

# Market Failure and Structure of Externalities and Environmental Damage by Different Industrial Activities

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***Abstract:** The goals of this assignment are modest. It does not attempt a systematic review of the current state of such externalities analysis, it serves as an introduction assessing environmental externality costs and their relation with each other, in addition it give general view on the market failure and externality, and gives references for who wishing to investigate further. The externality in energy production process was used case study in this work but not in details. The air pollution is presented as a result of energy production process is presented here associated with some forms of poison a chemical compounds that are assumed as the most danger gases could affect the environmental and human health.*

***Keywords:** market failure; externalities; renewable energy policy; environmental externality*

## 1 Introduction

Policy interest in renewable energy technologies has been gathering momentum for the past several decades, and increased incentives and funding for renewable energy is often described as the panacea for a variety of issues ranging from environmental quality. Sizable policies and programs have been implemented worldwide to encourage a transition from fossil-based electricity generation to renewable electricity generation technologies like wind, solar, and bio fuels [1]. If external costs exist in case of pollution, the producer may have a strategy to produce even more in order to be able to pay the future fines related to all associated environmental costs. It might be a cynical approach but it can be considered as a serious option in business life. External benefits used to be considered less important in case of pure public safety or public interest as if it can be connected to real profitable benefits for the company. The overall cost and

benefit for the society is calculated by costs and benefits of each individual party involved into the matter [2]. We use the topic environment or environmental issues or environmental problems in the same concept which consist of the problems listed by [3], in a catalogue à la Borges. The issue is wide-ranged, deprived of any stable and univocal criterion of inclusion: climate change, different types of pollution, natural and technological risks, environmental diseases, toxic wastes, species dying out, overuse and exhaustion of natural resources. These elements cause definitely serious problems for the whole society even if specific individuals are not aware of them. In the economic theory they are considered as negative externalities. Those markets are deteriorating where the social benefit (the sum of private benefits of all individuals in a society) minus the social cost (the sum of private costs of all individuals in a society) result in a negative sum and therefore the net private benefit of a market transactions result in a negative sum which is not sustainable in market economy. If the net private benefit doesn't equal with the net social benefit, there are two options. If the net private benefits  $> 0$  but net social benefit  $< 0$ , individuals can make exchanges that are privately beneficial but socially costly. If the net social benefit  $> 0$  but net private benefit  $< 0$ , it means transactions would be socially beneficial but privately costly. There are experts who propose the government should intervene and put the private costs and benefits into harmony with the social costs and benefits, and so the government intervention can be justified in the stake of the benefits of the whole society. As it articulated in [4], external costs exist when "the private calculation of benefits or costs differs from society's valuation of benefits or costs". If we think about pollution, it is typically involving external cost because of the caused damages to the society but it is not affecting directly the pure market transactions. The market allocation of natural resources depends on two factors: consumption/demand for products and access to natural resources. Both supply and demand are determined by many factors like superabundance or scarcity, tastes, preferences, fashion, religious prescription, number of buyers and sellers, income, prices of goods and resource, prices of production/mining technology, expectations, taxes, subsidies, etc The markets are usually failing in effective allocation of natural resources relying on pricing mechanism if the total social cost of exploiting the natural resource is not incorporated into the pricing.

## 1.1 Externalities

Let's look at the free entry/exit market failures. There are usually two main actors in a trade matter: the seller and the buyer. But it can happen that a trade matter or other business activity may have effect for those actors who are not directly involved in the business matters. Since those are outsiders, those can be considered as externals, this appearance can be called as externalities which can be either positive or negative as well. If the private benefits are small relative to the social benefit but private costs to provide them are large, public goods may not be supplied at all. The importance of the public good problem has long been

recognized in the field of public finance. Taxes often finance governments' delivery of public goods, such as law and order [2].

## **1.2 Environmental Economics and Externality Term**

The environmental economics is always part of the economics and the economics in general term is supplemented by different topics of the environment. The idea of environmental economics has been strengthened by the experience how market is not able to manage its failures successfully and how is illusion the omnipotent role of the market if we consider the externalities. The market itself is not able to allocate the natural resources successfully. "A market failure occurs when the market does not allocate scarce resources to generate the greatest social welfare. A wedge exists between what a private person does given market prices and what society might want him or her to do to protect the environment. Such a wedge implies wastefulness or economic inefficiency; resources can be reallocated to make at least one person better off without making anyone else worse off." Market failures usually include the externalities, and in this case the basic mechanism of market like the excludability or rivalry is missing. Let's emphasize again that the externalities mean the cost or benefit which in the field of economics as we mentioned earlier, an externality is the cost or benefit of the business activity which is not chosen for incurring such a cost or benefit [1]. We can see for example how industrial activities especially in the sector of energy, mining, metallurgy or forge we can find significant pollution of air, water or other natural factor which has serious impact both on health where the cost is bearing either by individuals or by the social security system or by both parties in some proportion; and also on elimination or reduction of the environmental damages, and in this case in this case the society bears the greatest cost most probably. If we look at the topic of the external benefits, which is in general term the safety of the public health, the producer has two options: either producing less for less profit with less environmental damages or producing with full capacity and causing growing damage in the nature and public health and paying compensation for individuals and/or society. What one must consider it is the total cost and benefit for the society which can be defined as the sum of the imputed cost of benefits and the costs for all relevant parties. We can state that in unregulated markets which have significant externalities the prices do not reflect to the total social cost or total social benefit of the production activity, and therefore we can state that unregulated markets are not efficient [5, 6]. The British economist A.C. Pigou has an important role to develop the theory of externalities. He analysed situations when some part of the cost or benefit affected - "spill over" onto - third parties. If the cost is imposed on a third party, it is called as negative externalities. If the benefit is imposed on third party, and this third party was not directly involved into the activity, we call it positive externality. These were an important research topic of Pigou in the beginning of twentieth century and it can be considered as part of the welfare economy [7]. He also examined how collective pressure is related to externalities. The example: if somebody doesn't take care of his/her

house the neighbours will be complaining and also ignoring any good social connection with this person. The big liberalist, F. Hayek proposed to choose the individual freedom which he considered deviant in such a case and do not bow before the communal pressure. ("Deviant" means in this case such a behaviour which is not agreed by many people but which is not violating the right of those who do not agree.) Of course the above mentioned story looks different if the authorities are introducing a regulation concerning the private houses and giving prescriptions. Another Austrian economist, Murray Rothbard refused the common distinction between the public and private goods, where the first one is to produce in collective way because of the positive externalities they create, and the second one is to produce by the market freely. Public goods are for example the different infrastructures, cultural and educational institutions, some general services like collecting garbage. There has been a consensus emerged: unless the state is providing these public goods, people will become quickly so called free riders, who take the benefit of such goods and letting other people pay for them [8].

## 2 Voluntary Exchange

In post-modern world has raised the concept of voluntary exchange in which buyer and seller are aware to not make trading if it would harm or would be maleficent for any party (see Figure 1). But the transaction can of course have effect on third parties as well, and it can be either negative (usual pollution-caused damage on nature or on the health of the population) or positive as well (let's look at the activities of bees when they take the pollen from one plant to another). Neoclassical welfare economics used to state that the consequences of externalities are not optimal from the point of view of the society. The situation of those, who are inadvertently affected by externalities, cannot be considered good in society. And the situation of those, who benefits from the externalities, is good and doesn't pay for it. And here is turning up the concept of voluntary exchange through which the social welfare cost can definitely be reduced. Anybody who is suffering from the negative externalities will think about as a failed or reduced utility because of the personal negative experience or because of the medical problems as consequences and also its financial consequences for the individual or for his/her family. If we think about the negative impact on the body it can be interpreted as the violation of a property right, i.e. the violation of the good condition/health of the body which is a private property. This means the negative externalities can be considered as an ethical problem as well which indicate political problems as well.

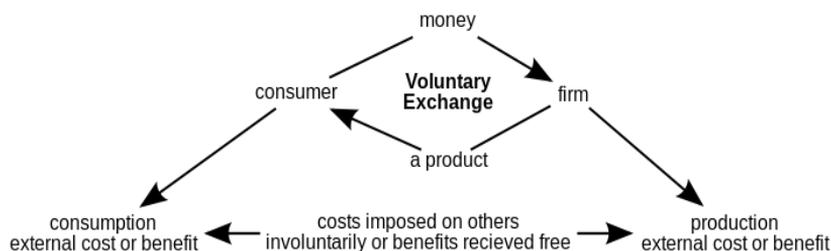


Figure 1  
External Costs and Benefits

If we look at the nature we can imagine that the water in general sense is not property of anybody and it is owned either by the country (i.e. the community or the society) or by legal entity (public water company) which is defined by the state. And in the case of the positive externalities the utility of third party can be higher without additional cost. As the welfare is growing we will see that fewer goods will be produced as it is needed. Positive externalities can be the education or the public health improvement or law enforcement as well.

## 2.1 Negative Externality

Negative externalities have competitive relevance in a market when they have selective impacts – as, for example, when a product in use imposes greater costs on consumers of rival products than on other people. Because managers have discretion over aspects of product design that affect external costs, the externality in such cases may be viewed as a strategic variable [9]. Many negative externalities can be found as environmental consequences of production.

*Some examples for negative externalities through production:*

- Air pollution from burning fossil fuels. This activity causes damages for vegetables, health of mankind, buildings [10, 11].
- Climate change is the topic which is now the most discussed by the international community. It is caused by the so called greenhouse effect, i.e. gas emissions from burning oil, gas, and coal. The Stern Review stated that "Climate change presents a unique challenge for economics: it is the greatest example of market failure we have ever seen" [12].
- Water pollution by industries especially mining, aluminium or paper producing, where the ground water reserve can be damaged and also it can also damage the plants, the animals, and the human population through the used effluent dirty water.

- Noise pollution during the production process or simply caused by traffic, or light pollution as a pregnant sign of civilization may cause mental or psychological illness.
- A very different but real danger is the systematic risk, i.e. the risk which is indicated by the banking system and shadows the whole economy and brings the standard feeling of fear. Beside bad regulation or not effective supervision also the moral hazard is always in the picture [13].
- Production of animal food in large facilities indicate serious environmental problems, like air pollution, contamination of water resources and soil with concentrated animal waste, animal's growing health problem because of the increased use of antibiotics that creates more and more rapidly antibiotic-resistant bacteria, etc. (The last one is a problem of mankind as well.) [14].
- Overfishing in oceans and seas are depleting rapidly the stock of fish, and in fact, this is already causing very serious problem in some areas. It illustrates well how a common good, common resource is depleted without any kind of state control. Or if one state introduces a limit the other is not following this rule and so exploits the so called "progressive" or more environment-sensitive one.
- The cost of storage of nuclear waste (used nuclear fuel cells) of nuclear plants is to include in the price of the electricity produced by the nuclear power station. There is usually an extra fee incorporated into the payment that will be transferred to a special account for the purpose of future storage. Although in some cases the storage can last up to hundred thousand years but in generally thousand years can be calculated. How for this period can be accumulated the financial resource? It is pure illusion. If we look at the hazardous chemicals, in this case the cost of waste treatment is not incorporated into the prices. Note: the USA Environmental Protection Agency declared that some hazardous chemicals can be dangerous up to ten thousand years and this type of additional cost is usually not incorporated into the prices and not analysed the negative impact of the long-term hazard.

*Some examples of negative externalities through consumption:*

- Sleep deprivation due to a neighbour listening to loud music late at night.
- Antibiotic resistance, caused by increased usage of antibiotics. Individuals do not consider this efficacy cost when making usage decisions. Government policies proposed to preserve future antibiotic effectiveness include educational campaigns, regulation, Pigouvian taxes, and patents.
- Shared costs of declining health and vitality caused by smoking and/or alcohol abuse. Here, the "cost" is that of providing minimum social welfare. Economists more frequently attribute this problem to the category of moral hazards, the prospect that parties insulated from risk may behave differently from the way they would if they were fully

exposed to the risk. For example, individuals with insurance against automobile theft may be less vigilant about locking their cars, because the negative consequences of automobile theft are (partially) borne by the insurance company.

- Higher congestion costs and increased accident risks when people use public roads.
- Consumption by one consumer causes prices to rise and therefore makes other consumers worse off, perhaps by reducing their consumption. These effects are sometimes called "pecuniary externalities" and are distinguished from "real externalities" or "technological externalities". Pecuniary externalities appear to be externalities, but occur within the market mechanism and are not considered to be a source of market failure or inefficiency, although they may still result in substantial harm to others [15].

## 2.2 Positive Externality

A positive externality (also called "external benefit" or "external economy" or "beneficial externality") is an economic activity that imposes a positive effect on an unrelated third party [16]. Similar to a negative externality, it can arise either on the production side, or on the consumption side [9].

Examples of *positive production externalities* include:

The example of apple garden and apiary farm falls into this class. Analyzing this example in parallel manner, we can indicate that the cost of apple garden is lower to the society because of the positive externality that apple garden cause on the production of the apiary farm. Hence, while, the apple production could be higher in amount of in the society that can take this information into account, the market will not reach to the Pareto optimum point because of lack of the information of the externality in prices. In other words, there is an inefficiency pretends to allocate the sources efficiently [17], and also:

- A beekeeper who keeps the bees for their honey. A side effect or externality associated with such activity is the pollination of surrounding crops by the bees. The value generated by the pollination may be more important than the value of the harvested honey.
- The construction and operation of an airport. This will benefit local businesses, because of the increased accessibility.
- An industrial company providing first aid classes for employees to increase on the job safety. This may also save lives outside the factory.
- A foreign firm that demonstrates up-to-date technologies to local firms and improves their productivity.

Examples of *positive consumption externalities* include:

- An individual who maintains an attractive house may confer benefits to neighbours in the form of increased market values for their properties.
- An individual receiving a vaccination for a communicable disease not only decreases the likelihood of the individual's own infection, but also decreases the likelihood of others becoming infected through contact with the individual.
- Driving an Electric vehicle. This reduces Greenhouse gas emissions and improves local air quality leading to better public health [18].
- Increased education of individuals, as this can lead to broader society benefits in the form of greater economic productivity, a lower unemployment rate, greater household mobility and higher rates of political participation [19, 20].

The existence or management of externalities may give rise to political or legal conflicts.

Collective solutions or public policies are sometimes implemented to regulate activities with positive or negative externalities.

## 2.3 Positional Externalities

Positional externalities refer to a special type of externality that depends on the relative rankings of actors in a situation. Because every actor is attempting to "one up" other actors, the consequences are unintended and economically inefficient. One example is the phenomenon of "over-education" referring to post-secondary education, in the North American labour market. In the 1960s, many young middle-class North Americans prepared for their careers by completing a bachelor's degree. However, by the 1990s, many people from the same social milieu were completing master's degrees, hoping to "one up" the other competitors in the job market by signaling their higher quality as potential employees. By the 2000s, some jobs that had previously required only bachelor's degrees, such as policy analysis posts, were requiring master's degrees. Some economists argue that this increase in educational requirements was above that which was efficient, and that it was a misuse of the societal and personal resources that go into the completion of these master's degrees [20]. One solution to such externalities is regulations imposed by an outside authority. For the example, the government might pass a law against firms requiring master's degrees unless the job actually required these advanced skills.

## **2.4 Inframarginal Externalities**

Inframarginal externalities are externalities in which there is no benefit or loss to the marginal consumer. In other words, people neither gain nor lose anything at the margin, but benefits and costs do exist for those consumers within the given inframarginal range.

## **2.5 Technological Externalities**

Technological externalities directly affect a firm's production and therefore, indirectly influence an individual's consumption; and the overall impact of society.

# **3 Industrial Air Pollution Has High Economic Cost**

The general measure applied on the environmental externalities in order to summarize the external costs of air pollution, its impact on the health of individuals and on the nature is expressed in currency. Achieving a monetary value finally, it needs collaboration between different disciplines and also different actors. We can say the cost of externalities should be monetised. Although the damages caused by externalities can be estimated and valorised not precisely, the estimation can implicate and support the decision-makers to realize the implicit trade-off which can be found inherently in the process, and can help to put together a legislative impact assessment as well. It's worth to remember the remark of H. Bruyninckx, executive director of EEA (European Environment Agency) that although we profit from the activity of industry and energy sector, but the technologies used during these activities cause hidden costs on the health of mankind and the nature. EEA stated that in Europe the damage of air pollution caused by the biggest industrial players might be at €59 billion and the total value of damage of air pollution caused by industry might be around €189 billion in 2012, and half of this damage was caused by around 1% of the industrial facilities [21]. The EEA's report displays many different harmful impacts caused by air pollution and counts the cost of hospital treatment; out-of working days; early death; less agriculture products; damage in buildings and in natural environment; etc. In the EEA report there are different methods for estimation of pricing altogether the damages we can call calculate associated damage costs. EEA listed the most dangerous plants in Europe and to total costs are presented by countries as well. Among the most polluting top 30 plants there are 26 from the energy sector, they are power plants which use mainly lignite and brown or black coal and we can find them beside Eastern Europe in Germany as well. EEA doesn't reveal or maybe did not examine whether the emission level of the plants is higher or not than the official requirement request. H. Bruyninckx expressed: "While we all benefit from industry and power generation, this analysis shows that the technologies used by these plants impose hidden costs on our health and the

environment. Industry is also only part of the picture – it is important to recognize that other sectors, primarily transport and agriculture, also contribute to poor air quality”.

## 4 Air Pollutants and Their Effects on Human Health and Environment

### *Nitrogen Oxides (NO<sub>x</sub>)*

Nitrogen oxides are emitted from fuel combustion, such as from power plants and other industrial facilities. NO contributes to acidification and eutrophication of waters and soils, and can lead to the formation of particulate matter and ground-level ozone. Of the chemical species that comprise NO<sub>x</sub>, it is NO<sub>2</sub> that causes adverse effects on health; high concentrations can cause airway inflammation and reduced lung function.

### *Sulphur Oxides/Sulphur Dioxide (SO<sub>x</sub>/SO<sub>2</sub>)*

Sulphur dioxide is emitted when fuels containing sulphur are burned. As with NO<sub>x</sub>, SO<sub>2</sub> contributes to acidification, with potentially significant impacts including adverse effects on aquatic ecosystems in rivers and lakes, and damage to forests. High concentrations of SO<sub>2</sub> can affect airway function and inflame the respiratory tract. SO<sub>2</sub> also contributes to the formation of particulate matter in the atmosphere.

### *Ammonia (NH<sub>3</sub>)*

Ammonia, as for NO<sub>x</sub>, contributes to both eutrophication and acidification. The vast majority of NH<sub>3</sub> emissions around 93% in Europe come from the agricultural sector. A relatively small amount is also released from various industrial processes, transportation and waste management.

### *Non-Methane Volatile Organic Compounds (NMVOCs)*

NMVOCs, important ground-level ozone precursors, are emitted from a large number of sources including industry, paint application, road transport, dry-cleaning and other solvent uses. Certain NMVOC species, such as benzene (C<sub>6</sub>H<sub>6</sub>) and 1, 3-butadiene, are directly hazardous to human health.

### *Particulate Matter (PM)*

In terms of potential to harm human health, PM is one of the most important pollutants as it penetrates into sensitive regions of the respiratory system, and can cause or aggravate cardiovascular and lung diseases and cancers. PM is emitted from many sources and is a complex mixture comprising of both primary and secondary PM; primary PM is the fraction of PM that is emitted directly into the atmosphere, whereas secondary PM forms in the atmosphere following the release of precursor gases (mainly SO<sub>2</sub>, NO<sub>x</sub>, NH<sub>3</sub> and some NMVOCs).

### *Heavy Metals*

The heavy metals arsenic (As), cadmium (Cd), chromium (Cr) lead (Pb), mercury (Hg) and nickel (Ni) are emitted mainly as a result of various combustion processes and from industrial activities. As well as polluting the air, heavy metals can be deposited on terrestrial or water surfaces and subsequently builds up in soils and sediments. Heavy metals can also bio-accumulate in food chains. They are typically toxic to both terrestrial and aquatic ecosystems.

### *Organic Pollutants*

Benzene, polycyclic Aromatic Hydrocarbons (PAHs), and dioxins and furans are categorised as organic pollutants. They cause different harmful effects to human health and ecosystems, and each of these pollutants is a known or suspected human carcinogen. Dioxins and furans and PAHs also bio accumulates in the environment. Emissions of these substances commonly occur from the combustion of fuels and wastes and from various industrial processes.

### *Carbon Dioxide (CO<sub>2</sub>)*

Carbon dioxide is emitted as a result of the combustion of fuels such as coal, oil, natural gas and biomass for industrial, domestic and transport purposes. CO<sub>2</sub> is the most significant greenhouse gas influencing climate changes, thereby posing a threat to public health and the environment.

## **5 Dealing with Externalities in the Industry of Energy**

We assume the best approach in this part is using the Coasian theorem dealing with externalities and we will show an example how it is working in the real reality. We will of course mention other models as well and we will argue why the Coasian model is chosen. The energy sector is chosen for the presentation (Figure 2). The Coasian model highlights the economic efficiency of an economic allocation/outcome in connection with externalities. The model argues if an externality is available and there is low enough transaction cost then the bargaining could most probably be successful and it doesn't depend on the initial allocation. Let's see the CO<sub>2</sub> issue in power plants and steel mills which are based on coal. Since the CO<sub>2</sub> emission cause for example acid rains which have afterwards many negative consequences there is a general need to reduce the emission.

*Three general approaches are presented; the:*

1. Command and Control. The state has the authority to make commands in order control the level of the emission. If the company is not complying with the regulation the state has the authority to impose sanctions as fines or criminal procedure.

2. Coasian permits trading. In this case the state uses its authority to manage the trade with Sulphur dioxide emission and to sell the emission quotas. Companies need permission for emission of SO<sub>2</sub> and the quantity of SO<sub>2</sub> is strictly controlled by the state.
3. Pigouvian taxes are taxation on pollutants named by A. Pigou, a British economist who proposed first, which is opposed to a Coasian system, to the cap and trade system as it is determining the socially optimal quantity, and afterwards it, allows for the price to find a market equilibrium. Theoretically this is the so called social cost, the difference between the two lines like of social and versus private equilibrium ones.

The Clean Air Act was the first which tried to limit thy Sulphur emission in 1970. It used both command and control and the state set up the procedures of pollution control. We can call it micro-management. And the EPA (Environmental Protection Agency) which is a state institution and it has the task to manage the environmental policy and fulfil the targets of this policy and also to improve the regulation for each3source endangering the environment.

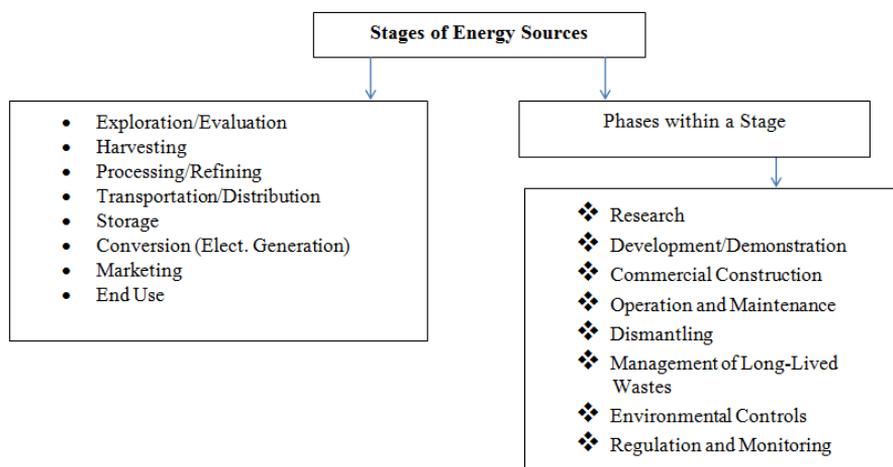


Figure 2  
Steps in Energy Production, Processing, and Use [21]

## Conclusion

- Always, if we observe any kind of pollution it is an externality. There is a common idea that the externalities can be detected as a market failure. An incomplete specification of property rights suggests that it might be better to think about externalities which are consequences of missing markets. The

other environmental problems are going back to the conflict of interest between the private and the public, and also to the concept of public good. In case of pollution there is public or private solution. Both have challenges in the realization; just think about the cost of implementation or access to appropriate information. Cost can be reduced by a combination of proper environmental regulation and tradable emission quotas. We can call it as the cost-effective application of environmental standards. The idea of sustainability is quite well developed in the western hemisphere but even these countries have constant problem how they can solve the continuous or even growing waste production and how they can handle the CO<sub>2</sub> emission? And even bigger question for them how they can reduce the big boom in both cases in the developing countries especially in South-East Asia, Africa and Latin-Amerika. The sustainable development requires a strong cooperation between nations, and the speed-up of technology transfer from the North to the South. Also idolizing of growth should be revised and growth should be considered together with criteria of sustainability. Let's see some means for it:

- The complex use of economic means taxis, tradable permits, etc. should reveal and internalize the importance of social costs and should initiate changes in consumption and production behaviour on both individual and corporate side.
- Improving the efficiency in using off our resources and switching toward the dematerialization of society.
- The concept of economic growth needs a profound re-evaluation where all type of cost even the long-term ones should be corporate into.
- It is important to address specific arrangements towards those who would be negatively affected by the new policies, it should especially be avoided the rise of inequality and social disintegration, the extension of unemployment.
- The education is key factor because the changes related to future generations. The need for individual and corporate conceptual and behavioural radical changes is inevitable. The social responsibility on both corporate and individual side is also inevitable.
- Strengthening democracy and more influence of citizens to the decisions – but the latter can always be misused by demagogic politicians.

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