

# Nuclear Power: Environmental and political challenges in the 21st Century

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## 1. Introduction

The aim of this paper is to examine the key environmental challenges of the 21<sup>st</sup> century and to sketch what role nuclear power could play in addressing these challenges. The geopolitical implications of a global shift from hydrocarbon fuels towards a nuclear/hydrogen combination are also considered.

## 2. Environmental challenges

It is common cause that the environmental challenges in the 21<sup>st</sup> century are becoming progressively delocalized and hence require global responses. The most prominent threats to the environment in the 21<sup>st</sup> century include (1-3):

### 2.1 *Climate change and chemical pollution*

There is increasingly convincing evidence that increased concentrations of gases such as methane and carbon dioxide in the atmosphere are long term causes global warming. These 'greenhouse gases' are produced by human activities, such as the use of oil, coal and wood for energy, deforestation and the substitution of natural vegetation by agricultural crops. Some of the predicted adverse impacts of climate change include droughts, floods rising sea levels and extinction of species. The industrialization and urbanization of the planet poses other chemical threats to life. Persistent organic pollutants are now found in animal tissues in the remotest corners the world. Fertility levels of many species, from frogs to humans are declining, while genetic abnormalities are increasing.

### 2.2 *Population Growth*

The earth's human population increased exponentially during the 20<sup>th</sup> century. This expansion coupled with the economic activities required to support it, places increasing pressure on the environment and its ability to support livelihoods.

### 2.3 *Contamination of Freshwater Sources*

The world's available fresh water, less than one-half of 1 percent of all the water on earth, is disappearing because of unsustainable practices, including production agriculture, increased industrial use, urbanization, deforestation, water diversion and solid waste disposal.

### 2.4 *Loss of Biological Diversity*

Biological diversity, the total variety contained by the earth's genes, plant and animal species, and ecosystems is considered a global important resource since it forms the basis of human needs such as food, fibre and medicines. Much of the developing world is purely dependent for their livelihood on the biological diversity of their habitat.

### *2.5 Land degradation and deforestation*

Millions of people in developing countries are dependent on subsistence agriculture for survival. Declining soil productivity and environmental health, increasing poverty and disasters such as droughts, floods and famine are challenges that need to be addressed for sustainable development. Erratic rainfall, possibly associated with long-term climate change, has a profound effect on the productivity of ecosystems, water and food security.

### *2.6 Industrialization*

The expanding industrial activity projected in various economic growth scenarios imply that toxic emissions could triple by 2050 and increase nearly five-fold in the developing regions, posing potential ecological and human health threats.

### *2.7 Poverty and food insecurity*

Africa moved from a position of food self-sufficiency to a hungry, undernourished, impoverished continent in the space of 30 years from 1960 to 1990. Persistent poverty has negative implications both for sustainable development and for sustainable management of natural resources.

## **3. The Impact of Nuclear Power**

Energy generation and use impacts on all these threats and the challenge is to model the integrated effects of various energy sources on the environment. However, the most obvious potential effects (positive and negative) of nuclear power are on climate change, pollution and the contamination of freshwater sources.

Regarding pollution and freshwater contamination, nuclear waste has a lifetime significantly longer than human life; the chance of leakages from buried waste containers/canisters is expected to increase over time, creating hazardous environmental conditions. However, new technologies such as vitrification will significantly reduce this risk. The problem of high level waste disposal is increasingly a political one as opposed to a technological one.

Views on the suitability of nuclear power for reducing emissions of greenhouse gases, acid gases, particulates, and metals are highly charged. There is no question that producing an increased share of electric power using nuclear fuels in lieu of fossil fuels will reduce greenhouse gas emissions (4). Substantial replacement of fossil fuels would result in substantial declines in acid gas emissions and if coal is replaced, particulate and solid waste production. Such changes would increase the volume of nuclear spent fuels that must be disposed.

In practice it is necessary to conduct an integrated assessment (E-linkage) in terms of energy source, environment and economics to answer the following: 1) What level of emissions reductions is desired, 2) What are the costs of obtaining the emissions reductions by using nuclear power when compared to other methods, 3) Do any costs involved in switching to nuclear power (such as spent fuel disposal) offset any

environmental gains from the displaced emissions? Table 1 provides an assessment of the main energy sources in this regard.

Table 1: The E-Linkage Analysis (5)

Table 1

Energy Source	Cost in € cents/kWh	Max. GHG Emissions CO <sub>2</sub> /kWh
Coal	4	1306
Gas	4	688
Nuclear	4	21
Wind	4-9	48
Biomass	5-8	400 est.
Solar	10-15	280
H <sub>2</sub> PEM Fuel Cell	200-500 est.	0, H <sub>2</sub> from H <sub>2</sub> O

#### 4. Hydrogen and geopolitics

Although hydrogen (see Table 1) is an extremely expensive energy source in terms of current extraction technologies, it has the potential to solve two major energy challenges that dominate E-Linkage today: reducing dependence on petroleum imports and reducing pollution and greenhouse gas emissions. The transition to hydrogen as a major fuel in the next 50 years could significantly change global energy economics, reducing air emissions and expanding domestic energy resources. However, reductions in oil imports and carbon dioxide emissions are likely to be minor during the next 25 years. The growing political tensions around oil resources will increasingly influence the future energy resources debate. The current geopolitical weighting of countries and regions is clearly a function of petroleum reserves -see Figure 1.

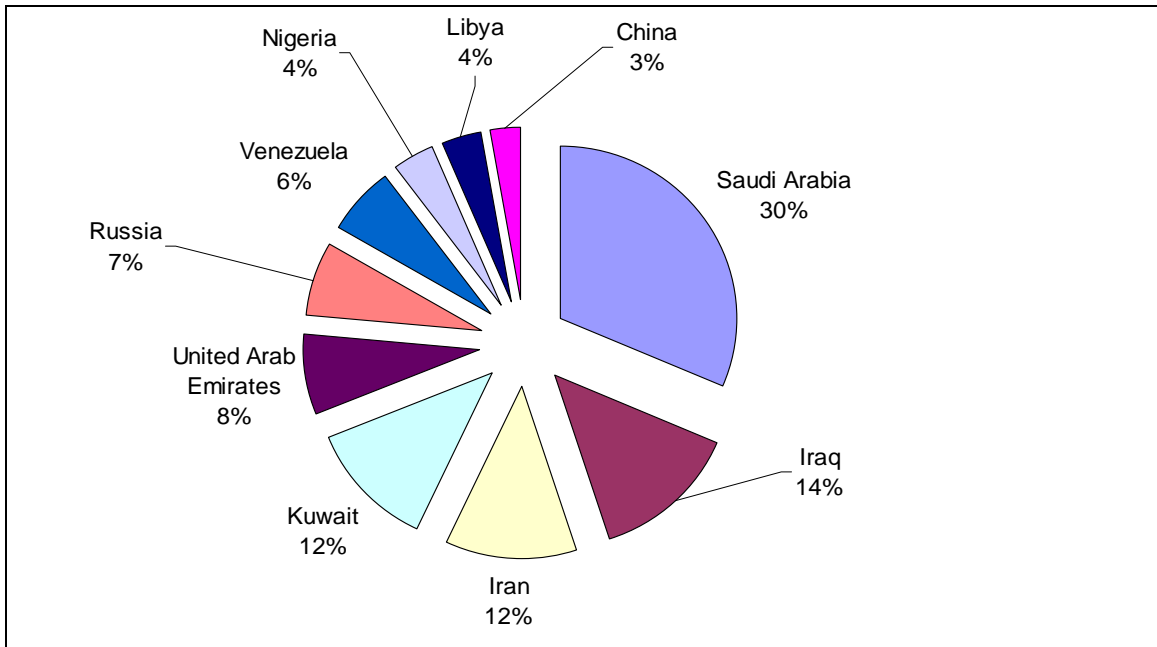


Figure 1: Global Petroleum Resources (6)

The emerging hydrogen economy will potentially move the focus from the oil producing countries to Platinum producing countries, because of the role of platinum in fuel cell catalysis - see Figure 2.

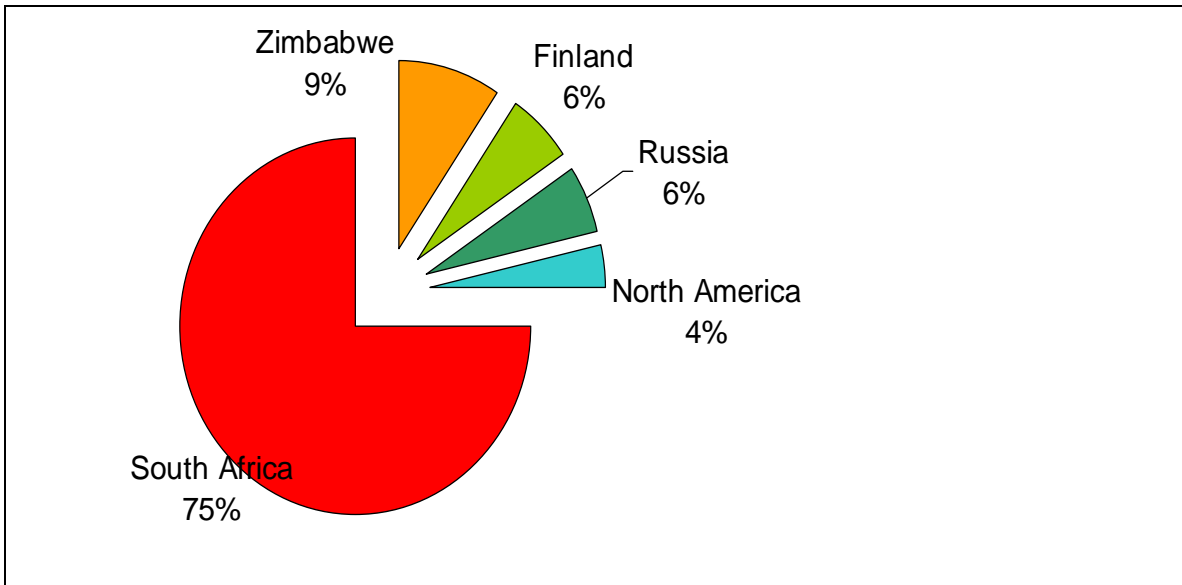


Figure 2: World platinum resources (7)

An intriguing picture emerges with Southern Africa playing a similar geopolitical role to that currently played by the Middle East. This picture is sharpened by the consideration that hydrogen only realizes its CO<sub>2</sub> emission free potential when it is generated using hydrocarbon free sources of energy. In particular, Generation IV nuclear power sources are able to catalytically crack water as a byproduct of electricity production using waste heat above 950°C. Promising prototypes of such reactors are being investigated in South Africa, China and France currently.

## 5. Conclusion

This article has sketched very briefly some of the key environmental challenges of the 21<sup>st</sup> century. The choices we make with respect to some of these challenges will influence the sources of energy we use. This, in turn, has the potential to profoundly change the current geopolitical landscape.

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