

The EU 'KYOTO' targets: 20-20-20 in 2020

1st 20%: RES 20% of energy mix (oil included!)

2nd 20%: Energy Efficiency +20%

3^d 20%: GHG emission -20%

4: Assuming that EU is not financially dead before 2020? Or?

1st energy target: RES 20% energy mix

20% RES : we should get because enormous public push in all the EU (with RES “Who pays get” / except if financial crisis ends in 1929 for half of the EU – which is more likely than ever ☹ ☹ **BUT**

1*At what price? RES always subsidized in 2020? Or at the market price got from the market trade? Will then be RES very close from non-RES generation costs (except for carbon price)?

2*And what consequences for non-RES generators? Will all nuclear and gas generation be under asphyxia by a lower level of energy demand for non-RES as well as with the low price in the wholesale market? Subsidized RES can be sold a 0 (zero) in the market because it is paid outside the market with support schemes.

20% RES (Cted)

20% RES : we should get BUT

- 3* how to keep working a set of non-RES generators big enough to remedy to the intermittency of RES? How to keep working a good enough gas supply chain (facilities and supply contracts) if non-RES generation becomes very intermittent: between 0% and 100% of its full capacity?
- 4* how to finance new non-RES generation plants being very fast and very flexible as to get a robust security of the electrical system?

20% RES (end)

20% RES : we should get BUT

5*How to upgrade the EU transmission grid as to make it more robust vis a vis higher intermittency of electricity generation?

6*How to prepare expansion of RES production till 2020 (as to double its current level)? Off-Shore wind? Massive Off-Shore wind with supergrid? North Sea Off-Shore project of 45 GM in North Sea requires 150 Billion euro of investment in a decade. Quid of its financial feasibility if the financial crisis deepens again?

2nd energy target: +20% efficiency

+ *20% efficiency with energy consumption we should'nt get because*

1*only a weaker public push

2*there is not a mandatory target and we won't get "National Plan" of implementation trajectory towards the final objective in 2020

3*there is no "burden sharing agreement" between countries as with RES

4*there is no miracle of "feed-in tariff" like with RES (It is rather the opposite: the one willing to consume less energy has to invest by herself; Then a- she sees the expense b- she has to invest q lot upfront instead of being charged little by little all along a decade or so)

+20% efficiency (Cted1)

+ 20% efficiency with energy consumption we should'nt get but

5* some ideas are discussed like:

a/ to centralize the new efficiency gains constraints on industries producing the goods (See bulbs) and the companies (air transportation, car makers, domestic appliances, Building norms etc.);

While we hear industry shouting not all business are complaining. Because it could be a good way to get a “passive trade barrier” > room for bargaining and manoeuvre??

+20% efficiency (Cted2)

b/ in a similar vein we could put the burden of household energy efficiency on the shoulders of energy suppliers (= energy suppliers are asked to reduce the consumption of their customers / as in UK). It looks crazy while it is not (entirely).

⌘ Political attractiveness can come for targeting poor or distressed households (or territories)
>> the social effect there amplifies the efficiency effect

⌘ Economic and financial attractiveness too: because the “miracle of feed-in” comes back! It is NOT the consumer who invests upfront full costs: it is the supplier company (or a Third Party energy service company). Of course this has to be reasonably designed as to not fall again into the craziness of the Spanish solar plan.

There we may see a new “Business Model” emerging for energy companies. They could become mixed companies (selling both Energy and Energy Services). Could it be discussed with these companies?

This “industrialization or corporatization” of energy efficiency might be discussed for all social housing and buildings of public authorities BUT financing is barrier (Whom will lend money? What conditions?)



+20% efficiency (End)

6* A new EU directive to remedy to it deeper? Or to accelerate the process? I don't think so: under the pressure of Member States Eu Commission did steep back this summer: NOT mandatory

3d target: -20% GHG emissions

Thirdly -20% GHG emission: we should get on the existing EU trajectory

1*we control the target by issuing only the right amount of allowances!

2*furthermore we “overshoot” with support to RES (RES are NOT delivering the GHG emission target – they are delivering the particular way we design to reach the target – or said differently because RES are directly greening our energy mix other “greening efforts” are not needed and not undertaken)

3*however our EU economic growth is specially low

4* energy consuming industries still localize outside EU ;

We should get *BUT* with a lot of *BUT*

-20% GHG (Cted1)

20% GHG emission: we should get BUT a lot of BUT

5* As the volume of GHG emission is already capped in the EU, the push for RES “kills” the carbon price by easing the demand for permits (low pressure on the carbon market low price of carbon). Low carbon price discourage carbon reduction elsewhere than RES push.

6*As a result social and industrial efforts based on carbon price are not got and the wave of decentralized initiatives to decarbonize is dried before been born. Major issue.

-20% GES (Cted2)

BUT a lot of BUT

7*decarbonization being pushed and financed by RES feed-In might become socially counterproductive. Major social and political problem because it is financed by a consumption tax paid by all (except if very low “social tariff”). RES support is paid by consumers inside their energy bill. It works as a consumption tax.

In fact poorest or more modest people are often the one who spend more of their income (in %) to buy energy [they are the “fuel poor” with 10% or more of their total revenue spent for energy].

Rise of energy prices hurts more on the bottom of the revenue scale while decarbonization is more a concern for the wealthy of the society...

Calculation in UK shows that financing decarbonization through feed-in is roughly 10 times more consequential for the lowest 10% of the household than for the first 10%. In other countries like France it does already exist a “tariff buffer” for the poor being called “social tariff”.

-20% GES (Cted3)

BUT a lot of BUT

- 8* Another very sensitive aspect of our EU decarbonization policy is that by pushing “RES + feed-in” we already select the winners of the decarbonization innovation race. We can see the results in the wind sector with many business stories for wind; But we also have seen shining disasters like solar PV. Too expensive support (Spain; Czech Republic) but also industrial disaster: our EU PV boom is more and more a bonanza for massive equipment imports from China. Our EU grand plan of a new technology miracle pulled by a demand boom is failing.
- 9* Another industrial difficulty is within the decarbonization of our fossil fuel usages. While pushing so much RES we abandon decarbonization investment and innovation for coal and gas. Let's assume that's OK for coal (being already a subsidized antiquity). But gas? Do we have to qui decarbonization of gas (like with CCS)? Or decarbonization trough gas? While the world is entering a “Golden Age for Gas” (IAE report).

-20% GES (Cted4)

BUT a lot of BUT

10* Not only gas is entering its world Golden Age BUT it has its own technological revolution on the way: Shale gas fracturing. A revolution which strongly shake the notion of “economically accessible” gas. Sure: like any technological rupture shale gas has numerous uncertainties like: a/ environmental impact; b/ actual quantity accessible (several decades or several centuries of consumption?) c/ actual price (vis a vis Qatar LNG? Vis a vis Russian oil indexed gas??)

If USA and Canda confirm having got *environmental sustainability **large quantity ***cheap price >> it results in USA and Canada quietly substituting gas to coal and quitting all RES push policy (except in a Californian or Masschussets show). As long as a decade or so? Then for all the period 2010 to 2020 which is so critical for our EU energy policy.

-20% GES (Cted5)

BUT a lot of BUT

11* Assuming that North America and let say Asia base their decarbonization and less GHG emission policy on gas and gas. With whom will EU negotiate anything else in the international post-Kyoto bargaining? What should become our EU post-Kyoto international strategy?

Can an “All RES” EU negotiate anything with anyone in “All gas” Americas & Asias?



-20% GES (End1)

BUT a lot of BUT

12* Knowing that our negotiation “carbon strength” beyond 2020 will anyway be very weak. Reducing 50% more our carbon emissions will then weight a few weeks of Chinese growth. It says that we will weight virtually nothing.

Logically we will then be bypassed by direct negotiations between the actually big polluters. Except if we put fresh EU money on the table to buy more depollution from big polluters.

Will we be after 2020 in a so brilliant economic and financing shape that buying significant fraction of world wide depollution will still be a feasible option?



-20% GES (End2)

BUT a lot of BUT

THEN: many questions raised despite our today's acclaimed EU 20-20-20 policy success.

Seen from today we should get 20-20 in 2020: 20% of RES and -20% of GHG. We should'nt make it for +20% energy efficiency while it should'nt damage the two other 20.

BUT we also might be in 2020 in a dire dead-lock vis-à-vis our 2050 ultimate targets.

OF course the two first 20 may also derail far before 2020. An acceleration of our financial crisis may kill all of it in 1 or 2 years.

Who will keep hard energy constraints on the shoulders of financially distressed economies?

Jean-Michel.Glachant@EUI.eu



**Then: Have a look
on the
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journal
I am chief-editor!!**

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Fenli Birol

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