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Health Costs of the Different Energy Sources

By Roland Masse

Energy, in all its forms, is an essential component in the life of our societies. But along with the benefits it provides it is accompanied at every stage, by negative repercussions.

At this time when there is growing awareness of the need to control and reduce the impact of human activities on the environment, the production and use of energy are coming under close scrutiny. In this vein, it is essential to weigh the relative health impacts of the various energy sources.

Such is the object of the document written by Roland Masse, "The Health Costs of Energy" published on the Save the Climate website.

This fact sheet presents a comparative summary.

I - The severe accidents due to energy generation -Table 1

A 'severe accident' is one that has induced at least: 5 premature deaths, or 200 evacuees; or a ban on consumption of locally produced food products, or a hydrocarbon spill exceeding 10,000 metric tons (10 Kt). Table 1 gives an overview for the period 1970-2008 [1].

	OECD Countries			Non-OECD Countries		
Energy Sector	Accidents	Number of Deaths	Number of Deaths/Gwe.yr[a]	Accidents	Number of Deaths	Number of Deaths /Gwe.yr [a]
Coal China 1994-1999 China 1999-2008 Outside China	87	2,259	0.157	2,394 818 1,214 162	38,672 11,302 15,750 5,788	0.597 6.169
Oil	187	3,495	0.132	358	19,516	0.897
Natural gas	109	1,258	0.085	78	1,556	0.111
LPG	58	1,856	1.957	70	2,789	14.896
Hydro	1	14	0.003	21	30,069	10.285
Nuclear	0	0	0	1	31 [b]	0.048
Biofuel	0	0	0	0	0	
Biogas	0	0	0	2	18	
Geothermal	0	0	0	1	21	
Total	**442**	**8,882**		**2,925**	**92,672**	

[A] Value calculated over the 1970-1999 period.
[B] Victims who died within 2 months after the accident.

Table 1 - Number of severe accidents and premature deaths attributable to the energy sector. Little data is available on accidents in the photovoltaic sector: involving around a hundred deaths, they lead to a normalized rate of around 10^{-3} per GWe.year; to this must be added deaths attributable to the installation of rooftop panels, for which there is no overall assessment. There is no comprehensive database on accidents in the wind power sector; despite various material accidents, human accidents are rare.

These values take into account direct short-term deaths; they must be increased by indirect and deferred effects, whose assessment may be subject to a high degree of uncertainty:

- *for coal,* in France, between 1946 and 1986, silicosis was involved in the death of 20 % of the underground miners which represents 80,000 to 120,000 individuals [2]; in China, more than 500,000 miners were affected.

- *for oil and gas,* the long term impact of professional exposure and of leakage to the environment due to severe accidents is not subject to precise assessment.

- *for nuclear*, most deaths are deferred, up to 50 years for radiation-induced pathologies (cancer, cardiovascular diseases…up to 33,000 premature deaths, the maximum estimation at Chernobyl [3]) and because of post-accidental stress and difficult living conditions (2,000 premature deaths attributable to Fukushima [4]).

2 - The health costs due to the production and use of electricity – Tables 2 & 3.

European and American studies provide a summary of the health damage caused by different energy sources. Table 2 shows, for Europe, this damage expressed in years of life lost per TWh after 2000 [5].

Coal	Fuel Oil	Gas	Nuiclear	Biomass	Wind	PV
122	150	32	9	77	6	12
Table 2						

Another way of expressing the health cost of electricity generation takes into account the ***number of premature deaths and fatal accidents and illnesses*** per TWh, resulting in a similar hierarchy of risks by sector, as shown in table 3 for the United Kingdom [6].

	Coal	Lignite	Fuel Oil	Biomass	Gas	Nuclear
Number of Accidents	0.12	0.12	0.03	---	0.02	0.02
Number of Deaths	24.5	32.6	18.4	4.6	2.8	0.05
Number of Diseases	225	298	161	43	30	0.22
Table 3						

These repercussions result from source-specific damage:

- *nuclear energy* generates external and internal exposure to ionizing radiation. Excessive doses lead to the development of cancers, and their probability of occurrence has been assessed. In domains where uncertainty is significant, dose-effect correlations are formulated to enable standardization and estimations;

- *carbon-based energies,* including biomass, emit CO_2, the main driving force behind global warming and its health repercussions; they also release toxic compounds that form in the gaseous phase, such as SO_2, nitrogen oxides NOx and ozone, or in the particulate phase, the particles being classified according to their size (PM10 with a diameter of less than 10µm, PM2.5, ultrafine particles...); metal pollution must also be taken into account. The pathologies observed are of various kinds: pulmonary,

cardiac, vascular pathologies and cancer. Causal factors are difficult to establish analytically, as global epidemiological assessments involve the interactions between pollutants;

- *Renewables, wind power and photovoltaics,* do not pollute much in their electricity generation phase. Their impact is due to the use of carbon-based energies in the other phases of their life cycle.

3 - Which energies to best preserve public health?

Firstly, it is clear that the framework within which a society evolves is paramount. High standards and compliance with these standards protect people, as shown by the gap between OECD and non-OECD countries when it comes to accidents and their consequences.

Energy sources can be grouped in two categories:

- *carbon-based energies*, the more damaging of the two with the fossil fuels, coal, oil, gas, but also with biomass, although it is renewable.

- *nuclear energy and the carbon-free renewable energies*, hydroelectricity, wind, solar...

In terms of health damage per TWh, the two groups differ, to the disadvantage of carbon intensive energies, by a factor of 3 to 10 evaluated in years of life lost and a factor greater than 100 expressed as the annual rate of added mortality.

Nuclear energy and carbon-free renewable energies thus stand out as the energies most able to efficiently limit health damage. This is in total agreement with their position as the energies best able to protect the environment, with the absence of CO_2 emissions, the main cause of global warming.

References

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