



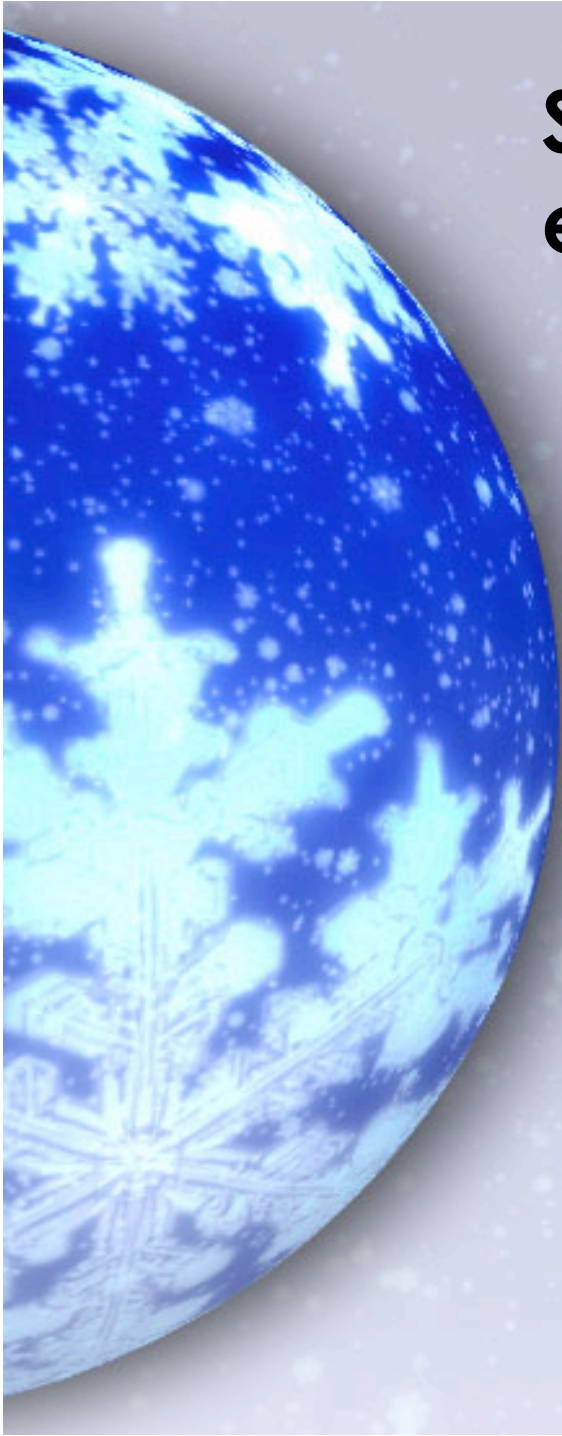
The Economic Prospects of a Nuclear Renaissance

Marco De Andreis, www.crusoe.it

Crusoe robinson

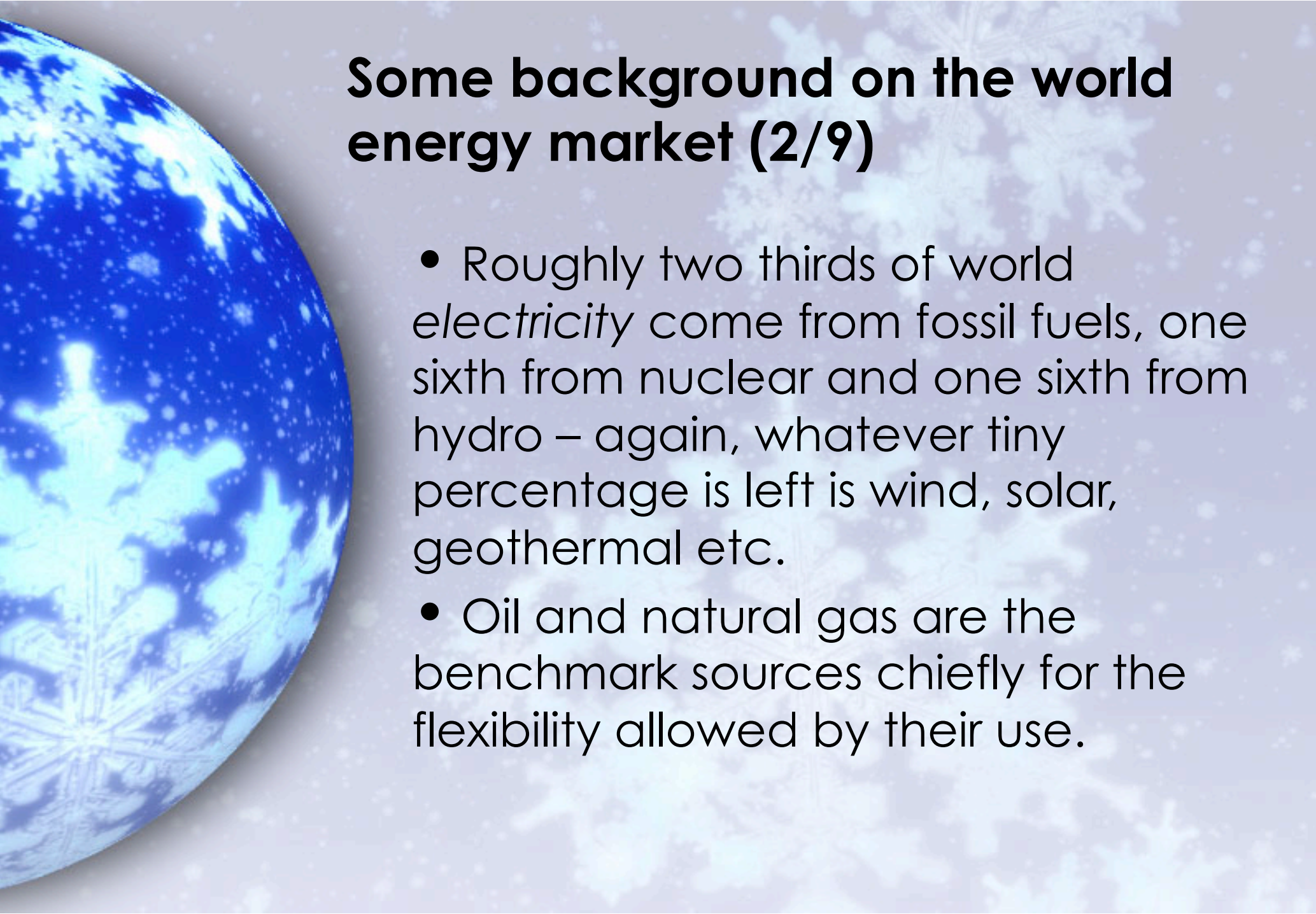
24th ISODARCO Winter Course, “Eliminating Nuclear Weapons and Safeguarding Nuclear Technologies”

Andalo, 9-16 January, 2011



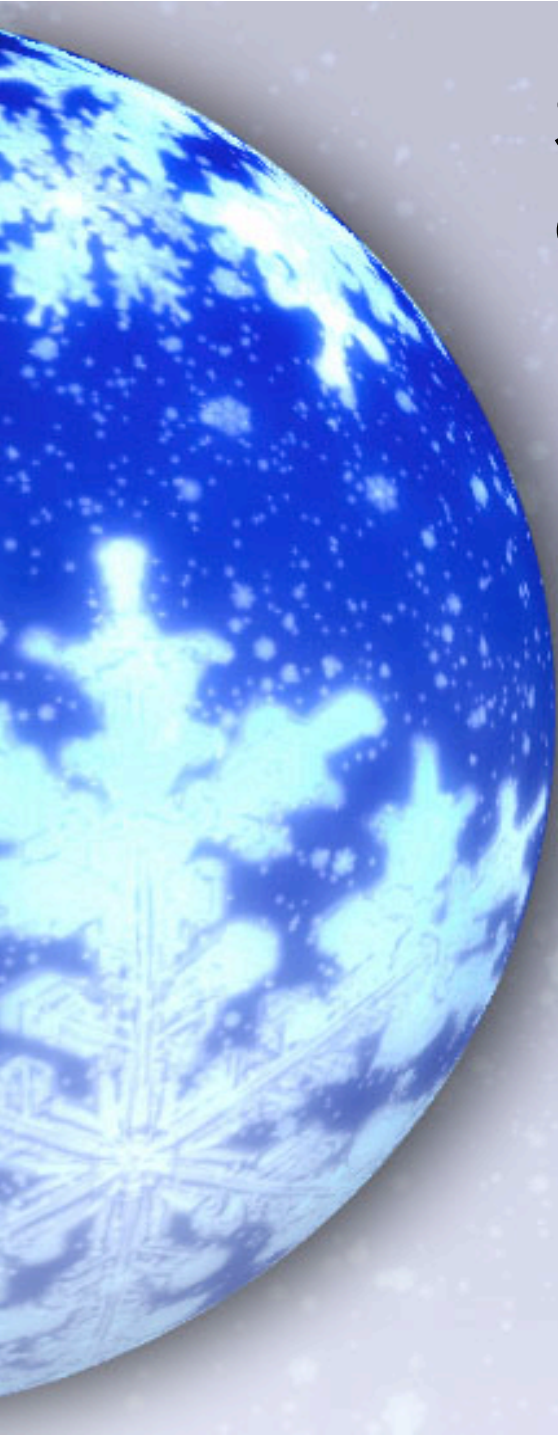
Some background on the world energy market (1/9)

- The bulk (~ 85%) of world primary energy is fossil fuels: Oil (one third), Coal (one fourth) and Natural Gas (one fourth).
- What remains (some 15 %) is made up in roughly equal parts by nuclear, hydro and biomass.
- Whatever tiny percentage is left is wind, solar, geothermal etc. - that we may also group with hydro and biomass under the label of “renewables”.



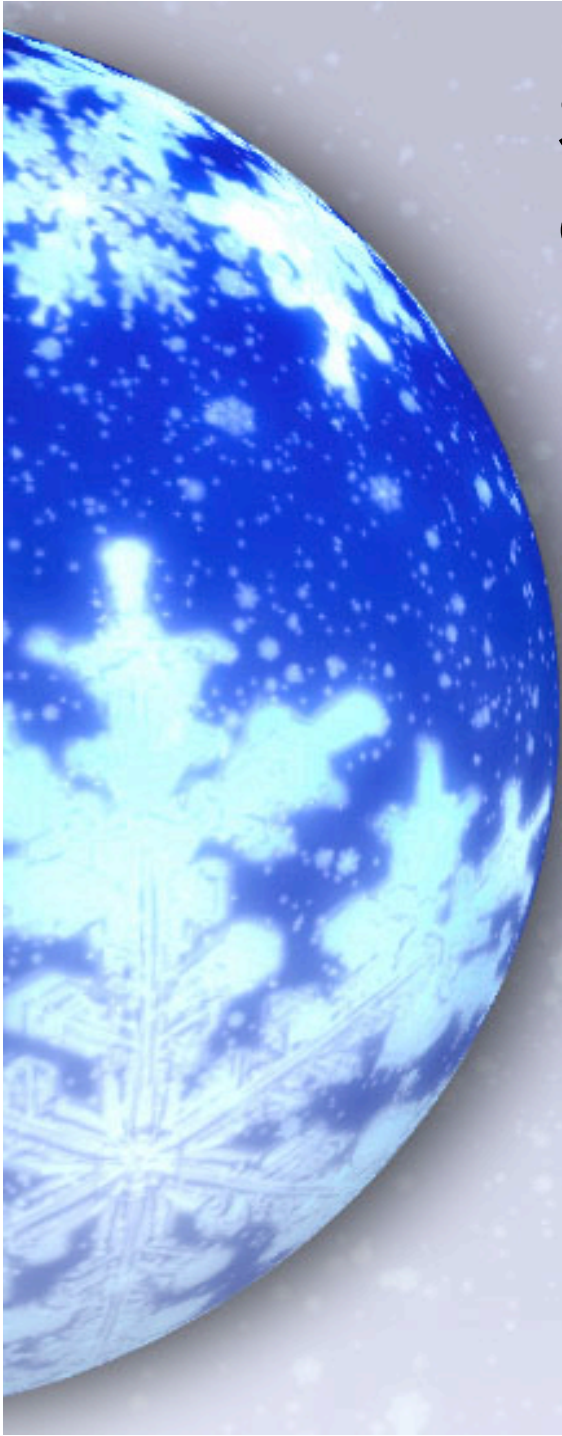
Some background on the world energy market (2/9)

- Roughly two thirds of world *electricity* come from fossil fuels, one sixth from nuclear and one sixth from hydro – again, whatever tiny percentage is left is wind, solar, geothermal etc.
- Oil and natural gas are the benchmark sources chiefly for the flexibility allowed by their use.



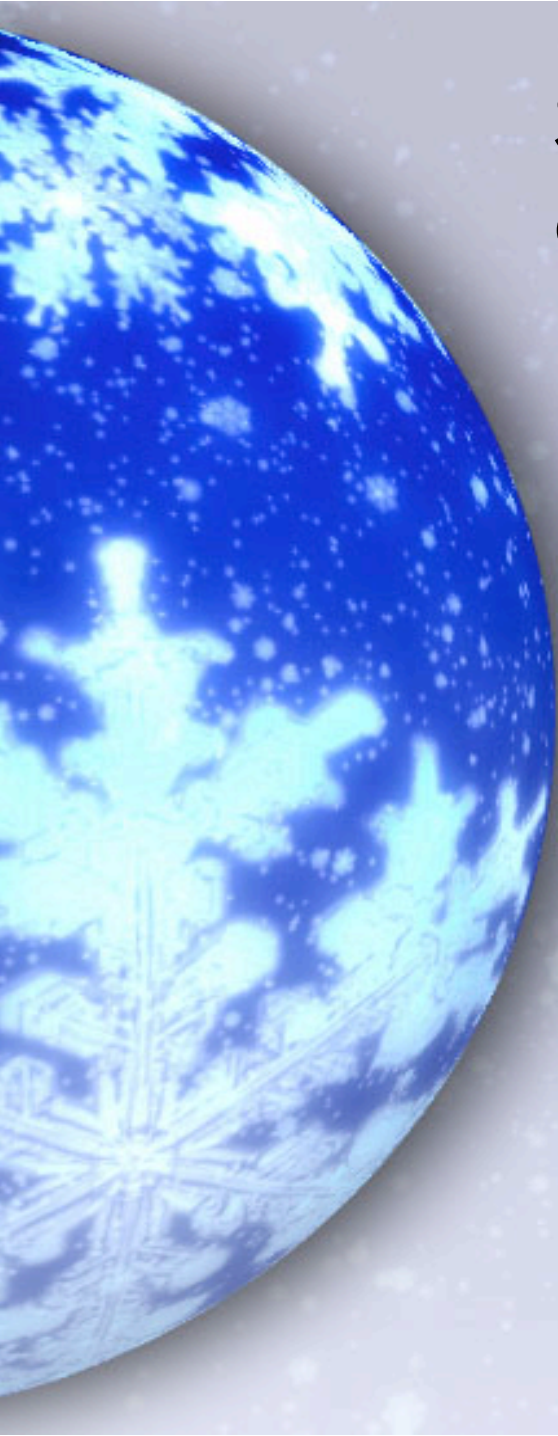
Some background on the world energy market (3/9)

- Gas turbines – basically the same on a plane, a ship or in a power station – can be installed and connected to an electrical grid in a matter of few months, as opposed to the years required by the construction process of nuclear and coal plants.
- Nuclear and coal plants (base load power plants) are instead complex to get started as well as brought to a halt, while wind and solar are discontinuous sources.



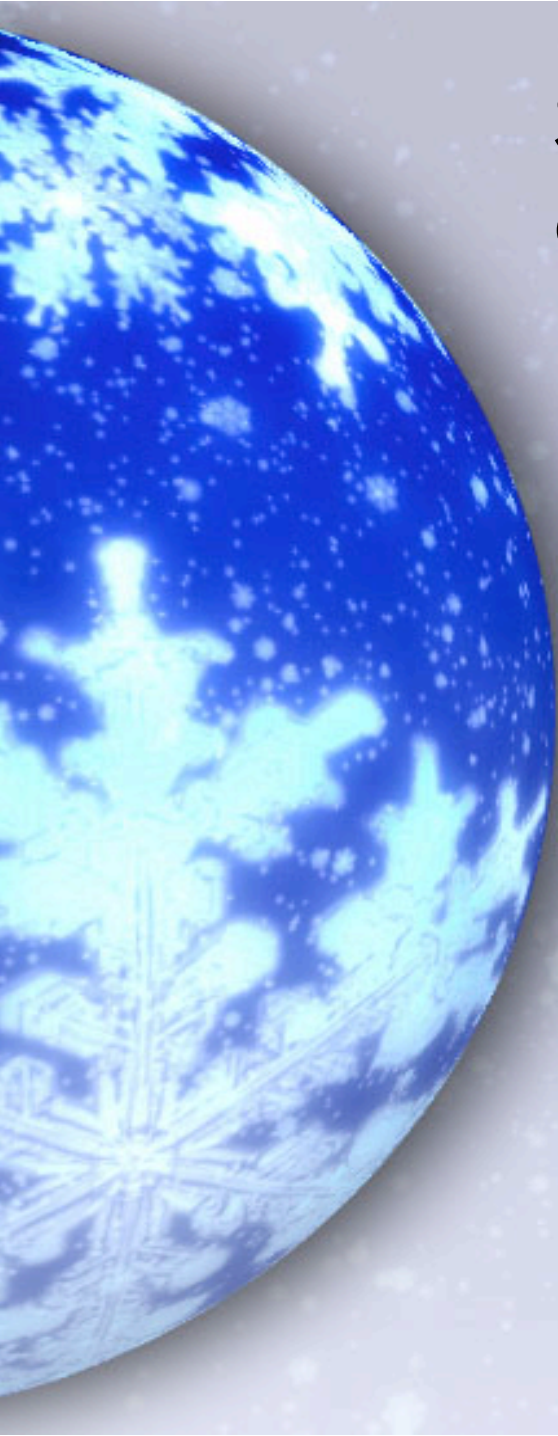
Some background on the world energy market (4/9)

- Since electricity is not easily stored (batteries) you cannot significantly use that produced by base load power plants for transport - in land vehicles, ships or aircraft. Trains are the exception, of course.
- **It is the availability (price) of the benchmark sources that determines the economic fate of the residual ones.**
- **If oil and gas are scarce (costly) the others become attractive. If oil and gas are abundant (cheap) the others remain unattractive.**



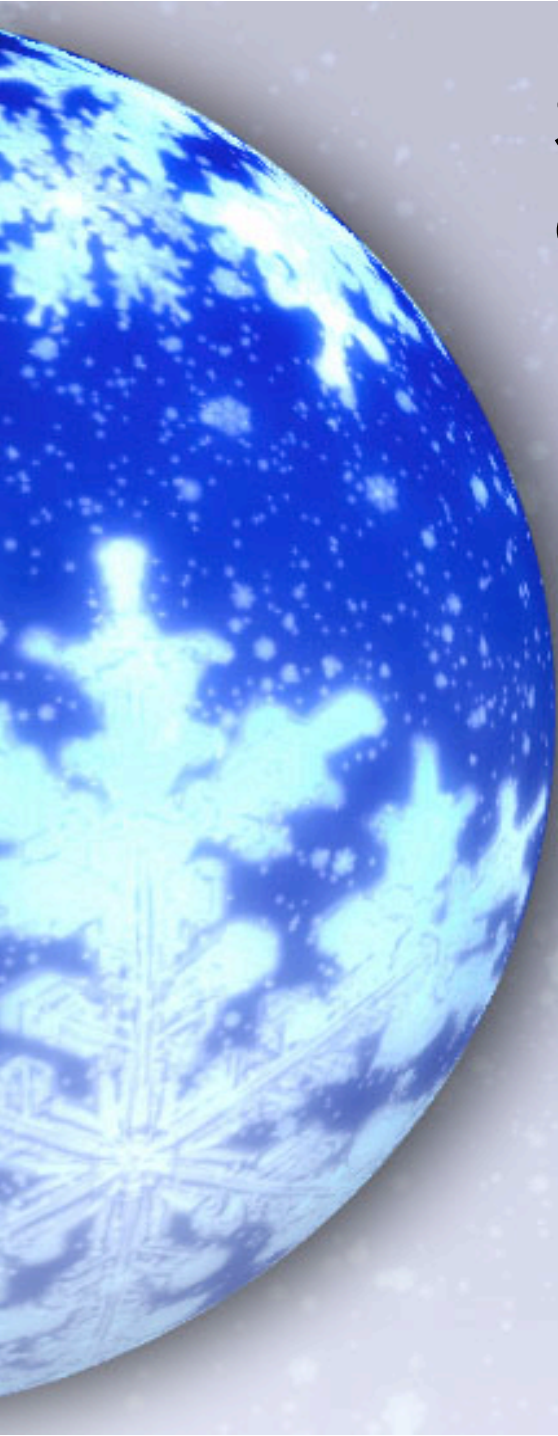
Some background on the world energy market (5/9)

- Even though oil and gas are finite resources, there is no such a thing as a definitive limit to their availability, or a precise quantitative definition of scarcity.
- The case of natural gas today.
- The case of oil tomorrow. The higher the price of crude oil goes, the more economic sense the marginal stuff makes, which in turn depresses, or moderates the growth of, the price of crude oil.



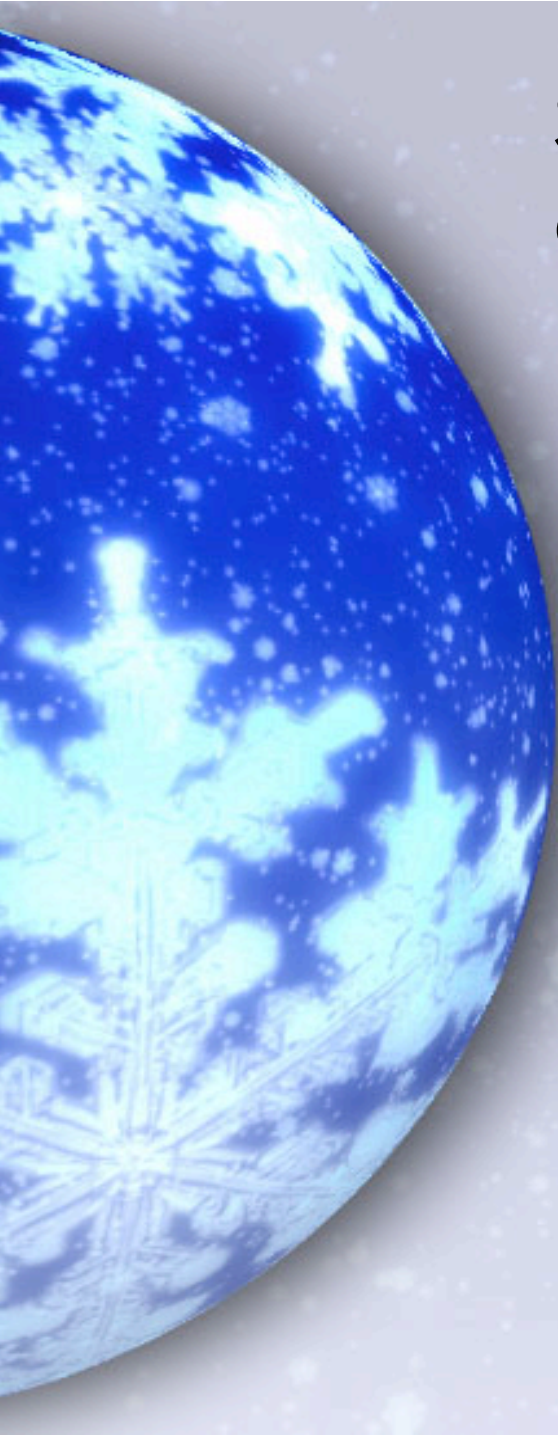
Some background on the world energy market (6/9)

- Another way of keeping oil and gas relatively abundant (cheap) is precisely to use the residual non-fossil energy sources whenever possible and feasible, even if not economical. Enter government subsidies.
- Negative externalities: CO₂ and global warming. Carbon tax. Price picture changes in favor of non-CO₂ emitting sources, i.e. wind, solar and nuclear.



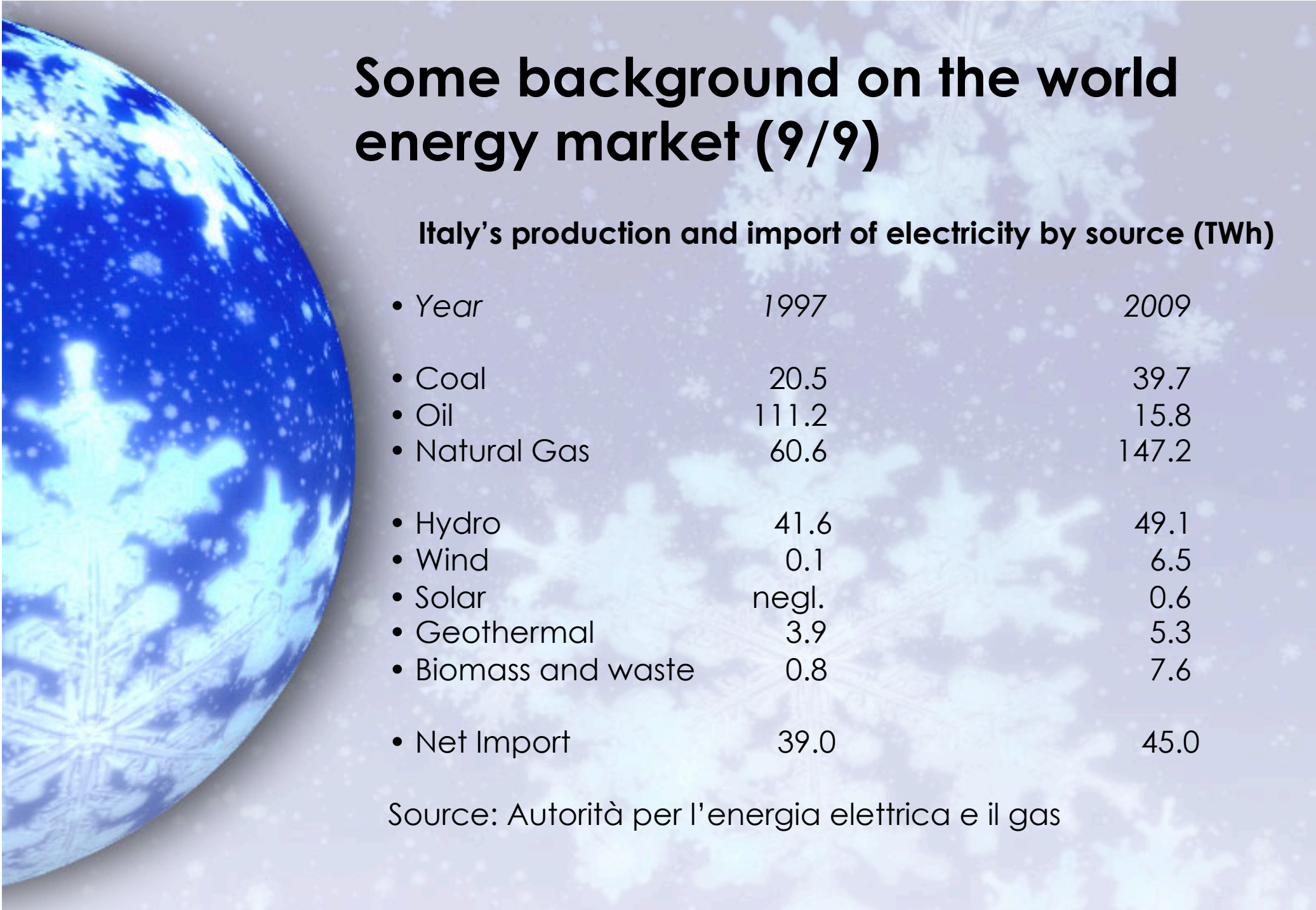
Some background on the world energy market (7/9)

- Governments in rich countries also subsidize renewables or nuclear independently from a carbon tax to cash in the *positive* externalities of fighting global warming, diversifying energy sources (thus increasing security of supply), and stabilize the price of fossil fuels.
- In rich countries at least, oil is used nowadays mainly for transport. Gas is widely used for heating and for electricity production.



Some background on the world energy market (8/9)

- The more open and competitive a market, the less administered the energy price, the greater the advantage of rapidly adapting to changes in demand (remember: the ability to turn the source on and off by a simple switch) - in another word, of flexibility.
- The gradual opening of a European-wide electricity market has put a premium on flexibility and hence on gas. Let's see what happened to Italy.



Some background on the world energy market (9/9)

Italy's production and import of electricity by source (TWh)

• Year	1997	2009
• Coal	20.5	39.7
• Oil	111.2	15.8
• Natural Gas	60.6	147.2
• Hydro	41.6	49.1
• Wind	0.1	6.5
• Solar	negl.	0.6
• Geothermal	3.9	5.3
• Biomass and waste	0.8	7.6
• Net Import	39.0	45.0

Source: Autorità per l'energia elettrica e il gas



Nuclear energy seen by a private investor (1/8)

- First piece of information needed is an educated guess about the future price of oil and natural gas.
- How far in the future? Many decades.
- It may take about a decade to build a nuclear power plant. Plus it may have up to 60 years of operation. But average age of the 123 units already closed is about 22 years.



Nuclear energy seen by a private investor (2/8)

- Simple point: no one knows what will happen to the price of oil and natural gas over the next seventy years.
- Err on the wrong side – prices, particularly natural gas', lower than expected – and your return on investment may be severely undercut by a competition whose main asset is speed and flexibility.
- Remember: to have a new gas turbine generating electricity takes only months and it costs only a fraction of a nuclear reactor.

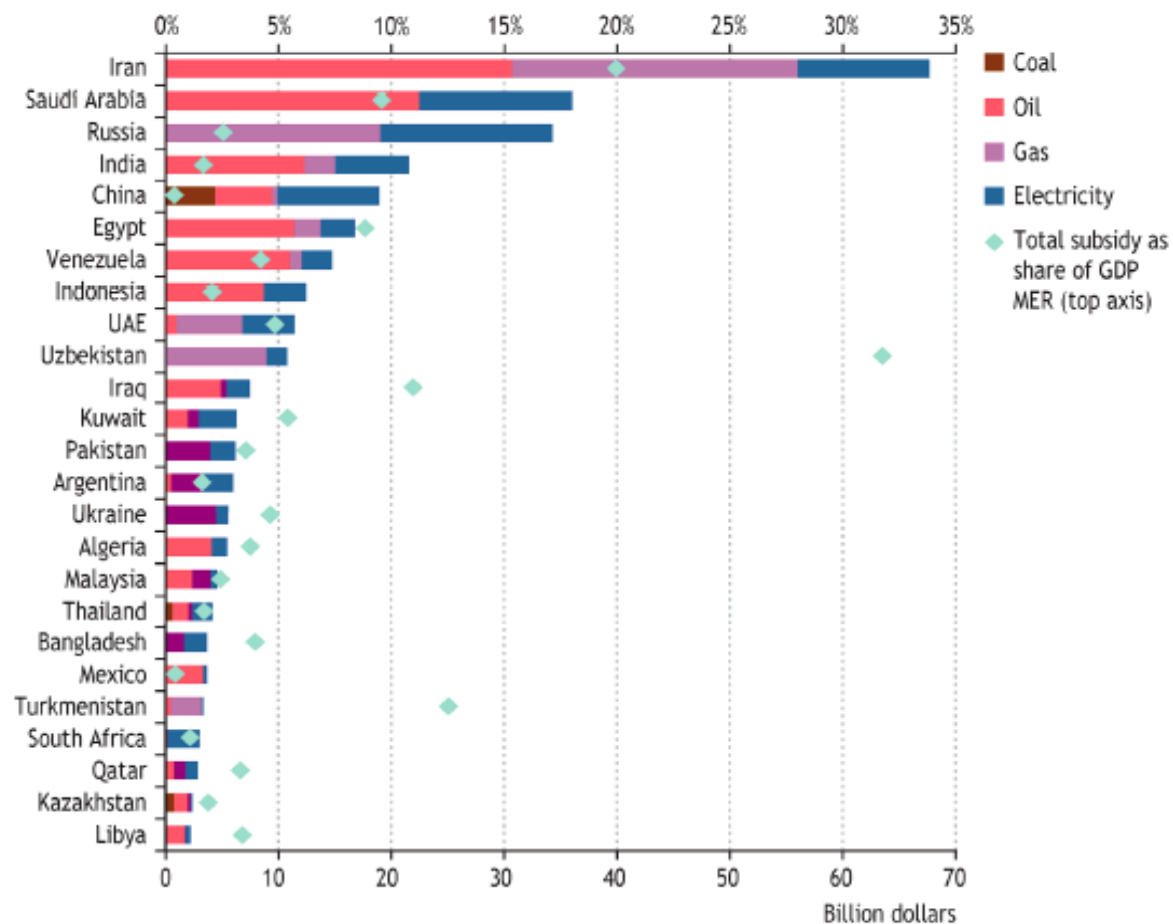


Nuclear energy seen by a private investor (3/8)

- One thing we know for sure: demand for energy and thus for fossil fuels will grow in the coming decades.
- The International Energy Agency (IEA) – an arm of the Organization for Cooperation and Economic Development (OECD) – in its last (2010) *World Energy Outlook* puts forth three scenarios from 2008 to 2035. Energy demand grows in all three .
- As for the future price of oil and gas, though, the IEA is silent – save perhaps for advocating getting rid of fossil-fuel subsidies.

Fossil-fuel subsidies are distorting price signals

Economic value of fossil-fuel consumption subsidies by country & type, 2009



Fossil-fuel consumption subsidies amounted to \$312 billion in 2009, with oil products accounting for almost half of the total



Nuclear energy seen by a private investor (4/8)

- A long record of spectacular failures in predicting the future scarcity/abundance of oil and its impact on price.
- The dire predictions made in the 1972 MIT-Club of Rome book *The Limits to Growth* on the duration of oil reserves were harshly criticized by the whole economic profession.

FINDINGS

Economic Optimism? Yes, I'll Take That Bet

By JOHN TIERNEY

Published: December 27, 2010

Five years ago, Matthew R. Simmons and I bet \$5,000. It was a wager about the future of energy supplies — a Malthusian pessimist versus a Cornucopian optimist — and now the day of reckoning is nigh: Jan. 1, 2011.


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Viktor Koen

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Readers shared their


The bet was occasioned by a [cover article](#) in August 2005 in The New York Times Magazine titled “The Breaking Point.” It featured predictions of soaring [oil](#) prices from Mr. Simmons, who was a member of the [Council on Foreign Relations](#), the head of a Houston investment bank specializing in the energy industry, and the author of “Twilight in the Desert: The Coming Saudi Oil Shock and the World Economy.”

I called Mr. Simmons to discuss a bet. To his credit — and unlike some other Malthusians — he was eager to back his predictions with cash. He expected the price of oil, then about \$65 a barrel, to more than triple in the next five years, even after adjusting for inflation. He offered to bet \$5,000 that the average price of oil over the course of 2010 would be at least \$200 a barrel in 2005 dollars.

 RECOMMEND


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Nuclear energy seen by a private investor (5/8)

- Bet 1: in 1980 Paul Ehrlich, John Holdren and John Harte, vs. Julian Simon on price of five metals – chrome, copper, nickel, tin and tungsten – ten years later.
- Bet 2: Simon's widow, Rita, and John Tierney, vs. Matthew Simmons on average price of oil in 2010.
- Spectacular errors are made also in the other direction, see next slide.



March 1999



April 2009



Nuclear energy seen by a private investor (6/8)

- The experience of the last 40 years shows that the key element in the decision to invest in nuclear energy is essentially an unknowable.
- Opening sentence of the executive summary of World Energy Outlook 2010: “The energy world faces unprecedented uncertainty”.



Nuclear energy seen by a private investor (7/8)

November 2009 Citigroup Report

- Five risks to be weighed in a decision to invest:
 1. Planning
 2. Construction
 3. Power price
 4. Operational
 5. Decommissioning/Waste



Nuclear energy seen by a private investor (8/8)

- “It is extremely unlikely that private sector developers will be willing or able to take on the construction, power price and operational risks of new nuclear stations. The returns would need to be underpinned by the government and the risks shared with the taxpayer/consumer. Minimum power prices, support for financing, and government-backed off-take agreements may all be needed to make new nuclear viable”.



Nuclear energy seen from a government perspective (1/2)

- Sometimes markets fail.
- Government-subsidized nuclear power may make more economic sense if we consider the positive externalities of mitigating global warming, increasing security of supply and containing demand for (and price of) fossil fuels brought by this energy source.



Nuclear energy seen from a government perspective (2/2)

- Public spending is not unlimited and governments can fail.
- Growing competing demand of public resources outside the energy domain: health care, pensions.
- Growing competing demand of public resources inside the energy domain, i.e. for renewables.



A Nuclear Renaissance?

- Over the last two years the contribution of nuclear generation to world electricity production has declined from 15% to less than 14%.
- 2008 was the first year since 1955 without at least one new reactor connected to the grid.
- 60 nuclear plants under construction in mid-2010. In 1979 there were 233 reactors being built concurrently, 120 in 1987.
- Of these 60, 11 have been under construction since before 1990, and of the 11 possibly only 3 are predicted to be commissioned in the next three years.



A Nuclear Renaissance?

- All 22 of the construction starts in 2008 and 2009 were in just three countries: China, Republic of Korea and the Russian Federation.
- “Western Europe” has 2 reactors under construction, North America 1.
- Increasing shortage of human resources. According to the IAEA, “about three quarters of all reactors in operation today are over 20 years old, and one quarter are over 30 years old. The generation that constructed and operated these plants has either already retired or will soon”.
- Manufacturing bottlenecks: only one facility in the world, Japan Steel Works, that can cast large forgings for certain reactor pressure vessels.

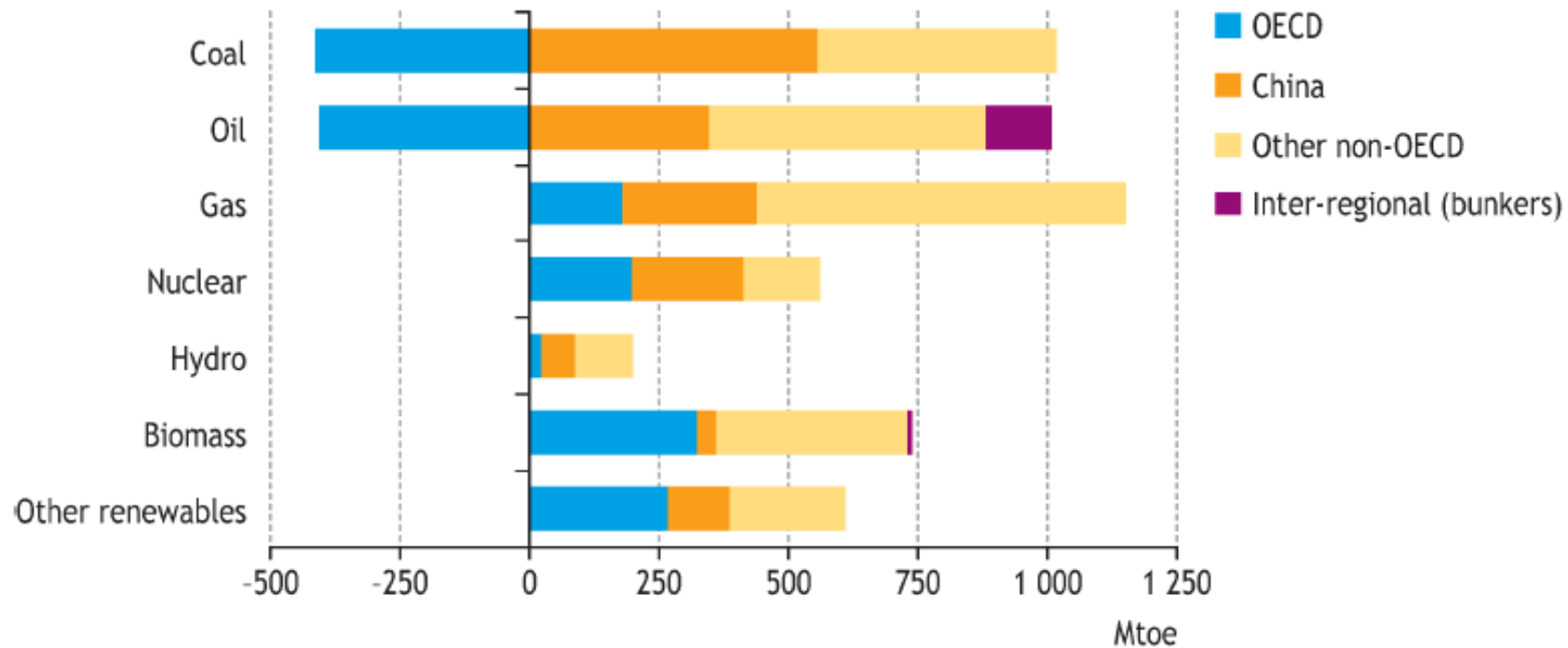


A Nuclear Renaissance?

- *The World Nuclear Industry Status Report 2009*: “Even if Finland and France each build a reactor or two, China goes for an additional 20 plants and Japan, Korea or Eastern Europe add a few units, the overall worldwide trend will most likely be downwards over the next two decades. With extremely long lead times of 10 years or more, it will be practically impossible to maintain, let alone increase, the number of operating nuclear power plants over the next 20 years. The one exception to this outcome would be if operating lifetimes could be substantially increased beyond 40 years *on average*”.
- Back to IEA 2010 *World Energy Outlook*:

Emerging economies dominate the growth in demand for all fuels

Incremental primary energy demand by fuel & region in the New Policies Scenario, 2008-2035



Demand for all types of energy increases in non-OECD countries, while demand for coal & oil declines in the OECD



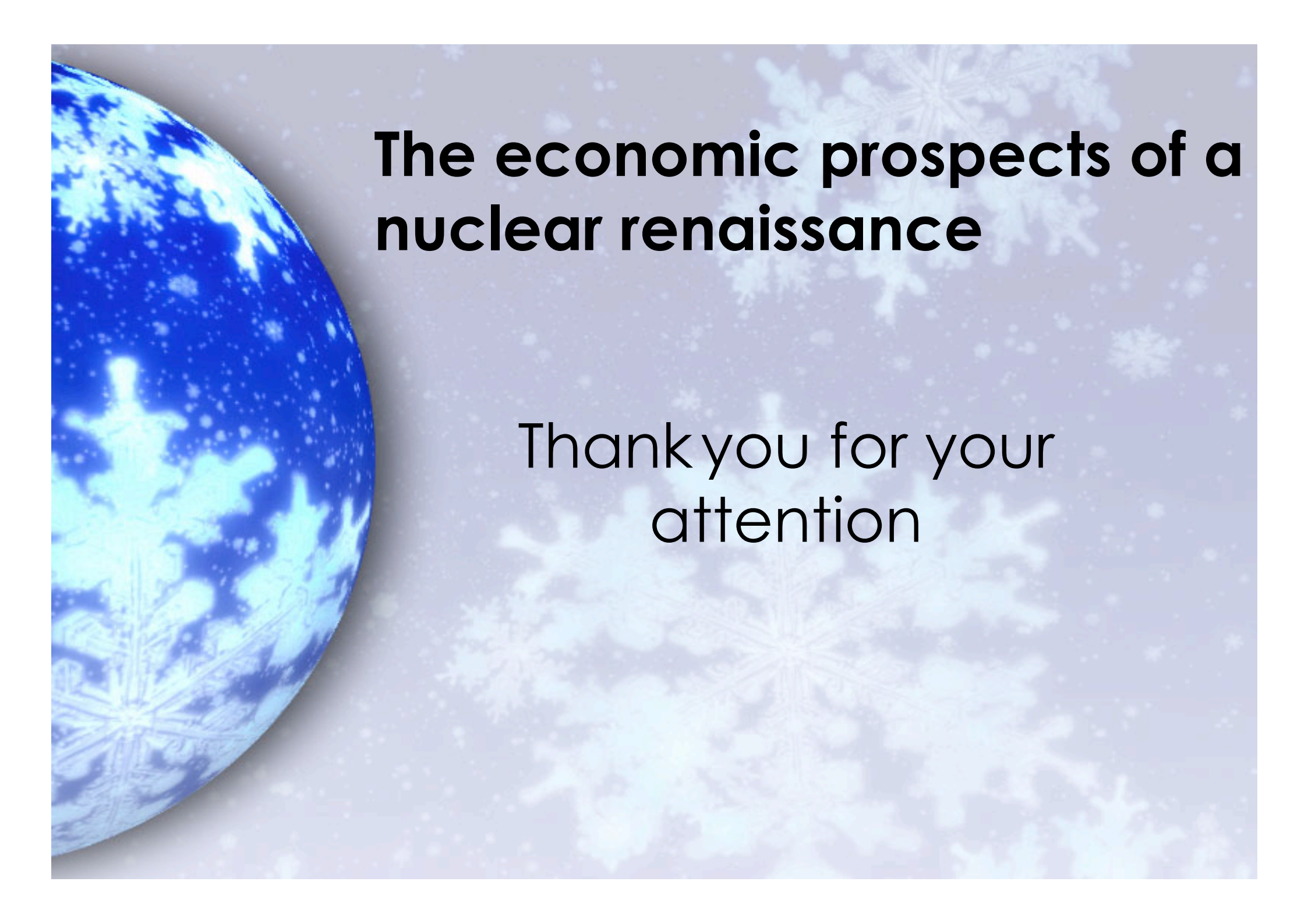
A Nuclear Renaissance?

- 2010 *World Energy Outlook*, “New Policies” scenario for 2035: “the share of nuclear power in generation increases only marginally, with more than 360 GW of new additions over the period and extended lifetime for several plants”.
- That means anything between 250 and 300 new nuclear reactors, 10-12 a year or about 1 a month connected to the grid over the next 25 years.
- Quite an optimistic assumption at current rates of orders and constructions.



A simple conclusion

- New nuclear reactors will be concentrated precisely where the risks of nuclear proliferation are highest.
- More than half of the reactors currently under construction are in the Far East, ten percent in the Middle East and South Asia – plus one fourth in “Eastern Europe”.



The economic prospects of a nuclear renaissance

Thank you for your
attention