Choosing Efficient Combinations of Policy Instruments for Low-carbon development and Innovation to Achieve Europe's 2050 climate targets

Country report: Poland

WP 1 – Taking stock of the current instrument mix

Contribution to Deliverable 1.2: Review of the existing instrument mix at EU level and in selected Member States

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0 Executive summary

This report aims at Polish institutions' response to climate protection targets established by the European Union. Until the year 2020 they boil down to reducing Greenhouse Gas (GHG) emissions by 20%, achieving 20% renewables' share in energy consumption (15% in Poland), and 20% improvements in energy efficiency. In the longer run it is expected to reduce GHG emissions down to a small fraction of the past level.

Five instruments – carbon taxes, other pollutants' taxes, subsidies, emissions trading, and 'green certificates' – were selected for in-depth analyses. It would be difficult to claim that these instruments are the only ones to support Polish policy response to European climate concerns, but they shed light on both strengths and weaknesses of this response.

The main conclusion from the analyses is that instruments studied do not contradict each other. To a large extent carbon pricing is not binding, especially for non-EU-ETS sources. Consequently the government must adopt additional instruments in order to pursue policy goals. The support for renewables is perhaps the most problematic area, where instruments deployed so far do not provide expected results.

The optimality of policies implemented is a difficult question. In order to assess optimality rather than effectiveness one needs to adopt a certain concept of benefits (assuming that costs are easier to grasp). Since climate protection benefits are considered by economists a public good, no single region – like the European Union – or a single country can control these benefits. For that reason a somewhat weaker criterion of cost effectiveness, i.e. achieving an exogenous target at a least cost, was studied. Our analyses suggest that cost effectiveness is not achieved for two reasons. First, Polish policy response has not been adequate in some cases. But also, second, European policies do not allow cost effectiveness to be achieved in some cases.

1 Description of policy landscapes

1.1 Classification of the instruments previously selected into policy landscapes

The objective of this report (and report series) is to perform an initial 'stock-take' of the climate policy instrument mix at the EU-Level and a representative group of Member States – the United Kingdom, Germany, France, Spain, Italy, the Netherlands, Poland and the Czech Republic. An initial list of up to 50 instruments from each country and EU-level was created, from which up to 15 key instruments for each state covering a broad selection of the economy, instrument type and objectives were selected for further analysis. Please refer to the Taxonomy of Instruments, developed under Task 1.1 of CECILIA 2050, for a full description of instrument classification. For each report, the selected instruments were categorised into policy 'landscapes', described below.

(1) **Carbon Pricing:** this includes policies that price CO_2 emissions or otherwise change the relative prices of fuel use, depending on the carbon intensities of fuels. Apart from the obvious candidates (carbon taxes and emissions trading) this would also include the reform or removal of fossil fuel subsidies;

(2) **Energy Efficiency and Energy Consumption:** this includes measures targeted at either increasing the efficiency of the energy sector, including power generation / combustion processes, transmission of energy (heat, electricity) and end-use efficiency, or at reducing overall energy consumption (demand-side management, energy saving, sufficiency);

(3) **Promotion of Renewable Sources of Energy:** this includes policies aimed at increasing the share of energy from renewable sources (solar, wind, hydro, biomass, geothermal);

(4) **Non-Carbon Dioxide Greenhouse Gases:** this covers policies geared at reducing non-CO_2 greenhouse gas emissions, typically from sectors other than the energy sector. It may include emissions like methane emissions from landfills or animal husbandry, N_2O emissions from agriculture, or greenhouse gas emissions from chemical industries (SF6, NF3, HFC, etc.)

The list of instruments for Poland, along with their landscape classifications may be seen in Table 1.1, below. This report describes each instrument based on a set of tabulated information found in Annex 1, and an attempt at assessing their individual 'optimality', based on the concept developed for use in the CECILIA 2050 project also developed in Task 1.1, is provided. Descriptions of interactions between instruments within each landscape are also provided, based on tables found in Annex 2. The categories and methods of interaction are based on best practice in instrument interaction assessment, and are completed in pairs against a single key instrument, or when important interactions between non-key instruments are present.

Five instruments were selected for analyses in Poland's country report. It would be impossible to claim that they are the only ones in the context of the European 2050 climate targets, but they illustrate both strengths and weaknesses of Poland's response to the Europe-wide endeavour. The instruments are:

(1) Carbon Tax (Charge for carbon dioxide and methane is 0.06 €/ton (0.24 PLN/t))

(2) Other taxes on inputs or outputs of a production process (All conventional pollutants – including more than 60 air pollutants – are subject to emission charges)

(3) Subsidies for environmentally-friendly activities (Environmental funds spend more than 400 M€ (1600 MPLN) annually in subsidies for environmental projects in addition to soft-loans and other instruments; around 20% are devoted for air and climate protection)

(4) Cap-and-trade (Polish firms participate in the EU-ETS)

(5) Green certificates (The price of a 'substitute charge' – almost equivalent to the 'green certificate' – was 72 €/MWh (287 PLN/MWh) in 2012)

They cover all the four policy landscapes (see table 1.1 below) even though the coverage is not uniform. Unless indicated otherwise the data come from the official statistics (GUS 2013). The total number of instruments deployed in Poland in order to address environmental (including climatic) concerns is much higher. In our previous list fifteen were indicated as directly relevant for the problem. Even this longer selection is not exhaustive, since virtually all regulations have some indirect influence on climate considerations. Nevertheless we chose five instruments which seem to be the most powerful ones, illustrative for key policy dilemmas, and diverse in terms of optimality criteria adopted in the project.

It should be noted that cap-and-trade implied by the EU-ETS is significant for the first policy landscape only. Even though it can be looked at from the other three angles too, its impact on energy efficiency, renewables and non-carbon dioxide GHGs is negligible.

The resulting optimality of each landscape based on instruments and their interaction are then assessed, followed by interactions between each landscape and, finally, an analysis of the optimality of the climate policy mix as a whole in each country and at the EU-level is provided.

Table 1.1 - Selection of GHG abatement instruments

	Policy Landscapes			
Policy Instrument	**Carbon Pricing**	**Energy Efficiency and Energy Consumption**	**Promotion of Renewable Sources of Energy**	**Non-Carbon Dioxide GHGs**
Carbon Tax	✓			✓
Other Taxes	✓			✓
Subsidies		✓	✓	
Cap-and-trade	✓			
Green certificates			✓	

The instruments presented in this report are contemplated in the context of achieving Europe's 2050 climate targets. The target is mainly reducing carbon dioxide emission from the European Union down to a small percentage of historic emission. There are, however, several implicit targets, such as

(a) reducing the global emission of carbon dioxide;

(b) winning the so-called first mover advantage by developing leadership in some economic sectors; and

(c) promoting the idea of sustainability at the global scale.

Given the fact that the European Union is but a small fraction of the global economy, achieving these implicit targets is a difficult task, which is unattainable by means of unilateral emission reductions. The global emission has grown substantially since the convention of UNFCCC (in 1992), and the pace of this growth increased after the Kyoto Protocol (in 1997). With recent withdrawals from the Kyoto Protocol by several countries, prospects of 'inspiring' non-European developed market economies to abate are even lower than before.

The idea behind unilateral abatement actions was that in the absence of such actions things would have been even worse. This is not necessarily the case, because of 'carbon leakage', a phenomenon down-played by some analysts. The 'carbon leakage' is a process of increasing emission elsewhere caused by a decrease in one region. This is not just a reallocation of a plant shut down in one place. The mechanism of 'carbon leakage' is much more subtle and for that reason much more permeating (Rauscher 2012). Its empirical demonstration is impossible due to the fact that actual developments cannot be statistically confronted with hypothetical alternatives. Hence it can only be simulated with the help of sophisticated global economic models (Kasek *et al*. 2012). Such models exist, but to a large extent they are assumptions-driven, and insufficient emphasis is put on clarifying what assumptions (whose impact on 'carbon leakage' is dramatic) are supported by empirical data.

In 1995 the UNFCCC parties agreed to the 'Berlin Mandate' which states that only one group of countries (so-called Annex I) are to take binding abatement commitments. Thus the rest of the world – one hundred-and-fifty countries plus – does not take any binding commitments which precludes capping the global emission in the foreseeable future. Thus – irrespective of the climate change rhetoric – unilateral abatement undertaken by the European Union can be judged only from the point of view of cost-effectiveness of achieving certain local targets (such as emission reduction or promotion of renewables). Considerations of their impact on the global emission of greenhouse gases cannot be competently addressed without building a global economy model, which is beyond the scope of Cecilia. Also other indirect targets (identified under (b) and (c) above) will not be addressed here.

1.2 Detailed description of instruments within each policy landscape

1.2.1 Carbon Pricing

'Other' (non-CO_2) taxes

Our description in this policy landscape starts with 'other taxes' rather than 'carbon tax', as legislative history seems to be the most important factor, and former were introduced earlier than the latter.

Pollution charges were established in centrally planned economies in the 1970s. As prices did not have a major regulatory role there, the charges were largely irrelevant for environmental protection. Indeed, despite the charges, centrally planned economies earned the reputation of the worst environmentally degraded region of the world (Timberlake 1981). The charge system has been quite extensive, with several dozens of pollutants listed. In many countries charging rates were corrected periodically. In Poland substantive increases took place at the very beginning of economic transition in 1989. They achieved their historic peak in 1992. Later on the rates were upgraded too, but they did not catch-up with inflation.

It is difficult to understand their differentiation, which is quite vast. They range from 0.11 PLN/kg (0.03 €/kg) for carbon monoxide to 315.80 PLN/kg (78 €/kg) for the most toxic substances (Council of Ministers 2004; charging rates are revised annually by the Minister of Environment so as to account for the inflation). Each periodic correction leaves their proportions intact. When attempts were made to trace this differentiation in the 1990s, it could not be explained convincingly. What is apparent is that the differentiation corresponds approximately to the toxicity of pollutants as reflected by ambient standards. Originally the absolute level of charges could have reflected some abatement costs from the 1970s, but this is difficult to ascertain now.

After 1989 the charges started to have some incentive role. Consequently, each revision is accompanied by polluters' lobbying against it, which leads to a slight relative decline over the last 20 years. As they are much below Pigouvian levels, they are not efficient. Nevertheless – to the extent that they are applied to all major polluters – they are capable of achieving cost effectiveness. This, however, is compromised by numerous additional source-related regulations implying very different marginal abatement costs. Their administrative costs are not excessive for two reasons. First, the regulations do not require actual measurements to be carried out regularly; for instance, emissions from gas stations are estimated on the basis of the stations' turnover and the engineering quality of installations. Only the largest sources have the so-called constant monitoring of emissions. Second, running the pollution charge system requires the monitoring capacity that would be required anyway by any system of enforcement.

Pollution charges are enforced by non-compliance fees, which are multiples of the original charging rates. Moreover, non-compliance fees are subtracted from after-tax profits and hence they are much more biting theoretically. Actually they are not so sharp, because of the system of suspensions. A non-compliance fee can be suspended for up to 5 years if the polluter invests in abatement. After this period it is at least as difficult to enforce the compliance as before.

Most of polluters come from the energy sector. Thus pollution charges provide incentives for power plants to improve their efficiency or reduce reliance on fossil fuels. There are no available technologies to abate carbon dioxide separately, so all the charges contribute to reducing emission of GHGs, although their impact is probably not very high. According to statistical records, industry's air abatement costs (2 billion PLN, i.e. 0.5 billion euro) correspond to around 0.2% of its sales (1,000 billion PLN, i.e. 250 billion euro). However, given the fact that the cost is concentrated in the energy sector whose sales is 94 billion PLN (23.5 billion euro), the share is higher but in any event it does not exceed 2% of the sales.

Some analysts contemplate the Carbon Capture and Storage (CCS) technology in this context. It is not relevant for the climate protection for several reasons, which are listed in Zylicz (2013).

Carbon Tax

Polish pollution charges contribute to reducing emission of GHGs, but there is a separate carbon dioxide charge introduced in the 1990s. The rate is very small, 0.24 PLN/t (0.06 euro/t) – roughly 1% of EU-ETS prices. Nevertheless it does provide a signal even for those installations that are not included in the EU-ETS. Like other pollution charges, it applies to all major stationary sources (above 50 kW capacity for power plants), but it remains below the Pigouvian level understood as the level necessary to undertake the abatement at the socially justified (efficient) scale. Estimating carbon dioxide emissions does not require measuring the effluent. It is carried out based on the fuel input into power plants or technological characteristics in non-energy production. There are no earmarking provisions for this tax. The revenues go the environmental funds.

EU Emissions Trading System (EU-ETS)

Cap-and-trade is mandatory for all large installations. Early Polish attempts to implement emissions trading were related to traditional pollutants, such as sulphur dioxide, particulate matter, and volatile organic compounds. The United States experience – the only major experience available at that time – was largely confined to traditional pollutants (such as those contemplated by the Polish Ministry of Environment, as well as Biological Oxygen Demand, and gasoline lead additives). Unfortunately most of European official bodies considered 'emissions trading' an unwise American product that does not fit the European regulatory culture. The attitude changed after adopting the Kyoto Protocol which envisaged 'emissions trading'. In order to be consistent with the Kyoto Protocol, the European Commission started to analyse cap-and-trade systems which ultimately led to introducing the EU-ETS, as envisaged by the Directive 2003/87/EC. It is too early to evaluate the entire commitment period (2008-2012). The pilot phase (2005-2007) was subject to an extensive evaluation (Miros & Zylicz 2008). Based on tentative information available from KOBIZE (National Registry), the conclusions are not very different from the earlier evaluation.

The Pilot Phase of the European Trading System was a necessary warm-up stage before countries tried to comply with the Kyoto Protocol in 2008-2012. As a pilot phase, it was not nearly as demanding as provisions binding during the commitment period. Nevertheless a number of developments were introduced that proved useful later on too.

Perhaps the most important institutional development was the establishment of the National Registry and reliable procedures to trace permits and emissions. Without such an infrastructure, it would be impossible for the Polish firms to take part in the European market for greenhouse gases. Polish firms did not participate in the European emissions trading widely, but they acquired knowledge that is indispensable in the long run. Also the government got used to the fact that climate policy is an important agenda item.

An initial perception of the carbon dioxide trading was that it could provide the Polish firms with an opportunity of revenues from selling an abundant asset demanded by other countries. They were deprived of this opportunity by having approved their participation in the European market as late as in the mid-2006, i.e. when it became apparent that there would be no demand for allocations. The price of a permit fell almost down to zero which eliminated incentives to seek potential buyers. Gradually a new perception developed that the asset is perhaps not as abundant as it once appeared, and – more importantly – it cannot be regarded as a source of easy revenues. In contrast, it is like any other asset that can be both bought and sold, and firm managers need to calculate which option is more profitable: to save it and to sell surpluses at the market price or to use it, perhaps buying additional units at market prices. Some early evidence from the United States demonstrates that firm managers need time to learn that an environmental permit is an asset, and it is subject to the same buying/selling logic as anything else owned by the company. Adaptations require organizational changes, perhaps creating new positions or empowering old officers with new competences.

These were beneficial experiences from the EU-ETS Pilot Phase. At the negative side, however, one should note that the struggle over initial allocation ruined earlier attempts in Poland to advertise marketable pollution permits as an instrument that is simple, transparent and free from a bureaucratic oversight. The trading rules and political disputes over plant-specific abatement options created an impression among plant managers that marketable permits are extremely complicated and subject to political manipulation to a larger extent than command-and-control. It will take years to restore confidence in flexible mechanisms. The optimality of this instrument is questionable. Its effectiveness is defined exogenously by the 'cap' (according to the official records, sources covered by the EU-ETS comply with regulation). Its cost-effectiveness is difficult to assess, as many sources are not involved in trading, and those that are complain about uncertainty caused by the instability and complexity of regulations. In contrast, feasibility is easy to confirm; administrative capacity to maintain the registry of emissions and trades has been established.

To sum up this policy landscape, there are several mechanisms in place to price CO_2. Carbon dioxide charges – as well as other pollution charges – are very low and they do not provide incentives to abate at scales required by the European Commission. EU-ETS provides such incentives, but poor implementation and political struggles slow down adaptations needed at the industry side. Hidden agendas accompanying EU-ETS implementation and the violation of the Directive 2003/87/EC Preamble (which states that the Directive is to lower the cost of the Kyoto Protocol in Europe) hamper the progress. The most difficult task will be to introduce carbon pricing to non-EU-ETS sectors (e.g. transport). As pollution charges are likely to stay at low levels, implicit carbon pricing can be introduced by excise taxes and technological standards.

1.2.2 Energy Efficiency and Energy Consumption

Energy consumption is not limited by any European or national policy. So-called ‘de-coupling’ (separating the rates of economic and energy consumption or emission growth) was declared as an objective in many policy documents, but to the extent that economic growth is very strong in some countries, energy consumption does not necessarily decrease. Between 2000 and 2010 the energy production in the European Union decreased by 12%. In some countries it increased. In Poland it fell by 15% (though the domestic consumption grew by 14%). At the same time Poland's GDP grew by more than 50%. Thus the de-coupling takes place. As there are no absolute targets, it would be difficult to judge whether relevant polices proved effective.

Energy efficiency is a different story, as there are specific targets to be achieved. By 2020 Poland's economy is to improve its energy efficiency by 20%. Extending the trend observed between 2000 and 2010 (improving energy efficiency by almost 25%) suggests that policies turned out effective in this area. As the Polish GDP grew at the annual rate of 4% in this period, the improved energy efficiency cannot be attributed to economic downturn.

Subsidies

Perhaps there are many instruments working towards improved energy efficiency, such as environmental labelling or construction standards, some of them mandated by the European Commission. In this report emphasis is put on one instrument, which exists in few countries only. In Poland there are 4 levels of environmental funds (1 National, 16 regional, 379 county, and 2479 municipal funds). Their disbursement regulations are diverse and complex. The scale of activities can be best characterized by annual revenues of 3426 MPLN (856 M€), more than 50% of which is collected by the National Fund. Energy efficiency is one of the funds' priorities.

An example of a subsidy scheme launched by the National Fund (2013a) is a 2013-2022 program of support for energy-efficient houses. Its budget is 300 MPLN (75M€). Annual energy savings are estimated at 93.5 GWh. The grant is based on the house's planned heating requirement (which must be more rigorous than mandated by the current legislation). There are two thresholds: NF40 corresponding to 40 kWh/m^2*year, and NF15 corresponding to 15 kWh/m^2*year. For detached houses the grant is 30,000 PLN (7,500€) if they satisfy NF40 and 50,000 PLN (12,500 €) if they satisfy NF15. For apartment houses the grants are 11,000 PLN (2,750 €) or 16,000 PLN (4,000€), respectively. Energy requirements are calculated according to very complex engineering criteria of thermal characteristics of building materials.

There are lively discussions on how to best promote energy efficiency. The system of subsidies for energy efficiency projects fails to achieve economic efficiency, since nobody checks if the marginal benefit from a project supported is equal to its marginal cost. An overwhelming belief is that the former is higher than the latter in most cases which contradicts efficiency. It also fails to achieve cost effectiveness, since empirical analyses find it that the marginal cost of providing a unit of energy saved vary widely. Yet it is consistent with common wisdom and it is likely to stay in place in the future. It does not contradict the economic efficiency completely, as subsidies – on average – cover only a part (roughly 20%) of the project costs.

1.2.3 Promotion of Renewable Sources of Energy

Subsidies

This instrument was already covered in 1.2.1. It is relevant for the promotion of renewables, but it works in other policy landscapes as well.

Green certificates

All governments claim that renewables are promoted. Some of them – like in the European countries – have adopted binding targets. In Poland the target is 15% share in 2020 energy consumption. To this end the government urges environmental funds to support renewable energy. It also introduced 'green certificates' to promote electricity production from renewable sources.

Every electricity producer that is connected to the public grid needs to demonstrate certain number of 'green certificates' to make sure that the total volume of electricity produced from renewables approaches the 15% target (for 2020). Every year the number is increased so that the 2020 mix can be achieved smoothly.

The price of 'green certificates' is backed by so-called 'substitute charge' imposed on those electricity producers who do not demonstrate a sufficient number of the certificates. The substitution charge has grown by 15% since 2008. In 2012 it was 287 PLN/MWh (i.e. 72€/MWh). Before the 2012 the price of a 'green certificate' was almost the same as the 'substitute charge'. In 2012 it went down to 230 PLN/MWh (57 €/MWh). In the first few weeks of 2013 it decreased even further so that it corresponds to roughly 50% of the 'substitute charge'. Then it has stabilized at a low level.

There are two reasons for this phenomenon. First, 'green certificates' were introduced with the Directive 2001/77/EC in mind. This old directive introduces indicative targets for renewables share in electricity production. It was amended by Directive 2009/28/EC, which introduces binding targets for renewables share in the entire energy production. While 'green certificates' promote renewable electricity up to the indicative targets, they obviously fail to promote renewable energy consistent with the 2009 Directive. Second, the falling price of 'green certificates' is based on stock exchange transactions. Most of the transactions, however, are carried out on a bilateral basis. Their prices are not known publicly. One can only conjecture that they are also much below the 'substitute charge'. Yet even if the total supply of 'green certificates' were channelled through the stock exchange, it would not increase the price up to the 'substitute charge' level.

The 'green certificate' price collapse is an important development in renewable energy market. One obvious consequence is that the government idea of promoting renewable energy with this instrument is insufficient. The 2009 Directive binding target for 2020 comprises the entire energy mix, including heat and transport fuels. By the very design 'green certificates' could not promote renewables in this sector. Consequently it should not come as a surprise that a major part of the energy market – including heat and transport fuels – is beyond the scope of this instrument. Certificates are issued (on a MWh basis) for renewable electricity producers including those who add biomass to conventional fossil fuel installations.

'Green certificates' failed to provide widely expected co-benefits of renewable electricity production. It was argued by many analysts that biomass combustion would enhance the energy security by promoting small-scale electricity producers. It has not. The fact that biomass import has increased since establishing 'green certificates' is not a very important concern for Poland (it may be for exporting countries, as it ruins their ecosystems' integrity).

What disturbs environmentalists is that the biomass can be combusted in traditional fossil fuel plants in the so-called co-combustion process. This makes sense solely from the point of view of fossil carbon dioxide abatement. Indeed, 1 MWh of energy produced in such a process leads to a lower emission of fossil carbon dioxide. Professionals complain that a co-combustion process ruins installations, and plant managers allegedly designate units about to be shut down anyway to be fuelled with biomass additives. What is more important is that biomass was thought of as a local fuel to minimize transport-related externalities and to substitute for dirty coal burnt in small plants lacking adequate abatement opportunities. Instead, it is transported over large distances and burnt in large installations equipped with scrubbers and high stacks so that its environmental effect is small if at all positive. Cost-effectiveness requires that the marginal abatement cost of carbon dioxide emission *via* the co-combustion method is the same across all its applications. The direct abatement cost is approximately the same indeed (provided that a ton of timber substitutes the same amount of coal, and its price is the same). Nevertheless, given the fact that the transport cost (the pecuniary one plus externalities) probably differs widely, indirect abatement costs are likely to be different in different projects.

While 'green certificates' largely failed to promote renewable energy (its share in primary energy production is 10%, and prospects for further improvements are dim), some progress took place. It was achieved thanks to subsidies offered by environmental funds. Historically they contributed a significant part of total environmental investment expenditures. In 2000 it was around 20%. This contribution gradually decreased so that in 2011 it was less than 13%. Nevertheless for some categories – including e.g. low-scale water retention – it was higher.

The National Fund (2013b) launched a number of subsidy programmes to promote renewable energy sources. For instance it has a program of grants for a partial repayment of loans taken in order to purchase solar collectors. The program is in operation for 2010-2015. Its total budget is 364 MPLN (91 M€). The grants are calculated on the basis of the area of collectors installed.

According to economic theory, subsidies should be proportional to benefits rendered. These, however, are very difficult to operationalize. For this reason, many environmental subsidies are based on expenditures. In the case of fairly uniform activities, where benefits are easy to demonstrate and calculate, this does not have to violate cost-effectiveness. In the case of complex projects with very diversified natural and technological circumstances cost-effectiveness is virtually impossible to be achieved. Consequently Minister of Environment was confused as to how such projects ought to be promoted.

In particular, the geothermal energy belongs in this category. From the purely engineering point of view, its deposits are vast. Nevertheless, because of very different geological and geographical conditions, the efficiency of its extraction is often problematic. The main conclusion from a report prepared by Zylicz & Czajkowski (2008) for the Minister of Environment was that subsidies should not be based on costs, but rather on expected benefits of a given geothermal energy project. The benefits were assumed to be proportional to the energy harnessed. Given the assessment of externalities avoided, our recommendation was that geothermal energy is subsidized at the level of 33 PLN (8€) per every MWh produced.

As far as we know, this advice was not adopted directly. Nevertheless operations of Polish environmental funds are gradually rationalized and more and more subsidy schemes are based on competitive criteria with benefit to cost ratio playing an important role.

There are heated discussions on how to best promote renewables. To a large extent the discussions are influenced by fossil fuel energy lobbies which do not confine to coal industry. As active as coal miners are promoters of the natural gas from Russia who would prefer to substitute coal with gas rather than with renewable sources. The role of 'green certificates' depends on whether the government succeeds in defining allowable technologies.

1.2.4 Non-Carbon Dioxide GHGs

Carbon Tax

To some extent carbon tax is relevant in this context, but it has already been covered in section 1.2.1. Thus it will not be repeated here.

Other Taxes

Methane is the most important non-carbon dioxide GHG. It is taxed according to the same rate as carbon dioxide. Nevertheless revenues from this charge are much smaller than from the latter. A part of the reason is that methane emission corresponds to just 0.5% of that of carbon dioxide (10% if the global warming is taken into account). A more important reason, however, is that methane originates in agricultural processes which cannot be monitored so closely as industrial ones. Consequently less polluters can be traced by environmental inspectors. Given the fact that agricultural sources are typically small ones (there are more than million farms in Poland), they do not pay pollution charges, which can be justified in terms of administrative feasibility.

There are also other trace gases with global warming potential. As they are considered air pollutants, they are subject to charges. Their charging rates are typically higher than for carbon dioxide and methane. For instance, the rate for nitrous oxide is 71.30 PLN/t (18 €/t). The rates for freons and halons are much higher: 157.91 PLN/kg (39 €/kg). Nevertheless their incentive role is low given the high commercial value of these chemicals and relatively low emissions.

An effective abatement policy with respect to methane must address agricultural production in the first place. In Poland's circumstances this boils down to cow husbandry. For political reasons, it is unlikely that the government will dare to do it unless pressed by international regulations. As most of emission comes from dispersed sources, measurements will continue to be based on theoretical calculations rather than actual measurements.

1.3 Identification of interactions of instruments within each policy landscape

1.3.1 Carbon Pricing

Objectives

Three instruments were selected for this policy landscape: carbon tax, other taxes, and cap-and-trade. The first two instruments belong to the same system of pollution charges, which in Poland has a long tradition (almost four decades now). They are consistent in a sense that – in principle – charging rates correspond to the toxicity of pollutants. The carbon dioxide charge was added later on and it has a much lower rate. This is understandable, since it is not a toxic substance from the environmental protection point of view.

Scope and Coverage

Charges applied in this policy landscape are mandatory for agents who are of sufficient size. In contrast, cap-and-trade applies to EU-ETS sectors only.

Functioning and Influencing Mechanisms

As charges are set at modest levels, affected agents raise modest complaints only. In contrast, cap-and-trade raises serious complaints. The EU-ETS prices are low and therefore they are not contested. What prompts the affected agents to question the cap-and-trade system is the arbitrariness and instability of rules established the European Commission.

The price of carbon implied by the EU-ETS is higher than the Polish domestic carbon dioxide charging rate. It makes the charging rate irrelevant for firms who participate in EU-ETS. At the same time there are sources not included in the EU-ETS. Their emissions are nevertheless taxed, so that some signals are sent to such polluters too. The signals are much weaker than those received by EU-ETS sources. Cost effectiveness requires that non-EU-ETS sources face the same carbon price as the EU-ETS ones. Even though ideal from the efficiency point of view, this solution would require a drastic increase in the charging rate. Potential payers of such a charge would insist that their emission is not calculated according to a theoretical formula, but rather based on actual measurements. Administrative cost of this development would be very high which makes its prospect rather dim.

Implementation Network/Administrative Infrastructure

No new administrative capacities were necessary in order to run the pollution charging system (which dates back to the 1970s). In contrast, the EU-ETS triggered the establishment of a necessary capacity. Establishing national registries, as discussed in 1.2.1, can be linked to the European emissions trading system. It goes beyond the scope traditionally attributed to the Ministry of Environment.

1.3.2 Energy Efficiency and Energy Consumption

Objectives

This policy landscape is addressed in many policies. While numerous policy makers embrace energy efficiency, few instruments can be unambiguously considered relevant for the problem. Only one instrument – environmental funds' subsidies – was selected for this study.

Energy savings in the housing sector were selected to illustrate how the subsidies work in practice. Environmental funds are free to frame the instrument in a way they seem adequate for achieving the government policy of the 20% improvement. The National Fund example demonstrates how this instrument is linked to other instruments deployed by the government. The amount of subsidy depends on government-regulated thermal insulation standards serving as a reference for what is a better-than-standard house in terms of energy consumption. The program is likely to be extended into other areas of energy efficiency.

Scope and Coverage

Improving energy efficiency has a strong sectoral dimension. So far, it has been focused on the housing sector. The transport sector seems to have a high savings potential too, but – for technological reasons – it is much more difficult to be included in various policy schemes.

Functioning and Influencing Mechanisms

The most difficult aspect of enforcing energy efficiency is the 'rebound effect'. Every product or every process can demonstrate improved energy performance, but the demand for such improved units may increase and, as a result, the total energy consumption may increase. Instruments aimed at energy efficiency are not successful at dealing with the 'rebound effect'.

Implementation Network/Administrative Infrastructure

No dedicated administrative infrastructure was established in order to implement energy efficiency measures.

1.3.3 Promotion of Renewable Sources of Energy

Objectives

The overall objective is fairly obvious. This is to increase the renewables' share in the country's energy balance. Nevertheless, when it comes to electricity production, there is an important difference between capacity (measured in MW or so) and production (measured in MWh or so). A typical fossil fuel based plant operates for most of the year. At the same time, a typical wind or photovoltaic installation operates for a fraction of the year. Consequently governments announce increases in renewable capacities, but their share in production does not increase correspondingly.

Scope and Coverage

In principle, the scope of renewable-promoting instruments is all encompassing. Unfortunately it also includes co-combustion which led to various undesired effects, as discussed in 1.2.3 above and later on (in chapter 1.4).

Functioning and Influencing Mechanisms

The collapse of the 'green certificate' price is perhaps the most important recent signal for the government to re-think its policy with respect to renewables. So far it was believed that two instruments selected for this policy landscape – subsidies and 'green certificates' – would be sufficient to bring a break-through in the development of the renewable energy market. It would be economically rational to impose Pigouvian taxes on fossil fuel energy. Yet, because of political reasons, no government dared to establish such a regulation. As an alternative solution, governments experiment with direct or indirect subsidies to non-fossil fuel energy.

The government of Poland believed that indirect subsidies implied by 'green certificates' and direct subsidies offered by environmental funds would substitute for the non-existing Pigouvian taxes on fossil fuel energy. Theoretically it could have been accomplished by imposing a 'green certification' requirement on all energy producers. The actually imposed requirement involves electricity producers only. As a result, the production of renewable electricity was boosted indeed. However, the drastic decrease of the 'green certificate' price is likely to introduce serious disturbances in the investment process. This casts doubts about Poland's ability to achieve the European renewable energy targets in the long run.

In addition to likely reforms in the 'green certificate' regime, the government will probably press environmental funds to extend programs of support for renewables. The urgency of targets to be achieved will emphasize the need to apply goal-oriented instruments. The Warsaw University recommendation to calculate subsidies for geothermal energy proportionally to benefits rather than to costs should be applied in other future programs.

Implementation Network/Administrative Infrastructure

No separate capacities were established in order to promote and monitor the development of renewables. Until now they fall under the jurisdiction of two government departments: Ministry of Environment and Ministry of Economy.

1.3.4 Non-Carbon Dioxide GHGs

Objectives

The objective of regulating non-carbon dioxide GHGs is to protect the global climate. Given its public good characteristics, unilateral abatement policies cannot be linked to such an objective. They are justified as a measure to achieve national reduction targets under e.g. the Kyoto Protocol or similar agreements.

Scope and Coverage

Methane emissions come mainly from non-point sources (such as e.g. farming), and therefore they require different measures than those targeted at point sources.

Functioning and Influencing Mechanisms

At the very basic level non-carbon dioxide GHGs are tackled by the Polish system of pollution charges. The charge rates are surely below their Pigouvian levels so they cannot achieve efficiency. If acting alone, they could have achieved cost effectiveness. But they do not act alone. Non-carbon dioxide GHGs include methane and substances controlled under the ozone-layer protection agreements. Methane is tackled by whatever policies address agricultural production. Ozone-depleting substances are tackled by international agreements such as the Montreal Protocol and its subsequent amendments. Confronted with these regulations, non-carbon dioxide GHGs cannot be regulated by charges cost effectively. Given their small contribution to the overall budget of GHGs this does not seem to be a problem with achieving overall emission reduction targets.

Implementation Network/Administrative Infrastructure

No separate capacities were established in order to promote and monitor the emission of non-carbon dioxide GHGs. They are overseen by KOBIZE, i.e. the same organization which registers carbon dioxide emissions.

1.4 Description and evaluation of policy landscapes in the light of the concept of optimality developed in task 1.1

Optimality is characterized by three concepts: environmental effectiveness, cost efficiency and feasibility. Ecologists prefer the first concept, as it looks at whether a policy objective can be reached. Unfortunately, given the public good characteristics of climate protection, broadly stated policy objectives cannot be implemented at the level of a single country. That is why, cost effectiveness – i.e. achieving a specific target as cheaply as possible – is a criterion that will be applied in our assessments widely. In addition, whenever possible, questions related to the feasibility of instruments applied will be raised.

1.4.1 Carbon Pricing

The policy landscape consists of two areas: EU-ETS and non-EU-ETS. The former is overwhelmed by the European price established in the cap-and-trade transactions. Even in 2012, when this price plummeted, it was much higher than Polish domestic carbon dioxide charges. Consequently the Polish EU-ETS sectors are subject to the same stimuli as anywhere else in the European Union. Non-EU-ETS sectors are not. Given the Kyoto Protocol commitments, the EU-ETS defines emission limits for non-EU-ETS sectors in all member states indirectly, but it does not mandate specific instruments to be deployed in order to stay under these limits. Thus it is largely up to member state governments to design policies with respect to non-EU-ETS sectors.

An appropriate carbon tax could help to achieve the optimality in this field. The Polish charging rate is too low to play such a role. Thus the government tries to regulate individual sectors by different instruments.

In the case of transport (14% of the carbon dioxide emission in 2010) this is the excise tax on fuels. It is lower than in some other countries, but increasing it further would be a very difficult task given the strength of the fossil fuel lobby and consumer preferences with respect to passenger car transport. The recent adjustment of petrol and diesel excise tax rates (so that diesel does not a consistently lower retail price any more) was a right move. Carbon dioxide emissions from diesel and non-diesel engines are similar while 'traditional' pollutants emitted by the former are higher. Thus – from the ambient air quality point of view – diesel engines should not be favoured.

In the case of dispersed household heating (the share comparable with the contribution of transport to carbon dioxide emission) the government does not have an equally handy instrument. Attempts to increase taxes on heating fuels meet with aggressive resistance of social critics who refer to allegedly regressive feature of such taxes. The government is thus doomed to regulations on thermal insulation of buildings with effectiveness characterized by very long lag periods.

To sum up, the existing carbon pricing mechanisms do not meet optimality criteria. Apart from the EU-ETS (which limits the domestic emission from major stationary sources), they are not environmentally effective; they do not provide strong incentives to abate. Because of instability and excessive administrative oversight of the EU-ETS, it fails to achieve cost-efficiency; different sources have drastically different marginal abatement costs. The political feasibility of the EU-ETS is questionable. In 1990-1991, thanks to a massive educational effort, public opinion was quite supportive for emissions trading. And yet it would be difficult to find a domestic coalition in favour of this instrument now. On the contrary, the government is lobbied to withdraw Polish industries from the EU-ETS, which is portrayed as a bad instrument.

1.4.2 Energy Efficiency and Energy Consumption

Despite feelings expressed by environmental NGOs, this is a landscape where the government turns out fairly effective – at least in its own opinion. Poland's economy was extremely inefficient under the central planning regime, and this troublesome heritage is difficult to overcome quickly. Consequently if one makes static comparisons with other developed market economies, which were never doomed to inefficiency of central planning, the distance still exists. Nevertheless by looking at two-decade indices, strong de-coupling can be observed. Between 1988 and 2011 energy consumption declined by more than 15%. At the same time GDP grew by more than 50% between 2000 and 2011 (between 1995 and 2010 it doubled, but the quality of aggregate data is too low to justify exact numerical conclusions).

If one looks at static comparisons, picture is less optimistic though. In 2010 Poland consumed 8% of the European Union energy, while it contributed only 4% to its GDP. In other words, average energy intensity of Poland's GDP is twice the EU average. Of course, there are opportunities to improve energy efficiency easily without increasing GDP. Yet a closer look reveals that the opportunities are limited and to a large extent they depend on the level of economic wellbeing as reflected by GDP per capita.

Energy intensity of GDP depends not only on the wellbeing of citizens, but also on the economy structure which changes slowly. Thus it is not much that the government can do about the energy efficiency at the macroeconomic level (apart from removing perverse incentives and internalizing externalities gradually). At the microeconomic level the government can support projects and processes that help to conserve energy even at the current level of development. It would be difficult to assess if the policies deployed – such as e.g. thermal insulation regulations and environmental funds' subsidies – are optimal. Probably more effort and spending would be justified, but there are insufficient data to draw conclusions. Nevertheless promoting energy efficiency is considered a feasible policy.

1.4.3 Promotion of Renewable Sources of Energy

This seems to be the policy landscape in the worst disarray. Not so much because of the lack of perspectives of achieving policy targets. The 15% target for 2020 can be achieved even without major additional efforts. The problems are both formal and economic. The formal one stems from the fact that the 2009/28/EC Directive on the promotion of the use of energy from renewable sources has not been transposed yet; the government has focused on the 2001/77/EC Directive on the promotion of electricity from renewable sources, which does not establish binding targets. The economic inefficiency problem is caused by 'green certificates' which worked fairly well until 2011 to make renewable electricity projects (mainly windmills) financially viable. Their prices collapsed in 2012 because of relatively high supply of 'green' electricity. The high supply, however, resulted not only from a large number of windmills in operation, but also from an unfortunate regulation on co-combustion.

'Green certificates' can be acquired by adding biomass to a coal-fired plant. This is an example of a regulation which is environmentally harmful and it was motivated by a sole desire to limit fossil carbon dioxide emission. Timber and wood production residues travel over vast distances to be combusted in large coal-fired power plants. At the same time they undermine the feasibility of small-scale local biomass plants constructed in order to cut low-stack emissions of the municipal sector. The co-combustion regulation is likely to be eliminated, but the disturbance introduced in the renewable energy sector will last a couple of years.

With photovoltaic prices close to commercial viability there is a large chance for a dramatic change in the energy sector resulting from a potential for so-called dispersed generation. With certain legal regulations it will be possible to install two-way electricity meters and to cut the demand for grid power. The regulations require a major breakthrough in the definition of a 'producer' and Value-Added-Tax obligations. Unfortunately (government and private consulting) services that will be indispensable in drafting these regulations seem to be unprepared (perhaps even unaware of the need) to perform the task.

For the time being, environmental funds' subsidies are the only stable source of support for renewables. As the example of geothermal energy shows, the funds still struggle for achieving cost effectiveness of their operations. Nevertheless their administrative cost is low (around 3% of the subsidies offered), and for that reason they are considered feasible.

1.4.4 Non-Carbon Dioxide GHGs

Given low methane emission, this policy landscape is not very crucial for the Polish government. Freons, halons and hydrochlorocarbons are subject to charging rates much higher than those for methane and nitrous oxide. It is not this charge, but rather quantity regulations of the Montreal Protocol which limit their emissions. Developments in this policy landscape result from agricultural considerations and ozone protection rather than from climate concerns. Therefore it would be premature to discuss the optimality of instruments applied in this policy landscape.

2 Description and initial evaluation of the overall instrument mix

2.1 Identification and description of the main interactions between policy landscapes

Objectives

Theoretically both carbon pricing and energy efficiency and energy consumption policy landscapes aim at a similar objective, i.e. reducing the demand for energy. Nevertheless carbon pricing may send signals to switch to less carbon intensive fuels, and ultimately may compromise energy efficiency if de-carbonized energy turns out to be very cheap. This, however, is a theoretical concern only, since (1) carbon prices implied by the EU-ETS and Polish pollution charges are low, and (2) prices for de-carbonized energy are rather high. As renewable sources of energy have low or zero carbon content, carbon pricing promotes renewables. Nevertheless, because of the low carbon price, its incentive impact is low. The objective of carbon pricing is to reduce carbon dioxide emissions. This is largely independent from reducing the emission of methane (which is the most important non-carbon dioxide GHG), and therefore the non-CO_2 GHG landscape.

Some analysts see a perverse link between energy efficiency and renewables. They argue that a hypothetical increase in energy consumption would require a massive investment in the sector resulting in the decreased dominance of fossil fuels as these new investments would have to include renewables. However, if the energy consumption does not grow, investment in the sector is limited which results in a slow pace of growth of renewable energy. This link is not inevitable. Given the right incentives, it can be conceived that the demand for energy decreases. As long as this decrease is slower than the capital depreciation rate, there is a need for new investment, which may go to renewable rather than fossil fuel sector.

The objectives between the energy efficiency and energy consumption and non-CO_2 GHG landscapes are largely disjointed. There is a theoretical risk that one policy landscape can be dealt with at the expense of the other, but no analyses could be referred to in order to verify this claim. To the extent that improved energy efficiency is linked to coal-to-gas conversion it may result in increased methane global (not Polish) emission. Russian gas extraction allegedly implies high methane emission caused by poor technological conditions. As the Russian GHG emission is not addressed by the European climate targets this is not addressed here. The objectives of the promotion of renewable sources of energy and non-CO2 GHG landscapes are also largely disjointed. There is a theoretical risk that one policy landscape can be dealt with at the expense of the other, but no analyses could be referred to in order to verify this claim. There is a risk that promoting biomass combustion implies producing gas from agricultural residues with some methane being released to the atmosphere. This unwanted effect, however, could be controlled by appropriate technological standards.

Scope and Coverage

Even though the EU-ETS is confined to certain sectors, Polish pollution charges affect all sectors. Their scope, however, is confined to large sources, leaving the transport and municipal sectors largely to the system of standards and subsidies. The scope/coverage of carbon pricing instruments is wide although not universal (for reasons identified above). Instruments for promotion of renewables are insufficient. As explained in 1.4.3, 'green certificates' are confined to the electricity production, and other potential applications of renewable energy sources are supported less effectively. Although the scope/coverage of carbon pricing is not complete, it includes most stationary sources. In contrast, methane emission originates mainly from agriculture, which is not covered by the existing system of pollution charges, since most farms are much too small to be covered.

Both energy efficiency and energy consumption and the promotion of renewables policy landscapes include instruments that are by far not universal. Energy efficiency is largely tackled by environmental funds' subsidies. Applications for support from these funds are not confined to any sectors or technologies, but high transaction costs and the limited availability of financing leave many potential projects unattended. Likewise, promotion of renewables is largely tackled by similar subsidies (and 'green certificates' whose price collapsed as a result of the co-combustion, as explained above). Consequently many potential projects are left unattended too.

Functioning and Influencing Mechanisms

EU-ETS has a very negative perception among Polish entities, mainly because of the instability of its rules, and opinions about 'hidden agendas'. In contrast, Polish pollution charges are subject to occasional complaints, but they seem to be universally accepted. As a result, subsidy programmes financed through environmental funds (fed by pollution charges) are considered more effective in promoting energy efficiency. The government attempts to promote renewable energy by applying separate instruments. As in the previous case, carbon pricing provides insufficient rather than perverse incentives. Therefore promoting renewable energy does not require withdrawal of carbon pricing instruments, but simply implementation of dedicated tools in order to achieve additional goals.

The existing system of pollution charges does not provide perverse incentives. Yet it is insufficient to achieve planned emission reductions. EU-ETS sector is subject to instruments, which imply a high price of methane. Non-EU-ETS sectors have to be tackled separately. Agriculture is the main concern, but as the cow husbandry is not very intensive in Poland, this does not seem to be an acute problem. Most of the other GHGs are controlled by ozone protection policies in a much stricter way than they would have been controlled by climate protection ones.

Implementation Network/Administrative Infrastructure

EU-ETS in Poland is monitored domestically by the National Registry (KOBIZE). The necessary infrastructure is in place. Pollution charges are monitored by the state inspection, which improves their coverage (still far from perfect). At the moment, there is little synergy between the two systems of services, but it is hoped that KOBIZE will gradually help inspectors to improve their effectiveness. Crucial for energy efficiency, the system of subsidies financed by environmental funds has a well developed infrastructure for project assessment and monitoring. Energy efficiency is overseen by a special government agency (KAPE, *Krajowa Agencja Poszanowania Energii*). There is no separate official body in charge of renewables. They fall into the jurisdiction of the Ministry of Economy which – as far as the renewables are concerned – seems to be captured by the biofuels' lobby.

Non-electricity related renewables do not have a government body dedicated for their promotion. Thus carbon pricing and renewables landscapes rely on different administrative infrastructures. While most important carbon dioxide sources are monitored by government bodies, methane sources are not. As they come mainly from agriculture (which is dispersed in Poland), their accounting and monitoring is an administrative challenge.

2.2 Summary discussion of the combination of policy landscapes (the overall instrument mix) against each one of the elements of the concept of optimality

Economic Efficiency

Economic theory asserts that cost effectiveness is reached if instruments deployed require the same marginal cost for all polluters whose actions are necessary to achieve a given policy target. It is also assumed that all externalities are properly internalized either by Pigouvian taxes or by equivalent requirements.

It is easy to see that criteria of cost effectiveness are not satisfied not only because of imperfect internalization, but first of all because of different carbon prices faced by different polluters. The most striking difference is between EU-ETS and non-EU-ETS sectors. The former (in principle) face the same price. In reality they do not because of reasons identified above. The latter are subject to diverse regulations implying very different carbon prices which preclude cost effectiveness. A high degree of instability does not allow to assess their impact in the long-run. In the case of other instruments – such as e.g. subsidies for energy efficiency projects – cost effectiveness is not achieved because of insufficient emphasis placed on this criterion by environmental funds and government departments.

Environmental Effectiveness

Benefits from climate protection depend on the global GHG emission. Therefore they cannot be confronted with the local cost of GHG mitigation. This precludes applying the standard notion of optimality. Abatement measures taken by an individual country can be judged from the point of view of cost effectiveness only. Nevertheless some policies deployed – such as e.g. promotion of renewable resources – can be judged from a purely domestic perspective.

Instrument Mix Feasibility

Other than GHG emission targets are more difficult to assess in terms of optimality. Targets set in terms of improved energy efficiency lack any economic justification, because of the 'rebound effects': lower energy intensity of a product or a process may result in increased demand for this product or process totally or partially undermining the original energy saving expectations. Hence it is impossible to apply any optimality criteria to energy efficiency in the framework of a partial equilibrium approach. Nevertheless public support for these policies seems to be rather high.

Promotion of renewable energy is a different story. The support of it – which is practiced or at least attempted by many governments – is justified in terms of lower externalities, improved energy security, low transmission costs etc. There are two basic support system options: feed-in tariffs and 'green certificates'. Like several other countries, Poland chose 'green certificates' which worked fairly well for a couple of years. The recent collapse of this system was caused by several reasons, including the lack of an integrated policy with respect to all renewables, not only renewable electricity. The most important flaw in the system was granting 'green certificates' for electricity produced in co-combustion processes. This bad policy solution was motivated by an absolute priority given to fossil carbon dioxide emission over any other environmental considerations.

Some interaction between EU-ETS and co-combustion occurs obviously. Large combustion plants are included in EU-ETS, they receive carbon dioxide permits that do not cover their planned emissions, so they look for abatement opportunities irrespective of whether they make sense from environmental protection point of view. Co-combustion is an example of a technology which makes environmental sense only for small local installations (close to biomass residue sources). Unfortunately large plants lobbied the Polish government to accept this technology as a carbon dioxide abatement option. Negative interaction exists to the extent that probably the total carbon dioxide emission is unaffected (it simply moves from EU-ETS to non-EU-ETS). Nevertheless the environmental effect is a negative one, as explained above.

3 Conclusions

This report aimed at Polish institutions' response to climate protection targets established by the European Union. Until the year 2020 they boil down to reducing GHG emissions by 20%, achieving 20% renewables' share in energy consumption (15% in Poland), and 20% improvements in energy efficiency. In the longer run it is expected to reduce GHG emissions down to a small fraction of the past level.

Five instruments – carbon taxes, other pollutants' taxes, subsidies, emissions trading, and 'green certificates' – were selected for in-depth analyses. It would be difficult to claim that these instruments are the only ones to support Polish policy response to European climate concerns, but they shed light on both strengths and weaknesses of this response.

The main conclusion from the analyses is that instruments studied do not contradict each other. To a large extent carbon pricing is not binding, especially for non-EU-ETS sources. Consequently the government must adopt additional instruments in order to pursue policy goals. The support for renewables is perhaps the most problematic area, where instruments deployed so far do not provide expected results.

The optimality of policies implemented is a difficult question. In order to assess optimality rather than effectiveness one needs to adopt a certain concept of benefits (assuming that costs are easier to grasp). Since climate protection benefits are a public good, no single region – like the European Union – or a single country can control these benefits. For that reason a somewhat weaker criterion of cost effectiveness, i.e. achieving an exogenous target at a least cost, was studied. Our analyses suggest that cost effectiveness is not achieved for two reasons. First, Polish policy response has not been adequate in some cases. But also, second, European policies do not allow cost effectiveness to be achieved in some cases.

After the 2010, shale gas development has become a major political issue in the European Union. While of interest as a method of lowering GHG emission, it nevertheless became a factor seen as an obstacle renewables. Inspired by the European Commission, Polish government planned very restrictive regulations to constrain the development of the shale gas. In the summer of 2013, it withdrew from some of these plans in order to let this option for reducing GHG emission be open.

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Annex I: table for the description of instruments

Areas of Policy interaction in design parameters	Instrument 1: **Carbon Tax**	Instrument 2: **Other pollution charges**	Instrument 3: **Subsidies**	Instrument 4: **Cap-and-trade**	Instrument 5: **Green certificates**
Instrument category	Taxes	Taxes	Taxes	EU-ETS	Technological support
Instrument subcategory	Carbon tax	Pollution charges	Negative tax for environmentally-friendly activities	Cap-and-trade	Green certificates
Level of governance	Central government	Central government	Multi-level	Central government	Central government
Degree of bindingness	Fully mandatory	Fully mandatory	Environmental funds are to disburse all the revenues, but specific disbursement titles are discretionary	Mandatory for all major installations registered in EU-ETS	Mandatory
Objectives*					
Goal(s)	Mitigation only	Mitigation only	Mitigation and other goals equally important	Mitigation only	Non-mitigation goals, with impacts on mitigation
Type of target	Steady emission reduction up to the permit level	Steady emission reduction up to the permit level	In principle projects are selected on cost-effectiveness basis in several areas (including GHG abatement)	Steady emission reduction up to the permit level	All power installations are supposed to own a certificate corresponding to a certain percentage of energy generated from renewable sources
GHG Scope		Not applicable (GHGs are covered by Instrument 1)			Not applicable

GHGs covered	All GHGs covered. Carbon dioxide and methane have the same charging rate. Nitrous oxide and other gases are charged much higher (roughly according to their global warming potential)		All	All GHGs	
Direct/indirect emissions	Actual emissions of major stationary sources. Some other sources (e.g. gas stations) are charged according to calculated (hypothetical) emissions		Both	Direct emissions	
Primary/final energy	Both		Both	Final energy and other sectors	
Opt-in/opt-out	Not applicable		Eligible for subsidies are investors who pay all the pollution charges due	No	
Sectoral scope					
Sectors of economy	All (including agriculture)	All	All	EU-ETS sectors	Energy sector
Covered entities	Installations with a reporting obligation	Installations with a reporting obligation	All	EC Directives	
Covered sites	As above	As above	All	EC Directives	

Capacity thresholds entities/sites	5 MW and over (for power installations)	5 MW and over (for power installations)	Central – Regional – County funds may establish thresholds for eligibility	EC Directives	
Opt-in/opt-out for sectors	Not applicable	Not applicable	Not applicable	EC Directives	No
Opt-in/opt-out for entities	Not applicable	Not applicable	Not applicable	No	No
Opt-in/opt-out for sites	Not applicable	Not applicable	Not applicable	No	No
Implementation network					
Competent bodies for adopting instrument	Minister of Environment	Minister of Environment	Supervisory Board of a fund	EC	Minister of Economy
Competent body for setting-up instrument	As above	As above	Supervisory Board of a fund	Minister of Environment	Minister of Economy
Competent body to administer instrument	As above	As above	Management of a fund	KOBIZE*	Energy Regulatory Authority
Competent body for registration of participating entities	As above	As above	Management of a fund	KOBIZE*	Energy Regulatory Authority
Competent body for Monitoring & verifying compliance	Chief Inspector of Environmental Protection	Chief Inspector of Environmental Protection	Management of a fund	Chief Inspector of Environmental Protection	Energy Regulatory Authority
Competent body for enforcement of compliance	As above	As above	Management of a fund	Chief Inspector of Environmental Protection	Energy Regulatory Authority

Rules & influencing mechanisms					
Market arrangements	Not applicable	Not applicable	Relative and/or absolute subsidy ceilings may take into account financial characteristics of the applicant	Europe-wide trading	
Non-obligatory for eligible parties					Paying a 'substitute charge' is possible
Number of participants					
Market flexibility	Not applicable	Not applicable	Not applicable	Europe-wide trading	
Trading					Yes
Unit type and name					1 MWh of 'green electricity'
Nature of unit					Green certificate
Lifetime of unit					1 year
Banking provisions					None
Borrowing provisions					None
Financing			Not applicable		
Cost-recovery	Not applicable			No	No
Revenues raised	Revenues raised from all air- and climate-related charges are 545 MPLN (136 Meuro) in 2011; GHGs make roughly 15% of the total	Revenues raised from all air- and climate-related charges are 545 MPLN (136 Meuro) in 2011; the revenues are dominated by sulphur dioxide charge		Minister of Finance to claim auction revenues	Revenues from selling 'green certificates' go to 'green electricity' producers; revenues from a 'substitute charge' (873 MPLN i.e. 218 Meuro in 2011) go to environmental funds
Technological	Not applicable	Not applicable	Funds may compile	EC Directives	

parameters			lists of supported technologies		
Eligible technologies					All types of solar energy and hydropower
Opt-in/opt-out					No
Treatment of additionality					Not applicable
Timing	Not applicable	Not applicable	Not applicable	EC Directives	Renewable energy obligation is gradually increased, so that in 2020 it will correspond to 15% of the electricity generated
Operational?					
Operational changes foreseen?					
Compliance period(s)					
Future continuation					
Compliance	According to general rules	According to general rules	Determined in a grant / soft-loan agreement	EC Directives	
Monetary penalties	Non-compliance fee = 5·regular charge	Non-compliance fee = 5·regular charge			A 'substitute charge'
Naming and shaming					
Administrative liability					
Civil liability					

*KOBIZE = *Krajowy Osrodek Bilansowania i Zarzadzania Emisjami* (National Centre for Monitoring and Managing Emissions

Annex II: Types of interactions between instruments

Carbon Tax – Other pollution charges (1-2)

Table 2: types of interaction between instruments Area of policy interaction	Type of policy interaction	Description
Instrument type	Identical	All pollution charges (including GHG charges) are imposed on the same entities are subject to the same implementation regime
Degree of bindingness	m-m	
Objectives	p-p	
Scope	f-pa	
Implementation network	Fully consistent	
Rules and influencing mechanisms	regulatory	

Carbon Tax – Subsidies (1-3)

Table 2: types of interaction between instruments Area of policy interaction	Type of policy interaction	Description
Instrument type	different	Even though formally subsidies are treated as 'negative taxes' they are different since in this case subsidies are offered on a project-by-project basis at the discretion of environmental funds that are not a part of the general budget
Degree of bindingness	m-v	
Objectives	p-s	
Scope	i-i	
Implementation network	Largely consistent	
Rules and influencing mechanisms	regulatory	Even though subsidies are not mandatory, the system (of pollution-charge earmarking) is a part of a 'regulatory' rather than 'trading' regime

Carbon Tax – Cap-and-trade (1-4)

Table 2: types of interaction between instruments	Type of policy interaction	Description
Area of policy interaction		
Instrument type	different	
Degree of bindingness	m-m	
Objectives	p-p	Despite political moves aimed at charging EU-ETS with non-mitigation functions, it is basically an emission-abatement instrument (like a carbon tax)
Scope	i-i	Interaction is indirect, since mitigation incentives provided by EU-ETS are much stronger than the carbon tax
Implementation network	Independent	
Rules and influencing mechanisms	Trading	Carbon tax is a regulatory instrument, but its impact is much weaker than that of EU-ETS

Carbon Tax – Green certificates (1-5)

Table 2: types of interaction between instruments Area of policy interaction	Type of policy interaction	Description
Instrument type	different	
Degree of bindingness	m-m	
Objectives	p-s	
Scope	i-i	
Implementation network	Independent	
Rules and influencing mechanisms	Trading	'Trading' was selected due to the methodology recommended for authors

Other pollution charges – Subsidies (2-3)

Table 2: types of interaction between instruments Area of policy interaction	Type of policy interaction	Description
Instrument type	different	Subsidies offered by environmental funds are financed from pollution charges
Degree of bindingness	m-v	
Objectives	p-s	
Scope	i-i	
Implementation network	Subsidies depend on funds' revenues	
Rules and influencing mechanisms	regulatory	Even though subsidies are not mandatory, the system (of pollution-charge earmarking) is a part of a 'regulatory' rather than 'trading' regime

Other pollution charges – Cap-and-trade (2-4)

Table 2: types of interaction between instruments Area of policy interaction	Type of policy interaction	Description
Instrument type	different	
Degree of bindingness	m-m	
Objectives	p-p	'Primary' is selected despite two caveats: (1) there are political moves aimed at charging EU-ETS with non-mitigation functions, but it is basically an emission-abatement instrument; (2) 'other pollution charges' affect carbon emissions because of the strong correlation
Scope	i-i	Interaction is indirect, since mitigation incentives provided by EU-ETS are much stronger than 'other pollution charges'
Implementation network	Independent	
Rules and influencing mechanisms	Trading	'Trading' was selected due to the methodology recommended for authors

Other pollution charges – Green certificates (2-5)

Table 2: types of interaction between instruments Area of policy interaction	Type of policy interaction	Description
Instrument type	different	
Degree of bindingness	m-m	
Objectives	p-s	
Scope	i-i	
Implementation network	Independent	
Rules and influencing mechanisms	Trading	'Trading' was selected due to the methodology recommended for authors

Subsidies – Cap-and-trade (3-4)

Table 2: types of interaction between instruments Area of policy interaction	Type of policy interaction	Description
Instrument type	different	
Degree of bindingness	m-v	
Objectives	p-s	
Scope	i-i	
Implementation network	Independent	
Rules and influencing mechanisms	Trading	'Trading' was selected due to the methodology recommended for authors

Subsidies – Green certificates (3-5)

Table 2: types of interaction between instruments Area of policy interaction	Type of policy interaction	Description
Instrument type	different	
Degree of bindingness	m-v	
Objectives	p-s	
Scope	i-i	
Implementation network	Independent	
Rules and influencing mechanisms	Trading/regulatory	'Trading' was selected due to the methodology recommended for authors

Cap-and-trade – Green certificates (4-5)

Table 2: types of interaction between instruments Area of policy interaction	Type of policy interaction	Description
Instrument type	different	
Degree of bindingness	m-m	
Objectives	p-s	
Scope	i-i	
Implementation network	Independent	
Rules and influencing mechanisms	Trading	