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SUSTAINABLE DEVELOPMENT, ENERGY AND CLIMATE CHANGE IN THE EUROPEAN UNION

Theoretical Article

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Abstract

Through sustainable development the needs of the current generation are fulfilled without jeopardizing the opportunities of future generations. The concept takes into account economic, social and environmental considerations. It has a wide range of applications from natural resources to population growth and biodiversity. One of its most important themes is energy. In this area, sustainable development relates with resource availability and green house gases emissions. Also it takes into account the needs of people without access to energy, and their legitimate quest for development. For the European Union, sustainable development represents an overarching objective. The present article analyzes the concept from a theoretical perspective, contrasting its strong points and weaknesses. It highlights the relation between sustainable development, energetic resources and climate change. The EU policies results in the field of energy are analyzed from the perspective of resources, energetic dependency and climate change efforts.

Theoretical considerations regarding sustainable development

The production process can be viewed from the perspective of an *input-black box-output* system. In this kind of a representation, the *input* is represented by the natural resources, work, capital, technology and knowledge. Within the *black box* the resources are processed and transformed through work and knowledge with the help of capital and technology. The *output* is represented by the goods and services obtained. Along the goods and services resulted, the *output* also consists in waste that may or may not harm the environment. Some of this waste can be reprocessed for further use, or they can remain as residual.

In relation with the groups which can be positively or negatively affected, we can distinguish externalities, which are effects of the production or consumption patterns, which causes costs or benefits to persons or groups that have not paid or have not been compensated (Samuelson, Nordhaus, 1989, 770). Externalities represent an effect of the production process and one of the reasons behind the sustainable development theory.

From the *input* side we can observe that knowledge and technology will always be on an ascending trend due to the fact that they are shared from one generation to another thus constituting the base of further improvements. Due to their improvement the capital base will also increase. However the question stands regarding the natural resources: will they always be on an ascending trend, to satisfy the needs of an ever growing population and economy. Once consumed a natural resource finds itself either in the products or services or in the waste that it generates. A natural resource in shortage can be further used by exploitation of lower grades or, substituted by another or its rate of consumption can be decreased through better use. For an economy it is not important the quantity of resources at a certain point in time, but the services that it can provide for society. Regarding the *output* it also raises the question of the environment capacity of handling an ever growing quantity of waste.

These matters raised the dilemmas during the seventies in Western world regarding the way society should follow its development. During this period a series of influential works appeared regarding the future of humanity, which highlighted the pressure of a growing population over a finite natural resource base (Elliot, 2006, 31). These works treated subjects raised earlier by reverend Malthus regarding an ever expanding population with limited resources of food. The neomalthusians of the seventies also raised concerns over natural resources and environment (Goklany, 2007, 6). One of the most influential of these reports was the *Limits of Growth* which concluded by using a computer simulated scenario that due to the exponential growth of the studied elements (e.g. population, industrial production) and the relations between these variables (*feedback loops*), the system would eventually crash due to resource failure in a finite world. The report called for a controlled contraction of the population and capital in order to live within the limits of the system (Meadows *et al*, 1972). Although being highly criticized, it did however raised concerns at the academic and policy makers level regarding the kind of development society should aim for.

Through the *Limits* the world realized that economic growth must be approached in the framework of population growth, natural resources and environment. To answer to this need the United Nations charged the World Commission on Environment and Development (WCED) in 1983 to develop a concept that would assure that economic growth can be obtained alongside with the improvement of the standard of life and the quality of the environment (Pohoaţă, 2005). The effort of the Brundtland Commission entitled *Our Common Future* report led to an alternative concept regarding development. Here we can find the most common definition of sustainable development: *the development that meets the needs of the present without compromising the ability of future generations to meet their own needs*. This concept combines the economic, social and environmental dimension of development in order to secure welfare for the future generations. It aims at correcting the way in which welfare is obtain by some, while at the same time reducing the poverty faced by others. The definition incorporates two concepts: the concept of needs referring to basic needs of world's poor and the concepts of limits from the perspective of state technology and social. The report recognizes the presence of relative but not absolute limits, but it remarks that technology and social organization can be turned into desired direction that will generate a new era of economic growth (WCED, 1987).

Reviewing the literature, we can find different perspectives related to the concept: UNESCO approaches SD from the point of intergenerational equity and the need to preserve unharmed the water, air and soil resources for the coming generations; Barbier and Markandya regard it as the economic activity that preserves the environment and maximizes the benefits of economic development (Dumitrescu, 2005, 17-18, after Barbier and Markandya, 1990); Turner sees in sustainability a policy that aims at maintaining an acceptable per capita revenue growth rate without diminishing the capital and natural resource stock (Elliot, 2006, 10, after Turner, 1998); Strange and Bayley consider that the natural resources should be divided equally between generations and that interests of the future generations should be protected even if it implies costs for the current generations (Strange, Bayley, 2008). Pearce and Atkinson distinguish between *weak sustainability* and *strong sustainability*. *Weak sustainability* presumes that the total stock of capital will not decrease over time, allowing for changes between different types of capital (for e.g. natural with produced), while *strong sustainability* focuses on the importance of natural capital that should not decrease over time (Dumitrescu, 2005, 26, after Pearce and Atkinson). For the two authors mentioned above for sustainability to occur each generation should leave for the next one a stock of productive capacity represented by produced capital and technology that can maintain the welfare per capita of the previous generation (Pearce, Atkinson, 1998).

On the other side if we take a close look at the critics regarding sustainable development we will find according to Mitchell that it is a creative and ambiguous concept that leaves room for interpretation (Elliot, 2006, 10, after Mitchell, 1997). Redclift observes that it is difficult not to approve such a concept but he also remarks that it is full of contradictions (Elliot, 2006, 10, after Redclift, 1997). Taylor considers that it is difficult to define sustainability in relation with needs due to the fact that we do not know which will be the needs of the future generations. Therefore it is not useful to save current resources from exploitation, as produced capital is more flexible than natural capital. Current exploitation leaves for the future generation science, technology and produced capital from which future generations can benefit (Taylor, 1994). Beckerman reclaims the fact that the concept embodies technical elements specific for development alongside moral aspects. Most of the sustainability definitions do not argue why this kind of development is preferable to other paths of development, such as highest level of welfare (Beckerman, 1996).

As we have seen above, sustainable development approaches the use of natural resources. The first thing that we would like to question is the natural character of resources. They are not at all natural, only the matter from which they originate is natural. They represent a man made creation being *produced* through work and capital. Most of them can not be used in their original state. This is why the natural stock of resources can not be viewed from a finite perspective (Hartwick, Olewiler, 1986, 1-2). Also the available resources represent a function of economics and technology. Through the geological availability of resources we understand the quantity of resources that can be extracted at certain price. If demand increases for a certain resource, efforts will be taken in order to substitute or find new quantities. This is why throughout the 20th century the quantity of available resources was on an ascending trend in spite of their use (Taylor, 1994). The most useful tool in order to characterize the rarity of a resource is its price. Today's resources may not be tomorrow's resources as technology and capital can develop new resources. Due to the fact that technology is evolving and resources are developed it is possible that certain resources left unexploited will remain so and they will represent a missed opportunity for certain countries that owe them.

Therefore, from our point of view natural resources should be exploited regardless of their current level of availability, because through their use there is created physical capital, technology and knowledge that can further develop new resources. Regarding the impact upon the environment we can observe that the sustainable development requires a certain kind of growth, focusing on the use renewable resources in contrast to non renewable, especially in the energy field. This kind of growth presence costs, and it is not affordable for the developing world, this being one of the paradoxes of sustainability the desired economic growth versus the affordable one. The dilemma is who can better preserve the health of the environment: the state through regulation or the private interest, aspect in which Taylor regards subsidies and public property as the main threats to sustainability (Taylor, 1994). From our perspective if the environment goods (e.g. fish stock) have an economic realizable value than it would be better protected and exploited by the private interest because it would be motivated in maintaining the resource availability. The role of the state should be to find ways in which to internalize the impact upon environment. Similar to Solow view, it is not feasible neither desirable to leave the world as we have found it (Solow, 1991).

Sustainable development in the EU

Sustainable development represents a key concept for the European Union. As early as 1992 with the *Summit of Earth*, the signatory parties of the *Rio Declaration* committed themselves in developing strategies regarding the implementation of the concept (European Commission, 2001a). We can also find the principle being mentioned in the Maastricht Treaty, as the Union should aim for a balanced and sustainable economic and social progress (European Union, 1992). The concept is also included in the Treaty of Amsterdam as an overarching objective of the EU polices. By taking into account sustainability EU policies should target in an integrated approach economic, social and environmental objectives (Hontelez, Buitenkamp, 2006).

In 2001 Gothenburg Summit the EU leaders recognized the importance of an integrated approach. The Council Conclusions highlight the fact that the development of new technologies with reduced impact upon the environment, in relation with the energetic and transportation sector could represent an opportunity for obtaining economic growth. (European Commission, 2001b). The adopted strategy (EU SDS) was not built upon specific measures and objectives, but rather as guidance for policy makers in order to take sustainability into account (Adelle, Pallemaerts, 2010).

In 2005 the SDS suffers a renewal process, in order to reflect the current evolutions. There were identified unsustainable trends in a number of areas such as natural resources pressure, climate change, biodiversity, poverty, inequality and population ageing where sustainable development should be applied. Also the unsatisfactory economic performance of EU coupled with competition from new industrialized countries such as China, India or Brazil opened new perspectives regarding sustainable development. The renewed strategy sets a series of objectives and specific measures in order to approach the unsustainable trends identified. For example, regarding climate change and energy the overall objective is to limit the phenomenon, its cost and effects on society and environment (Council of the European Union, 2006).

Finally the *Europe 2020 Strategy* developed in the context of the global economic crisis, recognizes the need for a smart, sustainable and inclusive growth. Sustainable growth implies a competitive, resource efficient and sustainable economy, which can develop new processes and technologies including those *green* with low environmental impact. The Union must be prosperous in a low carbon, in relation to climate change, and resource constrained world. In achieving its purpose and also being sustainable the EU must improve its competitiveness by maintaining its leading position in the *green* technologies market, tackle climate change by reducing its carbon emissions, developing carbon capture and sequestration technologies, improving resource efficiency and finally produce a clean and efficient energy by developing renewable energies that improve energetic security and create jobs (European Commission, 2010). We can observe that by following these objectives the EU is actually drawing a framework in which it wants to develop its energetic technologies and industries. By this it aims in directing its investment effort to a certain kind of development.

The link between sustainable development energy and climate change

The renewed SDS mentions the Union should aim to limit *"climate change and its costs and negative effects on society and the environment"*, by achieving the Kyoto Protocol commitment, developing an energy policy that assures the security of supply, competitiveness and sustainability of the sector and by integrating climate policy into all relevant policies (Council of the European Union, 2006). Also the Europe 2020 strategy mentions the objectives of the European energy policy up to 2020 in relation with climate change: *cut of 20% GHG emissions compared to 1990 levels (30% if other developed countries also commit)*; *20% share of renewable in final energy consumption*; *and a 20% increase in energy efficiency*. On the long run the EU aims to decarbonize its economy by cutting the GHG emissions up to 80-95% (European Commission, 2010).

But how does sustainable development relate to energy and climate change? Firstly it is the question of resources and their availability for the future generations. Taking into consideration the *input-black box-output* overview we can observe that the input availability can not be questioned as for the moment there is no clear alternative to fossil fuels and the demand for energy is presumed to be on an ascending trend, especially due to emerging economies. Secondly the energy process implies externalities which are a part of the *output* namely air pollutants and greenhouse gases (GHG) which can lead to climate change.

For the first issue we must mention that our energetic system is currently dominated by the fossil fuels, which represent over 80% of the 13.113 Mtoe, total primary energy supply from 2011, as seen in the Figure 1.

In theory fossil fuels are a non-renewable resource and by correlating their current inventory with the annual consumption rate we can determine their availability. However, if we approach the matter from a long term perspective all resources are renewable, for e.g. oil does regenerate itself in billions of years through geological processes. This is why for some generations certain resources are non-renewable. Time is the element through which from practical considerations we distinguish between renewable and non-renewable resources at a certain point (Hartwick, Olewiler, 1986, 1-2).

As we may observe in the Table 1 taking into consideration the proven reserves of fossil fuels, the availability of these fuels exceeds just above one century and this raises the question of the sustainability of our current energetic system. This matter can be approached from the perspective of intergenerational equity, as future generations may find themselves in shortage of energetic resources. However the overview changes if we take into account the recoverable resources which are known but not exploited due to economic considerations. We can observe that in the case of coal the recoverable resources are quite large, allowing this resource to be exploited for thousands of years.

We can highlight this aspect in the case of natural gas reserves which found themselves in an ascending trend in the period between 1992-2012, with a 64.64% increase in the non OECD area and 22.36% increase in the OECD countries (Figure, 2). The significant gap in reserves availability between the two entities explains the high dependency rate for gas imports on the OECD zone (British Petroleum, 2013).

Here we can also highlight the current developments taking place in the United States in the area of unconventional gas. Unconventional gas and oil resources represent traditional hydrocarbons for which alternative technologies are required in order to allow the economic exploitation (WEC, 2010). The difference between conventional and unconventional hydrocarbons is the rock in which they are located. The main characteristic of an unconventional reservoir is the fact that it has a low permeability which does not allow the flow of gas and oil to the well (IHS, 2012). They represent the gases that have not migrated to a traditional reservoir (IEA, 2012). However unconventional gas and oil resource existence is well-known but due to the low permeability of the rock the yield of these reservoirs was unsatisfactory to pursue their exploitation (WEC, 2010). Current technological improvements in the area of horizontal drilling and hydraulic fracturing allow the creation of a permeable reservoir within the source rock, aspect which led to the economic extraction of these resources (IHS, 2012). So the current developments in the area of unconventional gas are not a consequence of resource discoveries but rather of resource *creation* due to the technological breakthroughs in the extractive industry. At global level the unconventional resources can represent a game changer due to the availability and geographical location of these resources. As we can observe in the Table 2, the remaining technically recoverable resources of unconventional gas represent about 40% of the total technically recoverable gas resources, percent that highlights their potential.

Within the structure of unconventional gas, shale gas represents the main component (IHS, 2012). From a geographical perspective we can see that these resources are not located into the traditional areas of gas resources location namely the Eurasia and the Middle East, aspect which allows the development of new gas producers at the international level and a better diversification of gas supplies. The United States is the main actor in the field of unconventional gas, at the middle of the last decade due the technological developments, production of shale gas increased with over 45% in the interval 2005-2010. In 2010, unconventional gas production represented 60% of the total US gas production, (IEA, 2012a). With certitude this *created* resource will play an important role in the future of United States energetic security and economy.

Having the above taken into account, we can conclude that resource availability should not be regarded as a constraint. Resource availability can be taken into account at country or regional level in relation with its energetic security. Traditionally the energetic security represents the continuous supply of energy to an economy at an affordable price (WEC, 2008). This definition focuses onto quantities and prices, while other approaches take into account the impact upon environment (Pascual, Elkind, 2010). It is considered that a country is vulnerable in the energy field when its energetic decisions are dictated by economic factors which are beyond its control (WEC, 2008). Although obtaining energetic independence at a prohibitive cost is not a sustainable option, the presence or development of energy resource within a country will improve its energetic security. If we take a close look at the case of the European Union we will observe that it has a high dependency rates for fossil fuels, namely 42.2% for solid fuels, 86.4% for petroleum products, 65.8% for gas and 53.4% for all products (Eurostat, 2013). This raises questions regarding the efforts needed in order to secure supplies.

The second issue regarding sustainability in the energy field relates to the impact of the sector upon the environment, due to GHG emissions. Greenhouse gases such as carbon dioxide, methane or water vapour are gases that allow the sunlight to enter the atmosphere and also maintain the radiated heat from escaping back to the space thus creating the greenhouse effect. Due to greenhouse gases the average temperature on our planet is maintained at a hospitable level. However, if the effect becomes too strong due to emissions growth and not enough radiated heat can escape the atmosphere the temperatures may rise at dangerous levels (Bradley, Fulmer, 2004, 144). The Fourth Assessment Report of the IPCC (2007) states that most of the observed increase in global average temperatures since the mid of the last century is due to the growth of anthropogenic greenhouse gases concentrations (IEA, 2012b). And they occur mainly as a consequence of energy sector (65% of the anthropogenic GHG). Climate change is associated with negative consequences such as rising sea water levels, snow and rainfall in unusual places or the increasing occurrence of natural catastrophic events. Due to the increase of man made GHG emissions, observed temperature increase and the associated potential consequences the heads of states have decided at the G8 Summit in Heiligendamm that actions must be taken in order to reduce emissions and prevent the temperature rise above 2C (WEC, 2009). However up until now there is no international agreement regarding GHG reductions. Current efforts are concentrated in reaching an agreement with binding targets until 2015 (IEA, 2012).

As we have seen, the EU is committed into reducing its GHG emissions. It aims at achieving this with the help of two other objectives by raising the renewables share (20%) in the energy mix and also by improving its energy efficiency with 20%. In the transport area it aims a similar purpose through the use of biofuels, the Renewable Energy Directive setting a target for 10% renewable energy in this field (IEA, 2012b). Climate change is a potential threat at global level but also to the European Union as the Commission analysis shows that in contrast with 0.7C global increase in average temperature, the increase at the level of the European area was higher at 0.95C. (European Commission, 2005).

In the context of reaching an international agreement by 2015, the EU will have in theory at its disposal an advantage due to its early efforts. These technologies developed internally and supported by the Union could also be exported to other states. We can observe that as in the case of the US shale gas, the Union is actually aiming at *creating* its own energetic resources by harnessing the renewables potential and by saving energy. We can say that EU is trying to achieve more energetic output with less input. In conclusion the sustainable concept applied to energy in the EU aims at two interrelated objectives: energy security improvement and GHG reductions. However in order to be successful the EU must compare the costs of these policies with the developments taking place around the world, as the cost of energy impacts industries competitiveness at global level. By mitigating climate change and thus internalizing the carbon costs into the energy price we can say that at global level there will take place a leveling of the playing field in terms of energy costs which will be in favour of the states which tax carbon already in contrast with the ones who do not. It is difficult to believe that given the dominance of fossil fuels in the energy mix that they be replaced in the foreseeable future by other types of energies.

But how successful was the EU in its energetic options? In order to monitor the progress of the EU to a sustainable development path, every two years Eurostat releases a report in this area. In the field of climate change and energy we find three indicators that are monitored: greenhouse gas emissions, share of renewable energy in gross final energy consumption and primary energy consumption. If we take a close look at the evolution of these indicators over the last period we can observe favourable trends towards achieving the objectives. At the greenhouse gas levels in 2012 the emissions were situated at 82.14% of 1990 level with 1% bellow the previous year (Eurostat, 2014).

However if we look at the relation between the economic activity and the gas emissions we can observe that the most important reductions were achieved during the economic crisis with a low demand for energy when they fell from 90.41% to 83.83% of 1990 levels in the period 2008-2009 and raised their levels again to over 85% in 2010. These reductions are made in a context of declining demand for energy by the EU from 1688.7 Mtoe at the start of the crisis to 1583.5 Mtoe in 2012. Only in 2010 with the achievement of a 1.7% GDP growth the demand for energy grew with 3.4%. In the renewables area, their share in the gross final energy consumption has raised 14.1% in 2012 from above 8% in 2004 (Eurostat, 2014). However developments on the other side of the Atlantic have the potential of influencing the EU policy results. In this way we can observe the case of Germany which released in 2013 the largest quantity of CO_2 in the last 5 years totalling 834 million tones, quantity 1.2% higher than in 2010. The answer to the higher emissions levels is to be found in the shutting down of 8 nuclear reactors in the wake of the Fukushima nuclear plant accident in Japan in 2011. Due to the reduction of nuclear share in the electricity mix from 22.2% to 15.4% the role of coal has increased in the country's energetic system both as a substitute to nuclear but also as back up capacity for renewable intermittency. Due to the abundance of unconventional gas on the US market, large quantities of coal have become available for shipment to Europe and they have been used on the German energy market where the role of coal has grown from 41.5% to 45.2% in electricity generation. Due to the attractive price of coal in relation with gas and the reduced penalties on carbon emissions coal has also dispatched gas on the German market with gas reducing its share in the electricity mix from 14.1 to 10.5% (WNN, 2014).

Conclusions

Sustainable development as a concept can be applied in the field of energy in relation with the availability of resources and externalities upon the environment perspective. The first theme, resource availability is related with the *input* side of the *black-box* approach, while the second is dedicated to the *output*. The *black-box* approach can be perceived as the economy of a country which needs energy inputs in order to create goods and services but also releases air pollutants and GHG emissions. Also in conjunction with the climate change theme, due to the fact that the fossil fuels emissions are quite high, especially for coal and oil, it is raised the question regarding which kind of energetic resources should be used for assuring the energetic security of a country but also reducing its GHG emissions. Our energetic system is dominated by fossil fuels and regarding the availability of resources the discussion must not be raised at global but at state level. The European Union is aiming through its energetic policy at achieving this objective by harnessing the potential on renewable energies and also by consuming less energy. By this it develops its own energetic resource. In contrast the US has similar approach with the unconventional gas that improved the energetic security of the country and also limited the GHG emission. As he have seen the sustainable development indicators evolution in this field show that input and output side of this process are linked by the level of economic activity. Up until now the most significant reductions were obtained during the economic crisis. Also as in the case of Germany's emissions we can see the effect between competing energetic resources, as the cheapest resource will be preferred. Also the intermittency nature of renewable pursuit must be taken into account because it implies backup capacity and costs. In conclusion, in order for the European Union to achieve sustainability in the energetic filed it should also be the economic pillar which implies the assurance of its economies with energetic resources at sustainable prices. The climate change mitigation effort will also be influenced by the developments which will take place at the global level, so the reductions of the EU GHG should be correlated with the price of reductions and the impact upon the economies.

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Tables and |Figures

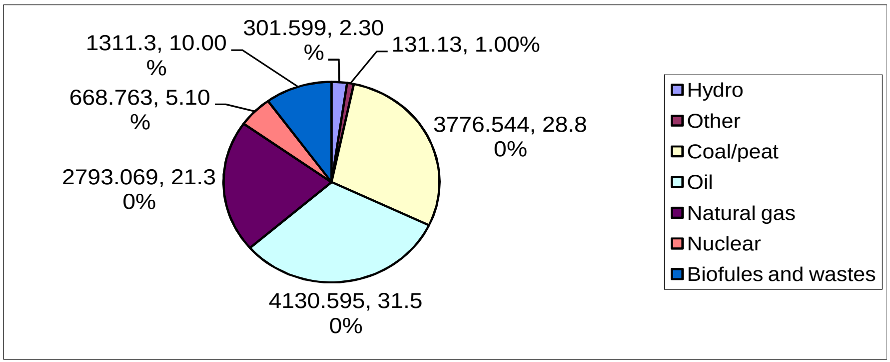

Figure No.1: Total Energy Primary Supply, 2011, Mtoe. Category *Other* includes geothermal, solar, wind, heat. Source: IEA, 2013.

Table No1:
Fossil fuels reserves and resources, 2011

Fossil fuels	Reserves/Resources	World	R/P ratio (years)
Coal (billion tonnes)	Proven reserves	1004	132
	Recoverable resources	21208	2780
Natural gas (tcm)	Proven reserves	232	71
	Recoverable resources	790	241
Oil (billion tonnes)	Proven reserves	1694	55
	Recoverable resources	5871	189

Source: IEA, 2012 after BGR (2011), O&GJ (2011), USGS (2000), USGS (2012a), IEA data base and analysis

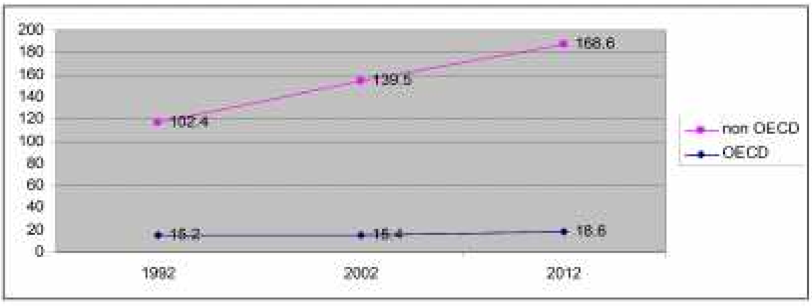

Figure No.2: Natural gas reserves evolution 1992-2012, OCED/non OECD, tcm. Source: BP, 2013.

Table No.2:
Remaining technically recoverable natural gas resource, 2011, tcm.

Region	Conventional	Unconventional	Total
Europe/Eurasia	144	44	187
Middle East	125	12	137
Asia-Pacific	43	94	137
OECD Americas	47	67	114
Africa	49	40	88
Latin America	32	48	80
OECD Europe	24	22	46
World	462	328	790

Source: IEA, 2012 after BGR (2011), US DOE/EIA (2011), USGS (2000, 2012).