

CSD14 – New York, USA

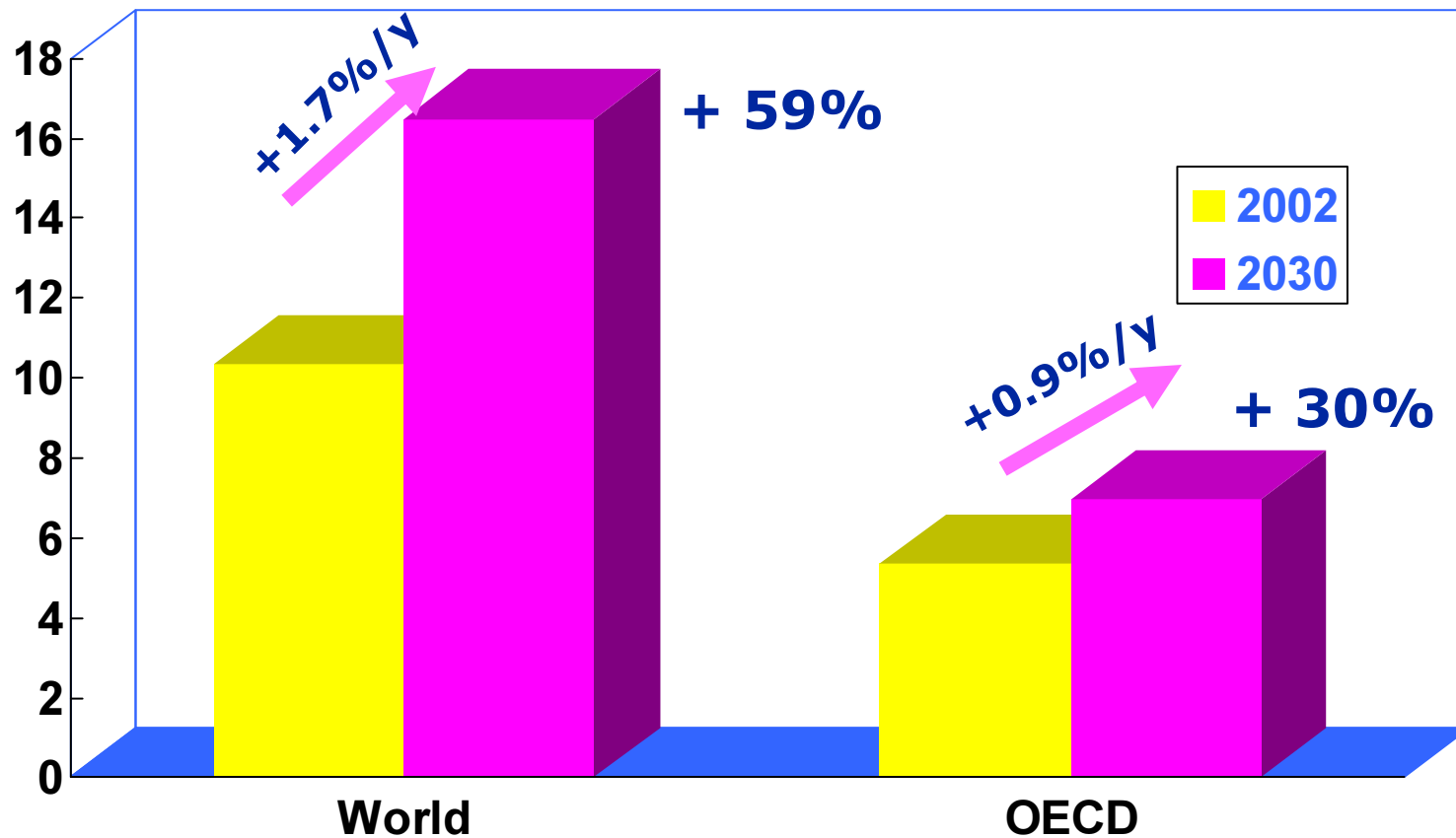
Nuclear Energy and Sustainable Development *Economics, Environment, Social*

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OECD Nuclear Energy Agency

Overview

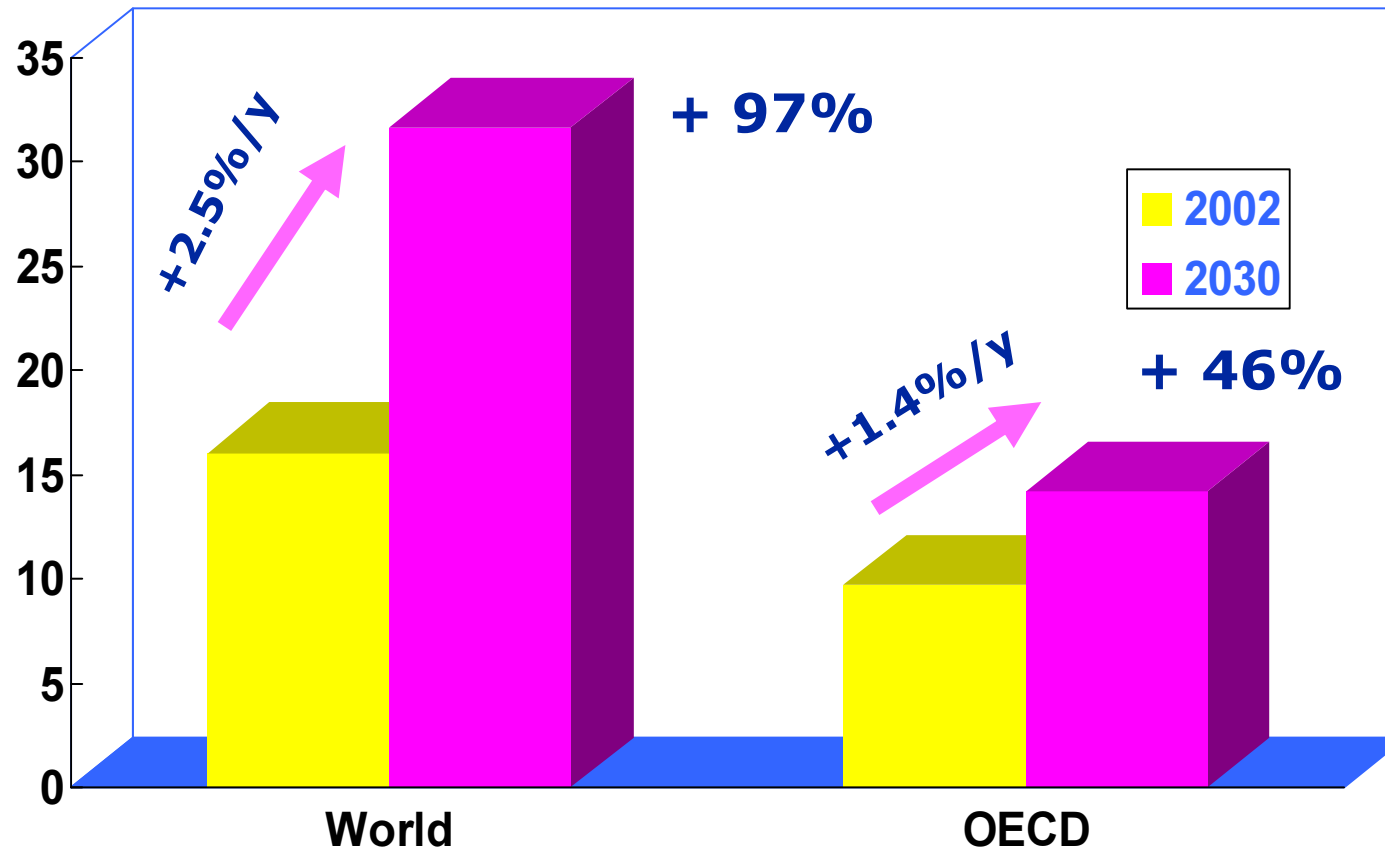
- ◆ **The Facts**
- ◆ **Economics**
- ◆ **Environment**
 - **Waste**
 - **Climate Change**
- ◆ **Social**
 - **Uranium Resources**
- ◆ **Concluding Remarks**

Primary Energy Demand (Gtoe)



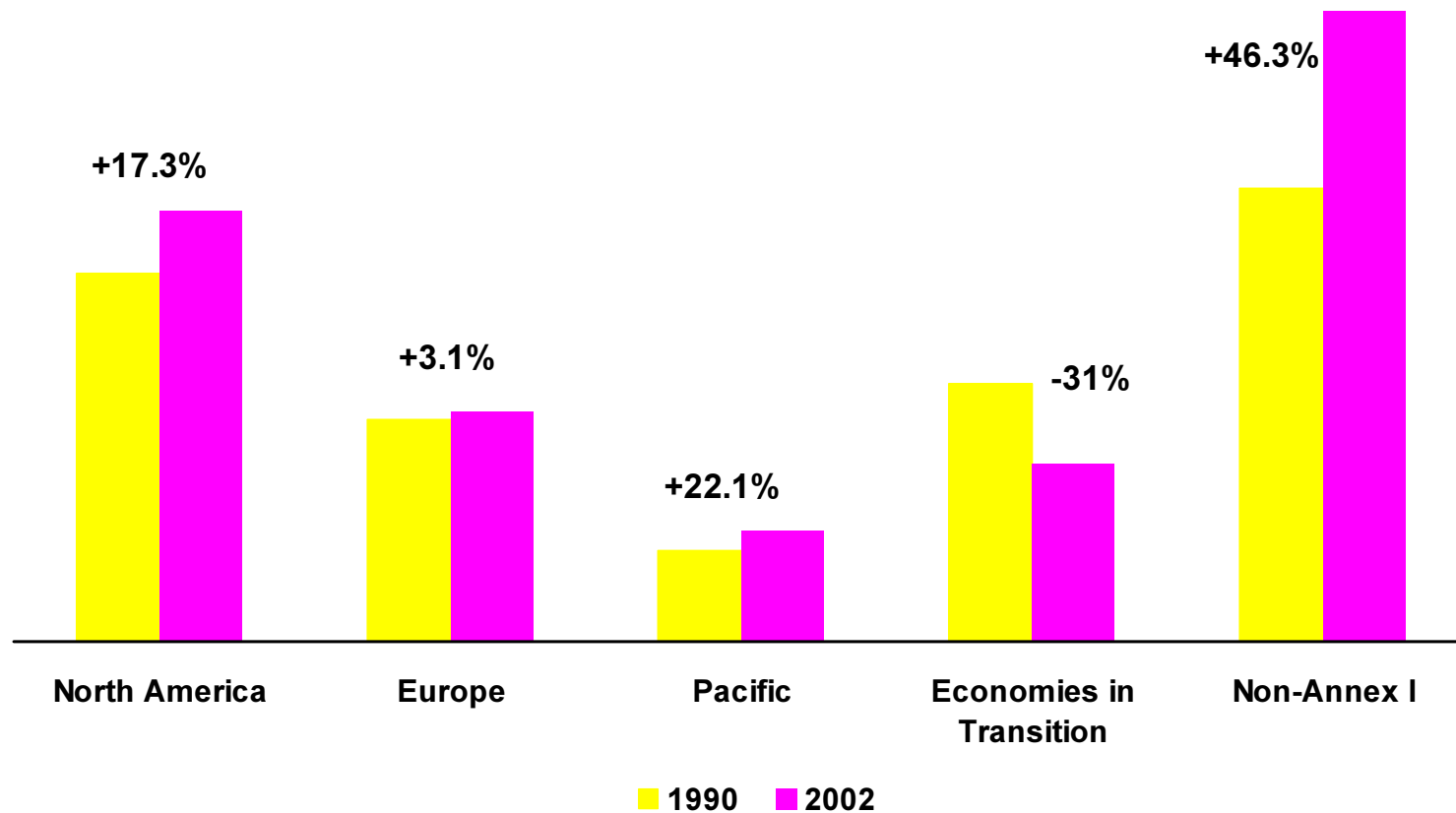
Source: IEA WEO 2004

Electricity Consumption (10³ TWh/y)



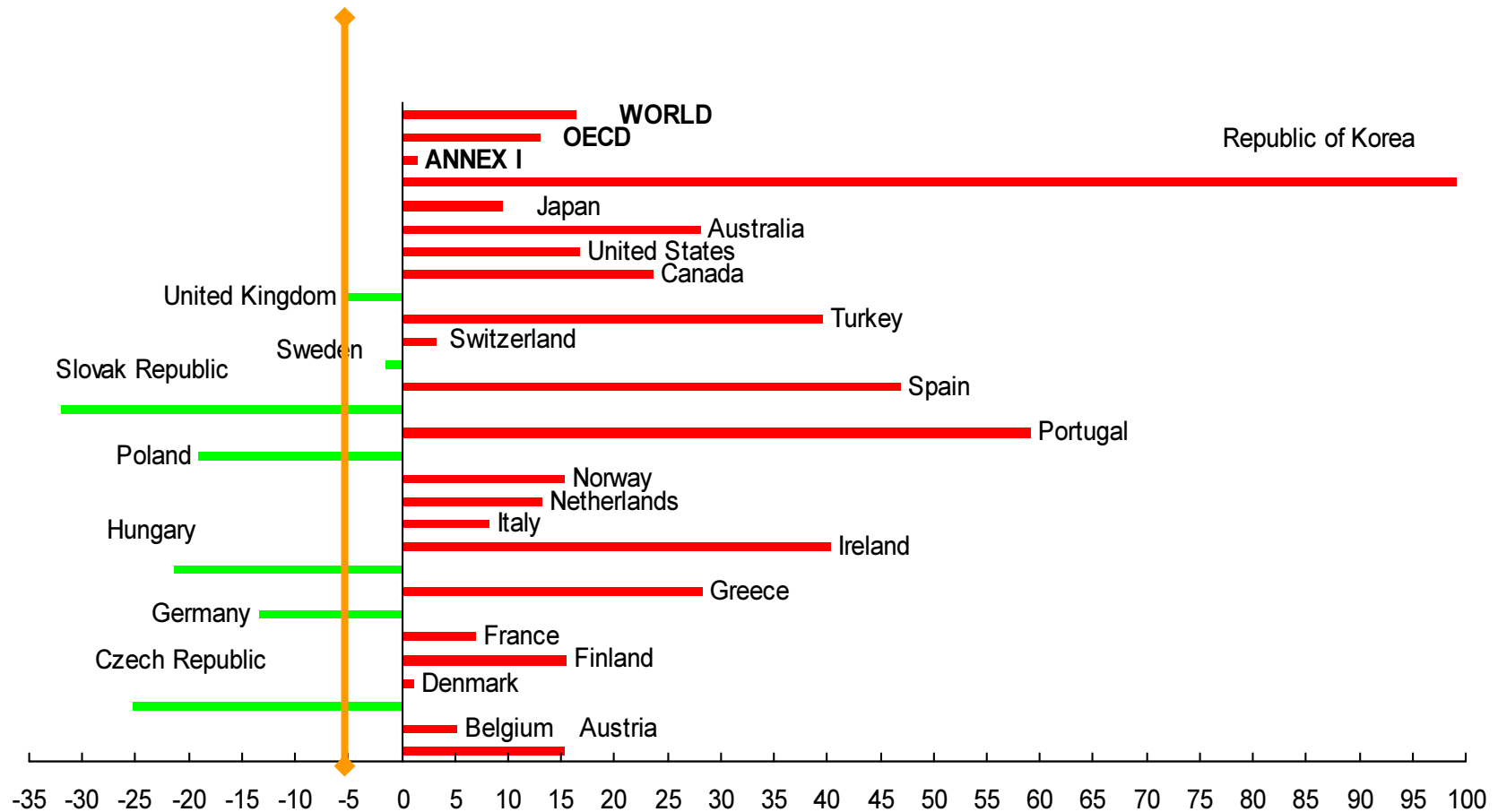
Source: IEA WEO 2004

Global Trends in CO₂ Emissions 1990 / 2002



Source: OECD/IEA Statistics

Evolution of CO₂ Emissions 2003 / 1990



Investments for the Electricity Sector [2003-2030]

| | OECD | World |
|--|-------------|--------------|
| Additional capacity (GWe) | 1975 | 4784 |
| Investment for plants (billion \$) | 2167 | 4607 |
| Investment for transmission & distribution (billion \$) | 1774 | 5191 |

Source: IEA WEO 2004

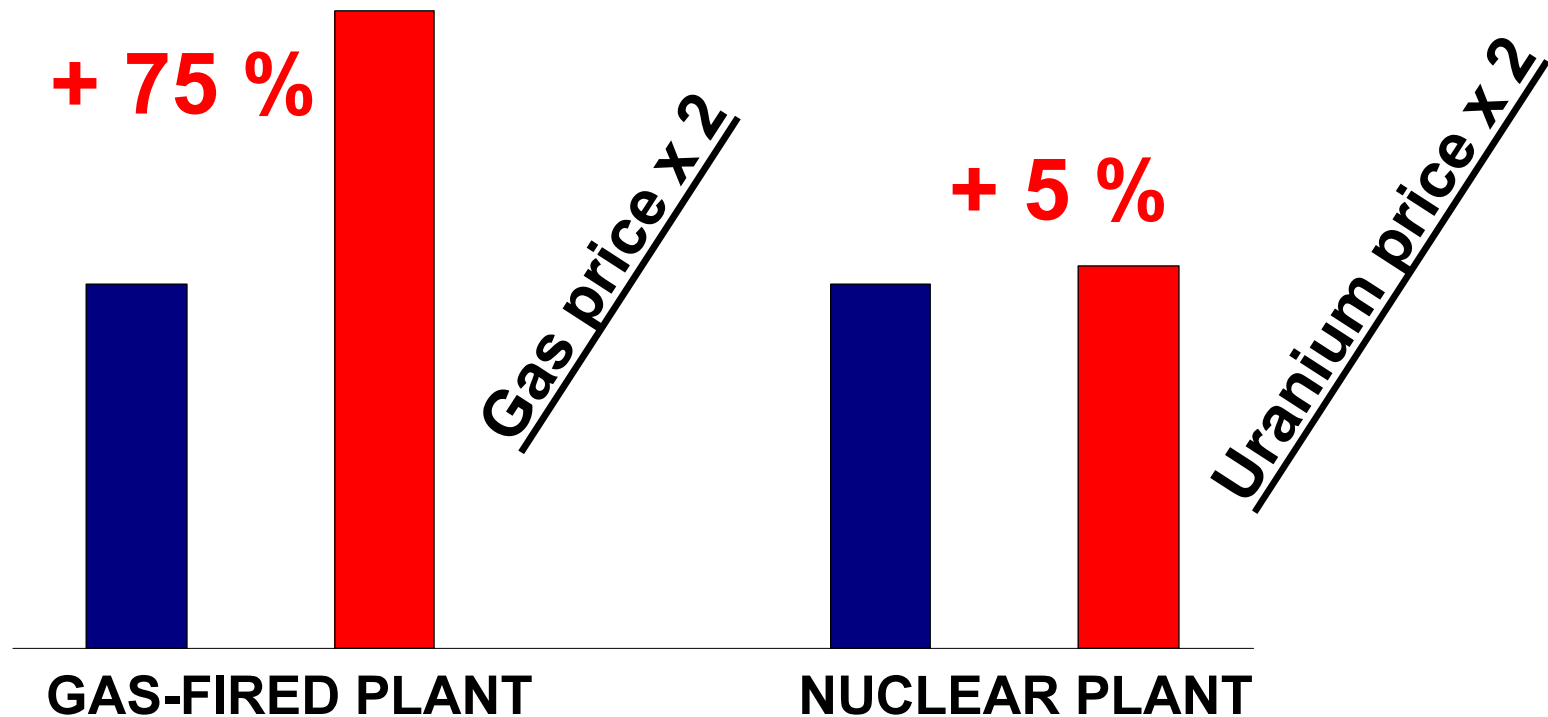
Nuclear Energy and the Economic Dimension of Sustainable Development

~ 17% of world electricity generated by nuclear

- ◆ **Low marginal cost of existing nuclear units**
 - Increasing load factors
 - Upgrading of plant capacities
- ◆ **Low cost of lifetime extension**
- ◆ **Long term stability of generation costs**
- ◆ **Very low sensitivity of nuclear KWh to natural uranium cost**

Competitiveness is no more a crucial issue

Electricity Cost Sensitivity to Fuel Price Volatility





Projected Costs of Generating Electricity

2005 Update

This sixth study in a series on projected costs of generating electricity presents and analyses cost estimates for some 130 power and co-generation (heat and power) plants using coal, gas, nuclear and renewable energy sources. Experts from 19 member countries, 2 international organisations and 3 non-OECD countries contributed to the study.

Levelised lifetime costs were calculated with input data from participating experts and commonly agreed generic assumptions, using a uniform methodology. The study shows that the competitiveness of alternative generation sources and technologies depends on many factors and that there is no absolute winner. Key issues related to generation costs are addressed in the report including methodologies to incorporate risk in cost assessments, impact of carbon emission trading and integration of wind power into electricity grids. The projected costs presented are generic and do not reflect the full range of factors (e.g., security of supply, risks and carbon emissions) that investors and other decision makers need to take into account. This report will be, however, a reference for energy policy makers, electricity system analysts and energy economists.



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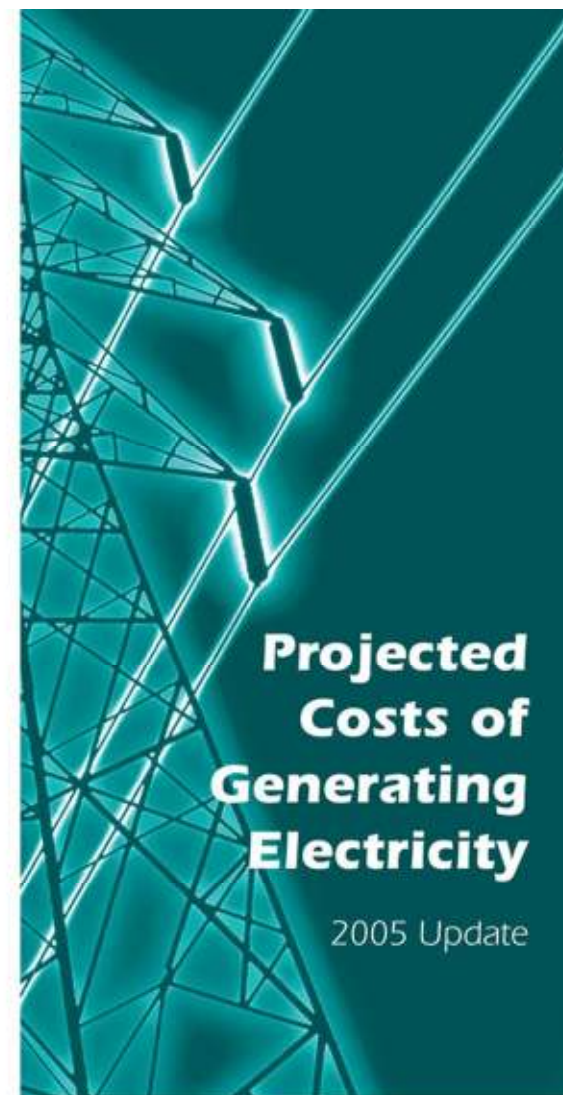
NUCLEAR
ENERGY AGENCY



INTERNATIONAL
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OECD



Projected Costs of Generating Electricity

2005 Update

What is the Study ?

- ◆ 6th edition in a series initiated in 1982
- ◆ Joint IEA/NEA endeavor
- ◆ Based on national data
- ◆ Relying on a common approach

Providing

- ◆ Reference information
- ◆ Analysis of cost elements
- ◆ Support to decision making

Framework

- ◆ **Cost data provided by participants**
 - **Technical characteristics**
 - **Construction costs and schedule and O&M costs**
 - **Fuel price projections**
- ◆ **Common levelised cost methodology**
- ◆ **Common assumptions**
 - **Discount rates [5%, 10%]**
 - **Economic lifetime [40 years – for most plants]**
 - **Load factor for base-load plants [85%]**

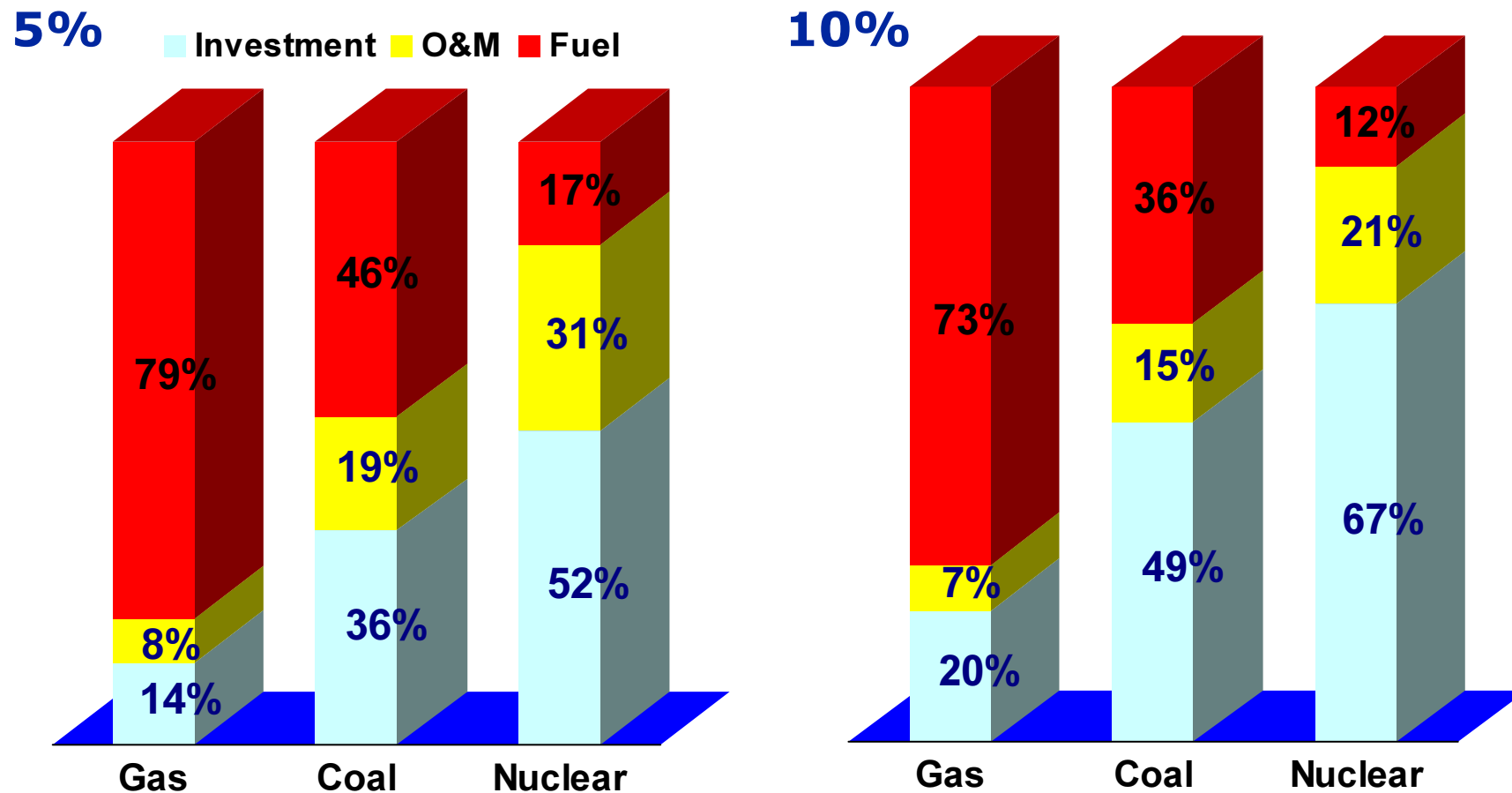
Scope of the Study

- ◆ ~ 130 power plants in 21 countries
 - Coal, gas, nuclear
 - Cogeneration
 - Wind, hydro, solar
 - Others (biomass, waste incineration, ...)
- ◆ Cost elements supported by electricity producers
 - Investment, including refurbishment, decommissioning and interest during construction
 - O & M
 - Fuel, including waste management and disposal

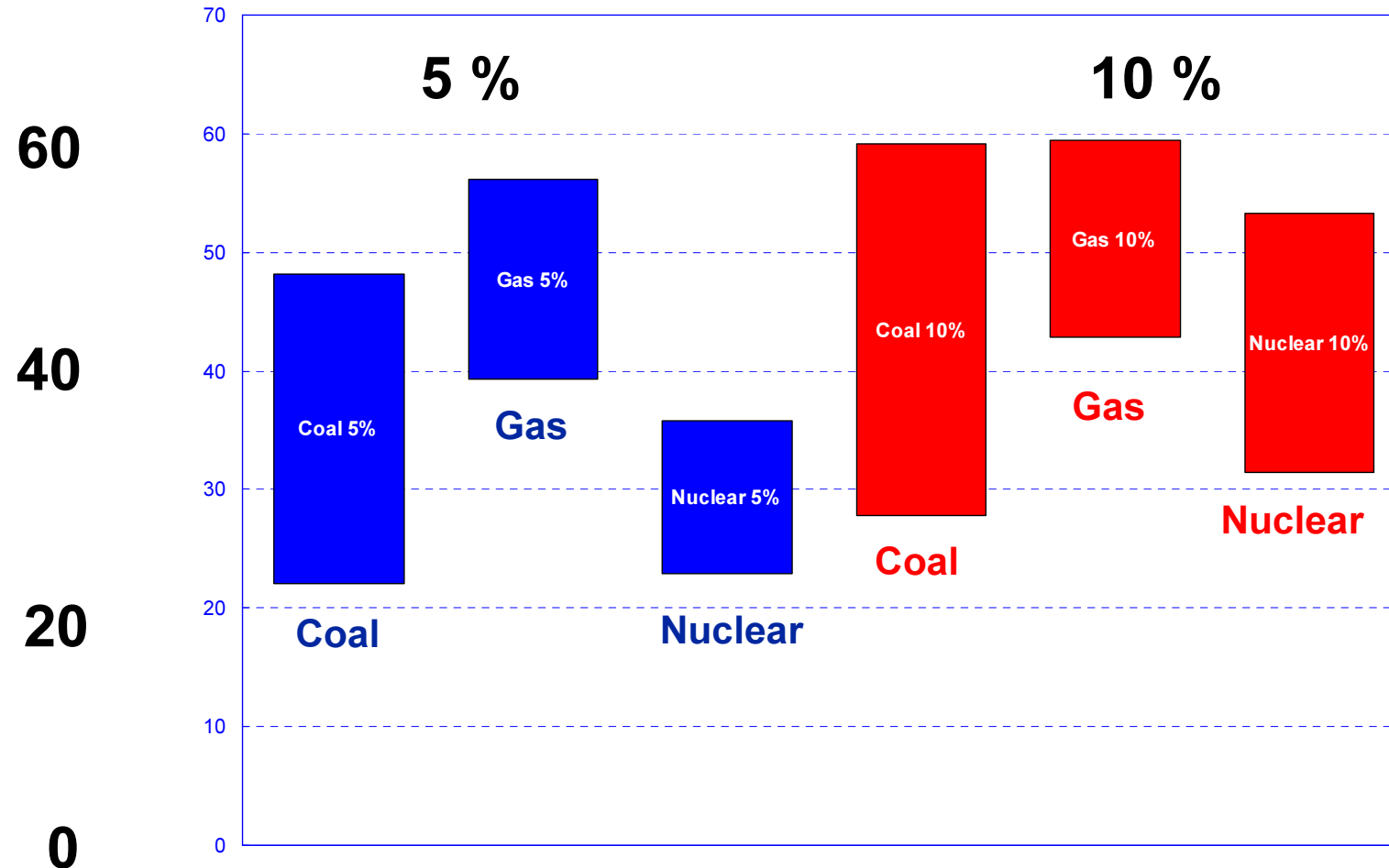
Out of the Scope

- ◆ **Transmission & distribution costs**
- ◆ **Business risks**
- ◆ **Externalities**
 - **Impacts of CO₂ or carbon value**
 - **Damage from residual pollution**
 - **Value of security of supply**
- ◆ **Site/project specific factors**

Generation Cost Structure



Cost Ranges* [USD/MWh]

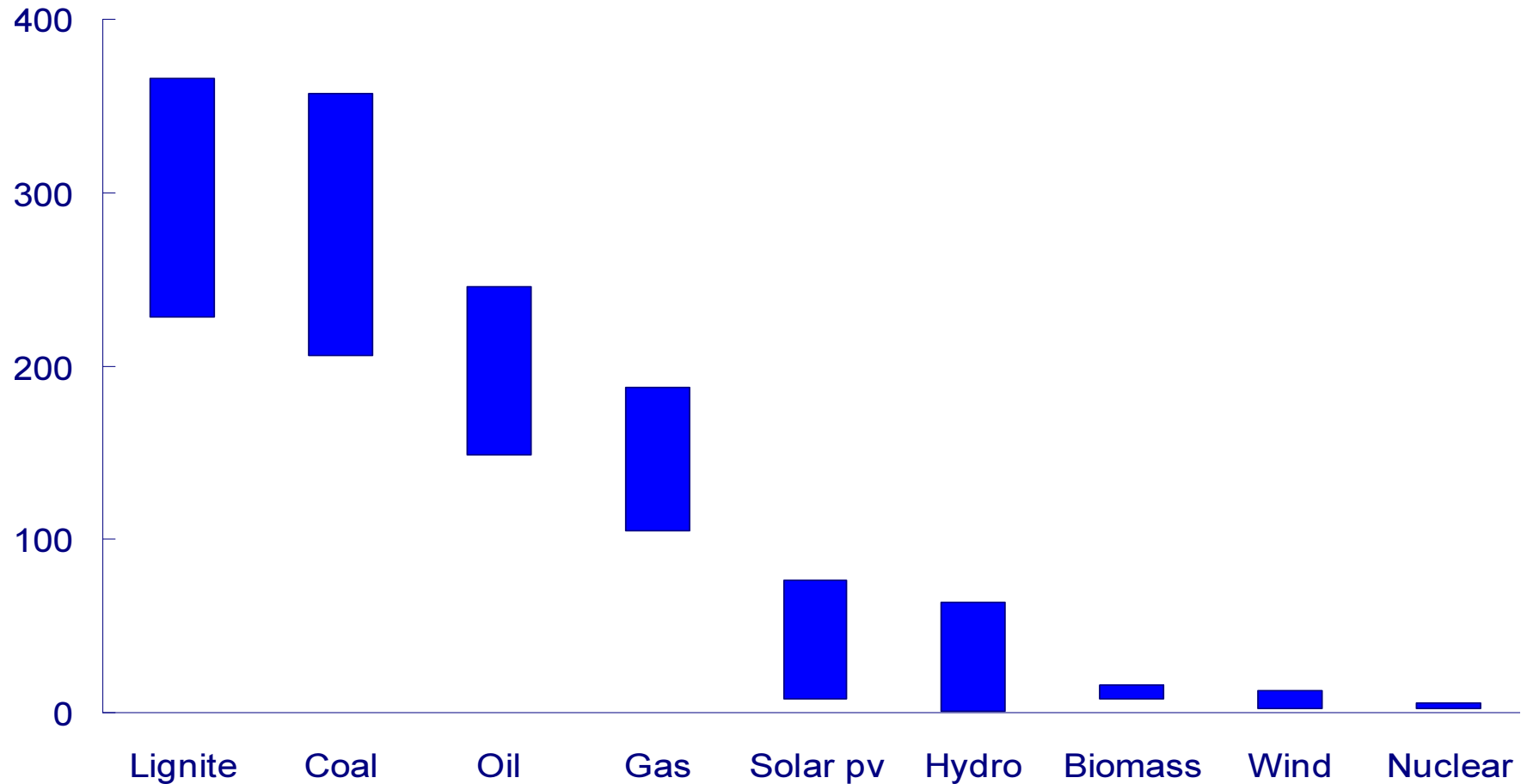


* Excluding the 5% highest and 5% lowest values

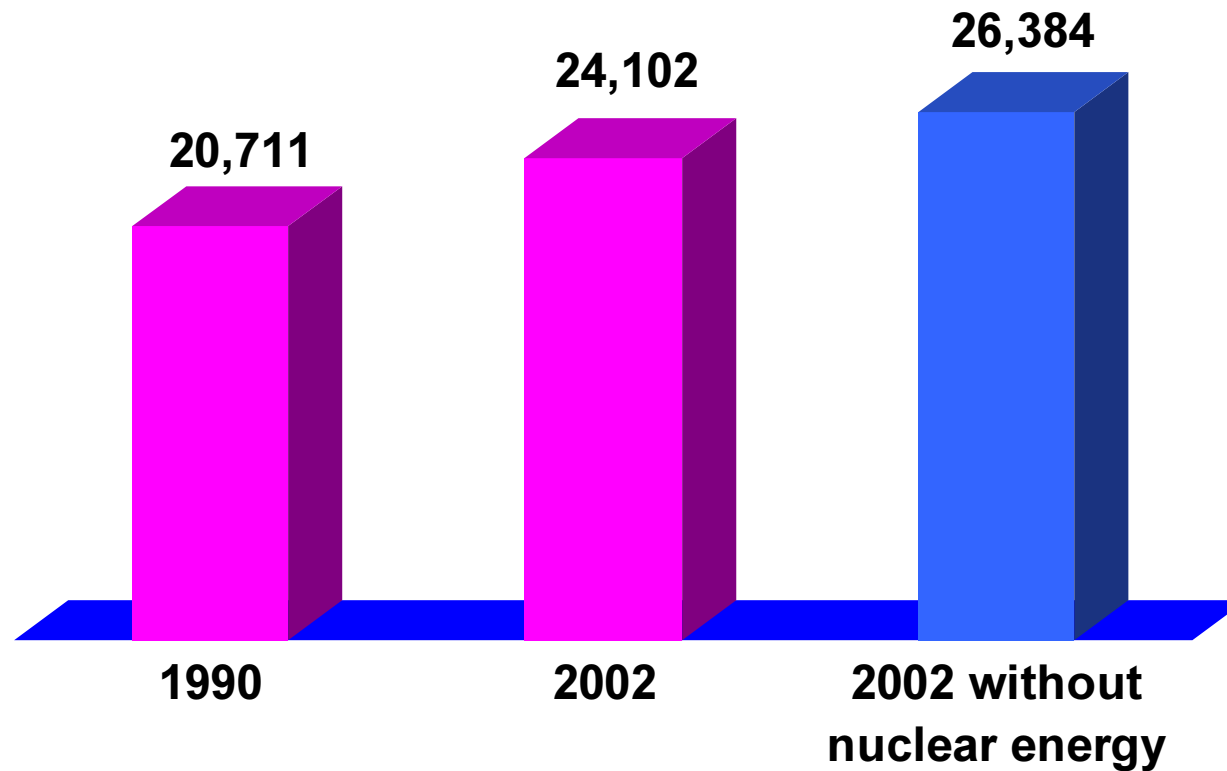
Nuclear Energy and the Environmental Dimension of Sustainable Development

- ◆ **Efficient use of natural resources**
- ◆ **Practically no greenhouse gas emissions**
- ◆ **Small volumes of solid waste**
 - **Feasibility of final disposals**
 - **Important social concern**

Greenhouse Gas Emissions from Electricity Production Chains (g C/kWh – equiv.CO₂)



World CO₂ Emissions (Mt CO₂)



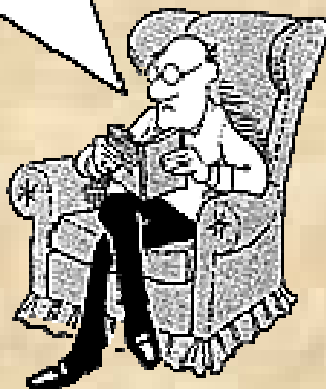
Radioactive Waste

3 categories : low, intermediate and high level

- ◆ **Disposal of LLW and most ILW, mature practice**
- ◆ **HLW**
 - **~ 1% of total volume, ~ 99% of total radioactivity**
 - **Deep geological disposal considered as practicable (*viable, reliable and safe solution*) by the scientific and technical community**
 - **Little societal consensus**
 - **Actual risk vs. perceived risk**
 - **Ethical considerations**
- ◆ **Greater involvement of stakeholders and better communication needed**

Nuclear Energy and Society

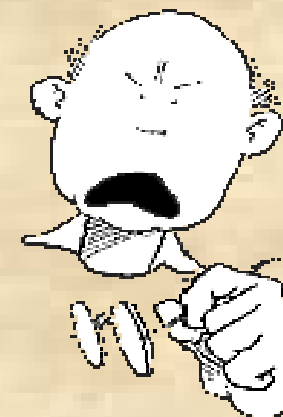
*This may well be a good book,
but I've got two problems with
nuclear power . . .*



*. . . I know absolutely
nothing about it . . .*

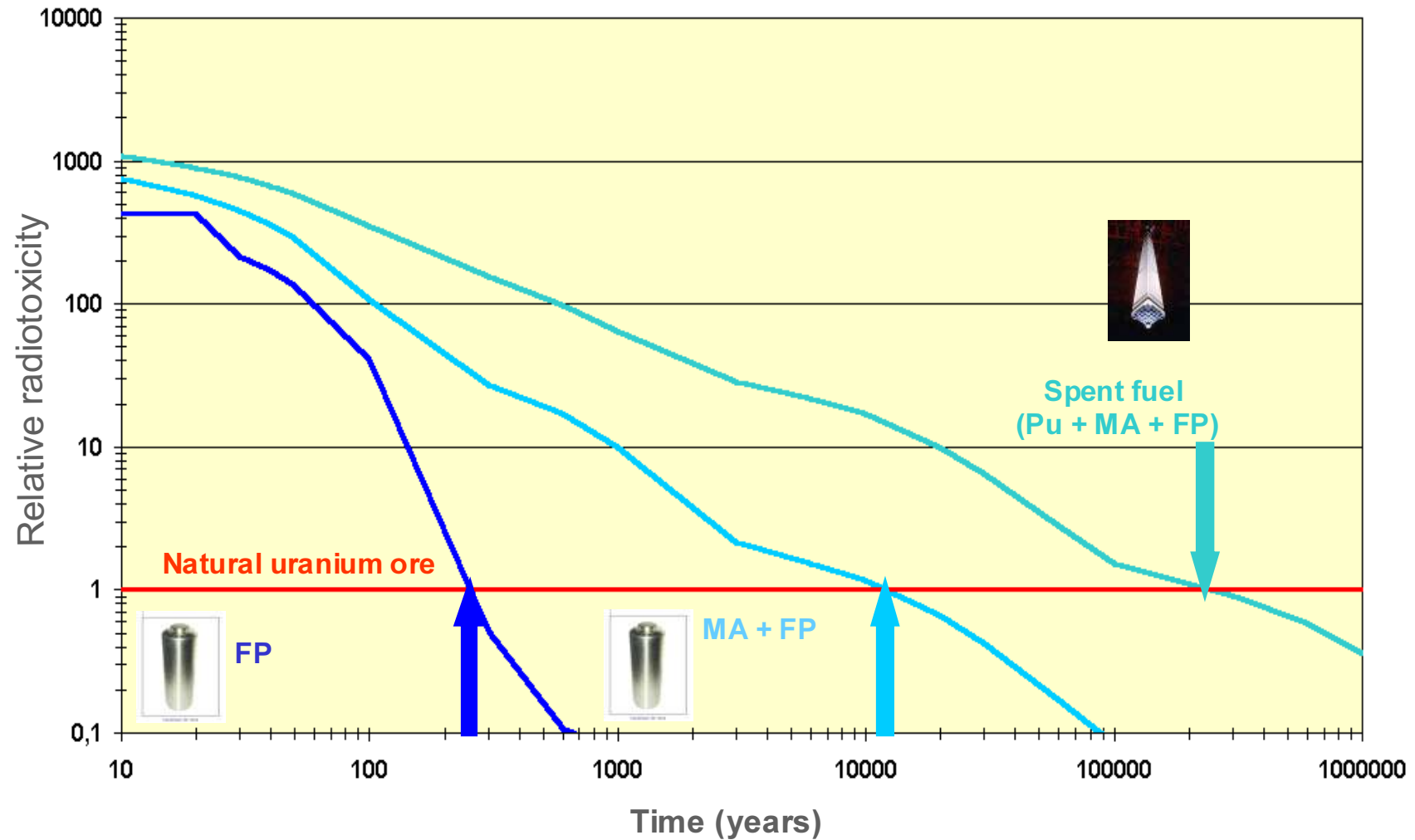


*. . . and I don't trust
those who know!*



Bjorn Wahlström

Radiotoxicity and Spent Fuel Management

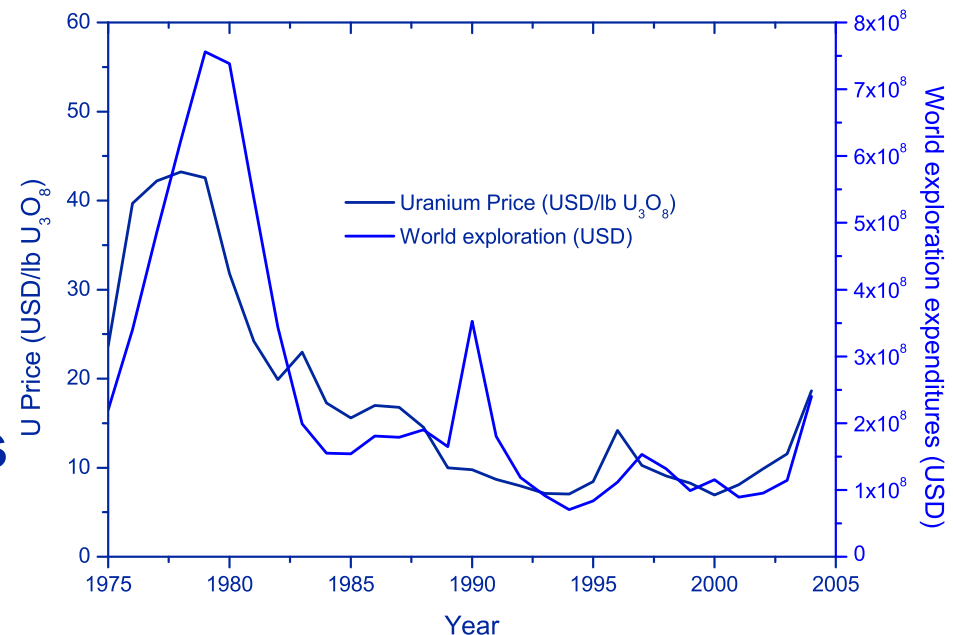


Nuclear Energy and the Social Dimension of Sustainable Development

- ◆ Human capital, scientific knowledge, highly qualified manpower
- ◆ Man-made asset, technology intensive industry
- ◆ Institutional framework, comprehensive laws and regulations
- ◆ Security of supply
 - reduced dependence, especially on oil and gas
 - geopolitical diversity of natural resources and technologies
 - “domestic” source of energy

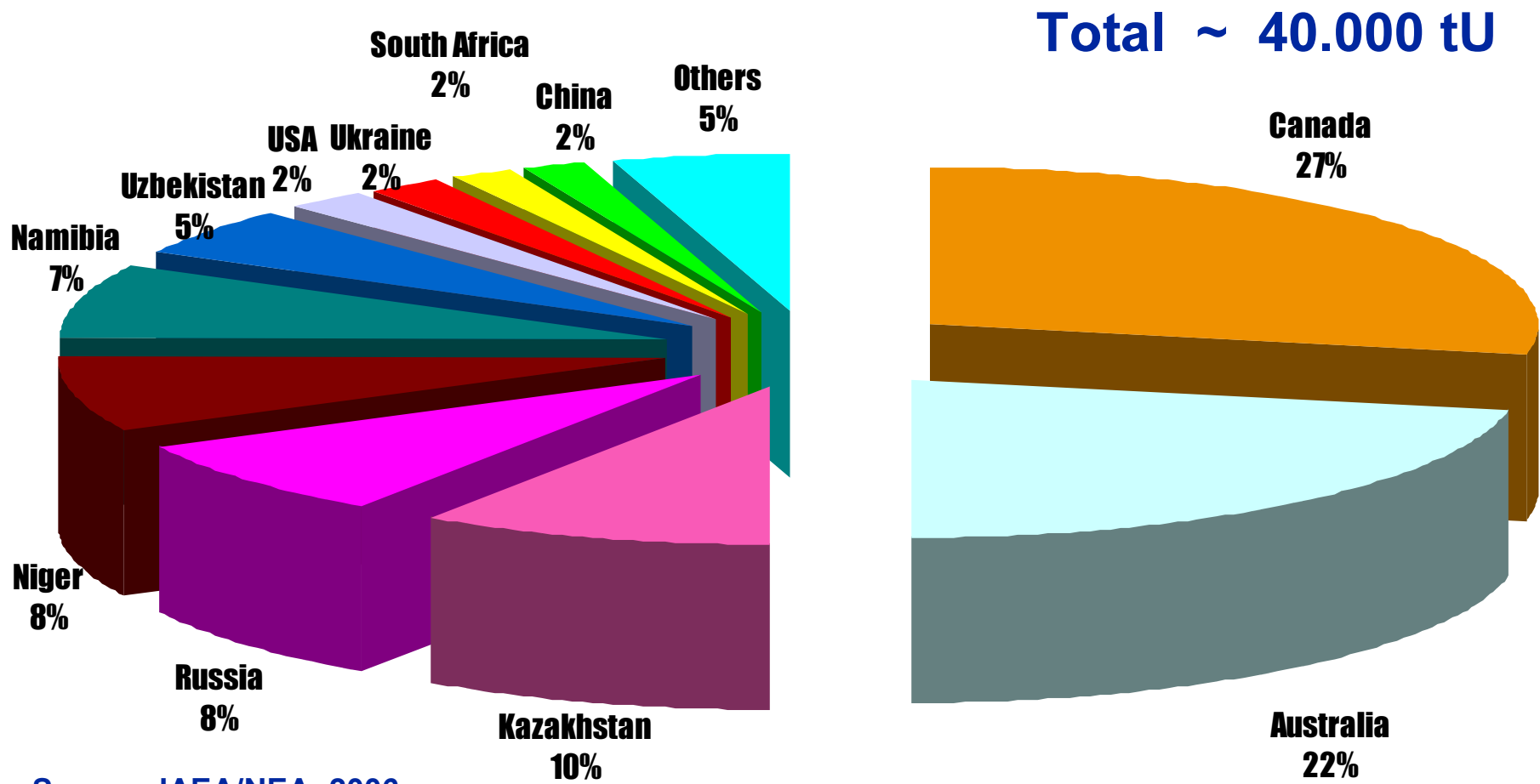
Uranium Resources

- ◆ **Plentiful ~ 14.8 MT**
Consumption ~ 60/70 kT/y
- ◆ **Well distributed**
Australia, Canada
- ◆ **Expandable**
Unconventional resources
 - ❖ Phosphates ~ 22 MT
 - ❖ Seawater ~ 4000 MT



**Technology exist to improve energy yield (over x 50)
with the fast neutrons reactors and closed fuel cycles**
Natural uranium ~ 0.7 % U235, 99.3 % U238

Uranium Production 2004



Source: IAEA/NEA, 2006

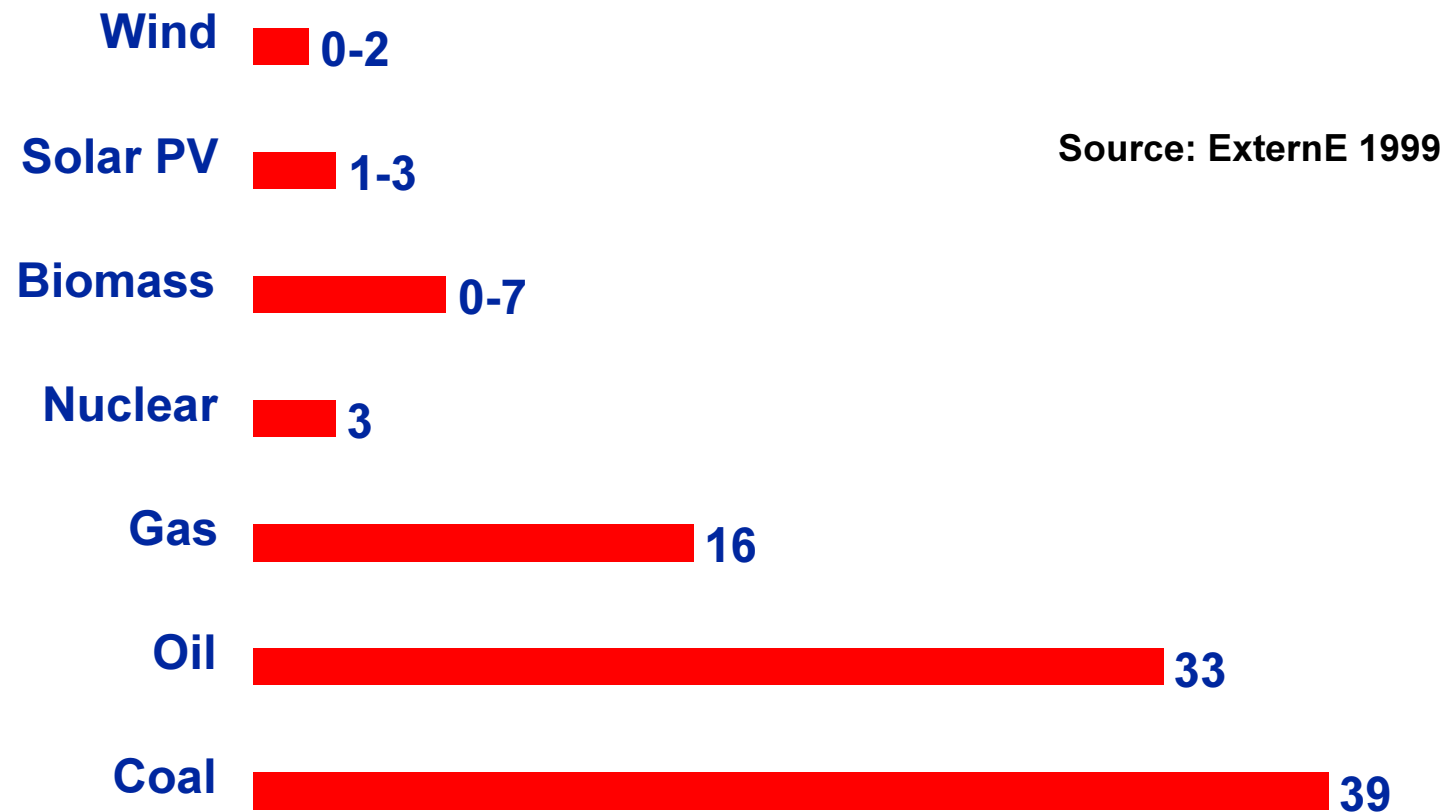
Externalities

Costs that are born by the society as a whole rather than by consumers

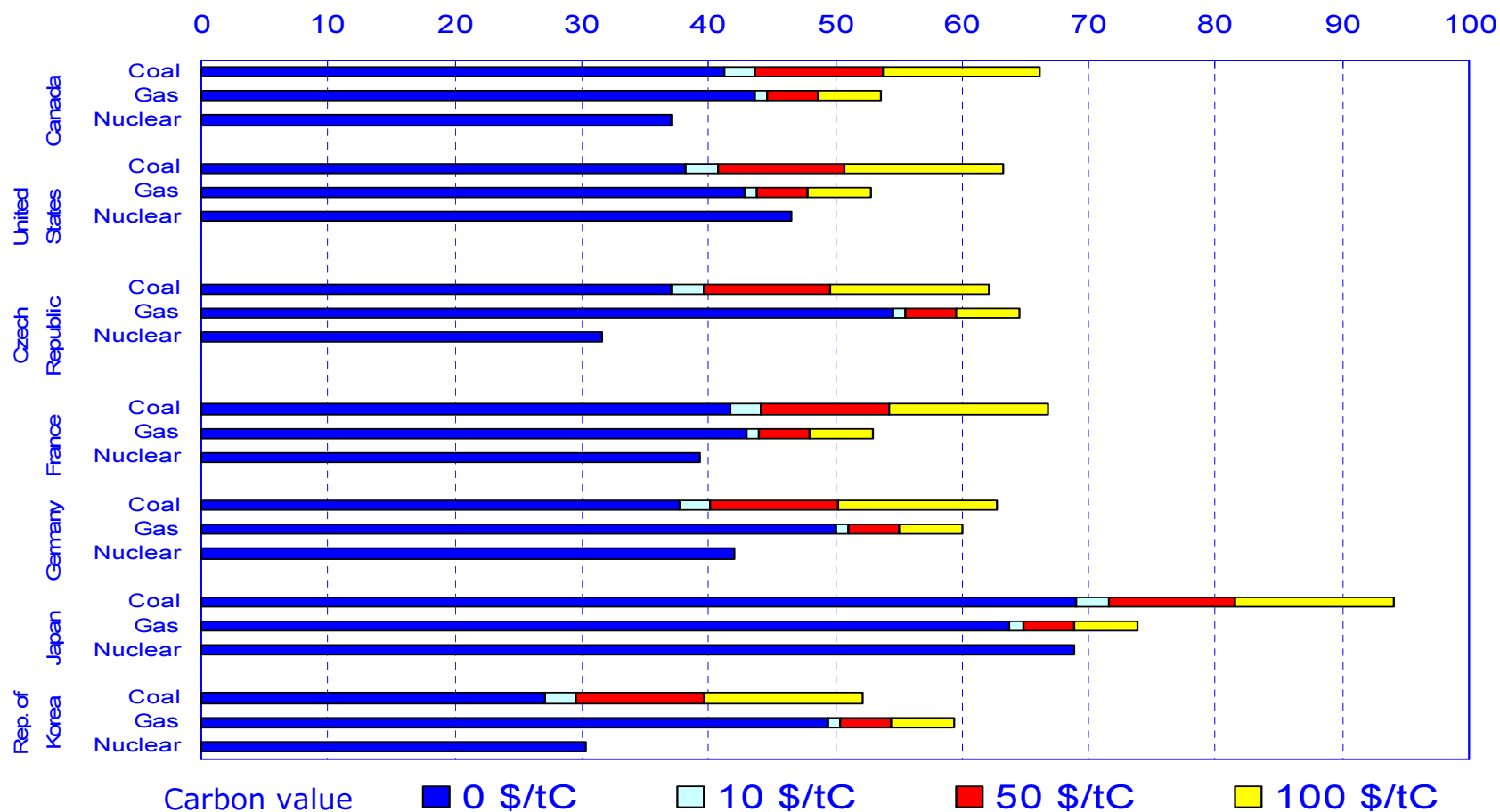
Detrimental to global economic, social and environmental optimisation

- ◆ **Health and environmental impacts of release of waste - CO₂, radioactive waste**
 - Routine operation
 - Decommissioning & dismantling (*included*)
- ◆ **Insurance (severe accidents)**
- ◆ **Policy factors not reflected in market prices**
 - Security of supply
 - Social acceptance

External Costs of Electricity Generation (m€/kWh)



Impact of Carbon Values on Generation Costs at 10% [USD/MWh]



Concluding Remarks (1)

- ◆ **Energy needs are huge, especially in developing countries**
- ◆ **No ideal or magic solution**
- ◆ **All technologies will be needed**
 - **A mix of sources will be needed to meet demand at affordable cost while protecting the environment**
 - **No opposition between renewable and nuclear energy**

Concluding Remarks (2)

◆ Economics

- **No technology/source is always cheaper for base load electricity generation**
- **Electricity generation costs are decreasing owing to technology progress and competition**
- **Nuclear competitiveness increases greatly and is no more a crucial issue**
- **“Internalising externalities” such as carbon value will enhance competitiveness of nuclear energy even more**

Concluding Remarks (3)

◆ Environment

➤ Waste

- ❖ Disposal of low level and most intermediate level waste, mature practice
- ❖ Deep geological disposal of high level waste considered as practicable - No social consensus

➤ Climate change

- ❖ Without nuclear energy GHG emissions from the power sector would be ~16% higher
- ❖ In the long term, nuclear energy has the potential to alleviate the risk of global climate change
- ❖ The nuclear option deserves to be considered by policy makers in the post-Kyoto period
 - ✓ Kyoto II – to reintroduce nuclear in CDM & JI

Concluding Remarks (4)

◆ Social aspects

- Security of energy supply
- Diversity of energy supply & price stability
- Innovative technology under development
 - *to improve economics, to minimize waste, to produce hydrogen, ...*
- Existing infrastructures (equipment and teams) are valuable assets

From a sustainable development perspective, nuclear energy has a major role to play in the 21st century - Dealing adequately with the societal concerns is a key issue

Thank you