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Laka speelt met oa. haar informatie-voorziening een belangrijke rol in de Nederlandse anti-kernenergiebeweging.

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This is a PDF from one of the publications from the library of the Laka Foundation; the Amsterdam-based documentation and research centre on nuclear energy.

The Laka library consists of about 8,000 books (of which a part is available as PDF), thousands of newspaper clippings, hundreds of magazines, posters, video's and other material.
Laka digitizes books and magazines from the international movement against nuclear power.

The catalogue of the Laka-library can be found at our website. The collection also contains a large number of digitized magazines from the Dutch anti-nuclear power movement and a video-section.

Laka plays with, amongst others things, its information services, an important role in the Dutch anti-nuclear movement.

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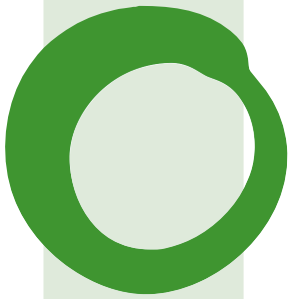
A comparison of CO_2 emissions: nuclear vs. non-nuclear European countries.

Hnutí DUHA
Friends of the Earth Czech Republic



Hnutí DUHA

Friends of the Earth International is the world's largest federation of environmental groups. Our member organizations in 68 countries and 13 affiliate groups unite close to one million activists. FoEI and its members campaign on the most urgent environmental and social issues of our day, while simultaneously catalyzing a shift toward sustainable societies.

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1. Introduction

Climate change has recently become one of the most important problems worldwide. The scientists have agreed that the main cause of the already proceeding climate change is the increasing emissions of greenhouse gases [1].

Between the polluting gases, carbon dioxide, produced by burning of fossil fuels, plays a key role. Its growing concentrations in the atmosphere are reinforcing the natural greenhouse effect bringing all the negative impacts - expected increase in frequency of the extreme weather disasters, droughts, floods, spreading of certain diseases into colder areas and a rapid shift of climatic zones, which will strongly influence biological diversity.

The seriousness and the urgency of the problem have brought about international talks about the possibilities how to reduce GHG emissions, which led to the agreement on the specific obligations in the Kyoto Protocol in December 1997.

The discussion about the flexibile mechanisms of the Kyoto Protocol are accompanied since the very beginning by controversies about the inclusion of the nuclear energy among the ways of emissions' reduction.

Electricity production in the nuclear power plants produces substantially less GHG emissions than the power plants which burn up fossil fuels. As an illustration, the table below compares different technologies of electricity production according to the volume of CO_2 emissions per unit.

Greenhouse Gas Emissions per Supply System (kg CO_2/MWh)

coal plant	1000–1200
coal cogeneration	700
gas combined cycle	400
monocristaline photovoltaic cell	170
gas combined cycle cogeneration	100
hydropower	18
wind turbine	10
nuclear power	35 (10–50)

Source: Oko-Institut Darmstadt, from WWF [4].

Note: Table shows CO_2 amount released during production of electricity in different sources. Differences between fossil fuels have a reason both in different obtained energy at the same releasing CO_2 amount and effectivity of power conversion (coal power plants 35–40 %, gas up to 60 %).
Non fossil sources have not zero CO_2 emissions. In the case of nuclear energy emissions come espacially from energy demanding process of mining and conversion of uranium, which uses fossil fuels.

However, the critics claim that nuclear reactors are connected with other risks.

There is a significant risk of a major accident in nuclear reactors. Also, the problem of handling the spent nuclear fuel and other radioactive waste remains unresolved. Against clear positive of the substitution of fossil power plants by the nuclear sources stand other environmental negatives. These two can hardly be compared because of their significantly different character of the risk and the impact.

New nuclear power plants are also extremely financially demanding and relocate vital financial sources away from other possibilities of emissions reduction (energy efficiency, renewables development).

The nuclear industry often use climate change as an argument in favous of the development of this technology. Nuclear Energy Agency claims that:

> *„Finding effective policies to respond to climate change is one of the challenges to sustainable development. Nuclear energy is essentially carbon-free and contributes to reducing anthropogenic emissions of greenhouse gases that induce global warming."* [2]

In another statement NEA says:

> *„Nuclear power is one of the options available for alleviating the risk of global climate change and its potential contribution to GHG emissions reduction could be significant. Keeping the nuclear option open in order to realise this potential will require a number of actions by goverments and by indusries in the nuclear sector."* [3]

However, the institutions that support energy conservation on the other hand state that the development of nuclear energy prevents other, more effective measures. *„Investments into nuclear power projects drain badly-needed funds from energy efficiency programs, most of which have a far lower specific greenhouse gas abatement cost than nuclear energy*.", says study of WWF [4].

This statement is supported by the results of several studies that the investments into the energy efficiency reduce the emissions two (France) to seven times (USA) more effectively than the investments into the development of nuclear energy. [5], [6]

This opinion is supported by the fact that some ambitious plans of the emissions' reduction do not include the development of nuclear energy at all. For example the German climate protection program aims to reduce the GHG emissions by 21% in the year 2012 (compared with 1990 levels). At the same time there is plan of the gradual withdrawal from the nuclear energy. Germany is one of a few countries where the absolute volumes of CO_2 emissions are actually decreasing.

The debate on nuclear energy and climate change got into a yet another stage in connection with the flexible mechanisms of the Kyoto Protocol. They allow industrial countries (the UNFCCC Annex I countries) to carry away CO_2 reduction projects in other (less developed) countries and to abate the reductions from their obligations. Because the reduction of the emissions in the third world or other industrial countries may be less costly, it will be beneficial for the governments of the developed countries to fund these projects.

Nuclear energy could be potentially included in two of the three flexible mechanisms: Clean Development Mechanisms (CDM) and Joint Implementation.

Because of the low effectiveness of the technology as an instrument for reducing emissions and other risks connected

with it, most of the participants on the international climate negotiations oppose nuclear energy in the Kyoto Protocol flexible mechanisms. Danish minister of environment Sven Auken said that *„the CDM is about Clean Development and nuclear energy has no place here“* [7]. The French minister of environment Dominique Voynet who led the EU delegation in the Hague conference declared that *„the position of the EU Environment Council is crystal clear on this...nobody wants to exchange the greenhouse effect for a nuclear chain reaction“* [8].

Association of Small Island States (AOSIS) also stood up against the inclusion of nuclear energy in the flexible mechanisms. For these countries a rapid reduction of the GHG emissions is vitally important.

On the other hand the groups connected with the nuclear industry see the flexible mechanisms as an opportunity to gain massive subsidies and to revive the stagnant industry. European Atomic Forum (FORATOM) believes that

> *„when a final deal is made, nuclear energy will not be excluded from Clean Development Mechanism (CDM), which seeks to promote the application of clean air energy technologies in developing world“* [9].

> *„Nuclear industry organisation are warning that developing countries will suffer if certain technologies are excluded from part of the international drive to curb carbon dioxide emissions.“* [10]

Because of the collapse of the Hague climate negotiations the nuclear energy in Kyoto Protocol is still an open question. Nevertheless the role of the nuclear energy has not played any role in the breakdown of the Hague talks. The U.S. delegation has joined the position of the Europian countries and agreed to exclude nuclear energy from the CDM. On the contrary, prospects that nuclear energy will be included in the JI mechanisms were quite high just before the breakdown of the talks. Yet, some of the potential target countries have stood up against it.

This research by Friends of the Earth International shows how low the efficiency of nuclear energy as a way of CO2 emissions reduction is. It compares the volumes of emissions produced in the European countries that have been covering its energy demands in the nuclear power plants for many years with the similar countries that have never accepted this energy source. The aim is to find out how effective is the nuclear energy in actually reducing the pollution.

2. Methodology

The aim of this comparative study was to assess the effectiveness of nuclear energy as a means of the reduction of CO_2 emissions and climate change prevention.

As a subject for this comparison we have chosen pairs of European countries with similar area, population, natural and economical conditions. EU or EFTA member countries form five of the pairs; one pair is formed by the Visegrad (Central Europian) countries and the last one by the Baltic republics.

The comparison includes a pair formed by the Netherlands and Belgium, although both of these countries use nuclear energy. Nevertheless the percentage share of nuclear electricity in the overall country consumption is fourteen times higher in Belgium, while in the Netherlands nuclear reactors play only very marginal role in the country's energy sector.

The 1998 figures, the last data available at the time of writing, are used in the analysis. As the primary criterion for the comparison we have chosen the volume of CO_2 emissions produced by burning of fossil fuels per GDP unit, i.e. the CO_2 efficiency of the economy. This relative indicator best demonstrates the CO_2 reduction effects of the nuclear energy.

The GDP trends, CO_2 emissions and the total consumption of the primary energy sources during the 1990s data show that the countries in each pair can be meaningfully compared with each other. Statistically significant differences can be observed especially between the West European and the ex-communist East European countries.

The data on the GDP, CO_2 emissions and overall electricity consumption were taken from the US Department of Energy statistics [11].

For data on the effectiveness of energy sectors and on the GDP converted according to PPP (Purchasing Power Parity) we looked into the the International Energy Agency statistics [12]. The same source was used for data about the share of renewable sources and the nuclear energy in the electricity consumption of individual countries [13].

3.The Results: country comparison

Italy

GDP converted according to Purchasing Power Parity: US$ 1,037 billions

Total CO_2 emissions from burning of fossil fuels: 121.66 mil. metric tons of Carbon Equivalent

Consumption of primary sources of energy: 8,408.4 PJ

Share of nuclear energy on total consumption of primary sources of energy: 0 %

Share of renewables in the total consumption of primary energy: 4.9 %

Spain

GDP converted according to Purchasing Power Parity: US$ 558 billions

Total CO_2 emissions from burning of fossil fuels: 76.62 mil. metric tons of Carbon Equivalent

Consumption of primary sources of energy: 5,317.2 PJ

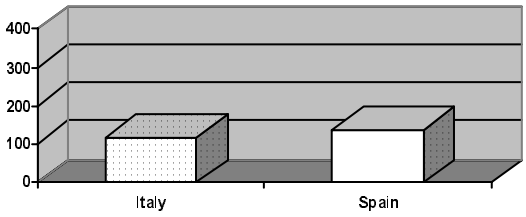
Share of nuclear energy on total consumption of primary sources of energy: 13.7 %

Share of renewables in the total consumption of primary energy: 5.9 %

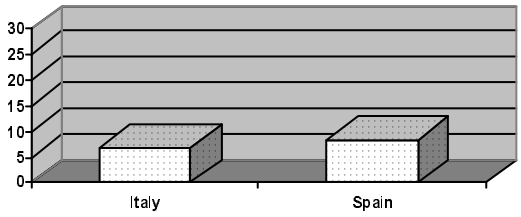
Italy – Spain

The comparison suggests that Italy produces 15% less CO_2 emissions per GDP unit than Spain. Nevertheless we must consider the fact that Italy has been covering substantial part (15 %) of its electricity consumption by imports for many years, while Spain is just about self-sufficient in this.
As concerning the satisfaction of overall energy demands, both the countries are strongly dependent on its imports (75%) – primarily oil. When comparing the energy consumption per GDP unit, Italian economy turns up to be less effective by 20% than Spanish economy.

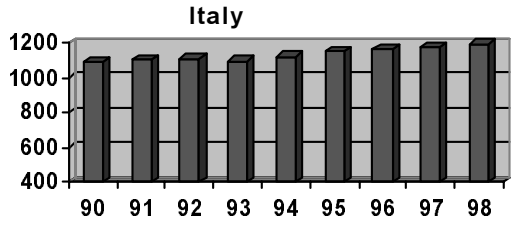
Volume of CO_2 emissions from the consumption and flaring of fossil fuels per GDP unit (converted according to Purchasing Power Parity) [10^5 metric tons/ billions of US$]

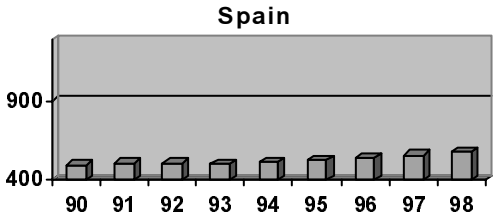


Energy demand of the GDP production converted according to Purchase Power Parity [PJ/ billions US$]

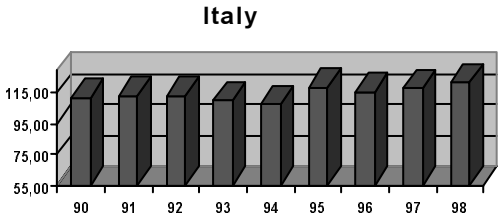


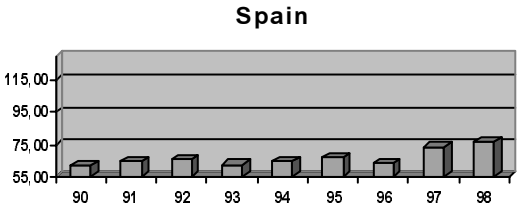
GDP [billions US$]



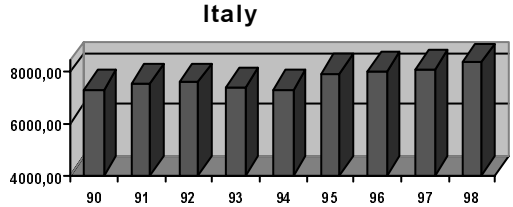


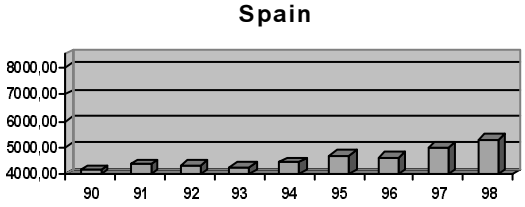
CO_2 emissions from burning of the fossil fuels in millions metric tons of Carbon Equivalent





Total consumption of the primary energy sources [PJ]





Norway

GDP converted according to Purchasing Power Parity: US$ 105 billions

Total CO_2 emissions from burning of fossil fuels: 11.55 mil metric tons of Carbon Equivalent

Consumption of primary sources of energy: 1,962.3 PJ

Share of nuclear energy on total consumption of primary sources of energy: 0 %

Share of renewables in the total consumption of primary energy: 44.5 %

Sweden

GDP converted according to Purchasing Power Parity: US$ 164 billions

Total CO_2 emissions from burning of fossil fuels: 16.42 mil. metric tons of Carbon Equivalent

Consumption of primary sources of energy: 2,405.4 PJ

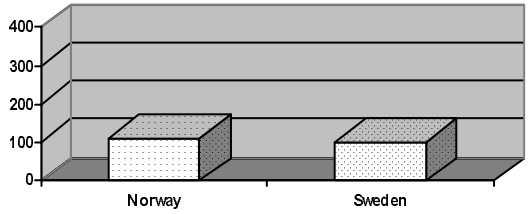
Share of nuclear energy on total consumption of primary sources of energy: 36.2 %

Share of renewables in the total consumption of primary energy: 27.1 %

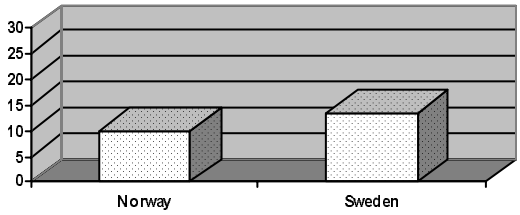
Norway – Sweden

The comparison suggests that Sweden produces less CO_2 emissions per GDP unit than Norway does (by 10%). Both the countries have been satisfying their electricity needs from their own sources in a long-term and Sweden even exports 5–10 % of its production. Sweden is 30% dependent on the imports of the primary energy sources (oil), while Norway comes among the prominent European exporters of primary energy (exports for times as much as it consumes). Norwegian economy demands less energy (by 25%) than Sweden to produce GDP.

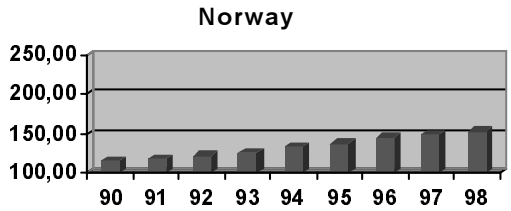
Volume of CO_2 emissions from the consumption and flaring of fossil fuels per GDP unit (converted according to Purchasing Power Parity) [10^5 metric tons/ billions of US$]

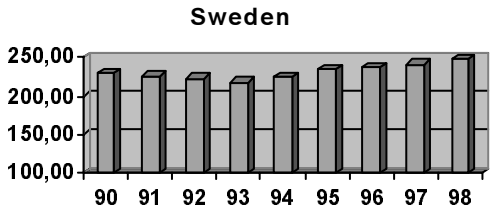


Energy demand of the GDP production converted according to Purchase Power Parity [PJ/ billions US$]

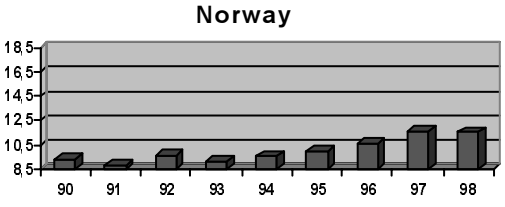


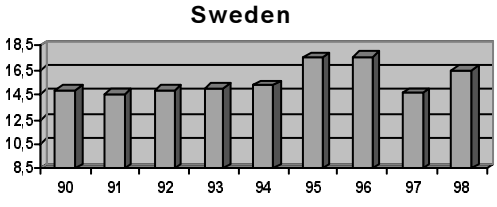
GDP [billions US$]



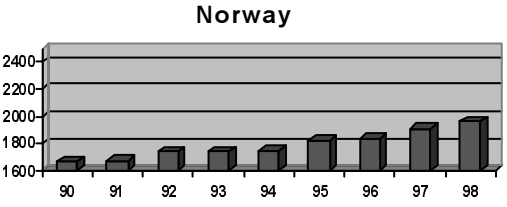


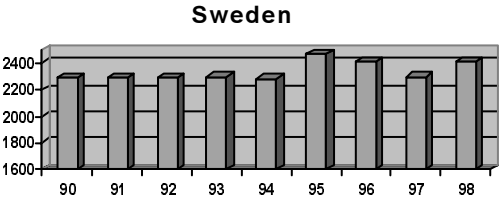
CO_2 emissions from burning of the fossil fuels in millions metric tons of Carbon Equivalent





Total consumption of the primary energy sources [PJ]





Netherlands

GDP converted according to Purchasing Power Parity: US$ 305 billions

Total CO_2 emissions from burning of fossil fuels: 65.57 mil. metric tons of Carbon Equivalent

Consumption of primary sources of energy: 4,019.6 PJ

Share of nuclear energy on total consumption of primary sources of energy: 1.4 %

Share of renewables in the total consumption of primary energy: 1.5 %

Belgium

GDP converted according to Purchasing Power Parity: US$ 196 billions

Total CO_2 emissions from burning of fossil fuels: 39.81 mil. metric tons of Carbon Equivalent

Consumption of primary sources of energy: 2,816.9 PJ

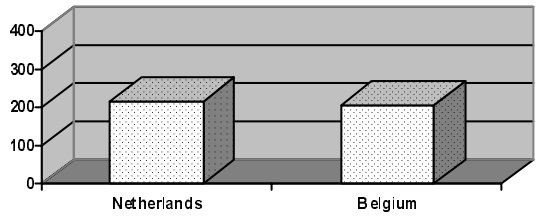
Share of nuclear energy on total consumption of primary sources of energy: 20.7 %

Share of renewables in the total consumption of primary energy: 1.1 %

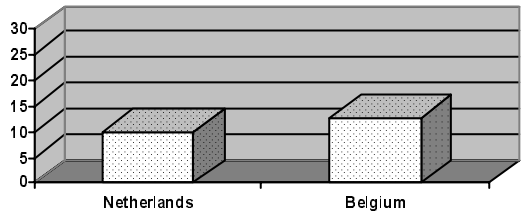
Netherlands – Belgium

The results show that Belgium produces slightly less (by about 5%) CO_2 emissions per GDP unit than the Netherlands. Both the countries cover parts of their electricity requirements by imports (Belgium up to 5%, the Netherlands up to 15%). While Belgium covers almost 80% of its primary energy consumption by imports of oil and natural gas, the Netherlands imports less than 30% (mostly oil). Dutch economy demands less energy (by 20%) than Belgian to produce a GDP unit.

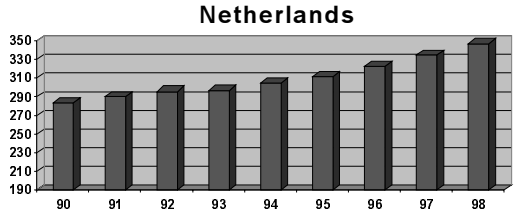
Volume of CO_2 emissions from the consumption and flaring of fossil fuels per GDP unit (converted according to Purchasing Power Parity) [10^5 metric tons/ billions of US$]

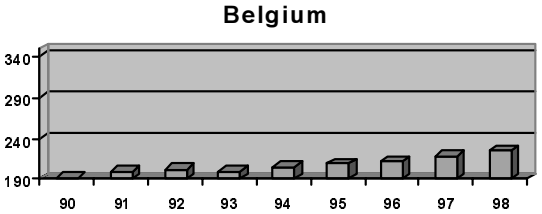


Energy demand of the GDP production converted according to Purchase Power Parity [PJ/ billions US$]

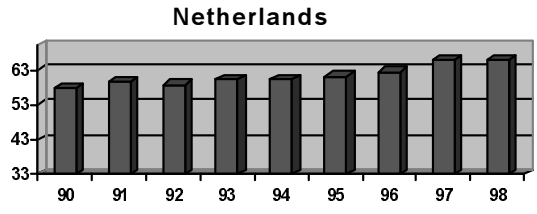


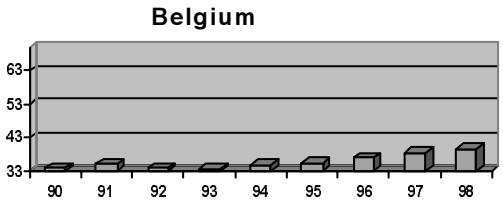
GDP [billions US$]



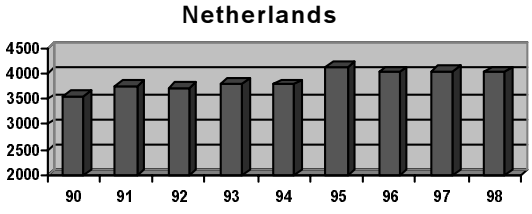


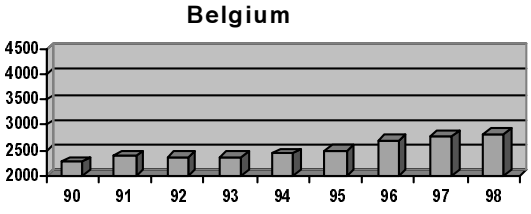
CO_2 emissions from burning of the fossil fuels in millions metric tons of Carbon Equivalent





Total consumption of the primary energy sources [PJ]





Austria

GDP converted according to Purchasing Power Parity: US$ 155 billions

Total CO_2 emissions from burning of fossil fuels: 17.17 mil. metric tons of Carbon Equivalent

Consumption of primary sources of energy: 1,413.7 PJ

Share of nuclear energy on total consumption of primary sources of energy: 0 %

Share of renewables in the total consumption of primary energy: 22.2 %

Switzerland

GDP converted according to Purchasing Power Parity: US$ 152 billions

Total CO_2 emissions from burning of fossil fuels: 12.06 mil. metric tons of Carbon Equivalent

Consumption of primary sources of energy: 1,267.6 PJ

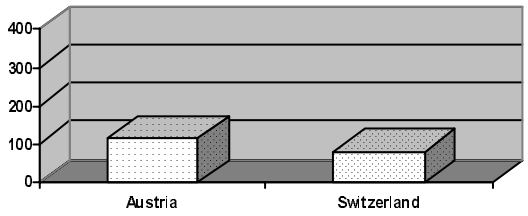
Share of nuclear energy on total consumption of primary sources of energy: 24.9 %

Share of renewables in the total consumption of primary energy: 16.3 %

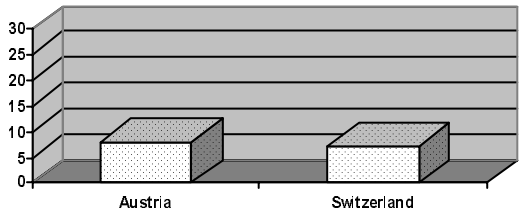
Austria – Switzerland

The comparison revealed that Switzerland produces significantly less CO_2 per GDP unit than Austria (the difference is about 30%). Both the countries cover their needs from their own resources and Switzerland even exports part (10%) of its production. Both countries strongly depend on imports of the primary energy sources (Switzerland by 50%, Austria by 60%). Swiss economy is by 10% more energetically efficient (consumption per GDP unit).

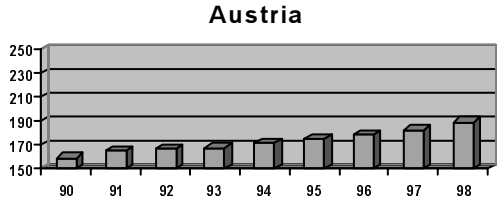
Volume of CO_2 emissions from the consumption and flaring of fossil fuels per GDP unit (converted according to Purchasing Power Parity) [10^5 metric tons/ billions of US$]

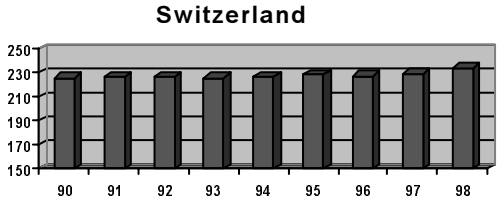


Energy demand of the GDP production converted according to Purchase Power Parity [PJ/ billions US$]

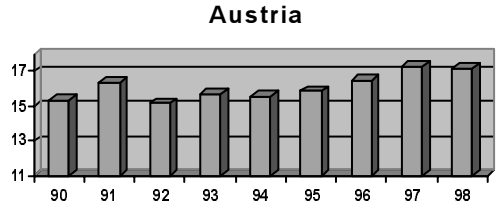


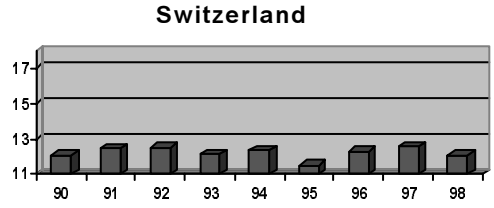
GDP [billions US$]



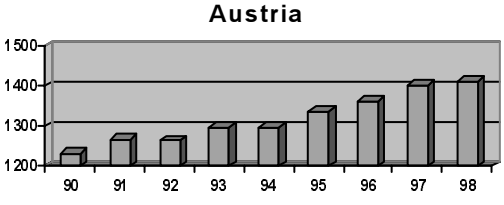


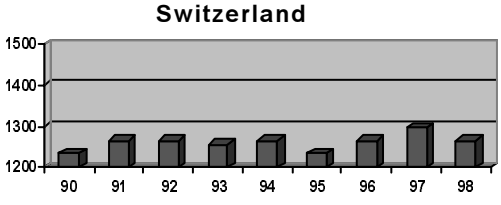
CO_2 emissions from burning of the fossil fuels in millions metric tons of Carbon Equivalent





Total consumption of the primary energy sources [PJ]





Denmark

GDP converted according to Purchasing Power Parity: 118 billions US$

Total CO_2 emissions from burning of fossil fuels: 17.11 mil. metric tons of Carbon Equivalent

Consumption of primary sources of energy: 949.5 PJ

Share of nuclear energy on total consumption of primary sources of energy: 0 %

Share of renewables in the total consumption of primary energy: 8.4 %

Finland

GDP converted according to Purchasing Power Parity: 93 billions US$

Total CO_2 emissions from burning of fossil fuels: 13.37 mil. metric tons of Carbon Equivalent

Consumption of primary sources of energy: 1,361.0 PJ

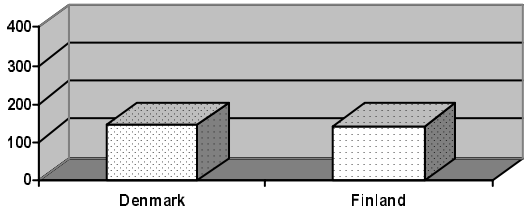
Share of nuclear energy on total consumption of primary sources of energy: 17.4 %

Share of renewables in the total consumption of primary energy: 22.7 %

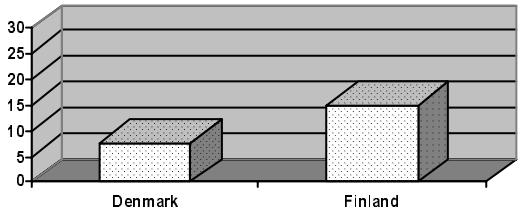
Denmark – Finland

The comparison does not show any significant difference in the production of CO_2 per GDP unit (the difference is less than 1%). Denmark covers its electricity demand from its own sources, Finland imports 5–10%. Denmark is just less than 10% dependent on imports of primary energy sources, while Finland imports about 60% (oil, gas). Danish economy demands just about half the energy to produce one GDP unit than the Finnish economy does.

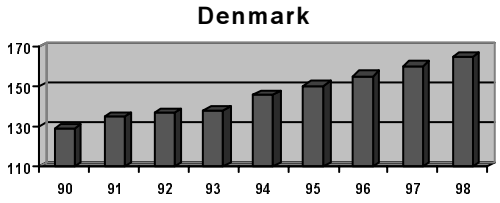
Volume of CO_2 emissions from the consumption and flaring of fossil fuels per GDP unit (converted according to Purchasing Power Parity) [10^5 metric tons/ billions of US$]

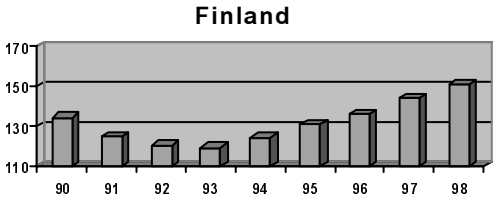


Energy demand of the GDP production converted according to Purchase Power Parity [PJ/ billions US$]

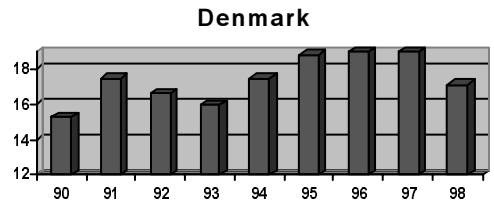


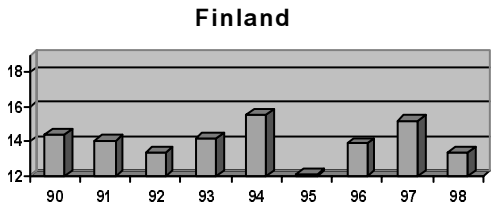
GDP [billions US$]



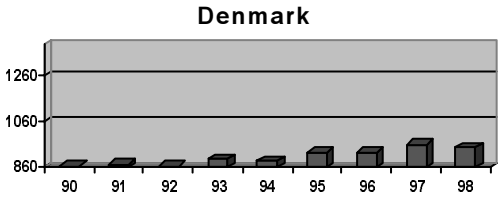


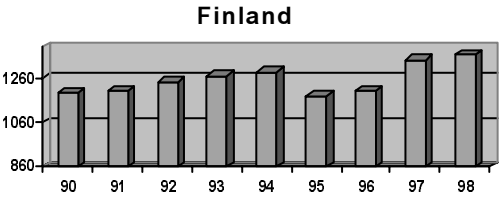
CO_2 emissions from burning of the fossil fuels in millions metric tons of Carbon Equivalent





Total consumption of the primary energy sources [PJ]





Poland

GDP converted according to Purchasing Power Parity:
US$ 257 billions

Total CO2 emissions from burning of fossil fuels: 85.37 mil. metric tons of Carbon Equivalent

Consumption of primary sources of energy: 4,082.9 PJ

Share of nuclear energy on total consumption of primary sources of energy: 0 %

Share of renewables in the total consumption of primary energy:
4.7 %

Hungary

GDP converted according to Purchasing Power Parity:
US$ 71 billions

Total CO2 emissions from burning of fossil fuels: 16.3 mil. metric tons of Carbon Equivalent

Consumption of primary sources of energy: 1,128.9 PJ

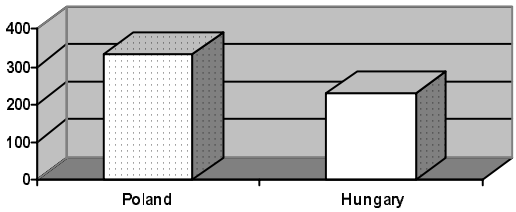
Share of nuclear energy on total consumption of primary sources of energy: 14.4 %

Share of renewables in the total consumption of primary energy:
1.4 %

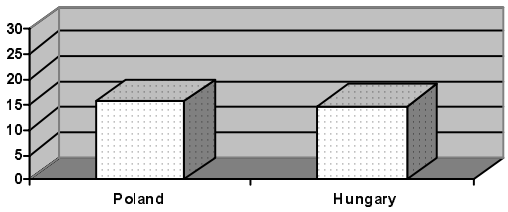
Poland – Hungary

The research revealed that Hungary produces significantly less CO_2 per GDP unit than Poland (the difference is again about 30%). Hungary imports small part of its electricity consumption (5%). Poland, on the contrary, exports about 5% of its production. About 50% of Hungarian consumption of primary energy sources comes from imports (oil and gas), while Poland imports only about 15% of the primary sources it consumes. Hungarian economy needs 5% less energy per a GDP unit.

Volume of CO_2 emissions from the consumption and flaring of fossil fuels per GDP unit (converted according to Purchasing Power Parity) [10^5 metric tons/ billions of US$]

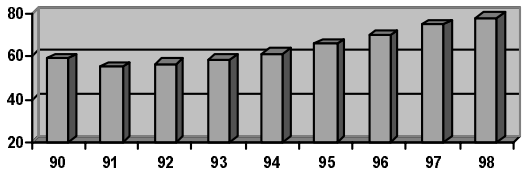


Energy demand of the GDP production converted according to Purchase Power Parity [PJ/ billions US$]

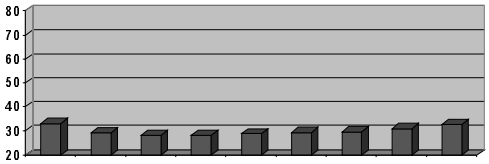


GDP [billions US$]

Poland

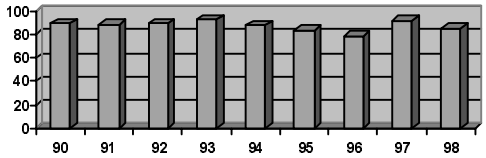


Hungary

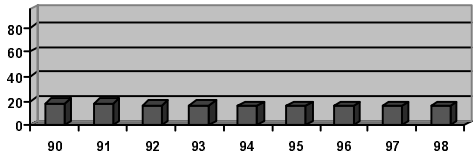


CO_2 emissions from burning of the fossil fuels in millions metric tons of Carbon Equivalent

Poland

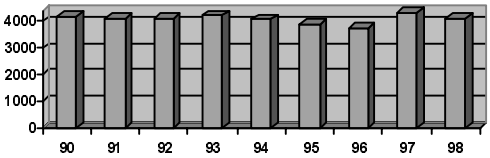


Hungary

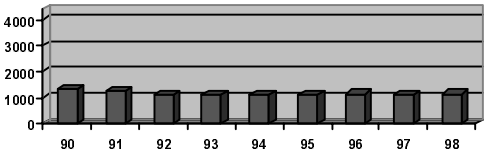


Total consumption of the primary energy sources [PJ]

Poland



Hungary



Latvia

GDP converted according to Purchasing Power Parity: US$ 11.5 billions

Total CO_2 emissions from burning of fossil fuels: 2.15 mil. metric tons of Carbon Equivalent

Consumption of primary sources of energy: 179.4 PJ

Share of nuclear energy on total consumption of primary sources of energy: 0 %

Share of renewables in the total consumption of primary energy: 33.5 %

Lithuania

GDP converted according to Purchasing Power Parity: US$ 14 billions

Total CO_2 emissions from burning of fossil fuels: 4.88 mil metric tons of Carbon Equivalent

Consumption of primary sources of energy: 379.8 PJ

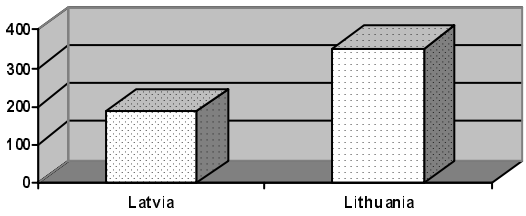
Share of nuclear energy on total consumption of primary sources of energy: 36.4 %

Share of renewables in the total consumption of primary energy: 6.2 %

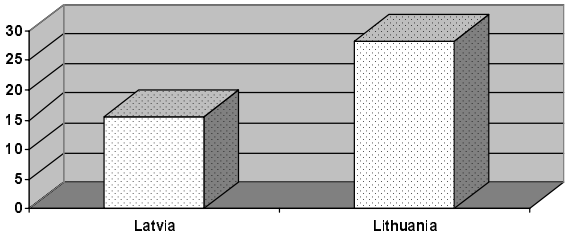
Latvia – Lithuania

The comparison suggests that Latvia produces significantly less CO_2 per GDP unit than Lithuania (the difference here is about 46%). Latvia covers about 30% of its electricity consumption by imports, while Lithuania exports one third of its production. Latvia imports about 75% of the primary energy sources, Lithuania imports something less than 60% (oil and natural gas in both cases). Latvian economy is by 45% more effective as concerning the consumption of energy per GDP unit.

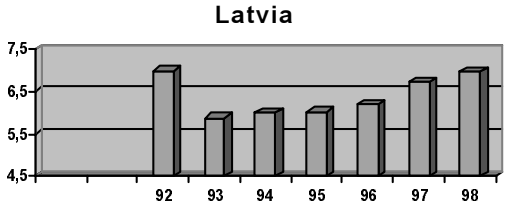
Volume of CO_2 emissions from the consumption and flaring of fossil fuels per GDP unit (converted according to Purchasing Power Parity) [10^5 metric tons/ billions of US$]

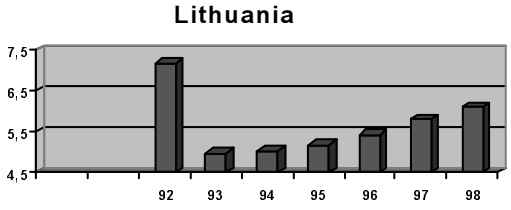


Energy demand of the GDP production converted according to Purchase Power Parity [PJ/ billions US$]

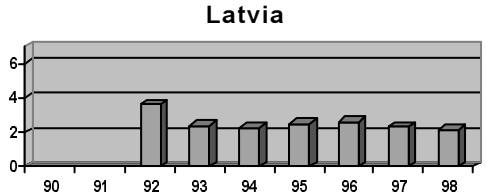


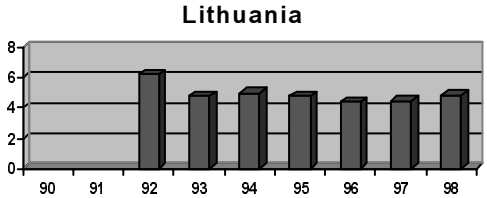
GDP [billions US$]



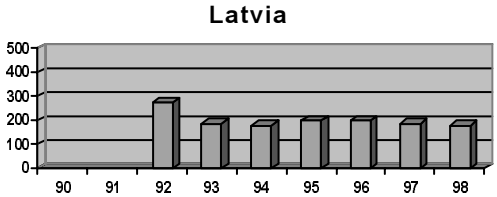


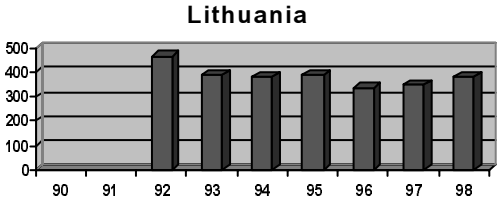
CO_2 emissions from burning of the fossil fuels in millions metric tons of Carbon Equivalent





Total consumption of the primary energy sources [PJ]





4. Analysis of the results

The sample of countries covered in this research is not big enough to deduce general conclusions - simply, there are not enough economies available for a relevant statistical study. Nevertheless the results of this report can reveal some information.

The comparison does not show any clear interdependence between the use of nuclear energy and reduction of the volume of emissions. The main reason is the markedly higher energy efficiency of the developed, non-nuclear economies.

The only exception is the Switzerland – Austria pair. Even Austria which is above average in energy efficiency (in the considered sample) cannot compete with the extremely energetically efficient Swiss economy. Nevertheless, the reason is probably the very special structure of the Swiss GDP. Nevertheless a detailed analysis of the GDP in the countries was not carried away.

The biggest difference in the production of specific emissions is between the two CEE countries. Nuclear Hungary has substantially better record (lower specific emissions) than non-nuclear Poland. But again, it is caused by factors that do not have much to do with the nuclear program. The first factor: big energy demands of the Polish economy have been conditioned historically. In the country with large coal supplies the energy intensive metallurgical sector has traditionally played an important role, while Hungary is a country oriented mainly on agriculture and light industry. The second factor: strikingly high share of coal on the Polish consumption of the primary sources - the highest in Europe.

On the other hand, Latvia embodies substantially lower specific emissions than Lithuania, the country with the highest share of nuclear energy in the world. The fact that Latvia is very much dependent on the import of electricity does not weaken these results. The demand of the energy sector in Lithuania is actually almost twice higher than in Latvia and the specific emissions are the highest of all the countries included in the study.

The concrete causes for the differences are analysed in detail in the chapters about the individual pairs of countries.

The comparison clearly suggests that the countries which cover part of their energy consumption from the nuclear sources do not show any reduction of GHG gases that would correspond to the share of this technology. The nuclear power plants do therefore not fulfill the promised benefit - reduction of CO_2 concentrations in the atmosphere and protection of the global climate.

A relationship can be found between the operation of nuclear power plants and higher specific energy consumption for the production of the GDP unit. The reason is probably lower pressure for the regulation of consumption in the nuclear countries.

However, the specific energy consumption for a GDP unit represents the most important parameter that influences the level of specific emissions. Moreover, as a structural characteristic of an economy, it blocks introduction of measures that would reduce the emissions. Therefore it applies especially for CEE countries that they must first improve the energy efficiency of their economies if they are to reach long-term perspective cut in the emissions.

The orientation towards the improving of energy efficiency will bring about even more positive effects. It allows the countries to get rid of the dilemma – CO_2 emissions or environmental risks of nuclear reactors. The latest research also suggests that substitution of nuclear reactors with energy efficiency measures brings provides more employment. Different studies suggest 150 to 420 % increase in the total number of employees (compared with nuclear power plants) [14].

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