Energy Optimization Policy Compliant with Sustainable Development in Polish Economy

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1. Polish Energy Sector

Poland is one of the main air polluters in Europe. Some parts of the country are known to be among the world's most polluted areas. The energy sector is one of the parts of national economy that has the worst negative environmental influence. The main reason is the quality of resources used by energy sector in Poland. Electricity and heating are generated using mainly solid fuels—75% of primary energy carriers comes from solid fuels combustion.

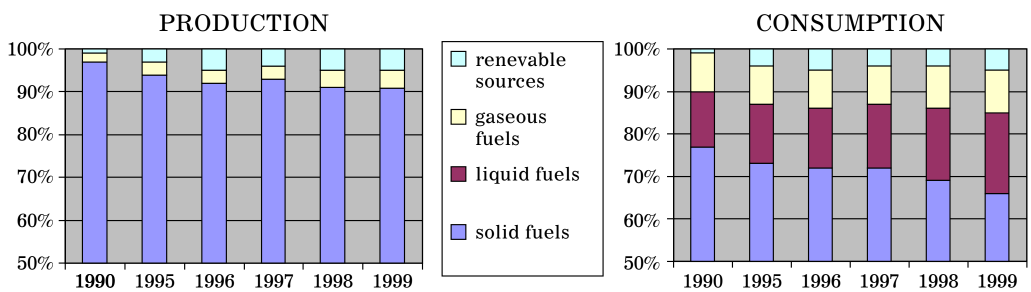

Figure 1.

Structure of primary energy production and consumption in Poland

Source: *Polish Statistical Yearbook* [2000a].

Every country has its own priorities that reflect its historical evolution and natural resources exploitation or overusing. Many Poles are subject to the effects of serious air pollution mainly as a result of global coal use for heating and electricity production (Figure 1). Emission sources are concentrated in four regions (Katowicki, Piotrkowski, Jeleniogórski, and Koniński) where most of Polish heat and power plants are located. The dominant position of coal and coal technologies in Polish energy sector create this fuel as the main source of air pollution in the whole country. Solid fuels use is responsible for 80% and 70% of national SO_2 and CO_2 emissions respectively.

Energy transformation and consumption are responsible for most of main emissions that have international limits established (Figure 2). For example, it contributes to climate changing (CO_2), acidification (SO_2, NO_x, VOC), other toxic pollutants, sunshine smog (NO_x, NMVOC), and waste.

Three main factors will determine changes of the above effects:
- economic growth,
- energy world price level,
- fossil fuels replacement by renewable fuels.

Additional factors are the following:
- population growth,
- energy services efficiency (see definition on page 158),
- quantity of energy services per capita.

Effects do not grow proportional to expenditures in the activity that has environmental quality improvement as a goal. The desirable thing is gradually implementing the emission standards to ensure sufficiently long run and expectable adaptation period for interested industries. To meet these standards it is necessary to achieve pollution emission reduction from many different sectors in the economy. The polluters usually protest against pollution emission reduction emphasizing the emission reduction costs to be borne by them.

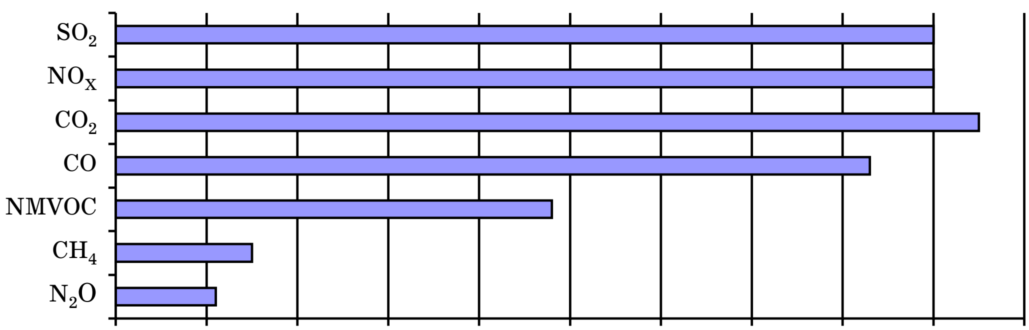

Figure 2.

Air pollution caused by energy use as a share of the total emission in Poland [%]

Source: *Polish Statistical Yearbook* [1999].

First of all, we should answer on the following question, if we want to solve conflicts between pollution emitters and their victims:

Will Polish society improve their welfare, if pollution emission is reduced?

Meeting environmental requirements may have wide economic repercussions. For this reason it is important for environmental policies to take into account their economic consequences. In 1990 the transition period from a centrally planned into a market orientated economy started in Poland. Economic transition should improve not just economic results, but also be able to create benefits for environment.

2. Energy saving direction of structural changes

The Polish Parliament resolution on ecological policy of 1991 imposed an obligation of energy rationalization under eco-development principle [Monitor of Poland, 1991]. This means not just an installation of environmental equipment, but first of all encouraging in a way that will minimize negative environmental influence. The basic principle of this eco-policy in energy sector is directing of structural changes in an energy saving manner.

Connecting air pollution with energy efficiency is important only in cases where required scale of emission reduction is not greater than 50–60% (i.e. by so much that it is possible to decrease energy use in a 10-year perspective to achieve a level of indicators appropriate for the European Union countries).[1] For example, this is a case of sulfur dioxide emission in Poland, but not a case of other pollutants such as dust or VOC where required scale of emission reduction is much higher. Therefore energy efficiency improvement is not a solution in some cases. Improvement of energy efficiency can work only with moderate air quality improvement and only in reference to some pollutants.

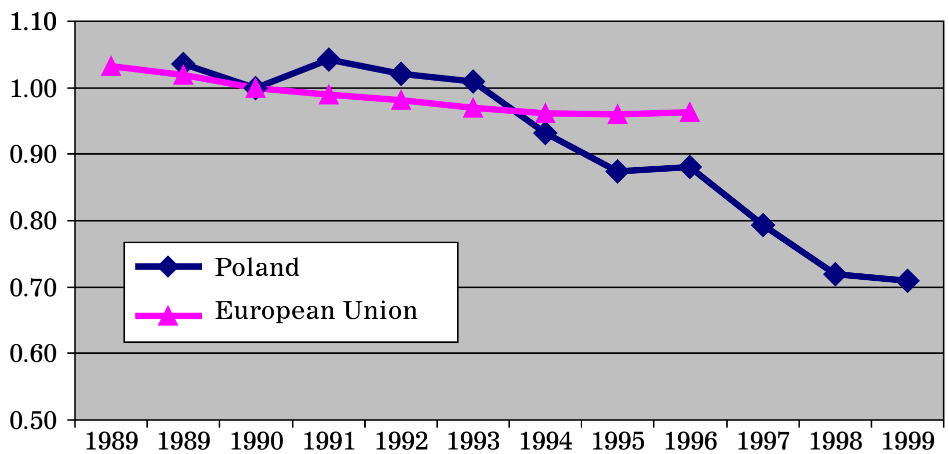

Figure 3.

Dynamics of GDP energy consumption in Poland and EU countries [1990=100]

Source: European Environment Agency [2000a], *Polish Statistical Yearbook* [2000b].

However, greater efficiency in energy production and consumption is a crucial requirement of energy policy according to sustainable development principle. We should therefore consider an answer to the following question:

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[1] This point of view was presented in the paper: G. Peszko & T. Żylicz [1998].

Will sustainable development policy be exclusively required a technological change or it may be also a force for energy consumption reduction?

Figure 3 shows the GDP energy consumption dynamics. Compared to 1990, the situation in Poland starts improving thanks to economic growth. However, economic growth can entail an energy consumption growth. Poland should aim to highest as possible independence of GDP growth rate on energy consumption growth rate.

3. The price for clean air

The environment, including atmospheric air, is an economic good. This means that its supply is not enough for all of applications. Any economic good should have its price. Environmental use during production process, including electricity and heating, must cost and this cost should be taken into account as a part of production cost. Payment mechanism for environmental use has been already introduced and strengthened in Poland. The significant part of financing of investment expenditures for environmental protection is secured through an ecological funds system.

Collected taxes are designed for subsidies of ecological investments. Subsidies may have an incentive effect, similar to pollution taxes. However, subsidies should be offered for each unit of eliminated pollution, according to Pigou theory. In reality, subsidies are introduced for each unit of environmental equipment cost or for each unit of service cost bought for the purpose of environmental protection.

The most benefits from ecological investments subsidization in Poland are derived by the public sector, because it receives more subsidies and paying less tax compared to the private sector.[2] According to theoretical point of view, however, subsidies should be distributed towards projects that are characterized by the greatest social benefits.[3]

Actual per capita emission of basic atmospheric pollution in Poland does not differ much from the average emission in European Union countries, except sulfur dioxide.[4] This situation requires considering a sulfur dioxide emission as a crucial task for national energy policy.

We cannot directly attribute the pollution emission decline to environmental taxes. Rather output decline caused by economy recession in transformation period has considerably influenced the pollution emission decrease. Taxes have helped to speed up this process, that may be an indicator of the effectiveness of ecological policy.

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[2] Mainly as a result of lower unit taxes rates.
[3] Theoretical point of view assumes efficiency as a basic criterion.
[4] Polish emission of sulfur dioxide is twice as much as the average in European Union.

Table 1.

The share of ecological tax revenue in the total government tax revenue [%]

	EU		Poland		*Annual changes*	
Parts of ecological taxes	1990	1997	1995	1997	*UE*	*Poland*
energy taxes	4.71	5.18	3.62	3.93	*+1.4*	*+4.3*
transportation taxes	1.29	1.26	0.54	0.68	*–0.3*	*+13.0*
pollution taxes	0.16	0.25	1.19	0.98	*+28.1*	*–10.7*
Ecological taxes	6.17	6.71	5.35	5.59	*+1.3*	*+2.3*

Source: own calculations on the basis of the following references: European Environment Agency [2000b], *Polish Statistical Yearbook* [1999].

The environmental taxes also include energy taxes according to European Union's definition. Energy taxes present 70% and 80% of total environmental tax income in Poland and European Union respectively (Tables 1 & 2). Energy and pollution taxes have increased considerably in some EU countries in the late 90th after so called ecological tax reform implementation. This reform assumes a compensation of tax burdens change. Implementation of ecological mark-ups for fuels is compensated by decreased tax burden on capital and labor.

The role of ecological tax is being of great importance in EU countries now. For example, ecological fuel tax, especially in the case of coal, can be introduced to provide incentives or to collect tax revenue. This issue has been well studied by EU—the changes in energy carriers demand, their prices, and budget revenues after fuel tax implementation have been a subject to verification. Just an insignificant part of projects analyzed by EU were aimed at accumulating tax revenue. Most of them were designed to provide an incentive to reduce pollution.

Table 2.

Tax share [%] in the final energy carrier price for different recipients in Poland

en. carriers	recipients	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997
Heavy fuel oil	industries	0	0	0	0	0	0	0	0	0	0
	households	*na*	*na*	*na*	*na*	*na*	*na*	*na*	*na*	*na*	*na*
Light fuel oil	industries	0	0	0	0	0	0	0	0	0	0
	households	*nd*	*nd*	*nd*	*nd*	*nd*	*nd*	6	7	11	15
Diesel fuel	industries	56	58	30	17	27	34	36	36	37	33
	households	*nd*	*nd*	*nd*	*nd*	*nd*	*nd*	48	47	49	45
Natural gas	industries	0	0	0	0	0	0	0	0	0	0
	households	0	0	0	0	0	3	7	7	11	15
Coal	industries	0	0	0	0	0	0	0	0	0	0
	households	0	0	0	0	0	3	7	7	11	15
Electricity	industries	0	0	0	0	0	0	0	0	0	0
	households	0	0	0	0	0	3	7	7	13	15

Source: IEA & OECD [1998] *na*—not applicable; *nd*—no data available.

Similar studies for the Polish economy has shown that ecological fuel taxes are a good incentive for achievement of environmental benefits.[5] The extent of benefits, however, depends strictly on the implemented tax level. In the long run, we can expect the following effects of ecological fuel taxes:

(a) energy production costs increase;
(b) gas demand increase and coal demand decline;
(c) coal and oil producers would not be able to shift the whole tax burden onto consumers—the price net of will decrease;
(d) increased incentives for energy-saving consumption and energy-efficient production.

4. Factors that determine changes in the energy-environmental interactions

Non-efficient environmental use creates a large economic burden—it reduces life quality and production efficiency. However, the polluter bears only part of costs that he caused and this implies that he has weak incentives to invest in pollution reducing equipment.

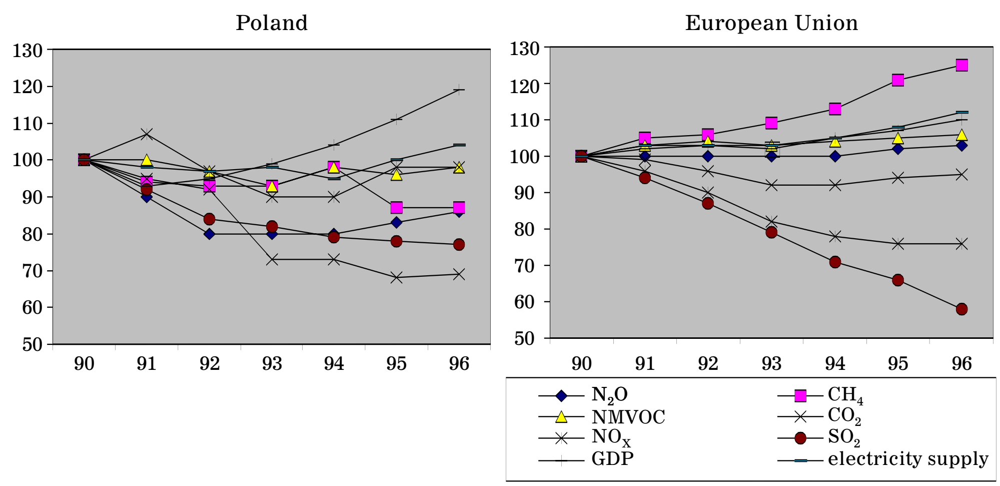

Figure 4.

Pollution emission dynamics and energy production dynamics [1990 = 100]

Source: European Environment Agency [2000c], *Polish Statistical Yearbook* [1999].

We shouldn't associate environmental pollution directly with insufficient use of modern technologies or with output level. It is, first of all, important to take care of so called "precision technologies" application. These technologies allow to increase inputs productivity and to reduce waste. Finding the

[5] For details about Polish studies, see M. Kudełko & W. Suwała [1998].

best solution for an ecological problem sometimes depends on the way it is presented. Solutions implementation often precedes data collection, i.e. things are done before they are really understood. For example, pollution emission is decreased by expensive "end-of-pipe" technology installation, while production process modification would be less expensive.

Better production techniques and changes in primary energy demand structures lead Polish environmental improvement. Figure 4 shows energy sector eco-efficiency, on its relative pollution intensity. Pollution emission clearly decreases. This owes, among other things, to energy saving caused by its higher prices, to an investments in emission reduction equipment and in modern structure, to a clean fuel use, and to shutting down the least efficient structures. The following question arises:

Does future economic growth mean an increase or decrease of influence on environment?

We want to analyze the factors that might determine the changes of environmental influence.

4.1. Population growth

Population growth can cause an energy consumption increase. This implies that we should take this factor into account. We should treat this factor as an exogenous one. The current Polish population growth rate is low—the real annual population growth in the last ten years was 0.2%. Nevertheless this means an increase in the number of potential consumers may result in final energy consumption increase.

4.2. Demand for energy

Per capita energy use growth as a result of increase in the life standard has also a negative environmental influence. Higher life standard automatically would mean higher demand for energy service. Increasing energy pressure on the environment is caused, among others, by energy service amount growth.

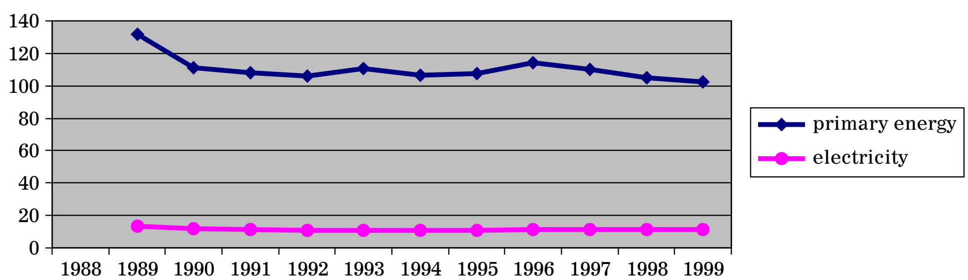

Figure 5.

Per capita energy consumption [GJ] in Poland

Source: *Polish Statistical Yearbook* [2000a].

Per capita primary energy use in Poland has been almost constant during the last decade (Figure 5). From a consumer point of view it is important to have a possibility to use light, hot water, refrigerator, energy equipment, comfortable heating, etc., but he/she is not interested in how many electricity [kWh] or natural gas [m^3] uses by himself/herself. The EU assessments have shown that growth in demand for energy service is 2% per year. GDP growth in the Polish economy since 1992 means that demand for energy service would increase as well.

4.3. Efficiency

Another factor that determines a pace of energy service amount changes is an efficiency growth. Energy service efficiency is the reduction of primary energy amount per energy service unit. Efficiency improvement may concern different levels of an energy cycle: primary energy processing, distribution, transport, and final consumption.

Energy processing efficiency is a ratio of secondary energy to used fuels (primary energy). This efficiency is better and better in Poland. For example, electricity production efficiency has been improved by 7% during the last 10 years and has reached 32%. However, it is still not enough to catch up with the EU countries indicators, where the efficiency has reached over 40%. This means that over 60% energy inputs are "lost" during production process in Poland. This "loss" can be partly used on the power plant's own needs and to supply additional service (aside from electricity) in the form of heat in the case of heat and power plant. Thus it is advised to associate heat production process with electricity production to be able to use heat that arise as by-product during the electricity production. An indicator of the heat and power plants share in the total electricity output will be a good measure of energy cycle improvement, on condition that heat and power plants have a heat energy market. Polish power plants are placed far from cities. This creates difficulties to sell off the heat energy.

Most household goods have better and better energy efficiency. For example, TV sets use 90W now compare to 360W in 60^{th}–70^{th} years—essential demand for energy has been decreased by 75% (average annual growth efficiency is 3%). The similar situation is appropriate for lighting and heating as well. On the other hand, the number of equipment that we use now has increased—instead of one TV set per flat, we use one TV set per room. This situation can be justified if *energy efficiency growth rate* would *greater than energy demand growth.*

As a result of technological progress the energy use efficiency of industrial production has improved as well. On the other hand, the demand for energy equipment has increased. We should consider both of these factors at the same time. Energy intensity indicator of the value added per national economy sector is a good measure that take both of these factors into account. This indicator has been increased by 2% during the last decade in construction sector, agriculture, and industry. At the same time other sectors of Polish economy like transportation, telecommunication, and services have decreasing tendency in energy intensity. Thus these last sectors has improved their efficiency of energy and fuels managing.

The Polish economy uses 3 times more energy to produce one unit of GDP than EU countries. The reason is that there were no incentives to increase energy use efficiency during the central planning system. In 1990 the transition period from a central planned economy into a market oriented economy started in Poland. From this time the energy intensity has been decreased for the whole country as a result of greater energy use fall than GDP fall. Further energy intensity fall was caused by considerable growth rate of GDP. We should aspire for the most possible *independence between the GDP growth rate and energy use growth rate*. This implies that GDP growth rate should be significantly greater than energy use growth rate.

4.4. Renewable resources

By renewable sources we mean energy derived from water, solar, wind, biomass, tides, and geothermal. Energy consumption in Poland is derived mainly from nonrenewable sources (Figure 1). Renewable sources supply only 3% of energy consumption, where over 90% is biomass energy. Renewable sources in European Union countries supply 6% of energy consumption, where 50 is biomass energy. European Union aspirations head towards *replacement of nonrenewable resources with renewable* to be able to decrease pollution emission. This does not mean that renewable energy is absolutely non-burden some for environment (for example, water energy use can be environmentally burden some, wind energy can ruin a natural scenery for someone). It can be environmentally burden some but significantly less than nonrenewable energy.

Renewable resources use generally requires higher costs, but we can obtain economic benefits as well. For example, if a biomass energy will be used on a large scale in Poland, it can solve few structural problems: (a) farmers hired to biomass production solves to some degree a village unemployment problem, brakes a migration from villages to cities; (b) national energy security grows.

Comparable high investment cost of solar and wind energy per energy production unit does not have a chance to become covered using present technologies. In a distant prospect, when Polish energy prices will cover its costs, solar and wind energy can become a reality. Those investments on a large scale are doubtful in a close prospect because much investment capital has been melted to modernize existing power plants. Nevertheless, it deems an aspiration for use increase of the renewable energy sources as feasible and justified.

Governmental document "Polish energy policy assumptions till 2020" assumes to achieve a 1.5% growth of renewable energy use till 2020 [Ministry of

Economy 2000]. This is neither an optimistic goal, nor hardly feasible one. Energy consumption from renewable sources has been increased by 2% during 1989–1999 period, but the governmental document assumes a 1.5% growth for the next 20 years. That policy will not favorable to sustainable development.

4.5. Summary

Combination of the basic factors:
- **Polish population growth trend is about 0.2% yearly;[6]**
- **per capita demand for the final energy is 2% yearly assumed;**
- **consumption and production share growth of renewable resources is 0.1% yearly;[7]**
- **energy efficiency will increase by 1.5% yearly.[8]**

The first two listed factors have an adverse influence on environment, but the last two—positive. Total balance of these factors shows a 0.6% annual growth of an adverse environmental influence as a result of the energy consumption and production. This is an imprecise estimation because of the used simplified methodology. Thus we should carefully interpret this result.

Table 3.

Average monthly energy expenditures by poor households per capita in Poland [percentage of the total expenditures]

Households	*1988*	*1989*	*1990*	*1991*	*1992*	*1993*	*1994*	*1995*	*1996*	*1997*	*1998*
blue-color workers	3	2	4	6	7	10	11	11	10	10	10
farmers	4	3	5	7	8	9	9	9	9	9	8
pensioners	7	4	7	10	12	14	14	14	14	14	14
keeping from non-paid sources	*nd*	*nd*	*nd*	*nd*	*nd*	10	11	10	10	11	11
all households	3	2	4	6	8	9	11	11	11	11	10

Source: IEA & OECD [1998]; nd—no data available.

We should analyze why energy demand can grow faster than efficiency. Two basic reasons could be found:

- The f i r s t one is a s o c i e t y i n c o m e g r o w t h. Disposable real income average increases by 3% yearly since 1991. Does it imply changes in expenditure structure, especially for energy expenditures? Energy expenditure share during the transition period has been increased from 2% in 1989 to 10% in 1998 (Table 3). This is determined both by greater energy share in the total households expenditures and by energy expenditures increase in

[6] *Polish Statistical Yearbook* [2000b]
[7] Ministry of Economy [2000]
[8] Bleijenberg A. & J. van Swigchem [1997]

proportion to personal income growth. Personal income growth means that we can assure a better comfort to ourselves, for example by energy demand increase. Even if we assume that future expenditure structure was constant, we still would have another factor (income growth) that finally can lead up to increase of the adverse environmental influence (for example, pollution emission growth).

Energy expenditure share by households is very big in Poland compared to EU countries. It does not imply of course that Polish energy consumption is greater than European Union one. Energy cost for Polish households makes much more greater budget load because of significantly lower income level.

- The second reason is an energy price decline. This price is determined by the following factors:
  - investment and operation costs of equipment (excluding energy cost);
  - end-users energy prices (i.e. these determine how much we pay for our essential energy needs);
  - efficiency (efficiency improvement results in lower energy consumption per unit of energy service).

Equipment prices generally decrease over the years. As a consequence, equipment quantity owned by households grows. The effect of lower purchase costs is that the price per unit of energy service falls. Average prices of energy to the end-user (Table 4) have substantially increased since 1989 when transition period had started in Poland (from 6-times growth for oil products to 70-times growth for heating and warm water). It was caused mainly by inflation rate increasing in the economy.

Table 4.

Average energy prices (without VAT) in Poland [1990 = 100]

Energy carriers	*1988*	*1989*	*1990*	*1991*	*1992*	*1993*	*1994*	*1995*	*1996*	*1997*
Coal	5	9	100	229	332	487	730	870	1094	1266
Oil products	4	14	100	162	227	324	390	439	524	612
Natural gas	4	8	100	470	1154	1491	2051	2558	3036	3447
Electricity	4	7	100	252	429	590	810	1038	1205	1406

Source: IEA & OECD [1998].

Energy prices policy should take into account many conflicting goals: an inflation decrease, a budget deficit reduction, a household’s protection, and an energy delivery security. Polish government has particularly protected households in the beginning of 1990. Government regulated energy prices for these consumers and subsidies were used for them. An inflation growth counteraction and a tendency to balanced budget started to be more important in the following years. This new policy has resulted in a market prices growth reduction and a relative large increase of regulated prices.

The reference price in the perfect competition should be between import and export parity prices for the given energy carriers. This condition was held by coal prices in 1994 on the Polish market. However it was an exception, because in the other years the unit cost has been always greater than average selling price on coal[9]. The transition period, nevertheless, has implied considerable changes of prices and relations between energy carriers. The Polish government has reported in official documents that it aims to reach the European Union's energy price levels.

Higher efficiency causes the price per unit of energy service to drop still further, as less energy is used to generate the same amount of energy service. Increased efficiency generates a shift from variable towards fixed costs. Because the variable cost—which is dependent on actual use—has a stronger impact on consumer behavior than the fixed cost, the shift away from variable cost encourages people to use equipment more frequently and thus makes for future growth in the use of energy services. With energy prices remaining constant, the price per unit of energy service falls: more energy service, more comfort can be bought for the same price. Thus higher efficiency results in more energy being used. This mechanism is sometimes called the rebound effect.

In addition, the domestic prices are determined by changes on the world market. If a group of countries—e.g. the OECD or EU countries—achieves a substantial reduction in energy consumption, this will cause a drop in world energy prices. This would also speed up the growth in energy use and hence wipe out part of the initial energy saving.

The analysis of the price of energy services reveals two negative feedback effects:

- The first is at micro level, and shows that improved energy efficiency has the side effect of reducing the price per unit of energy service. This accelerates the growth in the quantity in the of energy services, canceling out a substantial part of the efficiency gain.
- The second negative feedback loop relates to the prices of fossil fuels on the world market. If a large number of countries were to be successful in cutting back on their use of fossil fuels, this would cause a fall in market prices. As a consequence, use of fossil fuels would be encouraged, wiping out part of the initial energy saving

5. Towards sustainability

The next important issue is whether we need to reduce the growth in energy services consumed or whether we can avoid having to do this. According to our previous assumptions (on the page 158), the efficiency of the energy chain is increasing by around 1.5% per annum. We cannot suggest of course that a technical progress that would provide energy savings is not needed. Conver-

[9] Ministry of Economy [1998]

sely, we need new actions that would promote energy efficiency both in production and consumption. *The policy that has exclusively efficiency growth as a goal*, however, *would not succeed in pollution emission reduction.*

There are exist two options:

- The first one is that efficiency growth must be greater than energy demand growth. This technological progress will allow to achieve the desirable goals. Is it a feasible goal? It seems to be unlikely to achieve this in the current situation without an external intervention.
- Another option might be to force an improvement in efficiency by strict government regulation and/or strong financial incentives. This, however, would involve substantial costs in achieving the faster technological progress needed. The political question is whether the society is willing to accept these costs. An effect of these additional costs would be to make energy services more expensive, thus reducing the demand growth rate. It is not clear at the moment how far the improvement in efficiency can be brought about by compulsion, even if we accept the substantial costs entailed.

Energy efficiency improvement is not the only one possible solution. Another way of achieving a sustainable energy supply is to introduce renewable energy on a large scale. Biomass, wind energy and hydropower are the first sources to explore: they are relatively cheap compared to other renewable sources (e.g. solar energy is 15 times more expensive than wind energy).

Because of the higher prices of renewable energy compared to fossil fuels, they probably should be introduced by coercion (e.g. by compelling energy suppliers to use a certain percentage of renewable energy). The compulsory percentage of renewable energy could be increased gradually over time. This would speed up the development of renewable energy and bring the cost down. If the use of renewable energy were to be made compulsory on a large scale, solar energy would also become a realistic option.

Command-and-control instrument implementation would increase the average energy price, because renewable energy is more expensive than fossil fuels. This would promote higher efficiency in end-use and reduce the growth in the quantity of energy services. This creates a positive feedback effect towards sustainability.

An alternative policy would be to provide a strong financial incentive to use a renewable energy. This could be, for example, a charge on fossil fuels used to subsidize renewable energy. Both the charge and subsidy need to be substantial in order to be effective. This policy would accelerate the development of renewable energy and bring the cost down. At the same time it would push the average energy price up, because renewable energy is generally rather expensive. The higher energy prices would both encourage improvements in efficiency and reduce the growth of energy use.

Effectiveness of the economic and command-and-control instruments would depend on the renewable sources share growth in both consumption and production. For the Polish economy it should be around 0.5% per annum

(Table 5) instead of the Economy Ministry assumption (page 159). This assumption actually was accepted by Ministry of Environment that has prepared strategy of renewable energy development independent from the Ministry of Economy. Ministry of Environment has assumed 14% growth till 2020 [Ministry of Environment 2000]. As table 5 shows, it would result both in a faster improvement in efficiency and reduced growth in the quantity of energy services. This action would finally decrease a negative environmental influence (e.g. pollution emission drop).

Table 5.

Hypothetical scenarios of factors that determine environmental influence

Factors	Scenarios for the Polish economy per annum	
	previous	new
population growth trend	+0.2*	+0.2*
per capita demand for the final energy	+2*	+1.5*
renewable energy growth	+0.1	+0.5
energy efficiency growth	+1.5	+2

* Factors that have negative relations with sustainable development.
Source: Ministry of Environment [2000], Ministry of Economy [2000], *Polish Statistical Yearbook* [2000b], Bleijenberg A. & J. van Swigchem [1997].

Any interference into a market economy cause varied costs. If renewable energy prices would be regulated to below equilibrium price level and subsidies payment would be implemented, then over production would exist. Finally it will cause a social deadweight loss. However, subsidies can improve resources allocation efficiency if it applies for goods or services that are under supplied. This rule works for public goods and for goods that cause external benefits. Thus subsidies can internalize a positive external effects.

The average energy price will increase regardless of the implemented instruments type (command-and-control or economic). A crucial question is whether we are willing to pay this price. Price increase is non-popular decision from political point of view and it is worth trying to analyze other options. Energy efficiency in Poland is lower on average than in EU countries. This gives the opportunity to increase Polish efficiency faster than in EU. Thus the growth in energy services can continue in Poland with no environmental degradation increase. Future energy price growth, however, seems to be unavoidable with no environmental degradation increase.

Conclusion

The combination of three basic factors of sustainable development energy policy (efficiency increase, renewable energy use growth, and energy services growth reduction) would give desirable effects. An achievement of these effects may be not a subject of technical possibilities, but a political one that is determined by social acceptance. Current energy policy seem to ignore the dilemma of wilingess to bear costs of sustainable development policy and suggest that sustainability can be achieved for free. Our analysis in this paper leads to the opposite conclusion.

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