9. THE ISSUE OF INTERNALIZING ELECTRICITY PRODUCTION EXTERNALITIES: THE CASE OF THE ESTONIAN OIL SHALE INDUSTRY

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Introduction

For the first time in the history of mankind global economic growth is threatening to stop in foreseeable future because of constraints set by the natural environment. On a smaller scale, it has happened a number of times — a vivid example being the doom of the society living on the Easter Island — but so far only in separate communities.

Due to environmental pollution and exhaustion of natural resources, the constraints to economic growth emerge both at the regional and global level. The accumulation of harmful substances into the Baltic Sea fish species and resulting damage to fishing industry is mainly caused by the pollution from industries surrounding the Baltic Sea. On the contrary, the effects of global warming cannot be attributed to single sources, as carbon dioxide spreads itself evenly in the atmosphere around the globe.

Such challenges can be dealt with by local, regional or global means. The Kyoto Protocol illustrates one, although not parti-

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[1] The views presented herein are entirely those of the author and not of the institution he is affiliated to.

cularly successful, attempt to tackle a common challenge with concerted efforts on a global scale. The European Union's scheme for greenhouse gas emission allowance trading represents a regional approach to combating pollution and emissions of greenhouse gases. However, such large-scale attempts involve huge transaction costs, while the outcome might finally never become a reality. Thus local approaches, being potentially the most efficient, should be prioritized.

Most economic activities have some (usually negative) environmental consequences. In the Baltic Sea region and especially in Estonia, those that are connected with the energy sector are among the most severe environmental challenges. The energy sector is very large in any economy due to its relative importance — it gives an input to most of the other economic sectors. Also, heat and electricity form an integral part of a households' life quality. Their production is usually based on non-renewable resources whose usage has a two-sided negative effect — running out of natural resources combined with pollution caused by processing them. Considering its role, the energy sector (including electricity production) deserves special attention from economists in respect of analyzing its activities from the environmental aspect, using the tools of economic science to provide suggestions for policy makers.

The purpose of the chapter is to analyze what happens to electricity prices in Estonia if the negative externalities of the energy sector are taken into account more and more. It starts with presenting the basic concept of environmental economics: internalization of externalities. In a perfect world, its complete application to all economic activities would virtually remove environmental concerns for the society, as all damaging activities will either disappear or will be compensated for to a full extent. In reality, its implementation is difficult due to both methodological and political reasons. The analysis of those differences in the context of Estonia is presented in the second part of the chapter, following the internalization process step by step.

In the final part, a simple exercise is carried out to model the internalization of externalities in the oil shale based electricity production industry in Estonia. Calculations are made to analyze various scenarios describing the situation and possible future developments. It shows that a basic analytical internalization can be conducted without going deeply into methodological arguments. However, already such a simple process provides interesting insights and a basis for further analysis.

9.1. Externalities in electricity production

Environmental problems, including those brought about by energy production, have gained closer attention only in the recent decades, when the results of economic activities have started to threaten the well-being and even existence of mankind. In terms of economic theory, this means that the process of trying to increase the utility of humankind might reverse.

Real-life decision-makers have been ignoring the environmental constraints to a large extent as long as possible. Those constraints have also had little, if any, importance in the classical approaches of economic science. More advanced microeconomic textbooks admit the role of the environment as an input to the economic system (sometimes defined as ‘land’) beside labour and capital, while assuming that the ‘cost’ of using environmental goods and services has been already paid by producers or consumers. Thus, the environmental aspect is still not an integral part of those models, usually resulting in neglecting the environmental constraints whenever insights from those models are being applied for understanding real-life processes.

In the last few decades, though, the environmental component has started to gain more prominence in economic theory. Two new branches of economic theory have emerged — environmental economics and natural resource economics. They aim at enriching economic theory by giving insights into relations between the economic system and the natural environment, as well as providing a basis for much sounder decisions by economic policy makers.

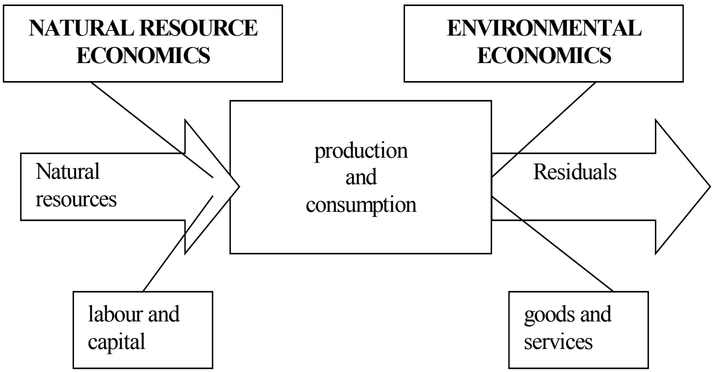

Figure 1. The linkages between the natural environment and the economic system (scheme idea based on Field 1994).

Figure 1 illustrates the role of those research areas in economic theory, while providing a simplified picture of interactions between economic system and natural environment. The first link on the scheme between the economic system and the environment represents raw materials flowing into production and consumption. The study of nature in its role as a provider of raw materials is called natural resource economics. The second link shows the impact of economic activity on the quality of the natural environment. The study of this residuals' flow (e.g. pollution, production leftovers, etc.) and its resultant impacts in the natural world comes under the heading of environmental economics. While the pollution control is the major topic within environmental economics, it is not the only one. Human beings impact on the environment in many ways that are not pollution related in the traditional sense. Habitat destruction from housing developments and scenic degradation from a number of human activities are examples of environmental impacts that are not related to the discharge of specific pollutants (Field 1994, pp. 21–22).

These two research branches tend to be seen as something complementary to general economic theory, not as an integral part of it. Yet, the development of natural resource economics and environmental economics presents an important step ahead. Research in those areas has contributed a number of significant concepts, from which the notion of 'externality' or 'external effect' is the most important one.

By definition, an externality results from an activity that imposes costs on, or provides benefits to, parties that do not participate directly in the particular economic transaction. Thus, one way to view externalities is to suggest that the price of the activity or good is incorrect, i.e. the market price does not reflect all the costs and benefits to parties outside the market transaction. In case of emissions from power plants, for example, the price of electricity does not include the full social costs associated with health and environmental damage. A follow-up to this line of reasoning is to suggest that an externality can be internalized and market distortions can be corrected by directly or indirectly altering the price of the good or activity (Curlee 1993, p. 927).

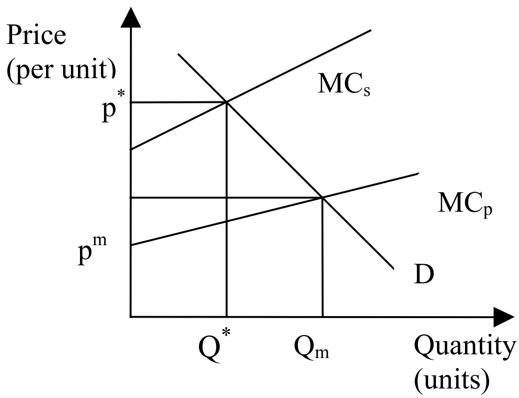

Figure 2. Market allocation with pollution (Tietenberg 1992, p. 53).

The effects of external costs on the industry can be seen in Figure 2, which depicts the market for electricity. Electricity production inevitably involves producing pollution as well as electricity. The demand for electricity is shown by the demand curve *D* and the private marginal cost of producing electricity (exclusive of pollution control and damage) is depicted as MC_p. As the society considers both the cost of pollution and the cost of producing the electricity, the social marginal cost function (MC_s) includes both of these costs. Also, we assume that the marginal cost of pollution increases with the production volume (Tietenberg 1992, p. 52).

If the electricity industry faced no outside control of its emission levels, it would seek to produce Q_m. That choice, in a competitive setting, would maximize their private producer's profits. But that is clearly not socially efficient, since the net benefit is maximized at Q^* not Q_m (*Ibid*, p. 52).

With the assistance of Figure 2, we can draw a number of conclusions about the market allocations of the commodities causing pollution externalities (*Ibid*, p. 52):

1) The output of the commodity is too large.
2) Too much pollution is produced.
3) The prices of products responsible for pollution are too low.
4) As long as the costs are external, no incentives to search for ways to yield less pollution per unit of output are introduced by the market.
5) Recycling and reuse of the polluting substances are discouraged since their release into the environment is so inefficiently cheap.

Economic theory suggests that the suppliers of external environmental costs can be induced to act ‘optimally’ (i.e. to reduce emissions to an optimal level) by imposing an emission fee on emitters equal to the marginal social damage. An alternative market approach to the emission fee is the marketable emission permit. Instead of setting a fee to encourage an ‘acceptable’ level of emissions, the marketable emission permit simply fixes the quantities of emissions that are allowed to individual firms in an industry. The regulator thus has direct control over the quantity of emissions emitted (Curlee 1993, p. 927).

In the Baltic Sea region, traditionally various taxes and charges have been used. At the same time, environmental externalities of electricity production have never been fully internalized by those economic instruments. In some countries (Denmark, Germany), state authorities have been more successful in tackling the same issue from a different prospect. They have provided incentives (like subsidies and feed-in tariffs) for developing energy production based on renewable inputs, as opposed to traditional production from highly polluting non-renewable sources.

The latest developments seem to favour economic instruments of a more flexible nature. Independently from the final outcome of the Kyoto Protocol and its flexible mechanisms (Joint Implementation, Emission Trading, Clean Development Mechanism), all the Baltic Sea countries will be heavily influenced by the European Union’s greenhouse gases emission allowance trading directive. It is going to be complemented also by the requirements set by the EU energy tax directive. However, both directives leave much space for exceptions and exemptions, calling into question their environmental integrity. In that light, economic research of the present situation becomes even more important — future scenarios can be analyzed successfully only if we have a clear overview of the current status of electricity generation, of the extent to which its externalities have been internalized, and of all the factors influencing these processes.

9.2. Externalities in Estonian electricity generation

The previously stated issues apply to the Estonian energy sector, concerning both the production of heat and electricity. The only dissimilar detail in comparison with the neighbouring countries is its dependence on its deposits of a specific fossil fuel — oil shale — which only a few other countries of the world (Australia, China, the South-African Republic, etc.) also possess. It is similar to coal, while the process of generating energy from it is environmentally even more damaging. At the same time, oil shale is a valuable input for chemical industry.

Estonia's dependence on this single non-renewable energy source is very strong — its whole electricity generating sector is based on it. As shown by the following table, the share of oil shale has decreased a bit in the recent years, but is still around 90%.

Table 1. Use of the resources for electricity generation in 1997–2001.

(%)

	1997	1998	1999	2000	2001
Oil shale	95.3	93.5	92.3	90.7	90
Natural gas	1.3	2.0	2.6	6.6	6.7
Other sources	3.4	4.5	5.1	2.7	3.2

Source: Eesti Energeetika 2001, p. 10.

To give a picture of the Estonian energy sector's role as a major polluter, let us have a look at some statistics from the year 2002 (Kraav 2003a). The oil shale sector accounted for:

- 91% of Estonian water consumption (incl. underground water from oil shale mines which is pumped into rivers);
- 97% of air pollution;
- 86% of waste;
- 23% of water pollution.

It is clear that any activity aimed at reducing the environmental damage caused by the oil shale sector will have a significant positive effect on the overall environmental quality in Estonia. Such a situation creates a need for a thorough analysis of the current reality. In that context, usage of various analytical tools for policy appraisal and implementation would be highly welcome.

The direct costs of running the oil shale industry can be seen from Eesti Energia's annual balance sheet. For a cost-benefit analysis which would take into account a longer perspective it would prove to be worthwhile to consider also those investments which are planned to be made into a depreciating machinery in the next few years. Not only are the amounts huge in the Estonian context (hundreds of millions of euros), but after having been made, they will also determine the future path of the Estonian energy sector for the next 10–15 years, which (continuing at the same level of environmental degradation) definitely cannot be defined as sustainable.

It is especially unfortunate if we consider the current share of renewable energy (mainly biomass and wind) of the total energy production, which is 0.2% (the indicative target set during EU negotiations being 5.1%). Of course, it is difficult to define whether restricting the development of renewable energy sources and making investments elsewhere is a direct or indirect cost (if the government has to make some special costly last-minute investments to achieve an EU indicative target, then those costs are surely to be considered as direct ones).

In order to provide a firm framework for our analysis of externalities, let us use the scheme in Figure 3. It describes the phases of externality internalization (externality identification, measurement and evaluation plus implementation of results) and most common problems related to each phase. As socio-economic consequences can often be expressed in numbers and monetary terms (like the number of potentially lost jobs in North-East Estonia — which has a tense social situation — and respective social welfare payments), the descriptive analyses of environmental degradation usually 'lose' to economic analysis when energy policy scenarios are designed by politicians. Thus also externality internalization has to be conducted in monetary terms.

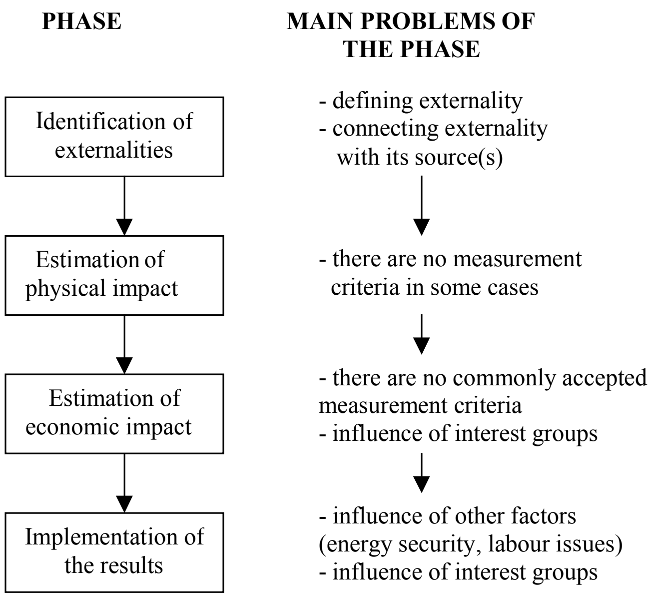

Figure 3. The phases of externality internalization (compiled by the author on the basis of Tietenberg 1992 and Field 1994).

For externality internalization, all direct benefits and costs as well as externalities have to be defined, assessed and attributed monetary value. The calculation of direct benefits-costs may require large amounts of data, but after data collection it is relatively easy to carry the activity out, whereas for externalities, the process is much trickier.

The first phase requires identification of all the relevant externalities. In the case of the Estonian energy system, environmental costs come from two sources — from mining oil shale and from subsequently burning it.

The main costs of mining oil shale are (Eesti Energia AS 2001, p. 7):
- loss of the oil shale resource (which could also be used by chemical industry);
- loss of valuable underground water;
- wasting land (which could be used for agriculture, recreation or maintaining biodiversity).

The main costs of processing oil shale to get energy are (Eesti Energia AS 2001, p. 7):
- atmospheric emissions (SO_2, NO_x, particulates, CO_2, V_2O_5, HCl, CO, carbon compounds — mainly CH_4, H_2S, phenols, volatile organic compounds);
- waste deposition (oil shale ash, oil shale semicoke, inert waste, construction waste, thermal insulation);
- emissions into watercourses (ash field water discharge, waste heat with cooling water, suspended solids, total nitrogen, phosphorus, sulphates).

Those harmful emissions into the environment are hazardous both for environmental quality and human health. Thus they represent true costs for the society and should be taken into account as costs, being also reflected in energy price. Also, oil shale production involves a big loss of natural resources — not only the oil shale resource itself, but also valuable underground water.

Some external benefits can also be defined. First and foremost, security of energy supply. It is of utmost importance for a small country like Estonia to have a secure supply of energy — as Estonia is generally quite poor in terms of non-renewable natural resources, it is essential to have at least its own energy supply due to national security reasons.

Also, scientists have proved that there is enough oil shale for at least the next thirty years. As the oil shale based chemical industry is not doing very well in economic terms, it seems sensible to use that resource for energy production.

The final important benefit is connected with employment issues — oil shale industry provides jobs for people in Northeast Estonia. As that region has quite many social and economic problems, it would be catastrophic to lay off more people because of environmental reasons.

All the above benefits are among the reasons why the Estonian state continues to support oil shale mining by enabling exceptions for environmental charges and is positive towards making huge investments for the next ten years. However, if we look a bit closer at those benefits, we can see that they are arguable.

Firstly, while security of energy supply has to be prioritized, it should not be taken for granted that the desirable situation is only achievable by concentrating on oil shale. More attention at and investments into alternative energy sources might achieve the same level of security with fewer environmental costs. At least this is an option worth looking into — not just taking for granted that only oil shale based energy could guarantee security for Estonia.

Also, while it is somewhat comforting to know that there are enough oil shale resources for the next 30 years, it does not only mean 30 years of security, but also 30 years of ongoing severe environmental damage (while mining gets more expensive all the time as unexploited resources are deeper inside the ground and harder to mine).

The true challenge is measuring the security of supply in monetary terms. Should we just add up all the costs that would occur in connection with importing all the necessary energy from foreign countries? This calculation itself would consist of a huge amount of uncertainty, as it is hard to predict energy sector developments in the neighbouring countries, future energy prices and the reaction of domestic non-oil shale based energy producers, whose production might get cheaper in comparison with imports and thus get an incentive for increasing their output.

Regarding the oil shale chemical industry, the uncertainty concerning future innovations has to be taken into account. In 15 years there might be profitable technologies invented for that branch of industry, thus using the resource now for environmentally damaging energy production would represent a true cost for future generations, as the resource which has been used up cannot be replaced.

The employment issue has also its down side — the people who work in the extremely labour-intensive oil shale industry could in other, more knowledge-based sectors, probably produce more added value to society, also getting higher salaries. This statement is certainly arguable, but in case some effort is put into training the workforce for other sectors, it might become relevant.

The next phase of externality internalization is measuring them. Some externalities, provided that relevant technologies have been installed (and they have in Estonia), are relatively easy to measure — this applies to most emissions (into air and water, plus waste deposition).

Others — costs like visual waste of the ‘ash-hills’ and benefits like the security of supply or generation of jobs — are practically impossible to measure in the current conditions. Measuring them would require the use of advanced methodologies, which are not yet available in Estonia. Thus only conventional environmental damage is measured so far.

The next phase in externality internalization is evaluation of externalities and applying relevant taxes in order to correct market failure. In practice, it is a complicated process and different economic tools could be used for it. In Estonia, the process is currently organized in the form of expert commissions whose task is to suggest the levels of efficient environmental charges. This guarantees that the opinions of different interest groups are taken into account; on the other hand, this arrangement tends to give those interest groups unbalanced influence on the decisions.

Moreover, final decisions are made by politicians (based on the suggestions of expert commission, though), who are even more open to various lobby groups. Such an analysis of the process proves that the literal journey from scientifically sound quantified evaluations to applied economic-environmental policies is very complicated, as there are many stumbling blocks on every step.

The main challenge is that the introduction and increase in charges influence energy prices, but rising energy prices will influence all the participants in the economy (both industries and households). On macroeconomic scale, it also has an effect on the competitiveness of companies and the economy as a whole at the international level. People tend to prioritize economic well-being more than environmental sustainability, especially in a transitional country like Estonia. Also, charge rises are opposed to by the energy company itself.

It is important to understand that implementation of the results — being the fourth and last phase of externality internalization — is the most crucial phase of the internalization process. No matter how good the analysis for identification of externalities is, how precise the technologies for measurement are and how sophisticated the methods for externality evaluation are — if the results are not taken into account in real-life policies, the country's development will fail to be sustainable.

The complicated nature of the process is shown by Figure 4, which describes the institutions and interest groups influencing the price of energy goods in Estonia.

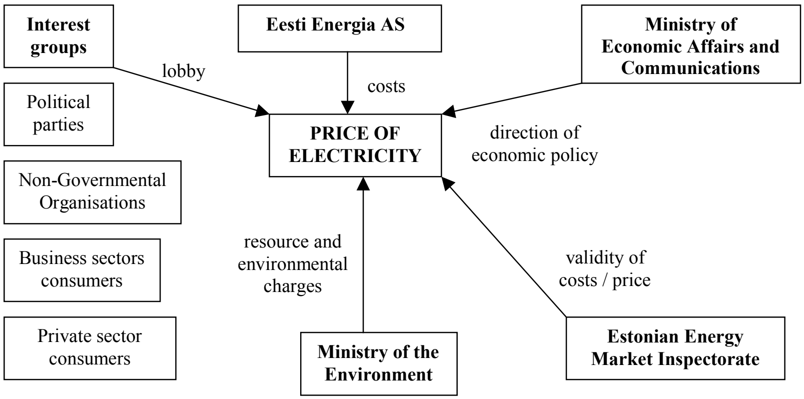

Figure 4. Institutions and interest groups influencing the price of energy goods in Estonia (by the author).

One of the most illustrative examples is the process of formation of the oil shale resource charge over the years. The scientific work started in the late 1980s, the main goal being a more rational use of natural resources in the Soviet Union. In 1990, a certain charge rate was suggested, which was applied from 1st of January 1991 onwards (Kraav 2003b).

At that time, huge political and economic changes occurred, which also brought about hyperinflation, which basically made the charge rate absurdly low in a short time. The Estonian Ministry of the Environment thus suggested changing it. The government did not agree, as the accompanying increase in energy prices would have brought about unforeseeable challenges, as the socioeconomic situation was very tense (*Ibid*).

From the mid-1990s onwards the economic situation stabilized, but by that time enterprises (including Eesti Energia) had become strong and powerful enough to do effective lobbying and prevent any changes in charge fees. The situation has stayed more or less the same until now (*Ibid*).

The Ministry of the Environment has increased the charge rates as much as it has been possible, the main stumbling blocks having been the socioeconomic situation (beginning of 1990s) and business lobby work (from the mid-1990s). Of course, a situation like this does not guarantee sustainable development for the society. So all arguable charge rates are worth investigating — in order to get them to be consistent with the actual damage to the environment.

Tabel 2. Charge rates for underground water consumption.

	Resource charge for underground water consumption (euros/m^3)						
	1999	**2000**	**2001**	**2002**	**2003**	**2004**	**2005**
1. Most upper ground level	0.01	0.02	0.02	0.02	0.02	0.03	0.03
2. Lowest ground level	0.02	0.03	0.03	0.03	0.03	0.04	0.04
3. For oil shale mining	0.001	0.003	0.003	0.004	0.004	0.004	0.004

Source: Vee erikasutuse tasumäärade kehtestamine 1998, Vee erikasutuse tasu määrad … 2001.

The main examples are the charge rates for underground water consumption. As indicated before, the oil shale industry literally wastes rather than uses (as it is just pumped into rivers) valuable subterranean water. The problem is illustrated in Table 2. The first two tax rates are applied to any company using underground water for no matter what purposes except for oil shale mining. But for oil shale mining, the rate is on average ten times lower than for other companies.

The annual rise in other charge rates varies from 5% (oil shale resource charge) to 20% (most pollution charges) but considerably less for 2 main items which would influence costs most: underground water charge (ca 2% per year) and CO_2 (will stay constant until 2005).

Continuous prioritization of oil shale will create exceptions and arguable charge rates, leading to the following problems:

- damage to the environment is not fully taken into account by arguable charge rates;
- because of that (indirect subsidizing!) and considerable legal bias (new electricity market law) alternative energy producers are not competitive;
- thus, Estonia will have difficulties in opening up its energy market at least to 35% by the end of 2008 as agreed with the European Union (Välisministeerium 2002) because of lack of incentives for other producers and achieving sustainable development for society. As a result, this will also lead to unfair competition between the oil shale based energy sector and the renewable sources based energy sector.

9.3. Model for internalizing externalities in Estonian electricity production

The basic step of internalizing external costs for the energy sector is getting rid of special charge exceptions. Not only would it make the government's policy more sustainability-oriented by having a direct influence on producers and consumers, but would also provide a level playing field for entrepreneurs (including those in the area of renewable energy sources) who are currently not enjoying such indirect subsidies.

The model compiled by the present author represents an example of internalizing the basic externalities of the energy sector, which have been caused by resource and environmental charge exceptions. For full internalization of the externalities, more steps have to be carried out, but even such simple modelling yields interesting results, providing useful insights into the situation and preparing the ground for possible further analysis.

The main goals to be achieved are the following:
1) to provide a thorough overview of the role of environmental costs in the formation of the prices for the oil shale resource and for oil shale based electricity;
2) to enable to play scenarios by varying the environmental charges in order to get insights by analyzing the results.

A principle that requires taking externalities into account at all steps of the production cycle is applied. The model is built up accordingly — environmental damage is not analyzed only in the context of Narva Elektrijaamad Ltd (NEJ), where electricity generation takes place, but also Eesti Põlevkivi Ltd (EP) that deals with oil shale mining is included.

The model for externality internalization is based on the program Microsoft Excel. The model consists of a database of numbers that are partially connected with one another by relevant formulas.

There is a possibility of varying environmental costs (which are formed by environmental charges) in two parts of the model. Any change in the environmental costs of EP will influence the price of the oil shale resource, which is being sold to NEJ. The price of the oil shale resource is a direct and important component of the price of electricity. Of course, the price of oil shale electricity is additionally influenced by all changes in the levels and structure of the NEJ environmental costs.

To create an initial model based on the available data is the first step of the analysis — in that form, it only represents the static picture of the year 2001/02. Based on that, the general structure and importance of the environmental costs can still be described. After that, it will be possible to analyze different scenarios — trying out what happens with the price of oil shale and electricity based on it if we internalize the external costs by varying the charge rates.

Before proceeding to the results of the models, a short overview of its assumptions and limitations has to be given. We consider three main aspects — the definition of electricity price, the company data, and the charge levels.

Price definition. In the model only the production prices of the oil shale resource and electricity are taken into account. We do not consider the influence of the environmental charges on the sales price of electricity for final consumers. Also, no profits are calculated for the oil shale industry, although in real life EE is both profit-oriented and profitable. It would require making normative statements about the level of Eesti Energia's fair profit margin, which would fall out of the scope of the current work.

Still, for interested readers it is relatively easy to carry out those calculations on their own, knowing the current tariff (as of December 2003) for household consumers (1.05 EEK/kWh). The change in the production price has to be divided by 0.85 in order to take into account the efficiency losses in grids and multiply by 1.18 (current VAT rate in Estonia), adding the result to the initial tariff. For example, a 1-cent change in the production price would change the household tariff by 1.4 cents.

Company data. In Eesti Energia, the last years have brought about important structural changes and more are yet to come. The final balance sheets of different years are difficult to compare (Kisel 2002). Therefore the model is static one, being based on Eesti Energia's financial year 2001/02 (1.04.2001–31.03.2002).

For compiling the model, data about Eesti Energia was gathered from various sources, but all of it comes directly from Eesti Energia or its subsidiary company Eesti Põlevkivi (Kaasik 2002, Kaasik 2003, Sokman 2003, Eesti Põlevkivi AS 2002). The author himself has made some calculations, but those are directly based on data gained from the enterprises. Also, Margus Kaasik, manager of

Eesti Energia's department of management accounting, has approved the model.

There are some minor contradictions in the initial data (for example, some of the data had a different number of decimal places than other, which can create some differences with very large numbers; also, various sources — like NEJ and EP — gave a bit different numbers for the same indicators). Thus it is not sensible to pay attention to the exact decimal places of numbers in the calculations.

The model assumes that other costs with the exception of those related to environmental charges, the levels of consumption and pollution remain constant (except for the scenario 'Financial year 2005/06'). As only a few next years are considered in the scenarios (the latest being the financial year 2005/06 — the last year for which exact charge rates are available), the assumptions are sensible as no large changes in those items can be expected. In a longer perspective, however, those indicators are inclined to change. Overall costs may increase or decrease depending both on the company's internal and external factors. Electricity consumption will rise together with the expected economic growth. Pollution levels will probably decrease despite an increase in electricity consumption, in view of the planned investments into oil shale industrial technology. But due to the extreme technical simplicity of the model, it is possible to replace the current figures very easily by more up-to-date and precise ones.

Charge levels. One of the challenges is non-convergence of environmental charge accounting from the perspective of model composition — the charge levels have usually changed once a year, on 1st of January, which naturally doesn't coincide with the beginning of Eesti Energia's financial year (beginning on 1st of April). As the pollution levels of EP and NEJ are known from the initial data, the exact charge levels in the model have been calculated by dividing the sum of the collected charge with the amount of a specific pollutant. As a result, the charge levels in the model do not coincide exactly with those stipulated by the laws

(Riigi omandisse kuuluvate… 1996, Riigi omandisse kuuluvate… 1998, Saastetasu seadus 1999, Saastetasu seaduse… 2001, Vee erikasutuse tasumäärade kehtestamine 1998, Vee erikasutuse tasu määrad … 2001).

Fortunately, using the scenarios does no harm, because in the modelling process those charge levels are changed, leaving the amounts of pollutants as independent variables. However, considering the previously presented information, the error in some calculations might be quite large — thus again it has to be stressed that one should ignore the exact number of decimal places in the calculations. Some trial calculations, on the other hand, showed that the price of electricity is not very sensitive to changes in variables, consequently, the results are trustworthy.

We start analyzing the scenarios by giving an overview of Eesti Energia's financial year 2001/02, thereafter proceeding with a more advanced analysis. The basic model is presented in Appendix 1 and overview of the results in Appendix 2.

"Base scenario"

The analysis of Eesti Energia's financial year 2001/02 enables us to analyze the share of environmental charges in overall cost structure. The environmental charges formed 5.5% of EP's total costs and 5.8% of NEJ's total costs. The main share of EP's environmental costs (75%) is formed by resource charge for oil shale mining. The previously considered case of the underground water charge forms only 14% of the environmental costs despite the huge amount of water consumed. NEJ's main environmental costs are various pollution charges (84%) as they are dealing with electricity generation, being responsible for various emissions (CO_2 and other).

Scenario "Financial year 2005/06"

The goal of this scenario is to predict the production price of oil shale based electricity on a year 2005/2006, so four years ahead from the base year 2001/02. To get more precise results, we also take into account the inflation. It makes sense as Eesti Energia's cost increase has been proportionate to the inflation (a quicker increase is not permitted by the Estonian Energy Market Inspectorate — Energiaturu Inspektsioon 2001, p. 5). Thus all the costs in the model have been multiplied by the expected inflation ratio 1.174 that is based on the forecast provided by the Bank of Estonia (Ross 2003). At the same time, EP's costs remain constant as the company's internal policy has been to keep the costs at the same level or even cutting them, and they are planning to pursue that policy in the next few years as well.

In order to provide entrepreneurs with some stability and facilitate planning, the Ministry of the Environment has set the levels of environmental and resource charges for some years ahead. Currently the levels are known until the year 2005, but the Ministry of the Environment has indicated that the increase will remain stable — for mining charges ca 5%, for underground water usage ca 10%, and for most environmental and waste charges ca 20% per year. For most environmental costs in the model, then, it is possible to use precise rates that are known for the year 2005.

So with this scenario we will find how the price of the oil shale resource and electricity is influenced if the environmental charges are at the level of what is planned for the years 2005/06, provided that the other costs and electricity production are kept constant. After performing the calculations it turned out that by the financial year 2005/06 the oil shale electricity production price should increase by 8.33% (from 44 cents to 48 cents). As this rise has two components (environmental charges and overall price increase), it would be interesting to see how big influences they would have separately. Without considering the inflation (keeping all the non-environment-related costs constant), the electricity production price would increase 2.22% (to 45 cents). Without regarding the rise of environmental charges, the electricity production price would rise 6.38% (to 47 cents). So 75% of the costs' increase occurs due to a general macroeconomic price rise, which enables us to conclude that despite the seemingly rapid growth rates, the increase in environmental charges has no significant effect on the electricity production price. The growth rates of the two most important charges are comparatively small. The resource charge for the underground water consumed by EP will rise annually ca 2%. The pollution charge for CO_2 — one of the most important emission items of NEJ — will stay constant for four subsequent years (2001–2004), rising for the first time in 2005 (but then considerably, by 34%).

Scenario "Underground water resource charge"

Looking at the cost structure of NEJ, we discover that the costs of using oil shale as a resource amount up to 31.5% of the total costs, while the environmental charges have a share of 3.8%. The changes in NEJ's environmental charges would not cause such a significant effect on the electricity production price than any change in EP, which is connected with the oil shale resource. As indicated above, the most significant charge exception concerning EP is that of the underground water industrial consumption charge.

In 2003, the charge for the industrial consumption of underground water by oil shale mining was 6.0 cents/m^3, for all other companies on average 48.0 cents/m^3. At the charge rate 6.0 cents, the oil shale resource production price would be 126.58 EEK per tonne and electricity production price 0.44 cents/kWh. If EP would have equal charge rates compared with other companies (on average 48 cents), the oil shale resource price would rise 5.1% (from 120.13 to 126.58 EEK) and the electricity generation price 1.5% (from 44 to 45 cents). The rise might not seem so important. The significance, however, becomes clear if we draw comparisons with the previous scenario. Equalizing the charge for only one model component will result in an increase which all the other annual rises would achieve together in four years' time.

Scenario "European Commission suggests"

The scenario is based on the European Commission's research work "Estimates of the marginal external costs of air pollution in Europe" (2002) and its suggested society's damage rates by some externalities. It is important to stress in the very beginning that currently this scenario has no practical application options within the Estonian context, as the price of electricity would become socially and economically unacceptably high. However, the scenario illustrates some important aspects of externality internalization, being therefore valuable.

The research analysis concentrated on the four components of environmental damage (sulphur dioxide, nitrogen oxides, volatile organic compounds, and particulates) and calculated respective damage to society. The European Union's average damage for three externalities, which are applicable in our model, are the following:
SO_2 — 81,120 EEK (5,200 EUR) per tonne,
NO_x — 65,520 EEK (4,200 EUR) per tonne,
Particulate matter — 218,400 EEK (14,000 EUR) per tonne.

The first question to arise is the accuracy and completeness of this data. Accuracy is a smaller concern, as the EU statistics are trustworthy enough, even though there might be some mistakes. Completeness is a more serious challenge — while calculating the damage, exclusions have been made for various reasons. The effects that were included were acute (short-term) and chronic (long-term) effects on mortality and morbidity, effects of SO_2 and acidity on materials used in buildings and other structures of no significant cultural value, effects on arable crop yield. The effects that were excluded were non-ozone effects on agriculture, change in air visibility (visual range), impact on ecosystems through exceeding the critical loads and critical levels (including forests, freshwater bodies, etc.), damage to cultural heritage, effects on certain materials (particularly rubber), macroeconomic effects of reduced crop yield and damage to building materials, altruistic effects of health impacts and, of course, effects not known yet. The reason for this is that the analysis lacks information for some stage in the impact pathway, from emission to impact to monetary damage, for example, dose response or valuation estimates. Other factors have not been taken into account, so those large figures represent only partial internalization.

The other important concerns are related to the issue of how applicable the data are within the Estonian context. The first one is about the alkaline soil of North-Eastern Estonia, which balances acid pollution. So the damage is insignificant. Another aspect is the price difference between the EU and Estonian averages — in an ‘average’ EU country the monetary values are much higher than in Estonia. The production price for electricity would be 2.6 EEK/kWh, which means a 5.9 times increase in the price compared with the base scenario. It is definitely not realistic in the current socio-economic context, at the same time, it provides food for thought when planning the long-term energy sector.

So application of these data in the model is more of illustrative nature, on the one hand, showing possible future charge rate trends, on the other, representing a challenge for conducting similar calculations in Estonia.

Conclusions

Energy generation, while being a crucial activity for every economy, is one of the most damaging industries for the environment in the Baltic Sea region. As the environmental problems are growing more serious in time, economists have to include environmental issues into their research in order to provide sound policy recommendations. This chapter dealt with the methodological and practical aspects of internalization of externalities for the Estonian energy sector. Both aspects involve some serious challenges, which have to be taken into account.

The methodological problems are connected with measuring the externalities and calculating their costs and benefits in monetary value. Still, some basic internalization can be carried out without going deeply into theoretical considerations. Such a simple calculation is demonstrated in the empirical part of the chapter. The model is based on the current environmental charge exceptions and possible developments in their levels. It is sensible to remove those exceptions as they send out wrong signals to energy producers without providing strong incentives for a more sustainable attitude. It is, however, much needed for the society in order to prosper in the long run. Also, the current exceptions create an unfair competitive advantage for those generating electricity from non-renewable sources.

Such a simple internalization calculation shows that the current energy prices fail to reflect the true environmental costs. From that conclusion, several policy options could be designed. Most environmentally integral — but unrealistic — would be a major increase in the charge rates. As the economy would not survive implementation of such high energy prices in a short time period, the other way to achieve long-term sustainable development would be prioritization of alternative energy sources. Taxation exceptions could be made for renewable energy producers in the same amount that oil shale energy producers are enjoying at the moment.

Another important aspect is conducting the same research on renewable energy sources in order to ascertain their real costs. It should not be taken for granted that they are cheaper for the society; however, their costs should be found out. Only then will it become possible to discover a sustainable path for the society and to achieve the desirable long-term goals.

The most advanced level of externality internalization would be performing a cost-benefit analysis for the Estonian energy sector. It would be very complicated — but the current situation expresses a clear need for it. The first step would be eliminating charge exceptions, after that more advanced techniques for externality internalization and monetary valuation could be used. Even if the final results were somewhat arguable (like, for instance, how to exactly measure the benefits of supply security offered by the domestic oil shale industry), the conducted analysis would definitely provide a firm enough basis for sound political decisions, making it more difficult for lobby groups to influence the process merely for their own interests. The results would be of interest to all the countries in the region, as their current situations possess many similarities.

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Appendix 1. The basic model.

EESTI PÕLEVKIVI Ltd (EP)	
Mined oil shale resource (t)	**12,199,000**
Total costs (EEK/t)	**1,465,454,464**
Environmental charges	80,599,919
Charge for the industrial consumption of underground water	11,499,960
Charge for oil shale mining rights	60,099,959
Other charges (waste water, waste, air pollution)	9,000,000
Other costs	1,384,854,545
Production price of the oil shale resource (EEK/t)	**120.13**
Used underground water during mining activities (m^3)	188,000,000
Average charge for the industrial consumption of underground water (EEK/m^3)	0.06
Oil shale resource charge (EEK/t)	4.93
Oil shale resource sales price for NEJ (EEK/t)	128.32
Amount of oil shale purchased by NEJ (t)	9,254,000
Total expenditure on oil shale by NEJ (EEK)	1,187,490,560

Appendix 1 (continued). The basic model.

NARVA ELEKTRIJAAMAD Ltd (NEJ)			
	EEK	t	charge (EEK/t)
TOTAL GOODS AND SERVICES	2,053,853,557		
Total purchases of electricity	183,000		
Total technological fuel	1,361,262,560		
Oil shale	1,187,490,560		
Other fuels	173,772,000.4		
Total environmental charges	166,269,997		
Water resource charge	26,324,996	1,020,000	25.81
Pollution charges	139,945,000		
CO_2	64,124,000	8,550,000	7.5
SO_2	4,794,000	60,000	79.9
No_x	1,843,000	10,000	184.3
Particulates	3,284,000	40,000	82.1
Heavy metals	264,014	101	2,614
Oil shale ash deposition	61,959,987	4,170,000	14.85
Waste deposition	670,000		
Water pollution	2,926,000		
Other	80,000		
Other costs	526,138,000		
TOTAL ACTIVITY COSTS	257,857,000		
TOTAL LABOUR COSTS	201,280,000		
TOTAL DEPRECIATION	374,656,000		
TOTAL BUSINESS COSTS	2,887,646,557		
Domestic electricity sales kWh	6,596,000,000		
Electricity price EEK/kWh	**0.44**		

Appendix 2. The results of the modelled scenarios.

	'Base scenario'	'2005–2006'
Environmental charges (EP) (EEK)	80,599,919	95,257,200
Oil shale production price (EEK/t)	120.13	121.33
Oil shale sales price for NEJ (EEK)	1,187,490,560	1,199,367,682
Environmental charges (NEJ) (EEK)	166,269,997	256,028,459
Production price of electricity (EEK/kWh)	0.44	0.48
	'Underground water'	**'European C'**
Environmental charges (EP) (EEK)	159,339,959	80,599,919
Oil shale production price (EEK/t)	126.58	120.13
Oil shale sales price for NEJ (EEK)	1,251,295,377	1,187,490.560
Environmental charges (NEJ) (EEK)	166,269,997	14,414,748,997
Production price of electricity (EEK/kWh)	0.45	2.6