# FEASIBILITY STUDY FOR

# "Revealing the Scale of Subsidies to Fossil Fuels"

GSI Global Subsidies Initiative
www.globalsubsidies.org

PAUL SCHERRER INSTITUT PSI

EPFL ÉCOLE POLYTECHNIQUE FÉDÉRALE DE LAUSANNE

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## TABLE OF CONTENTS

# FEASIBILITY STUDY FOR "REVEALING THE SCALE OF SUBSIDIES TO FOSSIL FUELS"

By Nicole Andréa Mathys

## 1. INTRODUCTION

This feasibility study focuses only on data collection, the main practical concern of this project. Computer models of the energy economy are available and have already been applied to other issues; only small modifications would be needed to apply them to the analysis of subsidies.

For the purposes of this subsidy project, ideal data sets would share the following characteristics:

(i) *frequency:* they should be annually available and regularly updated;

(ii) *coverage:* they should cover the largest fossil energy producing and consuming countries in the world; hence, data are needed that are comparable—or can be made comparable—across countries, even though each government has its own way of supporting its industries;

(iii) *disaggregation:* they should allow for distinguishing subsidies to specific benefiting industries.

Section 2 outlines existing studies. Section 3 provides a quick overview of the main fossil-energy producers and consumers at the worldwide level. The rest of the document is devoted to data sources. Section 4 outlines the available international data. In order to assure the accuracy of cross-country and cross-sector comparisons, data that have already been processed to make them internationally comparable would be preferable. However, this preliminary assessment indicates that such data exist for only a subset of the world's economies, and only for certain types of support, specifically market price and R&D support. To go a step further, national data will need to be collected. Possible sources are discussed in section 5. Section 6 addresses external costs; Section 7 devises a research strategy and section 8 concludes with the feasibility of this project.

## 2. REVIEW OF THE LITERATURE

Over the last two decades, a large number of studies that try to estimate the magnitude of energy subsidies have been undertaken. These studies range from assessments of subsidies to particular industries, such as the coal-mining industry in Germany, to multi-country studies of subsidies provided to consumers through under-pricing of fuels and electricity. To date, no study has attempted to systematically examine all forms of subsidies provided by large players in the fossil-fuel markets.

The following provides merely a brief overview of some representative studies, with an emphasis on those carried out at an international level.

Among the first multi-country studies was that by Kosmo (1987) for the World Resources Institute (WRI). This study found that national prices of electricity and fuels often did not reflect opportunity costs. He recommended that governments establish prices that would reflect the full costs to society of producing and consuming energy, including externalities, and specifically asked them to pay more attention to gas and coal compared with oil. Five years later, the World Bank (Larsen and Shah, 1992) presented evidence on the level of subsidies to the consumption of fossil fuels, and calculated their welfare costs for both fossil fuel exporters and importers and the implications for carbon dioxide emissions. They estimated that subsidies through under-pricing equalled roughly $230 billion U.S. a year, or 20 to 25 per cent of the value of world fossil fuel

consumption. They estimated that the welfare gains from removing these subsidies would be in the range of 15 per cent and emissions of carbon dioxide (CO2) would fall by roughly 5 per cent.

The IEA dedicated the 1999 edition of its *World Energy Outlook* to subsidies. Based on its price-gap calculations, removing energy subsidies worldwide would have reduced energy consumption by 3.5 per cent and $CO_2$ emissions by 4.5 per cent. Moltke *et al.* (2003) recently analyzed some particular energy subsidies for the OECD and some developing countries. They found that subsides in developing and transition economies often take the form of consumer subsidies and are relatively larger than those in OECD countries.

At least another two studies also focused on developing countries. Using the Global Trade and Environment Model (GTEM), Saunders and Schneider (2000) estimated the effect of the removal of energy consumption subsidies in developing and transition economies. Even though they identified complex interactions within an economy, they concluded that such a reform would reduce worldwide greenhouse gas emissions. More recently, Coady *et al.* (2006) looked at fuel subsidies in Bolivia, Ghana, Jordan, Mali and Sri Lanka. Besides quantifying the value of these subsidies, the authors pointed out that the subsidies cause significant social and fiscal costs and, in the countries they examined, the subsidies were poorly targeted.

Several studies have looked at energy subsidies in the European Union. Since most energy in the EU is sold at world market prices or above, the focus of these studies has been on subsidies to maintain high-cost production, or the construction of new energy-producing facilities. Steenblik and Wigley (1990) applied the producer subsidy equivalent (PSE) method to measuring support for coal production in Belgium, Germany, Spain, UK and Japan and estimated that subsidies to and protection of the industry was costing consumers and taxpayers $10 billion U.S. a year at the end of the 1980s. Steenblik and Coroyannakis (1995) later showed that reforming coal policies in Europe would yield substantial environmental benefits.

In a report for Greenpeace, Ruijgrok and Oosterhuis (1997) estimated budgetary support for fossil fuels in Western Europe. Several years later, Oosterhuis (2001) undertook a reassessment. He concluded that subsidies to energy in the EU are numerous and continue to involve substantial amounts of money. He also pointed out that fossil fuels were receiving more subsidies than renewable energy, and that a major part of identified subsidies are related to tax exemptions and reductions.

There are, of course, many more country-specific studies:

With its coal industry and relatively easily available data, **Germany** offers an interesting terrain for such studies. The work by Prange and Ahlswede (2006, known as *Schwarzbuch*) includes a whole set of subsidy estimations related to traffic, coal and nuclear energy and tax breaks. They estimated annual subsidies of roughly €6.6 billion for coal alone. Storchmann (2005) analyzed in detail the evolution of coal subsidies from the Second World War to the present and made some predictions about the future. He noted that the subsidy system was complex from 1958 to 2002 but had become much more streamlined by 2002, by which time only six support measures were being used. He estimated a total subsidy to cooking coal, steam coal and future closures of roughly €3 billion for 2004 and 2005.

The OECD *Environmental Performance Review* for **Switzerland** (2007) cited the exemption from the gasoline and diesel taxes granted to agriculture, forestry, fishery and public transportation under federal concession as harmful subsidies. It mentioned an exploratory study that did not lead to full-fledged estimation of harmful subsidies due to methodological and statistical difficulties.

In a detailed report for Greenpeace, Koplow and Martin (1998) analyzed federal subsidies to oil in the **United States**. For 1995, they obtained net federal subsidies of $5–12 billion U.S. and they estimated the defense

of oil supply to cost another USD$11–23 billion. At about the same time, the U.S. Energy Information Administration (EIA, 1999) undertook a detailed analysis of subsidies to primary energy sources. Its estimates show that, with USD$ 1.2 billion, natural gas obtained the largest support of the primary fossil fuels, and that this support came mainly from income tax expenditures. More recently, Koplow (2006) estimated subsidies to biofuels in the United States. Although the sector of concern is different, the estimation method was similar to what he used in his study of oil subsidies. These estimated subsidies sum to $5.5–7.3 billion U.S., the largest part being provided by a federal tax credit. Finally, in 2007, Koplow discusses political economy aspects of the U.S. subsidy policy.

Next to these works, there are at least three other countries where recent studies of subsidies to fossil fuels have been undertaken. The National Institute of Economic and Industry Research (NIEIR, 1996) investigated subsidies to the use of natural resources in **Australia**, one of the world's leading producers of coal and lignite. Concerning energy production, financial subsidies in 1994 cumulated to $2 billion Aus. for production and use (forgone revenue of $1.2 billion Aus. could be added depending on the subsidy definition). More recently, Riedy (2007) investigated energy and transport subsidies for Greenpeace and, after carefully defining "perverse subsidies," he estimated that, for 2005/06, the support was largest for coal in the electricity sector, for oil in the transport sector and for natural gas in the other stationary energy sector. In total, coal received the largest support and oil came second.

Taylor *et al.* (2005) focused on support provided by the **Canadian** federal government for conventional oil and gas and oil sands in the form of direct, program or tax expenditures. They estimated the total expenditures between 1996 and 2000 at roughly CDN$8 billion. Finally, Douthwaite and Healy (2003) estimated **Irish** subsidies and emissions related to fossil fuels and proposed numerous recommendations.

In summation, many studies have already investigated the order of magnitude of fossil fuel subsidies, hence proving the existence of available data even for developing countries (see Coady [2006)] or Saunders and Schneider [2000], described above). The challenging and new feature of this project is, however, the collection of high-quality data that would be updated every year, for many countries, and which would cover a significant part of the theoretical definition of fossil fuel subsidies.

## 3. SELECTING COUNTRIES FOR IN-DEPTH ANALYSIS OF FOSSIL FUEL SUBSIDIZATION

It will obviously not be possible to assess fossil fuel subsidization in over 180 countries, nor would it make sense: the relationship between additional effort and extra precision in the worldwide picture would rapidly exhibit diminishing returns. Therefore, the project will initially focus on the largest fossil fuel producers and consumers. This subset could be enlarged to more countries, of course, resources permitting.

The most important countries for fossil fuel production and consumption of each type can be identified from IEA data. They are available from 1980 with yearly updates. Appendix A displays world maps indicating which countries control important coal, petroleum and natural gas resources. Below, leading producers and consumers are identified by type of fossil fuel.

## 3.1 Petroleum

Petroleum consumption is led by the economies of the OECD (led by the United States, Japan, Germany, Mexico, United Kingdom, Korea, Italy, Canada and Australia) and the larger emerging and transition economies (China, India, Brazil and Russia) (see Table 1). Over the next two decades, the IEA forecasts that consumption will increase in all regions of the world, but most strongly (in absolute terms) in China, the Middle East and developing countries. Consumption in the EU and in the OECD Pacific region will each grow by just 0.6 million barrels per day.

**TABLE 1. WORLD PRIMARY OIL DEMAND (MILLION BARRELS PER DAY)**

| Country | 2005 | 2030 | Absolute increase |
|---|---|---|---|
| United States | 20.6 | 25.0 | +4.4 |
| European Union | 13.5 | 14.1 | +0.6 |
| China | 6.6 | 15.3 | +8.6 |
| Middle East | 5.8 | 9.7 | +3.9 |
| OECD Pacific (Japan, Korea, Australia, NZ) | 8.3 | 8.9 | +0.6 |
| India | 2.6 | 5.4 | +2.8 |
| Africa | 2.7 | 4.9 | +2.2 |
| Brazil | 2.1 | 3.5 | +1.4 |
| Other Latin America (excluding Mexico) | 2.8 | 3.5 | +0.7 |
| Russia | 2.5 | 3.2 | +0.7 |
| Rest of the World | 16.1 | 22.8 | +6.7 |
| **World** | **83.6** | **116.3** | **+32.7** |

Source: IEA, *World Energy Outlook 2006*.

The leading producers of crude petroleum are the Middle East members of OPEC (Saudi Arabia, Iran, Kuwait, the U.A.E.), followed by Russia, the U.S.A., Europe, China and Mexico. Between now and 2030, production is expected to shrink in North America and Europe, and grow in Russia, sub-Saharan Africa and Brazil. Supplementing crude petroleum in the future will be increased supplies of natural-gas liquids (like propane, which can be compressed and used to power dedicated fleets) and non-conventional oil, like Canadian tar sands.

## TABLE 2. WORLD PETROLEUM SUPPLY (MILLION BARRELS PER DAY)

| Country | 2005 | 2030 | Change |
|---|---|---|---|
| ***Crude petroleum*** | | | |
| OPEC Middle East (Saudi Arabia, Iran, Kuwait, etc.) | 20.7 | 34.5 | +13.8 |
| OPEC Other (Nigeria, Venezuela, Libya, Algeria, Indo.) | 8.4 | 11.2 | +2.8 |
| Russia | 9.2 | 11.1 | +1.9 |
| Sub-Saharan Africa (apart from Nigeria) | 2.9 | 4.3 | +1.4 |
| United States | 5.1 | 4.0 | -1.1 |
| Brazil | 1.6 | 3.5 | +1.9 |
| Mexico | 3.3 | 3.0 | -0.3 |
| China | 3.6 | 2.8 | -0.8 |
| Europe | 4.8 | 1.5 | -3.3 |
| Other Latin America (excluding Brazil and Mexico) | 2.2 | 2.5 | +0.3 |
| Rest of the World | 9.0 | 10.7 | +1.7 |
| ***Natural-gas liquids*** | | | |
| OECD countries | 3.7 | 4.4 | +0.7 |
| Saudi Arabia | 1.5 | 2.7 | +1.2 |
| Rest of the World (mainly Qatar, Iran, developing countries) | 4.1 | 8.7 | +4.6 |
| ***Non-conventional oil*** | | | |
| Canada | 1.0 | 4.8 | +3.8 |
| Venezuela | 0.1 | 0.4 | +0.3 |
| Rest of the World | 0.5 | 3.8 | +3.3 |
| **TOTAL WORLD** | 83.6 | 116.3 | +32.7 |
| *Of which:* | | | |
| Crude oil | 70.8 | 89.1 | +18.3 |
| Natural gas liquids | 9.3 | 15.8 | +6.5 |
| Non-conventional oil | 1.6 | 9.0 | +7.4 |

Source: IEA, *World Energy Outlook 2006*.

## 3.2 Natural gas

The situation regarding natural gas is somewhat like that for petroleum. The U.S.A. and the EU are the largest consumers, but the Middle East is poised to become an increasingly important consuming region than Russia, currently the third-leading consumer. China is an important consumer of natural gas, but not as relatively important as it is for petroleum and coal. Developing countries (captured by "the rest of the world") are expected to increase their consumption substantially over the next 25 years.

**TABLE 3. WORLD CONSUMPTION OF NATURAL GAS (BILLION CUBIC METERS PER YEAR)**

| Country | 2004 | 2030 | Absolute increase |
|---|---|---|---|
| United States | 626 | 728 | +102 |
| European Union | 508 | 726 | +218 |
| Middle East | 244 | 636 | +392 |
| Russia | 420 | 582 | +162 |
| Latin America (excluding Mexico) | 115 | 289 | +174 |
| OECD Pacific Region (Japan, Korea, Australia, NZ) | 148 | 223 | +75 |
| China | 47 | 169 | +122 |
| Canada | 94 | 151 | +57 |
| North Africa | 63 | 146 | +83 |
| Mexico | 51 | 118 | +67 |
| Rest of the World | 468 | 895 | +427 |
| **World** | **2784** | **4663** | **+1879** |

Source: IEA, World Energy Outlook 2006.

The leading producers of natural gas, from largest to smallest, are the transition economies (Russia and other former Soviet economies), OECD North America (including Mexico), the Middle East, "Developing Asia" (e.g., Indonesia), OECD Europe, Africa (especially North Africa), Latin America and OECD Pacific. Much of the growth in demand in future years is expected to be met by investments in liquefied natural gas (LNG) capacity in the Middle East, Africa and Southeast Asia.

## 3.3 Coal

Coal consumption is concentrated in North America and "Developing Asia" (China, India and Indonesia), with the other main consumers being Japan and Korea, Russia, South Africa, Germany, Poland and Australia (Table 4). Most of the growth in consumption in future years is forecast to take place in Asia, with China accounting for more than half of the growth.

### TABLE 4. WORLD CONSUMPTION OF COAL (MILLION TONS PER YEAR)

| Country | 2004 | 2030 | Absolute increase |
|---|---|---|---|
| China | 1881 | 3867 | +1986 |
| United States | 1006 | 1282 | +276 |
| European Union | 789 | 745 | -44 |
| India | 441 | 1020 | +579 |
| Other developing Asia (apart from China and India) | 202 | 419 | +217 |
| OECD Asia (Japan and Korea) | 262 | 287 | +25 |
| Africa (mainly South Africa) | 193 | 248 | +55 |
| OECD Oceania (mainly Australia) | 137 | 166 | +29 |
| Rest of the World | 647 | 824 | +177 |
| **World** | **5558** | **8858** | **+3300** |

Source: IEA, *World Energy Outlook 2006.*

The global pattern of coal production largely mirrors that of production, since only around 10 per cent of what is produced enters international trade. On the production side, China dominates, and is expected to account for 60 per cent of the increase in production between 2004 and 2030. Significant increases are also expected in the United States, India and Southeast Asia. With the phasing out of coal subsidies, the EU will see its production decline.

### TABLE 5. WORLD COAL SUPPLY (MILLIONS OF TONS)

| Country | 2004 | 2030 | Absolute increase |
|---|---|---|---|
| China | 1960 | 3927 | +1967 |
| United States | 1009 | 1267 | +258 |
| India | 413 | 937 | +524 |
| OECD Oceania (mainly Australia) | 360 | 564 | +204 |
| European Union | 597 | 477 | -120 |
| Other developing Asia (apart from China and India) | 222 | 408 | +186 |
| Africa (mainly South Africa) | 248 | 332 | +84 |
| Latin America | 67 | 130 | +63 |
| Canada | 66 | 77 | +11 |
| Rest of the World | 616 | 739 | +123 |
| **World** | **5558** | **8858** | **+3300** |

Source: IEA, *World Energy Outlook 2006.*

## Other fossil fuels

The other main fossil fuel used in the world is peat (which, by some definitions, is classified as "renewable"). In 1999, Finland produced almost 7 million tons of the fuel, and Russia, Ireland and Belarus each produced over 2 million tons. Almost all of this peat was used domestically. Although these are small quantities by the standards of coal production, the extraction of peat and its burning is especially environmentally destructive, turning land that was previously carbon absorbing into land that can no longer perform that function, and releasing large amounts of carbon into the atmosphere. In almost all countries, the industry is heavily subsidized.

The Section 4 looks at international data, while Section 5 focuses on countries that are important world players but that leave some hope for good data: the United States, Canada, Australia, Germany, China, Mexico, India and Indonesia.

# 4. INTERNATIONAL DATA

This section outlines international data that are available for prices and R&D expenditures. Even though a rather large number of countries are covered, data are missing for some of the important producers. Among the easiest subsidy elements to compute are market price support (transfers to producers through elevated prices) and consumer subsidies (transfers to consumers through artificially low process), both of which involve multiplying volumes by the gap between a reference price and the producer or consumer price.

Generally speaking, and in addition to the data sources listed below, the following two research centers have investigated subsidy issues and might therefore be of interest for this project: CEE (Center for Energy Economics) and ESMAP (Energy Sector Management Assistance program).

## 4.1 Worldwide price data

ENERDATA (an independent energy consulting and information services company) provides monthly updated consumer prices (including taxes), import and export prices, as well as consumption and production data in U.S. $ for 184 countries, for several years and many categories of fossil fuels. Tables 4–6 in Appendix B list recent data available for the countries of interest. Data coverage is best for countries in Europe and North America, but some data are also available for Russia, Algeria and Turkey. The complete set of variables and countries is sold as the GLOBALSTAT database for €1750 for a single university user, including two updates per year. Prices are doubled for multiple users and private companies. Hence the access to the updated database for multiple users belonging to a private company would cost €7000.

The GTZ (*Gesellschaft für Technische Zusammenarbeit*) in Germany publishes an annual survey of diesel and gasoline prices for 170 countries and estimates the consumer subsidies for each country. Its 2005 publication also includes estimates of some budgetary subsidies related to petroleum fuels.

## 4.2 Government energy technology R&D budget data (from the IEA)

The IEA collects data on government spending on energy-related R&D for Australia, Canada, the Czech Republic, Germany, Greece, the Netherlands, Norway, Switzerland, Turkey, the UK and the U.S.A. The expenditures are available in U.S. $ at latest prices and on a purchasing power parity (PPP) basis. The fossil fuel part is partitioned into the following subsections:

1.1 Enhanced oil production
1.2 Refining, transport and storage of oil and gas
1.3 Non-conventional oil and gas production
1.4 Oil and gas combustion
1.5 Oil and gas conversion
1.6 Other oil and gas

2.1 Coal production, preparation and transport
2.2 Coal combustion
2.3 Coal conversion
2.4 Other coal

The data do not distinguish between expenditure related to oil and to natural gas.

## 4.3 European and OECD data

There exist some databases that cover a sub-sample of the countries of interest defined above:

- The Commission to the European Communities published several reports on state aid to energy (most often to coal). There is, however, no guarantee that it will continue to update those reports regularly with the same estimation methods.
- The OECD/EEA database on instruments used in environmental policy (OECD, 2001 is a comprehensive report on that data) is periodically updated and reports the following information:
  - environment-related taxes, fees and charges with respect to the following categories:
    - ~ main characteristics: each instrument is briefly described
    - ~ revenues generated by environmentally related taxes: tax income in U.S. $
    - ~ their tax terms: tax base and tax rate in €
    - ~ their exemptions (no amount estimation)
    - ~ their refund mechanisms for selected countries
    - ~ their tax ceilings for selected countries
    - ~ their earmarking for selected countries
  - environmentally motivated subsidies:
    - ~ main characteristics: description of each type of reported subsidy
    - ~ types of activities supported: description
    - ~ annual cost: estimates of net financial cost in €
    - ~ target groups by subsidy

This detailed database contains all the EU state aid decisions and the corresponding amounts of aid and would allow computing state aid going to coal, oil and gas for each country. This database covers OECD and other EEA countries (mostly East European countries).

## 4.4 Agencies that do not provide any relevant data

For completeness, below is a list of organizations that were contacted but reported that they do not have or do not provide any data on subsidies to fossil fuels:

- The IEA no longer reports subsidy estimates (they did it for coal in the past);
- UN Economic Commission for Europe;
- The US Department of Energy and its Energy Information Administration only have energy consumption, production and price data;
- Eurostat only reports aggregate budget expenditures for energy.

## 4.5 In short

To sum up, databases covering a large number of countries are rare. The exceptions are data on prices and R&D expenditure. For OECD and European countries, in addition, a database on environmental policy instruments exists. This source contains detailed information, which would allow for a thorough analysis, albeit with a considerable amount of work.

# 5. COUNTRY-SPECIFIC DATA

A country-by-country investigation is necessary to identify other channels through which governments support fossil energy. In order to illustrate the feasibility of such country-based analyses, a small number of countries were selected on the basis of an *a priori* assessment of the likelihood that they might have good data (and their national language). A summary of the budget data that was found is reported in Table 6.

In addition to support provided at the national level, many countries, especially with federal systems, also provide support to fossil fuel production at the sub-national (province, state, prefecture) and local level. This is, for example, the case in Canada and the United States. The importance of subsidies at sub-national levels is nicely outlined in Loper (1994). He found for the United States that state and local governments would have collected an additional $4 billion U.S. for petroleum and almost $1 billion U.S. for natural gas if they had taxed these goods at the same rate as other goods. For Canada, Taylor *et al.* (2005) reported that natural gas royalties (from four royalty programs) to energy companies have been reduced by almost $0.5 billion Cdn for the province of Alberta. Most recently, Koplow (2006), in a study examining subsidies for biofuels, pointed at the possible interaction between state and federal tax systems and concluded that the largest subsides have been provided under federal programs but that many state-level programs also offer significant support. Conversely, for EU member states, one should also include EU aid in addition to national aid to fossil energy.

**TABLE 6: PRICE AND BUDGET DATA BY COUNTRY**

| Country | Price data (international sources) | Budget data | Comments |
|---|---|---|---|
| U.S.A. | Available | several detailed budget documents are available | state-level policies might also be important |
| Canada | available for oil and gas | detailed contributions are available | provincial-level policies might also be important |
| Australia | available for oil and gas | only aggregate fuel and energy data | possible contact person: Chris Riedy |
| Germany | available | tax exemption data | some additional support provided by Länder |
| China | available for some specific types | only on geological prospecting and R&D expenditure | a sub-contract to Mandarin speaking researchers would be needed |
| Mexico | available | only aggregate energy data | – |
| India | available | several sources are available | combing the different sources of information might not be easy |
| Indonesia | available | information might be available | a sub-contract to Bahasa speaking researchers would be needed |

For each country, the main data sources are mentioned below. Appendix C provides more details for the U.S.A. and Canada.

## 5.1 United States

For the U.S.A., estimates of federal tax expenditures are available from the **U.S. Treasury Department** and the **Joint Committee on Taxation** (part of the U.S. Congress). The **Energy Information Administration** also publishes federal funds going to energy programs in its tax-expenditure tables. These data are updated yearly and include all the budget details. However, it might not be possible to distinguish between subsidies going to oil and gas. (See Appendix C for more details)

## 5.2 Canada

Canada publishes transfer payment data (section: natural resources) annually in its *Public Accounts*. Tax expenditure tables are provided on the **Department of Finance**'s Web site. These tables include estimates for 2002 (and projections for more recent years) of expenditures relating to natural resources. (See Appendix C for more details.)

## 5.3 Australia

The Australian government's homepage (expenses by function) contains expenditure data only for the aggregate "Fuel and Energy." In 2004/05 these were listed as $4.5 billion Aus. For example, the **Department of Industry, Tourism and Resources** reports that the Australian government provides significant support to **Geoscience Australia** (a government agency) to undertake pre-competitive exploration data development, and there is a tax deduction of 150 per cent available for exploration expenditure incurred by companies operating in frontier areas. That tax deduction is administered by the **Australian Taxation Office** through the Petroleum Resource Rent Tax, but it is unknown how much this benefit is worth, as company tax details are confidential. The **Australian Petroleum Production and Exploration Association** (APPEA) publishes "financial survey results" that might be necessary to estimate the magnitude of the benefit. The Australian Bureau of Agriculture and Resource Economics may be another source of data.

Concerning coal, the **Australian Coal Association** might have more detailed information on financial support for UCC (ultra clean coal) technology and process.

## 5.4 Germany

For Germany, an important recent study is the *Schwarzbuch* (Black Book). It lists 19 budget categories for 2005 (concerning transport, coal and nuclear energy and tax breaks for energy intensive firms) that can be identified as potentially environmentally harmful. In addition to estimating how much those subsidies cost taxpayers, it also proposes how to diminish or abolish them.

The German government publishes a subsidy report (the long version is in German) every year. This document contains information on tax exemptions as well as budgetary expenditure. For example, there are many exemptions for the mineral oil tax that would be relevant for this study. However, some tax breaks (for example: the tax exemption for coal or tax breaks for diesel with respect to unleaded gasoline) are not reported.

A recent study (in German) by Meyer (2006) goes beyond these data and adds to the extended subsidy definition indirect subsidies provided through regulations and non-internalized externalized costs. Besides the large external costs generated by coal (both hard coal and brown coal), oil and gas, Meyer identifies important direct support for hard coal and important tax exemptions for oil. Moreover, she shows that the support listed in the government's annual subsidy report for direct financial support and tax exemption corresponds to half of her estimated direct support and to roughly a forth of her estimate of exemptions. Total fossil fuel subsidies using her larger definition (which includes non-internalized externalities) amount to €112.5 billion; using the narrow definition she obtains €36 billion (where, by far, the largest amount goes to oil).[1]

## 5.5 China

China's *Statistical Yearbook* is available online and contains information on prices, consumption and production for oil, gas and coal. Expenditures on geological prospecting are also reported. Unfortunately, the category "expenditures for price subsidies" covers all possible sectors, not only energy.

[1]Bettina Meyer would be a possible contact person for German subsidy information. She is also engaged in Green Budget Germany (www.foes.de).

The Web sites of the **China Sustainable Energy Program**, **China Energy Group**, **Energy Research Group**, or the **National Coal Industry Bureau** are also possible sources. The **Ministry of Finance** Web site seems to provide R&D expenditures to fossil fuels (in Mandarin).

## 5.6 Mexico

Information on Mexican energy programs can be obtained from the Web site of the **Energy Agency**. It offers also several statistical data, including prices. The Congress publishes a fiscal document containing data on expenditures. Unfortunately, energy is one of the few areas for which no detail is provided. However it might be possible to obtain these data from other sources.

## 5.7 India

The **Ministry of Petroleum and Natural Gas** makes available two kinds of documents. While the *Report of the Committee on Pricing and Taxation of Petroleum Products* discusses and reports subsidies to this sector, the petroleum statistics document lists subsidies to major petroleum products along with other useful data on production and prices.

Furthermore, a list of subsidies on major petroleum products (latest data for 2001) can be obtained from the **Statistical Office**, but the access is limited to members (annual access costs are $ 850 U.S. for an individual).

Budget data can be found on the *India budget* Web site. Detailed budget allocations are given separately for coal and petroleum and natural gas (*Volume II of Expenditure Budget*). The 2007/08 budget and a revised version for 2006/07 are currently available. Accounting information can also be obtained from the **Controller General of Accounts**. In addition, the **National Institute of Public Finance and Policy** published reports on energy subsidies.

Moreover, the **Planning Commission** of the government has some relevant information that can be seen, for example, in its publication *Integrated Energy Policy: Report of the Expert Committee*. One of its sections discusses policies covering the energy market and another section describes consumer subsidies through debit cards/Smart cards. Another source of information or contact is the **Energy and Resource Institute**, which is working on reports in the field (e.g. *Petroleum pricing in India: Balancing efficiency and equity*, 2006) and publishes the TERI Energy Data Directory and Yearbook. The 2005/06 edition, which covers national energy supply in its first part, sells for $130 U.S.

Some general information concerning fossil fuel energy can also be obtained from the *Energy Portal* Web site. The following research centres have been working also on subsidies **in India: CEE** (Center for Energy Economics, Texas) and **ABARE** (Australian Bureau of Agricultural and Resource Economics, see Australian References).

## 5.8 Indonesia

The Statistical Office reports some accounting data. Actual government expenditures 2005–07 contain oil and non-oil subsidy figures.

The National Development Planning Agency seems to have subsidy data, but knowledge of Bahasa is necessary to understand the documents. The same problem applies to other Web sites (cf. data sources for further links).

## 5.9 Summary

Statistical and governmental offices increasingly make more information available on their Web sites. However, identifying the best sources often requires a considerable amount of investigation. Some data may be collected but are not publicly available. For countries for which English is not a national language, good knowledge of the local language is necessary. The countries investigated above are those where the information is relatively easily available. For an in-depth study, involving local experts would be indispensable.

Beyond the national data sources that were identified above, there remains the problem of comparability between countries. For that, guidance will need to be provided to local researchers so that all are applying the same classification system and estimation methods.

## 6. ESTIMATION OF EXTERNALITIES

Externalities are changes in welfare generated by an activity but not reflected in market prices. They may be positive (benefits) or negative (costs). A cost (benefit) is external when it is not paid (enjoyed) by those who generate it.

Environmental externalities are not a problem for the manufacturer but rather for society, particularly the negative ones. Externalities are generated in every stage of energy production and consumption, from fuel extraction through transportation and processing, and the final disposal of waste. When prices do not account for harm or benefit done to third parties, economic agents have no incentive to change their behaviour. Welfare economics recommends that external costs be internalized to the point where marginal abatement costs equate marginal external costs imposed on society.

Some economists regard external costs associated with production or consumption as "implicit subsidies" because they are costs for society that are not reflected in the producer's or consumer's own cost equations. Other economists recognize externalities as vitally important to setting optimal policies, but prefer to keep the terms and the accounting separate from subsidies. Whether one considers non-internalized externalities as subsumed into the category of "subsidies" or not, there is little dispute that when evaluating policies they need to be taken into account.

State-of-the-art methods for the estimation of externalities employ an impact pathway approach developed within the ExternE[2] family of projects of the European Commission (e.g. Friedrich *et al.*, 2004). As a first step, all relevant pollutants emitted by existing sources are identified and assessed. Second, the dispersion of pollutants is simulated resulting in increased pollutant concentrations. Third, the impact of emissions on the affected population and the environment is estimated. More precisely, suitable exposure-response functions are employed and the impacts on health and ecosystems are estimated. Forth, the impact is converted into costs, monetizing the total impact on all receptors. Monetization as such is not without controversies and may include subjective aspects. While the value of crops lost due to air pollution can be estimated in a straight-forward manner on the basis of market prices for crops, there is no such option for the valuation of morbidity and mortality indicators, e.g. "year of life lost." Within the ExternE approach, willingness to pay (WTP) serves as the basis for establishing costs of such factors; with the implementation of WTP being supported by extensive surveys.

[2]The scope of the ExternE Project has been to value the external costs (i.e. the major impacts) coming from the production and consumption of energy-related activities such as fuel cycles. An external cost, also known as an externality, arises when the social or economic activities of one group of persons have an impact on another group and when that impact is not fully accounted, or compensated, for by the first group.

A non-exhaustive list of possible external effects that may be converted into monetary costs is as follows:

- Human health: mortality, morbidity due to non-fatal cancers, respiratory diseases, cerebro-vascular problems, etc.
- Building materials: ageing, soiling
- Crops: yield losses
- Global warming: global effects due to temperature rise
- Amenity losses
- Ecosystems: acidification and eutrophication
- Loss of biodiversity

Current experience suggests that health effects and global warming strongly dominate the external costs of fossil fuels (e.g. Dones *et al*., 2004). Particularly large uncertainties are associated with external costs of global warming. Due to differences in technology standards and vulnerability, damages caused by air pollution in non-OECD countries are normally much higher than in OECD countries (Hirschberg *et al*., 2003; Hirschberg and Heck, 2005). Occupational externalities are typically much smaller than the public ones; the former are also internalized to a higher extend. Though severe accidents in the energy sector are widely debated and subject to complex risk acceptance deliberations, the associated external costs are rather negligible compared to damages caused by air pollution from normal operation (Burgherr *et al*., 2004; Hirschberg *et al*., 2004a&b).

With relatively limited effort, PSI can provide estimates of dominant components of external costs for a number of countries, in particular for Europe and China. This can be done by suitable adjustments of results obtained by PSI and partners in earlier projects. Rough estimates could be provided for additional countries. Generally, a more precise estimation would call for extensive simulations, which in turn call for substantial extra resources.

## 7. RESEARCH STRATEGY

This overview provides an idea of the data that are already available and the data that will have to be gathered for this project. Given that the aim of the project is to go beyond price-gap estimates, it is necessary to work out a precise procedure to follow in order to be able to identify for each country on-budget and off-budget fossil fuel subsidies. Having examined the complexity of possible subsidy channels, it is clear that the following steps are necessary:

(i) Identify one or more subsidies specialists in each country.

(ii) Establish guidelines and criteria to be applied by local experts. These guidelines would set out the GSI's preferred scope of the subsidy definition and should allow the experts some flexibility in the degree of detail they can provide.

(iii) Compare the responses and data provided by different sources with a view to cross-validating the estimates. A plausibility test will also be devised and applied to the data.

(iv) Prepare additional estimations as necessary, in cases where some support programs are known but the amount is not available.

(v) Put together first results for subsidy estimates.

(vi) Provide feedback on the guidelines—what should be changed.

(vii) Start off into the second round of subsidy computations.

Parallel to step (v), modelling activities can also start.

## 8. CONCLUSION ON FEASIBILITY

As this study shows, a great deal of data useful for the estimation of fossil-fuel subsidies exists already. Some are already designed to be comparable across countries, but they are limited to prices and quantities, not subsidies. Subsidy data exist for the countries endowed with the best statistics and most transparent public accounts, but they rarely cover all possible forms of subsidization and they are not easily comparable across countries. Nevertheless, national data sources must be used to cover a sensible definition of subsidies. Extensive analyses of energy subsidization channels exist already for particular energy sources in selected countries, for example, biofuels in the U.S.A. This provides the methodological basis for the planned broad assessment of worldwide fossil energy subsidization.

Even though the Internet already allows access to considerable databases, the degree of access and of detail of the data differs considerably across countries. For all countries, it is necessary to have good knowledge of the local language and government organization in order to correctly understand national programs and to identify important sources of support for fossil energy producers and consumers. It is likely that the first round of data collection will be very time-consuming, but for the second round much less work will be needed if reliable contact persons and detailed data sources have been identified.

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# DATA SOURCES

## Multi-country data

ENERDATA, fossil fuel price data, www.enerdata.fr/enerdatauk/index.html

European statistics offices, http://epp.eurostat.ec.europa.eu/portal/page?_pageid=1072,62797445&_dad=portal&_schema=PORTAL

GTZ, diesel and gasoline prices and subsidy estimates, www.gtz.de/en/themen/umwelt-infrastruktur/transport/10285.htm

IEA, R&D Budget data, www.iea.org/Textbase/stats/rd.asp

IEA, price data availability, http://data.iea.org/ieastore/Assets/products/eptcoun.xls

OECD/EEA Database on instruments used for environmental policy and natural resource management: www2.oecd.org/ecoinst/queries/index.htm

CEE, Center for Energy Economics: http://www.beg.utexas.edu/energyecon/

ESMAP (Energy Sector Management Assistance Program, sponsored by World Bank and UNDP): www.esmap.org

## Single country data

*Australia*

Australian Government homepage: www.budget.gov.au/

Australian Government, Department of Industry, Tourism and Resources:

www.industry.gov.au/index.cfm

Australian Taxation office: www.ato.gov.au

(with petroleum resource rent tax page: www.ato.gov.au/large/pathway.asp?pc=001/009/029)

Australian Petroleum Production and Exploration Association (APPEA): www.appea.com.au

Australian Bureau of Agriculture and Resource Economics: www.abare.gov.au (or www.abareconomics.com)

Australian Coal Association: www.australiancoal.com.au

*Canada*

Public Accounts Transfer Payments: www.pwgsc.gc.ca/recgen/text/pub-acc-e.html

Department of Finance: www.fin.gc.ca

*China*

The statistical year book is online available at: www.stats.gov.cn/tjsj/ndsj/2006/indexeh.htm

The China Sustainable Energy Program: www.efchina.org

China Energy Group: http://china.lbl.gov

Energy Research Institute: www.eri.org.cn

National Coal Industry Bureau: www.chinacoal.gov.cn

The Ministry of Finance: www.mof.gov.cn/index.htm

*India*

Energy and Resource Institute: www.teriin.org

Energy Portal: www.indiaenergyportal.org

Ministry of Finance: http://indiabudget.nic.in and http://finmin.nic.in

Controller General of Accounts: http://cga.nic.in

Ministry of Petroleum and Natural Gas: http://petroleum.nic.in
Statistics: http://petroleum.nic.in/petstat.pdf
Report: http://petroleum.nic.in/report.pdf
Annual report: http://petroleum.nic.in/annual_report./ar06-07.pdf

Ministry of Coal: www.coal.nic.in

National Institute of Public Finance and Policy: http://www.nipfp.org.in/

Planning Commission: http://planningcommisssion.nic.in
Integrated Energy Report: http://planningcommisssion.nic.in/reports/genrep/intengpol.pdf

Statistical Office: www.indiastat.com

National Institute of Public Finance and Policy: www.nipfp.org.in

*Indonesia*

Statistical Office: www.bps.go.id
Actual Government Expenditures: http://www.bps.go.id/sector/pubfin/table2.shtml

National Development Planning Agency: www.bappenas.go.id

Department of Energy and Mineral Resources: www.djlpe.esdm.go.id

Coal Mining Association: http://www.apbi-icma.com

Mining Association: http://ima-api.com/index.php

Petroleum Association: http://www.ipa.or.id

Ministry of Energy and Mineral Resources: http://www.esdm.go.id/indexenglish.php

Regulatory Body for Oil and Gas Downstream Activities (BPH MIGAS): http://www.bphmigas.go.id/

Other pages of interest: www.dprin.go.id (ministry of industry and trade), http://www.depkeu.go.id/Ind/ (ministry of finance), http://www.nafed.go.id/ (ministry of trade), http://www.depperin.go.id/ENG2006/ (ministry of industry).

*Mexico*

Energy Agency: www.energia.gob.mx

Congress: www.cddhcu.gob.mx

*U.S.A.*

White House, www.whitehouse.gov/omb/budget/fy2008/pdf/apers/receipts.pdf

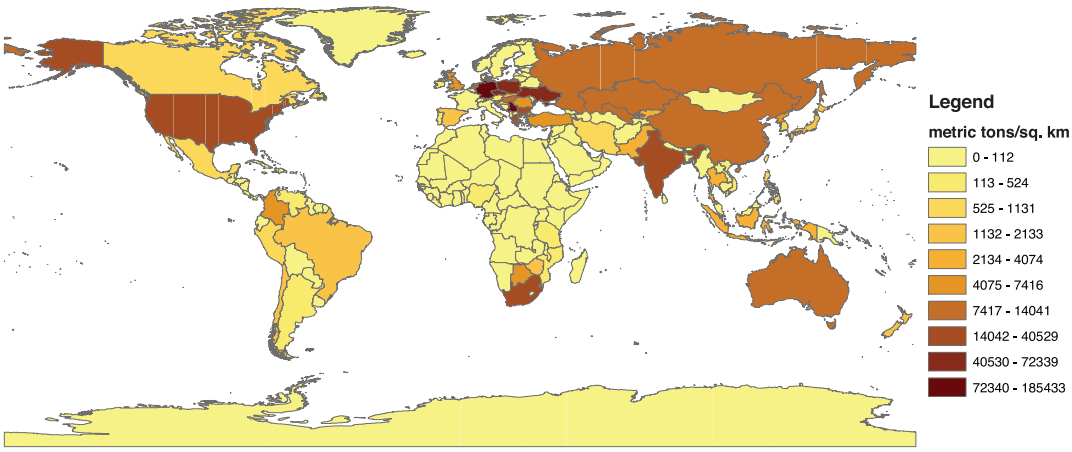
U.S. Congress, www.house.gov/jct/s-2-06.pdf

Energy Information Administration: Tax expenditure tables (1999): www.eia.doe.gov/oiaf/servicerpt/subsidy/tax.html

U.S. Government Printing Office; Energy Program: www.gpoaccess.gov/usbudget

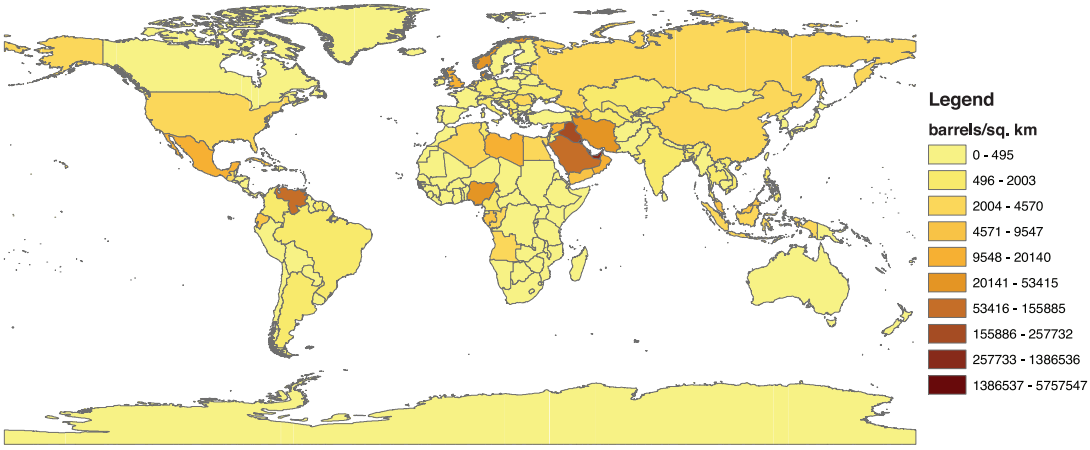
# APPENDIX A

## Map 1. International Distribution of Coal Reserves in 2001



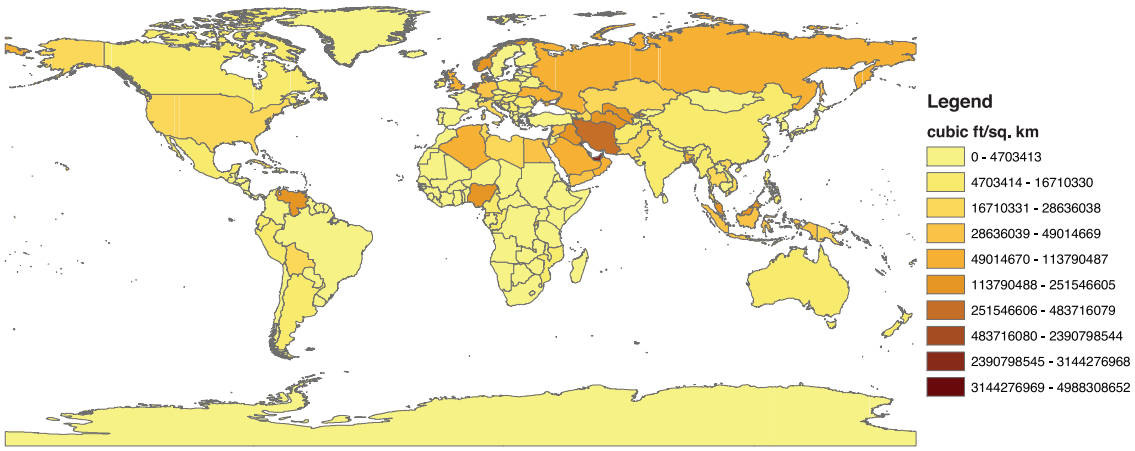

Values calculated from data from the *International Energy Annual 2001 Edition*
published by the Energy Information Administration of the US Department of Energy. Map template by ESRI.
Background materials for "Energy Resources and Global Development,"
*Science* 302 (5650), 28 November 2003.


## Map 2. International Distribution of Petroleum Reserves in 2001




Values calculated from data from the *International Energy Annual 2001 Edition*
published by the Energy Information Administration of the US Department of Energy. Map template by ESRI.
Background materials for "Energy Resources and Global Development,"
*Science* 302 (5650), 28 November 2003.

## Map 3. International Distribution of Natural Gas Reserves in 2001




Values calculated from data from the *International Energy Annual 2001 Edition*
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Background materials for "Energy Resources and Global Development,"
*Science* 302 (5650), 28 November 2003.

# APPENDIX B

## TABLE 4: PRICE DATA AVAILABILITY FOR FUEL OIL (IN U.S. $)

| Rank | Country | Light Fuel Industry | Residential | Heavy Fuel |
|---|---|---|---|---|
| 1 | Saudi Arabia | | | 00-06 |
| 2 | Russia | | | |
| 3 | United States | 00-06 | 00-06 | 00-06 |
| 4 | Iran | | | |
| 5 | Mexico | 00-06 | | 00-06 |
| 6 | China | | | |
| 7 | Norway | 00-06 | 00-06 | 00-03 |
| 8 | Canada | 00-05 | 00-06 | 00-06 |
| 9 | Venezuela | 00-04 | | 00-04 |
| 10 | United Arab Emirates | | | |
| 11 | Kuwait | | | |
| 12 | Nigeria | | | |
| 13 | United Kingdom | 00-06 | 00-06 | 00-06 |
| 14 | Iraq | | | |
| 15 | Algeria | | | 00-06 |
| 16 | Brazil | 00-04 | | 00-04 |
| 17 | Libya | | | |
| 18 | Kazakhstan | | | |
| 19 | Indonesia | 00-05 | 00-05 | 00-04 |
| 20 | Angola | | | |

## TABLE 5: PRICE DATA AVAILABILITY FOR NATURAL GAS GCV (IN U.S. $)

| Rank | Country | Industry | Residential | For Electricity |
|---|---|---|---|---|
| 1 | Russia | 00-05 | 00-05 | 01-03 |
| 2 | United States | 00-06 | 00-06 | 00-06 |
| 3 | Canada | 00-06 | | |
| 4 | United Kingdom | 00-06 | 00-06 | 00-06 |
| 5 | Netherlands | 00-04 | 00-06 | |
| 6 | Iran | | | |
| 7 | Norway | | | |
| 8 | Algeria | 00-03, 05 | 00-03, 5 | |
| 9 | Indonesia | 00 | 00 | |
| 10 | Saudi Arabia | 00-06 | | |
| 11 | Malaysia | | | |
| 12 | Uzbekistan | | | |
| 13 | Turkmenistan | | | |
| 14 | United Arab Emirates | | | |
| 15 | Argentina | 00-04 | 00-04 | |
| 16 | Mexico | 00-06 | 04-06 | 00-06 |
| 17 | China | | | |
| 18 | Qatar | | | |
| 19 | Australia | | | |
| 20 | Egypt | | | |

## TABLE 6: PRICE DATA AVAILABILITY FOR BITUMINOUS COAL (IN USD$)

| Rank | Country | Industry | Residential | For Electricity |
|---|---|---|---|---|
| 1 | China | 00-05 | 00-03 | |
| 2 | United States | 00-06 | | 00-06 |
| 3 | India | 00-04 | 00-03 | 00-04 |
| 4 | Australia | | | |
| 5 | Russia | 01-03 | | 01-03 |
| 6 | South Africa | 00-01 | 00-02 | 00-02 |
| 7 | Germany | 00-06 | | 00-06 |
| 8 | Poland | 00-06 | 00-06 | 00-06 |
| 9 | Indonesia | 00 | | 00, 02-03 |
| 10 | Kazakhstan | | | |
| 11 | Greece | 00-06 | | |
| 12 | Canada | | | 00-03 |
| 13 | Ukraine | | | |
| 14 | Czech Republic | 00-03 | 00-06 | 00-03 |
| 15 | Colombia | 00-04 | | 00-02 |
| 16 | Turkey | 00-06 | 00-06 | 00-06 |
| 17 | Serbia and Montenegro | | | |
| 18 | Romania | | 00-06 | |
| 19 | Korea, North | | | |
| 20 | Bulgaria | | | |

# APPENDIX C

## U.S.A.

*Examples from the Energy program (published by U.S. Government Printing Office): actual 2006 data*

Fossil Energy Research and Development: $587 million dollars U.S.

- President's coal research initiative: $310 million dollars U.S. (2006). The focus of this project is to decrease emissions and to build a near-zero emissions fossil fuel-fired power plant and to finance sequestration R&D.
- Program direction and management support: goes to fossil energy and clean coal projects as well as to natural gas transportation projects.

Naval petroleum and oil share reserves: $22 million U.S.

Strategic petroleum reserve (to reduce vulnerability of U.S.): $201 million U.S.

Energy Information Administration: should not be considered as an EHS

Federal Energy Regulatory Commission: This commission regulates key interstate aspects of electric power, natural gas, oil pipeline and hydropower industries; the commission might have some additional information concerning existing state-level subsidies.

Ultra-deep water and unconventional natural gas and other petroleum research fund (small amount)

*Estimates of federal tax expenditures (fiscal year 2006):*

Tax expenditures are reported separately for corporations and individuals (we report corporations).

In the Energy section one can find the following positions:

Expensing of exploration and development costs (oil and gas): $1.1 billion U.S.
Excess of percentage over cost depletion (oil and gas): $1 billion U.S.
Several subsidies not directly associated to oil and gas
Amortization of geological and geophysical costs associated with oil and gas exploration (small amount)

*Federal receipts and collections: Income tax expenditures (actual 2006 data)*

Expansion of exploration and development costs, fuels: $0.7 billion U.S.
Excess of percentage over cost depletion, fuels: $0.8 billion U.S.
Exception from passive loss limitation for working interests in oil and gas properties: small
Capital gains treatment of royalties on coal: small
Credit for investment in clean coal facilities: small
Temporary 50 per cent expensing for equipment used in the refining of liquid fuels: small
Natural gas distribution pipelines treated as 15-year property: small
Amortization of all geological and geophysical expenditures over 2 years: small

There are additional positions listed, but they cannot be attributed directly to the fossil fuels defined here, nor do they look very much like EHS.

## Canada

*Transfer payment data (2005/06):*

Contributions to the Atlantic Innovation Fund; Centre for Marine Compressed Natural Gas, St. John's, NL: $2 million Cdn

Contribution to the Canada/Nova Scotia Offshore Petroleum Board: $1 million Cdn
In support of infrastructural costs directly or indirectly related to the exploration, development, production or transportation of oil and gas in the offshore area of Newfoundland: $1 million Cdn

Contribution to the Canada/Newfoundland Offshore Petroleum Board: $2 million Cdn

Payments to the Newfoundland offshore petroleum resource revenue fund(s): $4 million Cdn

Payments to Canadian Gas, Ottawa, ON: $1 million Cdn

Enbridge Gas Distribution, North York, ON: $1.5 million Cdn

Some other contributions seem to be directly linked to environmental friendly projects like:

Contributions in support of climate change research, contributions in support of carbon capture and storage projects, support for clean coal research.

*Tax expenditure tables include the following positions:*

Earned depletion: $21 million Cdn
Net impact of resource allowance and the non-deductibility of Crown royalties and mining taxes: $360 million Cdn
Tax rate on resource income: $-210 million Cdn

The following paper may also be helpful for understanding the Canadian taxation system: Improving the *Income Taxation of the Resource Sector in Canada* (www.fin.gc.ca).

## THE GLOBAL SUBSIDIES INITIATIVE (GSI) OF THE INTERNATIONAL INSTITUTE FOR SUSTAINABLE DEVELOPMENT (IISD)

The International Institute for Sustainable Development (IISD) launched the Global Subsidies Initiative (GSI) in December 2005 to put a spotlight on subsidies – transfers of public money to private interests – and how they undermine efforts to put the world economy on a path toward sustainable development.

Subsidies are powerful instruments. They can play a legitimate role in securing public goods that would otherwise remain beyond reach. But they can also be easily subverted. The interests of lobbyists and the electoral ambitions of officeholders can hijack public policy. Therefore, the GSI starts from the premise

that full transparency and public accountability for the stated aims of public expenditure must be the cornerstones of any subsidy program.

But the case for scrutiny goes further. Even when subsidies are legitimate instruments of public policy, their efficacy – their fitness for purpose – must still be demonstrated. All too often, the unintended and unforeseen consequences of poorly designed subsidies overwhelm the benefits claimed for these programs. Meanwhile, the citizens who foot the bills remain in the dark.

When subsidies are the principal cause of the perpetuation of a fundamentally unfair trading system, and lie at the root of serious environmental degradation, the questions have to be asked: Is this how taxpayers want their money spent? And should they, through their taxes, support such counterproductive outcomes?

Eliminating harmful subsidies would free up scarce funds to support more worthy causes. The GSI's challenge to those who advocate creating or maintaining particular subsidies is that they should be able to demonstrate that the subsidies are environmentally, socially and economically sustainable – and that they do not undermine the development chances of some of the poorest producers in the world.

To encourage this, the GSI, in cooperation with a growing international network of research and media partners, seeks to lay bare just what good or harm public subsidies are doing; to encourage public debate and awareness of the options that are available; and to help provide policy-makers with the tools they need to secure sustainable outcomes for our societies and our planet

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The GSI is an initiative of the International Institute for Sustainable Development (IISD). Established in 1990, the IISD is a Canadian-based not-for-profit organization with a diverse team of more than 150 people located in more than 30 countries. The GSI is headquartered in Geneva, Switzerland and works with partners located around the world. Its principal funders have included the governments of Denmark, the Netherlands, New Zealand, Norway, Sweden and the United Kingdom. The William and Flora Hewlett Foundation have also contributed to funding GSI research and communications activities.

## FURTHER DETAILS AND CONTACT INFORMATION

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