ECONOMIC ASPECTS OF FOSSIL FUEL SOCIAL COSTS. WHY DO WE SUBSIDIZE AND MEDIATE THE CLIAMTE CHANGE PROCESS?

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Abstract: *Nowadays, humanity is in a position to choose carefully every step it makes in order to ensure economic development without compromising the welfare of future generations who will need a social and ecological climate as favorable it could be. On the other hand, the conventional energy production is achieved taking the risks of the Earth overheating and its aggregate economic consequences, actually this climatic changes already appear in a more and more aggressive way, including on global economies. Over the past few years international organizations such as OECD, the IMF, the IEA, the World Bank are focusing their attention on the fossil fuel subsidies impacts over the energy production and consumption, quantifying the economic and social impacts of fossil fuel reform. The reason this study had to be done is the disadvantageous position of renewable energy industry compared with the fossil fuel's industry situation which lies actually in the adopted subsidy strategy and the lack of measures for internalizing externalities on the sector, which are considered by IMF also a type of fossil fuel subsidy. So, this study presents an updated overlook on the fossil fuel externality problem, revises the identified literature linked to the"externality" notion, outlines the identified trends and polices of internalizing the fossil fuels externalities, and tries to review the estimations of the potential costs of the global warming as a consequence of too high social costs of the fossil fuel installed technologies. In this purpose there are on their way of implementation different systemic methods of research, including scientific abstraction, deduction, analysis and synthesis and quantitative analysis in order to outline the current situation of fossil fuel externality problem and its potential impact over the economic welfare.*

Keywords: *fossil fuel energy industry, subsidies, externalities, social costs, climate change costs.*
JEL Classification: *B41, D62, H23, L71.*

1. Introduction

Aiming the welfare toward which each economy strives, the issue of equidistant consideration of costs related to each type of energy produced will result, in time, being decisive in developing favorable climates for economic development at all levels. The core problem investigated in the present study is, in fact, reflecting the social costs of conventional energy that would ensure better development and better economic growth under the time and durability factors incidence. The reform of energy subsidies was being discussed for a long time, but in too few countries can be noticed a real implementation of this concept. Moreover, because in different countries externalities and fiscal costs of energy subsidy reform appear and are assessed differently, it is considered that this process is followed more or less insistent.

Until recently the conjuncture of planning and operation of energy markets was being realized basing on classical criteria of cost and operational safety, but given the interference of environmental impacts, a situation of intensive conflict was being established on the sector which is currently under insistent review. Decision making on the energy sector follows these three criteria and simultaneously more and more researches and studies are undertaken in order to detect the possible scenarios that could be considered in uncertain interconnection conjunctions of climate change and the expected economic growths. In fact, most of these studies confirm, unfortunately, the existence of interdependencies between these two factors and the XXI-th Conference of UNFCCC from Paris in December 2015 aimed the assessment of current situation and adoption of a global agreement to limit greenhouse gas (GHG) emissions to minimal levels avoiding a global warming increase of more than 2°C than pre-industrial levels. Last trends globally detected show a positive evolution given the stagnation of energy greenhouse emissions to a level of 32.2 Gt in the conditions of an economic growth of 3% globally in 2014. The motivation for undertaking this study come from the following key ascertainments:

1. The GHG emissions related to the energy sector forms 2/3 of total GHG worldwide.
2. The demand for energy is steadily increasing until 2035 by about 0.9% annually, coming from the incessant growth of global population.
3. The renewable energy industry does not meet the expectations of international organizations and scientists but rather seems to present a collapse of market penetration resulting from the unattractive climates at different economic levels formats.
4. The subsidies directed to conventional energy contrasts too much with subsidies directed to renewable energy (see Figure I), this undoubtedly encourages a progressive production of GHG emissions and respectively of externalities.
5. The drop in oil prices by more than 50% in recent years provided an opportunity to countries like India, Indonesia, Malaysia and Thailand to reform the system of subsidies directed to fossil fuels.
6. A recent study conducted by the International Monetary Fund in 2015 brought to light the importance of redirecting tax dividend from the energy subsidizing reform (referring here especially to the conventional energy) towards improving the social welfare and economic growth by lowering distortion taxes for example, or by increasing public spending or production.

The Figure no. 1 outlines the current picture on the energy sector and presents the results of subsidizing efforts basing on promotion policies developed over time. A convenient result is that, unlike fossil fuels, subsidies directed toward renewables was doubled in 2010-2013 years contributing to the stimulation of segment development. As well favorable is the shifting subsidy ratio targeted by the two types of energy, in 2009 conventional energy being subsidized by about 7 times more than the renewable one, in 2013, however, the first one gets to receive only 4 times more subsidies than the other. Moreover, Figure no. 1 reflects clearly the inversion trend of subsidizing stimuli directed to each of the two types of energy, noticing diminutions of increases for conventional energy subsidies and fulminant subsidizing of renewables. According to energy roadmaps released by international bodies this trend will keep being progressive in the next years. At the same time, the rhythms of market development of renewables seem to live up to the expectations of many international organizations and researchers forecasting more spectacular increases than those obtained to date.

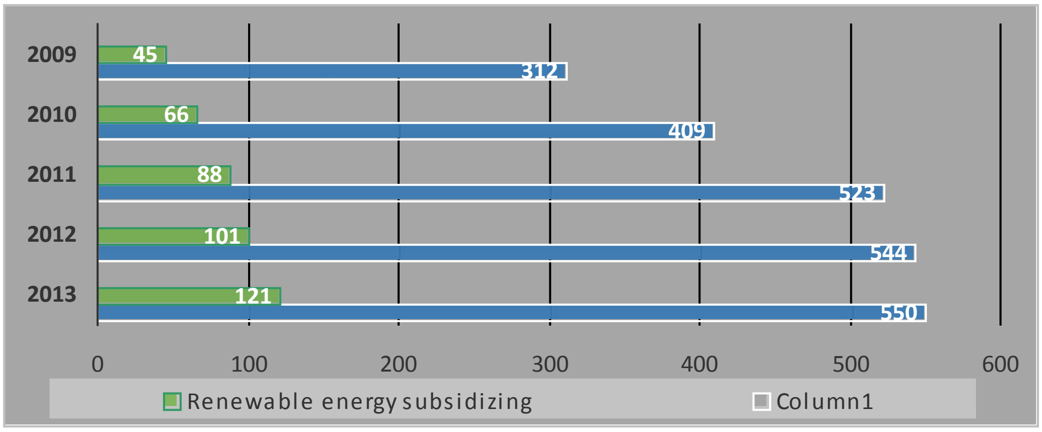

Figure no. 1. The subsidizing levels of conventional energy and renewables worldwide

Source: realized by the author basing on IEA data (International Energy Agency 2009, 2010, 2011, 2012, 2013)

Of course, we can't neglect the issue of penetration barriers for renewable technologies of energy markets, markets that have been and continue being abounded of fossil-based technologies start-ups. Impartiality in reflecting equidistant prices for energy emerges throughout state intervention for defraying financial "holes" both at investment stage as well as at the operational phase of energy plants based on fossils technologies, and respectively at the private cost levels and at the social cost levels through instruments like subsidization, exemptions from taxes, avoidance of externalities taxing, permissiveness in exploiting certain resources of national interest in unfairly conditions etc. For the fossil energy sector is characteristic a large avalanche of externality types and adapted subsidies to this sector that aim to balance costs and prices placing them at acceptable levels for both consumers and producers.

This study is a continuation of studies initiated by the author on the „subsidy" concept (Nasalciuc and Timus, 2015), thus following a parallelization of other economic problems facing the energy sector. In the previous study we admitted the existence of disputes on exact delimitation and placing in some economic and financial limits the term „subsidy". As in past studies, the central purpose of this paper doesn't envisage a counterbalancing of this concepts, so there can be mentioned that the term „subsidy" in the energy context implies the same concept met in foreign literature and it assumes "... any government measures that envisages preponderantly energy sector aiming the reduction of energy production costs, rising prices obtained by producers and decreasing prices paid by consumers".

Once on the subsidy concept, used in this paper, was elucidated our view, the starting point of the research will be to examine the concept of externality in the context of the energy industry (Section 2) which falls under the environmental and the climate change impact, and materializes in global economic impacts (Section 3). The last section (Section 4) systematizes the standpoints of this study and highlights the aggregated benefits of reforming fossil-fuel subsidies and the economic opportunities incorporated in renewable technologies.

2. Externalities and their impact on the energy sector

The concept of „**externality**" theoretically belongs to the neoclassical abstraction of economic welfare and is considered to be the interceder of the market failure process, as it violates the first Economic Welfare Theorem. Firstly, the concept of externalities in the context of energy production involves the economic activity costs of production, service or distribution of energy which results to be equivalent to the difference of social and private costs involved. In a more simple sense, energy externalities (or the **interaction costs** according to other sources) are those economic effects (positive or negative) arising from the production cycle, distribution or provision of energy services and are flapped away upon one third party and which were not taken into account when feasibility analysis was undertaken by entrepreneurs, or in other words, that have not been internalized.

In fact, there haven't been too much concern on the externality concept in the context of energy production until the moment of adverse effects interfering on economic development caused by climate regress, market economies going through a metamorphosis that has stimulated them to become more technologically advanced. It was only in 1960 when the conventional energy issue was highlighted understanding that it is producing pollution which is too costly to society, and consequently, there were first imposed restrictions on the activities of these producers. Many researchers from different fields have targeted efforts to integrate the concept of „externality" in an economic framework accepted by contemporary economists, the cornerstones in this direction began to emerge unceasingly - Hohmeyer (1988), Krupnick and Burtraw (1996), Freeman (1996), Stirling (1997). Given that externalities volume was seeking to incorporate first the pollutant emissions of plants in their vicinity, it turned out to be a fairly insignificant compared to private generation cost levels. Later, it became clear that only focus on the damage caused in the vicinity of plant is far representative when environmental damage of fuels transport is assessed implying significant distances from power plants. This internalization attempt resulted in external costs which were containing already enough consistency to impose their reflection by energy producers. However, internalization assessments did not stop there, and once it became accessible the monetization of fine particles impact on chronic death, researchers have enforced to integrate them into external costs of conventional energy production estimations. After that it followed the related impact of air pollution on human health, a new phase of value demarcation of conventional externalities. The evolution of methodologies seeking to integrate externalities in social costs are currently at the stage of identifying ways of computing and reflecting the climate change costs involved in developing conventional technologies. Externality issues are considered as **"biggest market failures"** (McChesney FS, 2006) and economists insist continuously on identifying patterns for a more efficient internalization of such losses in order to ensure the **most efficient levels** of plants activity efficacy.

Researchers as A.C. Pigou (Pigou, 1923) or R. Coase (Coase, 1960) who researched deeply the externality problem in their papers, unfortunately, do not offer applicable solutions to solve the problem relating to the energy industry data, as their impact is certainly higher to those found commonly in the economy. In his work, R. Coase came with proposals to avoid even taking into account the externalities and their induced effects as long as the product generated by the producer is more important as value and market necessity than the injury on third parties. However, a review of the position taken with regard to the externality problem was reflected by Harold Demsetz in his "Ownership and the externality problem" (Demsetz, 2003). The paper criticized the coasean approach submitting equidistant proposals for a better managing of externalities. The above mentioned authors debate the externality problem from the perspective of ordinary activities conjunctures of producing goods and services, in the case of energy industry and especially the one based on fossil fuels this issue takes quite a different matter. In this case we are talking rather about a cost-benefit production approach implying both the costs involved in investment and operational activity along with the benefits of private income as well as social benefits.

Despite countless study articles on the patterns of solving the externality issues, overall researchers and governments agree on the effectiveness of Pigouvian fees and the reasonableness of maneuvering with them on this segment at governmental levels, with the obvious condition of monitoring and reforming this system in time, given the intensive technological transitions recorded. Free enterprise entrepreneurs may choose going the way of other tactics for internalizing the externalities, either by joining a particular energy cluster system or maximizing the specialization level to ensure a qualitative management of externalities produced. However the corrective fees system is the most facile tool for controlling and implementing on economies of scale and at the same time the cheapest in terms of fiscal management and in spite of these advantages, however, practice along with unincorporated externality indicators demonstrates the shortcomings of effective implementation of these reforms. Externalities associated with energy industry are of entropic nature contrary to concepts of sustainability and green economies targeted by the contemporary countries directives. Governments often choose to apply methods of calculation that does not fully reflect externalities volume pursuing thus, indirectly, to protect the vulnerable social categories of population this giving rise to other undesirable economic effects on the energy market, namely:

- Unreasonable increasing of energy consumption within countries;
- Changing the export/import balance of energy (increased volume of foreign imports of energy, raw materials for energy production or possibly decreasing the volume of energy exports);
- Discouraging the externality producers to tech power plants with carbon absorption and purification installations, which could mean a qualitative control over their own externalities and respectively a more efficient yield of company's activity;
- Maintaining prices for conventional energy at privileged levels compared to renewable energy prices which makes the latter uncompetitive with the former, despite the amalgam of economic and ecological advantages involved;
- Excessive consumption of energy participates in acceleration of global warming and local air pollution and simultaneously can rise the demand fluctuations and increase energy prices.

The impact magnitude on sustainable economies and the chain effect that externalities associated with conventional energy segment causes, raise uncertainty and the necessity of initiating measures of certain strategic and economic defense. Thus, the "shirk" of reflecting externalities starts with the very first levels of the production chain - primary energy producers do not reflect fairly, and in some cases at all, the externalities associated with the extraction process and depletion of natural energy resources, and at next levels of production chain they are simply not taken into account coming from the pursuing of economic feasibility. In fact, externalities associated with fossil fuel-based energy production are not included in the accountancy evidence of enterprises and in most cases there are levied only certain annual taxes for CO2 emissions, environmental and water pollution, waste production, etc. My conviction is that: the impact and value associated to fossil fuel externalities and their exploitation requires a more rigorous approach to reflect these costs in equidistant final prices applied to consumers. A number of studies have agreed on the method of internalization of externalities in monetary units reported to units of pollutants emitted for conventional energy. Units of emitted pollutants varies from one technology to another and an illustrative example of unincorporated externalities is the study of researcher Drew Shendell (Shendell, 2015), a professor at Duke University, which evaluated losses in evaluating energy and fuel prices of $ 3.80 for a gallon of gasoline, $ 4.80 for a gallon of diesel, 24 cents for a generated kilowatt-hour of energy from coal and another 11 cents for a kilowatt-hour of energy resulted from natural gas. These avoided costs are just simple examples, existing the possibly that the real picture of uncaptured externalities to be even more disastrous than the approximated one.

On the other hand, we remind that looking for a minimization of negative effects of externalities, unfortunately, the marginal cost of energy increases and respectively decreases the marginal returns, contrasting with the profit interests of energy producers. Consequently, we can say that it is supported a convenient conjuncture by governments pursuing their political interests as well as by producers seeking maximum efficiency levels for their start-ups. So, we consider that we have basis to state that, in fact, the uncaptured externalities are, in reality, a kind of subsidy to this industry and this is due to state's consciously freezing of financial resources in this system, manifesting a lack of initiative to collect this money through fiscal and legislative policies. Moreover, this subsidy type is called **post-tax subsidy** and is calculated after the consumer's billing in order to recover those externalities and adjustment to social costs for this activity.

Externalities associated to fossil energy production is emerging mainly in GHG emissions, and as I mentioned, make up 2/3 of total worldwide GHG emissions. It appears that a strict placement of conventional energy social costs is utopian given the methodology barriers for measuring this indicator's component parts, yet many research studies carried out evaluations seeking an indicative reflection of economic wastes related to the lack of energy externality internalization. Despite the fact that most researchers come up with different recommendations on the size of external costs to be internalized, a consensus view seems to be that currently fossil energy market do not reflect fairly both the related costs as well as charged prices. Parry's study analyzed the levels of internalizing externalities among countries, so it became clear that technologies based on coal and natural gas do not reflect acceptable and close to the efficient social levels yield. The fuels are internalized more efficiently in countries like Great Britain, Poland, Israel, Germany, contrasting with countries like Egypt, Indonesia, India, Kazakhstan, Nigeria etc., these being rather the largest fuel subsidizers. However, it is established by numerous studies that an "accentuated coal and fuel taxation is justified both in developed as well as developing countries for various reasons- air pollution and carbon for coal, congestion and traffic accidents for fuels , even if corrective taxes are very sensitive to local factors. Natural gas should also be charged for the same reasons as those for coal, but far more moderately" (Parry et al, 2014). And if externalities are not reflected, in terms of social costs triggers a cumulative effect of them that sooner or later will be manifested including on economic and financial markets: "If climate change affects not only the country's economic output but its growth also, then it has a permanent effect of accumulation, leading to greater social costs of carbon" (Moore and Diaz, 2015).

3. The risks of global loss related to non-internalized externalities of fossil energy and the projected economic and social consequences

The CO_2 stocks accumulated in the atmosphere are being encountered in direct dependence with climate change processes and represent ultimately, the risks assumed by humankind in productivity growth and technological development in time. Conventional energy industry is responsible for a good part of these changes, and despite all this facts, fossil energy markets continues to grow from year to year and even more it is supported by governments and other types of structures. The interest for climate change in the context of economic growth theory emerged in recent decades only after a period of intensive tech to ensure fast economic growths. Nordhaus (Nordhaus, 2010) explains in his papers that, in fact, GHG in the atmosphere are "**a negative natural capital**" and their reduction minimizes current consumption to ensure the "growth opportunities of future consumption". International Panel on Climate Change (IPCC) considers that carbon emissions are just at the beginning of continuous increases as "future investment decisions in energy infrastructure, expected to reach $ 20 billion between 2005 and 2030, will have long-term effects on GHG emissions, coming from the long periods of life of power plants and of other types of energy infrastructure". And to the end of the IPCC study it is concluded that "global mean losses could be 1 to 5% of GDP for 4°C of warming, but regional losses could be substantially higher" (IPCC, 2007, p.69). Other studies however, have tried to quantify the decreases in GDP related to climate change costs per ºC changed in annual temperature increases, thus Bansal and Ochoa (Bansal and Ochoa, 2011) quantified an average of about 1.1% projected decrease of GDP in the poor countries, and (Dell, et al., 2012) consider a 1.3% decreasing rate of national GDP. Even if this indicators may seem inoffensive at first reviews, under the most aggressive scenarios of climate change evolutions, their cumulative effect could result being quite disturbing on global economies. Also, other sources assume that permanent losses of ecosystems and exploitation of labor and capitals for adaptation to the detriment of research and development investments will directly affect economic growth rates (Pindyck, 2011). In terms of climate shocks is highly expected the investor's awareness to economic uncertainty factors that may be expressed quite actively on strategic markets, thus diminishing the investment returns and the global GDP respectively. Thus, it is obvious that at least a minimum impact on macroeconomics, regional economies and even on global economies is expected to take shape with the deployment of conventional energy technologies and especially as a result of externality un- internalization for these technologies, as potential revenues from social adjustment costs could have the following socio-economic vectors of economic and social recovery:

1. State involvement in increasing the efficiency of green economies through targeted investments in rebalancing the degraded ecological environment as a result of fossil energy power business.
2. Financial support to socially vulnerable categories when applying higher energy prices as a consequence of the internalization of externalities through allocations, tax exemptions and social compensations.
3. Improving public services through investments oriented to social and economic welfare of citizens as a counterbalance to losses suffered from the activity of conventional power plants.
4. State intervention through financial support tools for energy efficiency projects. This involves identifying ways to stimulate the final energy consumers to save the generated energy through extensive information operations, adapting houses to modern standards of energy savings etc.
5. Creating a climate of co-financing of the fossil energy industry with the renewable energy. Namely the obtained revenues from internalization of external costs of fossil technologies could be threw up to the renewable energy industry branch in the form of subsidies and other financial supports.

To understand the possible scenarios that some researchers and research groups have predicted in the problem of quantifying the impact of GHG emissions and respectively the change of temperatures and climate change on Earth on economic welfare and to raise awareness of the magnitude of the global loss as a result of non-internalized externalities of conventional energy, we propose a parallel analysis of Figure no. 2 and Figure no. 3:

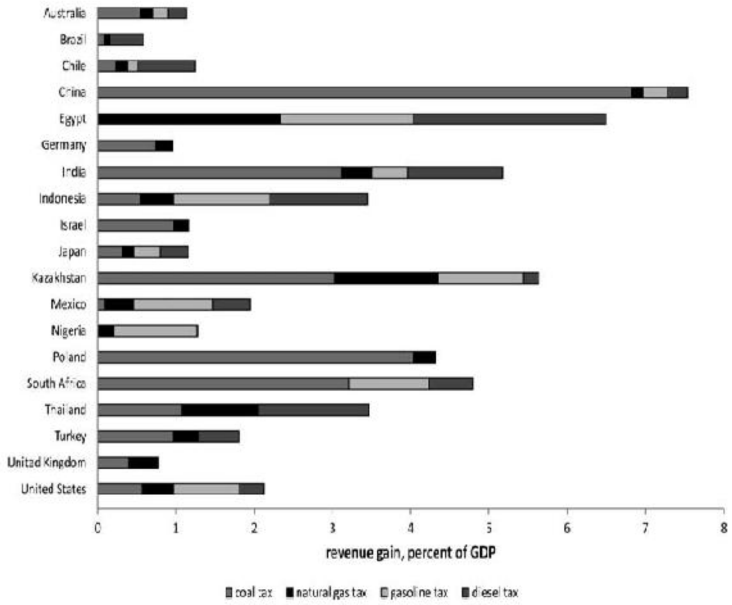

Figure no. 2. Potential revenues from corections

Source: I. Parry's study (2014) for IMF

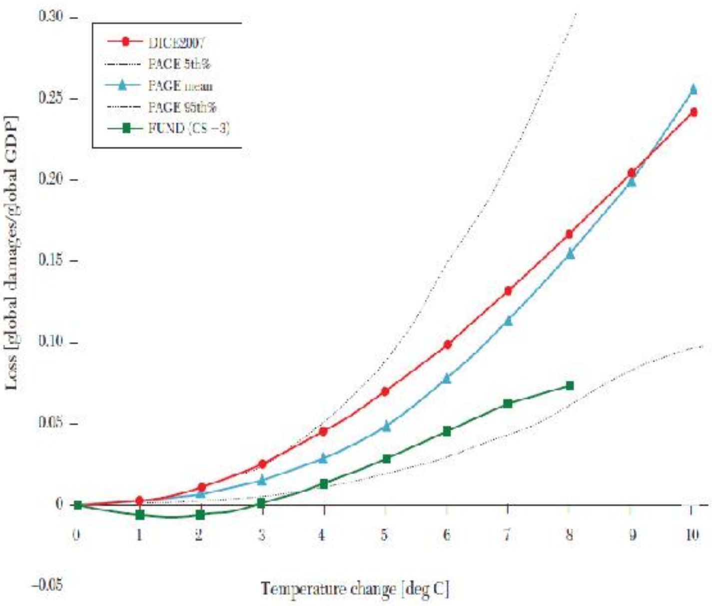

Figure no. 3. Losses in annual consumption as of fossil fuels. Selected countries in 2010, percentage of global GDP resulting from the temperature's annual global increases according to DICE, PAGE and FUND models

Source: Interagency Working Group on SCC (IAWG, 2010)

Notes: *DICE (Dynamic Integrated Climate and Economy)- model realized by William Nordhaus and presented in 1990.

** PAGE (Policy Analysis of the Greenhouse Effect)- model submitted by Chris Hope in 1991 for delegated authorities in policy adoption in Europe.

***FUND (Climate Framework for Uncertainty, Negotiation, and Distribution)- model designed by Richard Tol in 1990 (the researches and FUND forecasts may be reviewed by http://www.fund-model.org/publications)

The two above figures reflect on the one hand the potential revenue and on the other side the potential losses projected corresponding to the internalization of externalities for fossil technologies policy cource and respectively the effects of promoting the conventional energy in the detriment to the renewable one which involves, according to researchers, net lower externalities in terms of external costs and as economic effects on development. The Figure no. 2 illustrates countries where an equidistant taxation of interaction costs would generate aggregate revenues for conventional energy systems. This confirms the fact that the more countries rely on technologies that mine coal resources the greater the potential incomes related to the internalization of externalities are, adequate examples would be the case of China, Poland, South Africa, India, Kazakhstan, etc. Moreover, the corrected Pigouvian fees would generate revenues nothing negligible in countries like Brazil, Egypt, USA, Japan, Nigeria, Thailand, Indonesia etc. given the existent fuel-based technologies. Basing on the I. Parry research it is obvious that these countries are those who neglect the most the fossil fuel's reform and registers the lowest socio-economic returns, even if they imply the most developed economies in the world. Whatever the source of recovering the external costs is, the most notable revenues from internalisation may be identified in China, Egypt, Kazakhstan, South Africa, Poland, Thailand and Indonesia.

In the same context, it is important to specify that reforming the conventional energy production system could get to appeal to self-falsification in countries where technologies based on coal are in close competition with technologies based on natural gas, thereby to make more attractive the technologies which may contribute to reducing the social and ecological risks (those based on natural gas in this situation) it is preferred that governments establish temporary policy climates in order to create a false investment attractiveness on the sector and respectively avoiding the production of costly externalities to social welfare.

Figure no. 3 is based on projections of the three models of integrated assessment for the social costs of carbon which are considered essential in the IPCC and IAWG studies, calibrating potential economic losses as a result of increasing annual temperatures around the globe. These models combine the climate process analysis and evaluation of world economic growth and their feedbacks in time. To this end, these models run the steps of transformation of the changes in the emission of GHG in the atmosphere, appreciation of atmospheric concentration fluctuations in temperature changes and quantifying the temperature changes as economic costs to humanity. As we can see, the projections are not the most encouraging, and regardless of the methods applied, all three models have identified a codependency between climate changes and global economic growths. The models admit that climate change will produce economic remodeling, and in some major cases, will determine countries to change their profiling industries and their applied technology types, resulting finally advantaged or disadvantaged economies of the adapting process to other changing economic and geopolitical factors. Being based on aggregate costs and benefits of the transition to new climatic conditions, the three models confirm the negative projections of other top listed researchers with regard to the fact that overall economic losses are inevitable under climate shocks. The most affected countries as a consequence of climate change producing will be those that rely on agricultural sector, in other words, we refer to developing economies as they will need most to get adapted to new climatic conditions, favorable for certain types of productions, and countries in the equatorial region and in the regions of continental coast where changes in water levels and the types of precipitation will occur, as the researchers conclude. The biggest losses are foreseen in the PAGE model which until 2100 years involves higher costs than 0.25% of world consumption levels as a percentage of GDP. With close estimates comes also DICE model but FUND model, is the most optimistic regarding the impacts of climate change evaluates a loss of less than 0.05% of GDP under the conditions of temperature changes to a maximum of 2ºC compared to preindustrial levels. These ratings are rather indicative, as this type of studies are based on well-known to researchers factors and the probability of unanticipated third interferences occurrence is quite high. Moreover, IAWG specified in his 2013 paper that the three models have changed their evolutionary forecasts of analyzed indicators at the detriment of potential costs that will incur humanity as a result of temperature changes, and consequently it entered an increase of social costs of carbon at an average of $ 21/tone of CO_2 rated in 2010 to an average of $ 35/tone of CO_2.

So after an interdependent interpretation of the two figures above we believe that non-internalization of externalities for fossil energy production will undoubtedly lead to much more critical economic and financial consequences that will be, sooner or later, be manifested through **climate shocks**. The fact is that the threat of climate changes is a product of GHG emissions and fossil power plants are the most dominant triggers of these processes. The costs of climate change caused by unreflecting of social costs associated to conventional energy, can hit hard in modern economies given the need to adapt to the new market conditions.

4. What economic and social opportunities involves promoting the renewable energy?

Until recently, the SWOT analysis of renewable technologies were highlighting the big disadvantage of the industry namely the exaggerated investment and operational costs compared with those of fossil technologies, which now took a counterbalance direction. As we have seen in another paper initiated by the author (Nasalciuc and Timus, 2015), changes in investment costs of renewable start-ups strive for a close competitiveness with that of fossils as indicators of the past decade, especially the PV and wind energy based technologies, which could be a springboard passage to another level of policy choices able to promote start-ups based on renewable technologies. In these circumstances the energy market of renewables have the chance to penetrate it at more optimistic shares and parallel with this there can be reached an immobilization of the carbon accumulation in the atmosphere and that an adjournment and possibly even a cease of producing the climate changes.

The study ExternEPol (2005) placed the external costs of fossil plants at averages of 1.6 - 5.8 €/kWh and at the same time, it is inevitable a parallel analysis of externality costs associated to renewable technologies, studies bringing out an average of 5 € cents/kwh of produced energy which seems to be a quite generous approximation. However, a comparative view of current researches is welcomed in order to stress the irrevocable awareness of the **net lower externalities** involved in renewable technologies compared to the **exaggerated** ones that interfere with the conventional technologies. The vast majority of studies on energy externalities have been prepared in ‘80s - '90s and even if currently these values can be estimated slightly different, however, Figure no. 4 can provide a qualitative comprehensiveness of the actual situation on the energy market with regard to the considered problem. Sundqvist (Sundqvist, 2004) conducted a summative investigation following 132 research aiming to provide externality assessments for different energy technologies. Thus, Figure no. 4 is carried out on the basis of this assessment made by Sundqvist and shows the averages estimated by the author basing on the researches that fall under the viewfinder for different energy technologies. Figure no. 4 confirms once again the ecological and economic damage and the danger produced on human health resulting from the development of conventional technologies and non-internalization of related externalities. Coal-based technologies are the most expensive socially varying in those 29 assessments within 0.06 \$/kWh and 72.42\$/kWh (1998), thus ranking to an average of 14.87 \$/kWh in the Sundqvist's estimations. The fuels are considered, moreover, no less dangerous socially, foreseeing fluctuations within the range of 0.03 \$/kWh and 39.93 \$/kWh (1998) registering an average of 13.57 \$/kWh basing on 15 research studies.

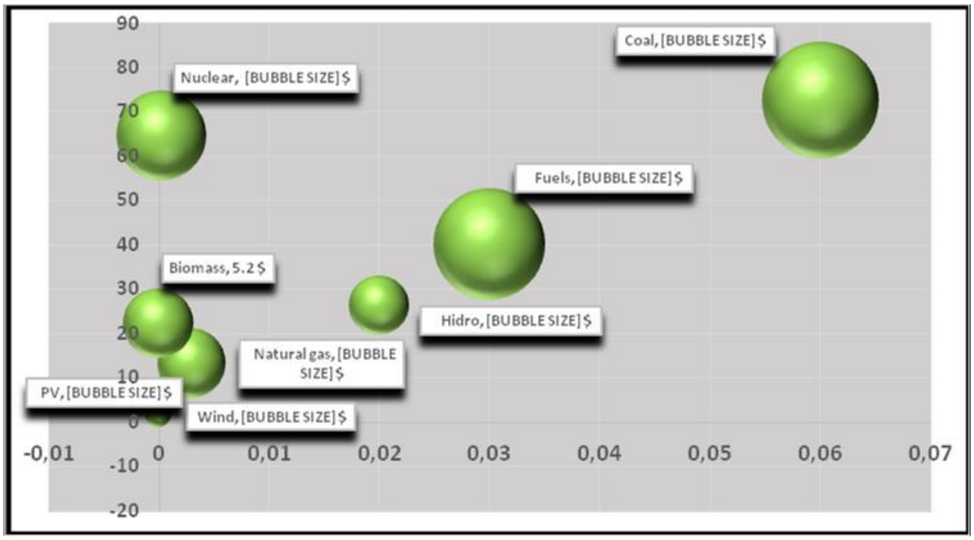

Figure no. 4. Descriptive statistics on externalities related to energy production technologies as assessed by Sundqvist

Source: realized by the author basing on the Sundqvist's assessments (2004)

The next type of energy technology as external consistency is the nuclear one that can vary within the levels of 0.0003 \$/kWh and 64.45\$/kWh, and receiving an average of 8.63 \$/kWh (1998). The high fluctuations of externalities associated to nuclear technologies lies on the researcher's methodologies in establishing different levels of business impact on human health. Given the high frequency of accidents in nuclear plants which involve harming human health and in some cases even carrying the deaths, externalities of this technology are estimated at considerable costs. Technologies based on biomass would be the following technologies involving proportionate costs to an average of 5.2\$/kWh (1998) ranging between 0 \$/kWh and 22.09\$/kWh considering the analysis of 16 evaluating studies. This type of technologies entail in the producing process the burning fossil fuels and respectively emits CO_2 gasses which automatically makes it the most expensive in terms of externalities of all renewable technologies. Near to the biomass externality averages follow the technologies based on natural gas. They range from a minimum of 0,003 \$/kWh (1998) reaching, according to some studies, a maximum of 13.22 \$/kWh and placing them at an average of 5.02\$/kWh according to 24 studies that underline this estimates. The next, in terms of social costs, appear the hydrological technologies with limits of 0.02 \$/kWh and 26.26 \$/kWh (1998) and an average of 3.84 \$/kWh in a series of 11 trials. And finally, the least costly technologies have proved to be those based on solar energy (resulting from seven researches on the technology) and those based on wind energy (relying of 14 research on the technology), they having the minimum limits of 0 \$/kWh as external costs and maximum limits of 1.69 \$/kWh and 0.80 \$/kWh respectively. The averages for the two technologies are 0.29 \$/kWh for wind and 0.69 \$/kWh for solar technology. Technologies based on solar energy appears to be slightly more expensive socially than those based on wind energy, because it turns a small part of the captured energy back into the atmosphere as a heating energy, which is in a somewhat, a negative impact on the ecological environment. Given the simple fact that the figures speak for themselves, it becomes obvious what types of technology should not be subsidized and financially supported and which ones alike, require financial support and promotion, especially solar and wind technologies which are the most competitive in terms of investment and operational-maintenance costs.

Once that with regard to the advantageous costs and modest externalities of renewables I have elucidated the current situation, it is appropriate to attempt foreseeing the benefits of subsidy reforming process targeted towards conventional energy that would generate both economic and financial benefits at the governmental level, and also with regard to consumers, renewable industry development and in the process of slowing down the climate change process, all referred to in this paper, and Figure no. 5 rendering this entire process:

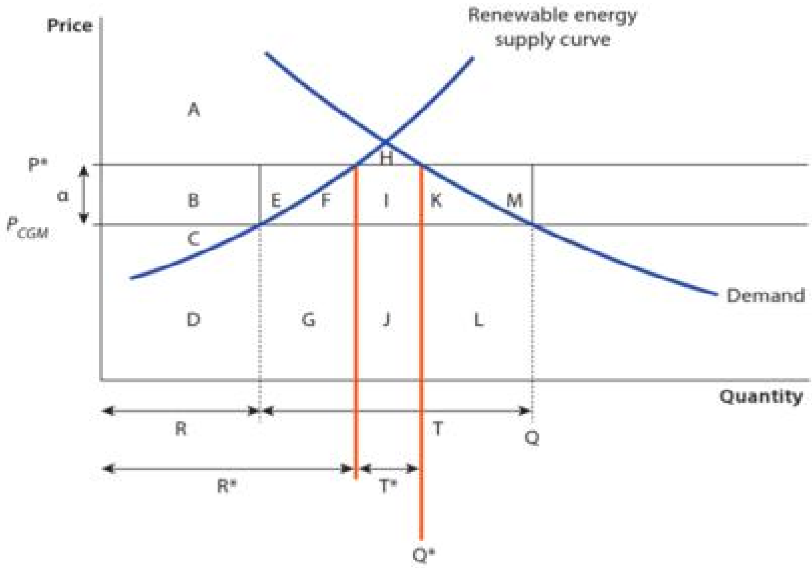

Figure no. 5. The economic impact of subsidizing the fossil fuel energy”
Source: World Bank (Meier P. et al 2015)

In the figure above, based on researches guided by the World Bank, the cost of fossil subsidizing to governments present themselves as *Ta* equivalent to the surface *E* + *F* + *I* + *K* + *M* to a consumption level *Q* and the subsidy reform for this segment would give rise to a series of successions on energy markets that would have the following advantages:

- **The benefits compassed by governments** as a result of reforming the fossil fuel subsidies would have the costs size of *E* + *F* + *I* + *K* + *M* and which would remain in countries' budgets and oriented towards other adjacent sectors in order to streamline the energy sector and promote technologies that are macro-economically strategic;
- **Yielding and balancing the energy consumption.** As specified in this paper, subsidizing the fossil energy induces an effect of irrational energy consumption on final customer given the unrepresentative private and social costs of its production. In the case of fossil energy subsidy reform, consumers would get to new levels of electricity consumption registering net superior yields and discarding the irrational costs of *B* + *E* + *F* + *I* + *K* scale, shifting to an electricity consumption having the size of just *A* + *H* dimension;

- **Bonuses targeted towards renewables.** Renewable energy industry would feel the effects of the reform through financial surpluses of size $B + E$ supplementing the benefits of modest size C;
- **Yielding quantitatively and qualitatively the energy production in social terms.** In the situation of fossil energy reform, the social costs of energy production would result in a total size of $A + B + C + E + H$ under the conditions of changing the consumption levels from Q to Q * and increasing the energy market supply rate for the renewable segment from R to R * thereby the generated environmental benefits would go from the T_a size to the T^*_a one.

Thus, it is obvious that the aggregate benefits resulting from the elimination of subsidies directed to fossils (reflecting the externalities represent subsidies which will be eliminated, that is internalized externalities) provides the perfect climate for sustainable development of the XXI's century economies and the welfare of future generations.

5. Conclusions

The data currently available allow us to understand that, in fact, the cost of conventional energy perceived daily by consumers in some form is really just a top of the an iceberg and its underneath (conventional energy externalities and subsidies) strike both in global economies and in the Earth's ecosystems.

The fossil's industry scattered subsidies (including here also the externalities as a subsidizing form) push new huge financings on this segment, this spoiling the attractiveness of producing renewable energy and hastening the climate change process. Investing in natural capital by reducing GHG emissions and the targeted pressure on the producers of fossil externalities for a maximum internalization must be pursued extensively from countries which involve high levels of potential climate risk and connecting the countries with medium levels of climate risk to reasonable limits in order to meet the global warming limits to a maximum of 2ºC compared to preindustrial levels. In fact, temperature variations and the global economic growth is presented as a bivariate process, so that a quantification of the costs of climate transitions is emerging the decreases of global projected GDPs.

The Pigouvian subsidizing fees along with other financial instruments are able to produce the degeneration of fossil fuels and the promotion of renewable energy and consequently there can be ensured the strategic development of the countries and reliability of future green economies.

In the course of awareness of the magnitude of the externality problem, in all its ways of manifestation, the greatest responsibility would need to be demonstrated by governments which have to adopt appropriate policies as directed to energy producers and directed towards the consumer's education in a spirit of **social cohesion**, this policies would stand for strategic economic and social development of current and future generations.

One of the strongest positions that could be manifested by humanity towards the slowdown process in producing climate changes and respectively in reforming the fossil energy, is the one which would follow the path of internalizing the external costs as closer to social costs and promote renewable energy through subsidies, through the instrumentality of the carbon allowances and green certificates markets and other incentives tailored for this sector. Despite some short-term economic disadvantages like- higher energy prices and slower economic growth, there are expected superior long-term economic benefits such as more efficient allocation of resources and higher levels of economic yields, which will undoubtedly generate a favorable climate for strategic developments of countries.

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