2

Sustainable Development vs Environmental Engineering: Energy Issues

Artur Pawłowski
Lublin University of Technology, Nadbystrzycka 40B, 20-618 Lublin Poland

1. Introduction

Man can't live without environment, one with some strictly specified parameters. Despite this known truth, the relation between man and environment is far from peaceful co-existence. From history's point of view, it can be noticed that mankind have repeatedly caused environmental disasters. At first those were purely local. The primitive nomad usually moved elsewhere in the face of an ecological problem. Later on, the situation became much more complicated. Underestimating the environmental conditions lead to the downfall of the first literate and highly advanced civilization in history, the Sumerians (Ponting, 1993), stabilized as early as 3000 B.C. The area it occupied, between the rivers of Euphrates and Tigris (Lower Mesopotamia), favored agricultural development. The yields were high due to the highly developed irrigating system. A rapid increase in population was observed, along with the increasing demand for food. The increase in yields slowed down however, and depleted systematically, reaching one-third of the maximal yields about 1800 B.C. The signs of crisis were ignored, however, which led to a complete breakdown of the agriculture as well as the entire civilization. Among many causes of the yields' decrease, two deserve a special mention.

- Widespread irrigation favored the increase of soil's salinity (one of the major causes of soil degradation).
- The growing demand for food, along with the increasing populace entailed expanding cultivated area. After utilizing all available farming areas, forests were cut out and the land obtained in this way was cultivated. This resulted in increasing erosion – another important form of soil degradation. Moreover, depletion of plant cover and erosion made way to creating large runoffs and the silting of rivers, which caused floods as a consequence.

Modern technical powers of mankind are much bigger however, than those of the Sumerians. Our pressure on the environment has also increased. Not only can mankind cause its own extinction, but the destruction of the entire biosphere.

Not so long ago it seemed that environmental protection will bring rescue. A breakthrough moment of its development was the U'Thant report in 1969. Although earlier efforts to help the environment were made – the first known act regarding the environment was introduced in China about 1122 B.C. – it was the 20th century and U'Thant's report that made way to large-scale international initiatives. Media publicity, that accompanied the report also helped shape the worldwide society's awareness of the environmental threats.

Alas, classic environmental protection was not able to stop biosphere degradation. Therefore, the discussion was broadened in 1987, with the formulation of sustainable development concept, merging various problematic groups, including technology, ecology, economics, but also politics, philosophy or social backgrounds.

2. Discussion over the notion of sustainable development

The concept of sustainable development refers to a highly popular category of 'development' as such. It plays a major role in economics, especially in the context of economic growth (increasing the elements of a given structure). Apart from that, many other features are assigned to growth, such as: intensiveness, dynamism, rapidity, speed, and on the other hand extensiveness, slowness or durability, sustainability, suspense (Piontek, 2005). It can also be referred to pan-civilizational changes as well as more specific issues, such as science, culture, language, economy or society.

Generally speaking, it can be said that 'progress' is a change of state of a given structure (in a civilizational sense, it would be the whole of a society's activities: aware or unaware) that is thought of as desirable (better, more perfect) in the given conditions, based on a set of criteria (Borys, 2005). Consequently, 'regress' is an undesirable (worse, less perfect) change of state of a given structure, based on the same criteria. At the same time, they need to have a normative character with a very specific axiological aspect. It should include both materialistic as well as spiritual aspects. In both cases it can be assumed that a change for the better is expected. In terms of materialistic values, usually a more complicated state (e.g. improved machines) will be recognized as progressive. In terms of spiritual aspect, it needn't be such – a turn to simplicity may be presented as more desirable (a commonly known slogan: through simplicity toward perfection, the value of ascension). Moreover, the interactions between the two fields are of significance, i.e. 'to have' or 'to be', or maybe 'to have and to be'?

How about sustainable development?

Sustainability is expressed in structural aspect of a given system and means reaching a state of balance between its components, e.g. the actions taken within separate fields of sustainable development must not lead to degradation of the bio-social system.

Sustainability also means durability, whose main characteristic is measured in time. If a given system has been functioning in the past, is functioning now and nothing indicates it could be damaged – that means it is durable in time. Time is also an important factor when it comes to the devastation caused by humans to the environment. In some cases, they are visible almost immediately, but often – especially when it comes to health issues – they become observable after a long period of the so-called 'hibernation'.

Durability also means self-support of the development process, related to the dynamism of life. This includes securing the reserves (energetic among others), that not only would support the present-day status, but also allow taking up new challenges as well as foster creativity, which creates stimuli to further development.

The commonly accepted definition of sustainable development comes from the UN report 'Our Common Future' from 1987. This publication was the result of the research of an independent World Commission on Environment and Development, established in 1983. It was an attempt on a holistic approach to the problems of the modern world. It discouraged from the commonly accepted narrow understanding of the term 'progress' (which only included purely economical development) as well as from an equally narrow term 'environment'. In the modern world – as pointed out by Donald J. Johnston in the OECD commentary – the environment is not independent from human actions, ambitions nor needs' (Johnston, 2002). Modern crisis situations (in their environmental aspect, as well as developmental, agricultural, social or energetic) are also not independent from each other. It is one global crisis related to man's approach towards the environment, which cannot be resolved within jurisdiction of separate countries.

Sustainable development has been defined in 'Our Common Future' report as such, 'that meets the needs of the present without compromising the ability of future generations to meet their own needs' (WCED, 1987).

Despite a couple of similar proposals and definitions, it was this report that proved to be a breakthrough. Its major achievement was to accept the concept of sustainable development in science as well as in politics and among the broad circles of global public opinion. The definition (referred to as the principle of sustainable development) gained a normative character and is connected with all development strategies presently formulated (Sanchéz, 2008; Redlicft, 2009; Durbin, 2010).

3. Sustainable development problematics

Speaking in detail, three problematic fields of sustainable development are distinguished in UN documents and strategies:

- Ecological (natural and artificial environment protection, also spatial planning).
- Social (not only natural environment, but also society may degrade).
- Economic (taxes, subsidies and other economic instruments).

In the journal 'Problems of Sustainable Development' (Problemy Ekorozwoju) no. 1/2006 (Pawłowski, 2006), I have introduced an enhancement to the list, with a couple of other problematic groups. Discussing the multidimensionality of sustainable development, I have pointed to the following additional aspects:

- Ethical layer (human responsibility for nature).
- Technical layer (new technologies, saving raw materials).
- Legal layer (environmental law).
- Political layer (formulating strategies of sustainable development, introduction and control thereof).

Then, in the journal 'Sustainable Development' no. 2/2008 (Pawłowski, 2008), and later on in the 'Problems of Sustainable Development' no. 1/2009 (Pawłowski, 2009a), I have proposed a hierarchical order of the layers in question (see table 1.).

Level I		Ethical layer	
Level II	Ecological layer	Social layer	Economic layer
Level III	Technical layer	Legal layer	Political layer

Table 1. Hierarchy of the layers of sustainable development. Author's own work.

The first level, which is the foundation to others, is an ethical reflection. It is one matter when a person makes decisions based on their beliefs or their system of values, and entirely different, when those decisions are determined only by the regulations of a legal system in force. It is the ethical justification of important questions like: what values must be accepted, or: why should we act in this way and not otherwise – is the foundation of the whole discussion (Durin, 2008; Laszlo, 2008; Udo, Pawłowski, 2010).

Level two covers ecological, social and economic issues, all treated as equally important.

The third level is an analysis of technical, legal and political details.

The traditional discussion over sustainable development concentrates on the second level. It will be incomplete, however, if not rooted in ethics (level one). On the other hand, without level three, actual practical solutions may escape our mind.

It needs to be pointed out that, despite their hierarchical structure, the layers interpenetrate one with another, which makes it hard to discuss problems characteristic exclusively for any one of them. Even in the case of fulfilling mankind's nonmaterial needs, we cannot avoid associations with the environment. This results from the biological principles of the functioning of the human body, which is in constant need for nourishment and therefore interacts with the environment in this sense at least.

The presented hierarchy proposal offers a new view at the problem of sustainable development. Such a wide range of problems proposed, together with an equally vast variety of changes postulated within individual layers as well as within the actual adopted strategies, allows for making the following assertion: should sustainable development be implemented, it would become a revolution comparable to the breakthroughs in mankind's history, also referred to as revolutions.

In this context, is it not – after the agricultural, scientific and industrial revolutions (Postman, 1995) – the time for a sustainable development revolution (see Table 2)? Or are present environmental problems still part of the industrial revolution? Also, it cannot be ruled out that another stage of human development will go in an entirely different, unsustainable direction (Sztumski, 2007).

Name of the stage	Time period referred to
Hunter-gatherer period	Upper Paleolithic
Agricultural Revolution	Began around 9000 years ago in Asia, and approx. 4000 years later in Europe
Scientific Revolution	1543 – symbolic beginnings with Copernicus' publication of "On the Revolutions of the Celestial Spheres". 1687 – development period, with I. Newton's publication of "Principia Mathematica".
Industrial Revolution	1769 – significant improvement to steam engine by Watt. Further stage (1860-1914): the beginning of oil use (in combustion engines) and electricity.
Sustainable Development Revolution	Three crucial dates: 1969 – U'Thant's report. 1987 – sustainable development definition introduced by the UN. 1992 – UN conference in Rio de Janeiro.

Table 2. Key stages in mankind's development. Author's own work.

The problem is, the current phase of development has not been clearly defined so far. Industry certainly still plays an important part in the shaping of our civilization, but a number of new phenomena have also appeared. Do these changes bespeak another revolution? Some authors support this and suggest that we are now dealing with a modernization revolution, understood as a conversion from the agricultural society living in the countryside, to a typically urban and industrial society. This process, however, would not be possible without prior scientific and industrial revolutions. These entailed i.a. the development of a new kind of modern urban infrastructure (water supply, waste collection, transportation of people and goods, including food, labor market and health service) that ensures the safe functioning of hundreds of thousands of people living in the same place.

Does mankind's transfer from the countryside to cities deserve the title of a revolution? Certainly, the negative human impact on the planet Earth is associated with urban rather than rural environments; therefore their massive expansion increases human pressure on the environment. However, this does not change the present shape of the relations between man and nature.

Also, there are opinions that we are currently dealing with Informatics Technologies Revolution bound up with the widespread use of the Internet, which is thought of as the next step after the industrial revolution. The Internet is indeed an extraordinary platform that allows accessing and spreading important information, which contributes to the development of an information society. On the other hand, this technology seems to run toward a dead end. In 2008, up to 95% of e-mails received by the users were the so-called spam messages, namely unwanted material containing brazen advertisement (as recently as 2001 this was only 5% of the mail). Moreover, the authors of these messages are impersonating well-known institutions and websites for the purpose of fraud and swindling personal data. Furthermore, the Internet has not changed people's approach towards nature, whereas even with their ever-improving ability to communicate, the people did not reduce their pressure on the environment. Informatics technologies are but a tool, which may be utilized in a more general revolution (analogically, a significant improvement to steam engine by Watt was but a symbol of the Industrial Revolution).

If so, what can bring about a desirable change?

In my opinion, sustainable development can be one such thing. Although development of this type has not been introduced yet, many contemporary political, as well as legal, economic and technological initiatives move in that direction.

Assessment of sustainable development revolution is difficult because of the relatively limited time horizon available. Moreover, there is not much we can say about the future, since factors may appear at any moment that could change our previous point of view completely. Just as terrorist attacks of September 11th in New York dispelled the illusion of safety in the modern world, we can experience unexpected ecological catastrophes, resulting from environment pollution caused by humans (such as rapid climate changes). We may as well witness new groundbreaking scientific or technical discoveries that could regard new, efficient energy sources as an alternative to decreasing fossil fuel reserves.

Undoubtedly, current human impact on the biosphere has a global character and calls for a global and balanced immediate response in all areas of human activity. Therefore, intense work is being made on international forums to clarify the basic paradigms of sustainable development, short-, middle- and long-term objectives as well as to search for the tools necessary to achieve the established goals.

Securing sustainable development is among the most important priorities in the EU politics. It can, therefore, be assumed that securing sustainable development is becoming the most important goal contemporary societies set before them.

4. Environmental engineering

Introduction of sustainable development is associated with using the knowledge from the fields of both social and technical sciences. Within the second group, a crucial position is occupied by environmental engineering.

Environmental engineering can be defined as (Pawłowski, 2007) a discipline in the field of technical science, utilizing engineering methods:

- For preserving, rational shaping and using external natural environment (e.g. water resources, waste management, air protection, soil protection),
- For preserving and shaping internal environment of rooms and constructions (devices and installations).

Environmental engineering realizes a wide variety of pro-ecologic activities within the described fields:

- Shapes appropriate conditions and technological methods to uphold proper parameters regarding the human environment,
- Shapes appropriate technical conditions and technological methods to secure the environment's natural biological balance,
- Limits adverse effects of mankind's economic activity,
- Provides technology allowing to reduce the usage of nonrenewable resources (e.g. cleaner production, recycling raw materials from waste),
- Mitigates the effects of natural disasters (floods, droughts, pollution in water, air and soil).

This definition shows how important environmental engineering is for realization of the sustainable development concept. It shapes the conditions of human life; it touches upon the issue of resources, which in turn determines meeting human material needs, both for the present generation and in the future.

Among other detailed problems, energy issues must be pointed out: energy supply, preserving energy carriers and, especially, the usage of fossil fuels.

5. Energy issues

Much has been said in recent years about energy security. Within the EU, situation is very diversified (see Table 3). Denmark is in the best position, since it has a surplus of energy reaching almost 40%.

All countries are grappling with the problem, that producing energy out of conventional fuels means an irrevocable loss of those resources.

Estimates say (Salay, 1997) that the world's reserves contain enough coal for about 150-200 years, enough oil for about 40 years and enough natural gas for about 60 years. These periods may actually be slightly longer. Data published in various sources vary from one another, moreover, some authors point at the possibility of exploiting deposits that are uneconomic today, and therefore, prolonging the time of resources availability (e.g. of crude oil by another 20 years). This does not change the main problem, however: world's resources will run out and the time of that disaster is very near. That is not all – it needs to be

remembered that natural gas and oil deposits are distributed unevenly on our planet. Table 4 characterizes the available gas reserves.
Unquestionable position of the Russian Federation is noteworthy. Beside it, Iran and Qatar have large gas reserves – although half that size. The Russian Federation also has significant coal reserves (2^{nd} to the US).
Another significant issue is that, along with the depletion of natural resources, a demand for energy, required for the processing of the poor resources, rises. E.g. smelting 1 Mg of iron from a 5% iron ore requires much higher energy input than in the case of a 20% iron ore.

No.	Country	Total energy consumption in millions of tons of fuel	% of imported energy
1.	Cyprus	2.6	100
2.	Malta	0.9	100
3.	Luxemburg	4.7	98.9
4.	Ireland	15.5	90.9
5.	Italy	186.1	86.8
6.	Portugal	25.3	83.1
7.	Spain	143.9	81.4
8.	Belgium	60.4	77.9
9.	Austria	34.1	72.9
10.	Greece	31.5	71.9
11.	Latvia	4.6	65.7
12.	Lithuania	8.4	64
13.	Slovakia	18.8	64
14.	Hungary	27.8	62.5
15.	Germany	349	61.3
16.	Finland	37.8	54.6
17.	EU 27	1825.2	53.8
18.	Slovenia	7.3	52.1
19.	France	273.1	51.4
20.	Bulgaria	20.5	46.2
21.	Netherlands	80.5	38
22.	Sweden	50.8	37.4
23.	Estonia	5.4	33.5
24.	Romania	40.9	29.1
25.	Czech Republic	46.2	28
26.	United Kingdom	229.5	21.3
27.	Poland	98.3	19.9
28.	Denmark	20.9	-36.8

Table 3. The characteristic of energy consumption and import dependence of individual EU countries; data from the end of 2008. Source: *Europe's Energy Portal,* http://www.energy.eu.

No.	Country	Quantity (trillions of m^3)	Graphic presentation
1.	Russian Federation	43,30	
2.	Iran	29,61	
3.	Qatar	25,46	
4.	Turkmenistan	7,94	
5.	Saudi Arabia	7,57	
6.	USA	6,73	
7.	United Arab Emirates	6,43	
8.	Nigeria	5,22	
9.	Venezuela	4,84	
10.	Algeria	4,50	

Table 4. Countries in possession of the world's largest natural gas deposits, data from the end of 2008. Source: *Europe's Energy Portal,* http://www.energy.eu.

No.	Country	Quantity (million tons)	Graphic presentation
1.	US	238308	
2.	Russian Federation	157010	
3.	China	114500	
4.	Australia	76200	
5.	India	58600	
6.	Ukraine	33873	
7.	Kazakhstan	31300	
8.	South Africa	30408	
9.	Poland	7502	
10.	Brazil	7059	

Table 5. Countries in possession of the world's largest coal deposits, data from the end of 2008. Source: *Europe's Energy Portal,* http://www.energy.eu.

No.	Country	Quantity (billion barrels)	Graphic presentation
1.	Saudi Arabia	264,1	
2.	Iran	137,6	
3.	Iraq	115,0	
4.	Kuwait	101,5	
5.	Venezuela	99,4	
6.	Un. Arab Emirates	97,8	
7.	Russian Federation	79,0	
8.	Libya	43,7	
9.	Kazakhstan	39,8	
10.	Nigeria	36,2	

Table 6. Countries in possession of the world's largest crude oil deposits, data from the end of 2008. Source: *Europe's Energy Portal,* http://www.energy.eu.

Moreover, the growing consumption of fossil fuels is associated with an increasing emission of dust and gases to the atmosphere. The one gas that has drawn scientists' special attention is carbon dioxide, considered to be the main cause of global warming.

Taking into account that CO_2 concentration in the atmosphere was 0.0280% at the beginning of the industrial era, 0.0315% in 1960 and 0.0385% at present day, is it possible that an increase in carbon dioxide concentration in the atmosphere by 0.0105% had such a long-term impact?

Or do other issues play a more significant role here? Cutting out forests – especially tropical forests – can be pointed out. It is no mystery that during the 20^{th} century alone as much as half of them have been cut out (Kalinowska, 1992) about 12 million ha is being cut out every year and about 50 ha every minute (Boc, Samborska-Boc, 2005). Since forests are known to serve as climate stabilizers, cutting out such a large part of the world's forests must have a significant impact on Earth's climate destabilization.

In fact, the issues of the diminishing forest cover and the growing carbon dioxide emission are linked to each other. It is estimated that forests – tropical and subtropical forests in particular – can bind around 25% of CO_2 released to the atmosphere! Moreover, with a proper economy the plant-based binding can be increased before 2050 by another 10-20% (Nabuurs, Mohren, Dolman, 2000).

Admittedly, the question of connecting climate changes to anthropogenic CO_2 emission is being challenged (Russel, 2009; Lendzen, 2010), but we should utilize the attitude of humility. The large emission of various pollutants from our scientific-technical civilization to the environment certainly does no good to the nature. Should our concerns over CO_2 turn out to be false, we will bear some costs, but the environment will not deteriorate. And what if our concerns are confirmed? We must remember that drastic climate changes and anomalies may lead to the downfall of our civilization – in this context the example of the Sumerians is a notable warning. Taking remedial action is fully justified.

Table 7 shows CO_2 emission in the years 2003-2007 as well as the degree of individual countries closeness to the limit specified in the Kyoto protocol.

The data indicate that 15 of the EU countries (including Poland) have already reached CO_2 emission below the limit set by the Kyoto agreement for the year 2012.

Limiting CO_2 and other pollutants' emissions does not change the primary challenge, namely the depletion of the resources. The principle of sustainable development calls for preserving our planet's ability to meet the needs of future generations, and since their access to energy carriers is threatened that means alternative solutions are required.

The progress of nuclear power is one of the possible ways we may choose. Contrary to the popular belief, uranium deposits are limited as well. If only the most popular reactor types are exploited – that is Pressurized Water Reactors (PWR, 60% of the market) and Boiling Water Reactors (BWR, 24% of the market) – there should be enough fuel for some 140 years. There are, however, alternative technological solutions. Introducing fast-neutron reactors for exploitation would prolong the time of uranium availability for power production by hundreds of years. The problem is, using fast reactors in civilian technology is associated with facilitated access to materials that might be used for the manufacture of nuclear weaponry. Also, the risk of meltdowns and nuclear disasters is being disputed. Even with the use of the most advanced technology, accidents cannot be ruled out. In September 1999, there has been a major breakdown at a Japanese nuclear power plant Takamura, which could have ended up in disaster. The cause was disregard for safety procedures – as much as 7 times more enriched uranium was added to the container than the technological standard allowed. A chain reaction broke out, but was luckily suppressed. Still, the radiation level jumped to such value that two employees were killed and several hundred people have been heavily radiated (*Science Daily,* 6 Dec. 1999). This incident entailed a series of publications critical towards safety in the supposedly highly advanced Japanese nuclear power plants. Therefore, since erecting new nuclear power plants is probably inevitable, the scientific community must pay special attention to safety issues – there can be no saving here.

Country	2003	2004	2005	2006	2007	Kyoto limit 2012	% below the Kyoto limit
Latvia	10,7	10,7	10,9	11,7	**12,1**	23,3	+48,07
Estonia	21,2	21,2	20,7	19,2	**22,0**	40	+45,00
Lithuania	16,7	21,1	22,6	22,8	**24,7**	44,1	+43,99
Romania	-	60,1	153,7	53,9	**52,3**	259,9	+41,40
Bulgaria	-	68,9	69,8	71,5	**75,7**	127,3	+40,53
Hungary	83,3	79,5	80,5	78,8	**75,9**	114,9	+33,94
Slovakia	51,1	49,5	48,7	49,0	**47,0**	67,2	+30,06
Poland	382,5	96,7	399	99,3	**98,9**	551,7	+27,70
Czech Rep.	147,5	147,1	145,6	49,1	**150,8**	180,6	+16,50
Sweden	70,9	69,7	67	66,9	**65,4**	75,2	+13,03
Un. Kingdom	658	60,4	657,4	647,9	**636,7**	678,3	+6,13
France	560,9	556,1	553,4	541,7	**531,1**	564	+5,83
Greece	137,2	137,6	139,2	128,1	**131,9**	139,6	+5,52
Belgium	147,6	147,6	143,8	36,6	**131,3**	135,9	+3,38
Germany	1024,4	1025	1001,5	980,0	**56,1**	972,9	1,73
Country	2003	2004	2005	2006	2007	Kyoto limit 2012	% above the Kyoto limit
Netherlands	215,4	218,4	212,1	208,5	**207,5**	200,4	-3,54
Portugal	83,7	84,6	85,5	84,7	**81,8**	77,4	-5,68 %
Ireland	68,4	68,6	69,9	69,7	**69,2**	63	-9,84 %
Finland	85,4	81,2	69,3	79,9	**78,3**	71,1	-10,13 %
Slovenia	19,7	19,9	20,3	20,5	**20,7**	18,6	-11,29 %
Italy	577,3	580,5	582,2	563,0	**552,8**	485,7	-13,82 %
Denmark	73,6	68,2	63,9	71,0	**66,6**	54,8	-21,53 %
Austria	92,5	91,2	93,3	91,6	**88,0**	68,7	-28,09 %
Spain	407,4	425,2	440,6	433,0	**442,3**	331,6	-33,38 %
Luxemburg	11,3	12,8	12,7	13,3	**12,9**	9,1	- 41,76 %
Malta	3,1	3,2	3,4	2,9	**3,0**	-	-
Cyprus	9,2	9,9	9,9	9,9	**10,1**	-	-

Table 7. Characteristic of the changes in CO_2 emission in the chosen countries in the years 2003-2007. Emissions shown in millions of tons of CO_2 per year. Source: *Europe's Energy Portal,* http://www.energy.eu.

Or should we rely on renewable energy sources (Pawłowski, 2009b)?
In economic policies of the EU action can be observed, leading to combining sustainable development with a well-balanced energy management, including renewables.
Even now one of these sources – water energy – comprises to as much as 20% of power installed in various power plants around the world (see figure 1). In Europe's scale Norway and Brazil are among water tycoons.

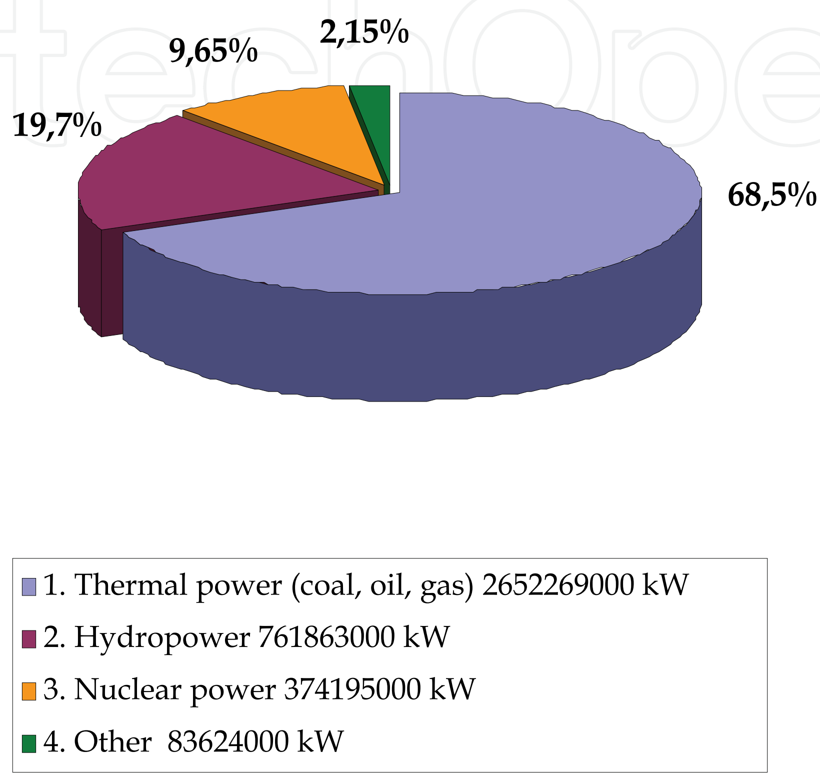

Fig. 1. Total Installed electricity capacity by type. Source: *International Energy Annual 2006,* Energy Information Administration, Washington 2008.

Still, the largest potential source of energy is the solar radiation. During one year 7500 times more solar energy (86000 TW) hit the Earth than the energy consumed by the whole human civilization. Perhaps that is why the EU conducted research over building a 400-billion-Euro solar power plant on the Sahara, which could cover about 20% of the whole EU's energy demand. This is in accordance to the general policy of the Commonwealth, which postulates that the member countries will gain 20% of their energy from renewables before 2020. Table 8 shows the characteristic of renewable energy coverage of individual member countries of the EU.
Developing technologies related to the usage of various energy sources is an important engineering task. The development of energy-saving technologies is just as significant. This is not only the issue of industrial facilities, but also of internal environment. It is a key problem field in environmental engineering, related to heating, ventilation and air conditioning, or – more generally – to public utilities. Its needs consume 17-32% of the world's total energy consumption. In the EU countries, it came at 26.5%.
This means that there are huge prospects both for energy saving and decreasing fossil fuel consumption in this sector. It is a crucial challenge for environmental engineering!

No.	Country	Share of energy from renewables in 2006	2020 objective	Amount missing
	EU	9,25%	20%	10,8 %
1.	United Kingdom	1,5 %	15%	13,5 %
2 .	Ireland	2,9%	16%	13,1 %
3 .	Denmark	17,2%	30%	12,8 %
4 .	France	10,5%	23%	12,5 %
5 .	Netherlands	2,7%	14%	11,3 %
6 .	Spain	8,7%	20%	11,3 %
7 .	Greece	7,15%	18%	10,9 %
8 .	Italy	6,3%	17%	10,7 %
9 .	Latvia	31,4%	42%	10,6 %
10 .	Belgium	2,6%	13%	10,4 %
11.	Cyprus	2,7%	13%	10,3 %
12 .	Germany	7,8%	18%	10,2 %
13 .	Luxemburg	1%	11%	10 %
14 .	Malta	0%	10%	10 %
15 .	Portugal	21,5%	31%	9,5 %
16 .	Slovenia	15,5%	25%	9,5 %
17 .	Finland	28,9%	38%	9,1 %
18 .	Austria	25,1%	34%	8,9 %
19 .	Lithuania	14,6%	23%	8,4 %
20 .	Estonia	16,6%	25%	8,4 %
21 .	Hungary	5,1%	13%	7,9 %
22 .	Sweden	41,3%	49%	7,7 %
23 .	Poland	7,5%	15%	7,5 %
24 .	Slovakia	6,8%	14%	7,2 %
25 .	Bulgaria	8,9%	16%	7,1 %
26 .	Romania	17%	24%	7 %
27 .	Czech Republic	6,5%	13%	6,5 %

Table 8. A percentage characteristic of the renewable energy share in the energy balance in the EU countries. Source: *Europe's Energy Portal,* http://www.energy.eu.

Speaking in detail, the main directions of engineers' work for the coming years should include searching energy-saving solutions and new ways to use renewable energy sources in public utilities – the usage of biomass to heat rooms in particular.

In some countries, e.g. in Poland, biomass is already the most popular renewable energy source.

Dry biomass burning for heating purposes in properly fixed ovens (another key design task for environmental engineering) is not the whole thing, however. The ash left over from the process should be used for fertilizing energy plants in plantations (like salix), so that the soils occupied by them would not deteriorate. This is one of the most important directions consistent with the principle of sustainable development, since not only it helps to reduce the consumption of nonrenewable energy sources (replaced with the biomass), but also prevents the soil from exhaustion of elements necessary for cultivation.

These positive conditions of 'green' energy do not exhaust the topic, however. The point is that the energy gained from renewable energy sources still is more expensive than that derived from fossil fuels. Adopting appropriate legal and economic mechanisms is the key. There is plenty of possible solutions; we will point to examples regarding biomass burning. In countries like Finland (Nicholls, Monserud, Dykstra, 2009), wider use of biomass as an energy source was achieved by introducing an appropriate tax on fossil fuels. In Austria a similar effect was reached by subsidies for investments making use of biomass. In the case of Netherlands, three separate fiscal instruments were applied: green funds, an energy tax and tax credits (Kwant, 2003). Also, we may expect that EU limits on CO_2 emissions will favor the development of renewable energy, including biomass burning.

Moreover, it is noteworthy that the development of new technologies regarding renewable energy sources contributes to a growth of employment level. When it comes to biomass, according to Hillring (Hilring, 2002), each PJ of energy produced with the use of biomass gives from 1.5 (where wood waste is used) to even 113 jobs (in the case of weakly mechanized, rapidly-growing plantations).

6. Conclusion: Can we secure sustainable development for the future generations?

When, at the end of the 19th century, gas lamps used so far were replaced by electric lights, the quality of air in the cities improved immediately. Unfortunately, the progress in coal energetics lead to much greater pollution levels in the second half of the 20th century, growing over the urban environment and becoming a global problem. It is a peculiar paradox. A solution, which brought good results at first, turned out to be a threat in the long run (Fox-Penner, 1997).

Research conducted in the field of sustainable development is interdisciplinary, which makes it ideally adapted to coping with the complex challenges of the modern world. There is, however, one phenomenon that escapes control – globalization.

Nowadays globalization is defined as an integrated, global socio-economic system, linked with large corporations, characterized by its transnational diffusion of capital and adopting the principle of free trade in the field of economy – so economic globalization – as well as assimilation of cultural models – so cultural globalization (Gawor, 2006).

Large corporations are an obstacle in the implementation of sustainable development, because they are profit-oriented and because of their transnational, post-national or somewhat anti-national character (Barber, 1995), thus weakening the role, played so far by the authorities of individual countries. If the solutions or strategies adopted by a country or a group of countries (even one like the EU) are seen as adverse, they simply move that part of their activities to other countries, where such actions are acceptable. Moreover, as many economists point out, corporations are able to destroy the progress of nearly any company that does not belong to them (Ikerd, 2005; 2008).

In this context it is worth asking: is sustainable development an alternative to globalization? Suggestions are formulated, that globalization and sustainable development are both two sides of one coin. Just as Duncan French convinces us, globalization organizes the world anew, whereas sustainable development points to the threats brought by this new order, which result from previous mankind's history (French, 2002).

Note that globalization needs not to rely on the currently dominant egoistic axiology – there also is an eco-humanistic (inclusive) globalization – one that refers to the common good. As John Paul II said in 2001 "globalization is not *a priori* good or evil. It will by such, as we make it" (the address at the 7th Plenary Session of the Pontifical Academy of Social Sciences, held in Vatican City on 25th-27th April 2001). This line of thought is carried on by Benedict XVI. In his address in 2008 he said that egoistic globalization "is not the synonym of the world order – on the contrary. The conflicts generated by the pursuit of economic primacy and providing for oneself access to energy, water and resource reserves impede the efforts of those who struggle for a world more just and solidary. It became clear that only through adopting a balanced way of life accompanied by serious efforts for equal distribution of goods, a fair and sustainable development is achievable. This requires people who have great hope and great courage (the address from 1st June 2008, made during Epiphany mass). This line of thought has been expanded in the encyclical "Caritas in Veritate" (Benedict XVI, 2009).

Such is the outline of the road towards eco-humanistic globalization, as well as an outline of the road towards sustainable development. It is also the road, which environmental engineers take, providing us with necessary technical tools that would show us how to preserve the environment and use it rationally. It is a challenge, but also a great responsibility in the struggle for our planet's future.

Be it assumed that we are on the threshold of a new revolution – the sustainable development revolution – then our conversion from fossil fuels to new energy sources is one of the most important tasks. Environmental engineering is the one discipline that can achieve this.

7. References

Amercian Institute Of Physics (1999). New Details on Japan Nuclear Accident, *Science Daily*, December 6, 1999, http://www.sciencedaily.com/, retrieved May 27, 2010, ISSN 1521-1878.

Barber, B.R. (1995). *Johan vs McWorld*, Ballantine Books, ISBN 0-345-38304-4, New York.

Benedict, XVI (2009). *Caritas in Veritate,* Ignatius Press, ISBN 9781586172800, San Francisco.

Boc, J. & Samborska-Boc, E. (2005). Z rozwoju koncepcji ochrony srodowiska [Development of the Idea of Protection of the Environment], *Ochrona środowiska [Protection of the Evironment]*, Boc, J. & Nowacki, K. & Samborska-Boc, E. (Ed.), Kolonia Limited, ISBN 83-88166-92-1, Wroclaw.

Borys, T. (2005). *Wskaźniki zrównoważonego rozwoju [Indicators of Sustainable Development]*, EiS, ISBN 83-88771-61-2, Warsaw.

Durbin, P.T. (2008). Is There a Best Ethic of Sustainable Development?, *Problems of Sustainable Development,* vol. 3, no 2, 5-14, ISSN 1895-6912.

Durbin, P.T. (2010). Humanitarian Motives for Sustainable Developments in a Global Economy: An Essay, *Problems of Sustainable Development,* vol. 5, no 1, 9-13, ISSN 1895-6912.

Energy Information Administration (2007). *International Energy Annual 2005,* http://www.eia.doe.gov/iea/, retrieved May 27, 2010, Washington.

Europe's Energy Portal (2010). http://www.energy.eu, retrieved May 27, 2010.

Fox-Penner, P. (1997). *Environmental Quality, Energy Efficiency and Renewable Energy, Electric Utility Restructuring, A Guide to the Competitive Era,* Public Utility Reports, ISBN 978-0910325677, Vienna.

French, D. (2002). The Role of the State and International Organization in Reconciling Sustainable Development and Globalization, *International Environmental Agreements, Politics, Law, and Economics,* no 2, 135-150, ISSN 1567-9764.

Gawor, L. (2006). Antyglobalizm, alterglobalizm i filozofia zrównowazonego rozwoju jako globalizacyjne alternatywy [Anti-globalism, Alter-globalism and the Philosophy of Sustainable Development as Global Alternatives], *Problems of Sustainable Development,* vol. 1, no 1, 41-42, ISSN 1895-6912.

Hillring, B. (2002). Rural Development and Bioenergy Experiences from 20 Years of Development in Sweden, *Biomass and Bioenergy* 23, 443-451, ISSN 0961-9534.

Ikerd, J.E. (2005). *Sustainable Capitalism a Matter of Common Sense*, Kumarin Press Inc., ISBN 1565492064, Bloomfield.

Ikerd, J.E. (2008). Sustainable Capitalism: A Matter of Ethics and Morality, *Problems of Sustainable Development,* vol. 3, no 1, 13-22, ISSN 1895-6912.

Johnson, D.J. (2002). Sustainable Development: Our Common Future, *OECD Observer*, no 8/2002, http://www.oecdobserver.org/, retrieved January 10, 2010.

Kalinowska, A. (1992). *Ekologia – wybór przyszłości [Ecology – the Choice for the Future],* Editions Spotkania, ISBN 83-85195-89-0, Warsaw.

Kwant, K., (2003). Renewable Energy in the Netherlands: Policy and Instruments, *Biomass and Bioenergy* 24, 265-267, ISSN 0961-9534.

Laszlo, C. (2008). Sustainable Values, *Problems of Sustainable Development,* vol. 3, no 2, 25-29, ISSN 1895-6912.

Lean, G. & Hinrichsen, D. (1994). *Atlas of the Environment,* Harper-Perennial, ISBN 9780062733146, New York.

Lendzen, R.S. (2010). Global Warming: The Origin and Nature of the Alleged Scientific Consensus, *Problems of Sustainable Development,* vol. 5, no 2, 13-28, ISSN 1895-6912.

Nabuurs, G. & Mohren, F. & Dolman, H. (2000). Monitoring and Reporting Carbon Stocks and Fluxes in Dutch Forests, *Biotechnology, Agronomy, Society and Environment* 4, 308-310, ISSN 1370-6233.

Pawlowski, A. (2006). Wielowymiarowosc zrownowazonego rozwoju [The Multidimensional Nature of Sustainable Development], *Problems of Sustainable Development,* vol. 1, no 1, 23-32, ISSN 1895-6912.

Pawlowski, A. (2008). How Many Dimensions Does Sustainable Development Have?, *Sustainable Development*, vol. 16, no 2, 81-90, ISSN 0968-0802.

Pawlowski, A. (2009a). The Sustainable Development Revolution, *Problems of Sustainable Development*, vol. 4, no 1, 65-76, ISSN 1895-6912.

Pawlowski, A. (2009b). Sustainable Energy as *sine qua non* for the Achievement of Sustainable Development, *Problems of Sustainable Development,* vol. 4, no 2, 9-12, ISSN 1895-6912.

Pawlowski, L. (2007), Slowo wstępne [Foreword], *Polska inzynieria srodowiska – informator [Polish Environmental Enginnering – Reference Book,* Anielak, A.M. (Ed.), , KIS PAN, 13-16, ISBN 83-89293-41-2, Lublin.

Piontek, F. & Piontek B. (2005). Kategoria „rozwoj" w alternatywnych koncepcjach jego urzeczywistniania [„Development" Category in Alternative Possibilities of Making it Real], *Humanistyczne, ekonomiczne i ekologiczne aspekty kategorii „rozwój" [Humanistic, Economic and Ecological Aspects of „Development" Category],* Piontek, F. & Czerny, J. (Ed.), WSEiA, 30-31, 83-246-0277-1, Warsaw, Bytom.

Ponting, C. (1993). *A Green History of the World: The Environment and the Collapse of Great Civilizations,* Penguin Books, 9780140176605, New York.

Postman, N. (1993). *Technopoly: The Surrender of Culture and Technology,* Vintage Books, 9780679745402, New York.

Redclift, M.R. (2009). Sustainable Development (1987-2005) – An Oxymoron Comes of Age, *Problems of Sustainable Development*, vol. 4, no 1, 33-50, ISSN 1895-6912.

Russel, D.L. (2010). Curmudgeon's Thougts on Sustaiability, *Problems of Sustainable Development,* vol. 5, no 1, 15-22, ISSN 1895-6912.

Salay, J. (1997). *Energy, From Fossil Fuels to Sustainable Energy Resources,* The Baltic University Press, ISBN 91-7005-125-9, Uppsala.

Sanchéz, A. (2008). Perspectives and Problems in Sustainable Development, *Problems of Sustainable Development*, vol. 3, no 2, 21-23, ISSN 1895-6912.

Sztumski, W. (2007). The Mythology of Sustainable Development, *Problems of Sustainable Development,* vol. 2, no 4, 13-23, ISSN 1895-6912.

Udo, V. & Pawlowski, A. (2010). Human Progress Towards Equitable Sustainable Development: A Philosophical Exploration, *Problems of Sustainable Development,* vol. 5, no 1, 23-44, ISSN 1895-6912.

UE (2004). *Water, Safe, Strong and Sustainable, Vision on European Water Supply and Sanitation in 2030, Water Supply and Sanitation Platform,* 978-92-4-159842 2, Brussels 2004.

WCED (1987). *Our Common Future, The Report of the World Commission on Environment and Development*, Oxford University Press, ISBN 0-19-282080-X, New York.

Yardley, J. (2007). Under China's Booming North, the Future is Drying Up, *New York Times,* September 28, 2007, http://query.nytimes.com/ retrieved May 27, 2010, ISSN 0362-4331.

Paths to Sustainable Energy
Edited by Dr Artie Ng

ISBN 978-953-307-401-6
Hard cover, 664 pages
Publisher InTech
Published online 30, November, 2010
Published in print edition November, 2010

The world's reliance on existing sources of energy and their associated detrimental impacts on the environment- whether related to poor air or water quality or scarcity, impacts on sensitive ecosystems and forests and land use - have been well documented and articulated over the last three decades. What is needed by the world is a set of credible energy solutions that would lead us to a balance between economic growth and a sustainable environment. This book provides an open platform to establish and share knowledge developed by scholars, scientists and engineers from all over the world about various viable paths to a future of sustainable energy. It has collected a number of intellectually stimulating articles that address issues ranging from public policy formulation to technological innovations for enhancing the development of sustainable energy systems. It will appeal to stakeholders seeking guidance to pursue the paths to sustainable energy.

INTECH
open science | open minds

InTech Europe
University Campus STeP Ri
Slavka Krautzeka 83/A
51000 Rijeka, Croatia
Phone: +385 (51) 770 447
Fax: +385 (51) 686 166
www.intechopen.com

InTech China
Unit 405, Office Block, Hotel Equatorial Shanghai
No.65, Yan An Road (West), Shanghai, 200040, China
中国上海市延安西路65号上海国际贵都大饭店办公楼405单元
Phone: +86-21-62489820
Fax: +86-21-62489821