SUSTANABILITY AND ENERGY EFFICIANCY

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Abstract. *The numbers of people on Earth constantly and rapidly are increasing. Number of people with access to electricity is also increasing. Unfortunately classic fuel sources are limited, and the problem of sustainable energy strategies that effective and safety, is a priority, at nationally and at internationally level. Energy efficiency can be made in different sectors: industry, buildings, lighting, transport, power and last but not least reduce greenhouse gas emissions (GHG). The main of this paper is to analyze the energy efficiency of the views listed above, with the emphasis placed on reducing greenhouse gases. For the calculations needed was software to GEMIS.*
Keywords: *energy, greenhouse gases (GHG), emissions, sustainable, reliable, energy efficiency.*

DURABILITATEA ȘI EFICIENȚA ENERGETICĂ

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Rezumat. *Numărul populației pe globul pământesc neîncetat și rapid crește. Numărul populației ce are acces la energia electrică de asemenea este in creștere. Din păcate sursele de combustibili clasici sunt limitate, iar problema strategiei energetice durabile, eficiente și sigure este prioritară, cât la nivel național, atât la nivel internațional. Eficiența energetică poate fi efectuată în diferite sectoare: industrie, clădiri, iluminare, transport, energie și nu în ultimul rând reducerea emisiilor gazelor cu efect de sera. Scopul de bază al acestei lucrări este de a analiza eficiența energetică din punctele de vedere enumerate mai sus, cu accentul de baza pus pe reducerea gazelor cu efect de sera. Pentru efectuarea calculelor necesare a fost utilizat softwarul GEMIS.*
Cuvinte cheie: *energie, gaze cu efect de seră, emisie, durabilitate, siguranță, eficiență energetică.*

УСТОЙЧИВОСТЬ И ЭНЕРГОЭФФЕКТИВНОСТЬ

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Аннотация. *Число людей на Земле, постоянно и быстро растет. Число людей, имеющих доступ к электроэнергии также растет. К сожалению, классические источники топлива ограничены, и проблема стратегий эффективного, безопасного и устойчивого развития энергетики является приоритетной задачей, как на национальном, так на международном уровне. Эффективность использования энергии может быть выполнена в различных отраслях: промышленности, зданий, освещения, транспорта, энергетики и не в последнюю очередь сокращению выбросов парниковых газов. Основной целью данной статьи является анализ эффективности использования энергии в соответствии с вышеперечисленными, с акцентом на снижение выбросов парниковых газов. Для расчетов был использован software GEMIS.*
Ключевые слова: *энергия, парниковые газы, выбросы, прочность, надежность, энергоэффективность*

. INTRODUCTION

One of the essential technological innovations that have accelerated the development of civilization is electricity. Actually we cannot imagine civilization life and activity without electricity.

In these early years of the twenty first century electricity is once again poised to permit fundamental shifts in the nature of our civilization. We face a future in which concerns for our global environment, for social welfare and for stable market economics are all linked to the future development of electricity systems.

The prospect of modern societies depends on their ability to deal with the challenge of climate change in the next decades. Technological innovations may help to reduce the output of greenhouse gases. But barriers in the innovation process seem to be a core problem.

Table 1

Growth in electricity access required to achieve universal access by 2030

	World
1990 population with electricity access (m)	3.1
2008 population with electricity access (m)	5.2
2008 population without electricity access (m)	1.5
2030 population (m)	8.3
Annual growth rate in electrified population achieved since 1990 (%)	2.9%
Annual growth rate in electrified population required to achieve universal access by 2030 (%)	2.1%

Source: Based on data from IEA global electrification database and Global Insight WMM

Energy solutions for our past, present and future energy mixes are commonly formulated by participants in a complex decision-making process. The principal participating groups in our society, responsible for achieving results in energy choices, are identified in an IAC Report [1] as follows: multinational organizations (IEA, UN, World Bank, regional development banks, etc.); governments (national, regional, local energy policy makers); science and technology community (academia and associations); private sector (industry, consultancies and foundations); non-governmental organizations (World Energy Council, Earth watch, etc.); media (Scholarly journals and popular media (print, web, radio, TV); general public (social networks, etc.).

These organizations, in special the governmants have to solve the problem of calculation the future energy scenario, which will be competitive, reliable, sustainable, durable and reasonable. Providing universal energy access will pose a number of critical challenges related to gaps in national and local institutional capacity and governance required to produce, deliver, manage, operate and maintain these solutions (including strengthening the capabilities of public sector utilities to provide improved services for all their customers in a commercially viable manner and without political interference), see Table 1.

Some factors that it is necessary to take in to account for planning/calculate a good energy scenario are: energy supply, energy delivery, grid connection, costs of solutions, quality of access provided by technologies, access to modern fuels and technologies, capacity development energy efficiency etc.

In this article, we try to analyze the sustainable, durable development and efficiency in energy sector and energy efficiency.

2. SUSTAINABILITY

The term "sustainable development" was used for fast time in 1987 in the World Commission on Environment and Development, known as the Brundtland Report. The report defined sustainable development as development that ensures the needs of present without compromising the ability of future generations to ensure their own needs.

Examples of the sustainability we can consider: planning, architecture, agriculture, eco fashion and home accessories, water sector and energy sector.

Sustainable technology in the energy sector is based on utilizing renewable sources of energy such a solar, wind, hydro, bioenergy, geoenergy, geothermal and hydrogen. Wind energy is the world's fastest growing energy source; it has been in use for centuries in Europe and more recently in the United States and other nations. Wind energy is captured through the use of wind turbines that generate and transfer electricity for utilities, homeowners and remote villages. Solar power can be harnessed through photovoltaics, concentrating solar, or solar hot water and is also a rapidly growing energy source [3]. Sustainable water technologies have become an important industry segment with several companies now providing important and scalable solutions to supply water in a sustainable manner.

The availability, potential, and feasibility of primary renewable energy resources must be analyzed early in the planning process as part of a comprehensive energy plan. The plan must justify energy demand and supply and assess the actual costs and benefits to the local, regional, and global environments. Responsible energy use is fundamental to sustainable development and a sustainable future. Energy management must balance justifiable energy demand with appropriate energy supply. The process couples energy awareness, energy conservation, and energy efficiency with the use of primary renewable energy resources [4, 5, 6].

From a sustainability perspective, a material, component or system may be considered durable when its useful service life (performance) is fairly comparable to the time required for related impacts on the environment to be absorbed by the ecosystem.

Some characteristics of sustainability are [14]:

the probability operation without failure - describes the objective function in period *0* to *t*.

$$R(t) = P(\xi > t) \qquad (1)$$

where ξ random variables.

the probability of failure – is the probability, that in a given time interval failure occurs.

$$Q(t) = P(\xi \leq t) = 1 - R(t) \qquad (2)$$

$R(t)$ non-growing time function, $Q(t)$ non-decreasing time function. The probability that $R(0) = 1$, $R(\infty) = 0$.

the probability density of failure:

$$f(t) = \frac{dQ(t)}{dt} = -\frac{dR(t)}{dt} \qquad (3)$$

the intensity of failury, rate of probability density of failure and the probability operation without failure:

$$\lambda(t) = \frac{f(t)}{R(t)} \qquad (4)$$

the middle time of operation without failure

$$m = E(\xi) = \int_0^\infty t f(t) dt \qquad (5)$$

where:

E – middle value, ξ – random failure time, m – integrate value.

$$m = \int_0^\infty \mathrm{R}(t) dt \qquad (6)$$

$$\mathrm{D}(\xi) = E\{[\xi - E(\xi)]^2\} = \int_0^\infty (t - m)^2 f(t) dt \qquad (7)$$

$$\mathrm{D}(\xi) = E(\xi)^2 - E^2(\xi) = \int_0^\infty \mathrm{t^2 f(t) dt - m^2} \qquad (8)$$

$$\mathrm{D}(\xi) = 2\int_0^\infty \mathrm{tR(t)dt - m^2} \qquad (9)$$

the deviations σ*:*

$$\sigma(\xi) = +\sqrt{D(\xi)}$$

(10)

To solve such problems in energy sector using methods such as: Monte-Carlo, method of incident matrix, method of minimum cats and others.

3. ENERGY EFFICIENCY

Energy efficiency measures in *industry* include switching away from energy-intensive materials (e.g., clinker substitution in cement), improved maintenance, using efficient burners, and cogenerating power by using waste heat from industrial processes. National policies that set targets and standards have resulted in significantly higher industrial efficiency in Japan and the Netherlands than most other countries [7]. Awareness, training and performance management to change the mindsets of management and staff is also crucial. Special attention should be focused on small and medium-size enterprises and on systems approaches that go beyond the process or technology level.

The biggest opportunities in *building* energy savings are improvements to insulation and design (e.g., windows, shell) and efficiency of heating, ventilation and air conditioning (HVAC) systems (e.g. district heating). Denmark [8] and China [9] are examples of countries where significant savings have been achieved through the effective introduction of building codes and standards.

For short- to medium-life assets such as *appliances and lighting*, the focus is on switching to more efficient devices such as appliances with low standby power consumption, and CFLs and LEDs rather than incandescent lighting. Making lighting more energy-efficient is often the first efficiency measure undertaken due to the low cost and ease of capture (e.g., as in Bangladesh, Bolivia, China, Cuba, Ethiopia, India, Mexico, Philippines, Rwanda, South Africa, Sri Lanka, Thailand, Uganda, and Viet Nam). Several developing countries have also successfully introduced standards for various appliances, including chillers (Thailand, India, Philippines), electric motors (China), refrigerators (Brazil, Mexico) and air conditioners (Thailand).

Similarly, in the *transport* sector, a mix of energy-efficient vehicles provides significant potential, inter alia by improving the fuel consumption of the vehicle fleet through improved fuels and engine technology as well as the increased use of all-electric and hybrid electric vehicles.

Integrated traffic planning and modern public transportation systems can create signifiant energy efficiency gains, while concurrently addressing congestion and air pollution. This is especially relevant in rapidly-growing urban areas in developing countries. Bogotá, in Colombia, is a good example. The city created special lanes for buses, introduced a more effective pricing system, and replaced the oldest buses with more efficient models. The project led to a reduced number of buses while maintaining the level of service, and lower fuel consumption per passenger-mile. As a consequence, the project was partly financed by CDM credits.

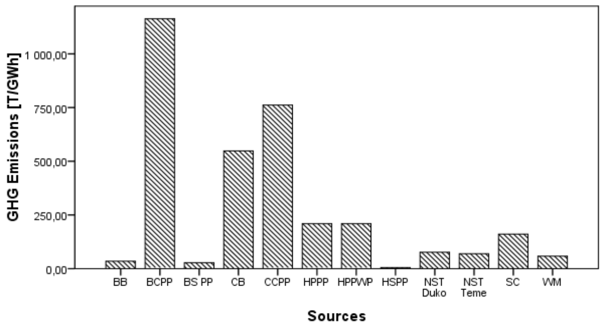
The *power* sector can significantly increase its energy efficiency through implementation of currently available improvements in many forms of power generation, and in improved electric grids that enhance reliability and reduce transmission and distribution line losses [10]. Reducing these line losses requires both improved maintenance and significant capital investment [11]. This is a particularly important opportunity in the developing world, where losses are typically significantly higher. (Transmission and distribution losses of 35-50 per cent are not unusual in the developing world, compared with 6-8 per cent in developed markets.)

Much of the recent attention to energy efficiency has its origins in the need to reduce carbon emissions; energy efficiency opportunities make up about a third of the total low cost opportunities to reduce GHG emissions globally.

In next part of this article we will compare different sources of electrical energy with their GHG emissions.

4. GREENHOUSE GASE EMISSIONS

One of the computation software used in our article is the balance computer program GEMIS, which is a database with energetic and economic data from the sector of EPS. It was developed in 1987 by Öko-Institut in Darmstadt (FRG) [13] and is updated annually.



Graph 1. Tons of GHG emissions per 1 GWh of different typical sources

One of the major pollutants emission of greenhouse gases is Brown Coal Power Plant (BCPP) and Combined Cycle Power Plant (CCPP).

5. COMPARISON BETWEEN RECOMMENDING SCENARIO AND CZECH NATIONAL ENERGY POLICY

The following part of article is dedicated to comparing data of emissions green house gas for proposed and reference scenario, three radical scenarios and three scenarios from Czech National Energy Policy. The reference scenario is a real mix of options for year 2010.

Scenario A, C, E are from the Czech National Energy Policy of August 2011, the values for year 2020.

Nuclear Scenario takes into account the moderate development of co-generation and renewable resources, limiting the construction of coal power plants, construction of new nuclear power plants.

Coal scenario is characterized by a moderate development of co-generation and generation from renewable energy sources, new coal plants and new combined cycle power plant.

RES scenario extensively use renewable energy sources, ie, biomass, hydropower and wind power.

The optimal scenario takes into account the moderate development of the use of renewable energy sources and construction of new nuclear power plants or block, decreasing use of coal power plants, coal and combined cycle power plants.

Table 2

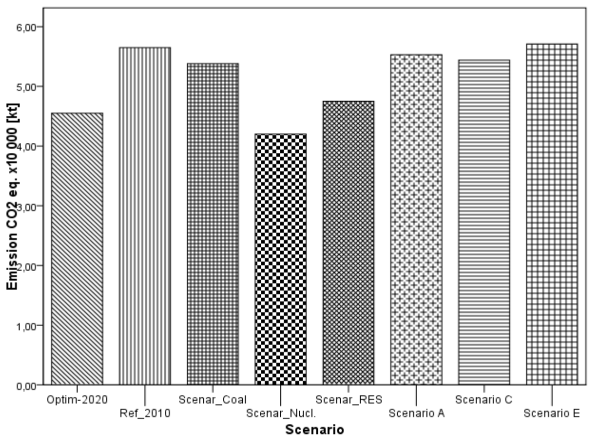
Input date

Sources	Optim. 2020	Ref. 2010	Scen.A	Scen.B	Scen.E	Scen. RES	ScenCoal	Scen. Nucl.
BB	3	6.04	7.58	7.6	7.58	5.6	8.6	5.6
CB	31.3	40.97	33.41	30.91	33.42	28.91	32.4	22.9
CCPP	3	3.7	1.3	10.95	7.99	8.95	10.9	10.9
HSPP	13.8	13.8	14.5	14.96	14.8	14.4	14.3	19.2
HPPWP	20	14.2	15	15	25.2	15.5	14.9	22.6
HPPP	3	1.5	9.0×10^{-1}	1.4	1.80×10^{-1}	5.1	2.26	2.26
NST Duk.	2.5	1	2.4	1.6	1.5	2	1.6	1.59
NST Tem.	6.0×10^{-1}	6.15×10^{-1}	2	6.16×10^{-1}	6.16×10^{-1}	2.5	2	2
BCPP	7.21×10^{-1}	3.35×10^{-1}	2.5	3.36×10^{-1}	3.26×10^{-1}	1	5.2×10^{-1}	5.2×10^{-1}
SC	2	1.5	1.9	1.48	1.48	2.5	8.0×10^{-1}	8.0×10^{-1}
WM	9	5.9×10^{-1}	2	5.9×10^{-1}	5.9×10^{-1}	2.5	1	9.0×10^{-1}
BS PP	1	1.32	1.3	2	1.22	1	6.0×10^{-1}	6.0×10^{-1}
Total	89.9	85.49	85.69	87.84	95.36	90.05	90.03	90.02

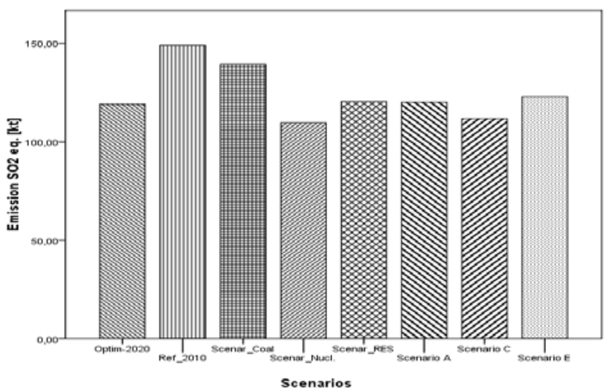
Table 3

The output values of greenhouse gases emissions with the program GEMIS for different energy development scenarios for the Czech Republic for year 2020

Emissions [kt]	$CO_2eq.\times10^4$	$CO_2\times10^4$	CH_4	N_2O
Scenarios A	5.53	5.31	66.6	1.77
Scenarios C	5.44	5.20	76.87	1.72
Scenarios E	5.71	5.47	75.58	1.79
Ref. 2010	5.65	5.51	35.96	1.58
Optim. 2020	4.55	4.44	28.21	1.30
Scen. Nucl.	4.20	4.03	51.94	1.25
Scen. Coal	5.38	5.18	60.13	1.54
Scen. RES	4.75	4.58	47.65	1.38



Graph 2. Evaluation scenarios on the power supply for CO_2eqv.



Graph 3. Evaluation scenarios on the power supply for SO_2eqv.

After the calculations in program GEMIS, we obtained the following results viz. Graph 2, Graph 3 and Table 3.

The best results in terms of the negative impact of electricity production on the environment in the CR of all the proposed options are the "nuclear", see Table 7, then follows an extreme scenario "RES". Both scenarios are radically, results that the optimal scenario would be scenario "optimal".

Table 4

A nomenclature section

Symbol	Notification
EPS	Electrical Power System
CR	Czech Republic
GHG	Greenhouse Gas Emissions
ST	Station
PP	Power Plant
CEZ	Czech distribution company
BB	Boiler Biogas
CB	Coal Boiler
CCPP	Combined Cycle Power Plant
HSPP	Hydro Small Power Plant
HPPWP	Hydro Power Plant without pumping
HPPP	Hydro Power Plant Pumping
NST	Nuclear Station
BCPP	Brown Coal Power Plant
SC	Solar Collector
Wind Mill	WM
BSPP	Biomass Steam Power Plant

6. CONCLUSIONS

✓ This paper serves as a recommendation and analyzes for the power sector, and shows the pathway to mitigate the negative impact of energy on the environment. Energy mix visions and strategies are important determining factors of our world's future prosperity and welfare.

✓ One of the methods for energy efficiency is to teach young generation to use electrical energy with economic.

✓ Energy efficiency can be done at different levels: international, national, governmental, local, houses and individual. It is mean that each of us can do the world cleaner, durable and prepared for future generations.

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