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Preliminary Assessment of an Environmental Improvement Project for the Estonian Oil Shale Industry

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Preliminary Assessment of an Environmental Improvement Project for the Estonian Oil Shale Industry

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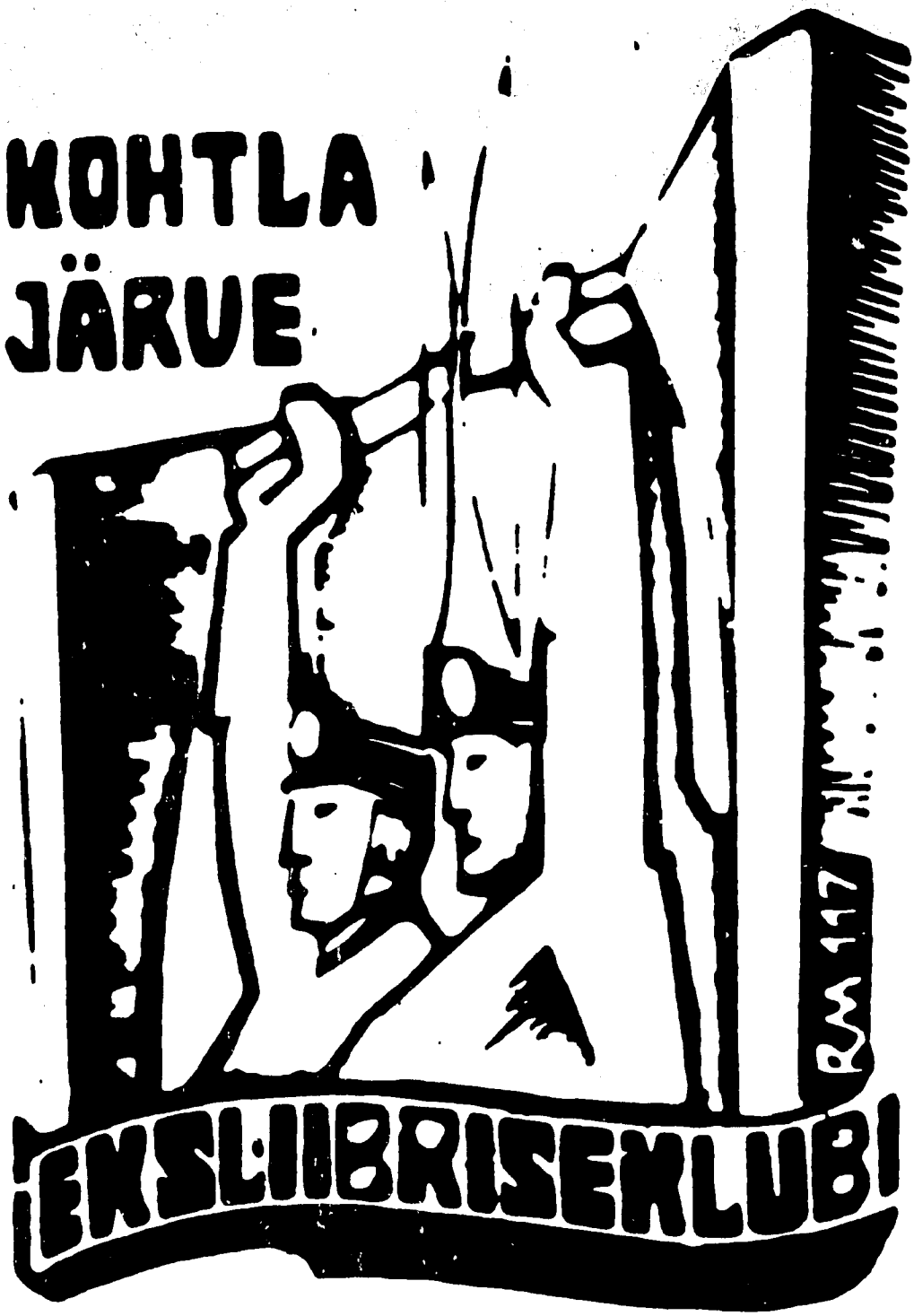
March 1994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EXECUTIVE SUMMARY

The project investigated the feasibility of the Estonian state-owned oil shale chemical firm, RAS Kiviter, as a demonstration project for the Environmental Action Program (EAP). The feasibility study sought to determine (1) whether the plant could be economically viable in a market economy over the medium term and the proposed demonstration project could contribute to that viability and (2) whether the project was environmentally "feasible," i.e., fulfilled the selection criteria provided in the Lucerne Conference document of the EAP.[1]

A. Findings: Economic and Environmental

A1. Assessment of Economic Prospects

The study team found that RAS Kiviter could be economically viable with the right resource pricing, management, and product marketing. However, for overriding political and security concerns, the Estonian Government has decided to keep the plant operating, at least for the short and medium terms.

If RAS Kiviter is lucky, it will survive the short term (the next five years), because it has access to a low-cost feedstock (oil shale at $3.50 per ton); it can sell fuel oil and oil products at western European prices; and it has no long-term debt. From a marketing standpoint, however, the enterprise is extremely vulnerable. The short-term prospects for RAS Kiviter depend on how quickly the enterprise can find new customers for its products and raise the average price of finished products above the equivalent of $60 per ton of shale oil. There is a danger that the enterprise will be caught between the rising cost of oil shale and the depressed level of heavy fuel oil prices in western Europe. On the other hand, there is an opportunity to earn profits from the processing of pyrolysis oils obtained from Russian chemical plants. The enterprise is in a weak competitive position because it has no marketing department and has lost many of its long-term customers in Russia, but this weakness is offset, in part, by the potential to profit from pyrolysis oils. The enterprise also should be able to earn profits from the sale of steam to Nitrofert.

In the medium term (up to 10 years), RAS Kiviter is less vulnerable to the loss of customers and markets, and the risk of failure is lower. The supply of pyrolysis oils will gradually decline as Russian enterprises build the capacity to process these oils, but RAS Kiviter will have time to develop the ability to manufacture products suited to western markets (including the domestic Estonian market). There is a significant upside potential, because the firm may be able to produce a gas oil or diesel fuel. In the medium term RAS Kiviter has time to adjust to a market economy, and the absence of long-term debt will strengthen its financial position.

[1] *Environmental Action Programme for Central and Easter Europe*, final draft, World Bank: Washington, D.C., 1994.

In the long term, RAS Kiviter's future will depend on oil prices and on the firm's ability to produce gas oil, diesel fuel, and other light products. If oil prices are high, RAS Kiviter may become extremely profitable. It will obtain oil shale at prices no higher than the value of shale as a substitute for coal in power generation. It will sell products that compete with petroleum products; if it can produce a diesel fuel it is practically guaranteed to be a commercial success. If oil prices are low, RAS Kiviter will be unable to attract capital investment and will gradually lose oil shale processing capacity as the oldest and least efficient retorts are shut down. In the worst-case scenario, however, RAS Kiviter is likely to experience a gradual decline rather than a sudden financial crisis.

A2. Assessment of Environmental Feasibility

The environmental study found a serious lack of detailed data in monitoring environmental conditions and methodological problems in gathering available data. However, the gross level, frequency, and variety of serious health threats from the many emissions points in the complex were such that the lack of data did not seriously hinder an analysis of environmental feasibility, i.e., relevance to the EAP. Significant opportunities for relatively low-cost environmental improvements were identified that would address worker health and safety and the health of populations near the plant. These included interventions in the following production plants: oil shale retort, dephenolization plant, pyrolysis gas processing, benzoic acid production and the power generation plant. Of special note, the team found an extraordinary amount of benzene being leaked into the atmosphere (18,811 tons/annum). Benzene is a known carcinogen that can be quite dangerous over long exposure periods.

The vast majority of environmental problems, like the economic problems, were found to be due mainly to poor management, lack of financial accountability, and lack of incentives for efficiency, cooperation, and initiative. A few measures were identified that would require significant investments in the plant ($5-10 million). However, most of the serious environmental health threats could be addressed through better management, reorganization, shutting down obsolete and unprofitable operations and equipment, and relatively low-cost or no-cost investments. A World Environment Center (WEC) Waste Minimization Demonstration program has already begun work in the latter area. This study concludes that the proposed project meets EAP criteria for selection as a demonstration project.

B. Assessment of Requisite Restructuring and Management Changes

The enterprise needs to improve drastically in marketing and accounting. Our assessment is that RAS Kiviter is living in the past while many other firms in Estonia are adjusting rapidly to the market economy. RAS Kiviter is fortunate to be located in a country where the economic growth forecasts are favorable and a large portion of the population is acquiring business skills. RAS Kiviter merely needs to catch up with the rest of the country in its management style; it does not need to be a leader and innovator.

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The necessary management changes are much more likely to happen if USAID assistance or other western donor assistance is provided. Grant funding can be "leveraged" by providing access to information that the firm can already afford to purchase. The problem is not that the enterprise is so unprofitable that it cannot be modernized, but rather that it is very conservative. There is no need for a large infusion of grant money or low-interest loans to pay for maintenance; there is simply a need to create a management structure in which there are rewards for good performance and penalties for poor performance. A well-crafted technical assistance program could give the organization the extra "push" it needs to implement reforms that plant managers have already identified.

C. Recommendations for Design of an Estonian EAP Project

The team recommends that USAID proceed with an assistance program for RAS Kiviter, under the framework of the EAP, with the following condition: the management of the enterprise must accept a medium-term objective of raising the revenue from the oil shale processing complex to at least $120 per ton of raw shale oil. Achieving this objective will require a strong commitment to marketing and to research and development of a distillate fuel oil suitable for export. Our assessment is that the $120 per ton price level is a reasonable target and can be achieved within three years.

Specific environmental recommendations for the plant as a whole and each relevant production department have been provided in Section III. Recommendations on the framework of an intervention project are provided in Section V.

SECTION I
BACKGROUND AND PURPOSE OF STUDY

A project identification mission to Estonia under the Environmental Action Program (EAP) for Central and Eastern Europe (CEE) was carried out 12-28 January 1994. The objective of the mission was to assess the economic and environmental feasibility of the Estonian oil shale chemical industry as a demonstration EAP project. The rationale is described below. The proposed project would address a serious environmental "hot spot" in northeast Estonia. This project identification mission also was undertaken in cooperation with an oil shale sector study, coordinated by the Nordic Investment Bank and the Ministry of Environment of Finland, both of which are members of the EAP Project Preparation Framework (see B2. below).

A. Relationship to USAID Country Environmental Strategy

The U.S. Government's assistance strategy for Estonia has, as one of its three principal "program goals," support for environmental protection. Within that overall goal, the strategy's program objective is to "support a sustainable transition to a market economy through environmental policy, institutional and investment assistance." Three mechanisms or targets are utilized to achieve that objective. The first is support for environmental economic policy reforms and their implementation. The second is strengthening government institutions related to the environment, and the third is to "promote the prevention of industrial pollution through demonstration investments."[1] As will be clear from its description in Section V, the proposed project clearly falls within this third target.

B. Relationship to the Environmental Action Program (EAP)

B1. Summary Description of the EAP

The EAP for Central and Eastern Europe was the outcome of a high-level meeting of ministers of environment in Lucerne, Switzerland, in April 1993. That meeting was intended to follow up both on the United Nations Conference on Environment and Development (UNCED) of 1992 and the perception that, despite the efforts of the CEE countries, more urgent efforts are needed to deal with the critical environmental problems of the region. The following discussion of the EAP is based upon the final draft report prepared by the World Bank.[2]

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[1] *United States SEED Act Assistance Strategy for Estonia, 1993-1995*, prepared by the U.S. Embassy, Tallinn, pp. 15-17.

[2] *Environmental Action Programme for Central and Eastern Europe*, Washington, D.C.: World Bank, 1994.

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The purpose of the EAP is to help CEE countries focus their resources and those of donor countries and international financial institutions (IFIs) on the most critical environmental health threats. The EAP approach is a triad of policy reform, institutional strengthening, and investments. A growing number of studies over the last five years has identified the most critical environmental health threats, especially in particular regions within countries, as follows:

- lead in air and soil from lead and zinc smelters and from transport;
- airborne dust from household furnaces, small-scale enterprises, power and heating plants, and metallurgical and other plants;
- sulphur dioxide and other gases, especially in combination with dust.

Other important health threats arise from agriculture-based, non-point source pollution of water, food, and water from toxic chemicals and heavy metals. Finally, the destruction and degradation of natural resource systems, loss of biodiversity, and degradation of wetlands, marine ecosystems, and similar habitats pose serious economic and quality-of-life problems.

The EAP process encourages CEE countries to develop national environmental action plans (NEAPs) to help set priorities and identify critical economic and environmental policy reforms, institutional development needs, and low-cost, high-payoff government expenditures and investments. In the CEE context, many of the policy and institutional reforms and investments needed to address the most critical environmental health threats will require actions and cooperation outside the sphere of traditional "environmental" activities, agencies, and organizations.

Many of the most serious environmental problems are a result of decades-long maldevelopment: the absence of market correcting mechanisms, the lack of public accountability, and the absence in enterprises of internal requirements for cost effectiveness and efficiency in the use of natural resources. Ultimately, integration into the wider European and world market economies will correct many of these problems. In the interim, however, public investment may still be required to address problems of enterprises that cannot be immediately closed or drastically restructured and to address environmental problems that persist even after transition to a market economy.

The Lucerne Agreement resulted in the formation of two interrelated entities. The first is a "Task Force" for the EAP, made up of CEE countries, donors, and IFIs, that is addressing the need to develop NEAPs and to encourage CEE countries to tackle policy reforms and institutional development. The second is a "project preparation framework" (PPF), the objective of which is to bring donors, IFIs, and CEE countries together to identify, select, and prepare projects for IFI environmental loans.

B2. Project Preparation Framework

The evolving PPF process. Since the start of the EAP, the project preparation framework has been implemented by means of a project preparation committee of donors and

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IFIs, which meets twice a year to discuss identified potential projects. More recently, some of the bilateral donors, notably the U.S. Government, have begun to field EAP project identification teams, which work with CEE counterparts to identify and select potential projects. The project preparation framework is still evolving in scope and procedure, in particular with respect to identifying realistic financing arrangements for projects and types of projects to be considered under the EAP. One of the most important priorities in selecting projects is to identify "win-win" proposals: projects that can be justified on economic and financial grounds alone but which also have significant environmental and/or energy efficiency benefits.

One of the fundamental problems facing the project preparation framework is its orientation towards preparing potential projects for IFI financing. First, the IFIs have a very high minimum threshold for individual loan projects; eligible projects usually require at least $5 million of financing. Many CEE governments are reluctant to provide sovereign guarantees for environmental loans, much less ones of that size. Second, many of the sources of the most serious pollution, e.g., large metallurgical, smelting, and chemical industries, power plants, and district heating plants, require major internal management changes, financial restructuring, and policy and regulatory reforms before they can be judged viable, never mind provide a reliable revenue stream for loan repayment. These same constraints, compounded on the industry side by a collapse of traditional markets for production, frequently result in a limited borrowing capacity. These problems argue for either phased incremental investment approaches or smaller investment packages, combining grants and loans.

Demonstration projects. While CEE countries, donors, and IFIs have little trouble identifying "traditional" environmental investment projects, such as wastewater treatment plants, the types of projects that pose the most significant environmental health risk may require innovative or unconventional approaches. Demonstration projects, usually grant-funded through bilateral donors, can be used, within a country or region, to identify the most successful and replicable types of environmental improvement project designs and approaches. This is especially important for public investments or state and private enterprises that face the kind of management and financial constraints described above.

C. Rationale for Identifying an Estonian Oil Shale Chemical Industry Project

The Estonian oil shale chemical industry, including RAS Kiviter, faces precisely the sort of structural management and financial problems described above. In fact, as described in the following chapters, these "non-environmental" problems have caused most of the plant's environmental health threats to the region. This feasibility study tries to assess the feasibility of combining a waste minimization approach to production with a complete restructuring of the management and financial accountability of the plant. This three-pronged approach offers the potential for the kind of "win-win" project endorsed by the EAP.

D. Socio-Political, Economic, and Environmental Factors Guiding the Selection of the Proposed Project

Northeast Estonia literally is dominated by the extraction, use, and disposal of oil shale and its waste products. Most of the oil shale (83 percent) was used to generate electricity; the remainder (17 percent) was used in the oil shale chemical industry. Estonia produces considerably more electricity than it needs. In 1990, in fact, about 48 percent of production was exported (mainly to Latvia and St. Petersburg).[3] By 1992, however, this export market had dropped substantially because of a big drop in electricity demand in the countries of the region.

Socio-political. Estonia's pre-war economy was largely agricultural. Following the war, during the Soviet occupation in the 1950s and 1960s, the northeast section of the country was industrialized and a large number of non-ethnic Estonians (mainly Russians) were brought in to staff the factories. Many of these industries and the electric power infrastructure relied on the extraction of oil shale. Most Estonian Russians remain attached to these industries since there is little alternative employment for them in the country and prospects in the former Soviet Union are far worse. Hence, with the collapse of the Soviet Union and Estonian independence, the position of the mainly Russian immigrants has become a difficult socio-political issue internally and, to some extent, between Estonia and Russia. Russia has justified the slowdown in the withdrawal of its troops by the need to protect its former citizens in the "near-abroad" countries, including Estonia. Thus, for socio-political reasons, the Estonian government is, for the medium term, committed to keeping oil shale industries going to the extent possible.

Economic. The development of the northeast Estonian economy based on oil shale extraction and use during the Soviet era was not founded on any market or comparative advantage calculation. It is doubtful whether much of the mining, manufacturing, and power plants dependent upon oil shale would have been developed under a market regime. Nevertheless, the capital investment and infrastructure is in place and, for Estonia, oil shale products (chemicals and power) are among its most important foreign exchange earners. Thus, the Estonian government depends on the continuing operation of oil shale-based industries, at least in the short-to-medium term, for economic reasons. Hence, making these industries more efficient and profitable is a major government priority.[4]

Environmental. Oil shale extraction, use and disposal produces serious environmental problems in all environmental media. Due to its relatively low extracted energy value, oil shale produces enormous amounts of solid waste in the form of clinker, ash, and ore residues. Water pollution arises from the leaching of toxic agents from exposed

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[3] "Part III-Appraisal of Estonian Air Quality," Vol. 3 of *Supplemental Environmental Studies in Estonia*, prepared by Plancenter, Ltd., Ministry of Environment, Estonia and Ekono Environmental Technology, August 1991, p. 82.

[4] From an interview with the executive manager of the Estonian Ministry of Economy's Chemical Holding Group, Tallinn, January 1994.

oil shale waste landfills and from by-products of oil shale use (in both chemistry and energy). Oil shale combustion and refining also produce large amounts of pollutants.

The two giant Narva power plants ("Estonia" and "Baltic") produce two-thirds of the SO_2 and dust emissions in Estonia. Oil shale has a very high sulphur content, which fortunately is partly mitigated by a high calcium (Ca) content that may absorb as much as 65-72 percent of the SO_2 during combustion. Nevertheless, both plants annually produce as much as 180,000 tons of SO_2 and large amounts of other air pollutants such as NOx and CO_2.[5] Particulates and SO_2 are serious problems mainly from the energy sector (and these emissions, on a per capita basis, are greater than those for Poland and five times those for Sweden). In contrast, heavy metal emissions, by air, are also a serious problem but appear to be mainly due to industrial sources.[6]

A Nordic heavy metal atmospheric deposition study carried out in 1992[7] found significantly elevated levels of cadmium, chromium, iron, and vanadium in the areas of Kohtla-Järve and Narva, while lead, nickel, and zinc levels were the same for southern Finland. The study concluded that this deposition composition and rate were directly related to the use of oil shale for energy and industrial products.[8]

In the industrial towns of Kohtla-Järve (where RAS Kiviter is located) and Kivioli, ammonia, formaldehyde, benzopyrene, and phenols often exceeded the Soviet maximum permitted concentrations (MPC) as did 10 percent of the H_2S values.[9]

The health effects of air pollution have been studied by Estonian authorities. The conclusions of those studies suggest that clear associations exist, though are difficult to precisely quantify, between industrial and power plant emissions and acute and chronic respiratory and vascular diseases. High associations between acute and chronic respiratory and cardiovascular diseases and oil shale were found in children in the region surrounding these plants and oil shale plant workers. Acute respiratory problem reports were higher on days when winds were unfavorable and in the city of Kohtla-Järve.[10]

Ecological effects, particularly on vegetation, showed the worst effects in the areas around the industrial districts. Acidification from the Narva power plants air emissions was also a problem for all of Estonia's international neighbors. The Estonian Government, the

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[5] "Part III-Appraisal of Estonian Air Quality," op. cit., p. 84.

[6] Ibid., p. 82

[7] "Atmospheric Heavy Metal Deposition in Northern Europe, 1990," prepared for the Nordic Council of Ministers, by Nord (n.p.: 1991), p. 12.

[8] "Part III-Appraisal of Estonian Air Quality," op. cit., p. 97.

[9] Ibid., p. 94.

[10] Ibid., p. 94.

public, and NGOs, as well as Estonia's neighbors, regard the prevention of oil shale based pollution and the clean up of existing polluted sites to be major priorities. Hence, attention to the oil shale sector is also justified on environmental grounds.

E. Current USAID Environmental Activities in Estonia

USAID has three environmental activities under way in Estonia: the World Environment Center's (WEC) Industrial Environmental Efficiency Program, the Harvard Institute for International Development's Environmental Economic Policy Program, and the Environmental Protection Agency's institutional strengthening program. All three of these activities have had or are undertaking assistance in addressing one or more aspects of the oil shale problem in Estonia. The Harvard program has looked at natural resource taxation and pricing issues, including oil shale mining. EPA is undertaking a demonstration environmental impact assessment of oil shale mining and reclamation as well as assistance in the more efficient use of oil shale for the chemical industry. WEC is undertaking a 12-month waste minimization demonstration at the RAS Kiviter oil shale refinery in Kohtla-Järve.

The WEC program is the one most immediately relevant to the proposed project. WEC has a one-year waste minimization demonstration project under way at RAS Kiviter of Kohtla-Järve, which, until late last year was known as "Polevkivikeemia."[11] The project consists of a variety of waste recovery, recycling, and reduction activities in the dephenolization plant and at the oil shale retort plant.[12] A series of waste minimization activities is being developed for the benzoic acid plant as well. WEC's activities include organization of plant-wide waste minimization committees, intensive technical assistance through these bodies, training, monitoring of progress and selective, low-cost provision of instrumentation, and equipment related to waste minimization and monitoring.

F. Activities of Other Donors

The activities described below include only donor activities in the Ida-Virumaa province, which is the largest jurisdiction of the Northeast.[13] The Finns are among the more active donors in Northeast Estonia. They are funding a full-scale pilot desulphurization plant for one of the Narva oil shale power plants and the design for a wastewater treatment plant for the municipality of Kohtla-Järve. The Finns also have provided some assistance in technology development for the Kohtla-Järve plant in cooperation with the Estonian Oil Shale Research Institute (apparently the only institute of its kind in the world). RAS Kiviter also

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[11] This plant was also known as "Slantsechim" and, in English, the "Oil Shale Processing Association of Kohtla-Jarve."

[12] Robert S. Kapner, "Trip Report on Visit to Oil Shale Processing Association, Kohtla-Jarve, Estonia, May 31-June 4, 1993," New York: WEC, 1993.

[13] "Environmental Projects in Estonia Implemented with Foreign Assistance," prepared by Ministry of the Environment, Estonia, Tallinn, 1993.

has received some assistance from the Germans, a cooperative project with Hamburg University, in pollution prevention.

The Swedes and Finns are cooperating on assistance in dealing with radiation leakage in the Sillamäe metallurgical plant. ECPHARE has two activities in the project region. One is an investigation on the use of oil shale mine waters for municipal and/or industrial water supplies and the other is a demonstration, low cost, oil shale mining land reclamation project. The European Bank for Reconstruction and Development is developing a loan project for provision of water supplies to small municipalities as part of the privatization of water and sewerage enterprises.[14] One of the candidate municipalities is Kivioli, which is in Ida-Virumaa and also has a small oil shale refinery ("Polevkivikeemiatehas Kivioli").

Given that the Nordic countries are addressing the problems of the Narva power plants, the rare earth metallurgical plant at Sillamäe and, with the EBRD, municipal water supplies and wastewater treatment, an appropriate focus for USAID's Estonia "Hot Spot" project should be the oil shale chemistry plants in Kohtla-Järve and Kivioli. Such a focus would also be in line with the EAP's call for more investment projects addressing serious health threats from air pollution and heavy metals.

G. Structure of the Feasibility Study

As noted above, the rationale for proposing a demonstration project in the oil shale chemical industry in Estonia was to demonstrate the potential for achieving significant environmental improvements *and* economic benefits to the firm and the surrounding region. It would address not only the visible "environmental" problems of the plant but the underlying management and financial, i.e., structural problems that have given rise to or exacerbated environmental pollution problems. Hence, this feasibility study includes an assessment of the economic feasibility of the project. In addition to this design rationale, the economic feasibility study has been undertaken to determine whether the subject firm had sufficient economic potential to warrant even grant funds for a demonstration project. For these reasons, the study is organized to address both economic and the environmental issues.

Section II, Economic and Financial Feasibility, examines the viability of a proposed framework for a demonstration project that was agreed on by the study team and the management of RAS Kiviter during the first days of the team's visit. Section III examines environmental issues to be addressed by the project, with special attention to the environmental health threats, in accordance with the criteria of the EAP project preparation framework. Section IV provides an overview of the Estonian Government's environmental management system and its past interaction with the plant. The proposed project will include assistance in helping the local environmental board and the RAS Kiviter plant move towards an effective compliance regime. The last section of the report, Section V, summarizes the project framework and the next steps in project preparation and implementation.

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[14] Timo Makela, European Bank for Reconstruction and Development, personal communication.

SECTION II
ECONOMIC AND FINANCIAL FEASIBILITY OF THE PROJECT

In this section, we present an assessment of the economic and financial feasibility of the project based on the information obtained in a project identification mission conducted in January 1994.

A. Definition of the Project and Study Scope

At the start of the project identification mission, the project was not clearly defined. On January 14 none of the organizations contacted during the mission had a specific proposal for the use of either bilateral grants or multilateral development bank loans to assist RAS Kiviter. Therefore, it was not possible to develop a data request for a particular type of analysis, such as a discounted cash flow analysis or cost-benefit analysis. By Friday, January 21, however, the U.S. team, working with the plant's management, had prepared a proposal to submit to the Ministry of Environment, the Ministry of Economy, and RAS Kiviter.

Under the terms of this proposal, USAID would provide about $3 million in grant funding for technical assistance, training, and "investment" as shown in the table below. Approximately $1 million would be devoted to technical assistance and training and $2 million to investment. The term "investment" in this context refers to the delivery of something tangible—equipment, computers, books, software—rather than "investment" in the usual economic sense—the purchase of debt or equity issued by a private company. This project is intended to be consistent with the framework of the Environmental Action Programme (EAP) for central and eastern Europe, but the decision to proceed will be made solely by AID on a bilateral basis and is not contingent on any form of loan, equity investment in a joint venture, or privatization of RAS Kiviter.[1] Although there could be a follow-on project involving loans or equity investments, the project defined here would be funded simply by USAID grant funds.

Hence, several types of financial analysis are *not* needed in this study. If the project involved a loan to RAS Kiviter, it would be necessary to determine the ability of the firm to repay the loan. If the project involved a joint venture, it would be necessary to determine the ability of RAS Kiviter to attract a joint venture partner and to estimate the amount of capital such a partner would provide. If the project involved privatization of RAS Kiviter, it would be necessary to determine the ability of the firm to raise capital through the sale of stock or the issuance of new stock. None of these determinations is required for USAID to make a decision.

[1] Privatization may be defined as an equity investment by shareholders other than the governments and state-owned enterprises.

B. Description of the Proposed Project

The proposed project is summarized in table form below:

	Technology/Production Process	Management/ Restructuring	Financial
Technical Assistance	- continue waste minimization - identify technology priorities - reduce energy losses, recover waste heat, and increase electrical generation	- business planning - marketing	- financial reporting/ accounting - cash management
Training	- process control simulation - tendering and specifications - ISO 9000	- business planning - leadership/ motivation - team building - problem solving/ decision making - environmental management - communication - maintenance	- financial management software - cost accounting - reporting and auditing - documents to issue debt and capital
Investment	- GC gas analyzer - process simulation computer - process controls/ dephenolization - steam turbines - upgrade benzene storage/ transfer	- reference materials - study tours - publications - translation support - publicity	- computer accounting software

C. Definition of Feasibility Criteria

What does it mean for a grant-funded project to be "economically and financially feasible?" What criteria should be used to distinguish feasible from infeasible projects? To

answer these questions we must distinguish economic/financial criteria from other criteria. The feasibility of a grant-funded AID assistance project has four aspects:[2]

- **Economic and financial feasibility.** A determination that the counterpart organization will be able to cover the cost of its participation in the proposed assistance program, and will remain in operation long enough to capture expected benefits. For example, to test the feasibility of a program to purchase equipment that must be installed at the recipient's expense, there should be a determination that the recipients will be able to pay for the installation.

- **Technical feasibility.** A determination that it is technically possible to accomplish the proposed activity (if the budget and the schedule are not constrained). For example, one might determine that it is possible to transfer certain computer software because the host country counterparts already have the necessary hardware.

- **Budget and schedule feasibility.** A determination that the proposed activities can be accomplished by USAID and other donor organizations within the budget and timetable proposed for the project. This is a determination that the estimated costs and the projected schedule are realistic from the donor's perspective.

- **Political feasibility.** A determination that over the implementation period, the project is likely to receive approval from the U.S. government and from the national or local governments whose cooperation is essential to the project's success. Political feasibility is related to the various government agencies' perceptions about the feasibility of the project. If a project requires the active participation of certain government ministries or authorities, it is necessary to determine whether these organizations will continue to exist during the implementation period.

There is some overlap among these criteria. In particular, political feasibility can have a strong impact on economic feasibility because a politically unpopular industry can be taxed, fined, and regulated out of existence. Conversely, economically inviable plants may be subsidized heavily because of a political imperative to maintain employment and the local economy. The economic viability of any state-owned enterprise is ultimately dependent on the political policies of the government that owns it. The following discussion is focused mainly on economic and financial feasibility but it inevitably touches on political issues.

The determination of economic and financial feasibility may be made by (1) donor agencies such as USAID, (2) the government of the country receiving assistance, (3) the enterprise receiving assistance, or (4) organizations that are opposed to the assistance

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[2] This discussion may be relevant to other projects in the Environmental Action Programme for Central and Eastern Europe. Some of the enterprises that are given a high priority from an environmental standpoint (i.e., the worst polluters) will not be in a strong enough financial position to qualify for loans from international financial institutions or to attract private sector capital. These enterprises may need grant-funded assistance to get to the point where they can attract debt and equity.

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program, such as local NGOs that want to shut down the enterprises viewed as the worst polluters. To identify the criteria used to measure economic and financial feasibility, we must distinguish political arguments from more objective criteria. In Estonia, for example, an opponent of public sector assistance to RAS Kiviter may argue that it is a waste of money to support a state-owned enterprise that is a relic of the Soviet economy and an organization that is incapable of paying for pollution control expenses. If this argument is made by a local environmental group, it may be considered an indicator of political feasibility rather than economic and financial feasibility. If this argument is made by the owner of the enterprise—the Ministry of Economy—it reflects the owner's willingness to invest in the enterprise, and therefore may be considered a measure of economic and financial feasibility.

A determination of the economic and financial feasibility of the RAS Kiviter project may be based on the following considerations:

1. Viability of RAS Kiviter. For the proposed project to be implemented, RAS Kiviter or its successors must be able to remain in operation long enough to receive the proposed technical assistance, training, and investment. The proposed program would span a three-year period from approximately October 1994 through October 1997. Thus a prerequisite for proceeding with the project is a determination that RAS Kiviter or its successor enterprises will be viable for at least three years.

The importance of the long-term viability of the enterprise also depends on the type of assistance provided. There are some categories of equipment and training—for example, the delivery of accounting software and training in accounting—that may be perceived (by USAID and by the Estonian participants) as beneficial regardless of the long-term survival of the enterprise. A general characteristic of this type of equipment is that it is movable and has a high resale value. Other types of equipment are worth purchasing only if the enterprise is likely to remain in operation until the equipment is fully depreciated and the rate of return on investment is acceptable. In the absence of specific guidelines we assume that stationary, plant-specific equipment should be depreciated over at least 10 years. Therefore a prerequisite for the purchase of stationary, plant-specific equipment is a determination that the plant will be viable for at least 10 years.

2. Viability of the Estonian oil shale mining industry. The oil shale processing complex at RAS Kiviter is entirely dependent on the Estonian oil shale mining industry for feedstock. If the mines are not viable, the oil shale chemical industry will not be viable; it will be forced to shut down. From RAS Kiviter's perspective, the optimal price of oil shale is the lowest price at which the supply of coarse shale is adequate to meet RAS Kiviter's needs at maximum capacity utilization, i.e., around 2 million tons per year. A price below this level would improve the short-term profitability of RAS Kiviter but lead to losses in the future, as a result of low capacity utilization. RAS Kiviter has high fixed costs (including labor costs) that make it important to maintain a high level of capacity utilization. Of course, a very low price would force the oil shale processing complex to shut down for lack of feedstock.

Among the four profit centers of the company, two are dependent on oil shale mining. The oil shale processing complex is entirely dependent on the viability of the mines, and the production of urea resins and phenol formaldehyde resins is largely dependent on the phenol waters obtained from the oil shale processing complex. The other two divisions (aromatic hydrocarbons and benzoic acid) do not depend on the oil shale industry; pyrolysis oils and other feedstocks are obtained from Russia.

3. Ability of RAS Kiviter to pay for programs with environmental benefits. Because this project is part of the Environmental Action Program, it must be designed to support activities that have environmental benefits. Some forms of pollution control and waste management will increase production costs; these may be called "win-lose" activities because the environmental gain results in a financial loss. If "win-lose" activities are part of the program, it is important to determine whether RAS Kiviter will be able to pay the pollution control costs. For example, if investments in dephenolization are proposed but there is no market for phenols and their chemical derivatives, the economic feasibility of dephenolization will depend on RAS Kiviter's ability to pay for it. To fund "win-lose" activities it is necessary to show that RAS Kiviter will not only survive but prosper, generating enough cash flow to cover environmental costs in addition to traditional production costs.

Other activities will have both environmental and financial benefits that offer the potential for a "win-win" situation. For example, a marketing initiative designed to find new buyers for phenol resins may result indirectly in a reduction in the level of phenols discharged to the air, water, and soil. Similarly, the export of wood impregnation oil would increase RAS Kiviter's revenues but it may also displace impregnation oils made from coal tars that are more toxic and carcinogenic. A marketing program for sulfur, in combination with taxes or standards designed to reduce sulfur dioxide emissions, would result in a lower sulfur content of fuel oil sold in Estonia. The implementation of an ISO 9000 program would result in higher revenues, but it might also reduce human exposure to toxic chemicals that would otherwise be spread in the form of contaminants.

At this point it is unclear whether "win-lose" or "win-win" activities will dominate the proposed project. The greater the proportion of "win-win" activities, the easier it is to demonstrate the economic and financial feasibility of the project. One of the policy issues in the project design is whether it should be limited to "win-win" activities.

4. Job security of potential trainees. To implement a training program, it is necessary to have a reasonable amount of continuity in the employment of the people trained. If the trainees cannot keep their jobs long enough to participate in several seminars (provided by several USAID missions), it will be impossible to provide training on complex issues. Moreover, if trainees are in imminent danger of losing their jobs, they may be unable to give the program the attention it requires; their highest priority will be preserving their jobs or finding new ones. Therefore the training component of the project may be considered feasible if USAID can determine that the process of privatization, restructuring, and/or downsizing over the three-year life of the program will not create so much turmoil that the enterprise is unable to receive USAID assistance.

It is possible that the economic and financial feasibility of "soft" investments in training will be difficult to demonstrate even when the economic and financial feasibility of "hard" investments in equipment can be demonstrated. Although it would not be reasonable to try to make a determination about the job security of individual counterparts, it is possible to assess the prospects for job turnover and job loss in the enterprise as a whole, based on the profitability of the enterprise and the government's plans for economic restructuring.

A related issue affecting the feasibility of training is the cooperation of plant management (and government directors) in ensuring that the people trained are allowed to practice what they have been taught and are supported in their efforts over an adequate period of time.

5. Economic and financial criteria used by USAID to rank alternative projects. Presumably USAID must strike a balance between giving assistance to the "neediest" enterprises—the ones that are least capable of implementing an environmental protection program without foreign assistance—and the "most promising" enterprises—the ones that are most likely to achieve success and demonstrate the effectiveness of USAID assistance. If USAID policy favors the "neediest," the enterprise does not necessarily have to be healthy to make the project feasible. If USAID favors the "most promising," the enterprise will have to be economically healthy.

At this point, USAID has not made a policy decision to focus on either the "neediest" enterprises or on the "most promising" enterprises. We therefore assume that USAID policy is neutral and that criteria (1) through (4) are far more important than criterion (5).

RAS Kiviter is the only major oil shale chemical plant in central and eastern Europe. If it is to be ranked among other enterprises, therefore, it must be compared with enterprises in other industries and perhaps in other countries. The project team was not given a list of alternative enterprises or alternative projects to be compared with RAS Kiviter.

6. Economic and financial criteria used by the government of Estonia to screen foreign assistance programs. The government of Estonia is the owner of the RAS Kiviter plant, as well as the regulatory authority. The government has the right to reject offers of assistance that do not meet its screening criteria.

The basic policy decision facing the government is whether to take a passive or active role. A passive role would be to welcome any grant-funded project with a net benefit to Estonia and to entrust the management of the enterprise with the task of screening out other projects. An active role would be to take responsibility for allocating foreign assistance funds to maximize the net benefit to Estonia.

Our understanding is that the Ministry of Economy will take a passive role. One of the principal reasons is the small size of the Ministry staff. Although Ministry officials are interested in obtaining studies that assess the economic health of the oil shale mining industry and the oil shale chemical industry, they do not have time to establish economic feasibility criteria for grant-funded projects.

7. Consistency with RAS Kiviter's business objectives. To be economically and financially feasible, an assistance project must be consistent with the business objectives of the enterprise. For example, there is no point in investing in pollution control associated with resorcinol production unless the company decides to start producing resorcinols. This production segment was shut down in 1993.

We assume that this feasibility criterion does not require special consideration because it is implicit in the project design process. The management of RAS Kiviter will be involved in every phase of project design and will have the opportunity to reject proposed activities that are inconsistent with its business objectives.

At the end of this chapter, we assess economic prospects for RAS Kiviter. This assessment covers criteria (1), (3) and (4) above—viability, ability to pay for programs, and job security. We also estimate the oil shale price needed to ensure the viability of the oil shale industry. This estimate addresses criterion (2) above. We do not address criteria (5), (6), or (7) for reasons stated above—USAID has not specified selection criteria, the government of Estonia appears to be taking a passive role, and the project design process will make the project consistent with RAS Kiviter's business objectives.

D. Macroeconomic Importance of the Oil Shale Chemical Industry

To assess the economic feasibility of the proposed project, the viability of RAS Kiviter and the Estonian oil shale mining industry must be examined. Lest the reader have the impression that this is simply a microeconomic analysis, the importance of these issues to the Estonian economy must be noted.

Oil shale is important to Estonia because the country has a very serious energy security problem. Estonia has no commercial production of oil, natural gas, or coal. It has no nuclear plants and no hydroelectric plants. It has modest windpower potential and extremely limited solar energy potential during the winter. It has no major facilities for storing natural gas, for which it is entirely dependent on Russia, which is not a reliable supplier. Until 1991, the country was entirely dependent on Russia for petroleum product supplies, but has largely switched to western sources. Its renewable energy resources consist primarily of wood and peat, but wood is needed for the forest products industry.

Oil shale is the only fossil fuel resource in Estonia. The country has 1.6 billion tons of oil shale reserves, enough to last 110 years at today's production rate (14.5 million tons per year). Existing mines have 600 million tons of reserves, enough to last 40 years at today's production rate.[3] Most of the electric power consumed in Estonia is generated from oil shale. A portion of the electric power is used to provide heat, although there are district heating systems designed to use natural gas and residual fuel oil. The cost of natural gas and heavy fuel oil required to operate district heating systems is very high relative to household income, and therefore electricity is regarded as a backup heat source.

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[3] Jaakko Pöyry, *Study on the Optimum Development of the Estonian Oil Shale Mining Operations and Retorting Industry*,. Draft, December 28, 1993, and overhead transparencies based on this report and presented in Tallinn on January 14, 1994.

In simple terms, Estonia can pursue three options with its oil shale:

- Generate electricity, so that the country does not have to import electricity and can minimize its dependence on imported fuels for electric generation.

- Produce heavy fuel oil, distillate oil, and possibly even diesel fuel, a low-Btu gas, and a low-octane gasoline, so that the country can reduce its dependence on imported petroleum products and imported natural gas.

- Produce products that can be exported to earn the foreign exchange needed to purchase imported fuels and energy. Among the products that can be exported are electrode coke, resins, specialized oil products, and petrochemicals. In theory, it would be possible to produce and export a synthetic crude oil.

In short, oil shale is used to produce energy or to pay for imported energy. In 1993, about 12.1 million tons of shale (83 percent) were used in power generation and 2.4 million tons (17 percent) were used in oil shale chemistry. If a greater portion of annual shale production were used to manufacture oil or chemicals instead of electricity, Estonia would have to import electricity or fuels for electric generation. The cost of imported fuel to Estonia is so high that the oil shale chemical industry may be a means of earning the foreign exchange needed to import fuel and energy.

The economic viability of RAS Kiviter is a measure of Estonia's ability to pursue the second option listed above (domestic fuels) or the third option (export earnings). Today RAS Kiviter is one of only two chemical plants capable of processing Estonian oil shale to produce a variety of chemicals and specialized oil products (the other, RAS Kivioli, in fact has only a modest capacity in this regard and may soon be brought under Kiviter's management.) In the pre-Soviet period of Estonian independence (1918-1940) and during the German occupation (1941-1944), oil shale was used to produce domestic fuels.[4] In the Soviet period (1945-1991), oil shale was used to produce chemicals and specialized oil products for "export" to other Soviet republics. In 1993 RAS Kiviter was still producing specialized oils (for example, a wood impregnation oil) but selling them as boiler fuels because it was no longer possible to sell them to Russia or other republics of the former Soviet Union. RAS Kiviter is now in a transitional phase in which it is unclear whether the optimal strategy is to produce domestic fuels or exportable products. If a cogeneration plant were built at RAS Kiviter, it could also contribute to the first option (electricity generation).

From an energy security perspective, it is important for Estonia to keep all of its options open. From a domestic political perspective, it is important to promote employment and reduce job losses in the northeastern portion of Estonia, where unemployment is high and the majority of the population is ethnic Russian. Thus the economic viability of RAS

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[4] For a history of Estonian oil shale, see A.V. Kozhevnikov, "On the History of Oil Shale Chemical Processing in Russia and in Estonia," *Oil Shale* 9,4, 1992, pp. 361-372; Enno Reinsalu, "Põlevkivi Kaevandamise Ja Energeetilese Kasutamise Majanduslikud Aspektid," paper presented at the Estonian-Finnish Joint Seminar on the Estonian Energy Economy, Tallinn, September 23-24, 1994.

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Kiviter is almost mandated by political circumstances. It would be politically difficult for the government of Estonia to state that RAS Kiviter is not economically viable. Arguably the question facing the Ministry of Economy is "How do we ensure that RAS Kiviter will continue to be a viable enterprise?" The least attractive solution is to pay the oil shale miners and oil shale chemical workers very low wages. Our understanding is that the Ministry is searching for more attractive solutions and would welcome USAID assistance in identifying ways to raise the economic productivity of the workers and the profitability of the enterprise.

E. Description of the Organization of RAS Kiviter

In the following paragraphs, the enterprise is described from a business management perspective.

E1. Component Plants

All of the operations of RAS Kiviter are located in Kohtla-Järve. The fertilizer plant that was a part of Pólevkivikeemia has been organized as a separate enterprise, Nitrofert. Because natural gas is the principal feedstock for the fertilizer plant and not for the other operations, it was relatively simple to divide Pólevkivikeemia into these two enterprises. In a market economy this separation would have been accomplished when fertilizer production was started; the fertilizer division would have been organized as a separate profit center. In the Soviet period, however, the chemical operations at Kohtla-Järve were consolidated in a single enterprise whose function was to meet production quotas, not to generate profits. In 1991 the enterprise was known as the Production Amalgamation "Oil Shale Chemistry."[5] From 1975 to 1989 it was subordinated to the Ministry of Oil-Processing and Petrochemical Industry.[6] In this period there was no real need to identify the component plants of the production amalgamation.

On January 21, 1994, the management of RAS Kiviter was planning to introduce a new accounting procedure to measure separate revenues and expenses for four profit centers:

- **Oil shale processing complex.** The primary feedstock for this division is raw shale, which is transported from the mines in open railroad cars.
- **Production of aromatic hydrocarbons.** The primary feedstock for this division is pyrolysis oils, which are produced at petrochemical plants in Russia.
- **Urea resins and phenol formaldehyde resins.** The primary feedstock for this division is the phenol water obtained as a byproduct of oil shale processing. RAS Kiviter plans to form a joint venture for this division.

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[5] Koidu Tenno and Veena Räägel, *Estonian Oil Shale*, Tallinn: Informare, 1991, p. 13.

[6] E. Reinsalu, "Economical Development of Estonian Oil Shale Industry," *Oil Shale* 8,3, 1991: 277. See Annex E. Our understanding is that this arrangement lasted until Estonia became independent.

- **Production of benzoic acid.** The primary feedstock for this division is the benzene produced by the aromatic hydrocarbon division.

These four divisions of the company may be regarded as its component plants. According to Lea Kivimaa (principal in the Department of Planning and Economics), the oil shale processing complex and the production of aromatic hydrocarbons are less profitable than the other two divisions.

To create the four profit centers, RAS Kiviter is changing its legal structure. At present it is a single legal entity. Plans are to transform it into a holding company with four subsidiaries, each of which will be a legal entity. One of these subsidiaries—the urea resin and formaldehyde resin company—is planning to form a joint venture. We do not know whether the intended joint venture partner is Russian (to secure feedstocks) or western (to secure product sales). Our impression is that this joint venture proposal is the stimulus to the formation of separate companies (as opposed to separate operating divisions of a single legal entity). It is also possible that restructuring is regarded by the Ministry of Economy as the most effective way to discourage internal transfers that subsidize unprofitable lines of business.

Our understanding is that many questions regarding cost allocation have not been resolved, for example:

- Allocation of environmental control costs and pollution taxes between upstream and downstream processes. A pollutant may be produced upstream, but the control cost or tax may be imposed on the downstream process.

- Allocation of the labor cost associated with workers who are on paid leave because the plant does not want to lay off large numbers of employees.

- Allocation of the cost of dephenolization, which can be viewed as either an environmental control cost (associated with the oil shale complex) or a production cost (associated with the urea resins and phenol formaldehyde resins).

- Allocation of costs to intermediate chemical products for which there is no market outside the plant.

- Determination of the price that should be applied to steam delivered by the oil shale complex to the other divisions of the enterprise. The oil shale complex uses 50 percent of the steam it generates and sells the remainder to Nitrofert and to other divisions of RAS Kiviter.

The project team requested but did not receive a diagram showing production processes at RAS Kiviter.

F. Principal Current Products

RAS Kiviter is going through a transition in which the Russian markets for many of its products have been lost and the possibilities to sell these products to western companies have not been fully explored. A substance that was once a valuable product may now become a residue or waste product. Therefore, the definition of a "product" is somewhat subjective; it is difficult to predict the ultimate disposition of substances that are added to inventories rather than delivered to customers.

From a financial standpoint, one of the most important products of the oil shale complex is steam, which is produced by burning low-cal (i.e., low-Btu) "retort gas" that is obtained as a byproduct of the retorting process.[7] It is assigned a price of 110 EEK per Gcal, which is equivalent to $2.05 per MMBtu (assuming 13.5 EEK/$ and 0.252 Gcal/MMBtu). Because 1.86 Gcal of steam is produced from every ton of shale oil, the steam may be valued internally at 200 EEK per ton of shale oil. If 50 percent of the steam is sold, this will generate a revenue of 100 EEK per ton of shale oil. The January 1994 production cost of shale oil is reported by RAS Kiviter as 800 EEK per ton, and therefore a revenue source of 100 EEK per ton is significant.

The project team requested and received data that indicate that the total production in 1993 was about 326,500 metric tons (see Exhibit II.1 on the following page). Because prices per ton vary widely and sales are unstable, the percentage distribution of product by weight is not a good indication of the percentage distribution by sales revenue.

G. Employment Structure

The majority of the employees of RAS Kiviter are chemical engineers, other engineers, or skilled in production operations. Very few employees are involved in marketing, corporate planning, accounting, personnel relations, and management in the headquarters of the enterprise. We did not request statistical data on the work force, so we have no data on the employment structure of RAS Kiviter.

The enterprise has a policy of trying to retain workers by offering paid leave and rotating leave among workers. The stated objective of this policy is to retain a skilled work force during a temporary transition period in which the need for personnel is reduced because sales to Russian enterprises are reduced relative to the 1990 level. From the standpoint of the Ministry of Economy it may also be desirable to minimize unemployment so that social unrest in northwestern Estonia is not exacerbated. The population of this region and the workers at RAS Kiviter are predominately ethnic Russians.

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[7] If the objective of oil shale chemistry were to produce a high-Btu gas, the heat content would be substantially higher. The retort gas that was once produced by tunnel ovens at Kohtla-Järve had a calculated gross calorific value of 33.7 MJ per cubic meter. This figure is reported in V. Yefimov, "Development of Oil Shale Processing Industry in Estonia Before World War II," *Oil Shale* 10,2, 1993, p. 246 (see Annex E). This heat content is not far from the western European standard of 38 MJ per cubic meter.

Exhibit II.1
Products Produced by RAS Kiviter in 1993

Profit center Product group Product	Natural weight, tons	Natural weight, tons	Dry weight, tons
Oil shale processing complex	217,753		
Oil products			
Wood impregnation oil		134,741	
Fuel oil		26,160	
Refined distillate oil		15,757	
Rubber softener		2,848	
Fuel for small boilers		696	
Heavy fraction of shale oil		80	
Road oil		15	
Electrode coke		34,530	
Sulphur		1,730	
Sodium thiosulfate		1,145	
2TM-3		51	
Production of aromatic hydrocarbons	88,924		
Benzene		43,430	
Toluene		18,245	
Solvent fractions		26,400	
Varnish LSP-1		527	
Superben silage preservative		271	
Siloben silage preservative		51	
Urea resins and phenol formaldehyde resins	14,610		
Synthetic resins and plastics			
Styrene-indene resin		7,320	
Urea resin		5,065	3,328
Phenol formaldehyde resins			
SFZ-3014		1,047	523
Phenol alcohol GFK-16		531	291
Phenol alcohol B		278	140
SFZ-81		96	56
Other			45
SFZ-3038, SFZ-3039		179	139
Epoxy resins		30	
Varnish-180		27	12
Composition TSG-9		37	
Production of benzoic acid	5,206		
Benzoic acid		5,035	
Reagent benzoic acid		171	
Total, all products		326,493	

Source: Data obtained from RAS Kiviter in January 1994, translated from Russian into English by an independent translator, and reformatted to show subtotals according to the definition of profit centers introduced in 1994.

The data received from RAS Kiviter do not allocate products to profit centers. This allocation was done by the project team based on a 1990 publication in which products were grouped without regard to financial accounting. Sulfur and sodium thiosulfate are byproducts recovered from shale, and we assume that 2TM-3 is also a byproduct recovered from shale. We assume that "solvent fractions" include S-absorbent solvent, which was produced in 1993, and the "benzene" includes pyrobeze, which was produced in 1993. The dry weight of pheno formaldehyde resin production is reported as 1,055 tons, of which 1,010 tons are identified by product and 45 tons are not identified. Resorcinols were not produced in 1993. The project team was told that RAS Kiviter did not keep an accounting record of products sold in 1993.

Employment data published in 1991 (see Exhibit II.2 below) suggest that the chemical complex at Kohtla-Järve was the second largest employer in the oil shale-related industries of Estonia in 1989.

Exhibit II.2
Distribution of Employment in Oil Shale Industries, 1989.

	Percentage of total production personnel in oil shale-related industries
Oil shale mining: Production Amalgamation "Estonian Oil Shale"	48.4
Baltic Electric Power Plant	9.4
Estonian Electric Power Plant	7.3
Kohtla-Järve Electric Power Plant	3.1
Electric power transmission in the region	2.6
Production Amalgamation "Oil Shale Chemistry"	20.8
Oil Shale Chemical Works "Kivióli"	8.4
Total	100.0

Source: Koidu Tenno and Veena Räägel, *Estonian Oil Shale* (Tallinn: Informare Ltd, 1991) p. 13.

H. Management

The management structure of RAS Kiviter appears to have changed very little since Estonia achieved independence in 1991. The enterprise reports to a government ministry that acts as the owner. There is no board of directors; the minister is the ultimate authority and represents the interests of the government, but he relies on his staff for day-to-day management. There are two senior positions in the enterprise: the general director, who is in charge of external relations and financial matters, and the technical director (in Russian, the "chief engineer") who is in charge of internal management and achieving production objectives. There are no marketing department, customer relations office, or public affairs office.

The general director is responsible for government relations and corporate planning but has only one or two staff to assist him in these functions. If he is faced with tasks such as restructuring the company, forming a joint venture, or selling off assets, he does not have enough staff to assist him. The accounting department reports to the general director and is responsible for complying with the reporting requirements of the statistical branch of the

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central government. The accounting department mainly tracks internal costs and does not spend a lot of time on customer orders and billing.

The technical director supervises managers who are each responsible for specific segments of the plant, such as benzoic acid production. Each of these managers is like a technical director on a smaller scale. The technical director tries to maintain high capacity utilization and increase the quantity of output per unit of raw material input. The technical director is a highly skilled engineer with many years of experience and is familiar with every aspect of plant design and operating practice. He personally takes part in redesigning the equipment and finding solutions to operating problems.

All of these management characteristics are typical of former Soviet enterprises. Among the differences from the Soviet period are the following:

- The enterprise reports to the Ministry of Economy of Estonia, not to a ministry in Moscow.
- The general director, the technical director, and the top officials in the Ministry of Economy are Estonians, not Russians.
- The Ministry of Economy has no ability to coordinate with other ministries to ensure a market for the output of the plant. There is no Gosplan, no central agency to ensure that an adequate supply of inputs will be available and that outputs will be purchased.

We requested an organization chart of RAS Kiviter but did not receive one; we were told that an old chart existed and had not been updated.

Although the plant is technologically sophisticated, it does not have a research and development department or even a product development and testing department. These functions are carried out by the Oil Shale Research Institute, which was formerly funded by the USSR Academy of Sciences. Since Estonia achieved independence from the Soviet Union, two-thirds of the staff of the Oil Shale Research Institute have lost their jobs.

Our impression is that the management structure of the company needs to change, and the Ministry of Economy is in a favorable position to initiate such change. The possibility of merging the Oil Shale Research Institute into RAS Kiviter was discussed in January, as was the possibility of making RAS Kivioli a subsidiary of RAS Kiviter. The Estonian oil shale industry has been restructured several times over the last 80 years (see Exhibit II.3 on the next page), and another restructuring would not be surprising.

One difficulty is that the management of RAS Kiviter does not have clear-cut objectives because the enterprise is owned by the government of Estonia and responsible for maintaining employment in the Kohtla-Järve region. If the objective were to maximize profits, it might be possible to shut down unprofitable lines of business, lay off unproductive workers, and shut down production capacity in excess of the level needed to meet customer

Exhibit II.3

Development of the Estonian Oil Shale Industry, 1916-1993

1916-1920	Three oil shale open casts, Russian capital						
1920 1940	Riigi Põlevkivi-töötus, national enterprise (Kohtla-Järve) 1938 P A/S Eesmene Eesti Põlevkivi-töötus, state joint-stock company	• A/Ü Kiviõli, (Kiviõli) German capital	• The New Consoli-dated Gold Fields, (Kohtla), British capital	• Mine Küttejõud (near Kiviõli) Tallinn Cellulose and Paper Factory	• Mine Ubja, (near Kunda) Cement Plant Port Kunda, Danish Capital	• Vanemõisa Oil-Fields LTD (near Kunda) ↑	• Eestimaalane Oljeskiffer-konsortiet (Sillamäe) Swedish capital
1940-1941	Whole industry was nationalised ⊕						
1941-1944	Baltische Ölgesellschaft in Estland · German occupation authorities ⊕						
1945 1957	All-Union enterprises ⊖			Enterprises of Estonian Ministry of Local, Oil Shale and Chemistry Industry ⊖			Secret plant ⊕
	Mines Kukruse, Kõve and new mines No 2,4,6,8,10	Kohtla-Järve Oil Shale Processing Plant (without mine)	Power Stations Kohtla-Järve, Ahtme, later Balti, Eesti	Mine and oil factory Kiviõli with mine Küttejõud	Mine and oil factory Kohtla (factory ↑)	Mine for Kunda Cement Plant Ubja ↑	Sillamäe Uranium Processing Plant
1957-1965	The time of National Economic Council of the E.S.S.R. ⊖						
1966 1992	Eesti Põlevkivi only mines and open casts	Eesti Energia power plants		Kohtla-Järve Põlevkivikeemia Kombinaat chemistry plant with oil shale processing factory	Kiviõli Keemiakombinaat chemistry plant with oil shale processing factory		
1993	QUO VADIS, ESTONIAN OIL SHALE INDUSTRY ?						Silmet

• Oil Shale plants with mine (quarry)

Source: Enno Reinsalu, "Pólevkivi Kaevandamise Ja Energeetilise Kasutamise Majanduslikud Aspektid," paper presented at the Estonian-Finnish Seminar on Estonian Oil Shale, Tallinn, September 23-24, 1993.

demand for the company's products. However, profit maximization, under present ownership, merely results in a transfer of tax payments and (in all likelihood) some form of "dividend" payments to the government of Estonia. An alternative strategy would be to maximize the workers' wages and salaries, subject to the constraint that the enterprise must not depend on subsidies to remain in business. Yet another strategy would be to maximize the salaries and benefits for top management, subject to the same constraint.

One step that would improve the transparency of the plant's accounting would be a commitment by the government of Estonia to a policy of returning profits and profit taxes to RAS Kiviter for reinvestment or to Kohtla-Järve to pay the social costs previously assumed by the plant. This measure would take away the incentive to present social welfare expenditures (for example, paid leave for unemployed workers) as production costs in order to minimize the cash flow to the central government (i.e., taxes and profits). We do not have firm evidence that production costs are overstated and profits understated, but we are concerned that social welfare objectives are interfering with the enterprise's ability to function efficiently.

I. Procurement of Feedstock

RAS Kiviter's predecessor in the Soviet period, "Slantsechim," purchased a variety of feedstocks in addition to oil shale. The various petrochemical enterprises reporting to the Soviet Ministry of Oil Chemistry or the Ministry of Chemistry developed ways of selling intermediate products to each other so that their gross production volume would be as high as possible, even if their value added was small.

Today the number of feedstock materials received at RAS Kiviter is low. Our understanding is that there is only one major feedstock other than oil shale: pyrolysis oils obtained from petrochemical plants in Russia that lack the capability to produce benzene and toluene from pyrolysis oils. In the Soviet period there were many such plants; the nearest one was 2000 km away and the farthest (in Omsk) was 4,000 km away. RAS Kiviter is no longer buying pyrolysis oils from Omsk, but it continues to buy pyrolysis oils from Russian chemical plants that have no capability to process these oils. The plant in Bashkortostan, for example, will build a new unit to process pyrolysis oils, scheduled for completion in 1995. Both Russia and Estonia have an economic incentive to sustain trade in pyrolysis oils. Despite the political rhetoric, neither country can afford to cut trade ties.

The two countries may be able to increase the level of trade between RAS Kiviter and Slantsy, a relatively closely situated Russian oil shale refinery. RAS Kiviter has the ability to take the raw shale oil from Slantsy and make more valuable products from it. Fuel oil "S" from Slantsy is inferior to fuel oil "A" from RAS Kiviter. Slantsy has a production capacity of 100,000 tons per year of raw shale oil but is actually producing only 60,000 to 80,000 tons per year. RAS Kiviter is actually producing 300,000 tons of raw shale oil per year and has the capacity to upgrade the quality of raw shale oil from Slantsy. Because this feedstock would not require the use of retort capacity at RAS Kiviter, it would enable RAS Kiviter to improve capacity utilization of downstream production while shutting down its

oldest and least efficient retorts. It is also reasonable to assume that RAS Kiviter would have lower production costs at the higher level of downstream capacity utilization.

J. Distribution and Marketing

One of the unfortunate consequences of the Soviet period in RAS Kiviter's history is the elimination of anything resembling a marketing department. Under the Soviet system, the most important objective was to meet or exceed production quotas. Sales were relatively unimportant and were largely beyond the control of the managers of the enterprise. In theory, the planning ministry (Gosplan) would ensure that the output of the enterprise would match the needs of consumers. The organization would wait to be notified where products should be shipped; this was equivalent to "waiting for the phone to ring" rather than looking for customers.

In January 1994 RAS Kiviter still had no annual report, no brochure describing the company's products, and no evidence of a marketing campaign. The enterprise had no record of the quantity of products sold in 1993. There was a sheet describing the product specifications for an "oil for small boilers;" this was written in Russian (not Estonian) and photocopied on ordinary A4 paper. The booklet describing the products manufactured at the plant had not been updated since 1990, despite the fact that the market situation was completely changed by the breakup of the Soviet Union. Many of the products listed in the old 1990 booklet are no longer produced, for example, resorcinols. This booklet is available in English but apparently it is not available in any other language, not even Estonian.

The absence of marketing resulted in an accumulation of inventories in 1992 and 1993. Before this accumulation, production cost was computed by dividing annual expenditures by annual production volume. Our understanding is that the pricing strategy was to set price equal to production cost—an approach that is guaranteed to result in a cash flow problem when production exceeds sales (i.e., when inventories are growing). Pólykivikeemia obtained a working capital loan from the government of Estonia.[8] To create the basis for a new pricing strategy, production cost is now computed by dividing annual expenditures by annual sales volume. This approach is an attempt to bill the customer for the cost of producing goods that no one wants to buy - the goods that end up in a growing stockpile. RAS Kiviter's management is not satisfied with this new approach, but because there is no agreement on the method of valuing unsold production, there is no agreement on a method of determining (for each product) the price that is needed to recover production costs.

To sell wood impregnation oil and other products, RAS Kiviter relied on a broker to identify customers and obtain the best possible price for each product. According to the director of the Planning and Economics Department, this broker's performance has been

[8] Apparently the fertilizer plant continued to produce fertilizer after the price of natural gas rose to a level at which the production cost of fertilizer exceeded any reasonable market price. The fertilizer could not be sold and therefore there was not enough revenue to pay Lentransgas, the Russian supplier, for the gas supplied to the plant. The enterprise borrowed money from the Estonian government to pay Lentransgas, which threatened to interrupt the nation's gas supply.

disappointing and RAS Kiviter is now attempting to hire a marketing specialist so that marketing can be done in-house. One of the firm's marketing objectives, for example, is to sell sodium benzoate to the Coca-Cola Corporation.

Not only is marketing expertise absent; there is no attempt to make the Estonian government adopt policies that would help RAS Kiviter market its products. Although it would be possible for RAS Kiviter to influence the government of Estonia to set sulfur dioxide emission standards or other incentives for the use of low-sulfur fuel oil, our impression is that RAS Kiviter has made no attempt to lobby for a fuel oil price that would reflect the fact that its fuel oil has a lower sulfur content than the Russian heavy fuel oil it displaces.

Effective marketing is needed to increase capacity utilization in the portions of the plant where marketable products are being made. In the benzoic acid division, for example, marketed production (12,000 to 16,000 tons per year) is only 30 to 40 percent of capacity (40,000 tons per year). Because fixed costs are high, the least-cost mode of operating the benzoic acid division is at 100 percent capacity utilization.

K. Relationship Between the Price of Oil Shale and the Prices of RAS Kiviter Products

In mid-January 1994, RAS Kiviter was paying an average of 48 EEK per ton of oil shale. This price includes railroad shipping charges and is based on the average cost of shale from several mines. In the December 1993 draft of the Jaakko Pöyry oil shale sector study, the 1993 average cost of shale at RAS Kiviter was reported to be 39 EEK per ton, but this figure is only an estimate; there was a significant increase in shale prices during the year, and the 1994 average was projected to be 48 EEK per ton. For 1992, the average price at RAS Kiviter was reported as 26.85 EEK per ton (see Exhibit II.4).

A small amount of oil shale is imported from Russia. This shale is mined at Slantsy, which has a chemical processing plant as well. RAS Kiviter does not pay for shale from Slantsy; rather, it has a barter arrangement to return a certain volume of oil to Russia for every ton of shale received from Slantsy. The contract between RAS Kiviter and Slantsy is intended to allow RAS Kiviter to cover its operating costs, but the net result is that Slantsy shale is more expensive than Estonian shale. Slantsy shale has a lower calorific value than Estonian shale, and the weight of shale oil extracted is only 12 percent of the weight of shale fed to the Kiviter retorts. Slantsy shale is purchased in small quantities by RAS Kiviter only when Estonian shale supplies are not available in the amount needed to keep the Kiviter retorts operating.

The cost of shale is one of the major components of the cost of products obtained from shale. To simplify the analysis of product prices we assume that the average unit revenue from the oil shale processing complex is equivalent to $60 per ton of raw shale oil. The primary products of this complex in 1993 were wood impregnation oil, fuel oil, and electrode coke.

Exhibit II.4

Basic Statistics of the Oil Shale Chemical Industry, 1992–1995

	1992	1993	1994	1995
Oil shale heating value	*kcal/kg, dry*			
RAS Kiviter	3318	3300	3300	
Kivioli	3265	3345		
Estonian power plant	2600	2600	2600	2600
Oil shale consumption	*Thousands of tons*			
RAS Kiviter	1443	1556	1730	1750
Kivioli	386	382	385	400
Estonian power plant	309	434	600	700
Total	2138	2372	2715	2850
Oil shale capacity utilization				
RAS Kiviter*			76%	
Production of crude shale oil	*Thousands of tons*			
RAS Kiviter				
Middle oil	146	151	168	
Heavy oil	78	81	90	
Total	224	232	258	
Kivioli				
Middle oil	47.4	46.0		
Heavy oil	16.3	17.8		
Total	63.7	63.8		
Production of finished products	*Thousands of tons*			
RAS Kiviter				
Boiler fuel oil and wood impregnation oil	155	159	174	175
Electrode coke	29.6	34	40	
Rubber softener	4.5	3.1	4	
Road oil	0.1	1.4	0	
Water soluble phenols	6.4	5.1	7	
Kivioli				
Boiler fuel oil	42.3	44.8	45	45
Road oil	7.3	10.5	12	
Road bitumen	4.1	6.1	6	
"Kukersoi" resin	9.9	0.8		
Estonian power plant				
Boiler fuel oil	38.6	57.3	78	90
Total				
Boiler fuel oil and wood impregnation oil	236	261	297	310

Exhibit II.4, continued

Basic Statistics of the Oil Shale Chemical Industry, 1992–1995

	1992	1993	1994	1995
Number of employees				
RAS Kiviter				
Retorting and oil production		500		
All other operations		2870		
Total		3370		
RAS Kivioli				
Retorting and chemical		235		
All other operations		1035		
Total		1270		
Average monthly wages	*EEK per employee per month*			
RAS Kiviter				
Retorting and oil production		1300		
Total plant		1200		
RAS Kivioli				
Retorting and chemical		1500		
Total plant		1450		
Delivered cost of oil shale	*EEK per ton of shale*			
RAS Kiviter	26.85	39	48	
Kivioli	34	44	55	55
Estonian power plant	24.65	40	50	50
Production cost of shale oil	*EEK per ton of oil*			
RAS Kiviter				
Oil shale		244		
Labor		44		
Kivioli				
Labor		89		
Price of shale oil	*EEK per ton of oil*			
RAS Kiviter		750		

* 100 percent capacity utilization is assumed to be 6220 tons per day, 365 days per year. RAS Kiviter has 51 shale retorts with a gross capacity of 6960 tons per day but seven retorts with a capacity of 740 tons per day were shut down for "maintenance" in 1993.

Source: Jaakko Poyry, "Study on the Optimum Development of the Estonian Oil Shale Mining Operations and Retorting Industry," Draft, 28 Dec. 1993

At present RAS Kiviter is having great difficulty in marketing its wood impregnation oil, so this oil is sold in western markets (in Rotterdam and in Scandinavia) as a residual fuel oil. In western markets, RAS Kiviter receives the same price for wood impregnation oil and for fuel oil.[9] For some reason the price FOB RAS Kiviter in January 1994 was only $55 per ton for 0.8 percent sulfur oil, which is at least $12 per ton below the monthly average spot market price of 1.0 percent sulfur fuel oil in Rotterdam (see Exhibit II.5 on the following page). The difference may be attributable to excessive charges for transportation costs or brokerage fees, or to poor marketing practices that resulted in the absence of any premium received for low sulfur content. We were informed by Oil Shale Research Institute staff that RAS Kiviter receives no premium for low (0.8 percent) sulfur content in sales to Estonian buyers of fuel oil, who prefer to buy the cheapest possible Russian (or perhaps Lithuanian) fuel oil regardless of sulfur content.

In eastern markets, RAS Kiviter receives a higher price for wood impregnation oil than for fuel oil. Wood impregnation oil is sold by RAS Kiviter to Russian purchasers at $75 per ton FOB RAS Kiviter. This price is substantially below the spot price of gas oil in Rotterdam and we believe that a specialized product such as wood impregnation oil should command a price comparable to gas oil. Several of the Russian plants for wood impregnation are shut down, possibly as a result of cutbacks in the level of Russian investment in infrastructure (railroad ties, low-voltage power lines, telephone poles).

Electrode coke is sold by RAS Kiviter at $130 per ton, according to the Jaakko Pöyry study cited with Exhibit II.5. Coke is more dense than fuel oil, but we do not have information on the quantity of raw shale oil needed to produce a ton of electrode coke. We assume that the average price of products of the oil shale processing complex is equivalent to $60 per ton of raw shale oil, i.e., a price that is only slightly higher than the fuel oil price.

The tonnage of shale oil extracted from a ton of shale at RAS Kiviter varies from about 15 percent to 16.5 percent, and averages about 15.5 percent. The retorts at RAS Kiviter vary greatly in size; the older retorts are much smaller than the newest ones. The available capacity of retorts is 6,220 tons per day:

- 36 retorts have a capacity of 50 tons per day per retort, providing a total installed capacity of 1,800 tons per day. Of this total, 4 retorts or 200 tons per day are not in operation and shut down for maintenance. The available capacity is therefore 1,600 tons per day.

- 12 retorts have a capacity of 180 tons per day per retort, providing a total installed capacity of 2,160 tons per day. Of this total, 3 retorts or 540 tons per day are not in operation and shut down for maintenance. The available capacity is therefore 1,620 tons per day.

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[9] The September 1993 Arthur D. Little report includes a chart that suggests that wood impregnation oil and heavy fuel oil both have a "world market value in Rotterdam" of $105 per ton. Arthur D. Little International, *Shale Oil Processing in the Republic of Estonia* (presented at a seminar in Tallinn, September 24, 1993), p. 11. We consider this chart misleading; the $105 per ton price is inconsistent with Rotterdam heavy fuel oil prices in the spot market in September 1993, and RAS Kiviter's wood impregnation oil does not have a spot market value in Rotterdam.

Exhibit II.5
Monthly Average Spot Prices of Gas Oil and Fuel Oil in Rotterdam, April 1993 - January 1994

Month	Price of 0.3 % sulfur gas oil (Rotterdam), $/ton	Price of 1.0 % sulfur fuel oil (Rotterdam), $/ton	Price of 3.5 % sulfur fuel oil (Rotterdam), $/ton	Price received by RAS Kiviter, $/ton
April 1993	179.21	102.50	77.88	
May	174.97	95.94	70.35	
June	166.59	86.80	58.95	
July	160.73	91.11	57.18	
August	159.59	84.14	60.64	
September	161.64	81.23	60.05	
October	169.77	83.83	62.33	
November	164.25	74.09	60.84	
December	144.80	67.35	53.07	55
January 1994	143.67	76.74	58.92	55

Source: Spot prices are from *The Reuter Benchmark* and are reprinted in *Petroleum Market Intelligence*, February 3, 1994, p. 2. The RAS Kiviter price of $55 per ton was cited in meetings with RAS Kiviter staff and was also reported in Jaakko Pöyry, *Study on the Optimum Development of the Estonian Oil Shale Mining Operations and Retorting Industry*, Draft, December 28, 1993.

- 3 retorts have a capacity of 1,000 tons per day per retort, providing a total installed capacity of 3,000 tons per day. All are operational.

The larger retorts recover a higher fraction of the oil present in the oil shale. Therefore the marginal cost of shale oil is higher for the older, smaller retorts. The use of an average recovery figure such as 15.5 percent tends to overstate the future cost of shale oil, because many if not all of the 50 ton per day retorts could be shut down.

At 6,220 tons per day, 365 days per year, the capacity of RAS Kiviter is 2.27 million tons of oil shale per year. In 1993, however, the plant used only 1.73 million tons of oil shale. Our preliminary assessment is that at least half of the 50-ton per day retorts could be permanently shut down if future shale requirements remain at the 1993 level. If the larger retorts could all be run at 100 percent capacity utilization, they could process 1.69 million tons of oil shale per year and possibly enable a shutdown of all of the 50-ton per day retorts.

The improvement in recovery rates achieved by the 1,000-ton per day retorts is described in a recent paper co-authored by Ivar Rooks, the technical director of RAS Kiviter:

> Over the past decade the development of retorting techniques has been directed to creating automated high capacity retorting units with improved technological procedures. The results show a significant increase in unit throughput rates of the retorts (from 35 to 1,000 tonnes per day). At the same time, however, the oil yield showed only a slight increase. The oil yield of the Fischer assay oil increased from 65-68 to 74-78 percent.[10]

If we take the overall average recovery ratio of 15.5 percent, however, we find that a shale price of $3.56 (or 48 EEK, at an exchange rate of 13.5 EEK per dollar) per ton leads to a shale cost of $23 (or 310 EEK) per ton of raw shale oil. An average product price equivalent to $60 per ton of raw shale oil may be expressed as 810 EEK per ton of raw shale oil. At this product price there is a margin of $37 (or 500 EEK) per ton of shale oil to cover the labor costs and capital costs of producing finished products from oil shale. The cost of shale, under these assumptions, is about 38 percent of the price of finished products.

We do not have useful information on the unit cost of finished products of the oil shale processing complex. The cost of labor, capital, raw materials, and fuels other than oil shale would have to be included in this calculation, not to mention management overhead, maintenance, taxes, fines, and other costs. We were informed that the cost of shale oil production is estimated by RAS Kiviter as 800 EEK per ton (about $59 per ton). If this were an accurate measure and if product revenues were equivalent to $60 per ton, there would be no operating margin to cover the cost of making raw shale oil into finished products. We consider the 800 EEK per ton cost estimate to be somewhat inflated as a result of low capacity utilization, payments for unemployed workers, and costs that are not being allocated to downstream products because these products (e.g., phenols recovered from phenol water) are no longer being sold. There does not appear to be any procedure in place for write off of investments in equipment (for example, the old 50-ton per day retorts) that is no longer needed to generate profits for the enterprise. The enterprise appears to incur the cost of maintaining production capacity in excess of the capacity needed to meet the demand for its products. Moreover, at RAS Kiviter "production cost" is defined to include "social aid," i.e., unemployment benefits or paid leave for workers who are "temporarily" unemployed. We suspect that under a more reasonable measure of production cost, RAS Kiviter can break even when product prices are in the range of $60 to $70 per ton of shale oil.

With increases in miners' wages over the next six years, and with new investment in mining equipment, the cost of oil shale is going to increase:

- In the Energy Master Plan for Estonia (March 1993), the price of oil shale is projected to rise to $9 per ton (in 1992 dollars) by the year 2000, based on the value of oil shale as a substitute for coal in power generation (see Exhibit II.6 on the following page).

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[10] V. Yefimov, I. Rooks, N. Nazinin, and K. Vakulov, "Experience of improving retort technologies for processing large particle kukersite," *Oil Shale* 10,1, 1993, p. 10.

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Exhibit II.6:

Projected Price of Oil Shale and Other Fuels, 1992-2020

Fuels	Unit	1992*	1995	2000	2010	2020
Oil shale,**	USD/t	3	5	9	10	11
2.4 MWh/t	USD/MWh	1.3	1.9	3.7	4.1	4.3
HFO 1% S***	USD/t	94	145	177	215	227
11.3 MWh/t	USD/MWh	8.4	12.8	15.6	19.0	20.0
Oil shale oil,*	USD/t	96	147	179	218	230
11.1 MWh/t	USD/MWh	8.6	13.2	16.1	19.6	20.7
Natural gas[3],	USD/1000m^3	90	116	128	150	162
9.7 MWh/1000m^3	USD/MWh	9.3	12.0	13.3	15.5	16.8
Coal[4],	USD/t	33	42	46	52	56
7.1 MWh/t	USD/MWh	4.6	5.9	6.5	7.3	7.9
Peat,****	USD/t	6	9	12	14	15
3.3 MWh/t	USD/MWh	1.7	2.6	3.6	4.3	4.6
Woodwaste,****	USD/t	10	14	18	22	26
2.9 MWh/t	USD/MWh	3.4	4.8	6.2	7.6	8.9

* Present purchaser prices (taxes excluded)

** Equivalent medium price

*** Estimation from Finland

**** Estimation from Master Plan team

In this projection the price of oil shale is based on its value as a substitute for coal in electric power generation. Prices are shown in constant 1992 U.S. dollars per metric ton and per megawatt-hour of energy.

Source: Ministry of Industry and Energy, Vattenfall AB, Imatran Voima Oy, and Eesti Energia, *Energy Master Plan for Estonia*, March 1993, page 65.

- In a September 1993 projection done by Enno Reinsalu, a professor at Tallinn Technical University, the price of oil shale is projected to rise to $12 per ton by the year 2000 (see Exhibit II.7 on page 26).

- In the Jaakko Pöyry study (January 1994) oil shale is projected to cost at least $7.50 (101 EEK) per ton in 1993 dollars in the year 2000, and possibly as much as $10.30 (or 139 EEK) per ton in 2000 (see Exhibit II.8 below). In our judgment $10.30 is much more realistic because land reclamation and environmental control costs must be included in mining production costs.

- On the basis of a very rough comparison between shale mining costs in Estonia and coal mining costs in different parts of the world, we doubt that shale mining costs can be kept under $10 per ton. Surface coal mined in Wyoming costs $6.50 to 14.50 per ton (in 1990 dollars), and surface coal in the Transvaal, South Africa, costs $8.50 to $16.50 per ton (in 1990 dollars).[11]

Exhibit II.8
Projected Average Cost of Oil Shale From All Estonian Mines in 1997 and 2000

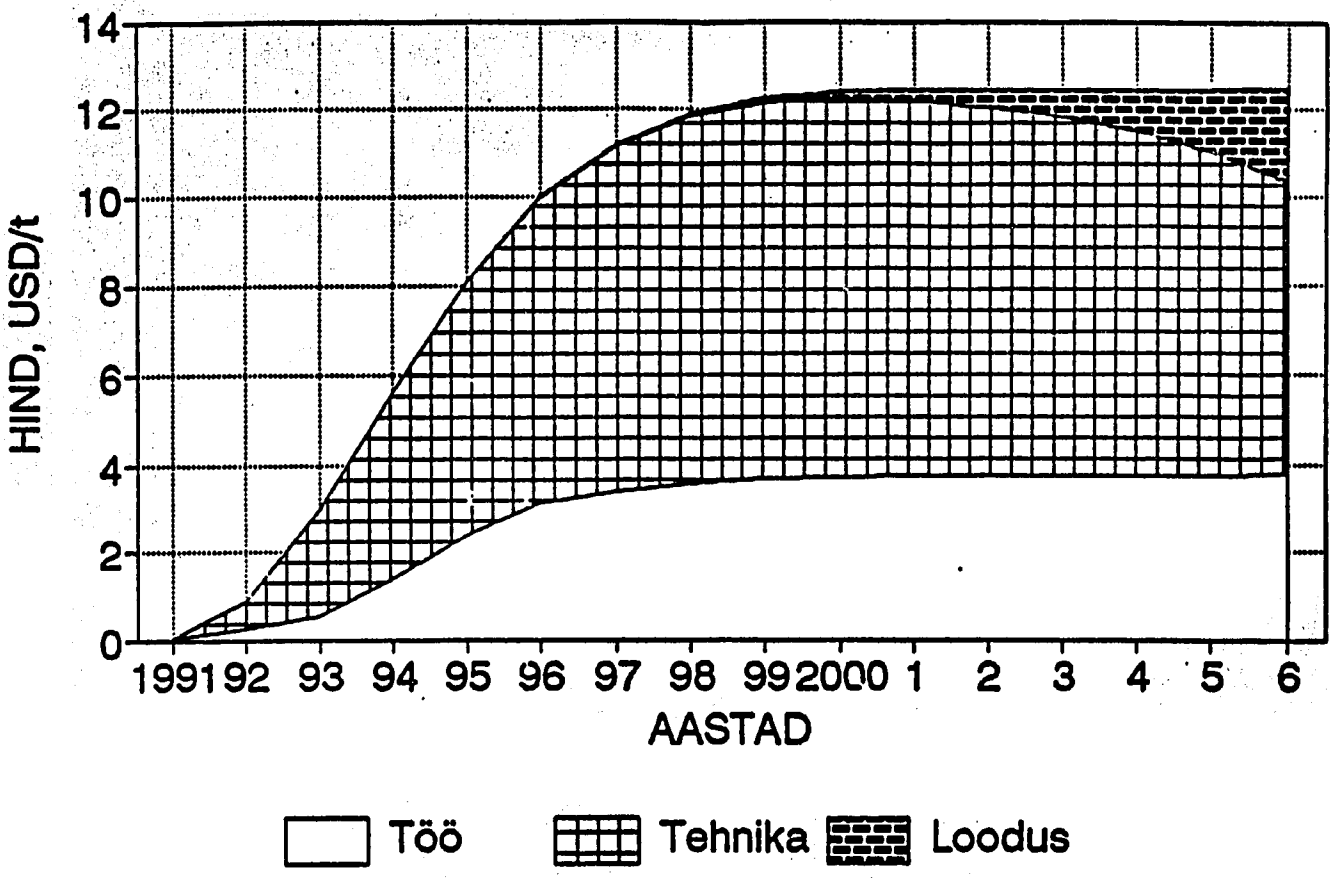
Scenario	Average cost in 1997, in constant 1993 US$ per ton	Average cost in 2000, in constant 1993 US$ per ton
Replacement of existing mining equipment; annual output of 15 million tons	6.20	10.30
Replacement of existing mining equipment; annual output of 20 million tons	5.80	9.50
Purchase of Loader-Hauler-Dumper vehicles; annual output of 15 million tons	5.10	8.30
Purchase of Loader-Hauler-Dumper vehicles; annual output of 20 million tons	4.70	7.50

Source: Jaakko Pöyry, *Study on the Optimum Development of the Estonian Oil Shale Mining Operations and Retorting Industry*, Revised draft, January 26, 1993.

If we assume $10.30 per ton and a 15.5 percent recovery ratio, the cost of shale required to produce shale oil will be $66.45 (or 897 EEK) per ton of raw shale oil. Obviously it will be impossible for RAS Kiviter to remain in operation at this shale price unless the average product price is raised above the present level of $60 per ton. We assume that the oil shale component of product cost can rise to 50 percent but not much higher. Thus the minimum acceptable product price level in the year 2000 is $120 per ton of raw

[11] International Energy Agency, *Coal Information 1991*, Paris: OECD, 1991, p. 27.

Exhibit II.7:
Projected Price of Oil Shale, 1991-2006



In this projection the price of oil shale is equal to its production cost; there is no allowance for royalties, severance taxes, lease payments, or excess profits associated with economic rent. The three components of the cost of oil shale are labor (Töö), equipment (Tehnika), and environmental protection or "nature" (Loodus).

Source: Enno Reinsalu, "Pólevkivi Kaevandamise Ja Energeetilise Kasutamise Majanduslikud Aspektid," paper presented at the Estonian-Finnish Seminar on Estonian Oil Shale, Tallinn, September 23-24, 1993.

shale oil. We believe that this price level can be achieved through modifications to the existing retorts and processing facilities; we do not see a need for complete replacement of the existing plant or for construction of facilities designed to produce a synthetic crude oil.

L. Assessment of Economic Prospects

L1. Short-term Prospects

If RAS Kiviter is lucky, it will survive the short term, because it has access to a low-cost feedstock (oil shale at $3.50 per ton); it can sell fuel oil and oil products at western European prices; and it has no long-term debt (i.e. "long term financial liabilities" in the balance sheet; see Annex A). From a marketing standpoint, however, the enterprise is extremely vulnerable. The short-term prospects for RAS Kiviter depend on how quickly the enterprise can find new customers for its products and raise the average price of finished products above the equivalent of $60 per ton of shale oil. The enterprise risks being caught between the rising cost of oil shale and the depressed level of heavy fuel oil prices in western Europe. On the other hand, it has an opportunity to earn profits from the processing of pyrolysis oils obtained from Russian chemical plants. The enterprise is in a weak competitive position because it has no marketing department and has lost many of its long-term customers in Russia, but this weakness is offset, in part, by the potential to profit from pyrolysis oils. The enterprise also should be able to earn profits from the sale of steam to Nitrofert.

L2. Medium-term Prospects

In the medium term, RAS Kiviter is less vulnerable to the loss of customers and markets, and the risk of failure is lower. The supply of pyrolysis oils will gradually decline as Russian enterprises build the capacity to process these oils, but RAS Kiviter will have time to develop the ability to manufacture products suited to western markets (including the domestic Estonian market). There is a significant upside potential because the firm may also have the potential to produce a gas oil or diesel fuel. In the medium term RAS Kiviter has time to adjust to a market economy, and the absence of long-term debt will strengthen its financial position.

L3. Long-term Prospects

In the long term, RAS Kiviter's future will depend on oil prices and on the firm's ability to produce gas oil, diesel fuel and other light products. If oil prices are high, RAS Kiviter may become extremely profitable. It will obtain oil shale at prices no higher than the value of shale as a substitute for coal in power generation. It will sell products that compete with petroleum products; if it can produce a diesel fuel commercial success is practically guaranteed. If oil prices are low, RAS Kiviter will be unable to attract capital investment and will gradually lose oil shale processing capacity as the oldest and least efficient retorts are shut down. In the worst-case scenario, however, RAS Kiviter is likely to experience a gradual decline rather than a sudden financial crisis.

L4. Assessment of Requisite Restructuring and Management Changes

The enterprise needs to improve drastically in the areas of marketing and accounting. Our assessment is that RAS Kiviter is living in the past while many other firms in Estonia are adjusting rapidly to the market economy. RAS Kiviter is fortunate to be located in a country where the economic growth forecasts are favorable and a large portion of the population is acquiring business skills. In its management style, RAS Kiviter merely needs to catch up with the rest of the country; it does not need to be a leader and innovator.

RAS Kiviter needs to maintain a strong research and development capability through the Oil Shale Research Institute, Tallinn Technical University, and the Chemistry Institute of the Estonian Academy of Sciences. The R&D facilities and skilled engineers and scientists are already in place. The challenge is to ensure that Estonia's long-term interests are not sacrificed as a result of cost-cutting measures executed in response to short-term political crises.

The necessary management changes are much more likely to happen if USAID assistance or other western donor assistance is provided. Grant funding can be "leveraged" by providing access to information that the firm can already afford to purchase. The problem is not that the enterprise is so unprofitable that it cannot be modernized, but rather that it is very conservative. Perhaps the best example is the way the plant is maintained (or not maintained). A large infusion of grant money or low-interest loans to pay for maintenance is not needed, but simply a management structure in which good performance is rewarded and poor performance is penalized. A well-crafted technical assistance program could give the organization the extra "push" needed to implement reforms that plant managers have already identified.

M. Study Recommendations

We recommend that USAID proceed with an assistance program for RAS Kiviter on one condition: the management of the enterprise must accept a medium-term objective of raising the revenue from the oil shale processing complex to at least $120 per ton of raw shale oil. Achieving this objective will require a strong commitment to marketing and to research and development for producing a distillate fuel oil suitable for export. Our assessment is that the $120 per ton price level is a reasonable target and can be achieved within three years.

SECTION III
DETERMINATION OF THE PROJECT'S ENVIRONMENTAL FEASIBILITY

A. Scope and Limitations of the Environmental Study

The RAS Kiviter plant is large and complex with many different process units spread over a large area. Countless sources of emissions range from small leaks to massive evaporative losses of benzene and poorly controlled stack emissions. A study in 1991[1] identified 850 individual sources of air pollution within RAS Kiviter and the much smaller Kivioli oil shale processing plant. Assessing the exact level of pollution within and from the plant is virtually impossible. In contrast to a modern, well maintained western plant, emissions are not predominantly concentrated in a few major process units with scattered fugitive emissions comprising a fraction of total emissions. Leaks are common throughout the plant as evidenced by the ubiquitous and oppressive odors and the fluids running down the sides of the reactors and dripping from pipe joints. The large number of sources make accurate monitoring impossible and a quantitative assessment of the plant's environmental state difficult.

At the same time, the many leaks and poor stack controls that make a quantitative assessment difficult make the final qualitative conclusion simple: the plant is in very poor condition, workers are constantly exposed to high levels of numerous hydrocarbons, and the impact of the plant must extend well beyond its boundary. This is obvious even without the data to prove it quantitatively.

The examination of RAS Kiviter's impact on workers and neighbors begins with the plant's emissions, moves to an assessment of ambient concentrations, and concludes with basic measures of health impact. This would seem to be a logical progression from cause to effect. At each step, however, the uncertainty in this analysis grows. The assessment of RAS Kiviter's impact is plagued by a lack of available data. Partly this is because we can access only references that have been translated into English. More fundamentally, however, the weak connections from step to step are rooted in the lack of a comprehensive data collection program.

In meeting with health professionals at the plant, it quickly became apparent that their monitoring program is well conceived and professionally executed. It is limited, however, by a lack of resources. The laboratory facilities are simple, and many tests that are automated in the west are done manually. This limits the number of samples that can be processed. Typically, a sample is taken at each work place only once per quarter or twice per year. The ambient monitoring network is similarly vestigial. There are only four monitors in the Kohtla-Järve area, and one is located where it is virtually useless for

1 Ratsep, A. Liblik V, "Polevkivitootlemisectte votete osatahtsusest Ida-viru maakonna atmosfaariohu saastetasement" and "Kaasaegse okoloogia probleemid," Tartu, 1992, p. 153-155.

monitoring RAS Kiviter. Even the available data are presented in a way that is seriously deficient by western standards. In the studies of health impacts, the relative rates of incidence are presented, but there are no supporting statistical tests of significance.

As a result of these limitations, the following discussion will make the case that RAS Kiviter is damaging workers' health and the environs, but it will not do so in the quantitative way expected of such studies in the West. When this discussion is complete, it will still be possible to doubt its conclusions, but it is reasonable and likely that RAS Kiviter has serious environmental problems with serious health impacts.

B. Environmental Impacts of Plant Operations

B1. Emissions

Quantitative assessment of the plant's emissions is hampered by the lack of detailed and accurate data on emissions, in-plant ambient conditions, and the plant's impact on air or water quality. Neither of the major studies of Estonian air quality include detailed data.[2,3] The Arthur D. Little study[4] of the plant is virtually devoid of accurate environmental information.

The best estimate of emissions to date was provided in hand-written form by Ivar Rooks, the general manager of the plant, to the USAID study team on the last day of the January site visit. His data on airborne emissions are shown in Exhibit III.1 below. The emissions are in tons per year for the RAS Kiviter plant and the fertilizer plant that was formerly part of RAS Kiviter. In several cases, estimates of emissions from other studies are provided in the table along with the Rooks data. Unless otherwise noted, all data are for 1993. Estimates of emissions were provided in the Arthur D. Little report for most of the same emissions categories. The Arthur D. Little estimates differ substantially from the Rooks data in several cases and are not provided here. The Arthur D. Little report provides the data without citation or substantiation, and several estimates conflicted with actual available data.

A brief summary is presented in subsection C. of the health effects of the pollutants listed below and of the metals known to be contained in the ore and ash. These summaries are taken from Sax and Lewis's *Hazardous Chemicals Desk Reference*, the standard reference on the dangerous properties of industrial chemicals. The summary omits description of effects observed as a result of any pathway other than respiration and ingestion. Effects of acute poisoning are not emphasized.

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[2]"Supplemental Environmental Studies in Estonia: Volume 3," Ministry of the Environment of Estonia, et. al., August 1992.

[3]Kallaste, Tiit, et. al., *Air Pollution in Estonia 1985-1990*, Environmental Data Center, National Board of Waters and the Environment, 1985-1990, Helsinki, 1992.

[4] Arthur D. Little, International, "Restructuring and Privatization of the Chemical Industry of the Republic of Estonia: Environmental Assessment, 1993.

Exhibit III.1 RAS Kiviter Airborne Emissions, 1993

Pollutant	Annual Emissions (tons)
SO_2	4489.131
	5559 (1990 data, MoE, 1992)
CO	400.289 (23.377 from fertilizer)
	700 (1990 data, MoE, 1992)
NOx	223.253 (52.106 from fertilizer)
	359 (1990 data, MoE, 1992)
CnHm	208.544
Benzene	18,811.119
Toluene	290.393
Oil shale gasoline	856.797
H2S	12.892
NH3	77.035 (74.725 from fertilizer)
C6H5OH (phenol)	5.754
C6H5C2H5	3.611
Formaldehyde	0.239
Butylacetate	36.469
Diisopropyl ether	3.014
Furfurol	0.089
Epichlorydrin	0.046
Urea dust	153.153 (all from fertilizer)
Oil shale dust	16.373
Methanol	2.579
Organic dust	79.734
Diphenyl oxide & Diphenyl	0.293
Inorganic dust	3.273
Maleic anhydride	0.075
Styrene	5.210

Total solids from the Rooks list amount to slightly less than 100 tons. This is inconsistent with the 940 tons for 1990 reported by the Ministry of the Environment. There are several possible explanations for the discrepancy between the MOE estimate and the Rooks estimate. The two may be using different definitions of solids, with Rooks including only the finer (10 micron) respirable particulates. Also, the MOE number may be for uncontrolled emissions and the Rooks estimate for controlled emissions. A reduction of 960 tons to 100 tons would be typical for a basic baghouse such as the one employed at RAS Kiviter. It seems likely that the difference between the Rooks and Ministry numbers are rooted in a difference in definition and not an error in measurement, since the two sources are exceptionally consistent for basic SO_2 and CO emissions, accounting for lower production in 1993.

This discrepancy is a serious concern, since the ash from the plant is relatively rich in metals. Exhibit III.2 provides a crude assay of the metals content of the ore and ash from the Ministry report. The report does not distinguish between bottom ash (disposed of as a solid) and fly ash (airborne).

Exhibit III.2 Metals Content of RAS Kiviter Shale and Ash

	Hg	Cd	Pb	Ni	Cr	V	Sb	As	Co	Cu	Zn	Mn	Mo
Oil Shale	0.26	2.83	21.4	13.5	25.9	18.6	0.49	9	3.30	92.2	62	302	3.8
Ash	1.03	2.70	163.6	18.5	47.1	55.6	3.04	38	6.04	82.9	284	278.9	14.6

Source: Kallaste, p. 8

B2. Air Quality Impact

Air quality in the town of Kohtla-Järve is dominated by the emissions of the RAS Kiviter oil shale plant, the associated power plant, and the fertilizer plant. Accordingly, the ambient air quality data largely represent the impact of the plant. Ambient air quality data have been collected in Kohtla-Järve since 1974. From 1974 to 1977, the plants measured dust, SO_2, CO, and Nox. The Russian dust measurements correspond to U.S. measurements of total suspended particulates, and do not differentiate by particle size. Since 1978 hydrogen sulfide and formaldehyde have also been measured. Various other measurements, including heavy metals, benzo(a)pyrine (BaP), sulfate ions, and ammonia have been added at one or more of the four sites in recent years.

It is apparently standard practice in Estonia to combine concentrations of different pollutants into a single measure of aggregate pollution level. Each pollutant is converted to a unitless value by dividing its ambient concentration by the maximum permissible concentration for that pollutant, and averaging these ratios. The validity of this measure rests on two assumptions—that the maximum permissible concentration of each measure represents the same aggregate health risk, and that the health impact is linearly related to concentration. Since the levels of risk associated with each pollutant are highly uncertain, and because effects vary widely with other risk factors such as smoking and preexisting respiratory problems, the scientific basis for the aggregate measure of air quality is highly questionable. Still, this measure has some practical value given the inconsistent and incomplete pattern of air quality monitoring in Estonia. It allows comparison of air quality in different towns where different pollutants are measured. It also establishes a unitless measure of compliance so that aggregate air quality can be tracked over time with a single measure as the monitoring system is improved. While the unitless air quality index has severe limitations from a scientific perspective, it is actually a clever and pragmatic regulatory measure for a country where monitoring data are spotty by U.S. standards.

The air quality index for the town of Kohtla-Järve showed that the town achieved compliance in 1990. The marked improvement in air quality from 1986 to 1987 is undoubtedly related to reduced operations at RAS Kiviter. Assuming that emissions in 1993 are 70 percent of the 1990 level, and that ambient air quality is linearly related to RAS

Kiviter emissions, the current air quality index should be in the range of .65 to .70, indicating substantial compliance with the broad spectrum of ambient standards.

Exhibit III.3 below shows air quality at four monitoring stations in the vicinity of Kohtla-Järve. The exhibit also compares ambient air quality of the four sites to Estonian annual average air quality standards. Boxes showing explicit violation of Estonian standards are shaded. Bold type indicates cause for concern, though there is no explicit violation of the standards. In some cases there is no Estonian standard, international standards are typically stricter, or, in the case of H2S, the high annual concentration makes it likely that the short-term (8-hour) standard has been violated. Three of the four sites are at or near the limit, while one is nearly double the limit. The problem site is Kivioli. Its monitor is about 15km west of the plant, located closer to another oil shale processing plant.

Exhibit III.3
1990 Ambient Air Quality Standards
Monitoring Sites Near RAS Kiviter
(Annual Average Concentration Except Where Noted)

Pollutant	Annual Standard (mg/m3) 24 hr avg.	Site			
		Kivioli	Sots. Linnaosa	Ahtme	Johvi
Dust	0.150	**0.10**	**0.10**	**0.10**	**0.10**
SO_2	0.050	**0.06**	**0.04**	**0.05**	**0.04**
SO4	none		0.01		
NO	0.060	0.02			
NO2	0.040	0.02	0.02	0.02	0.01
CO	3.000	1.00	1.00	1.00	1.00
H2S	0.008 (daily)	**0.003**	0.002	0.02	0.002
NH3	0.040	**0.05**	**0.06**		**0.05**
Formal-dehyde	0.003	**0.004**	**0.004**	**0.007**	0.002
B(a)P	none	**0.25**		**0.39**	
Phenols	0.003	**0.003**	0.002	0.001	0.001

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The Ministry of the Environment reports that standards for daily concentrations were violated for eight pollutants, as follows:

SO_2	1 day
CO^2	3 days
NO2	6 days
H2S	11 days
Phenols	1 day
Ammonium	21 days
Formaldehyde	3 days

The exceeded standards for ammonia are predominantly, if not completely, due to the fertilizer plant. The exceeded standards for hydrogen sulfide are due to the oil shale plant.

These data would indicate that there are significant problems with air pollution in towns near RAS Kiviter, but that the situation is not extreme. This conclusion contrasts with the general perception of the Kohtla-Järve area as severely polluted, a perception held not only in the West but also by the Ministry of the Environment and local environmental officials. Is the environment in Kohtla-Järve truly as bad as perceived? Are the monitoring data correct?

The best answer seems to be that air quality in Kohtla-Järve is truly very bad, and that the data are accurate, but incomplete and deceptive. The first problem is the number of monitors. Excluding the monitor in Kivioli, where the air quality is not principally influenced by RAS Kiviter emissions, there are only three monitors. These were logically placed near the highest concentrations of population around the plant (except, until recently, when one was placed in Kohtla-Järve itself). They were not placed in areas where air pollution is likely to be at a peak.

Based on wind data from Narva (see Exhibit III.4), the monitor locations for Kohtla-Järve would seem to miss the areas of greatest concentration.

Furthermore, the relatively lax Estonian standards provide a deceptive view of air quality. The annual average particulate standard for Estonia is 0.150 ug/m3, which is met at every monitoring site. The Finnish standard is 0.060 ug/m3, which every site exceeds by more than 60 percent, while the U.S. standard is 0.050 mg/m3 for fine particulates. The Estonian standard for SO_2 is 0.060 mg/m3 (annual average). Every site meets this standard. The Finnish standard is 0.040 mg/m3. The Sots. Linnaosa and Johvi sites are at this level, while annual average concentration in Johvi exceed this level by 20 percent. The U.S. standard is not a relevant comparison as the averaging time is different.

Concentrations of NO2 and, likely, ozone are not problematic. They are well within the Estonian standard and the less stringent U.S. standard. This is to be expected given the relatively small number of motor vehicles in the areas.

Exhibit III.4
Frequency of Prevailing Winds in Narva, Estonia
And Monitors in the Vicinity of Kohtla-Järve

Wind Direction	% Of Year	Monitor Location
North	18	
Northeast	19	
East	11	Sots. Linnaosa
Southeast	15	
South	9	Johvi, Ahtme
Southwest	7	
West	7	Kiviter
Northwest	14	

C. Health Effects

Efforts to study the health effects of the plant have been spotty, but provide some direct evidence of the impact of RAS Kiviter on the surrounding communities. The Ministry of the Environment reports[5] that:

- Rates of chronic heart disease are 1.5 to 1.9 times higher in the vicinity of RAS Kiviter than in rural areas outside the plant's influence.
- Rates of acute heart disease are 1.2 times higher in areas affected by the plant.
- Rates of emergency room visits from an area for acute respiratory problems are 40 percent higher when meteorological conditions favor transport from the plant to the area.
- Workers at the plant exhibit 12.4 percent higher rates of heart disease than a comparable population of individuals who do not work at the plant.
- Workers at the plant exhibit 72.2 percent higher rates of blood vessel diseases.

The observed health effects are entirely consistent with the list of pollutants in the plant presented earlier. The data presented in the MOE report, however, are not sufficient to establish a causal relationship as is expected in American environmental studies.

The MOE report also notes that children in Kohtla-Järve show a 4.7 percent incidence of alopecia (loss of hair), as well as elevated incidence of "dystrophy of nails and pathological diseases including skin, neuro-physical, digestive tract and inner secretion system pathologies." Rickets and abnormal structure of the blood cells were all reported. The MOE report speculates that these could be caused by exposure to thallium, but does not make this conclusion.

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[5]MOE, pp. 88-89.

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Some of these symptoms, including alopecia, can be caused by thallium, but rickets is not related to thallium, and no thallium is noted in the assay of metals in the ore ash presented earlier. A deficiency of vitamin B1 will also cause alopecia and most of the other symptoms. Rickets, however, is caused by a deficiency of calcium, phosphate, and Vitamin D. Taken together, these symptoms would point to a general vitamin deficiency at least as much as they point to any specific pollutant. This vitamin deficiency could be related to diet or may, indeed, stem in part from exposure to the several pollutants that cause gastrointestinal irritation and could inhibit vitamin uptake. The data are not sufficient to determine the cause of the effects observed in the children, and several contributing factors are likely.

Health effects associated with pollutants emitted from RAS Kiviter are summarized below:[6]

Sulfur dioxide chiefly affects the upper respiratory tract and the bronchi. It may cause edema of the lungs or glottis and can produce respiratory paralysis. Exposure over two years to variable concentrations on the order of 30ppm can produce a significantly higher than normal incidence of nasopharyngitis and laceration of the sense of smell and taste, high urinary tract acidity, and increased fatigue. The duration of colds also increases, but not the incidence. Plants are affected at concentrations below the level at which human health effects are observed.

Carbon monoxide is a highly poisonous gas, with experimentally demonstrated teratogenic effects. Symptoms of the chronic exposure include auditory disturbances and contraction of the visual field. Glycosuria occurs and heart irregularities have been reported. Long periods of exposure at higher concentrations (more typical of in-plant exposure) have been linked to cerebral congestion and edema, and long-lasting mental and nervous system damage.

Benzene is moderately toxic via inhalation and ingestion. It is an accepted human carcinogen and an experimentally demonstrated teratogen and mutagen. It is known to cause leukemia and damages the bone marrow. Short-term exposure to very high levels does not appear to cause lasting damage, but long-term exposure to even low levels is dangerous.

Toluene is moderately toxic though inhalation. Exposure to levels of 200ppm for eight hours will impact coordination and reaction time. Higher levels and longer exposure will cause headache, nausea, loss of appetite, a bad taste, and lassitude. Very high levels cause anemia, leucopenia, and an enlarged liver.

Ammonia is toxic by inhalation and ingestion. There are also experimental data indicating a slight mutagenic effect. It is an eye, mucus membrane, and systemic irritant. Ammonia emissions from RAS Kiviter are not sufficient to cause any effect beyond the plant boundaries. Ammonia emissions from the fertilizer plant may be significant.

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[6] The summaries are extracted from Sax, Irving N. and Richard J. Lewis, *Hazardous Chemicals Desk Reference*, New York: Van Nostrand Reinhold, 1987.

Phenol is toxic by inhalation and ingestion and moderately toxic by skin contact. Experimentally, it is indicated to be carcinogenic and mutagenic, as well as a neoplastigen and tumorigen. Low-level exposure can damage the kidneys, liver, pancreas, and spleen, and cause edema of the lungs. Ingestion can cause corrosion of the lips, mouth, throat, esophagus, and stomach as well as gangrene. Chronic exposure can cause death from liver and kidney damage.

Formaldehyde is a mutagen and possible tumorigen of the lung. It is a poisonous irritant to the skin, eyes, and mucous membranes. Prolonged exposure to high concentrations (greater than 10ppm) can lead to contact dermatitis. Concentrations greater than 10ppm are immediately irritating to the eyes.

Butyl acetate is a systemic irritant and moderately toxic when inhaled. There is inconsistent evidence of systemic toxicity from prolonged exposure to low concentrations. The level of emissions from RAS Kiviter are not likely to have an effect outside the plant.

Disopropyl ether is a moderately toxic systemic irritant when inhaled and an irritant to the skin. Emissions from RAS Kiviter are not likely to have an effect outside the plant.

Methanol is moderately toxic by inhalation and poisonous when ingested. Oxidation of methanol in the body forms formaldehyde and formic acid, both of which are toxic. The principal effects are damage to the optic nerves, leading to permanent blindness if exposure is prolonged. Because methanol is eliminated very slowly from the body, it is regarded as a cumulative toxin.

Mercury is highly toxic if inhaled or ingested. There are also experimental indications of carcinogenicity. Principal effects are damage to the central nervous system and to the gastrointestinal tract.

Cadmium is toxic if inhaled or ingested. If ingested, however, the emetic action is so severe that little cadmium can actually be absorbed. Inhalation affects the respiratory tract and kidneys. Brief exposure to high concentrations may result in pulmonary edema and death. Fatal concentrations may be breathed without discomfort prior to the onset of edema. Cadmium is teratogenic and has been experimentally determined to be carcinogenic.

Lead affects the central nervous system if ingested. It particularly effects nervous system development in children. It is a carcinogen of the lung and kidneys, and experimental data indicate a teratogenic effect.

Nickel is poisonous if ingested. It is experimentally indicated to be a carcinogen, tumorigen, and neoplastigen. Ingestion causes nausea, diarrhea, and vomiting. Some data indicate mutagenicity. It may cause dermatitis in sensitive individuals.

Chromium compounds (chromic acid and related) are corrosive to the skin and mucous membranes. Nonsupperating ulcers develop on the skin and heal very slowly.

Experimental data indicate that the hexavalent components are carcinogenic. The hexavalent compounds are more toxic than other compounds, causing dermatitis.

Vanadium is experimentally indicated to be carcinogenic. Different vanadium compounds have different toxicity. Principal effects are respiratory irritation. Prolonged exposure may lead to pulmonary involvement. There is controversy about the effects of industrial exposure on other systems of the body. Acute effects are polycythemia followed by red blood cell destruction, loss of appetite, and pallor. Gastrointestinal disorders, nervous system complaints, and severe coughing have been reported, but more recent reports describe symptoms restricted to the respiratory system. The effects of vanadium, particularly at low doses are a matter of considerable uncertainty. Concern focuses on vanadium sulfite, which certainly causes severe respiratory damage in animals.

Astatine - no toxic effects are listed in any of the references checked.

Copper is very poisonous when ingested. Inhalation of Cu dust has caused hemolysis of the red blood cells. The lungs, pancreas, and liver are damaged. Cuprous oxide can be irritating to the eyes and respiratory system. Cancer rates are higher in workers in copper smelting.

Cobalt is mildly toxic when ingested or breathed in large doses. It is readily excreted in urine and feces, so that prolonged exposure to low doses has little or no effect. It is unlikely that the cobalt emitted from RAS Kiviter has an impact on human health.

Zinc is irritating to the skin and respiratory system, but pure zinc powder is relatively non-toxic by inhalation. RAS Kiviter emissions are not significant.

Molybdenum is toxic through intratracheal and intraperitoneal routes. It has been suggested that precautions should be taken against breathing large concentrations, but there is little or no experimental data indicating any danger from breathing low to moderate concentrations. Molybdenum is rapidly excreted from the body. It is highly unlikely that the molybdenum released by RAS Kiviter poses any threat to workers of neighbors. Molybdenum may, in fact, be an asset to plant life in the vicinity of the plant.

Manganese has been experimentally linked to cancer. There are data indicating some level of mutagenicity. The dust and fumes are toxic. The symptoms are languor, sleepiness, weakness, emotional disturbances, spastic gate, and paralysis.

Antimony compounds are generally toxic when breathed or touched. The principal effects are respiratory and skin irritation.

D. Priorities for Environmental Management

This discussion of priorities for environmental management begins with the details and works toward the general. It begins with a survey of plant operations, working through the major components of the plants and the most immediate needs and opportunities for

environmental improvement. From this detailed look, the chapter develops a picture of systemic problems at the plant that underlie specific problems.

D1. Plant Operations

RAS Kiviter is a large and complex plant, with a diverse but diminishing product slate. Essentially, the plant has three components: a line that produces shale oil and related products; a line that produces aromatic hydrocarbons from pyrolysis gas; and a power plant that provides electricity and steam to the oil shale and hydrocarbon lines. Current and past products are listed below. Those marked with an asterisk are not currently produced, but production could be resumed if a market develops.

From Oil Shale:

- Wood impregnation oil to inhibit decay, used principally to preserve railway sleepers*
- Ligno wood antiseptic for preservation of wood, used in construction and to intensify grain for aesthetic reasons*
- Rubber softener*
- Electrode coke
- Fuel oil for industrial boilers and residential use
- Refined distillate oil, used for fuel, for the production of bitumen mastics, and for the manufacture of corrosion resistant epoxy
- KU Oil, used as an intermediary in the production of construction mastics*
- Shale road oil*
- Sodium thiosulfate for treatment of leather and furs
- Technical grade sulfur
- Phenol*
- Alkyres (with high content of 5-methyl resorcinol), used in the manufacture of tires and high-quality cold setting wood adhesives*
- Modified epoxy resin*
- Epoxy adhesive*
- Plugging compositions for oil and gas injection wells*
- Phenolic resins*

From Pyrolysis Gas:

- Benzene
- Toluene
- Benzoic acid
- Sodium benzoate solutions as silage preservatives
- S-Absorbent (principally xylenes)
- Pyrobenzene
- PTU oil used in the production of carbon black*
- Styrene-indene resins
- Varnish*

The oil shale line begins with the retorting of ore mined in the region. The processing then splits into branches, one for deriving products from the retorted oil and one for processing the waste water that contains phenol. In the past, phenol was both an asset to the plant and a problem. The oil shale contains substantial amounts of phenol, a valuable feedstock for many products, but also a serious pollutant. Conceptually, it is possible to extract the phenol from the retort waste water, sell the phenol, and produce phenol derived-products. In this way, a pollution problem is turned into a product line. This was done at the plant until a few years ago. Since then, the market price for phenol has declined, so the plant can no longer successfully sell the phenol it produces. This is due in part to impurity levels in the phenol. As a result, the plant no longer produces commercial grade phenol nor any derivative products (those listed below phenol on the list of oil shale products). The dephenolization plant now operates strictly as an environmental control. The principal airborne emissions from oil shale operations are sulfur dioxide and gasoline fractions. Most of the plant's solid waste is residue from retorting, contaminated with some sulfuric acid sludge and oil.

The pyrolysis gas line uses pyrolysis oil purchased from Russia. At one time this portion of the plant used a byproduct of the oil shale retorting operation, but this was less efficient than working with purchased oil. The initial step in processing is rectification, which produces three fractions—a light fraction from which benzene and toluene are produced, an intermediate fraction from which the solvents are produced, and a styrene fraction from which resins are produced. Benzoic acid is produced from toluene, which is also sold as a product.

The complexity of RAS Kiviter, like any large plant, is a matter of perspective. Up close, it is a collection of innumerable valves, pipes, wires, switches, and process units. Final design of improvements to the plant must take this perspective. This examination, however, has the objective of determining whether it is practical and wise to invest in RAS Kiviter and to make preliminary decisions on where these investments should be directed. The appropriate perspective of the plant for this objective is broader and more conceptual. Accordingly, the plant will be examined in five parts:

- retort, including the production of oil shale derived products other than those based on phenol
- dephenolization
- pyrolysis gas processing, including benzene, toluene, resin, and solvent production
- benzoic acid production
- electricity and steam production

D2. Retort

Oil shale processing is headed by Mr. Nikolai Petrovich. It is organized into four departments that operate with some degree of independence, but not as separate profit centers. The components are:

- Oil Shale Processing Plant, headed by Ms. Ludmilla Pallady

- Chemical Plant, headed by Mr. Nikolai Sedov
- Plant for Chemical Treatment and Gas Utilization, headed by Mr. Victor Ohtayer
- Division for Spent Shale, headed by Mr. Koslov

Mr. Petrovich identified the current principal products as shale oil, electrode coke, and retort gas for electrical generation in the plant. Former products were epoxy resins and alkyl resorcinols. Production of these could be resumed quickly if the market develops. Mr. Petrovich identified phenol derived products as having the highest potential, citing their value.

The principal pollution problems associated with the retort are the typical combustion products (SO_2, Nox, CO, and CO_2), phenol in the liquid waste stream, and solids, with particular concern about the oil bearing fuses. Dephenolization operates independently from the actual retort operation and is discussed separately in this report.

Pollution control activities in the retorting operation have focused on:

- improved process control
- recycling of the waste gases
- marketing of fuses
- mechanical improvements to the retort

The key to process optimization is, in the opinion of the retort engineers, accurate real time analysis of the retort gases. They have identified a gas chromatograph as the best instrument to provide the analysis. Data presented to the WEC in July 1992 showed substantial variability in the quality of the input shale over time, and between the three sources of shale used at the plant. This variability is at the root of the need to monitor and adjust retort operations continually, using data from the gas chromatograph. Two experts from the WEC, Dr. Moe Vadekar and Dr. Robert Kapner, both agreed that the gas chromatograph would provide the data needed for better process control, but were concerned about the difficulty of maintaining and using a chromatograph in the absence of factory support and maintaining a clean and constant operating environment. For example, use of the chromatograph would require a supply of laboratory grade hydrogen, and hydrogen generators are temperamental and costly. The RAS Kiviter engineers made a commitment to maintain the required environment for the gas chromatograph and to use pressurized cylinders of hydrogen. They stressed that their experience with the two gas chromatographs at the oil shale research institute demonstrated their ability to use one.

Several waste minimization activities were undertaken at the retort in the past year. Leaks were repaired in the condenser unit, reducing losses of phenol water and improving the potential for producing phenol-based products. Modifications were also made in the use of sprinkler water, reducing phenol water production from 360 l/ton to 140 l/ton of shale produced. This reduction in volume is for phenol water, not for phenol contained in the water. This means a higher concentration of phenol in the waste stream, another essential step back to production of phenol-based products.

Another major waste minimization activity has been the disposal of fuses, which are the asperitic solid residue of the retort. The plant is attempting to sell the fuses as paving material. They are having some success, but are not able to sell them all. There is hope that sales of fuses will increase with the national road improvement project undertaken by the central government. While this is a clever use of fuses, there are some potential problems. Experiments in Pennsylvania to use coal clinker and combusted mine waste (burnt culm) for paving were not successful. The road surface was very abrasive and, ultimately, collected a coating of rubber that was unsafe. It will be several years before it is clear whether similar problems will result from the use of the fuses.

Experiments have been conducted for separating oil from the fuses, but no program is in place for systematic recovery. The plant has no data available in English regarding the solvents tried, the separation process, the level of extraction, the quality of the extracted oil, or the environmental impact of the separation. Discussions with the retort engineers give the impression that these experiments were not high priority, systematic, or comprehensive.

The director of retort, Ms. Pallady, is currently working with the oil shale research institute on process optimization to reduce the production of fuses. These experiments are being conducted on one of the 1,000 ton/day retorts in unit No. 5. The experiments are examining the effects of temperature and time in the retort.

RAS Kiviter is working with Hamburg University in Germany to explore the combustion of fuses in a fluidized bed. A medium scale FBC (1 ton/hour) has been constructed. Combustion is at 600 degrees to 700 degrees. Data are not yet available on the performance of the combustor, but the principle is sound, and constructing a fluidized bed fuses combustor with very low emissions should be possible. Questions to be resolved involve the reliability of the unit and its cost.

On one retort, the plant has installed a new grating that uses a square grid rather than cylindrical tubes to improve efficiency and reduce emissions at the point where the oil shale is introduced into the retort. Ms. Pallady stated that the new grid was a success in qualitative terms. The monitoring program at RAS Kiviter does not measure before and after emissions. There are plans to install the new grid on other operating retorts as the maintenance schedule permits.

Ms. Pallady cited two priorities to improve retort operations. First is preheating the feedstock. RAS Kiviter analysis indicates that this will substantially reduce oil consumption. Further, the heat content of the product would increase threefold. The logic of preheating is apparent. Certainly it would improve efficiency and, depending on the energy source for preheating, could reduce emissions. Opportunities for heat recovery seem abundant in the plant, so preheating should be possible with little or no incremental emissions or energy use. The magnitude of the predicted increase in heat content seems unrealistic, but should be examined further.

Ms. Pallady's second priority is flue gas desulfurization. She agreed with the Arthur D. Little report that the existing system is not adequate. She referenced a study by a Russian

institute in 1972 to rebuild the system. The upgrade was never implemented. The study is not available in English. Ms. Pallady feels that there is no point in proceeding with the 1972 design as it is already obsolete. The Unocal retort in the U.S. may be a better model for RAS Kiviter, and she has requested information on the Unocal process.

The final topic of discussion in the USAID/WEC meeting with the retort staff was simulation tools. It is clear that Mr. Petrovich, Ms. Pallady, and her assistant, Mr. Shelov, are good engineers who have pursued many approaches to improving all aspects of retorting. The efforts listed above are only the high points of their activities. Their commitment to process improvement is obvious. The WEC suggested that they could make use of process simulation software. Ms. Pallady's response was immediate and positive. As is the case with the gas chromatograph, this measure would have a positive effect both technically and psychologically by encouraging these professional and highly motivated engineers and giving them the tools to improve operations.

The issue of maintenance was raised with the retort staff. They agreed that maintenance of the pipe systems was very poor. Maintenance is performed by a separate organization outside the retort staff's control. This lack of direct reporting was cited as a principal cause of the poor state of the plant. Mr. Petrovich felt that the maintenance staff had no accountability.

It was suggested that USAID make maintenance the first priority for investment. Mr. Petrovich strongly disagreed with this recommendation. He felt that resources within the plant are adequate to get maintenance under control, that organization is the principal issue, and that investments should be directed at more substantive measures.

The Arthur D. Little reports made numerous suggestions for improving retort operations and reducing emissions. These were reviewed with the retort engineering staff. Their conclusions follow:

- **Improved flue gas desulfurization.** The retort staff agreed this is a priority. They want to know more about the technology used on Unocal's retort.

- **Leaking tank farms.** RAS Kiviter engineers agreed that the tank farms are in very poor condition, but felt that the situation was not as bad as Arthur D. Little described, since production volume at the plant is far below capacity and not all tanks are needed. Only the better tanks are used.

- **High volume of air emissions from electrode coke production.** RAS Kiviter engineers agreed that emissions from the coking operation are a problem. They have evaluated the options and feel that a change in production technology is necessary. This will be costly—about $8 million.

- **Waste water from the oil shale retorting not sufficiently treated.** The plant engineers disagree, and believe that the upgraded waste treatment plant, currently

being designed with Finnish assistance, will address the residual problem adequately.

- **Insufficient removal of phenol from waste water.** This is discussed in the next section.

- **Waters not directed to the waste treatment plant.** RAS Kiviter engineers believe that the waters are treated at the plant to a reasonable level and will be diverted to the upgraded water treatment plant when it is operational.

- **The dust/heavy oil mixture is disposed of on ash mound.** The dust and heavy oils are not recycled.

- **The pipe systems are poorly maintained and not clearly marked.** This question was not addressed specifically. The poor condition of the pipes and lack of labeling are apparent from inspection.

Retort Operation Recommendations:

- Provide the requested gas chromatograph.

- Provide appropriate process simulation software and training in its use, after assessing current hardware capabilities and training needs.

- Provide reference materials on western flue gas desulfurization, specifically the Unocal retort.

- Press for data on the impact of the grate change on throughput and emissions.

- Obtain additional information on the impact of preheating the feedstock. For example, how was the estimate of a threefold increase in heat content determined?

- Conduct a more detailed analysis of preheating based on the RAS Kiviter work.

- Provide ISO 9000 standards to Mr. Petrovich to support his exploration of phenol-based products.

- Improve storage tanks in the tank farm to support the current level of production and even a modest gain (20 percent?). Identify the optimum tanks in terms of design, location, and current condition. Identify tanks that should no longer be maintained.

- Continue the sale of fuses for paving.

- Obtain information on approaches tried at RAS Kiviter to extract oil from the fuses, and identify other alternatives (e.g., frothing).

- Continue work with Hamburg University.

- Help RAS Kiviter establish a technical link between Mr. Petrovich, Ms. Pallady, and Mr. Shelov and western counterparts so that they have ready access to western technical resources to support their research.

- Help RAS Kiviter establish a system under which Mr. Petrovich obtains a higher measure of control over maintenance in his sphere of operations. Possible measures include:
  - bringing staff responsible for maintenance of retort and related operations under the direct supervision of Mr. Petrovich
  - establishing maintenance as a separate profit center paid by the retort only for work completed satisfactorily
  - establishing power generation as a separate profit center and paying for steam at the point of delivery.

D3. Dephenolization

The dephenolization unit processes the phenol water from the retort. Phenol is extracted for environmental cleanup. The phenol is currently returned to the retort and burned. Previously it was sold and used as a feedstock for various chemical products. The sale of phenol was discontinued due to a decline in phenol prices. Production of phenol-based products was stopped in part because of the poor quality of the phenol produced at the plant.

The initial impression on visiting the dephenolization unit is that the process equipment is in relatively good condition and free of obvious leaks. There appears to be greater attention to maintenance here than in other parts of the plant. The managers reported that they recently completed an overall cleanup of the equipment, and the results of their effort were apparent. There are two dephenolization lines. Both are operable, but only one is in use. The second is not needed because of reduced production and a reduced volume of phenol water from the retort as a result of conservation efforts.

The principal concern of the dephenolization managers is the concentration of phenol in the water after processing. This concern is preeminent because the phenol is not used chemically at this time. About $50m^3$ of phenol water are received for processing each hour. The concentration of phenol in the incoming water varies, but averages 10g/l. After processing, the average concentration is 0.3 to 0.4 g/l., but can be as high as 0.7 g/l. The variation in output concentration is principally due to variation in the incoming concentration but imperfect control of the process is also a contributing factor.

The second concern at the dephenolization unit is the consumption of the solvent—butyl acetate. The current rate of consumption is 36kg of phenol water processed.

These losses were studied intensively during a recent 10-day period. The amount of butyl acetate supplied to the process following start-up was measured carefully. Then, the concentration of butyl acetate emitted to the air and retained in the phenol and in the dephenolized water was measured. Total consumption was 79.1 kg per ton of phenol produced. The methyl acetate concentration of the phenol was 2.2 percent. The dephenolized water contained 5.7mg/l. The remainder was either emitted to the air or decomposed during the process. Butyl acetate emissions were roughly calculated from data in this analysis. Emissions were estimated to be ca. 4 tons/year. This is substantially lower than the estimate of 14 tons in the Arthur D. Little report. Engineers in the dephenolization section felt that the lower number was more accurate. In the final meeting, however, Mr. Rooks reported measured emissions of 36 tons. There are several possible explanations for this discrepancy:

- The dephenolization plant operated better during the test period than at other times. This is a reasonable assumption, since the unit was cleaned and refurbished immediately before the test. Also, it is not unreasonable to speculate that operations were done more carefully during the test.

- The emissions reported by Mr. Rooks include emissions from other parts of the plant, though there is no apparent source of methyl acetate emissions other than, possibly, solvent storage.

- Processing rates were lower for the test period than for the full year.

Substantial additional information would be necessary to resolve the discrepancy and is not essential for this strategic study of the plant. However, in the course of a detailed design for the demonstration project, the discrepancy would clearly be among the issues addressed, e.g., in the context of redesigning an in-plant monitoring program.

Dr. Mo Vadekar suggested that isopropyl ether might be a better solvent and would be less likely to decompose in the process unit. The dephenolization engineers confirmed this, but said that isopropyl ether was not available. They stated, however, that they were experimenting with a "secret" new solvent, produced from locally available materials, which resulted in a threefold decrease in solvent consumption. It is not possible to comment further on the performance of this solvent without additional information.

The operators of the dephenolization plan were asked to list their priorities for process improvement. They stated that they would prefer a new process unit that was not counterflow, but this is not now feasible. In lieu of a new process unit, the highest priority is a new control system. The control system, like that for the retort, was largely, if not entirely, manual. The control room was clean and orderly. Data were logged by means of strip chart recorders, some of which were inoperative, and some of which had damaged squibs or squibs without ink. The dephenolization managers said that a new control system has been designed by Russian engineers, but that there was not enough money for its implementation.

Dephenolization Recommendations

- Investigate reasons for variation in butyl acetate emission measurements.
- Investigate the availability of isopropyl ether as a replacement solvent.
- Review the Russian design for the new control system and determine if it is appropriate for implementation.
- Implement a new, automatic control system retaining the hydraulic links to the process monitors and controls.
- Continue experimentation with the solvent produced at RAS Kiviter.
- Recognize the achievement of the dephenolization engineers and staff for maintaining their equipment comparatively well.

D4. Pyrolysis Gas Processing—Benzene/Toluene Production

Benzene and toluene (b/t) production uses pyrolysis gas (pygas) as a feedstock. The pygas is reported variously to be obtained (1) directly from Russia, (2) from Russia through a Finnish broker, and (3) from various sources. Previously, the gas was obtained from the processing of oil shale, but this was not satisfactory. The meeting on the pygas processes was attended by Mr. Sergie Golubev, principal deputy of aromatic hydrocarbon production, Ms. Irina Federova, an engineer in the technology department, Mr. Tonis Pussepp, the chief technologist, and Mr. Ivar Rooks, the technical director of the plant.

The discussion began with a complete and systematic description of the process. The basic process flow as shown in the Arthur D. Little reports (p. 33) was confirmed in all details. Some additional information was obtained:

- The rectification cut for chemical production is from 130 to 150 degrees.
- The cut for styrene production is from 150 to 180 degrees.
- The acid used to purify the benzene is then used the treat the toluene.

The purpose of using the residue of benzene purification for toluene purification is to reduce the consumption, emissions, and contamination of the sulfuric acid. The sulfuric acid process is the central problem in b/t production at RAS Kiviter. This is an obsolete process that produces an inferior product and higher emissions. Engineers at the plant recognize this problem and would prefer to make fundamental changes in the process if money were available. Nevertheless, they appear to have done a reasonably competent job of optimizing the process. Dr. Mo Vadekar reviewed the process at some length. RAS Kiviter staff have considered many of the options suggested by Mr. Vadekar, with two notable exceptions. First, Dr. Vadekar suggested heat soaking prior to rectification to polymerize the fractions over 180 degrees to improve product purity. Mr. Rooks felt that their process effectively accomplished this through a series of ovens providing sufficient residence time. The careful

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notes taken by Mr. Pussepp and Mr. Golubev indicate, however, that they had not considered this option. Up to this point in the discussion they had not opened their notebooks.

The second of Dr. Vadekar's suggestions concerned a basic process change that would focus exclusively on b/t production rather than their production in conjunction with chemicals (a dark varnish and solvents) and styrene resins. Mr. Rooks rejected this option, citing the imperative for the subsidiary products. The conclusion, however, was not based on analysis of the markets for the different chemicals.

Given this constraint, which may be artificial, no readily apparent way exists to improve the rectification and pyrolysis steps. Focusing on the cleaning step, the clear alternative to using sulfuric acid is hydrogenation. This would substantially improve the quality of the product, which is essential to sustain the market given increasing customer emphasis on purity. The critical element to this change is a supply of hydrogen. Tentatively, it was proposed that hydrogen could be obtained from the fertilizer plant and purified in sufficient quantity using a membrane technology.

When asked about his priorities for the unit, Mr. Rooks expressed his conviction that heat soaking to a limited extent will be the fundamental process change.

Suggestions:

- Emphasize housekeeping. Of all areas of the plant visited, this area had the most leaks of both steam and process fluids.
- Develop a basic design and rough cost estimate for a hydrogen process to replace the sulfuric acid process using hydrogen from the fertilizer plant.
- Conduct a realistic market analysis for all of the products associated with b/t production to estimate sales as a function of quality so that the basis for setting purity standards and evaluating possible product changes is sound.
- Develop a preliminary design and estimate of the cost for heat recovery and preheating.
- Develop a process model to assess the value of heat soaking, and the extent to which the desirable polymerization is accomplished in the unit as now constituted and with preheating.

D5. Benzoic Acid Production

Benzoic acid is made at RAS Kiviter from the catalytic oxidation of toluene in the liquid phase. The toluene is produced from pyrolysis gas, as discussed in the previous section. The benzoic acid is sold in crystalline form as a preservative and chemical intermediary. Production is about 60 tons per day.

The reaction is highly exothermic, so productivity and product quality are highly dependent on good temperature control and suppression of byproduct formation. The principal engineers of the benzoic acid plant (Mr. R. Magsumov and Mr. N. Ostrouhko) have identified better temperature control as their highest priority both to reduce waste and to improve product quality. They have asked the WEC to provide a sophisticated temperature control valve and, in a series of discussions, developed specifications to which the WEC responded with a proposed valve. Discussions in January during the USAID site visit brought the negotiations over the specifications for the valve essentially to closure. The WEC is expected to provide this valve in the near future. The principal environmental problems associated with benzoic acid production at RAS Kiviter are:

- dust from the loading operation
- toluene lost to the atmosphere
- reactor residue with various contaminants (particularly acid hydron, Na_2SO_4, phenols, and oil residues)
- acid waste water

Dust was particularly problematic in the past. Visitors to the plant reported very high levels of dust in the loading area, to which workers were exposed without protection. Plant engineers have been working on this problem. Their strategy was to improve extractive ventilation with a dust trap, and to improve an automatic loader that spills benzoic acid. The plant engineers consider the dust problem largely solved. They report only trace emissions of dust. This improved ventilation system was cited as the highest priority for the benzoic acid plant in the Arthur D. Little report. Mr. Magsumov reported that the objectives of the Arthur D. Little report have been fully met, at a much lower cost than estimated.

Similarly, emissions of toluene (which were reported at 531 tons in 1992 by Arthur D. Little), are reported to have been reduced by at least half by adding a second processing stage. Following good practice, toluene is extracted from the exhaust gas and recycled to the process unit.

The acid waste water can readily be treated. It needs simply to be neutralized, since the low concentration of benzoic acid is not toxic. Disposal on the alkaline may be adequate. The plant is pursuing a more clever solution, however. It is attempting to sell the waste water as a silage preservative with some initial success. Since it currently market a silage preservative (Siloben), the plant is familiar with the market and so may be successful. A few initial sales have been made.

The solid waste problem remains problematic and symptomatic. It is problematic because of the volume (ca. 8,000 tons per year), and symptomatic because the waste contains more than 1,200 tons of benzoic acid, which is not being recovered. Currently, the plant reports 70 percent recovery of benzoic acid. Comparable plants in the United States recover 90 percent. This low recovery rate is possibly due to two root causes—(1) suboptimal process conditions and 2) contamination of the product with terepthalic acid (TPA).

Process control focuses on the high pressure of the process (90psi), which is higher than in the U.S., and imprecise temperature control, which will be addressed in part by the new valve. Mr. Magsumov and Mr. Ostrouhkov said that the operating pressure was worked out in process design and was verified experimentally. They were confident that 90psi is essentially correct. They are currently experimenting with varying the temperature of the process between 170 and 180 degrees. Within these general operating parameters, the next issue is precision. Better process control was cited by the plant engineers as their single highest priority. They stated that an initial feasibility study had been done for the process controls but did not progress to the design stage. They were unable to provide an estimate of the cost of the control system.

The other principal concern of the Benzoic acid staff was the purity of their product. Contamination with TPA is also a factor in the low recovery rate and attendant large volume of solid waste. The principal contaminants include benzyl alcohol, benzyl benzoate, benzyl aldehyde, diphenyls, toluene, and terepthalic acid.

Beyond process control, the effort to improve the quality of the product, and particularly to reduce the concentration of TPA, has focused on the catalyst. The catalyst used is cobalt-manganese napththenate. This was supplied by Russian sources prior to Estonian independence. Mr. Magsumov felt that the quality of the catalyst was good, but he did not have specific data for the catalyst either when it was new or after recovery. Catalyst quality is a clear priority for further research.

Beyond reducing residue, the solid waste must be treated properly. The acid hydron and Na_2SO_4 are discharged to a settlement pond and subsequently to the river. Plans for the plant call for discharge to the water treatment plant when the planned upgrade is complete and the plant is able to accept the waste. The phenols and oil residues are burned at the retort.

Benzoic Acid Recommendations

- Monitor emissions more closely as resources allow, and provide emissions data to benzoic acid plant to support further emissions reduction.
- Measure levels of dust in the loading area to confirm that the additional ventilation and loading equipment have reduced worker exposure to dust to acceptable levels.
- Continue to experiment with the relationship between temperature and product purity.
- Review selection of 90psi as process pressure, using process model and subsequent experiment.
- Analyze the catalyst and compare to specifications for catalysts used by Western producers of benzoic acid and/or ISO 9000 specifications.

- Resurrect available documentation on past redesign of the process control system and consider whether it should be updated as a possible improvement project.

- Engage U.S. experts in further investigating the possible causes of the TPA contamination and low recovery rate.

- Explore the use of another catalyst.

D6. Power Generation

Power and steam generation for the plant is done at a central boiler complex. Power operations are headed by Mr. Yuri Utt. The boiler complex currently has four boilers:

Two Type E-50-30G (Numbering convention is not familiar)
Capacity: 49 MW, Temperature 350 +/- 10, pressure: 2.4MPa

Two Type E-75-40G
Capacity: 68 MW, Temperature 430 +/- 10, pressure: 4.0MPa

An additional boiler of the second type has been purchased but not installed. All of the boilers are of Russian design and were manufactured at the Belgrade boiler plant. Mr. Utt reports that they are in very good repair. One of the smaller boilers is not currently operating.

The boilers are all fueled by gas from the retort. At present, there is a surplus of gas, which, if not burned, is recycled to the retort as an emissions control measure. This is essentially a waste of this valuable fuel, which could be used to supply a greater fraction of the plant's electrical demand. The highest pressure demand for steam at the plant is 1.2MPa from the high pressure boilers, and 0.7MPa from the lower pressure boilers. At present, these lower pressures are achieved using pressure reducing valves. The pressure differentials are sufficient for moderate scale cogeneration. Additionally, the idle but operational boiler could be used strictly for electrical generation in the near term, and to supply steam if production at the plant can be increased. The unmounted boiler could also be brought on line for electrical generation and future steam generation, without electrical generation exceeding the plant's requirements and bringing RAS Kiviter into direct competition with the state electrical utility.

A preliminary design for expanded generating capacity has been completed. Generation from the available steam was estimated to be 5-7MW. A 12 MW turbine from the Kaluga turbine plant in Russia was specified. Another proposal for electrical generation along the same lines was developed by a U.S. firm, Legis Corporation. The proposal from Legis was not made available, so it is not clear how complete the Legis system design was.

Mr. Utt provided an analysis of the project in Russian. The basic elements are that the system will be capable of generating power at near the current rate of purchased power (ca. 0.20 EEK/Kwh). Since the price of power from Eesti Energia (the state utility) is

expected to increase by a factor of four over the next seven years, the project will provide a very quick payoff. The white paper on cogeneration does not include maintenance costs or credit for reduced air emissions.

The key issues in the cogeneration project are financing and logistics for specifying, purchasing, and installing the equipment. While the RAS Kiviter plant could handle these issues, it may be easier to arrange financing by establishing an independent power production company that has a contract with RAS Kiviter to purchase steam and to sell back electricity. RAS Kiviter could be an equity partner or not as the plant management prefers. A turbine supplier or established IPP could be the managing partner in the company or maintain a large minority share.

RAS Kiviter's operations are organized so that the central power plant is responsible for all of the steam lines to the point of their connection to process units. Steam leaks, some very large, were common throughout the plant during the January visit, and large sections of insulation were torn or missing. The maintenance of the steam delivery system is clearly falling through the cracks. The process unit managers do not accept responsibility, and the attention of the power generation staff is clearly focused on the electrical side of their operation. The poor state of the steam lines in January may not be typical, since maintenance of non-critical components is largely confined to the summer months, but it is difficult to imagine that the lines leaking so badly in January were tight and well insulated in September.

Recommendations:

- Obtain and review the Legis proposal.
- Review the Utt analysis of generator capacity and specifications.
- Assess the environmental benefit of increased generation at RAS Kiviter based on more efficient use of the retort gas and displaced generation from Estonian central power plants.
- Obtain estimates for the cost of generating equipment from several suppliers (U.S. and European). Candidate companies are ABB, Westinghouse, GE, and Siemens, among others.
- Evaluate the financial viability of the cogeneration project at various scales, with several assumptions regarding the cost of purchased power.
- Conduct on-site verification that the boiler plant is in good condition as represented by plant management.
- Assess the feasibility of RAS Kiviter to sell power to Eesti Energie if further expansion of generating capacity is possible.

- Evaluate development of the cogeneration project by an established independent power producer in partnership with RAS Kiviter.

E. Overview of the Plant and Suggestions for Action

On arriving at RAS Kiviter, you first see four large unfinished retorts in an open framework. They are rusting and there are no plans to finish them. Next you notice the smell. It is uniquely RAS Kiviter's and pervades everything. Your first impression on entering the plant is of neglect and decay. Walls are cracked, pipes and reactors are leaking, all exposed metal is rusting, abandoned parts are laying about, insulation hangs uselessly from pipes and walls, and odd holes in the ground lead to eroded cavities. The sight is profoundly discouraging.

It contrasts with the photos in RAS Kiviter's brochure, printed about 10 years ago, and the pictures of the plant on the director's wall. There you see a modern plant, in good order. Somewhere in the past decade something went seriously wrong. RAS Kiviter no longer seems able to heal the damage and wear that come from operations. The immediate challenge faced by any USAID funded demonstration project would be to determine whether this trend can be reversed or whether RAS Kiviter is in an unstoppable decline.

RAS Kiviter's precipitous decline has three causes. First was the shortage of spare parts. During the initial years of Estonian independence, the plant was cut off from its Soviet suppliers and engineering support. Second was a failure to invest in the plant. In the hard times that Estonia has suffered, it was difficult to justify long-term investments. Immediate needs took precedence. Third was human neglect. Even repairs of leaking pipes, which require no parts and almost no investment, are left undone. The disorder is symptomatic of a lack of concern.

Of these three factors, the last is of greatest concern. Parts are now available, and their availability will increase as the plant moves towards western technology. The assessment of the plant's viability presupposes some investment or at least reinvestment of the profits. These two factors alone, however, cannot reverse RAS Kiviter's decline. There must be a shift in attitudes of the plants managers and workers. They must understand that the plant's survival is at stake, that neither success nor failure is inevitable, and that their personal efforts will help determine the outcome.

During the USAID site visit in January, the team spent many hours talking to the engineers who run the plant. The data collected in those visits form the bulk of this report. These visits also helped answer whether the people of RAS Kiviter have the personal resources and motivation to save the plant. Without exception, all of the engineers interviewed were very capable and clearly dedicated to doing a good job. None of them denied the poor state of the plant. They were full of ideas to make things better, and were all actively engaged in experiments to improve operations. When pressed hard technically, they all showed their mastery of the processes. The engineers of RAS Kiviter are as impressive as the plant is discouraging.

This chapter concludes with specific suggestions about actions that RAS Kiviter, the WEC, and USAID can take to improve the plant's efficiency and reduce emissions. Beyond these specific actions, however, it is critical to organize the plant to empower the process managers to take initiative and to reward individuals at all levels for their contributions to the plant success. Each process area and each group, including waste disposal, power generation, and maintenance, must operate as separate profit centers. The supporting organizations must receive credit only for successfully completing services. Finally, the plant must have leadership, not just management. The leaders of the plant must speak openly and honestly to the workers, engage them in developing strategies, and instill in them a sense that the plant can be successful. This may sound like cheerleading, but apathy must be reversed if RAS Kiviter is to survive and prosper.

Exhibit III.5
Specific Actions for RAS Kiviter, the WEC, and AID

RAS Kiviter

- Evaluate the cost of resuming production of phenol-based products that meet ISO 9000 product standards.
- Aggressively pursue the use of fuses in the upcoming Estonia paving project.
- Continue to pursue the work with Hamburg University.
- Establish a system under which process unit managers have a higher measure of control over maintenance in their sphere of operations.
- Continue experimentation with the solvent produced at RAS Kiviter.
- Recognize the achievement of the dephenolization engineers and staff for maintaining their equipment comparatively well.
- Emphasize housekeeping in the pyrolysis gas line.
- Develop a basic design and rough cost estimate for a hydrogen process to replace the sulfuric acid process in b/t production. Assume the use of hydrogen from the fertilizer plant.
- Conduct a realistic market analysis for all of the products associated with benzene/toluene production to estimate sales as a function of quality, so that the basis for setting purity standards and evaluating possible product changes is sound.
- Develop a preliminary design and estimate of the cost for heat recovery and preheating.
- Develop a process model to assess the value of heat soaking and the extent to which the desirable polymerization is accomplished in the unit, as now constituted and with preheating.
- Monitor emissions more closely as resources allow, and provide emissions data to process managers to support further emissions reduction.
- Provide workers with dust masks, respirators, and hard hats.
- Measure levels of dust in the benzoic acid loading area to confirm that the additional ventilation and loading equipment have reduced worker exposure to dust to acceptable levels.
- Continue to experiment with the relationship between temperature and product purity in benzoic acid production.

- Review selection of 90psi as the benzoic acid process pressure, using process model and subsequent experimentation.
- Resurrect available documentation on past redesign of the process control system and consider whether it should be implemented or updated.
- Explore the use of another catalyst for benzoic acid production.

World Environment Center

- Provide the requested gas chromatograph.
- Provide appropriate process simulation software and training in its use.
- Provide reference materials on western flue gas desulfurization and, specifically, the Unocal retort.
- Provide ISO 9000 standards to Mr. Petrovich to support his exploration of phenol-based products.
- Verify that the upgraded municipal/industrial waste water treatment plant will be adequate for the plant's needs.
- Establish a technical link between Mr. Petrovich, Ms. Pallady, and Mr. Shelov and western counterparts so that they have ready access to western technical resources to support their research.

Agency for International Development

- Provide appropriate process simulation software and training in its use.
- Press for data on the impact of the change in the grate on throughput and emissions.
- Obtain additional information on the impact of preheating the feedstock—for example, how was the estimate of a threefold increase in heat content determined?
- Conduct a more detailed analysis of preheating based on the RAS Kiviter work.
- Support RAS Kiviter in evaluating the market for phenol-based products.
- Verify that the upgraded municipal/industrial waste water treatment plant will be adequate for the plant's needs.
- Improve tanks in the tank farm to support the current level and achieve some modest gain (20 percent?). Identify the optimum tanks in terms of design, location, and current condition. Identify tanks that should no longer be used.
- Obtain all available information on approaches tried at RAS Kiviter to extract oil from the fuses, and identify other alternatives (e.g., frothing).
- Investigate the availability of isopropyl ether as a replacement solvent for dephenolization.
- Review the Russian design for a new dephenolization control system and determine if it is appropriate for implementation.
- Implement a new automatic control system, retaining the hydraulic links to the process monitors and controls.
- Establish a system under which process unit managers have a higher measure of control over maintenance in their sphere of operations.

- Develop a basic design and rough cost estimate for a hydrogen process to replace the sulfuric acid process in b/t production. Assume the use of hydrogen from the fertilizer plant.
- Conduct a realistic market analysis for all of the products associated with b/t production to estimate sales as a function of quality, so that the basis for setting purity standards and evaluating possible product changes is sound.
- Develop a preliminary design and estimate of the cost for heat recovery and preheating.
- Develop a process model to assess the value of heat soaking and the extent to which the desirable polymerization is accomplished in the unit as now constituted and with preheating.
- Provide workers with dust masks, respirators, and hard hats.
- Analyze the catalyst and compare to specifications for catalysts used by Western producers of benzoic acid and/or ISO 9000 specifications.
- Resurrect available documentation on past redesign of the process control system and consider whether it should be updated as a possible improvement project.
- Engage U.S. experts in further investigating the possible causes of the TPA contamination and low benzoic acid recovery rate.
- Explore the use of another catalyst for benzoic acid production.
- Obtain and review the Legis cogeneration proposal.
- Review the Utt analysis of generator capacity and specifications.
- Assess the environmental benefit of increased generation at RAS Kiviter, based on more efficient use of the retort gas and displaced generation from Estonian central power plants.
- Obtain estimates for the cost of generating equipment from several suppliers (U.S. and European). Candidate companies are ABB, Westinghouse, Siemens, among others.
- Evaluate the financial viability of the cogeneration project at various scales, with several assumptions regarding the cost of purchased power.
- Conduct on-site verification that the boiler plant is in good condition as represented by plant management.
- Assess the feasibility of RAS Kiviter to sell power to Eesti Energie if further expansion of generating capacity is possible.
- Evaluate development of the cogeneration project by an established independent power producer in partnership with RAS Kiviter.

SECTION IV
ENVIRONMENTAL INSTITUTIONAL AND REGULATORY COMPONENTS OF PROJECT FEASIBILITY

A. Estonian Environmental Management System

Estonia's system for environmental management is divided into national and regional (county or district) spheres. This division has come about mainly since independence from the former Soviet Union. This section will summarize the roles and responsibilities of each jurisdiction.

A1. National-level Roles and Authorities

The Ministry of the Environment (MOE) is the principal environmental authority at the national level. Its mandate covers:

- legislation and regulations
- policies and strategies
- coordination of activities and research on the environment
- organization of monitoring
- environmental impact assessment of nationally important projects
- management of protected areas
- environmental staff training
- promotion of environmental education and coordination of international cooperation on the environment.

In addition to environmental management, the Ministry's mandate also encompasses forestry and fisheries. These are departments within the Ministry reporting directly to the Minister.

The primary legal basis for Estonian environmental protection is Article 53 of the new Constitution of the Republic of Estonia, which states: "Everyone shall be obligated to preserve [the] human and natural environment and to compensate for damages caused by him or her to the environment. The procedures for compensation shall be determined by law."[1] The specific framework for environmental protection is contained in the Law on the Protection of Nature in Estonia, approved on February 23, 1990. Media or resource-specific laws have also been approved or are being developed.

[1] National report of Estonia to UNCED, prepared by the Ministry of Environment of Estonia, Tallinn: Ministry of Environment, 1992, p. 34.

A2. District Roles and Authorities

District and Municipal Environmental Boards have existed since 1990 and are relatively independent of the MOE since they report to local government authorities.[2] Nineteen such boards exist for 14 counties and five municipalities. Staffing has been highly variable, with a sophisticated operation in Tallinn but only citizen volunteers in some of the smaller boards. In some cases, industrial enterprises do not take the environmental boards seriously because they are unable to engage in a technical dialogue with them (on compliance, monitoring, etc.).[3] However, close coordination and informal relationships between national and district levels do exist. District environmental boards are responsible for issuing licenses and permits for exploiting natural resources and pollution discharge; monitoring and regulating polluters, including the collection of fines, fees, and other charges; and undertaking environmental impact assessments of proposed projects within their jurisdictions that are not of national importance.

This feasibility study focuses specifically on the Environmental Board of Ida-Virumaa District, which is where the RAS Kiviter plant is located.

A3. Roles of NGOs and the Public and Private Sector

The locus of public participation and influence over decision-making on environmental matters is more concentrated at the district than national levels. Formal mechanisms, such as hearings, for incorporating public comment and input to regulation and investment decisions is still relatively nascent. One encouraging sign is the recent setting up of a Sustainable Development Commission for Northeast Estonia. This commission, initially funded by an Estonian environmental non-governmental organization, the International Institute for Environmental Technology and Management, and politically supported by the MOE, is a three-year effort to develop a dialogue with industry, the public, NGOs, and the government on a practical sustainable development approach to the region's future economic development.[4] As is the case in other countries of the region, environmental NGOs of various types are also involved in supporting protection of endangered habitats and in environmental education.

State and academic research institutes are also involved in environmental management with government and non-government entities, including emerging private sector enterprises. These relationships are still evolving, a consequence of the drastic "downsizing" caused by a dramatic decline in funding, especially of the National Academy of Sciences network of research institutes, when Estonia became independent. This decline has affected all scientific and technological research, not just those in natural resources and the environment (the more

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[2] Ibid., p. 34.

[3] World Bank Country Economic Mission, Aide-Mémoire, Annex 2-Environment Sector, prepared by Ministry of Environment of Estonia, Tallinn: Ministry of Environment, January 1992, p. 10.

[4] From an interview with Ms. Kaja Peterson, SEI/Tallinn, January 1994, Tallinn.

widely used term in Estonia is "ecology" for "environmental" subjects). Many researchers left to join the private sector, while others have tried to maintain a more restricted research program. The number of active researchers has declined greatly and many research programs have all but ceased.[5]

B. Environmental Economic Instruments and the Environmental Fund

B1. Environmental Charges

Since 1990, a government regulation ordering a system of "charges and taxes in nature management" has been in force. This system consists of resource taxes, pollution charges, and fines for violating environmental laws and regulations. The revenue from these various charges is divided between the local environmental board, which collects the various charges, and the National Environmental Fund, which was established in 1983.

The following instruments are used in Estonia:[6]

- **Natural resource charges.** Assessed on the exploitation of oil shale, natural building materials (e.g. timber and stone), peat, and water. As is the case with most European countries, the State owns all sub-soil mineral rights.[7] Natural resource charges are based on the volume of the resource *used* rather than the amount *produced*, so as not to penalize actual production. The charges are aimed at conserving the resource as well as providing funding for restoration. The resource charges are divided between national and local budgets by varying ratios. For example, 80 percent of water charges go to the national budget and 20 percent are retained locally, while the national-local ratios for oil shale are (50:50), construction materials (30:70) and timber (100:0). In 1991, at least, the actual rate of the individual resources taxes was not based on an evaluation of their real market scarcity or tradeable value and hence did not have any significant conservation or resource allocative impact. Since the Estonian Government has made an essentially non-market decision to continue to exploit oil shale as a resource for electricity generation and chemical manufacture, the resource charge is mainly for revenue generation.

- **Pollution taxes.** These taxes are assessed on set levels for specific media. Threshold levels are set in which pollutant discharges beyond a specific threshold trigger a multiplier in the amount of assessed tax. Water pollution taxes have been set for the following pollutants: BOD_{total}, suspended solids, oil products, phenols, total phosphorus, total nitrogen, sulfates, and fats. Air pollution taxes are set not

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[5] Interview with Professor Dimitri Kaljo, Estonian Academy of Sciences, September, Tallinn, 1993.

[6] National report of Estonia to UNCED, op. cit., 1991, p. 36.

[7] "Natural resources pricing and taxes in Estonia: Issues and Selected international experience," by Roger A. Sedjo, HIID Environmental Economic Policy Paper, Cambridge, MA: HIID, 1993, p. 14.

only by pollutant but also by the area polluted. The latter is determined by defining a circle the radius of which is 80 times the stack height of the pollution discharge point. Taxed pollutants include SO_2, CO, non-toxic dust, oil shale fly ash, other ash, and NO_x calculated through NO_2. Other pollutant taxes are based on their MPCs (see below).

Waste taxes. Taxes for solid and other kinds of waste are based on their toxicity class. Discharges in excess of a determined limit are charged progressively.

B2. Economic Incentives

Enterprises that reduce their pollution by at least 25 percent through environmental protection investments are relieved of pollution taxes in the value of 1.5 times their investment. It is not clear whether investments in waste minimization or energy conservation, both of which reduce pollution but might not be classified as "environmental protection" investments, would also qualify for the tax relief.

The various charges and taxes described above have different final dispositions. Natural resource charges are divided between national and district budgets, as noted. The ratio between the two budgets depends upon the particular resource and the amounts allocated to the national budget range from 30 percent-100 percent. Fines for pollution emissions in excess of permitted levels are paid into the district budget, while regular pollution charges, i.e., for permitted levels, are paid into the Estonian Environmental Fund.

B3. Enforcement Issues

While it is evident that Estonia has already adopted a partially market-based approach to environmental management to complement the traditional command and control approach, the fact that the country remains in a state of transition to a full market economy has tended to mitigate the effectiveness of these economic instruments. This is particularly the case for the large state-owned enterprises, such as RAS Kiviter, which have not yet assumed full accountability for their finances. In cases in which a plant actually pays the fines, its soft budget constraint shields it from being compelled to find ways of operating more efficiently and minimizing waste generation to avoid the fines and charges. In 1991, environmental fees and fines were reported as averaging between 5 percent-25 percent of total profits of those firms which were charged.[8] It is not known how these percentages were calculated (since virtually all firms were state-owned at the time). Nevertheless, if these firms were operating on a truly market basis, even this level of financial impact would likely have been a major incentive to reduce emissions.

In the event that fines do not result in compliance, the District Environmental Board has the power to shut down a factory or the particularly offending process. While extreme,

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[8] World Bank Country Economic Mission, op. cit., p. 6.

this measure has been used in the past in Estonia. A closure decision can be appealed to the MOE. A Parliamentary-appointed Chief Environment Inspector makes the final decision.[9]

B4. The Environmental Fund

National and district budgets provide for environmental monitoring, staffing, and construction of environmental protection facilities. An off-budget mechanism, the Environmental Fund, established in 1983, provides a separate source of financing for a wide range of environmental activities. These include:

- financing of national, regional, and local environmental programs in addition to state and regional budgets
- improving the environmental monitoring system
- international cooperation
- staff training
- environmental awareness
- updating environmental information
- awards and stipends, contests and competitions related to the environment
- environmentally sound technology and scientific research funding

Half of the funds designated for the Fund are provided to the National Fund, while the other half remain with the District authorities. Decisions on the use of the National Fund are made by a board that includes representatives of national and district environmental authorities, ministries of finance and economy, environmental NGOs, and scientists. The use of district funds is decided by a locally appointed board. In 1991, the Environmental Funds capital amounted to SUR 56 million.[10]

C. Relationship of Ida-Virumaa Environmental Board and RAS Kiviter

C1. Monitoring of Environmental Emissions

Monitoring pollution discharges, in all media, is based on the old Soviet system of "maximum permissible concentrations" (MPC). MPCs define the allowed concentrations of specific pollutants in all media. The system has several deficiencies, including (a) far too many standards to practically measure and analyze (there are 1300 for water alone) and (b) the MPCs are often far too strict to be "practically achievable," which has led to their being ignored. This has made negotiating or enforcing compliance with standards extremely difficult, simply on a credibility level. Estonia aims to reform its system of environmental quality standards more along the lines of Western Europe, based on a concept of permissible amounts per unit of production.[11]

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[9] Ibid., p. 6.

[10] National report of Estonia to UNCED op. cit., 1992, p. 37.

[11] Ibid., p. 36.

During the field visit for this study, key staff from the Ida-Virumaa Environmental Board were out of the country. However, it was reported that the Board operates one air quality monitoring unit (a Swedish OPSIS system) mounted at Kohtla-Järve's City Hall. In addition, a 1991 report stated that the Hydrometeorology Institute conducted continuous monitoring of air emissions in several towns in the area around RAS Kiviter and that the company itself has three monitoring stations.[12] The air emissions data reported in Section III did not identify the location of the station.

C2. Enforcement of Regulations

Compliance schedules and negotiations. We were informed[13] that present relations between the new management of RAS Kiviter and the Ida-Virumaa Environmental Board are not close. The new general director, for example, had not yet met the head of the board after five months in office. No active negotiations appear to be under way between the two parties regarding compliance with the company's pollution permits or setting up a management plan to tackle environmental problems posed by the plant. It appears that the chief engineer of the plant (the technical director) along with the chief of the plant's Environmental Division, are the ones who have the most contact with the Environmental Board.

The Environmental Board, for its part, has some good staff, in particular, Mr. Antti Roose, who has an advanced degree and is very active on the board (as its advisor). However, the team was not able to assess the overall competence of the Ida-Virumaa Board or its plans for dealing with the chemical companies and other polluters within its jurisdiction.

Fines, user fees, and other charges. In 1991, it was reported that waste charges imposed by the District Environmental Board on RAS Kiviter for all media amounted to SUR 5.5 million. In the summer of 1993, RAS Kiviter was in arrears with its environmental charges and fines by EEK 4 million (about $317,460 at that time). Most of that amount was for water charges and pollution. According to Mr. Rooks, permitted water charges were 10 times higher than permitted air emission charges.[14]

D. Study Recommendations

This study recommends that the proposed demonstration project's efforts to bring the plant into compliance with Estonian Government environmental regulations be integrated with assistance to the plant for management and financial restructuring. As is evident from Sections II and III, a significant part of RAS Kiviter's emissions in excess of permitted levels and probably some of permitted amounts could be avoided through restructuring and

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[12] World Bank Country Economic Mission, op. cit., p. 6.

[13] Interview with Mr. Alan Gromov, councillor, Estonian Ministry of Environment, Tallinn, January 1994.

[14] Interview with Mr. Ivar Rooks, technical director, RAS Kiviter, September 1993.

improved management, along with a rigorous program of waste minimization. A second reason for adopting this approach is to emphasize positive, internally rational reasons for reducing pollution and waste in the plant: i.e., that such an approach reduces the costs of production (waste of raw material, energy and expenses for pollution fines), improves relations with the community, and improves the local ecology and quality of life, which are high local priorities. To the extent that waste minimization leads to significant economies and efficiency gains, internalizing good environmental management may help save the plant and hence the local economy and livelihoods of its workers. At this stage in the firm's transition, the feasibility study team felt that a special project component on compliance, separate from the management component, would send the wrong signal to the firm's management, namely, that compliance with environmental regulations was an externality and an additional cost to production, essentially unrelated to the overall management of the firm. This is, of course, precisely the opposite of what is being proposed.

A number of specific recommendations can be made:

- Initial steps have reportedly been made to work out a compliance schedule for air pollution emissions with the county Environmental Board.[15] These should continue, perhaps with the assistance of a conflict resolution team, which would identify the stakes and common grounds of each party.

- The access of the plant to loans from the National Environmental Fund needs to be clarified. Evidently, the plant has made proposals for pollution control loans, in the past, without success. The fund seems to have relatively limited funds. This issue is complicated by the fact that RAS Kiviter, as noted, was in arrears with its environmental fines. Whether the tardiness in payment of the fines and charges makes access to the fund more difficult is uncertain. However, the fund could help by identifying criteria for and setting priorities for its loan funds for various sectors and industries.

- At the national level, the MOE needs to move quickly towards reform and clarification of the inherited Soviet environmental monitoring and measuring system. As noted, the existing system has too many parameters and overly strict standards. Moreover, the existing system invites disregard, because it is not well-linked to negotiations over a compliance regime and realistic fines and charges. U.S. EPA's monitoring project, in conjunction with the Harvard Institute for International Development's long-term resident advisor for environmental economic policy, who will be focusing on the use of economic instruments, can provide assistance in this area. Both activities are funded by USAID.

- RAS Kiviter should try to play an active role in the newly founded Sustainable Development Commission for Ida-Virumaa, particularly as a way to ensure good relations with the public and to provide information on the efforts it is making to improve environmental conditions and its use of natural resources.

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[15] Interview with Mr. antti Roose, Ida-Virumaa Environmental Board, September 1993.

SECTION V
FRAMEWORK OF ENVIRONMENTAL MANAGEMENT PROJECT AND DISCUSSION OF ALTERNATIVES

A. The Framework of the Proposed Estonian EAP Project in the Oil Shale Chemical Industry

This section sets out a framework on which a more detailed project design can be elaborated. It is the team's hope that this detailed design would be undertaken in collaboration with the management of RAS Kiviter, especially given the wide-ranging assistance in restructuring the plant that is required to make it environmentally sound.

A1. Criteria for Sound Project Design and Implementation

As noted several times in this report, the environmental problems of RAS Kiviter are structural in nature and intimately related to the old Soviet economic planning and management regime. Given this situation, several criteria for sound design of this demonstration environmental project can be set forth:

- The project design should be undertaken in collaboration with the management of RAS Kiviter.

- Project design should be a flexible and responsive process that does not take place only at the beginning of the project. The project should identify a set of specific, measurable objectives that can be attained over a three-year period and have the support of the firm's management and the directors in the Ministry of Economy.

- The project's design should pay close attention to parts of the plant that are contributing to serious health threats to workers and populations near the plant, in accordance with the EAP.

- Whenever possible, the project design should attempt to find "win-win" activities on which to focus assistance. "Win-win" refers to activities that provide both economic as well as environmental benefits.

A2. Description of the Proposed Project Framework

The figure below describes the principal components that the study team and RAS Kiviter management felt could comprise a strategic framework for a feasible EAP demonstration project. This figure does not identify a specific sequence for the proposed activities. It does assume, however, that in most cases the assistance would form a "package" of technical assistance, training, and commodities or equipment. In addition, this framework attempts to track the most serious problems as identified by the feasibility

this framework has been discussed with the plant's management, it is nevertheless open for further refinement and change after review of the whole study.

	Technology/ Production Process	Management/ Restructuring	Financial
Technical Assistance	- continue waste minimization - identify technology priorities - reduce energy losses, recover waste heat, and increase electrical generation	- business planning - marketing	- financial reporting/ accounting - cash management
Training	- process control simulation - tendering and specifications - ISO 9000	- business planning - leadership/motivation - team building - problem solving/ decision making - environmental management & compliance - communication - maintenance	- financial management software - cost accounting - reporting and auditing - documents to issue debt and capital
Investment	- GC gas analyzer - process simulation computer - process controls/ dephenolization - steam turbines - upgrade benzene storage/transfer	- reference materials - study tours - publications - translation support - publicity	- computer accounting software

B. Interim Assistance

All the team members observed that RAS Kiviter had reached a critical point in its slow transition to a market-oriented company. The plant's management knows it must change, but is somewhat at a loss to begin. The declaration of "profit centers" was made under pressure of growing financial insolvency, but, it seems, without a clear idea of the changes this would entail in the management and financial structure of the plant. The team felt that it was critical to sustain the momentum for improved efficiency and accountability that the waste minimization demonstration program of the World Environment Center has helped generate. Program activities have been under way at the plant for over a year. A viable waste minimization committee has been formed and is actively pursuing several projects.

The WEC program will continue through May 1994. The EAP demonstration project will take time to organize, including identifying and selecting a contractor and mobilizing a field team. This process might take as long as six to eight months. Given the fragility of morale and trust at the plant, being able to provide some interim, concrete assistance is important for project credibility.

The most logical place to start would be to provide immediate technical assistance and training in the following areas:

- preparing a business plan
- basic accounting and financial reporting
- basic marketing, sales, and distribution

USAID will attempt to find existing contractors and cooperators under its CEE program to provide such assistance over the next six months before full project implementation.

ANNEX A
FINANCIAL STATEMENTS FOR RAS KIVITER, 1993

This annex contains financial information for fiscal year 1993 that the project team received from RAS Kiviter on January 21, 1994. Like its predecessor enterprises (RE "Pólevkivikeemia" and PO "Slantsechim"), RAS "Kiviter" has a fiscal year ending December 31. At January 21, 1994 the accounts for fiscal year 1993 had not been completed; we assume that the reporting deadline is March 1, 1994. According to the cover page for the 1992 accounts (see Annex B), a copy of the approved balance sheet for 1992 had to be submitted to the local Bureau of Statistics no later than March 1, 1993.

Accounting procedures for Estonian state enterprises are based on a gradual transition from Soviet accounting principles. A state enterprise does not prepare its own accounting documents on the basis of generally accepted accounting principles; instead, the enterprise is required to fill out a standard set of forms prepared by the central government and issued to all state enterprises. In some cases (for example, RAS Kiviter's income statement) the form contains a line to identify the ministry to which the enterprise is subordinated; the ministry is in effect the owner, not the independent regulator.

The project team requested balance sheet and income statement information for 1991, 1992, and as much as of 1993 as possible. We received data for 1991 (see Annex C) and 1992 (see Annex B) and for the 10-month period ending November 1, 1993 (this annex). For 1993 the balance sheet is prepared on a form in which the month and year can be filled in; we infer that year-to-date balance sheets are prepared monthly. The "Profit and Financial Indices" statement is prepared on a form designed for year-to-date reporting at three-month intervals, but we were given figures for the first 10 months of the year.

During 1993, the fertilizer plant ("Mineraalväetiste tehas") was sold to Lentransgaz, the Gazprom subsidiary responsible for delivery of natural gas to Estonia, Latvia, and parts of northwestern Russia. The fertilizer plant then became the primary asset of "Nitrofert," an enterprise organized as a stock company under Estonian law. Nitrofert is "privatized" in the sense that Lentransgaz is not simply a Russian state enterprise; it is a Russian joint stock company that is being privatized in accordance with the privatization plan for Gazprom that was initiated by Russian government decree in late 1992. Gazprom was once a Soviet state enterprise; it was formed from the assets of the Soviet Ministry of Oil and Gas.

For the period spanning the first 10 months of 1993, RAS Kiviter provided two sets of accounts: (1) accounts for the chemical plant and the fertilizer plant combined, and (2) accounts for the fertilizer plant alone. As of January 21 there were no comparable accounts for the present RAS Kiviter organization, which excludes the fertilizer plant.

On the following pages the English text was provided by a translator and the Estonian text contains the data received from RAS Kiviter. A few of the figures are illegible on the

document received from RAS Kiviter. The Estonian word for balance sheet ("Raamatupidamisbilanss") is translated "Accounting Balance." The Estonian word "Passiva" is frequently translated as "Liabilities" but a more accurate translation would be "Liabilities Plus Net Worth." The Estonia statement of "Profit and Financial Indices" is similar to an income statement but it also has some of the characteristics of a statement of cash flow—for example, one of the "costs" consists of earnings (after depreciation) that are re-invested in the business (line 4.17, "Fixed capital made for self-consumption"). Note that depreciation (line 4.15) is only 2.5 percent of gross revenue, and therefore the true profitability of the enterprise may be overstated.

Four accounts are shown on the following pages:

1. Balance sheet for RAS Kiviter at November 1, 1993.

2. Profit and financial indices for RAS Kiviter, Jan. 1 - Oct. 31, 1993

3. Balance sheet for the fertilizer plant operations at November 1, 1993.

4. Profit and financial indices for fertilizer plant operations, Jan. 1 - Oct. 31, 1993

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RAS"Kiviter" including fertilizer plant

ACCOUNTING BALANCE

1 November 1993

ASSETS	Line No	Thous. kroons (without sents) Beginning of year	End of year
1.LIQUID ASSETS			
1.1. Money and securities			
1.1.1. Cash and bank accounts			
1.1.2. Foreign currency accounts			
1.1.3. Shares and other securities (short-term investments)			
1.1.4.			
Total Group 1.1.			
1.2. Short-term credit debts of buyers			
1.2.1. Buyers bills of exchange			
1.2.2. Buyers unpaid bills			
1.2.3. Buyers other credit debts			
1.2.4.			
Total Group 1.2.			
1.3. Other short-term credit debts (excl. those of buyers)			
1.3.1. Bills of exchange			
1.3.2. Prepayment of taxes			
1.3.3. Payments in advance to suppliers			
1.3.4. Settlements with shareholders			
1.3.5. Non-compensated losses			
1.3.6. Other credit debts			
1.3.7.			
Total Group 1.3.			
TOTAL SECTION 1			
2. STOCKS OF COMMODITIES AND PRODUCTION RESERVES			
2.1. Production reserves			
2.2. Unfinished products			
2.3. Finished products			
2.4. Commodities			
2.5. Other			
2.6.			
TOTAL SECTION 2			

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RAS "Kiviter"

RAAMATUPIDAMISBILANSS

13006412

1 november 1993

tuhandetes kroonides (komakohata)

AKTIVA	Rea nr.	Aasta alguseks	Aasta lõpuks
1. LIKVIIDSED VARAD	0	1	2
1.1. Raha ja väärtpaberid 1.1.1. Kassa ja pangakontod (50, 51, 55, 56)	011	2257	6650
1.1.2. Valuutakontod (52)	012	4325	5
1.1.3. Aktsiad ja muud väärtpaberid (lühiajalised investeeringud) (55, 56)	013		
1.1.4.	014		
Kokku 1.1. rühm	020	6582	6655
1.2. Ostjate lühiajaline debitoorne võlgnevus 1.2.1. Ostjate vekslid (59)	021		
1.2.2. Ostjate tasumata arved (62)	022	140439	153315
1.2.3. Ostjate muu debitoorne võlgnevus (63, 64, 73)	023	22	23
1.2.4.	024		
Kokku 1.2. rühm	030	140461	153338
1.3. Mitmesugune lühiajaline debitoorne (v. a. ostjate) võlgnevus	031		
1.3.1. Vekslid (59)	032		
1.3.2. Maksude ettemaksed (68, 69)	033		9656
1.3.3. Avansid hankijatele (61)	034	3	—
1.3.4. Arveldused aktsionäridega (75)	035		
1.3.5. Hüvitamata kahjud (72, 84)	036	3	28
1.3.6. Mitmesugune muu debitoorne võlgnevus (60, 70, 71, 73, 76, 79)	037	48246	23474
1.3.7.	038		
Kokku 1.3. rühm	040	48252	33158
KOKKU 1. OSA	100	195295	193151
2. KAUBA- JA TOOTMISVARUD	0	1	2
2.1. Tootmisvarud (05, 06, 07, 08, 09, 10, 12 miinus 13)	110	30247	30141
2.2. Lõpetamata toodang (03, 20, 21, 23, 29, 30)	120	3801	15794
2.3. Valmistoodang (40)	130	39385	11380
2.4. Kaubad (41, 42)	140	1340	360
2.5. Muud (31)	150	15	25
2.6.	160		
KOKKU 2. OSA	200	74788	57700

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ASSETS

	Line No	Beginning of year	End of year
3. FIXED CAPITAL AND UNFINISHED CAPITAL WORKS			
3.1. Fixed capital (01 minus 02)			
Beginning of year			
Cost of fixed capital			
End of year			
3.2. Unfinished capital works			
3.3. Uninstalled machinery and equipment			
3.4. Other			
3.5.			
TOTAL SECTION 3			
4. LONG-TERM FINANCIAL INVESTMENTS AND RESOURCES GIVEN ON A LOAN			
4.1. Shares, holdings, deposits, and other securities			
4.2. Resources given on loans			
4.3. Other investments			
4.4.			
TOTAL SECTION 4			
5. INTANGIBLE ASSETS			
Intangible assets			
6. OTHER ASSETS			
Other assets			
ASSETS TOTAL			
Assets total			

AKTIVA

3. PÕHIVARA JA LÕPETAMATA KAPITAALTÖÖD		Rea nr.	Aasta alguseks	Aasta lõpuks
		0	1	2
3.1. Põhivara (01 miinus 02)		210	40050	145685
Põhivara kulum (02) Aasta alguseks		211	×	×
Aasta lõpuks	107257	212		
3.2. Lõpetamata kapitaaltööd (33, 35)		220	7590	11809
3.3. Paigaldamata masinad ja seadmed (07)		230	9739	28581
3.4. Muud		240	-	
3.5.		250		
KOKKU 3. OSA		300	57379	186075

4. PIKAAJALISED FINANTSINVESTEERINGUD JA LAENUKS ANTUD VÄHENDID	0	1	2
4.1. Aktsiad, osakud, deposiidid ja muud väärtpaberid (58)	310	2464	4892
4.2. Laenuks antud vahendid (73)	320		
4.3. Muud investeeringud (61, 76)	330		
4.4.	340		
KOKKU 4. OSA	400	2464	4892

5. IMMATERIAALSED AKTIVAD	0	1	2
Immateriaalsed aktivad (01)	500		

6. MUUUD AKTIVAD	0	1	2
Muud aktivad	570		

KOKKU AKTIVA	0	1	2
Kokku aktiva	590	329926	441818

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LIABILITIES

	Line No	Beginning of year	End of year
7. SHORT-TERM LIABILITIES			
7.1. Bank loans			
7.1.2. Loans from legal and physical entities			
7.1.3. Other loans			
7.1.4. Overdue loans			
7.1.5.			
Total Group 7.1.			
7.2. Short-term debts on bills of exchange			
7.3. Short-term indebtedness to suppliers and contractors (excl. bills of exchange)			
7.4. Indebtedness for wages and social tax			
7.5. Debts for taxes			
7.6. Other short-term debts			
7.6.1. Payments in advance from buyers			
7.6.2. Unpaid dividends			
7.6.3. Other debts			
7.6.4.			
Total Group 7.6.			
7.7.			
TOTAL SECTION 7			
8. LONG-TERM FINANCIAL LIABILITIES			
8.1. Bank loans			
8.2. Other liabilities and debts			
8.3. Overdue financial liabilities			
8.4.			
TOTAL SECTION 8			
9. RESERVES AND TARGET RESOURCES NON-TAXABLE BY INCOME TAX			
Reserves and target resources non-taxable by income tax			

PASSIVA

7. LÜHIAJALISED KOHUSTUSED	Rea nr.	Aasta alguseks	Aasta lõpuks
	0	1	2
7.1. Lühiajalised laenud 7.1.1. Pangalaenud (90)	601		
7.1.2. Laenud juriidilisteit ja üksikisikutelt (95)	602		
7.1.3. Muud laenud	603		
7.1.4. Tähtajaks tasumata laenud (90, 95)	604		
7.1.5.	605		
Kokku 7.1. rühm	610	16	
7.2. Lühiajalised vekslivõlad (66)	620		
7.3. Lühiajaline võlgnevus hankijatele ja töövõtjatele (v.a. vekslid) (60)	630	117768	85364
7.4. Võlgnevus palga ja sotsiaalmaksu alal (69, 70)	640	6570	8343
7.5. Maksuvõlad (68)	650	13699	4919
7.6. Muud lühiajalised võlad 7.6.1. Ostjatelt saadud avansid (62)	651		17007
7.6.2. Maksmata dividendid (75)	652		
7.6.3. Muud võlad (61, 76)	653	272	7027
7.6.4.	654		
Kokku 7.6. rühm	660	2721	24034
7.7.	670		
KOKKU 7. OSA	700	140774	122660

8. PIKAAJALISED FINANTSKOHUSTUSED	0	1	2
8.1. Pangalaenud (92, 97)	710	44	26
8.2. Muud kohustused ja võlad (95)	720		
8.3. Tähtajaks tasumata finantskohustused (92, 95, 97)	730		
8.4.	740		
KOKKU 8. OSA	800	44	26

9. TULUMAKSUGA MAKSUSTAMATA RESERVID JA SIHTVAHENDID	0	1	2
Tulumaksuga maksustamata reservid ja sihtvahendid (88, 96)	900		

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LIABILITIES

10. REGULATIVES
Regulatives

11. EQUITY CAPITAL
11.1. Restricted equity capital
11.1.1. Fixed capital
11.1.2. Reserves
11.1.3. Rise in the prise of fixed capital due to inflation
11.1.4.
Total Group 11

11.2. Free equity capital
11.2.1. Undistributed earnings of previous years
11.2.2. Net profit, loss (-)
11.2.3.
Total Group 11.2.

TOTAL SECTION 11

12. OTHER LIABILITIES
Other liabilities

LIABILITIES TOTAL
Liabilities total

PASSIVA

10. REGULATIIVID	Rea nr.	Aasta alguseks	Aasta lõpuks
	0	1	2
Regulatiivid (83)	910		

11. OMAKAPITAL	0	1	2
11.1. Seotud omakapital 11.1.1. Põhikapital (85)	921	42860	34452
11.1.2. Reservid (86, 87, 88, 89, 96)	922	103646	100383
11.1.3. Põhivara hinnatõus inflatsiooni tõttu (85-5)	923		112904
11.1.4.	924		
Kokku 11.1. rühm	930	146506	247739
11.2. Vaba omakapital 11.2.1. Eelmiste aastate jaotamata kasum (80)	931	42602	42557
11.2.2. Aruandeaasta puhaskasum, kahjum (—) (80)	932		28836
11.2.3.	933		
Kokku 11.2. rühm	940	42602	71393
KOKKU 11. OSA	950	189108	319132

12. MUUD PASSIVAD	0	1	2
Muud passivad	970		

KOKKU PASSIVA	0	1	2
Kokku passiva	990	329926	441818

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PROFIT AND FINANCIAL INDICES
1993
Public statistical statement
According to quarters (fill in x)
1st quarter 1st half-year 9 months
Presented to the 25th day following the end of the accounting period

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Presented by all the self-sufficient legal entities to local bureaus of statistics

Enterprise (organization) (fill in with block letters):
RAS"KIVITER"
Address: **EE2020**
KOHTLA-JARVE
JARVEKOLA TEE, 14
Reg. No.13006412

	Codes
Subordination: Ministry of Economy	Filled by a bureau of statistics
Main field of activity: Production	
Form of enterprising: Public corporation	
Form of ownership: Public	

Ths. kroons (without sents)

1.Gross revenue	Line No	During accounting period
TOTAL	S1	

2.Deductions from gross sales
2.1. Sales tax
2.2. Excise tax
2.3. Customhouse receipts
2.4. Price differences to state and local budget and funds
2.5. Price deduction (rebate, etc.)

TOTAL SECTION 2 S2

3. Net revenue
S1 - S2 = S3

4.Costs
4.1. Commodities
4.2. Materials
4.3. Fuel and energy
4.4. Wage costs
4.5. Social tax
4.6. Health insurance
4.7. Land tax
4.8. Tax on natural resources within permitted limits
4.9. Pollution tax with the emission within permitted limits

Ths. kroons (without sents)

4. Costs	Line No	During account. period
4.10. Custom house receipts (-duty) and custom tariffs		
4.11. State duty		
4.12. Capital levy		
4.13. Other taxes and duties used by an enterprise abroad according to legal acts of foreign countries		
4.14. Other financial expenses, incl. fixed capital rental (lease)		
4.15. Depreciation (cost)		
4.16. Inventory (unfinished products, future costs and residues of finished products) change		
4.17. Fixed capital made for self-consumption (subtracted)		
TOTAL SECTION 4 (total line 031 to 049)		

5. SALES PROFIT (LOSS-)

S3 - S4 = S5

At the present year, 1993

At the same period of the previous year, 1992

6. OTHER BUSINESS YIELD	Line No	During account. period
6.1 Profit from the liquidation of fixed capital and immaterial items		
6.2. Received fines, forfeits, fines for delays		
6.3. Outdated credit debt		
6.4. Profit of the previous year that has turned out this year		
6.5. Public grants		
6.6. Other		
TOTAL SECTION 6 (total line 061 to 066)		

7. OTHER BUSINESS COSTS

7.1. Loss from the liquidation of fixed capital and immetrial items

7.2. Paid fines, forfeits, fines for delays and other collections

7.3. Bad and outdate credit debts

7.4. Loss of the previous year that has turned out this year

7.5. Other

TOTAL SECTION 7 (total line 071 to 075)

92

Riigi Statistikaamet
Finantsstatistika osakond, tel.45 24 84,
45 09 20, 45 37 27, 45 03 56
EE0106 Tallinn, Endla 15

KASUM JA ÜKSIKUD FINANTSNÄITAJAD

Lk.1 (2)

1993.a. 5–finantsid

Riiklik statistiline aruanne

Finantsid täiskirjaga nr.63. 25.11.1992.a.

Kvartaalne (märgi X)

☐ I kvartal ☐ I poolaasta ☐ 9 kuud

Esitatakse 25.kuupäevaks pärast aruandeperioodi lõppu.

Esitavad kõik iseseisvad juridilised isikud

kohalikule statistikabüroole

Ettevõtte (organisatsiooni) nimetus (trükitähtedega)

RAS "KIVITER"

Aadress EE2020

Kohtla-Järve

Järvekülla tee, 14

Ettevõtte registri number 13006412

		Koodid[1]
Kuuluvus	Majandus (ministeerium, jne.)	049
Põhitegevusala	Tootmine (nimetada)	2412
Ettevõtluse vorm	Riiklik Aktsiaselts (nimetada)	200
Omandivorm	Riiklik (nimetada)	10
	(nimetada)	

[1] Täidetakse statistikabüroo poolt.

Kohtla-Järve Statistikabüroo
EE2045 Jõhvi, Kaare tn. 7, p/k 47

Tuhandetes kroonides (komakohata)

1.Realiseerimise brutokäive

		Rea nr.	Aruande perioodil
KOKKU	S1	010	422492

2.Mahaarvamised brutokäibest

2.1. Käibemaks	011	12161
2.2. Aktsiisimaks	012	
2.3. Tollitulu	013	
2.4. Hinnavahed riigi ja kohalikesse eelarvetesse ning fondidesse	014	
2.5. Hinnavähend (rabatt jm.)	015	
KOKKU 2 OSA (summa ridade 011 kuni 015) S2	020	12161

3.Realiseerimise netokäive

S1 – S2 = S3	030	410331

4.Kulud

4.1. Kaubad	031	13120
4.2. Materjalid	032	157816
4.3. Kütus ja energia	033	67040
eelnest: energia 39009	034	———
4.4. Palgakulu	035	34602
4.5. Sotsiaalmaks	036	6920
4.6. Ravikindlustusmaksed	037	5536
4.7. Maamaks	038	–
4.8. Loodusvarade maks kuba-tud pärast	039	260
4.9. Saastemaks heitme looga kuba-tud pärast	040	3133

4.Kulud

		Rea nr.	Aruande perioodil
4.10.Tollimaks (-tõlv) ja tollitariif		041	2070
4.11.Riigilõiv		042	816
4.12.Kapitalimaks		043	
4.13.Muud maksud ja lõivud, mida ettevõte tasub väliemaal vasta-vali vällerikide õigusaktidele		044	
4.14.Mittemaagused rahalised kulud		045	24751
eelnest: põhivara rendimaks (üür)		046	———
4.15.Amortisatsioon (kulum)		047	10451
4.16.Varude (lõpetamata toodangu, tulevaste perioodide kulude ja valmistoodangu jääkide)muutus		048	16002
4.17.Omatarbeks valmistatud põhi-vara (minusega)		049	
KOKKU 4 OSA (summa ridade 031 kuni 049)	S4	050	342517

5.Realiseerimis-kasum (-kahjum)

S3 – S4 = S5 Kõiseeval. 1993.a.	059	67814
Eelmise.1992.a., samal perioodil	060	———

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8. FINANCIAL INCOME
8.1. Received interests (interests)
8.2. Received dividends (shares)
8.3. Profit from the change in the foreign currency rate
8.4. Profit from the sale of shares and other securities
8.5. Profit from the sale (purchase)of foreign currency at auction
TOTAL SECTION 8 (total line 081 to 085)

	Ths. kroons (without sents)
Line No	During account.period

9. FINANCIAL EXPENSES
9.1. Paid interests
9.2. Loss from the change of foreign currency exchange rate
9.3. Loss from the sale of shares and other securities
9.4. Loss from the purchase of foreign currency at auction (difference in the exchange rate)

TOTAL SECTION 9 S7
(total line 091 to 094)

10.GROSS INCOME (LOSS-)
S5 + S4 -S7 -S9 =S10
This year,1993
For the same period of the previous year

11. EXTRAORDINARY INCOME
TOTAL S11

12.EXTRAORDINARY COSTS
TOTAL S12

13.INCOME (LOSS) BEFORE TAXATION WITH INCOME TAX
S10 + S11 - S12 MINUS AND PLUS THE SUMS THAT DECREASE AND INCREASE THE INCOME TAXED BY THE INCOME TAX =S13

14.COMPANY INCOME TAX
TOTAL S14

15. OTHER TAXES (According to the p.15 of the "The principle system of the profit statement of an enterprise")
TOTAL S15

16. NET PROFIT (-LOSS)
S10 + S11 -S12 -S14 -S15 =S16

17.EVIDENCE
Paid sales tax by purchasing
commodities and services

Executive: N.Bulattshik Date: Nov.16,1993 Director
(phone) 15-774 Chief Accountant

incl. tresspassing of the items in the agreement		6235
steal		61
lay-up		9605
other		16
Total:	15 947	

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Tuhandetes krooniides (kumulatiivne)

6.Muud äritulud

	Rea nr.	Aruande perioodil
6.1.Kasum põhivara ja immateriaalsete objektide likvideerimisest	061	124
6.2.Saadud trahvid, leppetrahvid, viivised	062	
6.3.Aegunud kreditoorne võlgnevus	063	474
6.4.Aruandeaastal selgunud eelmise aasta kasum	064	4123
6.5.Riiklik detaisleen	065	
6.6.Muud	066	25
KOKKU 6 OSA (summa rida 061 kuni 066) S6	070	4746

7.Muud äritulud

7.1.Kahjum põhivara ja immateriaalsete objektide likvideerimisest	071	1901
7.2.Makstud trahvid, leppetrahvid, viivised ja mitmesuguused sissenõuded	072	1029
7.3.Laotusest ja segunud debitoorsest võlast	073	5764
7.4.Aruandeaastal selgunud eelmise aasta kahjum	074	1547
7.5.Muud	075	15947
KOKKU 7 OSA (summa rida 071 kuni 075) S7	080	26288

8.Finantstulud

8.1.Saadud intressid (kasvitud)	061	186
8.2.Saadud dividendid (reaalsed)	062	146
8.3.Kasum vahetuskursi muutustest	063	23244
8.4.Kasum aktsiate ja teiste väärtpaberite müügist	064	
8.5.Oksjonil välisvaluuta müügist (ostust) saadud kasum	065	
KOKKU 8 OSA (summa rida 061 kuni 065) S8	090	23576

9.Finantskulud

	Rea nr.	Aruande perioodil
9.1.Maksud intressid (kasvitud)	061	345
9.2.Kahjum vahetuskursi muutustest	062	34784
9.3.Kahjum aktsiate ja teiste väärtpaberite müügist	063	
9.4.Oksjonil välisvaluuta ostust (müügist) saadud kahjum	064	
KOKKU 9 OSA (summa rida 061 kuni 064) S9	100	35129

10.Brutokasum (-kahjum)

S6 + S8 – S7 + S8 – S9 = S10 Kliendevel, 1993.a.	110	34719
Eelmise, 1992.a., samal perioodil	111	—

11.Erakorralised tulud

KOKKU S11	120	

12.Erakorralised kulud

KOKKU S12	130	

13.Kasum (kahjum) enne tulumaksustamist

S10 + S11 – S12 miinus ja pluss summad, mis vähendavad ja suurendavad tulumaksuga maksustatavat kasumit = S13	140	25415

14.Ettevõtte tulumaks

KOKKU S14	150	8895

15.Muud maksud

(vastavalt "Ettevõtte kasumiaruande põhiskeemi, p.15)

KOKKU S15	160	1401

16.Puhaskasum (-kahjum)

S10 + S11 – S12 – S14 – S15 = S16	170	24423

17.ÕIEND

Makstud käibemaks kaupade ja teenuste ostmisel	180	

Aruandevormi täitmisel tuleb juhinduda ettevõtte kasumiaruande põhiskeemist, mis on kinnitatud

Rahanduministeeriumi poolt 1993.aastaks.Antud skeem on trükitud Riigi Teataja Lisas nr.8, 15.juuni 1992.a.

Täitja (nimi, telefon) N.Bulattšik 45-774	Kuupäev 16.11.93.a.	Direktor(juhataja)
		Peraamatupidaja

s.h. lepingu punktidest ülleastumine 6235
varguse 61
tööseisak 9605
muud 46
Kokku 15947

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Fertilizer plant

ACCOUNTING BALANCE

1 November 1993

ASSETS	Line No	Thous. kroons (without sents) Beginning of year	End of year
1.LIQUID ASSETS			
1.1. Money and securities			
1.1.1. Cash and bank accounts			
1.1.2. Foreign currency accounts			
1.1.3. Shares and other securities (short-term investments)			
1.1.4.			
Total Group 1.1.			
1.2. Short-term credit debts of buyers			
1.2.1. Buyers bills of exhange			
1.2.2. Buyers unpaid bills			
1.2.3. Buyers other credit debts			
1.2.4.			
Total Group 1.2.			
1.3. Other short-term credit debts (excl. those of buyers)			
1.3.1. Bills of exchange			
1.3.2. Prepayment of taxes			
1.3.3. Payments in advance to suppliers			
1.3.4. Settlements with sharcholders			
1.3.5. Non-compensated losses			
1.3.6. Other credit debts			
1.3.7.			
Total Group 1.3.			
TOTAL SECTION 1			
2. STOCKS OF COMMODITIES AND PRODUCTION RESERVES			
2.1. Production reserves			
2.2. Unfinished products			
2.3. Finished products			
2.4. Commodities			
2.5. Other			
2.6.			
TOTAL SECTION 2			

RAAMATUPIDAMISBILANSS

1 november 1993.a.

tuhandetes kroo
(komakohat

AKTIVA

1. LIKVIIDSED VARAD	Rea nr.	Aasta alguseks	Aasta lõpuks
	0	1	2
1.1. Raha ja väärtpaberid 1.1.1. Kassa ja pangakontod (50, 51, 55, 56)	011		317
1.1.2. Valuutakontod (52)	012		
1.1.3. Aktsiad ja muud väärtpaberid (lühiajalised investeeringud) (55, 56)	013		
1.1.4.	014		
Kokku 1.1. rühm	020		317
1.2. Ostjate lühiajaline debitoorne võlgnevus 1.2.1. Ostjate vekslid (59)	021		
1.2.2. Ostjate tasumata arved (62)	022		5503
1.2.3. Ostjate muu debitoorne võlgnevus (63, 61, 73)	023		
1.2.4.	024		
Kokku 1.2. rühm	030		5503
1.3. Mitmesugune lühiajaline debitoorne (v.a. ostjate) võlgnevus	041		
1.3.1. Vekslid (59)	042		
1.3.2. Maksude ettemaksed (68, 69)	043		325
1.3.3. Avansid hankijatele (61)	044		
1.3.4. Arveldused aktsionäridega (75)	045		
1.3.5. Hüvitamata kahjud (72, 81)	046		
1.3.6. Mitmesugune muu debitoorne võlgnevus (60, 70, 71, 74, 76, 79)	047		5524
1.3.7.	048		
Kokku 1.3. rühm	040		5849
KOKKU 1. OSA	100		11669

2. KAUBA- JA TOOTMISVARUD	0	1	2
2.1. Tootmisvarud (05, 06, 07, 08, 09, 10, 12 miinus 13)	110		4019
2.2. Lõpetamata toodang (03, 20, 21, 23, 29, 30)	120		33
2.3. Valmistoodang (40)	130		2947
2.4. Kaubad (41, 42)	140		2
2.5. Muud (31)	150		
2.6.	160		
KOKKU 2. OSA	200		7001

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ASSETS

	Line No	Beginning of year	End of year
3. FIXED CAPITAL AND UNFINISHED CAPITAL WORKS			
3.1. Fixed capital (01 minus 02)			
Beginning of year			
Cost of fixed capital			
End of year			
3.2. Unfinished capital works			
3.3. Uninstalled machinery and equipment			
3.4. Other			
3.5.			
TOTAL SECTION 3			
4.LONG-TERM FINANCIAL INVESTMENTS AND RESOURCES GIVEN ON A LOAN			
4.1. Shares, holdings, deposits, and other securities			
4.2. Resources given on loans			
4.3. Other investments			
4.4.			
TOTAL SECTION 4			
5. INTANGIBLE ASSETS			
Intangible assets			
6.OTHER ASSETS			
Other assets			
ASSETS TOTAL			
Assets total			

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AKTIVA

3. PÕHIVARA JA LÕPETAMATA KAPITAALTÖÖD		Rea nr.	Aasta alguseks	Aasta lõpuks
		0	1	2
3.1. Põhivara (01 miinus 02)		210		28365
Põhivara kulum (02) Aasta alguseks		211	×	×
Aasta lõpuks	24431	212		
3.2. Lõpetamata kapitaaltööd (33, 35)		220		126
3.3. Paigaldamata masinad ja seadmed (07)		230		
3.4. Muud		240		
3.5.		250		
KOKKU 3. OSA		300		28491

4. PIKAAJALISED FINANTSINVESTEERINGUD JA LAENUKS ANTUD VAHENDID	0	1	2
4.1. Aktsiad, osakud, deposiidid ja muud väärtpaberid (58)	310		
4.2. Laenuks antud vahendid (73)	320		
4.3. Muud investeeringud (61, 76)	330		
4.4.	340		
KOKKU 4. OSA	400		

5. IMMATERIAALSED AKTIVAD	0	1	2
Immateriaalsed aktivad (01)	500		

6. MUUUD AKTIVAD	0	1	2
Muud aktivad	570		

KOKKU AKTIVA	0	1	2
Kokku aktiva	590		47161

100

LIABILITIES

	Line No	Beginning of year	End of year
7. SHORT-TERM LIABILITIES			
7.1. Bank loans			
7.1.2. Loans from legal and physical entities			
7.1.3. Other loans			
7.1.4. Overdue loans			
7.1.5.			
Total Group 7.1.			
7.2. Short-term debts on bills of exchange			
7.3. Short-term indebtedness to suppliers and contractors (excl. bills of exchange)			
7.4. Indebtedness for wages and social tax			
7.5. Debts for taxes			
7.6. Other short-term debts			
7.6.1. Payments in advance from buyers			
7.6.2. Unpaid dividends			
7.6.3. Other debts			
7.6.4.			
Total Group 7.6.			
7.7.			
TOTAL SECTION 7			
8. LONG-TERM FINANCIAL LIABILITIES			
8.1. Bank loans			
8.2. Other liabilities and debts			
8.3. Overdue financial liabilities			
8.4.			
TOTAL SECTION 8			
9. RESERVES AND TARGET RESOURCES NON-TAXABLE BY INCOME TAX			
Reserves and target resources non-taxable by income tax			

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PASSIVA

7. LÜHIAJALISED KOHUSTUSED	Rea nr.	Aasta algusseks	Aas lõpu
	0	1	2
7.1. Lühiajalised laenud 7.1.1. Pangalaenud (90)	601		
7.1.2. Laenud juriidilisteit ja üksikisikuteit (95)	602		
7.1.3. Muud laenud	603		
7.1.4. Tähtajaks tasumata laenud (90, 95)	604		
7.1.5.	605		
Kokku 7.1. rühm	610		
7.2. Lühiajalised vekslivõlad (66)	620		
7.3. Lühiajaline võlgnevus hankijatele ja töövõtjatele (v.a. vekslid) (60)	630		3427
7.4. Võlgnevus palga ja sotsiaalmaksu alal (69, 70)	640		85
7.5. Maksuvõlad (68)	650		7
7.6. Muud lühiajalised võlad 7.6.1. Ostjatelt saadud avansid (62)	651		24
7.6.2. Maksmata dividendid (75)	652		
7.6.3. Muud võlad (61, 76)	653		6
7.6.4.	654		
Kokku 7.6. rühm	660		31
7.7.	670		
KOKKU 7. OSA	700		3551

8. PIKAAJALISED FINANTSKOHUSTUSED	0	1	2
8.1. Pangalaenud (92, 97)	710		
8.2. Muud kohustused ja võlad (95)	720		
8.3. Tähtajaks tasumata finantskohustused (92, 95, 97)	730		
8.4.	740		
KOKKU 8. OSA	800		

9. TULUMAKSUGA MAKSUSTAMATA RESERVID JA SIHTVAHENDID	0	1	2
Tulumaksuga maksustamata reservid ja sihtvahendid (88, 96)	900		

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LIABILITIES

10. REGULATIVES
Regulatives

11. EQUITY CAPITAL
11.1. Restricted equity capital
11.1.1. Fixed capital
11.1.2. Reserves
11.1.3. Rise in the prise of fixed capital due to inflation
11.1.4.
Total Group 11

11.2. Free equity capital
11.2.1. Undistributed earnings of previous years
11.2.2. Net profit, loss (-)
11.2.3.
Total Group 11.2.

TOTAL SECTION 11

12. OTHER LIABILITIES
Other liabilities

LIABILITIES TOTAL
Liabilities total

PASSIVA

10. REGULATIIVID	Rea nr.	Aasta alguseks	Aasta lõpuks
	0	1	2
Regulatiivid (83)	910		

11. OMAKAPITAL	0	1	2
11.1. Seotud omakapital			
11.1.1. Põhikapital (85)	921		7373
11.1.2. Reservid (86, 87, 88, 89, 96)	922		1005
11.1.3. Põhivara hinnatõus inflatsiooni toimel (85-5)	923		22881
11.1.4.	924		
Kokku 11.1. rühm	930		31259
11.2. Vaba omakapital			
11.2.1. Eelmiste aastate jaotamata kasum (80)	931		
11.2.2. Aruandeaasta puhaskasum, kahjum (—) (80)	932		-19613
11.2.3.	933		
Kokku 11.2. rühm	940		-19613
KOKKU 11. OSA	950		11646

12. MUUD PASSIVAD	0	1	2
Muud passivad	970		

KOKKU PASSIVA	0	1	2
Kokku passiva	990		47161

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PROFIT AND SINGLE FINANCIAL INDICES p.1 (2)
1993
Public statistical statement
According to quarters (fill in x)
1st quarter 1st half-year 9 months
Presented to the 25th day following the end of the accounting period

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Presented by all the self-sufficient legal entities to local bureaus of statistics

Enterprise (organization) (fill in with block letters):
MINERAL FERTILIZER PLANT
Address: EE2020
KOHTLA-JARVE
JARVEKULA TEE, 14
Reg. No.13006412

Codes

Subordination: Ministry of Economy — Filled by a bureau of statistics
Main field of activity: Production
Form of enterprising: Public corporation
Form of ownership: Public

	Line No	Accounting period
1.Gross revenue		
TOTAL		
2.Discountings from gross sales		
2.1. Sales tax		
2.2. Excise tax		
2.3. Customhouse receipts		
2.4. Price differences to state and local budgets and funds		
2.5. Release (rebate,etc.)		
TOTAL SECTION 2 (total lines 011 to 015)		
3. Net revenue		
4.Costs		
4.1. Commodities		
4.2. Materials		
4.3. Fuel and energy, incl.: energy		
4.4. Wage costs		
4.5. Social tax		
4.6. Health insurance		
4.7. Land tax		
4.8. Tax on natural resources within permitted laws		
4.9. Pollution tax with the permitted limits of wastage		

Ths.kroons (without sents)

4. Costs Line No During account. period

4.10. Custom house receipts (-duty) and custom tariffs
4.11. State duty
4.12. Capital levy
4.13. Other taxes and duties used by an enterprise abroad according to legal acts of foreign countries
4.14. Other financial expenses, incl. fixed capital rental (lease)
4.15. Depreciation (cost)
4.16. Inventory (unfinished products, future costs and residues of finished products) change
4.17. Fixed capital made for self-consumption (subtracted)
TOTAL SECTION 4 (total line 031 to 049)

5. Sales profit (-loss)
S3 - S4 =S5
At the present year, 1993
For the same period of the previous year, 1992

6. Other business yield Line No During account. period

6.1 Profit from the liquidation of fixed capital and immaterial items
6.2. Received fines, forfeits, fines for delays
6.3. Outdated credit debt
6.4. Profit of the previous year that has turned out this year
6.5. Public grants
6.6. Other
TOTAL SECTION 6 (total line 061 to 066)

7.Other business yield

7.1. Loss from the liquidation of fixed capital and immetrial items
7.2. Paid fines, forfeits, delays and other collections
7.3. Bad and outdate credit debts
7.4. Loss of the previous year that has turned out this year
7.5. Other
TOTAL SECTION 7 (total line 071 to 075)

8. Financial income

8.1. Received interests (interests)
8.2. Received dividends (shares)
8.3. Profit from the change in the foreign currency rate
8.4. Profit from the sale of shares and other securities
8.5. Profit from the sale (purchase)of foreign currency at auction
TOTAL SECTION 8 (total line 081 to 085)

Riigi Statistikaamet
Finantsstatistika osakond, tel.45 24 84,
45 09 20, 45 37 27, 45 03 56
EE0106 Tallinn, Endla 15

KASUM JA ÜKSIKUD FINANTSNÄITAJAD

Lk.1 (2)

1993.a. 5-finantsid

Riiklik statistiline aruanne

Kinnitatud käskkirjaga nr.83, 25.11.1992.a.

Kvartaalne (märgi X)

☐ I kvartal ☐ I poolaasta ☐ 9 kuud

Esitatakse 25.kuupäevai pärast aruandeperioodi lõppu.

Esitavad kõik iseomandavad juridilised isikud kohalikule statistikabüroole.

Ettevõtte (organisatsiooni) nimetus (trükitähtedega)

Mineraalväetiste tehas

Aadress EE20220

Kohtla-Järve

Järveküla tee, 14

Ettevõtte registri number 13006412

		Koodid[1]
Kuuluvus	Majandus (ministeerium, jne.)	049
Põhitegevusala	Tootmine (nimetada)	2412
Ettevõtluse vorm	Riiklik Aktsiaselts (nimetada)	200
Omandivorm	Riiklik (nimetada)	110

[1] Täidetakse statistikabüroo poolt.

Kohtla-Järve Statistikabüroo
EE2045 Jõhvi, Kaare tn. 7, p/k 47

Tuhandetes kroonides (komakohata)

1.Realiseerimise brutokäive

		Rea nr.	Aruande perioodil
KOKKU	S1	010	34643

2.Mahaarvamised brutokäibest

2.1. Käibemaks	011	1832
2.2. Aktsiisimaks	012	
2.3. Tollitulu	013	
2.4. Hinnavahed riigi ja kohalikesse eelarvetesse ning fondidesse	014	
2.5. Hinnavähend (rabatt jm.)	015	
KOKKU 2 OSA (summa rida 011 kuni 015) S2	020	1832

3.Realiseerimise netokäive

S1 - S2 = S3	030	32811

4.Kulud

4.1. Kaubad	031	725
4.2. Materjalid	032	31222
4.3. Kütus ja energia	033	11777
sellest: energia 10195	034	———
4.4. Palgakulu	035	2179
4.5. Sotsiaalmaks	036	436
4.6. Ravikindlustusmakse	037	349
4.7. Maamaks	038	
4.8. Loodusvarade maks lubatud piires	039	
4.9. Saastemaks heitme loaga lubatud piires	040	

4.Kulud

		Rea nr.	Aruande perioodil
4.10.Tollimaks (-lõiv) ja tolliteenused		041	
4.11.Riigilõiv		042	
4.12.Kapitalimaks		043	
4.13.Muud maksud ja lõivud, mida ettevõte tasub välismaal vastavalt välisriikide õigusaktidele		044	
4.14.Mitmesugused rahalised kulud		045	2638
sellest: põhivara rendimaks (üür)		046	———
4.15.Amortisatsioon (kulum)		047	945
4.16.Varude (lõpetamata toodangu, tulevaste perioodide kulude ja valmistoodangu jääkide) muutus		048	-2980
4.17.Omatarbeks valmistatud põhivara (miinusega)		049	
KOKKU 4 OSA (summa rida 031 kuni 049)	S4	050	47341

5.Realiseerimiskasum (-kahjum)

S3 - S4 = S5 Käesoleval, 1993.a.	059	-14530
Eelmise, 1992.a., samal perioodil	060	———

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Ths. kroons (without sents)
Line No During account.period

9. Financial expense
9.1. Paid interests (interests)
9.2. Loss from the change of foreign currency exchange rate
9.3. Loss from the sale of shares and securities
9.4. Loss from the purchase (sale) of foreign currency at auction
TOTAL SECTION 9 (total line 091 to 094)

10.Gross profit
S5 + S6 - S7 + S8 - S9 - S10
At the present year, 1993
At the same period of the previous year, 1992

11.Special income
TOTAL

12.Profit (loss) before imposing income tax
S10 + S11 -S12, sums subtracted and added that reduce and increase the profit taxed with income tax=S13

14. Income tax of the enterprise
TOTAL

15. Other taxes
(according to "Principle system of the profit statement of an enterprise", p.15
TOTAL

16. Net profit (-loss)

S10 + S11 - S12 -S14 -S15 = S16

17.Evidence
Paid sales tax by buying commodities and services

By filling the form of statement the principle system of the profit statement for an enterprise approved by the Minister of Financies for the year 1993 must be taken for a regulation.
The given system is printed in "Riigi Teataja", Appendix 6 from June 15 1992.

Executive (name,phone) Date Director (head)
General accountant

6.Muud äritulud

	Rea nr.	Aruande perioodil
6.1.Kasum põhivara ja immateriaalsete objektide äravõõrandmisest	061	
6.2.Saadud trahvid, leppetrahvid, viivised	062	
6.3.Aegunud kreditoorne võlgnevus	063	
6.4.Aruandeaastal selgunud eelmise aasta kasum	064	
6.5.Riiklik dotatsioon	065	
6.6.Muud	066	2
KOKKU 6 OSA (summa rida 061 kuni 066) S6	070	2

7.Muud ärikulud

7.1.Kahjum põhivara ja immateriaalsete objektide äravõõrandmisest	071	12
7.2.Makstud trahvid, leppetrahvid, viivised ja mitmesugused sissenõuded	072	
7.3.Loobumised ja aegunud debitoorsest võlast	073	
7.4.Aruandeaastal selgunud eelmise aasta kahjum	074	
7.5.Muud	075	081
KOKKU 7 OSA (summa rida 071 kuni 075) S7	080	1024

8.Finantstulud

8.1.Saadud intressid (kasvikud)	081	
8.2.Saadud dividendid (osalusd)	082	
8.3.Kasum valuutakursi muutustest	083	29
8.4.Kasum aktsiate ja teiste väärtpaberite müügist	084	
8.5.Oksjonil välisvaluuta müügist (ostust) saadud kasum	085	
KOKKU 8 OSA (summa rida 081 kuni 085) S8	090	

9.Finantskulud

	Rea nr.	Aruande perioodil
9.1.Makstud intressid (kasvikud)	091	
9.2.Kahjum valuutakursi muutustest	092	21
9.3.Kahjum aktsiate ja teiste väärtpaberite müügist	093	
9.4.Oksjonil välisvaluuta ostust (müügist) saadud kahjum	094	
KOKKU 9 OSA (summa rida 091 kuni 094) S9	100	21

10.Brutokasum (-kahjum)

S5 + S6 – S7 + S8 – S9 = S10 Kleeslevat, 1993.a.	110	-19613
Eelmise, 1992.a., samal perioodil	111	—

11.Erakorralised tulud

KOKKU S11	120	

12.Erakorralised kulud

KOKKU S12	130	

13.Kasum (kahjum) enne tulumaksustamist

S10 + S11 – S12 miinus ja pluss summad, mis vähendavad ja suurendavad tulumaksuga maksustatavat kasumit = S13	140	

14.Ettevõtte tulumaks

KOKKU S14	150	

15.Muud maksud
(vastavalt "Ettevõtte kasumiaruande põhiskeemi, p.15)

KOKKU S15	160	

16.Puhaskasum (-kahjum)

S10 + S11 – S12 – S14 – S15 = S16	170	

17.ÕIEND

Makstud käibemaks kaupade ja teenuste ostmisel	180	

Aruandevormi täitmisel tuleb juhinduda ettevõtte kasumiaruande põhiskeemist, mis on kinnitatud Rahanduministeeriumi poolt 1993.aastaks.Antud skeem on trükitud Riigi Teataja Lisas nr.8, 15.juuni 1992.a.

Täitja (nimi, telefon) N.Bulattšik 45-774	Kuupäev 16.11.93.a.	Direktor(juhataja)	
		Pearaamatupidaja	

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ANNEX B
FINANCIAL STATEMENTS FOR PÓLEVKIVIKEEMIA, 1992

This annex contains financial information for fiscal year 1992 that the project team received from RAS Kiviter on January 21, 1994. This information is more detailed than the information received for 1993. We assume that by March 1, 1994 this type of detailed accounting information will be available for 1993.

Eight accounts are shown on the following pages:

1. Accounting balance for Pólevkivikeemia at January 1, 1993
2. Profit and financial indices for Pólevkivikeemia, 1992
3. Statement of financial situation, January 1, 1993
4. Distribution of net profit, January 1, 1993
5. Analysis of long-term real and financial investments, January 1, 1993
6. Analysis and time limits of long-term loans at the end of year, January 1, 1993
7. Flow of fixed capital (acquisition cost), January 1, 1993
8. Flow of special funds and foreign currency, January 1, 1993

Approved by the regulation No 91, Nov.12,1992, Tallinn
Ministry of Financies of the Republic of Estonia
Codes:

Main field of activity	Reg. No	Form of ownership	Subordinate
	13006412		

ACCOUNTING BALANCE
1992

A copy of the approved balance must be presented the latest March 1,1993.
1) To the local Bureau of Statistics of a town or county
2) To the local Revenue Office of a town or county
3) To owner

Enterprise: State enterprise "Põlevkivikeemia"
Form of enterprising: state eneterprise
Form of ownership: public
Subordination (ministry, state department, etc.): Ministry of Economy
Main field of activity: production
Address: Kohtla-Järve, Järveküla tee 14
Phone Telex Fax

	Name	Date
Auditor control /signature/	M. Shulatsheva	9 March,1993

CONTENTS

1. Accounting balance 2.Profit Statement
3. Statement of Financial situation
4. Distribution of net profit
5. Analisis of long-term real and financial investments (Supplementary 3)
6. Analysis and time limits of long-term loans (Supplementary 4)
7. Analysis and time limits of long-term receivables and payables (Supplementary 5)
8. Analysis of equity shares and shares (Supplementary 6)
9. Flow of fixed capital (acquisition cost) (Supplementary 7)
10. Flow of special funds (Supplementary 8)
    Foreign currency flow (Supplementary 8)
11. Outside balance accounts (Supplementary 9)
12. Impact of the change of calculation methods during accounting year on profit (Supplementary 10)

Kinnitanud:
EV Rahandusministeerium
määrusega nr. 91. 11. 12. 1992. a. Tallinn

Koodid:

Põhitegevusala	Ettevõtte registri nr.	Omandivorm	Kuuluvus
	13006412		

1992 a. RAAMATUPIDAMISE AASTAARUANNE

Kinnitatud aruande ärakiri esitatakse hiljemalt 1. märtsiks 1993. a.
1) Asukohajärgsele linna või maakonna statistikabüroole
2) Asukohajärgsele linna või maakonna maksuametile
3) Omanikule

Ettevõtte nimetus	RE Põlevkiviõlitehase
Ettevõtluse vorm	Riigiettevõte
Omandivorm	Riigi
Kuuluvus (ministeerium, riigiamet jne.)	Majandusministeerium
Põhitegevusala	Töötmine
Aadress	Lehtla-Jõhvi Jõhvi küla tee 141
Telefon	Teletaip	Telefaks

	Nimi	Kuupäev
Audiitorikontroll		9.05.93
Riigikontroll		

SISUKORD

1. Raamatupidamisbilanss. 2. Kasumiaruanne. 2
3. Finantsseisukorra aruanne. 6
4. Puhaskasumi jaotus (Lisa 2). 7
5. Pikaajaliste reaal- ja finantsinvesteeringute liigendus (Lisa 3). 9
6. Pikaajaliste laenude liigendus ja tähtajalisus (Lisa 4). 9
7. Pikaajalise debitoorse ja kreditoorse võla liigendus ja tähtajalisus (Lisa 5). 10
8. Omaaktsiate ja osamaksude liigendus (Lisa 6). 11
9. Põhivara liikumine (soetusmaksumuses) (Lisa 7). 12
10. Erifondide liikumine (Lisa 8). 13
Valuuta liikumine (Lisa 8). 14
11. Bilansivälised kontod (Lisa 9). 14
12. Aruandeaasta arvestusmetoodika muutuste mõju kasumile (Lisa 10). 15

SPETSIALISEERITUD TEHNILINE KIRJASTUS
pakub asutustele polügraafilisi töid:
Blanketid, tehniline dokumentatsioon, instruktsioonid teie toodangu kohta, prospektid teile sobivas keeles, kus kasutatakse ladina või slaavi kirja (šrift).
FOLIO
a/a 1461211, Eesti T&EKP Peapangas, kood 420101772
Tallinn, EE0090, p/k 3627, Endla 15 III korrus, tuba 335, tel. 450949.

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ACCOUNTING BALANCE
1 January 1993

ASSETS	Line No	Thous. kroons (without sents) Beginning of year	End of year
1.LIQUID ASSETS			
1.1. Money and securities			
1.1.1. Cash and bank accounts			
1.1.2. Foreign currency accounts			
1.1.3. Shares and other securities (short-term investments)			
1.1.4.			
Total Group 1.1.			
1.2. Short-term credit debts of buyers			
1.2.1. Buyers bills of exhange			
1.2.2. Buyers unpaid bills			
1.2.3. Buyers other credit debts			
1.2.4.			
Total Group 1.2.			
1.3. Other short-term credit debts (excl. those of buyers)			
1.3.1. Bills of exchange			
1.3.2. Prepayment of taxes			
1.3.3. Payments in advance to suppliers			
1.3.4. Settlements with shareholders			
1.3.5. Non-compensated losses			
1.3.6. Other credit debts			
1.3.7.			
Total Group 1.3.			
TOTAL SECTION 1			
2. STOCKS OF COMMODITIES AND PRODUCTION RESERVES			
2.1. Production reserves			
2.2. Unfinished products			
2.3. Finished products			
2.4. Commodities			
2.5. Other			
2.6.			
TOTAL SECTION 2			

RAAMATUPIDAMISBILANSS

1 aanuar 1993

tuhandetes kroonides (komakohata)

AKTIVA

I. LIKVIIDSED VARAD	Rea nr.	Aasta alguseks	Aasta lõpuks
	0	1	2
1.1. Raha ja väärtpaberid 1.1.1. Kassa ja pangakontod (50, 51, 55, 56)	011	61	2257
1.1.2. Valuutakontod (52)	012	18960	4325
1.1.3. Aktsiad ja muud väärtpaberid (lühiajalised investeeringud) (55, 56)	013		
1.1.4.	014		
Kokku 1.1. rühm	020	19021	6582
1.2. Ostjate lühiajaline debitoorne võlgnevus 1.2.1. Ostjate vekslid (59)	021		
1.2.2. Ostjate tasumata arved (62)	022	4840	140439
1.2.3. Ostjate muu debitoorne võlgnevus (63, 64, 73)	023	4	22
1.2.4.	024		
Kokku 1.2. rühm	030	4844	140461
1.3. Mitmesugune lühiajaline debitoorne (v. a. ostjate) võlgnevus	031		
1.3.1. Vekslid (59)	032		
1.3.2. Maksude ettemaksed (68, 69)	033		
1.3.3. Avansid hankijatele (61)	034	5	3
1.3.4. Arveldused aktsionäridega (75)	035		
1.3.5. Hüvitamata kahjud (72, 84)	036	10	3
1.3.6. Mitmesugune muu debitoorne võlgnevus (60, 70, 71, 73, 76, 79)	037	12686	48246
1.3.7.	038		
Kokku 1.3. rühm	040	12701	48252
KOKKU 1. OSA	100	36566	195295

2. KAUBA- JA TOOTMISVARUD			
	0	1	2
2.1. Tootmisvarud (05, 06, 07, 08, 09, 10, 12 miinus 13)	110	3386	30247
2.2. Lõpetamata toodang (03, 20, 21, 23, 29, 30)	120	488	3861
2.3. Valmistoodang (40)	130	777	39585
2.4. Kaubad (41, 42)	140	73	1340
2.5. Muud (31)	150	4	15
2.6.	160		
KOKKU 2. OSA	200	4728	74888

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ASSETS

	Line No	Beginning of year	End of year
3. FIXED CAPITAL AND UNFINISHED CAPITAL WORKS			
3.1. Fixed capital (01 minus 02)			
Beginning of year			
Cost of fixed capital			
End of year			
3.2. Unfinished capital works			
3.3. Uninstalled machinery and equipment			
3.4. Other			
3.5.			
TOTAL SECTION 3			
4.LONG-TERM FINANCIAL INVESTMENTS AND RESOURCES GIVEN ON A LOAN			
4.1. Shares, holdings, deposits, and other securities			
4.2. Resources given on loans			
4.3. Other investments			
4.4.			
TOTAL SECTION 4			
5. INTANGIBLE ASSETS			
Intangible assets			
6.OTHER ASSETS			
Other assets			
ASSETS TOTAL			
Assets total			

AKTIVA

3. PÕHIVARA JA LÕPETAMATA KAPITAALTÖÖD		Rea nr.	Aasta alguseks	Aasta lõpuks
		0	1	2
3.1. Põhivara (01 miinus 02)		210	35970	40050
Põhivara kulum (02) — Aasta alguseks	32,053	211	×	×
Aasta lõpuks	36 589	212		
3.2. Lõpetamata kapitaaltööd (33, 35)		220	2,878	2590
3.3. Paigaldamata masinad ja seadmed (07)		230	459	9739
3.4. Muud		240		
3.5.		250		
KOKKU 3. OSA		300	39407	57379

4. PIKAAJALISED FINANTSINVESTEERINGUD JA LAENUKS ANTUD VAHENDID	0	1	2
4.1. Aktsiad, osakud, deposiidid ja muud väärtpaberid (58)	310	1117	2464
4.2. Laenuks antud vahendid (73)	320		
4.3. Muud investeeringud (61, 76)	330		
4.4.	340		
KOKKU 4. OSA	400	1117	2464

5. IMMATERIAALSED AKTIVAD	0	1	2
Immateriaalsed aktivad (04)	500		

6. MUUUD AKTIVAD	0	1	2
Muud aktivad	570		

KOKKU AKTIVA	0	1	2
Kokku aktiva	590	81818	329926

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LIABILITIES

		Line No	Beginning of year	End of year
7. SHORT-TERM LIABILITIES				
7.1.	Short-term loans			
7.1.1.	Bank loans			
7.1.2.	Loans from legal and physical entities			
7.1.3.	Other loans			
7.1.4.	Overdue loans			
7.1.5.				
	Total Group 7.1.			
7.2.	Short-term debts on bills of exchange			
7.3.	Short-term indebtedness to suppliers and contractors (excl. bills of exchange)			
7.4.	Indebtedness for wages and social tax			
7.5.	Debts for taxes			
7.6.	Other short-term debts			
7.6.1.	Payments in advance from buyers			
7.6.2.	Unpaid dividends			
7.6.3.	Other debts			
7.6.4.				
	Total Group 7.6.			
7.7.				
	TOTAL SECTION 7			
8. LONG-TERM FINANCIAL LIABILITIES				
8.1.	Bank loans			
8.2.	Other liabilities and debts			
8.3.	Overdue financial liabilities			
8.4.				
	TOTAL SECTION 8			
9. RESERVES AND TARGET RESOURCES NON-TAXABLE BY INCOME TAX				
	Reserves and target resources non-taxable by income tax			

PASSIVA

7. LÜHIAJALISED KOHUSTUSED	Rea nr.	Aasta alguseks	Aasta lõpuks
	0	1	2
7.1. Lühiajalised laenud 7.1.1. Pangalaenud (90)	601	1982	
7.1.2. Laenud juriidilisteit ja üksikisikutelt (95)	602	27	16
7.1.3. Muud laenud	603		
7.1.4. Tähtajaks tasumata laenud (90, 95)	604		
7.1.5.	605		
Kokku 7.1. rühm	610	2009	16
7.2. Lühiajalised vekslivõlad (66)	620		
7.3. Lühiajaline võlgnevus hankijatele ja töövõtjatele (v.a. vekslid) (60)	630	698	117768
7.4. Võlgnevus palga ja sotsiaalmaksu alal (69, 70)	640	281	6570
7.5. Maksuvõlad (68)	650	548	13699
7.6. Muud lühiajalised võlad 7.6.1. Ostjatelt saadud avansid (62)	651		
7.6.2. Maksmata dividendid (75)	652		
7.6.3. Muud võlad (61, 76)	653	625	2721
7.6.4.	654		
Kokku 7.6. rühm	660	625	2721
7.7.	670		
KOKKU 7. OSA	700	4164	140774

8. PIKAAJALISED FINANTSKOHUSTUSED	0	1	2
8.1. Pangalaenud (92, 97)	710	43	44
8.2. Muud kohustused ja võlad (95)	720		
8.3. Tähtajaks tasumata finantskohustused (92, 95, 97)	730		
8.4.	740		
KOKKU 8. OSA	800	43	44

9. TULUMAKSUGA MAKSUSTAMATA RESERVID JA SIHTVAHENDID	0	1	2
Tulumaksuga maksustamata reservid ja sihtvahendid (88, 96)	900		

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LIABILITIES

10. REGULATIVES
Regulatives

11. EQUITY CAPITAL
11.1. Restricted equity capital
11.1.1. Fixed capital
11.1.2. Reserves
11.1.3. Rise in the prise of fixed capital due to inflation
11.1.4.
Total Group 11

11.2. Free equity capital
11.2.1. Undistributed earnings of previous years
11.2.2. Net profit, loss (-)
11.2.3.
Total Group 11.2.

TOTAL SECTION 11

12. OTHER LIABILITIES
Other liabilities

TOTAL LIABILITES
Total liabilities

PASSIVA

	Rea nr.	Aasta alguseks	Aasta lõpuks
	0	1	2
10. REGULATIIVID			
Regulatiivid (83)	910		

	0	1	2
11. OMAKAPITAL			
11.1. Seotud omakapital 11.1.1. Põhikapital (85)	921	38167	42860
11.1.2. Reservid (86, 87, 88, 89, 96)	922	5131	103646
11.1.3. Põhivara hinnatõus inflatsiooni toimel (85-5)	923		
11.1.4.	924		
Kokku 11.1. rühm	930	43.298	146.506
11.2. Vaba omakapital 11.2.1. Eelmiste aastate jaotamata kasum (80)	931	3885	
11.2.2. Aruandeaasta puhaskasum, kahjum (—) (80)	932		42.602
11.2.3.	933		
Kokku 11.2. rühm	940	3885	42.602
KOKKU 11. OSA	950	47183	189108

	0	1	2
12. MUUD PASSIVAD			
Muud passivad	970	39831	—

	0	1	2
KOKKU PASSIVA			
Kokku passiva	990	87013	329326

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PROFIT AND FINANCIAL INDICES

Ths. kroons (without sents)

	Line No	Previous year	Year of account.
1. Gross revenue			
TOTAL	S1		
2. ~~Discountings~~ deductions from gross sales			
2.1. Sales tax			
2.2. Excise tax			
2.3. Customhouse receipts			
2.4. Other			
2.5.			
TOTAL SECTION 2	S2		
3. Net revenue			
S1 - S2 = S3			
4. Costs			
4.1. Commodities			
4.2. Materials			
4.3. Fuel and energy			
4.4. Wage costs			
4.5. Social tax			
4.6. Other taxes			
4.7. Health insurance			
4.8. Other financial expenses			
4.9. Costs (amortization)			
4.10. Inventory (unfinished products, future costs and residues of finished products) changes (increase -, reduction +)			
4.11.			
TOTAL SECTION 4	S4		
5. SALES PROFIT (LOSS-)			
S3 - S4 = S5			
6. FINANCIAL INCOME			
6.1. Received interests			
6.2. Received dividends (shares)			
6.3. Changes in exchange rate			
6.4. Other			
6.5. Income from the sale of foreign currency (difference in the exchange rate) at auction			
TOTAL SECTION 6			

	Line No	Ths. kroons (without sents) During account.period
7. Financial expenses		
7.1. Paid interests		
7.2. Change of foreign currency exchange rate		
7.3. Other		
7.4. Loss from the purchase of foreign currency at auction (difference in the exchange rate)		
TOTAL SECTION 7	S7	
8.Gross profit (loss-)		
S5 + S6 - S7 = S8		
9.Sums reducing the total income taxed by income tax		
TOTAL	S9	
10. Sums increasing the total income taxed by income tax		
TOTAL	S10	
11.Total income taxed by income tax		
S8 - S9 + S10 =S11		
12.Income tax of the enterprise		
TOTAL	S12	
13.Other costs total (according to "Principle system of profit statement, p.13)		
TOTAL	S13	
14.Net profit (loss-)		
S8 - S9 - S12 - S13=S14		

Data in the row 1 (previous year) must not be filled for 1991.

KASUMIARUANNE

tuhandetes kroonides (komakohata)

1. REALISEERIMISE BRUTOKÄIVE	Rea nr.	Eelmisel aastal	Aruande aastal
	0	1	2
KOKKU S1	010	42,144	511615

2. MAHAARVAMISED BRUTOKÄIBEST	0	1	2
2.1. Käibemaks	011	2251	40196
2.2. Aktsiisimaks	012	—	
2.3. Tollitulu	013		
2.4. Muud	014		
2.5.	015		
KOKKU 2. OSA S2	020	2251	40196

3. REALISEERIMISE NETOKÄIVE	0	1	2
S1 — S2 = S3	030	507893	471419

4. KULUD	0	1	2
4.1. Kaubad	031	412	13943
4.2. Materjal	032	176227	185384
4.3. Kütus ja energia	033	5632	6204
4.4. Palgakulu	034	5609	46317
4.5. Sotsiaalmaks	035	482	5261
4.6. Ravikindlustusmakse	036	1601	4152
4.7. Muud maksud	037	5964	11897
4.8. Muud rahalised kulud	038	—	31465
4.9. Kulum (amortisatsioon)	039	1432	6265
4.10. Varude (lõpetamata toodangu, tulevaste perioodide kulude ja valmistoodangu jääkide) muutus (suurenemine —, vähenemine +)	040	[illegible]	[illegible]
4.11.	041		
KOKKU 4. OSA S4	045	35964	333345

5. REALISEERIMIS-KASUM (-KAHJUM)		1	2
S3 — S4 = S5	050	3949	138071

6. FINANTSTULUD		1	2
6.1. Saadud kasvikud	051	12	281
6.2. Saadud dividendid (osakud)	052	1	38
6.3. Valuutakursi muutused	053	—	39470
6.4. Muud	054	815	1204
6.5. Tulu (kursivahe) välisvaluuta müügist oksjonil	055	2863	952
KOKKU 6. OSA S6	060	3693	42945

7. FINANTSKULUD	Rea nr.	Eelmisel aastal	Aruande aastal
	0	1	2
7.1. Makstud kasvikud	061	171	11662
7.2. Valuutakursi muutused	062	48	27008
7.3. Muud	063	1659	20271
7.4. Kahjum (kursivahe) välisvaluuta ostmisel oksjonil	064		
KOKKU 7. OSA S7	070	1878	58941

8. BRUTOKASUM (KAHJUM—)	0	1	2
S5 + S6 — S7 = S8	080	5689	171604

9. SUMMAD, MIS VÄHENDAVAD TULUMAKSUGA MAKSUSTATAVAT TULU	0	1	2
KOKKU S9	090	41	96253

10. SUMMAD, MIS SUURENDAVAD TULUMAKSUGA MAKSUSTATAVAT TULU	0	1	2
KOKKU S10	100	5	35

11. TULUMAKSUGA MAKSUSTATAV TULUSUMMA	0	1	2
S8 — S9 + S10 = S11	110	5653	75385

12. ETTEVÕTTE TULUMAKS	0	1	2
KOKKU S12	120	1681	22616

13. MUUD KULUD KOKKU (vastavalt «Ettevõtte kasumiaruande põhiskeemi» p.13)	0	1	2
KOKKU S13	130	82	10235

14. PUHASKASUM (KAHJUM —)	0	1	2
S8 — S9 — S12 — S13 = S14	140	3885	42602

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STATEMENT OF FINANCIAL SITUATION

		Ths. kroons (without cents)	
	Line No	Previous year	Account. year
1.SOURCES OF THE CAPITAL OF CIRCULATION			
1.1. Receipts from economical activities			
1.1.1. Net profit (loss-)			
1.1.2. Cost of fixed capital (depreciation)			
1.1.3. Other			
1.1.4.			
Total Group 1.1.			
1.2. Other receipts and income			
1.2.1. Income from the sale of fixed capital (profit (-), loss (+) from these transactions			
1.2.2. Other (according to categories)			
Total Group 1.2.			
1.3. Financing of the capital of enterprise			
1.3.1. Accumulation of long-term external capital during the accounting year (according to categories)			
1.3.2. Accumulation of equity capital during the accounting year (according to categories)			
Total Group 1.3.			
TOTAL SECTION 1			
2.USE OF THE CAPITAL OF CIRCULATION			
2.1. Long-term investments			
2.1.1. Acquirement of fixed capital			
2.1.2. Other (according to categories)			
Total Group 2.1.			
2.2. Recompensation of long-term liabilities (according to categories)			
Total Group 2.2.			
2.3. Reduction of equity capital (according to categories)			
Total Group 2.3.			
2.4.			
2.5. Other use of the capital of circulation			
2.6.			
TOTAL SECTION 2			

FINANTSSEISUKORRA ARUANNE

tuhandetes kroonides (komakohata)

1. KÄIBEKAPITALI ALLIKAD	Rea nr.	Eelmisel aastal	Aruande aastal
	0	1	2
1.1. Tulud majandustegevusest 1.1.1. Puhaskasum, (kahjum—)	011	3885	42,602
1.1.2. Põhivara kulum (amortisatsioon)	012	1437	6265
1.1.3. Muud	013		
1.1.4.	014		106391
Kokku 1.1. rühm	110	5322	155258
1.2. Mitmesugused muud tulud ja laekumised 1.2.1. Laekumised põhivara müügioperatsioonidest (kasum (=), kahjum (+) nendest operatsioonidest	111	27	130
1.2.2. Muud (liikide lõikes)	112		
Kokku 1.2. rühm	120	27	130
1.3. Ettevõtlekapitali finantseerimine 1.3.1. Pikaajalise võõrkapitali juurdekasv aruandeaastal (liikide lõikes)	121	-3	-10
1.3.2. Omakapitali juurdekasv aruandeaastal (liikide lõikes)	122	29861	261
Kokku 1.3. rühm	130	29858	251
KOKKU 1. OSA	190	35207	155639

2. KÄIBEKAPITALI KASUTAMINE	0	1	2
2.1. Pikaajalised investeeringud 2.1.1. Põhivara soetamine	201	1442	27941
2.1.2. Muud (liikide lõikes)	202		1547
Kokku 2.1. rühm	210	1442	31488
2.2. Pikaajaliste kohustuste tasumine (liikide lõikes)	211		
			606
Kokku 2.2. rühm	220		606
2.3. Omakapitali vähendamine (liikide lõikes)	221		
Kokku 2.3. rühm	230		
2.4.	240		
2.5. Käibekapitali muu kasutamine	250	111	31565
2.6.	260		
KOKKU 2. OSA	290	1553	63659

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Lisa nr. 2

PUHASKASUMI JAOTUS

tuhandetes kroonides (komakohata)

	Rea nr.	Eelmisel aastal	Aruande aastal
	0	1	2
Aruandeaasta puhaskasum (bilansi rida 11.2.2.) — kokku:	010	3885	42602
sealhulgas: 1. Omanikutulu kokku (021+022+023)	020		
sealhulgas: 1.1. Dividendid (osakud) — oma töötajatele	021		
— teistele	022		
1.2. Muud (liikide lõikes)	023		
2. Jaotamata kasum	030	3885	42602
3.	040		

Lisa nr. 3

PIKAAJALISTE REAAL- JA FINANTSINVESTEERINGUTE LIIGENDUS

tuhandetes kroonides (komakohata)

	Rea nr.	Eelmisel aastal	Aruande aastal
	0	1	2
1. Kapitaalmahutused kokku	010	[illegible]	[illegible]
2. Pikaajalised finantsinvesteeringud kokku:	020	1112	2464
sealhulgas: 2.1. Aktsiad, osakud	021	1112	2464
2.2. Muud väärtpaberid	022		
2.3. Muud (liikide lõikes)	023		

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	Line No	Previous year	Account. year
3. ACCUMULATION (+) OR DECREASE (-) OF THE CAPITAL OF CIRCULATION DURING THE ACCOUNTING YEAR			
Accumulation (+) or decrease(-) of the capital of circulation during the accounting year (p.1 minus p.2)			
4. ACCUMULATION (DECREASE) OF THE CAPITAL OF CIRCULATION ACCORDING TO THE BALANCE DATA OF THE ACCOUNTING YEAR*			
4.1. Change in the residue of money and securities (accumulation (+), decrease (-)			
4.2. Change in the residue of unpaid accounts (accumulation (+), decrease(-)			
4.3. Change in the residue of commodity stock and production reserve (accumulation (+), decrease (-)			
4.4. Change in the residue of other capital of circulation (accumulation (+), decrease (-)			
4.5. Change in short-term liabilities (accumulation (-). decrease (+)			
TOTAL SECTION 4			
5. CAPITAL OF CIRCULATION EXCEEDS SHORT-TERM LIABILITIES (ACCORDING TO BALANCE)**			
5.1. At the beginning of the year (+ or -)			
5.2. At the end of the year (+ or -)			
6. RATIO OF THE CAPITAL OF CIRCULATION AND SHORT-TERM LIABILITIES (%, SENTS NOT CONSIDERED)			
6.1. At the beginning of the year			
6.2. At the end of the year			
7. CASH BALANCE (THS. KRÖONS, WITHOUT SENTS)			
7.1. At the beginning of the year			
7.2. At the end of the year			

* The total of Section 3 must equal to the that of section 4

** The total of the capital of circulation in the assets of the balance:
total Section 1 plus total Section 2

3. KÄIBEKAPITALI JUURDEKASV (+) VÕI KAHANEMINE (-) ARUANDEAASTAL*	Rea nr.	Eelmisel aastal	Aruande aastal
	0	1	2
Käibekapitali juurdekasv (+) või kahanemine (-) aruandeaastal (p.1 miinus p.2)	300	33654	92176

4. KÄIBEKAPITALI JUURDEKASV (KAHANEMINE) ARUANDEAASTA BILANSI ANDMETEL*	0	1	2
4.1. Raha ja väärtpaberite jäägi muutus (juurdekasv (+), kahanemine (-)	410	18382	-12439
4.2. Laekumata arvete jäägi muutus (juurdekasv (+), kahanemine (-)	420	3513	135617
4.3. Kauba- ja tootmisvarude jäägi muutus (juurdekasv (+), kahanemine (-)	430	1625	70060
4.4. Muu käibevara jäägi muutus (juurdekasv (+), kahanemine (-)	440	11782	35551
4.5. Lühiajaliste kohustuste muutus (juurdekasv (-), kahanemine (+)	450	-1648	-136613
KOKKU 4. OSA	490	33654	92176

5. KÄIBEVARA** ÜLETAB LÜHIAJALISI KOHUSTUSI (BILANSI JÄRGI)	0	1	2
5.1. Aasta algul (+ või -)	510	3363	32133
5.2. Aasta lõpul (+ või -)	520	32367	129356

6. KÄIBEVARA JA LÜHIAJALISTE KOHUSTUSTE SUHE (%-des, komakohata)	0	1	2
6.1. Aasta algul	610	-244	99.2
6.2. Aasta lõpul	620	116.3	141.2

7. KASSA JÄÄK (tuhandetes kroonides, komakohata)	0	1	2
7.1. Aasta algul	710	164	18898
7.2. Aasta lõpul	720	X	1351

* Osa 3 summa peab võrduma osa 4 summaga.
** Käibevara üldsumma võrdub bilansi aktivas: kokku 1. osa pluss kokku 2. osa.

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Supplementary 2

DISTRIBUTION OF NET PROFIT

Net profit of the accounting year (balance, line 11.2.2.)-total:
incl.:

1. Owner's income total (021+022+023)
   incl.:
   1.1. Dividends (shares)
   - employees of the company
   - others

1.2. Other (according to categories)

2. Undivided profit
3.

Supplementary 3

ANALYSIS OF LONG-TERM REAL AND FINANCIAL INVESTMENTS

Ths. kroons (without cents)

1. Capital investments, total
2. Long-term financial investments, total:
   incl.:
   2.1. Shares, holdings
   2.2. Other securities
   2.3. Others (according to categories)

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Supplementary 4

ANALYSIS AND TIME LIMITS OF LONG-TERM LOANS AT THE END OF THE YEAR

	Line No	Loan sum	int.%	Date of repayment (year)	Thous. kroons (without cents) Residue to end of year Total incl. overdues
1.Registered loans from banks legal and physical entities (each loan on a separate line)					
Total Group 1					
2. Registered loans to legal and physical entities (each loan on a separate line)					
Total Group 2					

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Supplementary 5

ANALYSIS AND TIME LIMITS OF LONG-TERM RECEIVABLES AND PAYABLES

No data

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Supplementary 6

ANALYSIS OF EQUITY SHARES AND SHARES

No data

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Lisa nr. 4

PIKAAJALISTE LAENUDE LIIGENDUS JA TÄHTAJALISUS AASTA LÕPUL

tuhandetes kroonides (komakohata)

	Rea nr.	Laenu		Laenu tagastamise tähtaeg (aasta)	Jääk aasta lõpuks	
		summa	kasviku %		kokku	sealhulgas tähtajaks tasumata
	0	1	2	3	4	5
1. Saadud laenud pankadelt, juriidilistelt isikutelt ja üksikisikutelt nimeliselt (iga laen eraldi real)						
aianduse maade-ehit	110	4	20	2002	44	—
Kokku 1. rühm	100	4	x	x	44	
2. Antud laenud juriidilistele isikutele ja üksikisikutele nimeliselt (iga laen eraldi real)						
aianduse maade-ehit	110	4	20	2002	44	
Kokku 2. rühm	200	4	x	x	44	

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Lisa nr. 5

Pikaajalise debitoorse ja kreditoorse võla liigendus ja tähtajalisus

tuhandetes kroonides (komakohata)

	Rea nr.	Tasumise tähtaeg (aasta)	Tasumata summa		
			aasta algul	aasta lõpul	
				kokku	sh. tähtajaks tasumata
	0	1	2	3	4
1. Pikaajaline debitoorne võlgnevus (nimeliselt, kellelt saada)					
Kokku 1. rühm	100	X			
2. Pikaajaline kreditoorne võlgnevus (nimeliselt, kellele maksta)					
Kokku 2. rühm	200	X			

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Lisa nr. 6

OMAAKTSIATE JA OSAMAKSUDE LIIGENDUS

tuhandetes kroonides
(komakohata)

	Rea nr.	Ühe aktsia nominaalväärtus kroonides	Aasta algul		Aasta lõpuks		Ühe aktsia turuhind aasta lõpul kroonides
			kogus	summa	kogus	summa	
		1	2	3	4	5	6
1. Aktsiakapital kokku (võrdub bilansireaga II.1.1.) (011+012+013)	010	×	×		×		×
sealhulgas: 1.1. Aktsiad väljas (liikide lõikes)							
Kokku 1.1. rühm	011	×					×
1.2. Tagasiostetud omaaktsiad (liikide lõikes), mis on ettevõttes hoiul ja kuuluvad edasimüümiseie							
Kokku 1.2. rühm	012	×					×
1.3. Aktsiate emissioonist saadud summa üle (alla) nominaalväärtuse (+ või —)	013	×	×		×		×
2. Osamaksud kokku (võrdub bilansireaga II.1.1.)	020	×	×		×		×

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FLOW OF FIXED CAPITAL (acquisition cost)

Ths. kroons (no sents)

	Line No.	To beg. of year	Income total incl. new	Expense total incl. sale	To end of year	Same at residual price
	0	1	2	3	4	5	6	7
Fixed capital, total incl.:								
1.Productive fixed capital, total incl.:								
- buildings								
- facilities								
- machines and equipment								
- means of transport								
- inventory								
- land								
- other								
2. Non-productive fixed capital, total incl.:								
- housing								
- public utilities								
- services								
- health care								
- education								
- culture								
- art								
- science								
- societies								
- others								

Raamatupidamisaruande lisa nr. 7

PÕHIVARA LIIKUMINE
(soetusmaksumuses)

tuhandetes kroonides (komakohata)

	Rea nr.	Aasta alguseks	Sissetulek kokku	Sissetulek sh. uued	Väljaminek kokku	Väljaminek sh. müük	Aasta lõpuks	Sama jääkmaksumuses
	0	1	2	3	4	5	6	7
Põhivara kokku	010	68023	11281	11019	2665	41	76639	40850
sealhulgas: 1. Tootmislik põhivara kokku:	100	59599	11276	11019	2024	27	68851	34795
sealhulgas: — hooned	101	17425	–	–	–	–	17425	12559
— rajatised	102	10476	165	165	–	–	10641	6385
— masinad ja seadmed	103	19463	8559	8503	1796	17	26226	8604
— veovahendid	104	2994	537	336	18	11	3513	2285
— inventar	105	129	2015	2015	20	–	2124	1062
— maa	106							
— muud	107	9112	–	–	190	–	8922	3900
2. Mittetootmislik põhivara kokku	200	8292	5	–	641	14	7656	5173
sealhulgas: — elamumajandus	201	6882	–	–	41	–	6841	4549
— kommunaalmajandus	202							
— teenindus	203							
— tervishoid	204	879	–	–	545	14	334	202
— haridus	205	476	5	–	–	–	481	422
— kultuur	206	55	–	–	55	–	–	–
— kunst	207							
— teadus	208							
— ühiskondlikud organisatsioonid	209							
— muud	210	132					132	82

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Supplementary 8

FLOW OF SPECIAL FUNDS

	Line No	Ths. kroons (no sents) Residue to beg of year	Calcul.	Spent	Residue to end year
1. Special funds on account of expenses (registered)					
Total Group 1					
2. Special funds permitted by law that decrease the sum of income taxed by income tax (registered)					
Total Group 2					
3. Special funds the profit that remain at the disposal of the enterprise					
Total Group 3					

Supplementary 8

FOREIGN CURRENCY FLOW

	Line No	Residue to beg. of year	Ths. kroons (no sents) Circulation Income	Expense	Recidue to end of year
Total					

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Supplementary 9

OUTSIDE BALANCE ACCOUNTS

No data

Supplementary 10

IMPACT OF THE CHANGE OF CALCULATION METHODS DURING ACCOUNTING YEAR ON PROFIT

No data

Lisa nr. 8,

ERIFONDIDE LIIKUMINE

tuhandetes kroonides (komakohata)

	Rea nr.	Jääk aasta alguseks	Arvestatud	Kulutatud	Jääk aasta lõpuks
	0	1	2	3	4
1. Erifondid kulude arvel (nimeliselt)	922	5131	147392	48877	103646
Kokku 1. rühm	100				
2. Seadusandlusega lubatud erifondid, mis vähendavad tulumaksuga maksustatavat tulusummat (nimeliselt)					
Kokku 2. rühm	200				
3. Erifondid ettevõtte käsutusse jäävast kasumist (nimeliselt)					
Kokku 3. rühm	300				

Lisa nr. 8,

VALUUTA LIIKUMINE

tuhandetes kroonides (komakohata)

	Rea nr.	Jääk aasta alguseks	Käive		Jääk aasta lõpuks
			sissetulek	väljaminek	
	0	1	2	3	4
Kokku	100	18960	44888	59523	4325

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Lisa nr. 9

BILANSIVÄLISED KONTOD

tuhandetes kroonides (komakohata)

Konto nimetus	Rea nr.	Jääk aasta alguseks	Jääk aasta lõpuks
	0	1	2

Lisa nr. 10

ARUANDEAASTA ARVESTUSMETOODIKA MUUTUSTE MÕJU KASUMILE

tuhandetes kroonides (komakohata)

	Rea nr.	Kasumi muutuse summa (+, —)
	0	1
1. Käibevara arvestuskorra muutused 1.1.		
1.2.		
1.3.		
Kokku 1. rühm	100	
2. Põhivara amortisatsiooninormide muutused 2.1.		
2.2.		
2.3.		
Kokku 2. rühm	200	
Tehtud muudatuste sisuseletus 1.		
2.		
3.		

Koostamise kuupäev:

Pitsat

ASUTUSE JUHT:

RAAMATUPIDAJA:

"PÕLEVKIVIKEEMIA" EV KOHTLA-JÄRVE

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RIIGI STATISTIKAAMET

1992. A. RAAMATUPIDAMISE AASTAARUANDE ARITMEETILISED SEOSED

Murru lugejas on aruande rea number ja nimetajas veeru number

BILANSS

1. 020/1,2=011/1,2+012/1,2+013/1,2+014/1,2
2. 030/1,2=021/1,2+022/1,2+023/1,2+024/1,2
3. 040/1,2=031/1,2+032/1,2+033/1,2+034/1,2 +035/1,2+036/1,2+0,37/1,2+038/1,2
4. 100/1,2=020/1,2+030/1,2+040/1,2
5. 200/1,2=110/1,2+120/1,2+130/1,2+140/1,2 +150/1,2+160/1,2
6. 300/1,2=210/1,2+220/1,2+230/1,2+240/1,2 +250/1,2
7. 400/1,2=310/1,2+320/1,2=330/1,2+340/1,2
8. 590/1,2=100/1,2+200/1,2+300/1,2+400/1,2 +500/1,2+570/1,2
9. 610/1,2=601/1,2+602/1,2+603/1,2+604/1,2 +605/1,2
10. 660/1,2=651/1,2+652/1,2+653/1,2+654/1,2
11. 700/1,2=610/1,2+620/1,2+630/1,2+640/1,2 +650/1,2+660/1,2+670/1,2
12. 800/1,2=710/1,2+720/1,2+730/1,2+740/1,2
13. 930/1,2=921/1,2+922/1,2+923/1,2+924/1,2
14. 940/1,2=931/1,2+932/1,2+933/1,2
15. 950/1,2=930/1,2+940/1,2
16. 990/1,2=700/1,2+800/1,2+900/1,2=910/1,2 +950/1,2+970/1,2
17. 990/1,2=590/1,2

KASUMIARUANNE

1. 020/1,2=011/1,2+012/1,2+013/1,2+014/1,2 +015/1,2
2. 030/1,2=010/1,2 miinus 020/1,2
3. 045/1,2=031/1,2+032/1,2+033/1,2+034/1,2 035/1,2+036/1,2+037/1,2+038/1,2+039/1,2 +010/1,2+041/1,2
4. 050/1,2=030/1,2 miinus 045/1,2
5. 060/1,2=051/1,2+052/1,2+053/1,2+054/1,2 +055/1,2
6. 070/1,2=061/1,2+062/1,2+063/1,2+064/1,2
7. 080/1,2=050/1,2+060/1,2 miinus 070/1,2
8. 110/1,2=080/1,2 miinus 090/1,2+100/1,2
9. 140/1,2=080/1,2 miinus 090/1,2 miinus 120/1,2 miinus 130/1,2

FINANTSSEISUKORRA ARUANNE

1. 110/1,2=011/1,2+012/1,2+013/1,2+014/1,2
2. 130/1,2=121/1,2+122/1,2
3. 190/1,2=110/1,2+120/1,2+130/1,2
4. 201/1,2=<010/1,2 Lisa nr. 3
5. 210/1,2=201/1,2+202/1,2
6. 290/1,2=210/1,2+220/1,2+230/1,2+240/1,2 +250/1,2+260/1,2
7. 300/1,2=190/1,2 miinus 290/1,2
8. 490/1,2=410/1,2+420/1,2+430/1,2+440/1,2 +450/1,2
9. 300/1,2=490/1,2

PUHASKASUMI JAOTUS (Lisa nr. 2)

1. 010/1,2=020/1,2+030/1,2
2. 020/1,2=021/1,2+022/1,2+023/1,2

PIKAAJALISTE REAAL- JA FIN. INVEST. LIIGENDUS (Lisa nr. 3)

1. 020/1,2=021/1,2+022/1,2+023/1,2
2. 010/1,2=>201/1,2 (Lisa nr. 2)

POHIVARA LIIKUMINE (Lisa nr. 7)

Selles aruandes on veerud: 1, 2, 3, 4, 5, 6, 7

1. 010/1,...=100/1,...+200/1,...
2. 100/1,...=101/1,...+102/1,...+103/1,...+104/1,... +105/1,...+106/1,...+107/1,...
3. 200/1,...=201/1,...+202/1,...+203/1,...+204/1,... +205/1,...+206/1,...+207/1,...+208/1,... +209/1,...+210/1,...
4. 010/6=010/1+010/2 miinus 010/4

ERIFONDIDE LIIKUMINE (Lisa nr. 8)

1. 100/4=100/1+100/2 miinus 100/3
2. 200/4=200/1+200/2 miinus 200/3
3. 300/4=300/1+300/2 miinus 300/3

VALUUTA LIIKUMINE (Lisa nr. 8)

1. 100/4=100/1+100/2 miinus 100/3

AASTA ARUANNETE TABELITE VAHELISED SEOSED

Kasumiaruanne

140/1,2= bilanss 932/1,2

Finantsseisukorra aruanne

012/1,2= kasumiaruanne 039/1,2
410/2= bilanss rida 020 lahter 2 miinus lahter 1
420/2= bilanss rida 030 lahter 2 miinus lahter 1
430/2= bilanss rida 200 lahter 2 miinus lahter 1
440/2= bilanss rida 040 lahter 2 miinus lahter 1
450/2= bilanss rida 700 lahter 2 miinus lahter 1
520/2= bilanss rida 100/2+200/2 miinus 700/2
620/2= bilanss rida (100/2+200/2):700/2
510/2= bilanss rida 100/1+200/1 miinus 700/1
610/2= bilanss rida (100/1+200/1):700/1

Puhaskasumi jaotus (Lisa nr. 2)

010/1,2= bilanss rida 932/1,2

Bilanss ja lisad nr. 4 ja 5

800/2=> lisa 4 rida 100/4+ lisa 5 rida 200/3
320/2+330/2-340/2> lisa 4 rida 200/4+ lisa 5 rida 100/3
730/2= lisa 4 rida 100/5+ lisa 5 rida 200/4

Omaaktsiate ja osamaksude liigendus aktsiaseltsidele (Lisa nr. 6)

010/3= bilanss rida 921/1
020/3= bilanss rida 921/1
010/5= bilanss rida 921/2
020/5= bilanss rida 921/2

Põhivara liikumine (Lisa nr. 7)

010/1= bilanss rida 210/1+211
010/6= bilanss rida 210/2+212
010/7= bilanss rida 210/2

Erifondide liikumine (Lisa nr. 8)

bilanss 922/1,2=> lisa 8 leht 1 rida 100/1,4+200/1,4+300/1,4

Valuuta liikumine (Lisa nr. 8)

100/1= bilanss rida 012/1
100/4= bilanss rida 012/2

Finantsstatistika osakond
Tel. 45 24 84, 45 09 20, 45 37 27

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ANNEX C
FINANCIAL STATEMENTS FOR SLANTSECHIM, 1991

This annex contains financial information for fiscal year 1991 that the project team received from RAS Kiviter on January 21, 1994. All of the accounts were in Russian.

Three accounts are shown on the following pages:

1. Accounting balance for Slantsechim, January 1, 1992

2. Profit statement for Slantsechim, 1991

3. Income tax return for Slantsechim, January 1, 1992.

ACCOUNTING BALANCE
1 January 1992

Thous. roubles

ASSETS	Line No	Beginning of year	End of year
1.LIQUID ASSETS			
1.1. Money and securities			
1.1.1. Cash and bank accounts			
1.1.2. Foreign currency accounts			
1.1.3. Shares and other securities (short-term investments)			
1.1.4.			
Total Group 1.1.			
1.2. Short-term credit debts of buyers			
1.2.1. Buyers bills of exhange			
1.2.2. Buyers unpaid bills			
1.2.3. Buyers other credit debts			
1.2.4.			
Total Group 1.2.			
1.3. Other short-term credit debts (excl. those of buyers)			
1.3.1. Bills of exchange			
1.3.2. Prepayment of taxes			
1.3.3. Payments in advance to suppliers			
1.3.4. Settlements with shareholders			
1.3.5. Non-compensated losses			
1.3.6. Other credit debts			
1.3.7.			
Total Group 1.3.			
TOTAL SECTION 1			
2. STOCKS OF COMMODITIES AND PRODUCTION RESERVES			
2.1. Production reserves			
2.2. Unfinished products			
2.3. Finished products			
2.4. Commodities			
2.5. Other			
2.6.			
TOTAL SECTION 2			

БУХГАЛТЕРСКИЙ БАЛАНС

на 1 января 199[illegible] г.

АКТИВ

I. ЛИКВИДНЫЕ ИМУЩЕСТВА	№ стр.	На начало года	На конец года
	0	1	2
1.1 Денежные средства и ценные бумаги 1.1.1 Касса и счета в банках (50, 51, 55, 56)	011	3159	60
1.1.2. Валютные счета (52)	012	3233	18966
1.1.3. Акции и прочие ценные бумаги (краткосрочные инвестиции) (55,56)	013		
1.1.4.	014		
Итого по группе 1.1	020	6392	19022
1.2. Краткосрочная дебиторская задолженность покупателей 1.2.1. Векселя покупателей (59)	021		
1.2.2. Неоплаченные покупателями счета (62)	022	13316	48400
1.2.3. Прочая дебиторская задолженность покупателей (63, 64, 73)	023	3	4[illegible]
1.2.4.	024		
Итого по группе 1.2	030	13319	48401
1.3 Разная краткосрочная дебиторская (за исключением покупателей) задолженность	031		
1.3.1 Векселя (59)	032		
1.3.2 Переплаты по налогам (68, 69)	033		
1.3.3 Авансы поставщикам (61)	034	93	4[illegible]
1.3.4. Расчеты с акционерами (75)	035		
1.3.5. Расчеты по возмещению ущерба (72, 84)	036	35	95
1.3.6. Прочая дебиторская задолженность (60, 70, 71, 73, 76, 79)	037	7104	124916
1.3.7.	038		
Итого по группе 1.3	040	7232	125057
ВСЕГО ПО РАЗДЕЛУ 1	100	26943	363717

2. ТОВАРНЫЕ И ПРОИЗВОДСТВЕННЫЕ ЗАПАСЫ			
	0	1	2
2.1 Производственные запасы (05, 06, 07, 08, 09, 10, 12 минус 13)	110	23588	31398
2.2 Незавершенное производство (03, 20, 21, 23, 29, 30)	120	2736	4880
2.3 Готовая продукция (40)	130	2728	7771
2.4. Товары (41, 42)	140		729
2.5. Прочие (31)	150	17	39
2.6.	160		
ВСЕГО ПО РАЗДЕЛУ 2	200	29069	45317

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ASSETS

	Line No	Beginning of year	End of year
3. FIXED CAPITAL AND UNFINISHED CAPITAL WORKS			
3.1. Fixed capital (01 minus 02)			
Beginning of year			
Cost of fixed capital			
End of year			
3.2. Unfinished capital works			
3.3. Uninstalled machinery and equipment			
3.4. Other			
3.5.			
TOTAL SECTION 3			
4.LONG-TERM FINANCIAL INVESTMENTS AND RESOURCES GIVEN ON A LOAN			
4.1. Shares, holdings, deposits, and other securities			
4.2. Resources given on loans			
4.3. Other investments			
4.4.			
TOTAL SECTION 4			
3. INTANGIBLE ASSETS			
Intangible assets			
6.OTHER ASSETS			
Other assets			
ASSETS TOTAL			
Assets total			

АКТИВ

3. ОСНОВНОЕ ИМУЩЕСТВО И НЕЗАКОНЧЕННЫЕ КАПИТАЛЬНЫЕ РАБОТЫ		№ стр	На начало года	На конец года
		0	1	2
3.1 Основное имущество (01 минус 02)		210	141727	359702
На начало года	153072	211	•	×
На конец года	320770	212		
3.2 Незаконченные капитальные работы (33, 35)		220		
3.3. Машины и оборудование для установки (07)		230		
3.4 Прочие		240		
3.5.		250		
ВСЕГО ПО РАЗДЕЛУ 3		300	141727	359702

4. ДОЛГОСРОЧНЫЕ ФИНАНСОВЫЕ ИНВЕСТИЦИИ (ВЛОЖЕНИЯ) И СРЕДСТВА, ВЫДАННЫЕ В КРЕДИТ	0	1	2
4.1. Акции, вклады, депозиты и прочие ценные бумаги (58)	310	18190	11174
4.2 Средства, выданные в кредит (73)	320	1	
4.3 Прочие инвестиции (61, 76)	330		
4.4.	340		
ВСЕГО ПО РАЗДЕЛУ 4	400	18191	11174

5. НЕМАТЕРИАЛЬНЫЕ АКТИВЫ	0	1	2
Нематериальные активы (04)	500		

6. ПРОЧИЕ АКТИВЫ	0	1	2
Прочие активы	570	•	

БАЛАНС	0	1	2
Баланс	590	216530	779910

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LIABILITIES

	Line No	Beginning of year	End of year
7. SHORT-TERM LIABILITIES			
7.1. Bank loans			
7.1.2. Loans from legal and physical entities			
7.1.3. Other loans			
7.1.4. Overdue loans			
7.1.5.			
Total Group 7.1.			
7.2. Short-term debts on bills of exchange			
7.3. Short-term indebtedness to suppliers and contractors (excl. bills of exchange)			
7.4. Indebtedness for wages and social tax			
7.5. Debts for taxes			
7.6. Other short-term debts			
7.6.1. Payments in advance from buyers			
7.6.2. Unpaid dividends			
7.6.3. Other debts			
7.6.4.			
Total Group 7.6.			
7.7.			
TOTAL SECTION 7			
8. LONG-TERM FINANCIAL LIABILITIES			
8.1. Bank loans			
8.2. Other liabilities and debts			
8.3. Overdue financial liabilities			
8.4.			
TOTAL SECTION 8			
9. RESERVES AND TARGET RESOURCES NON-TAXABLE BY COMPANY INCOME TAX			
Reserves and target resources non-taxable by company income tax			

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ПАССИВ

7. КРАТКОСРОЧНЫЕ ОБЯЗАТЕЛЬСТВА	№ стр	На начало года	На конец года
	0	1	2
7.1 Краткосрочные ссуды 7.1.1 Ссуды банков (90)	601	16000	19822
7.1.2 Ссуды юридических и физических лиц (95)	602	128	269
7.1.3 Прочие ссуды	603		
7.1.4. Ссуды, не погашенные в срок (90, 95)	604		
7.1.5.	605		
Итого по группе 7.1.	610	16128	20091
7.2. Краткосрочные векселя выданные (66)	620		
7.3 Краткосрочная задолженность поставщикам и подрядчикам (за исключением векселей) (60)	630	4026	6976
7.4. Задолженность по заработной плате и по социальному налогу (69, 70)	640	1207	2810
7.5 Задолженность по налогам (68)	650	1279	4948
7.6 Прочая краткосрочная задолженность 7.6.1 Авансы покупателей (62)	651		
7.6.2. Неоплаченные дивиденды (75)	652		
7.6.3. Прочая задолженность (61, 76)	653	345	4639
7.6.4.	654		
Итого по группе 7.6.	660	6857	15276
7.7.	670		
ВСЕГО ПО РАЗДЕЛУ 7	700	22985	39461

8. ДОЛГОСРОЧНЫЕ ФИНАНСОВЫЕ ОБЯЗАТЕЛЬСТВА	0	1	2
8.1. Ссуды банков (92, 97)	710	456	428
8.2 Прочие обязательства и долги (95)	720		
8.3 Финансовые обязательства не погашенные в срок (92, 95, 97)	730		
8.4.	740		
ВСЕГО ПО РАЗДЕЛУ 8	800	456	428

9. РЕЗЕРВЫ И ЦЕЛЕВЫЕ ПОСТУПЛЕНИЯ, НЕ ОБЛАГАЕМЫЕ ПОДОХОДНЫМ НАЛОГОМ С ПРЕДПРИЯТИЯ	0	1	2
Резервы и целевые поступления, не облагаемые подоходным налогом с предприятия (88, 96)	900		

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LIABILITIES

10. REGULATIVES
Regulatives

11. EQUITY CAPITAL
11.1. Restricted equity capital
11.1.1. Fixed capital
11.1.2. Reserves
11.1.3. Rise in the prise of fixed capital due to inflation
11.1.4.

Total Group 11

11.2. Free equity capital
11.2.1. Undistributed earnings of previous years
11.2.2. Net profit, loss (-)
11.2.3.

Total Group 11.2.

TOTAL SECTION 11

12. OTHER LIABILITIES
Other liabilities

BALANCE
Balance

ПАССИВ

	№ стр.	На начало года	На конец года
	0	1	2
10. РЕГУЛАТИВЫ			
Регулативы (831)	910	2	2

	0	1	2
11. СОБСТВЕННЫЙ КАПИТАЛ			
11.1. Зависимый собственный капитал 11.1.1. Основной капитал (85)	921	169105	381667
11.1.2. Резервы (86, 87, 88, 89, 96)	922	23982	15185
11.1.3. Повышение цен основного имущества за счет инфляции (86/5)	923		
11.1.4.	924		
Итого по группе 11.1.	930	193087	402852
11.2. Свободный собственный капитал 11.2.1. Нераспределенная прибыль прошлых лет (80)	931		
11.2.2. Чистая прибыль (убыток —) за отчетный год (88)	932		38850
11.2.3.	933		
Итого по группе 11.2.	940	193087	441702
ВСЕГО ПО РАЗДЕЛУ 11.	950		

	0	1	2
12. ПРОЧИЕ ПАССИВЫ			
Прочие пассивы	970		298314

	0	1	2
БАЛАНС			
Баланс	990	216530	779910

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PROFIT STATEMENT

1.Gross revenue	Line No	Previous year	Year of account.
TOTAL	S2		

2.Discountings from gross sales
2.1. Sales tax
2.2. Excise tax
2.3. Customhouse receipts
2.4. Other
2.5.
TOTAL GROUP 2 S2

3. Net revenue
S1 - S2 = S3

4.Costs
4.1. Commodities
4.2. Materials
4.3. Fuel and energy
4.4. Wage costs
4.5. Social tax
4.6. Other taxes
4.7. Other financial expenses
4.8. Depreciation (amortization)
4.9. Inventory (unfinished products, future costs and residues of finished products)
(increase -, reduction +)
4.10

TOTAL Group 4 S4

5. SALES PROFIT (LOSS-)
S3 - S4 = S5

6.FINANCIAL INCOME
6.1. Received interests (interests)
6.2. Received dividends (shares)
6.3. Changes in exchange rate
6.4. Other
6.5. Income from the sale of foreign currency (difference in the exchange rate)
TOTAL Group 6

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Ths. kroonc (without sents)

	Line No	During account.perio
7. Financial expenses		
7.1. Paid interests (interests)		
7.2. Change of foreign currency exchange rate		
7.3. Other		
7.4. Loss from the purchase of foreign currency at auction (difference in the exchange rate)		
TOTAL Group 7	S7	
8.Gross profit (loss-)		
S5 + S6 - S7 = S8		
9.Sums reducing the total income taxed by income tax		
TOTAL	S9	
10. Sums increasing the total income taxed by income tax		
TOTAL	S10	
11.Total income taxed by income tax		
S8 - S9 + S10 =S11		
12.Income tax of the enterprise		
TOTAL	S12	
13.Other costs (according to "Principle system of profit statement)		
TOTAL	S13	
14.Net profit (loss-)		
S8 - S9 - S13=S14		

Data in the row 1 (previous year) must not be filled for 1991.

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ОТЧЕТ О ПРИБЫЛИ

		№ стр	За прошлый год*	За отчетный год
1. БРУТТО-ОБОРОТ РЕАЛИЗАЦИИ		0	1	2
ВСЕГО	C1	010		421442

2. ВЫЧЕТЫ ИЗ БРУТТО-ОБОРОТА РЕАЛИЗАЦИИ		0	1	2
2.1. Налог с оборота		011		22571
2.2. Акцизный налог		012		
2.3. Таможенный доход		013		
2.4. Прочие		014		
2.5.		015		
ВСЕГО ПО ГРУППЕ 2	C2	020		22571

3. НЕТТО-ОБОРОТ РЕАЛИЗАЦИИ	0	1	2
C1 – C2 = C3	030		398931

4. РАСХОДЫ		0	1	2
4.1. Товары		031		4122
4.2. Материалы		032		156273
4.3. Топливо и энергия		033		56322
4.4. Расходы по оплате труда		034		33072
4.5. Социальный налог		035		2818
4.6. Прочие налоги		036		10000
4.7. Прочие денежные расходы		037		57040
4.8. Износ (амортизация)		038		14371
4.9. Изменение запасов (незавершенная продукция, расходы будущих периодов и остатков готовой продукции (увелич. —, снижение +)		039		-2309
4.10.		040		
ВСЕГО ПО ГРУППЕ 4	C4	045		359625

5. ПРИБЫЛЬ (УБЫТОК-) ОТ РЕАЛИЗАЦИИ	0	1	2
C3 – C4 = C5	050		39293

6. ФИНАНСОВЫЕ ДОХОДЫ		0	1	2
6.1. Полученные интересы		051		169
6.2. Полученные дивиденды (вклады)		052		14
6.3. Изменения валютного курса		053		
6.4. Прочие		054		8151
6.5. Доход, полученный от продажи валюты на аукционе (разница в курсе)		055		28042
ВСЕГО ПО ГРУППЕ 6	C6	060		36376

7. ФИНАНСОВЫЕ РАСХОДЫ		№ стр	За прошлый год	За отчетный год
		0	1	2
7.1. Уплаченные интересы		061		1314
7.2. Изменения валютного курса		062		434
7.3. Прочие		063		16589
7.4. Убыток при покупке валюты на аукционе (разница в курсе)		064		
ВСЕГО ПО ГРУППЕ 7	C7	070		18477

8. БРУТТО-ПРИБЫЛЬ (УБЫТОК –)	0	1	2
C5 + C6 – C7 = C8	080		56892

9. СУММЫ, УМЕНЬШАЮЩИЕ ОБЛАГАЕМУЮ ПОДОХОДНЫМ НАЛОГОМ СУММУ ДОХОДА		0	1	2
ВСЕГО	C9	090		426

10. СУММЫ, УВЕЛИЧИВАЮЩИЕ ОБЛАГАЕМУЮ ПОДОХОДНЫМ НАЛОГОМ СУММУ ДОХОДА		0	1	2
ВСЕГО	C10	100		49

11. ОБЛАГАЕМАЯ ПОДОХОДНЫМ НАЛОГОМ СУММА ДОХОДА	0	1	2
C8 – C9 + C10 = C11	110		56515

12. ПОДОХОДНЫЙ НАЛОГ С ПРЕДПРИЯТИЯ		0	1	2
ВСЕГО	C12	120		16803

13. РАЗНЫЕ РАСХОДЫ ВСЕГО (согласно п. 13. "Схемы отчета прибыли)		0	1	2
ВСЕГО	C13	130		1437

14. ЧИСТАЯ ПРИБЫЛЬ (УБЫТОК–)	0	1	2
C8–C9–C12–C13=C14	140		38856

*Данные по графе 1 (за прошлый год) не заполняются за 1991 г.

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Annual
Form E 1

1. Revenue Department

2. Date of reception

COMPANY INCOME TAX RETURN

3. Enterprise: Production Association "Põlevkivikeemia"
3.1. Reg. No: 13006412
3.2. Address: Kohtla-Järve, Järveotsa tee, 14
3.3. Phone: 15774 3.4. Telex 3.5. Fax: 19824

Index	incl. second half-year
4. Gross sales	
5. Deductions from gross revenue, incl.:	
5.1. Sales tax	
5.2. Excise tax	
5.3.	
5.4.	
6. Net sales (it.4 - it.5)	
7. Costs incl.	
7.1. Commodities -	
7.2. Other materials, spare parts low value items	
7.3. Purchased intermediate goods	
7.4. Fuel	
7.5. Energy	
7.6.	
7.7.	
7.8.	
7.9.	
7.10. Rental for spaces	
7.11. Other material costs	
7.12. Wages, bonuses, benefits	
7.13. Health insurance	
7.14.	
7.15.	
7.16. Other financial costs	
7.17. Depreciation	
7.18. Social tax	
7.19. Land tax	
7.20. Charges for natural resources incl.:	
7.20.1. For water	
7.20.2.	
7.20.3.	
7.21. Customs duties and charhes for customs procedures	
7.22. Pollution tax within the limits	
7.23. Other taxes incl.:	

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7.23.1.
7.23.2.
7.23.3.
7.24. Allocations to special funds according to law
7.25. Other costs according to law
incl.:
7.25.1. State duty
7.26. Changes of residuals of unfinished production, future residuals and stocks of ready-made products
8. Profit (loss) from sales
(it.6it.7)
9. Financial income
incl.:
9.1. Received interests
9.2. Received fines, deferrals
9.3. Received dividends
9.4. Profit from property sale
9.5. Prolonged credit debt
9.6. Profit of the previous year that has turned out this year
9.7. Insurance sums
9.8. Free of charge acquired property
9.9. Other
10. Financial expenses:
incl.:
10.1. Paid off credit interests
10.2. Paid off fines, deferrals, other penalties
10.3.
10.4. Losses from the sale of property
10.5. Prolonged receivables
10.6. Losses from the last year that have turned out this year
10.7.
10.8. Other
11. Gross profit (loss)
(it.8 + it.9 - it.10)
12. Taxes and allocations that decrease the total income taxed by income tax
incl.:
12.1. Grants to legal entities of the Estonian Republic, excluding enterprises, up to 15 % from gross profit
12.2.
12.3. Special funds permitted by law
12.4. Fund for increasing fixed capital
13. Sums increasing the total income taxed by income tax
incl.:
13.1. R
13.2. C
13.3.
13.4.
14. Total icome taxed by income tax
(it.11 - it.12 + it.13)
15. Company income tax
16. Tax incentives

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17. Company income tax taking into account:
17.1. Income tax total
(it.15 - it. 16)
17.2. Average rate of income tax in percents
(it.17 : it. 14 x 100)
18. Income tax in foreign currency
18.1. Income in foreign currency
18.2. Costs in foreign currency
18.3. Income in foreign currency taxable by income tax
(it.18.1 - it. 18.2)
18.4. Income tax from the income in foreign currency
(it.18.3 x 17.2)
19. To be included in the bydget:
19.1 In foreign currency translated into roubles (no more than it.17.1.)
19.2. In Estonian kroons (it.17.1 - it.19.1)
20. Total income tax for the accounting period:
20.1. In foreign currency translated into roubles
20.2. In Estonian kroons
21. Extra payment to be made:
21.1. In foreign currency translated into roubles
(it. 19.1 - it. 20.1)
21.2. In roubles (it.19.2. - it.20.2.)
22. To be decreased:
22.1. In foreign currency translated into roubles
(it.20.1. -it.19.2.)
22.2. In Estonian kroons (it.20.2. - it.19.2.)
23. Date of approval of the annual balance
24. Director of the nterprise
25. General accountant
26. Conclusion of the tax return:
26.1. According to supervision results the total income shown by the enterprise:
- increased - in roubles;
in foreign currency translated into roubles
- decreased - in roubles;
in foreign currency translated into roubles

27. Director of the Tax Revenue Department /signature/

28. Inspector /signature/

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Годовой

Форма Е 1

1. Налоговый департамент 2. Дата получения .....

НАЛОГОВАЯ ДЕКЛАРАЦИЯ ПРЕДПРИЯТИЯ

3. Название предприятия ПО "Сландехим"
3.1. Нр. регистра 13006412
3.2. Адрес Кохтла-Ярве, Ярвекюла тее,14
индекс,город,уезд
улица,Нр.дома
3.3. Телефон 45774 3.4. Телетайп ..... 3.5. Телефакс 49-824

	ПОКАЗАТЕЛЬ		в том числе II полугодие
4.	Брутто-оборот реализации	511615	236950
5.	Отчисления с брутто-оборота	40196	16919
	в том числе:		
5.1.	Налог с оборота	40196	16919
5.2.	Акцизный налог		
5.3.			
5.4.			
6.	Нетто-оборот реализации п.4 - п.5	471419	220031
7.	Затраты	333349	206455
	в том числе:		
7.1.	Товары -	13943	12327
7.2.	Сырье,материалы,запасные части,малоценные предметы	185387	110959
7.3.	Покупные полуфабрикаты		
7.4.	Топливо	3577	2529
7.5.	Энергия	5059	2906
7.6.			
7.7.			
7.8.			
7.9.			
7.10.	Плата за наем помещений	10	9
7.11.	Прочие материальные расходы	5	5
7.12.	Зарплата,премии,пособия	2637	16432
7.13.	медицинский налог	4152	2626
7.14.			
7.15.			
7.16.	Прочие денежные расходы	31750	22497
7.17.	Амортизационные отчисления	6265	4536
7.18.	Социальный налог	5261	3281
7.19.	Земельный налог		
7.20.	Платежи за природные ресурсы	38	18
	в том числе:		
7.20.1.	плата за воду	38	18
7.20.2.			
7.20.3.			

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7.21.	Таможенный сбор и плата за таможенные процедуры	9988	9414
7.22.	Налог за загрязнение в пределах лимита	1837	617
7.23.	Прочие налоги в том числе:		
7.23.1.	.....		
7.23.2.	.....		
7.23.3.	.....		
7.24.	Отчисления в спецфонды, предусмотренные законом		
7.25.	Прочие расходы, предусмотренные законом в том числе:		
7.25.1	....Госпошлина.....	34	23
7.26.	Изменение остатков незавершенного производства, расходов будущих периодов и запасов готовой продукции	-41932	-29182
8.	Прибыль от реализации (убыток) /р.6-р.7/	138070	11576
9.	Финансовые доходы в том числе:	23827	13250
9.1.	Полученные интересы	64	24
9.2.	Полученные штрафы, пени	917	516
9.3.	Полученные дивиденды	58	1
9.4.	Прибыль от продажи имущества	226	182
9.5.	Просроченная кредиторская задолженность	116	116
9.6.	Выявленная в текущем году прибыль прошлого года	862	800
9.7.	Суммы, полученные от страхования		
9.8.	Безвозмездно полученное имущество		
9.9.	.прочие.....	21584	11609
10.	Финансовые расходы: в том числе:	58941	57296
10.1.	Выплаченные кредитные интересы	839	768
10.2.	Выплаченные штрафы, пени, различные взыскания	10823	10524
10.3.	.....		
10.4.	Убыток от продажи имущества	19	19
10.5.	Просроченная дебиторская задолженность	11	11
10.6.	Убыток прошлого года, выявленный в текущем году	1	-
10.7.	.....		
10.8.	..прочие.....	47248	45974
11.	Брутто-прибыль /убыток/ /р.8+р.9-р.10/	102956	-32470
12.	Налоги и отчисления, которые уменьшают облагаемую подоходным налогом сумму прибыли в том числе:	27605	

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12.1.	Пожертвования действующим в Эстонской Республике юридическим лицам за исключением предприятий до 15% от брутто-прибыли	1866	
12.2.	.....	.....	
12.3.	Спецфонды, разрешенные законом	.....	
12.4.	фонд увелич.осн.имущ.....	25739	
13.	Суммы, увеличивающие облагаемую подоходным налогом сумму дохода	35	
	в том числе:		
13.1.	Расходы на приемы	21	
13.2.	сделки за наличный расчет	14	
13.3.	.....	.....	
13.4.	.....	.....	
14.	Сумма дохода, облагаемая подоходным налогом (п.11 - п.12 + п.13)	75326	-60065
15.	Подоходный налог предприятия	22610	-18020
16.	Льготы по налогу	-	
17.	Подоходный налог предприятия с учетом по налогу:		
17.1.	Сумма подоходного налога (п.15 - п.16)	22610	
17.2.	Средняя ставка подоходного налога в процентах (п.17 : п.14 x 100)	30	
18.	Подоходный налог в иностранной валюте		
18.1.	Доходы в иностранной валюте		
18.2.	Расходы в иностранной валюте		
18.3.	Облагаемая подоходным налогом выручка в валюте (п.18.1 - п.18.2)		
18.4.	Подоходный налог выручки в валюте (п.18.3 x п.17.2)		
19.	Подлежит внесению в бюджет:		
19.1.	В иностранной валюте в пересчете на рубли (не более чем в п.17.1)		
19.2.	В кронах (п.17.1 - п.19.1)	22610	
20.	Сумма начисленного подоходного налога за отчетный период:		
20.1.	В иностранной валюте в пересчете на рубли		
20.2.	В кронах	37343	

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21. Подлежит доплате:

21.1. В иностранной валюте, пересчете в рубли (п.19.1 - п.20.1) .....

21.2. В рублях (п.19.2 - п.20.2) .....

22. Подлежит уменьшению :

22.1. В иностранной валюте в пересчете на рубли (п.20.1 - п.19.1) .....

22.2. В кронах (п.20.2 - п.19.2) .....14733.....

23. Дата утверждения годового отчета .....01.04.93г.....

24. Руководитель предприятия .....
подпись

25. Главный бухгалтер .....
подпись

26. Заключение налогового департамента:

26.1. В результате проверки сумма налога, показанная предприятием:

-увеличена - в рубля:
в иностранной валюте, в пересчете в рубли

-уменьшена - в рубля:
в иностранной валюте, в пересчете в рубли

27. Инспектор налогового департамента .....
подпись

28. Инспектор .....
подпись

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ANNEX D
FACTORS AFFECTING THE PRICE OF ESTONIAN OIL SHALE

In Section 2 we present a comparison of the current price of oil shale and the average revenue obtained from products of the oil shale processing complex. At January 1994 prices the cost of shale is estimated to be 38 percent of the cost of the products of the oil shale processing complex. With projected increases in the cost of shale, however, RAS Kiviter will be forced to shut down unless it can raise the price level of products of the oil shale processing complex. We believe that shale prices will be in the range of $10 to $12 per ton (in 1993 dollars) by the year 2000. The projected increase in shale prices is the largest single threat to the viability of RAS Kiviter.

The purpose of this annex is to describe the market for Estonian oil shale and describe the factors affecting oil shale prices, so that the reader will have a better understanding of the viability of RAS Kiviter.

A. The Transition to a Market Economy

The Estonian oil shale chemical industry has survived many political changes. The industry was formed in a market economy when Estonia was part of pre-revolutionary, czarist Russia; grew rapidly in the period of Estonian independence; fell under the control of German occupation forces in World War II; became a part of the Soviet central planned economy; and fell under the ownership and control of the newly formed government of Estonia. The industry should not be regarded as the product of the Soviet era; it is reasonable to suppose that the industry would have survived in some form if Estonia had not been annexed by the Soviet Union. However, the present style of business management has been very strongly influenced by the Soviet period.

Oil shale is a hydrocarbon that can be used to provide substitutes for some of the fuels and chemicals that are produced from natural gas, petroleum, and coal. To a western economist, therefore, the price of oil shale should be related to the supply and demand for oil shale, and there exists the possibility that some or all of the mines producing oil shale will be able to extract an economic rent—an "excess profit" resulting from the difference between the market price and the average cost of production. In a policy study, three alternative methods of determining prices could be considered:

Competitive pricing. Because there are 10 producers (the mines named Estonia, Viru, Ahtme, Tammiku, Kohtla, Sompa, Sirgala, Aidu, and Narva, plus the Russian mine at Slantsy) and at least four large buyers (the Estonia power plant, the Baltic power plant, RAS Kiviter and RAS Eesti Kivióli), the potential for competitive, market-based pricing exists. If the price of oil shale were established through competition, any mine whose average cost is below the market price would recover an economic rent. The economic rent might be captured by the government of Estonia through lease payments, royalties, or severance taxes,

or it might be captured by the mining companies (if the miners are not unionized) or by the miners (if there are unions capable of raising wages).

Oil shale pricing in a competitive market would probably resemble coal pricing; there would be spot and contract prices for each grade of oil shale. In a market economy, spot prices will be linked to short-run marginal cost (SRMC) and contract prices will be linked to long-run marginal cost (LRMC) for the industry as a whole.

Controlled prices based on coal. The government of Estonia could set a price for oil shale by calculating its value as a substitute for coal in electricity generation. Any mine that could produce shale for an average cost below this price would recover an economic rent.

Controlled prices based on oil. The government could set a price for oil shale by calculating its value as a feedstock for the production of low-sulfur heavy fuel oil, or as a feedstock for the production of a variety of products. If a group of products is examined, the calculated price of shale oil could be called a "netback value," because this type of calculation is routinely performed in the oil industry to compute the netback value of different grades of crude oil.

A refining company facing a choice among crude oil supplies will favor the crude oil for which the netback value is higher than the market price, by as wide a margin as possible. Although there are other considerations in crude oil purchasing decisions, the difference between price and netback value is one of the most important considerations. The concept of netback value can also be applied to oil shale.

The government of Estonia has given some thought to the second alternative. The Energy Master Plan states that "the oil shale must have an equivalent price to the price of coal, which will be the highest price for oil shale that a power plant can accept" (Ministry of Industry and Energy, Vattenfall AB, Imatran Voima Oy, and Eesti Energia, *Energy Master Plan for Estonia*, March 1993, page 65). The master plan cites I. Öpik, "The equivalent price of Estonian oil shale to the price of coal, *Oil Shale* 9,2 (1992): 89-97 (see Annex E).

Despite the discussion of coal-based pricing in the Master Plan, there appears to be no serious attempt to introduce any one of the three pricing alternatives described above. Instead, the government appears to support pricing principles similar to those developed in the Soviet era but modified to reflect current political conditions. To the best of our knowledge, these pricing principles are as follows:

- The mining industry should be a monopoly. All of the mines should be owned by a single enterprise which negotiates one price for all of the oil shale produced in the country.

- The government of Estonia should estimate the quantity of coarse shale (for chemical processing) and fine shale (for electricity generation) to be produced in the country over a calendar year. Annual production targets can be divided by

twelve to obtain monthly figures; the month-to-month fluctuations in consumption are not important to producers because the cost of holding inventories is minor.

- The government of Estonia has a choice between two policy options:

  Single price system: The government estimates the average cost of producing the nation's supply of oil shale over a month, a quarter, or a year. The FOB mine price should equal this average cost and should be fixed monthly, quarterly, or yearly on the basis of these calculations. The lower-cost mines should subsidize the higher-cost mines. If higher-cost reserves at a particular mine must be mined at a loss to meet production targets, the lower-cost reserves should be used to subsidize the production of higher-cost reserves. For a particular delivery to a purchaser, the delivered price of shale equals the FOB mine price plus railroad freight charges.

  Two-tier price system: This is exactly the same as the single price system, except that coarse shale and fine shale are each assigned an FOB mine price based on average production cost.

Although this description of pricing principles may not exactly match present policy, it is at least a close approximation of the status quo.

One proposal that we have heard is that the oil shale mining industry be merged into the electric power industry so that transactions between the two industries are simply a matter of internal accounting. Under this arrangement, transactions between the mining/power industry and the oil shale chemical industry would probably result in an oil shale3. price designed to cover the incremental cost of serving the oil shale chemical industry.

B. Demand for Oil Shale

As purchasers of oil shale, the power sector and the chemical processing sector are competing for shale resources. If shale is less valuable as a feedstock for chemical production than as a fuel for power generation, it is possible that the oil shale chemical industry will be unable to offer the oil shale mining companies an acceptable price (i.e., one that is competitive with the price offered by the electric power sector). In this case the oil shale chemical industry (including the oil shale processing complex at RAS Kiviter) will be forced to shut down. The future of power sector demand for oil shale is therefore very important to RAS Kiviter.

There are at least six types of facilities that can be used to obtain products from oil shale:

1. Power plants that produce only electricity.

2. Combined heat and power (CHP) plants, which can produce electricity, district heat, and steam for industrial processes.

3. Simple chemical processing plants that produce only one or two grades of shale oil.

4. Complex chemical processing plants that make a variety of products from shale oil—oils used for nonfuel purposes, electrode coke, fuel oil, resins, and petrochemicals.

5. Syncrude plants, which produce a crude oil suitable for delivery to an oil refinery. In Estonia a syncrude plant would have to include hydrotreating facilities.

6. Gas production plants, which produce a substitute for natural gas.

At present, categories 2 through 4 represent the market demand for Estonian oil shale. Heat production at the Estonian power plant is very small (84 MWt heating capacity in a 1610 MWe power plant) and therefore the economics of shale use at this plant are driven by electricity prices and costs rather than district heat prices and costs.

Category 1 is technically possible but the economics of district heat in Estonia tend to favor the use of oil shale over imported fuel oil and natural gas. Category 5 has never been attempted in Estonia, although the potential for syncrude production is examined in the Jaakko Poyry study, *Optimum Development of the Estonian Oil Shale Mining Operations and Retorting Industry* (in progress).

Category 6 was implemented in Estonia from 1945 to about 1975. A gas production plant was built in Kohtla-Järve in the 1945-49 period, a gas pipeline from Kohtla-Jarve to Leningrad was completed in 1947, and a pipeline from Kohtla-Järve to Tallinn was completed in 1953. In the postwar period a similar gas production plant was built at Slantsy, Russia, to supply Leningrad. With the development of Russian natural gas reserves it became uneconomical (even in the Soviet economy) to produce gas from oil shale. There are no proposals to build gas production plants in Estonia; our understanding is that oil shale is more valuable when it is used for chemical processing (categories 3 and 4 above) than when it is used for gas production.

In Estonian statistical data on the oil shale industry, categories 1 and 2, are combined under the heading of "power engineering," which is a term used to describe the electric power sector. Categories 3, 4, and 6 are combined under the heading of "industry;" it is difficult to obtain data on category 6 (gas production). The relative proportions of these two broad categories of demand has changed over time; the power sector became dominant around 1965 and is still the leading consumer of oil shale, as shown in the table below.

Production and Consumption of Oil Shale in Estonia, 1940-1993

Year	Production, million tons	Consumption, million tons	Consumption at power plants, million tons	Consumption at chemical processing plants and gas production plants, million tons
1940	1.9		...	1.1
1945	0.9		...	2.6
1950	3.5		...	...
1955	7.0		...	3.7
1960	9.2	5.4	2.2	3.2
1965	15.8	14.6	10.1	4.5
1970	18.9	19.4	15.0	4.4
1975	28.5	26.6	22.1	4.5
1980	31.3	29.4	25.8	3.6
1985	26.4	25.8	23.1	2.7
1989	23.3	24.9	22.6	2.3
1993	14.5		approx. 12	2.4

Source: 1940-1989 data are from Koidu Tenno and Veena Räägel, *Estonian Oil Shale* (Tallinn: Informare Ltd, 1991), p. 9. 1993 data are from Jaakko Pöyry, *Study on the Optimum Development of the Estonian Oil Shale Mining Operations and Retorting Industry*, Draft, December 28, 1993. In this report a production figure of 14.52 million tons is given for present mining operations, and 1993 oil shale use for retorting (at RAS Kiviter, Kivioli, and the Estonian power plant) is reported as 2.372 million tons.

There are three locations at which oil shale is chemically processed in Estonia: RAS Kiviter, Kivioli, and the Estonian power plant. In the draft Jaakko Pöyry report cited in the table above, the quantity of shale consumed in 1994 is projected to be 1.73 million tons at RAS Kiviter, 0.385 million tons at Kivioli, and 0.6 million tons at the Estonian power plant. Oil shale is also chemically processed in Slantsy, Russia, and at one time it was processed in Kirishi, Russia. The Russian oil shale market is practically a separate market now, for political reasons.

The Kohtla-Järve power plant produces more district heat than electricity; it may be considered a district heating boilerhouse first and an electric power plant second, as the following table shows. In oil shale studies funded by Finnish organizations, the primary focus is typically on electric power (an exportable commodity) rather than district heat (a domestic commodity for which there is an urgent need to reduce expenditures on imported

fuel). From an Estonian perspective the use of shale in district heat is quite important. In 1992 this form of heat was one-sixth the cost of district heat obtained from imported fuels, and Estonian government representatives were asking whether the residents of Narva and Kohtla-Järve should be entitled to pay lower district heat than residents of Tallinn, Tartu, and other cities. The national government favored a policy of making district heat the financial responsibility of municipal governments but feared the political implications of allowing northeast Estonian cities to have much cheaper heat than the rest of the country. With the recent rise in heating bills in cities such as Tallinn (i.e. the rise in the heating component of apartment rents), this issue remains very sensitive politically.

According to a study published in 1991, Eesti Energia produced 29,400 TJ of heat; we assume that this figure is for 1990 and measures the amount of heat exiting the boiler in pipes used to supply district heating networks and industrial plants. Of this total, 75 percent (22,000 TJ) was delivered in the form of hot water and 25 percent (7400 TJ) was delivered in the form of steam up to 21 bar. See Jorgen Fenhann, ed., *Energy and Environment in Estonia, Latvia, and Lithuania* (Roskilde, Denmark: Riso National Laboratory, August 1991), p. 41. We do not have data on the proportion of hot water and steam in the heat produced in Eesti Energia's oil-shale CHP plants.

Estonian Power Plants Using Oil Shale, 1989

	Electrical capacity, MW	Heating capacity, MW	Electrical output, Gwh	Heat production, TJ
Baltic power plant[a]	1645	470	7606	6327
Estonian power plant	1610	84	8980	130
Kohtla-Järve power plant[b]	39	416	82	3823
Ahtme power plant	20	102	87	2148
Kivioli oil shale processing plant[c]	10		42	

[a] Eesti Energia's heat production in Narva is reported as 6110 TJ, of which 1733 TJ was for residential use, 3304 TJ was for industrial use, and 1074 TJ for other uses.

[b] Eesti Energia's heat production in Kohtla-Järve is reported as 5590 TJ, of which 1331 TJ was for residential use, 3438 TJ was for industrial use, and 820 TJ for other uses.

[c] The Kivioli plant is not owned by Eesti Energia. We assume that heat obtained from the oil shale retort is used to produce electricity, but we do not have information to confirm this.

Source: Jorgen Fenhann, *Energy and Environment in Estonia, Latvia, and Lithuania* (Roskilde, Denmark: Riso National Laboratory, August 1991), pp. 37, 39.

C. Grades of Oil Shale

In Estonia only two grades of oil shale are presently being marketed:

1. Coarse ("high quality"), which consists of fragments with a diameter of 25 to 125 mm. The heating value depends on the geological characteristics of the deposit, the mining plan, and quality control at the mine; in Estonia it is presently 10.9-11.3 MJ/kg. Coarse shale delivered to RAS Kiviter in 1993 had a heating value of 3300 kcal/kg (dry).

2. Fine ("energy quality"), which consists of fragments smaller than 25 mm in diameter. The heating value in Estonia is presently 8.6-9.0 MJ/kg. The open pit mines at Narva and Sirgala produce only fine shales. In 1990 the average heating value of shale delivered to the Baltic power station and the Estonian power station was 8.8 MJ/kg ("lower heating value").

In some countries, coal fines are used to produce briquettes that are sold for small commercial and household use. For example, briquettes are produced in Hungary. There is no briquetting in the oil shale industry; fines are used only for power generation.

Estonian oil shale is chemically similar to Australian oil shale. Estonian shale requires hydrotreating to produce lighter petroleum products (gasoline or diesel fuel) or synthetic crude oil. For synthetic crude oil production, Estonian shale requires more hydrotreating than the oil shale that has been produced in the United States.

In a market economy, each grade of oil shale would have a different price. In Estonia, price is apparently based on production cost regardless of product quality.

There is no reason to believe that two is the optimum number of grades of oil shale in a market economy. There could be different grades based on Fischer assay as well as particle size.

Coarse shale is used at present in chemical processing. The Oil Shale Research Institute is interested in developing or identifying technologies for processing fine shale. One of the retorting technologies already developed in the United States may be suitable for processing fine shale, but testing is necessary to determine whether Estonian shale can be processed efficiently in a retort designed for American shale.

D. Local Nature of the Oil Shale Market

The market for Estonian oil shale is geographically limited to northeastern Estonia and the western portion of the Leningrad oblast, for three reasons:

1. Oil shale is a bulky commodity, and therefore it is expensive to transport over large distances. When oil is extracted from the shale delivered to RAS Kiviter, it is necessary to process 6.5 tons of shale to obtain 1 ton of oil. The price of shale at

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RAS Kiviter in December 1993 was 48 EEK/ton, which is slightly below the spot price (USD 4.00/ton) of subbituminous coal sold in the Powder River Basin of Wyoming and Montana in the mid-1980s. In price per ton, shale is roughly comparable to lignite.

2. Special facilities are needed to obtain electric power, synthetic crude oil, or liquid fuels and chemicals from shale. Even after oil is extracted from shale, it requires further processing to be suitable as feedstock for an oil refinery. Estonia and Russia are the only countries in the Baltic Sea region that presently have the facilities needed to produce shale oil or electric power from shale.

3. Where new facilities are needed, it is not very profitable to produce electric power, synthetic crude oil, or liquid fuels and chemicals from shale (at 1994 prices). If crude oil prices were much higher or electricity prices in the Baltic countries were much higher, it might be possible to build new facilities (in a larger geographic region) that would consume Estonian shale.

Higher energy prices might result in a larger geographic market. With higher energy prices, it might be profitable to transport Estonian shale to Finland, Russia, Latvia, or other countries for the production of electricity or liquid fuels. Under these conditions there would probably be long-term contract prices for shale, but spot prices of shale might be determined by competitive bidding among the various buyers. Estonian buyers would still have a competitive advantage due to lower transportation costs, but it is possible that other factors (for example, a higher cost of capital for plants located in Estonia) would lead to the construction of new facilities located in other countries.

E. Possibilities for Competitive Pricing

At present the mining of oil shale in Estonia is controlled by a monopoly (Eesti Polevkivi) with Estonian government ownership. There are six underground mines and three surface mines, and there is no technical reason why all of these mines should be owned by a single company. Two of the mines (Kohtla and Tammiku) have only a few years of reserves remaining and therefore are not suitable for privatization. The other seven mines can be privatized if they become sufficiently profitable.

Shale is mined in Russia at Slantsy, and shale oil is produced at Slantsy. The St. Petersburg region has a long history of oil shale mining and research. In 1990 the "Baltic" power plant located at Narva received 25 percent of its shale supplies from Russia. In 1992 electricity demand in Estonia was below the 1990 level, and Russia stopped purchasing power from Estonia, and therefore the need to purchase Russian shale was greatly reduced. At present Eesti Energia purchases little or no shale from Russia. Today the Russians sell to RAS Kiviter shale oil from Slantsy at prices that are so high that RAS Kiviter purchases such oil only occasionally, when supplies of Estonian shale are inadequate.

The Russians have announced plans to increase production at Slantsy, build retorts needed to increase production of shale oil at Slantsy, and build a power plant to generate

electricity from shale oil. Because the capital cost is high and the quality of Russian oil shale reserves is inferior to Estonian oil shale, it is not clear whether these plans are realistic and will be implemented.

The production of electricity from oil shale in Estonia is controlled by an integrated electric power system (Eesti Energia) that has a monopoly over generation, transmission, and distribution. As long as Estonia's electric power supply is primarily obtained from only two power plants, a competitive market for power generation is possible only if Estonia becomes part of a larger power grid that is considered (by Estonians) to provide a reliable basis for the export and import of electricity. A direct connection with Finland might make it technically possible for Estonia to restructure Eesti Energia so that power generation becomes a competitive business. In Russia, the director of RAO EES Rossii is already planning to make power generation a competitive business, but Russia can hardly be considered a reliable supplier or purchaser of Estonian electric power.

Soviet planners chose to build two large power stations rather than several smaller stations (for example, a power station located at each mine). The existing oil shale power plants contain several generating units. At the Estonian power plant there are 8 double boilers built between 1967 and 1972, and each pair of boilers has a capacity of approximately 201 MWe. At the Baltic power plant there are 8 front wall fired boilers built between 1962 and 1964, each with approximately 91 MWe capacity, and 18 smaller boilers built between 1958 and 1963, each with approximately 40 Mwe capacity. If the older boilers were shut down and replaced with new generating capacity (perhaps shale-fired) at other locations, it might be possible to create a competitive market for power generation in Estonia.

The RAS Kiviter plant has the technical potential to produce electricity (as well as steam) from oil shale. There could be a "secondary" market for electric power in Estonia, if Eesti Energia offered to wheel power for independent power producers and cogenerators. In the next 10 years this market is likely to represent only a small portion of Estonia's power generation and therefore a small portion of shale use in the power sector.

In the Soviet period there were four chemical plants and one power plant capable of processing oil shale to produce liquid fuels and chemicals:

1. RAS Kiviter (formerly "Polevkivikeemia" or, in 1991, Production Amalgamation "Oil Shale Chemistry"), a large chemical complex at Kohtla-Jarve that processes petroleum feedstocks as well as shale. The retort produces two grades of shale oil that are used to produce a variety of products, including boiler fuel oil.

2. RAS Kivioli (formerly Oil Shale Chemical Works "Kivioli"), a small complex that produces two grades of shale oil ("middle" and "heavy" oil) that are in turn used to produce boiler fuel oil, road oils, road bitumens, and a special type of resin named "Kukersol."

3. The Estonian power plant, which has a shale retort that is used to produce only one grade of boiler fuel oil.

4. Slantsy, a chemical plant in Russia that is similar to RAS Kivioli and produces one or two grades of boiler fuel oil.

5. Kirishi, a chemical plant in Russia that is no longer operating.

When Estonian shale oil is not processed, or is separated into two grades without further processing, its market value is much lower than the average value of products obtained from further processing. Therefore the RAS Kiviter plant has a "monopoly" on chemical processing of Estonian oil shale.

ANNEX E
SELECTED ARTICLES FROM *OIL SHALE*

This annex contains copies of articles in the Estonian journal *Oil Shale* that are pertinent to the assessment of the viability of the oil shale processing industry and the viability of the oil shale mining industry. The first two articles describe the evolution of the industry in a market economy, before the Soviet period.

The articles selected are as follows:

1. E. Reinsalu, "Economical Development of Estonian Oil Shale Industry"

2. V. Yefimov, "Development of Oil Shale Processing Industry in Estonia Before World War II"

3. A.V. Kozhevnikov, "On the History of Oil Shale Chemical Processing in Russia and Estonia"

4. I. Öpik, "Electricity of Oil from Estonian Oil Shale - An Old Problem"

5. I. Öpik, "The Equivalent Price of Estonian Oil Shale to the Price of Coal"

6. "Development of Estonian Energy Economy: Estonian-Finnish Joint Seminar in Tallinn, September 23-24, 1994"

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E. REINSALU

ECONOMICAL DEVELOPMENT OF ESTONIAN OIL SHALE INDUSTRY

Э. РЕЙНСАЛУ

ЭКОНОМИЧЕСКОЕ РАЗВИТИЕ СЛАНЦЕВОЙ ПРОМЫШЛЕННОСТИ ЭСТОНИИ

Although the first reliable written evidence of oil shale mining on the Kukruse headland stems already from the 1870s [1], the real beginning of oil shale industry in Estonia is considered to be June, 1916 when the first amount of produced oil shale was sent to Petrograd [2]. Thus 1991 is the year of its 75th anniversary.

November 25, 1918 the government of the Estonian Republic took possession of all three shale opencasts, which were founded with Russian state's and private capitals, but at that time controlled by German occupation authorities [3]. In the course of years the oil shale industry has undergone several economical and political crises influencing its development. An idea of the dynamics of this development can be obtained from Figure, representing the annual increase (decrease) of oil shale output, calculated by the method of sliding average of 5-year period. Having analyzed the data given in Figure and taking into account historical events, the author of this paper has divided the development of Estonian oil shale industry into eight different periods.

At the first, so to say, foundation-period up to year 1930 the main investor, particularly at the beginning, was the Estonian government. In 1929 one open-cast and two mines of national enterprise «Riigi Põlevkivitööstus» produced 356 thousand tonnes of oil shale. The output of pits of four private enterprises was 162 thousand tonnes. The average annual increase of oil shale production in the years 1919—1929 was 133 %. Certain lagging behind of the private capital investments can be explained not only by monopolistic attitude of the Estonian government, but also while making investments into a principally new branch of industry was connected with great risk.

From the start the oil shale industry was aimed at giving various products, including solid fuel as well as products of oil shale distillation [4]. To produce electricity and heat for industrial and commercial needs, power plants utilizing fine oil shale and generator gas were built. Only two pits, one at Küttejõu, the other at Ubja supplied with solid fuel their partner plants the Tallinn Cellulose and Paper Factory and the Kunda Cement Plant, respectively. In 1929 the railway was the main consumer of oil shale from the national enterprise. Only 9 % of the mined oil shale was processed at the distillation factory of the latter and 5,7 % sent to the Sillamäe oil shale distillation plant (Estländska Oljeskifferkonsortiet, Swedish capital), which up to 1936 possessed no pits.

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The second period was greatly influenced by the economic crisis of 1930—1933. The mean annual increase of the output in these years was only 0,7 %. The open-cast of the national enterprise at Käva and "Vanamõisa Oil-fields Ltd" belonging to private capital were closed then. Although there was no remarkable increase of oil shale output, thank to multi-product technology the production of shale oil grew 3.7 times.

In the third period 1934—1940 the growth of oil shale industry was at its maximum, on the average 23 % per year. Since 1933 private enterprises began to dominate, including also foreign capital. In 1936 mining was started at Viivikonna, in 1937 at Kohtla, financed by Swedish and British capitals, respectively. In 1939 five private mining enterprises gave already 59 % of the total oil shale production [5]. The national enterprise «Riigi põlevkivitööstus» which in 1936 was reorganized into a state joint-stock company «A/S Esimene Eesti põlevkivitööstus» reopened in 1934 mining at Käva. In 1940 the Estonian Republic was incorporated into the Soviet Union and the whole industry was nationalized. Before World War II the maximum annual output 1,89 million tonnes was achieved in 1940. However, the growth rate was only 13 %, i. e. much lower than the mean yearly increase at the beginning of that successful period.

The activity at the pre-war period was mainly aimed at the expansion of the oil shale products market. The greatest consumer of those, as well as the investor was Germany. It is known by some information sources that shale oil export from Sillamäe to Germany lasted till June 1941. In 1940 the share used for distillation reached 60 %. This was the technological limit for oil shale with the lump size over 20—25 mm, suitable for distillation. Therefore methods for processing fine oil shale were investigated and an example of this was briquetting of fine oil shale at the Sillamäe plant.

The fourth period 1941—1945 was delimited by World War II. Although the joint-stock company of German occupation authorities "Baltische Ölgesellschaft in Estland» succeeded in increasing of the oil shale output to 1,32 million tonnes, the oil shale industry in Estonia was destroyed to a great extent in these years. In 1945 the output was only 830 thousand tonnes and average yearly decrease of the production during the whole period was 7,6 %.

The fifth period, comprising the years 1946—1956 is the post-war restoration time. The oil shale mining enterprises were divided between the Ministry (People's Commissariat) of Coal Industry of the U.S.S.R. and the Ministry of Local, Oil Shale and Chemical Industries of the E.S.S.R. Oil shale processing industry remained in the possession of the latter with the exception of Sillamäe plant where the processing of kukersite was stopped. In 1945 the enterprises of local industry gave 55 % of the whole oil shale production, but since 1946, due to the considerable investments of the Soviet Union capital, the All-Union mining enterprises (belonging to the Ministry of Coal Industry of the U.S.S.R.) gained advantages for their development. In this system five new mines were opened and the Viivikonna open-cast restored. The large investments into the oil shale industry of Estonia for its rapid development was conditioned by the need to supply gas to Tallinn and Leningrad and to produce liquid fuel for marine. The mean annual increase of the output during the fifth period was 20 % in the All-Union enterprises, 4 % in local enterprises and 15 % in the whole oil shale mining industry of Estonia. In spite of all efforts, the annual increase of production did not reach the pre-war level, except for 1946.

At the sixth period, including the years 1957—1965, the whole oil shale industry was subjected to the National Economic Council of the E.S.S.R. The output increased promptly from 8,35 million tonnes in 1957 to 15,83 million tonnes in 1965. The average growth rate was 8,3 % yearly. It was called forth by development of power industry with new big consumers of oil shale, for example the Baltic Thermal Power Station (TPS), that gained its full capacity in the years 1960—1965.

At the beginning of **the seventh period** in 1965 the oil shale industry was divided between various departments finally. Mines and open-casts were subordinated to the Ministry of Coal Industry of the U.S.S.R., oil shale processing enterprises to the Ministry of Oil-processing and Petrochemical Industry of the U.S.S.R. and power stations to the Ministry of Energetics of the U.S.S.R. In consequence of it the contacts between enterprises became more complicated. The year 1980 can be regarded as the last of that period and oil shale production reached its maximum then in Estonia as well as in the whole U.S.S.R. This enormous encrease can be easily explained with the fact, that the main indices in the Soviet planned economy to estimate the development were the data of the production growth. So the mining branch did their possible to produce bigger amounts of oil shale with lower calorific value. In turn it forced the consumers to use ever increasing amounts of low-quality fuel, making it possible for the mining industry to overfulfil their production plans, as the last of that period and oil shale production reached its maximum then in Estonia as well as in the whole U.S.S.R. This enormous increase can be easily explained with the fact, that the main indices in the Soviet planned economy to estimate the development were the data of the production growth. So the mining branch did their possible to produce bigger amounts of oil shale with lower calorific value. In turn it forced the consumers to use ever increasing amounts of low-quality fuel, making it possible for the mining industry to overfulfil their production plans, measured in tonnes. Thus, in 1965—1967 the output grew from 15,83 million tonnes to 16,12 tonnes. Useful output, recalculated into conventional fuel, however, remained constantly 5,76 million tonnes.

In 1969—1973 a new gigantic consumer of oil shale, the Estonian TPS was completed, causing the increase of oil shale output volume up to 14 % in 1971. This was the maximum growth rate of that period, to a large extent achieved on account of intense development of Viivikonna, *Sirgala* and *Narva* open-casts, producing relatively low-quality oil shale. Therefore increase of the useful production was only 10 % in 1971. The mean annual growth of oil shale output was 4,9 % for that period.

The eighth period was the logical continuation of the previous one. It started with the output of 31,33 million tonnes in 1980, surpassing already the needs of consumers. So in this year 3 million tonnes of fuel were accumulated. The decrease of oil shale output began in 1981 and continues up to now. In 1990 22,5 million tonnes were produced and the plan for the 1991 is 19,5 million tonnes. The average annual decrease of oil shale production in 1981—1990 was 3,4 % and it was more rapid only at war-time in 1941—1942 and 1944—1945.

The decline of the productivity in oil shale industry that began in the late 1970s was first of all called forth by the competition between the producers of energy carriers and to a smaller extent by general decline of Soviet economy. Competition in the market of energy carriers was due to the development new capacities of nuclear energetics, as well as new deposits of oil and gas. Processing of oil shale is decreasing since 1965 and it began with the reducing of gas production. The same phenomenon in power industry was to be seen since 1979. In the last decade the

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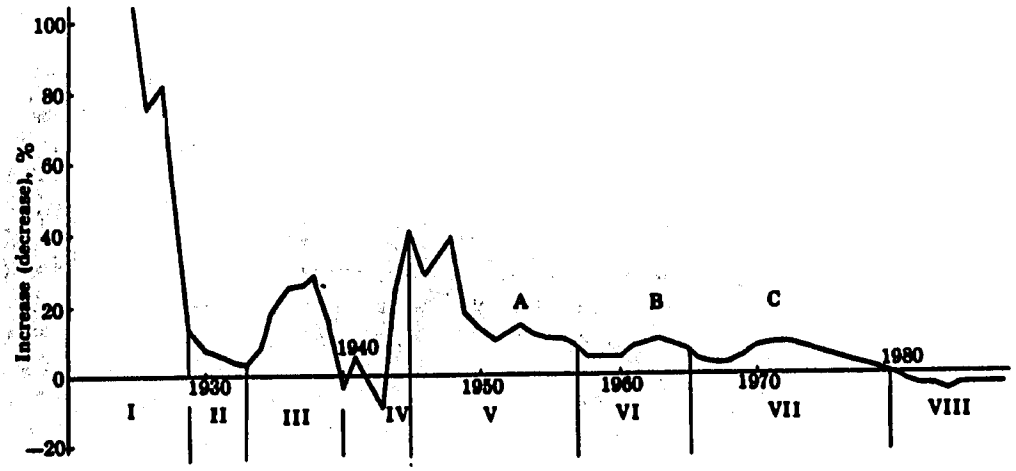
annual consumption of oil shale in power industry has decreased by 5 million tonnes, i. e. approximately 20 %. The amount of thermally processed oil shale has decreased by 3 million tonnes, that is a half the inital value. The economic reason for it can be the low competition capability of oil shale in the Soviet power market. This has caused also insufficient financing of renovation of means of production both in oil shale processing and in power industry.

It is yet not clear, whether this decline is temporary (see Figure) and will be followed by an upswing, or it is the beginning of extinction of oil shale industry, after having exhausted more than a half the useful resources of the deposits, foreseen already some years ago [6].



The increase (decrease) of oil shale production in the years 1918—1990 (calculated by the method of sliding average of a 5-year-period): I—VIII — the periods of economical developments. Construction: A— processing plants, B — Baltic Power Plant, C — Estonian Power Plant

График прироста (убыли) добычи горючего сланца за 1918—1990 гг. Прирост (убыль) подсчитаны методом скользящего среднего для 5-летнего периода. I—VIII — периоды экономического развития. Строительство: A — сланцеперерабатывающих заводов, B — Прибалтийской ГРЭС, C — Эстонской ГРЭС

РЕЗЮМЕ

В 1991 г. Эстония отмечает 75-летие своей сланцевой промышленности. За годы существования она пережила ряд экономических и политических кризисов, поэтому и темпы ее развития в разные периоды были различными (см. рисунок). Автор предлагаемой вниманию читателей статьи взял на себя смелость разделить историю развития сланцевой промышленности Эстонии на восемь характерных периодов.

Первый период, становление, продолжался до 1930 г. Основным инвеститором было государство. Некоторое отставание на старте частного капитала объясняется не только монополистическим подходом просоциалистического правительства Эстонской Республики того времени, но и высокой степенью риска при помещении капитала в принципиально новую отрасль промышленности. С самого начала было взято направление на создание многопрофильного производства — на выпуск как твердого топлива, так и продуктов перегонки сланца. Для выработки электро- и теплоэнергии для производственных и бытовых нужд были сооружены ТЭС, на которых использовались мелкий сланец и генераторный газ.

Второй период совпал во времени с экономическим кризисом 1930—1933 гг. и определялся им. Роста объема добычи практически не было, изменений

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REVIEWS

V. YEFIMOV

DEVELOPMENT OF OIL SHALE PROCESSING INDUSTRY IN ESTONIA BEFORE WORLD WAR II

The Baltic oil shale (kukersite) possesses unique properties due to a high oxygen content of kerogen (≈ 10 %). Long experience of commercial oil shale processing in Estonia has demonstrated that these properties become most evident when kukersite is used for the production of shale oil. Since oxygen-containing compounds prevail in the oil, it is possible to use the latter as feedstock for the manufacture of products not easily obtainable from petroleum, coal and oil shales other than kukersite.

During the early years of development of the oil shale industry in Estonia several methods of retorting were used (Table 1). A series of long experiments in different units (Geissen, Rolle, Pumpherston, etc. type retorts) demonstrated their complete unfitness for retorting kukersite [1—5]. On the other hand, test runs in a Pintsch-designed experimental retort with a throughput of 7—8 tonnes per day erected at Kohtla-Järve in 1921 showed promising results. An oil yield of 18 % from the feed shale was attained. Taking into account, however, that at that period mostly high organic oil shale was used for retorting (Table 2), the oil yield obtained could not be regarded as sufficiently high (77 % of Fischer assay oil).

Based on positive results obtained by testing the retort, already in 1921 "J. Pintsch A/G" began to design the first oil shale retorting plant at Kohtla-Järve, which consisted of 6 retorts with a throughput of 33 t/day each (later named GGS-1). The Pintsch-type retorts where the retorting zone was separated from the gasifier by a narrowed shaft at the mid-height were selected for the first plant. The air needed for processing was drawn in through the lower part of the retort by vacuum maintained within the whole reaction volume.

By the end of 1924 the construction of GGS-1 was completed with the start-up on December 24, 1924. The first production was obtained two days later. In December 1926 GGS-1 was commissioned into full commercial operation. A two-week balance test run gave the following results [3—4]: average throughput of oil shale — 33.4 t/day, the oil yield — 17.3 % from feed shale (68 % of Fischer assay oil), specific gas yield — 690 m^3/t* (incl. 20.6 g/m^3 C_5^+ hydrocarbons) with a calorific value of 4.86 MJ/m^3. The characteristics of the feed shale used and the spent shale discharged during the test run are given in Table 3.

The demand for liquid fuels increased considerably in the early 1930's as a result of the beginning economic crisis. The State Oil Shale Works began to intensively search for opportunities of introducing new retorting capacities as fast and least

*All data given at 20 °C and p = 101.3 kPa.

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Table 1. **Start-up of Oil Shale Processing Units in Estonia before World War II**

Plant	Unit	Through-put rate, t/day	Number of retorts/ ovens	Start-up	Cease of operation
Kohtla-Järve	Experimental vertical retort (generator)*	7—8	1	3.08.21	December, 1924
	GGS-1	33	6	24.12.24	30.07.85
	GGS-2	40	8	31.03.36	30.07.85
	GGS-3	40	16	28.05.38	
	GGS-4	45	20	1943	
Kiviõli	Experimental tunnel oven section		1	1926	In the 1930's
	Commercial-scale experimental tunnel oven	75	1	1927	
	Commercial tunnel oven	250	2	1931	The last oven was closed down in 1975
		350	2	1935	
Sillamäe	Commercial tunnel ovens	270	1	1928	Most likely during World War II
		500	1	1938	
Kohtla-Nõmme	Davidson horizontal rotary retorts	25	4	1931	1961
		25	4	1934	1961

* In the Baltic oil shale basin a mode of direct heated vertical retorts is historically referred to as "oil shale generators".

expensive as possible. Under these circumstances local specialists led by K. Luts developed a new "Kohtla-Järve" design of a cylindrical retort without the narrowed shaft for an oil shale throughput rate of 37.5 t/day. The units GGS-2 and GGS-3 were equipped with such retorts. On GGS-1 and GGS-2 the spent shale residue was removed from the units by small steel trucks (initially driven by horses, later by electric locomotive), but at GGS-3 a steel conveyer was used, replaced by belt conveyer in 1953. Analogous belt conveyers were installed on GGS-1 and GGS-2 in 1956.

Table 2. **Properties of Feed Shale Processed at the Kohtla-Järve Plant**

Year	Moisture W^r, %	Content, %			Fischer assay oil yield, %	Calorific value (bomb calorimeter), MJ/kg
		Mineral carbon dioxide, $(CO_2)_M^d$	Ash A^d	Conventional organic matter*		
1922	18.2	11.6	42.8	45.6	30.1	17.1
1923	18.8	11.9	45.6	42.5	28.1	16.0
1924	18.3	11.9	45.6	42.5	28.1	16.0
1925	19.0	12.2	46.0	41.8	27.6	15.7
1926	16.0	12.6	42.7	44.7	29.5	16.8
1927	12.3	12.2	40.1	47.7	31.5	17.9
1928	13.2	12.0	41.9	46.1	30.4	17.3
1929	12.5	12.6	43.1	44.3	29.2	16.6
1930	12.7	12.3	41.3	46.4	30.6	17.4
1931	11.8	12.1	40.4	47.5	31.3	17.8
1932	11.6	12.0	40.4	47.6	31.4	17.9
1933	11.6	12.0	40.3	47.7	31.5	17.9
1934	11.2	14.0	44.5	41.5	28.6	16.3
1935	11.0	15.2	46.7	38.1	26.3	15.0
1936	11.0	17.5	45.9	36.6	24.4	13.9
1937	11.0	19.4	46.6	34.0	23.3	13.3
1938	10.6	17.9	45.7	36.4	25.1	14.3
1939	10.6	18.7	46.6	34.7	23.6	13.4
1940	10.7	19.1	47.5	33.4	23.2	13.2
1941	10.7	19.3	48.2	32.5	22.7	12.9

* $100 - (CO^2)_M^d - A^d$.

Table 3. **Properties of Feed Shale Used and Spent Shale Discharged in Test Run on GGS-1 in 1926**

Properties	Oil shale	Semi-coke*	Spent shale
Moisture, %	13.2	-	-
Proximate analysis (dry basis), %:			
carbon dioxide, $(CO2)_M^d$	12.5	18.0	13.2
ash, A^d	39.6	62.4	75.7
organic matter	47.9	19.6	11.1
Fischer assay product yield, %:			
shale oil	29.3	-	-
pyrogenetic water	2.2	-	-
semicoke	59.1	-	-
gas and losses	9.4	-	-
Calorific value (bomb calorimeter), MJ/kg	17.2 5	6.15	3.43

* Sample of semicoke taken from the narrowed shaft.

Table 4. **Oil Shale Processing on Retorting Plants in Estonia**

Year	Kohtla-Järve			Kiviõli		
	Oil shale processed	Produced		Oil shale processed	Produced	
		crude oil	motor petrol		crude oil	motor petrol
1921	1013	115				
1922	1668	259				
1923	2368	361				
1924	2196	337				
1925	18746	2652				
1926	39601	5784				
1927	31621	4237				
1928	42412	6595				
1929**	32454	5453				
1930	37959	6318				
1931	43842	6829				
1932	52503	9001				
1933	61200	10404				
1934	64888	11031				
1935	69165	11758				
1936	133703	22868	1179	116393	22926	3569
1937	178205	30008	968	284782	55563	8852
1938	301926	48977	1041	328876	65079	10034
1939	370198	60545	1443	340185	70004	11515
1940	386341	59701	946	354530	68195	10772

* Calcualted by difference.
** 1929-1933 - the years of world economic crisis.

The daily throughput of these cylindrical retorts was 41—42 tonnes of oil shale, the shale oil yield being 14.0—14.5 % on feed shale or 60—65 % of Fischer assay oil. The gas yield was 720—750 m^3/t.

The construction of a new plant (GGS-4) was started before the World War II, the Pintsch-type retorts with a design capacity of 37—40 t/day were selected again, but this time with more complete control of the process which enabled to obtain higher oil yields. As on GGS-3, for removal of ash residue a steel conveyer was also installed on GGS-4 which in 1955 was replaced by conveyer belt.

At the Kiviõli and Sillamäe plants tunnel ovens were selected for processing of oil shale, where the retorting process was carried out in steel oven-trucks. The tunnel ovens enabled to obtain oil with a higher content of gasoline fractions in the oil (up to 20 Vol. %). Owing to the use of the gas and oil vapours formed in the tunnel oven process as circulating gaseous heat carrier heated in heat exchangers

before World War II, tonnes

Sillamäe			Kohtla-Nõmme*			Total		
Oil shale processed	Produced		Oil shale processed	Produced		Oil shale processed	Produced	
	crude oil	motor petrol		crude oil	motor petrol		crude oil	motor petrol
	-			-	-	1313	115	
	-			-	-	1668	259	
	-			-	-	2368	361	
	-			-	-	2196	337	
	-			-	-	18746	2652	
	-			-	-	39601	5784	
	-			-	-	31621	4237	
	5271			-	-	69951	11866	
	3549			-	-	61896	10776	910
	-			-	-	49466	10066	251
	-			1586	154	106674	17149	1223
	-			4124	678	198261	36595	4209
	-					202099	37617	4992
	-			8248	1356	243465	46876	5899
	-					250866	47273	6217
43893	8019	1342	49391	9643	1649	343380	63456	7739
81452	15703	2959	54220	10619	1612	598651	11893	14401
81904	14938	2403	54498	10637	2582	767204	139631	15160
204443	36944	7623	54639	11397	2034	969465	178890	22615
196989	35197	6719	73374	10936	2063	1011234	174029	20500

(superheaters), the plant oil yield reached that of the Fischer assay. In addition, about 1 % (on the initial feed shale) of light gasoline was recovered in a refrigerating plant. The calorific value of the product gas with a specific yield of 20—30 m^3/t was about 33.5 MJ/m^3 (excl. 20—25 g/m^3 of C_5^+ hydrocarbons which remained in the gas after light gasoline separation).

At Kohtla-Nõmme the low-capacity Davidson horizontal rotary retorts were operated for a relatively short period. The plant consisted of 4 rotating horizontal drums, heated externally with flue gases, generated by burning of their own semicoke. The oil vapours were withdrawn through offtake pipe. The oil yield was 19—20 % from the feed shale, i.e. about 90 % of Fischer assay oil. The gas yield was within a range of 80—120 m^3/t, its calorific value (excl. C_5^+ hydrocarbons) being about 3,500 $kcal/m^3$.

Table 5. **Export of Estonian Oil Shale Fuel Products**

Year	Crude oil				Motor petrol		
	Tonnes	Thousand kroons	Average price, kroons/tonne	Export, per cent of total production	Tonnes	Thousand kroons	Average price, kroons/tonne
1923	8.1	0.34		2.5			
1924	9.3	1.31		2.7			
1925	72.8	4.96		4.1			
1926	11.2	1.67		1.9			
1927	863.3	93.60		20.8			
1928	2516.8	244.30	97.0	21.3			
1929	1866.5	132.0	74.5	16.7	209.5	37.2	187
1930	1568.9	104.3	67.0	15.7	227.8	39.4	173
1931	2353.9	125.1	53.2	13.8	518.3	48.4	271
1932	3939.9	220.8	60.5	10.0	753.3	188.3	250
1933	6210.7	320.0	51.5	16.8	1573.5	437.4	278
1934	13967.4	691.7	49.8	30.0	2078.4	685.9	330
1939	90000.0			50.3			

Table 6. **Properties of Feed Shale and Basic Operational Data for Semicoking in Retorts of Different Design**

Characteristics	Tunnel ovens		Davidson retort Dec. 12, 1960	Retorts GGS-3 October 21—24, 1963
	Kiviõli December 1973	Kohtla-Järve February 1961		
Test number	1	2	3	4
Oil shale				
Moisture, %	8.3	9.0	8.0	8.8
Conventional organic matter, (dry basis), %	31.2	35.0	30.0	34.0
Fischer assay oil yield, %	21.6	23.6	20.2	23.1
Calorific value (bomb calorimeter), MJ/kg	11.97	13.44	11.22	13.15
Yield of products				
Shale oil, %				
Plant yield (raw shale basis)	19.0	20.8	16.5	13.9
Yield of Fischer assay oil	97.6	97.0	89.0	66.0
Specific gas yield, m^3/t	20	25	100	585
C_3^+ hydrocarbons in product gas, g/m^3	22	22	no data	24
Operational data				
Feed shale throughput rate, t/day	384	388	23	47
Temperature of oil vapours at the retort offtake, °C	460	480	450	210
Final gas temperature after condensation system, °C	25	30	20	63

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Table 7. **Properties of Oil Produced by Semicoking Oil Shale**

Properties	Test number (see Table 6)			
	1	2	3	4
Density at 20 °C, g/cm³	0.9644	0.9650	0.9490	1.0031
Viscosity at 75 °C, °E	1.76	1.4	1.5	2.9
Flash point, °C	10	25	9	104
Distillation, Vol. %:				
Initial boiling point, °C	91	65	60	183
80 °C	-	2	4	-
100	1	3	6	-
120	3	4	9	-
140	4	5	12	-
150	6	7	14	-
160	8	9	15	-
180	11	11	18	-
200	15	14	22	3
220	19	16	24	5
240	23	20	27	9
250	25	22	30	11
260	27	24	30	13
280	32	28	34	18
300	39	35	39	24
320	45	40	48	31
340	56	55	53	40
350	64	73	60	49
360	79	-	68	58
Calorific value (bomb calorimeter), MJ/kg	40.19	40.11	40.11	39.27
Phenolic compounds, %	23.3	22.3	23.1	26.7
Molecular mass, M	276	-	-	280
Elemental composition, %:				
C	82.1	82.6	81.5	83.1
H	9.9	10.4	9.9	9.7
S	0.8	0.9	1.1	0.8
O + N (by difference)	7.2	6.1	7.5	6.4

Table 8. **Chemical Group Composition of Light-Middle Fractions of Shale Oil, wt. %**

Fractions and compounds	Test number (see Table 6)			
	1	2	3	4
Fraction boiling up to 200 °C				
Alkanes and cycloalkanes	23	7	20	16
Alkanes	50	77	57	34
Aromatic hydrocarbons	15	11	13	30
Neutral oxygen compounds	10	3	9.5	17
Phenols	2	2	0.5	3
Fraction yield, %	11.9	12.8	17.5	4.4
Fraction 200—350 °C				
Alkanes and cycloalkanes	11	9	11	9
Alkanes	14	17	13	13
Aromatic hydrocarbons	29	28	33	32
Neutral oxygen compounds	22	22	20	24
Phenols	24	24	23	22
Fraction yield, %	36.6	27.4	29.5	35.1

Table 9. **Properties of C_5^+ Light Gasoline Fraction Recovered from Gas**

Indices	Tunnel ovens Kiviõli, 1963				Retorts GGS-3 1.—5. november, 1963
	Two ovens 26.—29.11. I and II lines		Three ovens 10.—11.12. II line		
	prior to recovery	after recovery	prior to recovery	after recovery	
Test number	5	6	7	8	9
C_5^+ hydrocarbons, g/cm³	270	22	287	22	24
Density at 20 °C, g/cm³	0.6569	0.6764	0.6445	0.6528	0.7160
Refraction index, n_D^{20}	1.3840	1.3865	1.3752	1.3870	1.4140
Molecular mass	75	-	-		89
Distillation, Vol. %					
Initial boiling point, °C	25	-	21		31
30	8	-	17		-
40	31	-	37		2
50	53	-	56		8
60	67	-	71		16
70	78	-	78		25
80	84	-	82		36
90	92	-	83		48
100	-	-	84		59
110	-	-	-		70
120	-	-	-		79
130	-	-	-		86
140	-	-	-		92
150	-	-	-		93
Calorific value (bomb calorimeter), MJ/kg	-	-	48.15		45.80
Elemental composition, %					
C	-	-	-		85.4
H	-	-	-		13.4
S	-	-	-		0.8
O + N	-	-	-		0.6

As can be seen from Table 4, by 1940 the annual oil shale processing capacity reached 1 million tonnes from which 170—180 thousand tonnes per year of oil were produced. The oil was refined to produce 20—22 thousand tonnes of motor petrol annually. Up to 50 % of the oil and a portion of motor petrol were exported (see Table 5) [5]. The motor petrol was of low quality (octane number 66—68), however, at that time it met the needs of home market.

For complete characterization of the oil shale retorts operated in Estonia in the pre-war period, in Tables 6—11 the physical and chemical properties of the retort products are presented. The analyses were performed after World War II by the Oil Shale Research Institute when systematic investigation of oil shale processing plants was carried out.

Table 10. **Chemical Composition of C_5^+ Light Gasoline Fraction Recovered from Gas, wt. %**

Hydrocarbons	Test number (see Table 9)			
	6	7	8	9
Alkanes				
n-propane	-	-	-	0.7
n-butane	6.0	5.9	8.1	3.8
n-pentane	17.3	16.6	14.4	6.5
n-hexane	10.9	11.8	9.1	6.4
n-heptane	2.9	2.0	2.7	6.2
n-octane	1.0	0.7	2.0	3.6
higher paraffins			1.0	
Total	38.1	37.0	37.3	27.2
Alkenes				
propene-1	-	-	-	-
butene-1	2.8	3.4	7.3	4.7
trans-butene-2	2.5	2.0	4.9	1.8
cis-butene-2	1.3	1.2	2.8	1.2
1,3-butadiene	0.3	0.3	0.6	-
pentene-1	12.2	12.4	9.9	6.0
trans-pentene-2	5.9	6.1	4.4	3.0
cis-pentene-2	2.8	2.8	2.2	1.9
2-methylbutene-2	1.1	1.2	0.9	-
cyclopentene	1.3	2.5	1.4	-
trans + *cis*-1,3-pentadiene	4.8	5.9	4.4	-
hexene-1	11.6	12.7	8.9	7.7
hexehe-2	3.9	4.1	3.4	2.2
heptenes	6.9	4.7	4.7	8.7
octenes	1.5	1.0	1.2	4.6
isoolefins	-	-	-	1.1
diolefins	-	-	-	10.1
cycloolefins	-	-	-	1.8
Total	58.9	60.3	57.0	54.8
Aromatics				
benzene	1.0	0.8	1.9	7.1
toluene	1.3	0.6	1.3	4.6
Total	2.3	1.4	3.2	11.7
Identified	99.3	98.7	97.5	93.7
Not identified	0.7	1.3	2.5	6.3

Table 11. **Characteristics of Retort Gas**

Indices	Tunnel ovens [6]		Davidson retorts [6]	Retorts GGS-3
	Kiviõli	Kohtla-Järve		
Content of components, vol. %				
CO_2	21.0	22.7	12.6	18.3
H_2S	9.0	12.9	4.7	0.5
C_nH_m	9.9	10.6	5.5	1.3
Including:				
C_2H_4	3.5	3.3	1.9	0.8
C_3H_6	4.6	4.2	2.0	0.4
C_4H_8	1.8	3.1	1.6	0.1
O_2	1.2	1.2	3.2	2.0
CO	7.4	8.9	4.4	5.6
H_2	5.6	5.6	5.5	6.2
C_nH_{2n+2}	24.5	32.9	13.1	4.6
Including:				
CH_4	9.6	15.0	5.5	3.5
C_2H_6	8.8	11.1	4.5	0.8
C_3H_8	4.8	5.0	1.9	0.2
C_4H_{10}	1.3	1.8	1.2	0.1
N_2	21.4	5.2	51.0	61.5
Content of H_2S, g/m³	130	186	28	8
Calculated gross calorific value (without C_3^+ hydrocarbons), MJ/m³	27.26	33.70	15.20	3.8

REFERENCES

1. *Winkler H.* Der estländische Brennschiefer. Untersuchung, Gewinnung und Verwertung. Reval, 1930. 350 S.
2. *Zeidler R.* Neue Wege der Verwertung des Ölschiefers und seiner Umwandlung in Öle. Reval, 1933. 194 S.
3. *Luts K.* Der estländische Brennschiefer Kukersit, seine Chemie, Technologie und Analyse. Tallinn, 1934. 356 S.
4. Riigi Põlevkivitööstus 1918—1928. - Tallinn: Riigi põlevkivitööstuse kirjastus, 1928.
5. *Кузнецов Д.Т.* Очерки развития сланцевой промышленности Эстонской ССР. Л, 1960. С 200.
6. *Баршевский М.М., Безногин Э.С. Шапиро Р.Н.* Справочник по переработке горячих сланцев.- Л., 1963. С .238.

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К ИСТОРИИ РАЗВИТИЯ ХИМИЧЕСКОЙ ПЕРЕРАБОТКИ ГОРЮЧИХ СЛАНЦЕВ В РОССИИ И В ЭСТОНИИ

A. V. KOZHEVNIKOV

ON THE HISTORY OF OIL SHALE CHEMICAL PROCESSING IN RUSSIA AND IN ESTONIA

A. V. Kozhevnikov

A. V. Kozhevnikov, Professor, Doctor of technical sciences, Laureate of State Prize of the U.S.S.R. (born in October 1, 1911) began his work in 1933 at the Leningrad Oil Shale Institute and attested the birth of the new branch of science on oil shale. His most known works used on industrial scale concern coking of higher fractions of oil shale tar, synthesis of ion exchangers, and improvement of the quality of fuels for marine engines.

A. V. Kozhevnikov was one of those Soviet scientists who in the 30ies visited the Estonian Republic and was acquainted with Prof. P. Kogerman from Tallinn Technical University.

His first monograph "Oil Shale" was published in Tartu in 1947. On the whole he has written more than 200 scientific papers, 4 manuals and 3 monographs. Under his direction 16 candidate and 3 doctor theses have been accomplished.

Горючие сланцы известны людям с древних времен. В старинных легендах рассказывается, например, о пастухе, который обогревался огнем костра из «горючих камней», о сложенных из таких «камней» печах, которые сгорали вместе с дровами.

Первый этап развития переработки горючих сланцев — это история познания и первые попытки использовать полученные знания на практике.

В 1697 г. русский царь Петр Первый приказал отправить образцы горючего сланца из России в Голландию на исследование (прив. по [1]).

В 1809 г. корреспондент С.-Петербургской Академии наук Т. С. Борноволоков описал в «Технологическом журнале» физико-химические свойства горючих сланцев, залегавших в бассейнах рек Печоры и Ухты [2]. Годом позже, в 1810 г., известный в то время берлинский химик Клапрот опубликовал в «Горном журнале» статью о горючем сланце «из Вологодской губернии» (прив. по [1]).

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проводимые профессором В. Г. Каширским и коллективом его сотрудников в Саратовском политехническом институте.

Положительное значение в обобщении знаний о горючих сланцах и их химии и технологии в послевоенные годы имели монографии А. Ф Добрянского «Горючие сланцы СССР» [14] и А. В. Кожевникова «Горючие сланцы» [15]. Значительным явлением стало издание книги Н. И. Зеленина, В. С. Файнберга и К. Б. Чернышевой «Химия и технология сланцевой смолы».

В 1968 г. в Таллинне был проведен Международный симпозиум по проблемам горючих сланцев, что стало еще одним признанием достижений наших сланцехимиков как в области теории, так и в области практики.

В последние годы перед сланцехимиками встали новые задачи — научное обоснование в техническая реализация промышленных процессов нового поколения.

Главным результатом этого должно быть не только достижение экономической эффективности, но и создание новых безотходных, экологически обеспеченных химических технологий, что для многозольных горючих сланцев представляет большие сложности.

На наш взгляд, в настоящее время наметились и развиваются три основных принципиально новых направления химической сланцепереработки, способных стать малоотходными или безотходными и достаточными для удовлетворения природоохранных требований.

Это:

— полукоксование сланца с одновременным получением клинкера [16], предложенное сотрудниками ВНИИнефтехима (Г. А. Ластовкин, И. Л. Глезин, Г. А. Тимофеев и др.);
— полукоксование сланца в генераторах смолы с одновременным получением карбида кальция и ацетилена [17], предложенное учеными СЗПИ (А. В. Кожевников, С. А. Апостолов и В. П. Зайцев);
— непирогенное использование керогена горючих сланцев в ряде процессов химического и биохимического направления, предложенное учеными ЛТИ (В. А. Проскуряков, В. И. Яковлев и др.).

На наш взгляд, все эти направления имеют черты оригинальности, экологичности и ожидаемой высокой экономической эффективности и достойны всяческого внимания.

A. V. KOZHEVNIKOV

ON THE HISTORY OF OIL SHALE CHEMICAL PROCESSING IN RUSSIA AND ESTONIA

Summary

The first period of oil shale history began as early as 1697, when tsar Peter I ordered to send samples of oil shale to Holland for examination. At the beginning of the XIX century, Russian scientists T. S. Bornovolokov and V. M. Severgin, along with a German scientist Klaprot, published the results of their investigations of Estonian and Russian oil shales.

In Estonia, the first written information on oil shale was published by A. V. Hupel (1737—1818). Later, a professor at Tartu University, A. Petzholdt (1810—1889), published his works on the chemical composition of Estonian oil shale. Investigations of oil shales from Estonia and the St. Petersburg area were published by academician Gelmersen in 1830.

Local inhabitants have used oil shale as a fuel for ages in Russia, Kazakhstan and Daghestan.

The second period began in 1916—1917. The first shipment of Estonian oil shale was sent to Petrograd in 1916. Domestic gas was produced from it there. The centre of oil shale investigations was established in Petrograd. During

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the first five-year plan new oil shale processing plants were built in Kashpir and Leningrad. Lenin highly appraised oil shale investigations and ordered to give state support to these works.

The Estonian scientist P. Kogerman (1891—1951) was one of the founders of oil shale chemistry. In the 1930-s, he worked in the laboratory of the Nobel-prize winner L. Ruzicka and maintained a thesis for a Doctor's degree there.

In 1934 the oil shale processing plant was put into operation in Kashpirsk. Methods for producing gas, liquid fuel, construction materials and many chemicals from oil shale were developed in Leningrad. A full size box furnace, a tunnel furnace and a semicoking generator with fluid slag disposal were built and succesfully tested at the same time. In 1936 production tests of Gdov area oil shale were carried out in the shaft furnace under the guidance of Prof. Klimov. The daily throughput of the furnace was 100 t, the yield of the oil was 88 % of the laboratory output. These tests ascertained that bituminization and coking do not take place during oil shale processing in the shaft furnace. On the ground of these tests it was decided to build a plant for processing Gdov area oil shale at Redkino. The building of the first furnace was finished at the end of 1939. The first oil was used to produce motor gasoline. Because of the war, further building of the plant was stopped.

The third period began after the war. In 1945 the government of the USSR decided to restore oil shale processing in the Leningrad district and Estonia in order to produce domestic gas for Leningrad. It was decided to build 3 new oil shale processing plants in Slatoi (Russia), Kohtla-Järve and Ahtme (Estonia) and a gaspipeline from plants to Leningrad 262 km long. It was also decided to rebuild the gas plant in Leningrad.

Generators and box furnaces were used in oil shale processing plants in Kohtla-Järve, Kiviõli (Estonia), Slantsoi and Kashpir (Russia) at this time.

In the beginning of the 60-s, processing was stopped in such units for semicoking as vertical retorts, revolving retorts, Pitsh retorts and tunnel furnaces.

It was established that shale oil is the complex solution, comprising not only hydrocarbons, but first of all oxigenated and other heterogeneous compounds. Special attention was paid to separation and using of water-soluble and shaly phenols. The processing of higher fractions of shale oil by means of coking was worked out by A. V. Kozhevnikov and S. M. Butkov and introduced into production at the Kohtla-Järve plant.

It has been shown by many investigations that oxidated kerogen may be obtained by oxidation of oil shale with oxidizers or air. The product contains carboxylic and dicarboxylic acids.

The most important information sources on oil shale chemistry and processing are: "Oil shale of the USSR" by A. F. Dobryanski (1947) (in Russian), "Oil shale" by A. V. Kozhevnikov (1947—48) (in Russian) and "Chemistry and processing of shale oil" by N. I. Zelenin and others (1968) (in Russian).

Nowadays great attention must be paid to creating new wasteless treatments, which is difficult because of the high ash content of oil shale. Up to now, a convincing method of processing oil shale with low waste or without waste does not exist. In our opinion there are 3 new directions for chemical treatment of oil shale which may be wasteless and respond to the demands of environmental protection:

1. Semicoking of oil shale with simultaneous producing of clincer (Oil Shale, 1982, No. 2);
2. Semicoking of oil shale in generators with simultaneous producing of calcium carbide and acetylene; and
3. Nonpyrogenic processing of kerogen of oil shale for chemical and biochemical purposes.

ЛИТЕРАТУРА

1. *Кожевников А. В.* Из истории исследования горючих сланцев // Природа, 1951. № 9.
2. *Борноволоков Т. С.* 1. О доманите или вологодском смоляном сланце (шифере) // Технологический журнал. 1809. Т. 6, ч. 2. С. 111.
   2. О приготовлении из доманита черного мела, или карандаша для рисования // Там же. С. 118—122.

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I. ÕPIK

ELECTRICITY OR OIL FROM ESTONIAN OIL SHALE — AN OLD PROBLEM

И. П. ЭПИК

СТАРАЯ ПРОБЛЕМА: ЭСТОНСКИЕ ГОРЮЧИЕ СЛАНЦЫ — СЖИГАТЬ ИЛИ ПЕРЕРАБАТЫВАТЬ?

Since the foundation of the oil shale and shale oil industry in Estonia in the early twenties there has been disputable the question, what will be more profitable — combustion of oil shale to generate electric power or processing it to get oil and gas.

The oil shale utilization in Estonia has been developed in both directions, although between the 1960—1975 the generation of electricity was preferably enhanced. The energy prices in the U.S.S.R. which determined the sale of Estonian shale products at the post-war period were conventional and did not express the real export values of electricity and shale oil in the Baltic region.

This review presentes a comparison of values of Estonian oil shale products with the import prices of fuel and electricity in Finland during the period 1960—1989. As Finland is situated in the neighbourhood of Estonia it can be regarded as a potential consumer of electricity which can be transferred by DC-link across the Gulf of Finland as well as shale fuel oil can be transported by tankers.

Unupgraded Estonian oil shale has on the average a water content of 9.5 %, lower heat value 8.6 MJ/kg and the laboratory oil yield from dry shale (Fisher Assay) 18.2 wt.%. The average price of Estonian oil shale in 1991 is SUR 16.7 per tonne.

Net production of electric power with 200 MW units (steam pressure 135 at, temperatures of steam preheat and reheat 775—790 K) is 0.65 MWh per tonne of burnt oil shale. Commercial oil yield from the similar oil shale by retorting is on the average 130 kg raw shale oil per tonne of retorted shale.

Estonian shale oil without the expensive upgrading is not to be used as synthetic crude oil (syncrude) in existing oil refineries. Because of the high summary content of oxygen, nitrogen and sulphur compounds in the raw shale oil the treatment costs of upgrading will be very high, estimately more than US$ 10 bbl. Therefore the shale oil is not sold as a synthetic crude but is used without the upgrading for specific purposes. The raw shale oil, for example, after separation of the gasoline fractions (3—6 wt.% from the oil of internal combustion retorts, 10—16 wt.% by retorting in indirect heated units) gives fuel oil of

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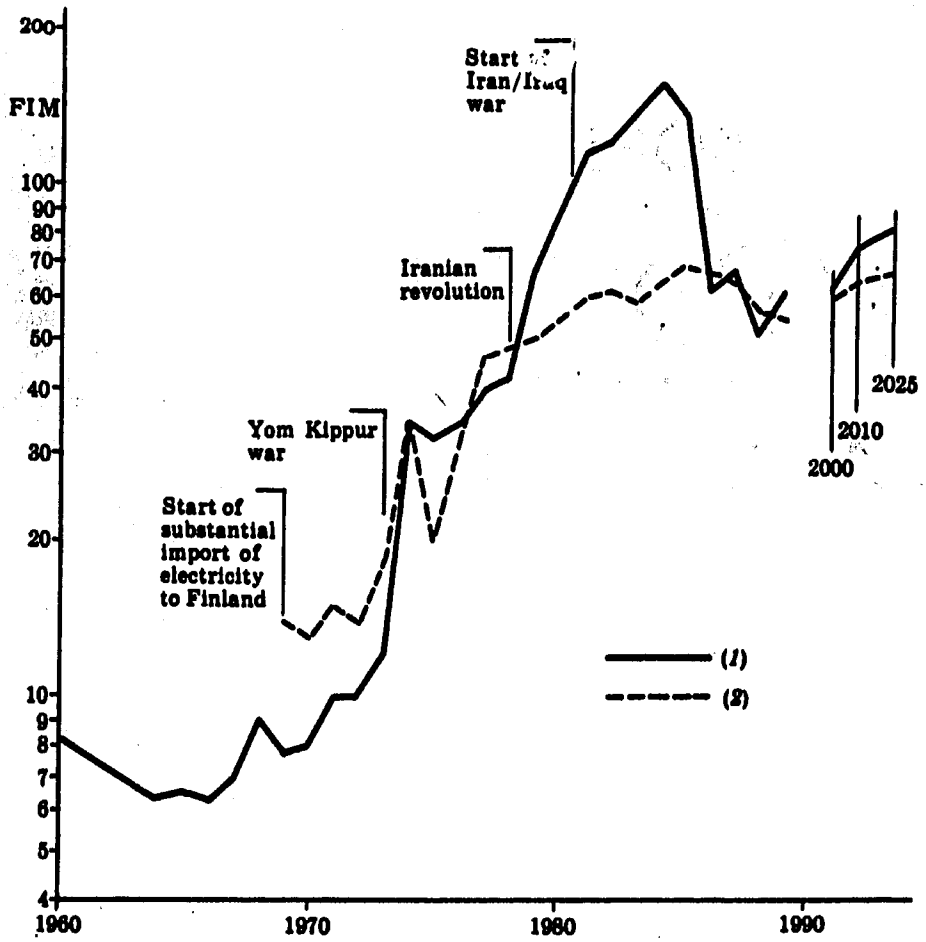
Shale oil, also electric power from 1 t Estonian oil shale evaluated in heavy fuel oil and electricity import prices in Finland during 1960—1989

Стоимость вырабатываемых из 1 т эстонского сланца-кукерсита электроэнергии и сланцевой смолы в ценах импорта в Финляндию соответственно электроэнергии и топочного мазута в период 1960—1989 гг.

Year		Arabian light crude oil official world-market price (1 bbl = 0.138 т)			Average import price in Finland, FIM			Value of the production, FIM, from 1 t oil shale as:	
		$/bbl	FIM/$	FIM/t	Crude oil, per/t	Heavy fuel oil, per/t	Electric power, per/MWh	0.13 t fuel oil	0.65 MWh electric power
1960		1.86	3.207	43	63	69	15	8	10
61		1.80			58	60	11	8	7
62		1.80			56	56	—	7	—
63		1.80			54	51	6	7	4
64		1.80			51	48	6	6	4
1965		1.66	3.223	39	51	50	7	6	5
66		1.53			49	48	8	6	5
67		1.50			51	53	10	7	7
68		1.45			63	67	11	9	7
69		1.40			64	60	22	8	14
1970		1.35	4.180	41	65	62	20	8	13
71		1.75	4.174	53	86	80	23	10	15
72		1.90	4.146	57	89	80	21	10	14
73	1—6 7—12	2.17 3.10	3.816	60 86	110	95	28	12	18
74	1—6 7—12	9.12 10.00	3.774	249 274	327	261	54	34	35
1975		10.46	3.679	279	320	244	30	32	20
76		11.51	3.864	324	350	265	50	34	32
77	1—6 7—12	12.09 12.70	4.029	353 371	400	313	69	40	45
78		12.70	4.117	379	412	324	74	42	48
79	1—6 7—12	14.81 20.86	3.896	418 589	583	524	77	68	50
1980	1—6 7—12	27.99 20.77	3.730	757 561	903	685	84	88	55
81	1—6 7—12	32.75 33.58	4.315	1024 1050	1156	880	92	114	60
82	1—6 7—12	33.62 33.40	4.820	1174 1167	1169	932	95	120	62
83	1—6 7—12	34.00 29.00	5.570	1372 1170	1219	1064	91	137	59
84		29.00	6.100	1282	1270	1195	98	154	64
1985	1—3 4—12	29.00 28.00	6.206	1304 1259	1252	1040	106	134	69
86		28.00	5.078	1030	681	473	105	61	68
87	1—3 4—12	21.10 17.52	4.404	673 559	596	515	99	67	64
88		17.52	4.191	532	455	392	88	51	57
89		17.52	4.295	545	573	475	85	62	55

quality with 0.8 % sulphur and low vanadium contents and the pour-point temperature about —15 °C. Its minimum price is on a level with that of the high-quality heavy fuel oil derived from the crude oil. There exist also shale oil constituents that are not used for combustion but are sold at higher prices than fuel oil.



Export value of two kinds of production from 1 tonne Estonian oil shale calculated in Finnish average annual import prices: (*1*) — 0.13 tonnes shale oil as heavy fuel oil; (*2*) — 0.65 MWh electricity. 2000—2025 — based on the prognosis of the Ministery of Trade and Industry, Finland [2]

Экспортная стоимость продуктов, получаемых из 1 т эстонского сланца-кукерсита, выраженная в среднегодовых ценах финского импорта: *1* — 0,13 т сланцевой смолы как топочного мазута; *2* — 0,65 МВт·ч электроэнергии. 2000—2025 гг. — данные базируются на прогнозе Министерства торговли и промышленности Финляндии [2]

The Table below is compiled on the data of the "Finnish Energy Statistics" and is presenting the Finland's import prices of crude oil, heavy fuel oil and electricity for the period of 1960—1989 and corresponding prices of 0.13 t heavy fuel oil and 0.65 MWh of electricity, both produced from 1 t Estonian oil shale. The data given in the table are plotted in the Figure.

Up to the end of the seventies the electric power generated from Estonian oil shale by its combustion (0.65 MWh/t) was evaluated much higher than the oil (130 kg/t), yielded from the same amount of oil

shale. At this period two large power stations were built in Estonia for the direct combustion of oil shale in pulverized condition, both with the capacity of 1.6 GW. The foundation of oil shale plants was stopped except the pilot retorting plant in Kiviõli — a solid heat carrier retort UTT-500 with oil shale throughput 500 t per single day (TPSD).

Notable for this period are the R&D carried out for utilization of shale oil and the products from it as basic material for chemical engineering.

The crude oil high-price period during 1979—1985 was too brief for the shale oil industry to rise it considerably from its state of depression. During this period two UTT-3000 (3000 TPSD oil shale capacity) retorting units were installed at the Estonian Thermal Power Station and a pilot internal combustion retort with the capacity of 1000 t upgraded oil shale per calender day (TPCD) in Kohtla-Järve [1]. Two new retorting plants were also designed: the 6th plant with two 1000 TPCD retorts and the 7th plant with four 1500 TPCD retorts in Kohtla-Järve. The 6th plant is in operation at present, but the 7th is still under construction. Expansion of electricity generation by direct combustion of Estonian oil shale did not take place.

In the late eighties after the slump of crude oil prices the values of 0.65 MWh electricity and 0.13 t fuel oil, produced from 1 t oil shale were equalized.

Some prognoses of the Ministry of Trade and Industry of Finland [2] are predicting increase of prices for heavy fuel oil (61 %) and electrisity (18 %) when comparing the price levels of 1988 and 2025. The prices for electricity will rise slowlier while hydroelectric and nuclear power plants give great share of energy in the interconnected Nordic electric power system "Nordel".

The prices of heavy fuel oil (sulphur 3.0 %) are the lowest level for Estonian shale oil (sulphur 0.8 %, vanadium 0.0002 %, pourpoint —15 °C) prices. But its real value is much higher, particularly when marketing specific shale oil products — refined destillates, resorcinols and their products, impregnation oils (antiseptics, water repellents), ingredients of mastics a.s.o.

РЕЗЮМЕ

Одновременно с зарождением в начале 20-х гг. сланцедобывающей и сланцеперерабатывающей промышленности в Эстонии встал и вопрос о том, что выгоднее: сжигать кукерсит, чтобы получать тепловую или электрическую энергию, или подвергать его термической переработке для получения сланцевой смолы и газа. Этот вопрос не утратил актуальности и по сей день.

Однако найти ответ не так-то просто, поскольку цены, по которым Эстония продавала свою электроэнергию и продукты сланцепереработки после Второй мировой войны, как и бóльшая часть цен в Советском Союзе, были весьма условными и не соотносились с реальной стоимостью этих товаров в Балтийском регионе.

В публикуемом обзоре цены на электроэнергию и сланцевую смолу в виде топочного мазута сопоставляются со среднегодовыми ценами, по которым Финляндия импортировала названные продукты начиная с 1960 г.

За основу берется 1 т необогащенного эстонского сланца-кукерсита. Выработка товарной электроэнергии в сланцевых энергоблоках мощностью 200 МВт при средней теплоте сгорания необогащенного сланца составляет 0,65 МВт·ч/т, а выход товарной смолы при термической переработке такого же сланца — в среднем 130 кг/т.

Без дорогостоящей гидрогенизации (порядка 10 долларов США за баррель) сырью сланцевую смолу нельзя использовать в качестве искусственной (син-

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ILMAR ÖPIK

THE EQUIVALENT PRICE OF ESTONIAN OIL SHALE TO THE PRICE OF COAL

While discussing the economical development of the Estonian oil shale industry in the interim 1920—1990, E. Reinsalu [1] described two periods with the oil shale output decrease in Estonia. The first period, 1941—1945, with the average yearly decrease of 7.6 %, was delimited by the World War II. The second period of decrease started after 1980 and is still going on. For the interim 1981—1990, the average annual decrease of the output was 3.4 %. The initial annual output when the decrease started was 31.3 million tonnes and it has fluently subsided to 19 million tonnes in 1991. According to [1] it is not clear whether the decline is temporary or it is the onset of the extinction of oil shale industry after the resources have been exhausted?

Today six underground and four open pit oil shale mines operate in Estonia. Their total resource for commercial output in 1991 was approximately 0.6 billion tonnes [2]. As a result of the exhaustion of their resources between 1993—2025 the majority of existing today oil shale mines in Estonia will be closed. On the basis of the rest of their 0.6 billion tonnes resource only one underground and one open pit mine will remain in operation after 2025. The 0.6 billion tonnes net resource is today included to the existing mines and no supplementary payment for the land as well as royalties is necessesary. That is not the case with new mines to be opened on the basis of additional oil shale resources. We can conclude from the above that the decline of oil shale output in Estonia results from the exhaustion of the cheapest available local resources.

The equipment of oil shale power stations as well as that of the oil shale processing units will be exhausted mainly during the first decade of the next century or even earlier [2]. Taking into account that in 1991 approx. 87 % of Estonian oil shale output (84 % in energy units) was utilized at the electricity generating stations, the primary energy resources must guarantee a lifetime of 30—40 years for the investments made in the first decade at electricity generating stations. For this purpose, new oil shale mines based on new resources should be opened. As an alternative to the oil shale as a fuel for power generating in Estonia imported hard coal can be used, in particular for the combined combustion with oil shale in CFB-boilers. The latter method enables to overcome the air quality problems and to do it without expensive desulphurization equipment [3]. With an alternative fuel at disposal we get search prices for both fuels that when exceeding one of them the other looses its competitiveness.

The price of oil shale has not been quoted at the international market while the price of the alternative fuel — imported hard coal has been. So, the oil shale must have an equivalent price to the price of coal, which will be the highest price for oil shale that a power generating station can afford. By higher price than the equivalent price the imported coal begins to compete with oil shale as a fuel. The International Union of Producers and Distributors of Electrical Energy (UNIPEDE) has pre-

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sented long-term prognoses of international fuel prices for investment planning in the electricity generating stations.

The assessment of UNIPEDE from January 1991 [4] presents a forecast of fuel prices to the interim 2000—2030, taking into account that the lifetime of a thermal power plant is approx. 30 years. Forecasted price scenarios are needed to identify relative competitiveness of different types of generating stations. Assumptions for common coal price (CIF-price) were adopted by UNIPEDE: two extremal scenarios, high and low, covering the forecast values proposed by the experts of various countries and the medium scenario as the averaged version of them are presented in Table 1.

Table 1. **UNIPEDE 1991 coal price assumptions**

Coal common price scenarios	Year			
	2000	2010	2020	2030
Price US$-1990 per tonne				
High	50	58	67	78
Medium	46	52	56	62
Low	42	45	45	45
Price ECU/t (1 ECU/t = 1.168 US$)				
High	43	50	57	67
Medium	39	45	48	53
Low	36	39	39	39
Price ECU/GJ (1 tonne coal = 25.54 GJ)				
High	1.7	1.9	2.2	2.6
Medium	1.5	1.7	1.9	2.1
Low	1.4	1.5	1.5	1.5

The UNIPEDE low scenario assumes a moderate growth in coal prices of around 0.7 % a year up to the year 2010, and following stable price of 45 US$/t. The high scenario with a high world economic growth assumes a rapid rise in prices: a price of 50 US$/t in 2000, subsequently increasing at a rate of 1.5 % a year. The equivalent price of an unit of the energy (MWh, GJ, kcal, BTU) of oil shale to the price of it in coal is determined according to relative effectivity by electricity generation in the oil-shale- and coal-fired-power stations.

The thermal efficiency of a coal-fired power plant is between 0.38 and 0.42. The same at oil-shale-fired power plants is limited in average with a net efficiency of 0.28. This low efficiency is a result of chlorine-caused corrosion and ash fouling of heating surfaces. The maximum steam temperatures in pulverized oil-shale-burning boilers are limited by steel corrosion at 515—520 °C while decreasing during a 10 weeks nonstop run approximately to 480—490 °C. The steam temperatures at coal-fired blocks are stable and reach 550—570 °C. So, the thermal efficiency of an oil-shale energy-generating block will be only 0.67—0.75 compared to that at a modern coal station.

During the combined combustion of coal and oil shale in CFB-boilers the heat surfaces corrosion and fouling activity of shale fly ash is due to low temperature combustion suppressed. So, the thermal efficiency of power generation can be higher than in the stations with high temperature pulverized oil-shale combustion. The efficiency of such a station can rise up presumably to 0.32—0.34 or approximately to 0.85 from the thermal efficiency of a coal station. The operation and maintenance (O & M) costs as well as capital costs at a pulverized oil-shale-fired station are higher as at a coal station.

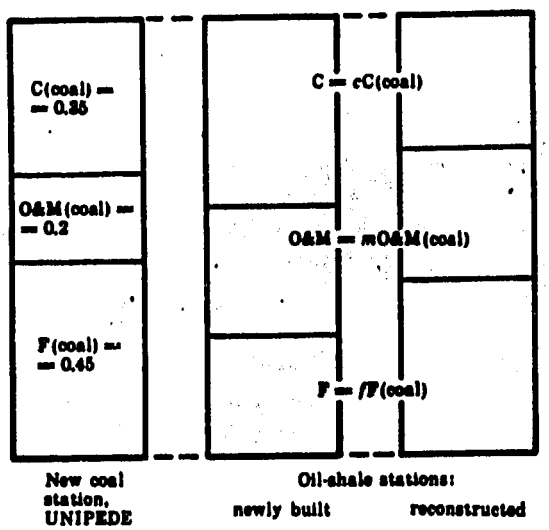
Specific repairs of boiler units inside the boilers as well as repairs of fuel- and ash handling equipment increase the O & M costs. O & M costs for planned coal stations in different countries are from 0.45—0.5 cECU/kWh in the Netherlands, Portugal and Canada up to 1.05—1.25 cECU/kWh in Belgium and Japan, in average 0.72 cECU/kWh. The maximum O & M costs in Europe are 1.45 times higher than the average O & M costs. There is no reason to evaluate that the O & M costs at a new pulverized oil shale burning station will be lower than their maximum values for coal stations.

The capital costs for coal stations vary from 0.95 (the Netherlands) to 1.6 (Italy) in Europe and 1.8 in Japan. The maximum of capital costs in Europe is approximately 1.2 times over their average (1.36 cECU/kWh). But the investment cost of a 215 MWel pulverized oil-shale boiler is approximately on the level of the investment cost of a 400 MWel lignite fired boiler. So, the capital cost per kWel for an oil shale boiler unit will be approximately 1.7—2 times higher than for the lignite boiler unit, and the additional investment cost per kW for an oil shale station will be about 15—20 % over these of the lignite (brown coal) station or 25—35 % more than at the coal station.

Marking the ratio between the oil shale equivalent price and the price of hard coal by r, the value of r will be:

$$r = f(k, c, m),$$

where k — is the ratio between the thermal efficiency of an oil-shale electric power station and that of a coal station;



Relative costs of electricity generation for the equal price of coal- and oil-shale-generated electricity in Estonia.

The equivalent price of oil shale as a fuel to the price of coal is determined by the coefficient

$$r = kf = k = \frac{1 - cC(\text{coal}) - mO\&M(\text{coal})}{F(\text{coal})}$$

where — C, O &M and F = 1 — C — O & M are the capital, O & M and fuel cost components by electricity generation;
— c, m and f are the ratios between the costs components at oil shale and coal stations;
— k is the ratio between the thermal efficiency at an oil shale station and that of a coal station

c — is the ratio of capital costs per kWh;
m — is the ratio of O & M costs per kWh.

The determination of r is explained in the Figure.

For a new pulverized oil-shale-combustion station with $k = 0{,}85$, $c = 1.25$—1.35 and $m = 1.5$, the value for r will be:

$$r = 0.43—0.50 = \text{approx. } 0.45.$$

For a reconstructed oil-shale plant with minimum investment costs the capital costs per kW of reconstruction will be approximately 50—60 % of the cost at a new station, accordingly with $c = 0.65$—0.8. In this case, with $k = 0.85$ and $m = 1.5$, the value for r will be:

$$r = 0.79—0.93 = \text{approx. } 0.9.$$

By making the presented calculations we assumed that the construction, installation and maintenance costs in Estonia between 2000—2030 will be on the same level as in the Central Europe.

Table 2. **Oil shale equivalent energy price to forecasted by UNIPEDE coal energy price for the interim 2000—2030, ECU/GJ**

Year	Eqivalent oil shale price scenarios ($r = 0.45$)		
	High	Medium	Low
2000	0.80	0.70	0.60
2010	0.90	0.80	0.70
2020	1.00	0.90	0.70
2030	1.20	0.95	0.70

Table 3. **Oil shale average equipment prices in Estonia for the interim 2000—2030, ECU/t**

Year	Average value of oil shale, GJ/t	Oil shale price scenarios ($r = 0.45$)		
		High	Medium	Low
2000	9.6	7.3	6.5	6.0
2010	9.9	8.5	7.6	6.7
2020	8.6	8.5	7.4	5.8
2030	6.7	7.8	5.7	4.5

In Tables 2 and 3 the equivalent oil shale prices are presented for the interim 2000—2030. The annual output of oil shale in Estonia in Table 3, is the output from the resource 0.6 billion tonnes, included to the Estonian mines in 1991 [2]. By higher oil shale prices than given in Tables 2 and 3, the imported hard coal will remain economically more preferable as fuel for Estonian electricity generating thermal power plants. But the equivalent price of oil shale as a fuel may be substantially higher in case of economic crisis situation, for example as in the Baltic States at the time of the collapse of the Soviet economy. In such a situation the capital costs can be reduced to minimum and there are also essentially lower O & M costs taking into account the lag of real wages and salaries in this situation. With c approx. 0 and m approx. 1—1.2, the value of r will be about 1.3—1.5. In this case, the energy in oil shale has the higher value compared with the energy in imported coal, and the equivalent price of Estonian oil shale will be approx. 18—25 ECU a tonne.

Due to the lack of the calculations based on hard currency (excluded [5]) and of estimates for Estonian oil shale electricity generating projects, some data in the present paper could be disputable and need to be specified.

REFERENCES

1. *Reinsalu E.* Economical development of Estonian oil shale industry // Oil Shale. 1991. V. 8, No. 3.
2. *Öpik I.* Scenarios for shale oil, syncrude and electricity production in Estonia in the interim 1995—2025 // Ibid. 1992. V. 9, No. 1.
3. *Holopainen H.* Experience of oil shale combustion in Ahlstrom Pyroflow CFB-boilers // Ibid. 1991. V. 8, No. 3.
4. UNIPEDE. Cost of electricity generation // UNIPEDE Copenhagen Congress 1991.
5. *Moller K., Moller L.* Problems of Estonian power system economics (in Estonian) // Trans. Tallinn Techn. Univ. 1990. No. 714.

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DEVELOPMENT OF ESTONIAN ENERGY ECONOMY

Estonian-Finnish Joint Seminar in Tallinn, September 23-24, 1993

The seminar was organized by the Estonian Ministry of Economy and the joint working group on energy problems of the Estonian Academy of Sciences and Finnish Academies of Technology. The objective of the seminar was to analyze the present state of the Estonian energy economy and perspective development scenarios, to find ways for solving different problems concerning planning of future political and economical decisions.

The seminar was financed by the Finnish Academies of Technology. 83 energy and economy experts, including 12 from Finland participated. The programme of the seminar included 15 reports on the basic problems of the Estonian energy economy. Many questions were asked and the presentations were followed with lively discussions. From the reports and discussions can be concluded:

1. The present state and main problems of the Estonian energy economy.

The energy demand in Estonia is covered for 70 % by local energy resources and complementary imported energy carriers are available as well. The existing generating capacities (technology is mostly obsolete) are practically underloaded and operate at uneconomical regime.

It results mainly from the low purchasing power of energy consumers due to the depression in the economy, problems of tax collection and acute lack of investments. At the same time the production price of oil shale and electric energy (established in Dec.,1992) does not cover the real production cost and provides no accumulation for indispensable investments. Enterprises work only for depreciation.

The consumption of electricity and oil shale has decreased compared to 1990 50 %, essential energy potential (up to 7-8 TWH annually) is unused.

The decrease in oil shale and electric power consumption has caused social tensions in the North-East Estonia where the population of towns and employees in enterprises are mostly foreign speaking. These tensions can be taken advantage of in political games.

Many basic problems: developement of energy economy and oil shale industry, price and tax policy, status and structure of energy companies, energy legislation, are not well-expressed and there exist no principles based on concrete studies and accepted by the government.

The present electricity tariffs and oil shale price do not enable privatization of energy companies.

2. Proposals and recommendations.

- ☐ Considering the critical situation in the oil shale production and processing industry, the highest priority must be given to investigations into the oil shale industry with the aim of stopping the reduction of production level and its further development, including the problems of electric power market. The results of the investigations should be discussed and the main principles of national oil shale policy approved on the government level;
- ☐ Lifetime of the equipment and facilities of oil shale fired power stations must be evaluated;
- ☐ Economical (feasibility) studies for financial (via shares) or administrative integration of oil shale mines, oil shale processing industry and power stations to provide rational use of oil shale reserves and investment funds must be carried out;

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- ☐ Flexible price regulation and control mechanism which would take into account inflation, production and investment costs as well as energy tariffs and principles of tax policy at the Estonian energy market must be elaborated;
- ☐ The highest priority must be given to the cooperation of Baltic Sea states, including three Baltic republics, and development of the corresponding studies;
- ☐ A schedule for the gradual increase of oil shale price and electricity tariff to the level that would enable minimum required investments, municipalization (privatization) and augmentation of share capital must be made up.
- ☐ A system for the settlement of bad debts and accounts must be elaborated and presented to the Estonian government;
- ☐ Energy legislation, relations between authorities and energy companies, but also interrelations of the latter and principles of price formation for energy carriers in Finland, including possible implementation of theses principles in Estonia must be analyzed. Taking into account the need for complex handling of energy problems, to consider reasonable closer coordination and centralized financing of the above and other relevant studies by the corresponding commission (council) and foundation.

The future cooperation of the Estonian-Finnish joint working group mustbe continued and a meeting of the working group arranged in the nearest future for planning further activities.

ANNEX F
PROJECTED COST OF PRODUCTS OBTAINED FROM SHALE OIL

A report on the "Projected Cost of Products Obtained From Shale Oil" will be prepared by Sergei Krainiukov, Director of the Economics Division of the Oil Shale Research Institute in Kohtla-Järve. This report should be completed by March 1 and received in the United States by March 15. The report serves three objectives:

- To project the production cost in 1997 and 2000 of wood impregnating oil, fuel oil, and electrode coke. (These products now account for most of the production volume and most of the revenue from the oil shale processing complex of RAS Kiviter.)

- To determine whether the oil shale processing complex can increase its average revenue per ton of output by producing distillate fuel oil for sale in western Europe.

- To determine whether it is better (economically and environmentally) to produce a fuel oil for export or a fuel oil for domestic use.

The terms of reference for this study are shown on the following pages.

STATEMENT OF WORK FOR CONSULTANT

Consultant shall write a report, "Projected Cost of Products Obtained From Shale Oil." This report will contain projections of the cost of various shale oil products, in 1993 EEK per metric ton (and in 1993 USD per metric ton) of shale oil product. The following products will be evaluated:

- Wood impregnating oil
- Fuel oil "A", suitable for export
- Fuel oil for use in Estonia
- Distillate fuel oil, suitable for export
- Electrode coke

Other products may be added to this list by the Consultant but not by Hagler Bailly. For example, the Consultant may choose to include an analysis of products obtained from processing of pyrolysis oils.

Costs will be projected for 1997 and 2000. Costs must be estimated on the basis of production at RAS Kiviter facilities in Kohtla-Jarve. If the Consultant desires to estimate costs for other locations in Estonia (for example, at Kivioli or at a new location where no plant exists today), Consultant should assess the competitive position of RAS Kiviter in relation to other plants in Estonia.

For each product, costs will be projected under two scenarios:

Scenario A: Low Price of Shale. In this scenario, shale prices are kept to a minimum through improvements in mine technology and productivity. No new mines are opened unless they are capable of producing shale at a lower cost than existing mines. Expenditures on wastewater treatment and mine reclamation are minimized. Wages of miners are increased slowly, due to slow increases in wages in other Estonian industries.

Scenario B: Moderate Price of Shale. In this scenario, shale prices are increased to cover the full cost of environmental controls and wage increases. No new mines are opened unless they are capable of producing shale at a lower cost than existing mines. Wages of miners are increased rapidly, due to rapid increases in wages in other Estonian industries.

Where possible, assumptions used in these scenarios should match the assumptions used by Jaakko Poyry in at least one of their scenarios for oil shale cost projections. Although Jaakko Poyry will probably not use Scenarios A and B, it should be possible to use similar assumptions on the cost of explosives, fuel, and electricity.

Consultant shall also collect information on the price of each product for which costs are estimated, and shall compare prices and costs to develop indicators of the future profitability of each product. Consultant shall prepare a table showing prices in 1993 EEK

per ton and in 1993 USD per ton. If price information is very difficult to obtain for one or more products, Consultant is not required to obtain such information.

In the projection of production costs, Consultant shall state the assumptions regarding product specifications and technological processes required. These assumptions will be made by the Consultant.

The report will contain a discussion of the profitability of various products that are now produced at RAS Kiviter or could be produced at RAS Kiviter in the future. For each product for which costs are estimated, the report shall contain a comparison between prices and costs and a commentary that allows the reader to obtain a better understanding of the overall profitability of RAS Kiviter.

The report shall contain a chapter on "Conclusions and Recommendations." In this chapter, the consultant will give an opinion for each product, regarding:

- The likelihood that Estonia can produce the product at a reasonable profit.
- The type of research needed to demonstrate the feasibility of producing, storing, transporting, and selling the product.
- The next steps that should be taken by the Estonian Ministry of Economy to support investments needed to produce and sell the product.

The report will be translated into English and delivered to the USAID offices in Tallinn or to Hagler Bailly's offices in Virginia. The report must be completed and sent to USAID (or Hagler Bailly) no later than March 1, 1994.

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ANNEX G
ARTHUR D. LITTLE PRESENTATION
AT THE ESTONIAN-FINNISH JOINT SEMINAR

One of the papers presented at the Estonian-Finnish Joint Seminar on Development of the Estonian Energy Economy (Tallinn, September 23-24, 1993) addresses the question of how RAS Kiviter might alter the mix of products from the oil shale processing complex so that diesel fuel or other light products could be produced, rather than heavy fuel oil and wood impregnation oil. This paper was submitted by Arthur D. Little International, which recently conducted a study of *Restructuring and Privatization of the Chemical Industry of the Republic of Estonia*. The environmental assessment in the privatization study was presented to a steering committee in Tallinn on June 9, 1993. We assume that ADL's recommendations on diesel fuel production were therefore examined carefully by the Ministry of Economy.

According to this report, it would not be feasible to build a new oil shale processing plant the capacity of RAS Kiviter:

> Investments to build a 2 million t/a oil shale processing plant will reach 100-150 mill. US $. Payback of such an investment is hardly feasible.[1]

The report suggests that it would be feasible to modify the existing complex to produce a diesel fuel, but no investment cost is given and no source of funds is identified.

We agree with the basic hypothesis that RAS Kiviter should produce oil products that are more valuable than heavy fuel oil, but we would make the following comments on the ADL presentation:

1. The first and most urgent task for RAS Kiviter is to try to sell the products that RAS Kiviter already produces or has the capability to produce. This is more urgent than trying to develop new products based on research and development (the course recommended by ADL).

2. The economic feasibility of RAS Kiviter should be evaluated on the basis of all four operating divisions, not just the oil shale processing complex.

3. From 1929 to 1934 Estonia was an exporter of gasoline ("motor petrol") made from oil shale. On the basis of the historical achievements of the Estonian oil shale industry it is reasonable to assume that the most cost-effective investment would provide Estonians with the capital they need to solve the technical problem of producing light products or more valuable products from oil shale. It is not

[1] See page 9.

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reasonable to suggest that Estonian oil shale technology development should be managed by western Europeans or other foreigners.

4. The statement that a transportation cost of $33 per ton should be subtracted from "world market value at Rotterdam" (page 11) is not credible. This transportation margin is excessive.

5. ADL's suggestion that higher value products need to be exported is incorrect. It would be desirable for the government of Estonia to set sulfur emission tax or whatever regulations are needed to make the price of low-sulfur fuel oil produced in Estonia equal to the price of low-sulfur fuel oil imported from western Europe. This simple step would probably eliminate the need to export any type of fuel oil.

In short, we do not agree with many of the statements in the ADL presentation, but we believe that this presentation makes an important contribution to the policy debate over the future of RAS Kiviter.

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Shale Oil Processing in the Republic of Estonia

Tallinn,
September 24, 1993

Arthur D. Little
International

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Shale Oil Processing

KFW/w 1411

Currently Estonian shale oil competes successful on the world market, but to ensure long-term substainability further investments are required

- 10-20 % of the annual shale production is used in oil shale processing
- Shale oil resembles heavy fuel oil, a high boiling crude fraction
- Currently two companies are processing shale oil on sizeable scale
- The current raw material price for shale rock at 39 EEK/t (3 US $/t) allows for a profitable operation
- Long-term sustainability of shale oil refining requires detailed assessment of all processing steps
- Every step has to be fitted into a processing program meeting the requirements of an integrated energy master plan

Arthur D Little

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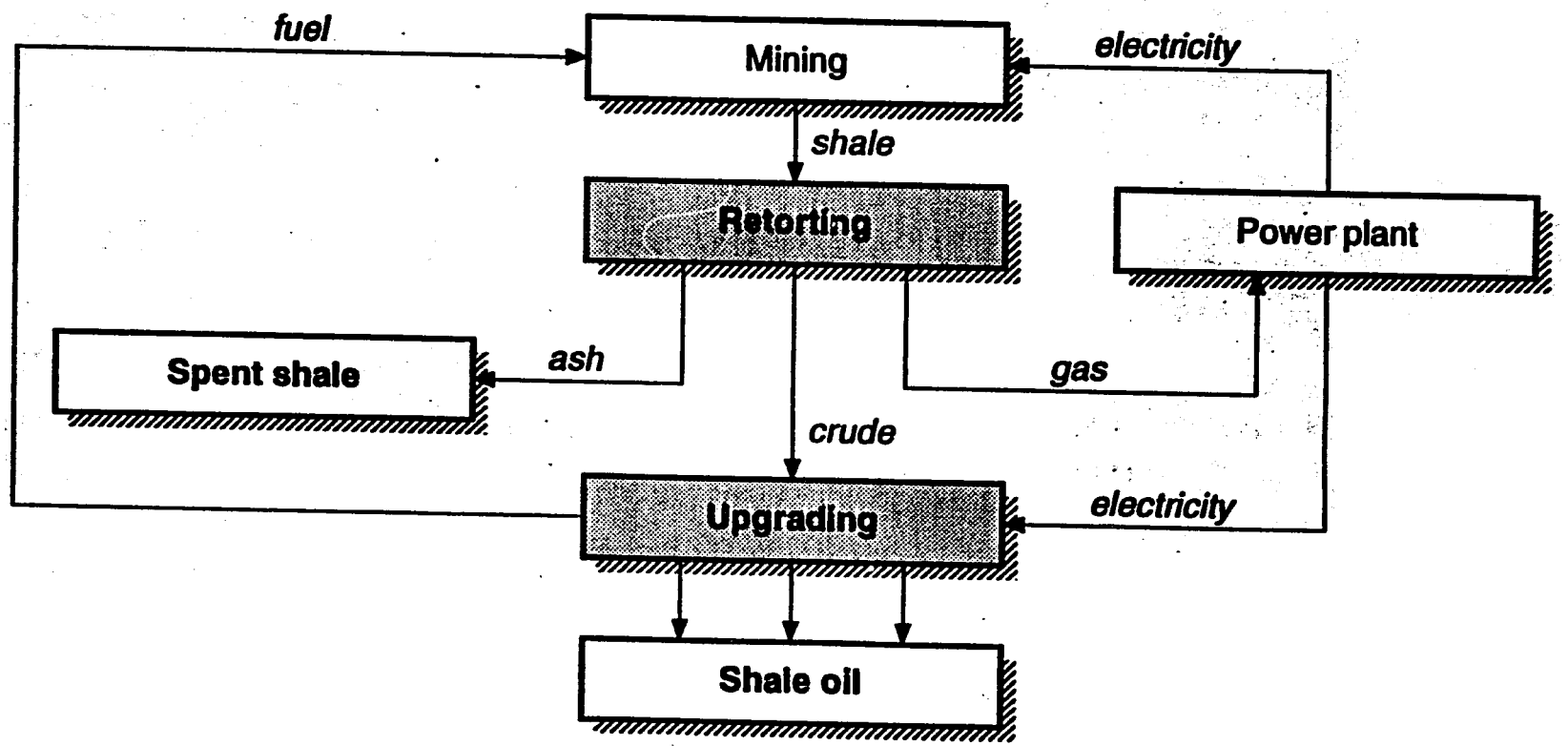
Shale Oil Processing

Oil shale processing requires a complex infrastructure of different operations and processing steps. Retorting and upgrading are only two steps among others and require 10-20 % of annual shale production



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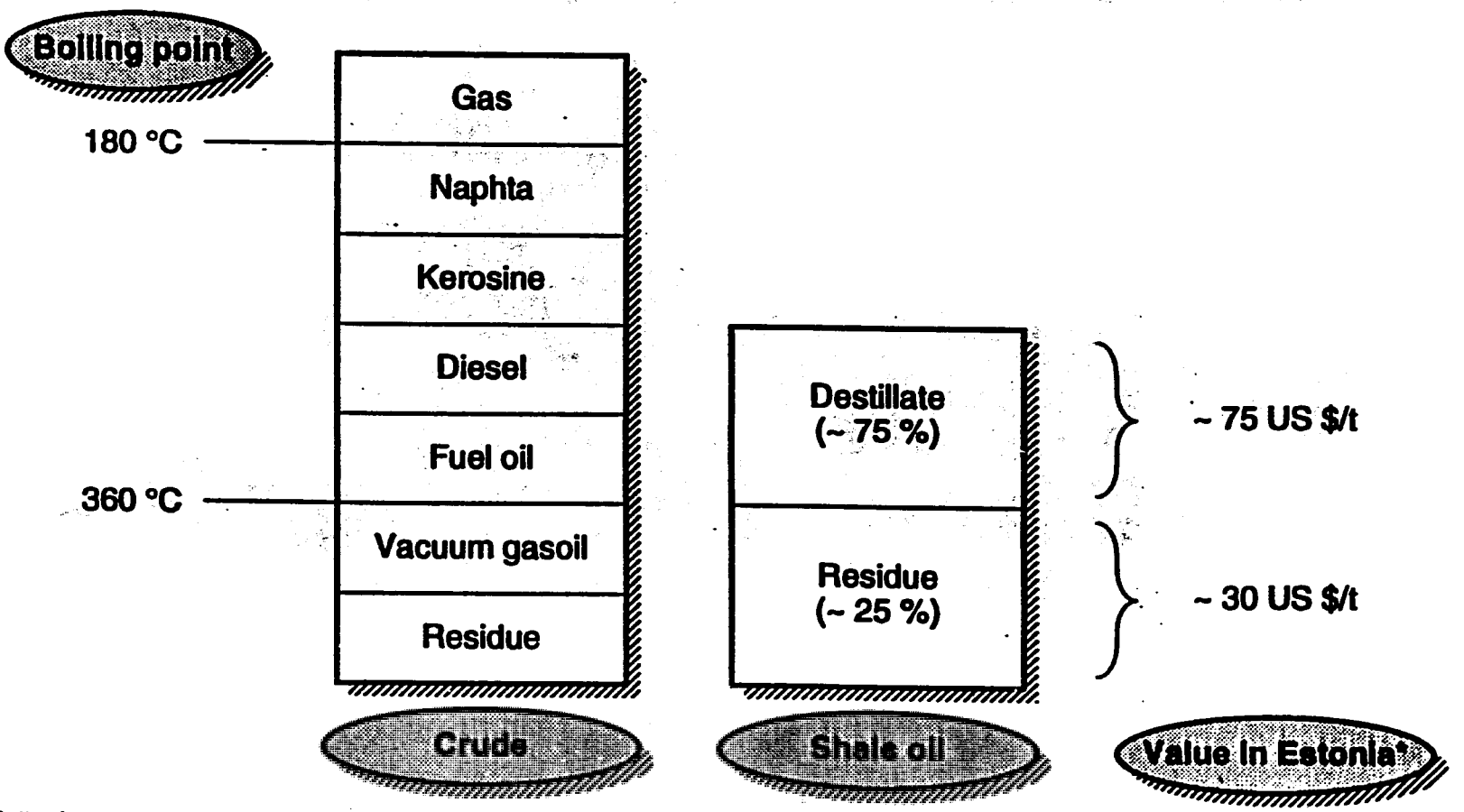
KFWw 1413

Shale oil differs from crude by its lack of low boiling fractions. Therefore shale oil processing has a disadvantage in comparison to natural oil



* Rotterdam . / . transportation (product flow line east → west)

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KPWw 1414

Currently two companies are processing shale oil - Kiviöli and Kohtla Järve. The technology base is similar, the product range is broader at Kohtla Järve

Shale Oil

Kiviöli

- S 1-Oil
- Shale Road Oil
- Shale Bitumen
- Kukersool

➡ 63,500 t processed in 1992

➡ 36.2 mill. EEK turnover

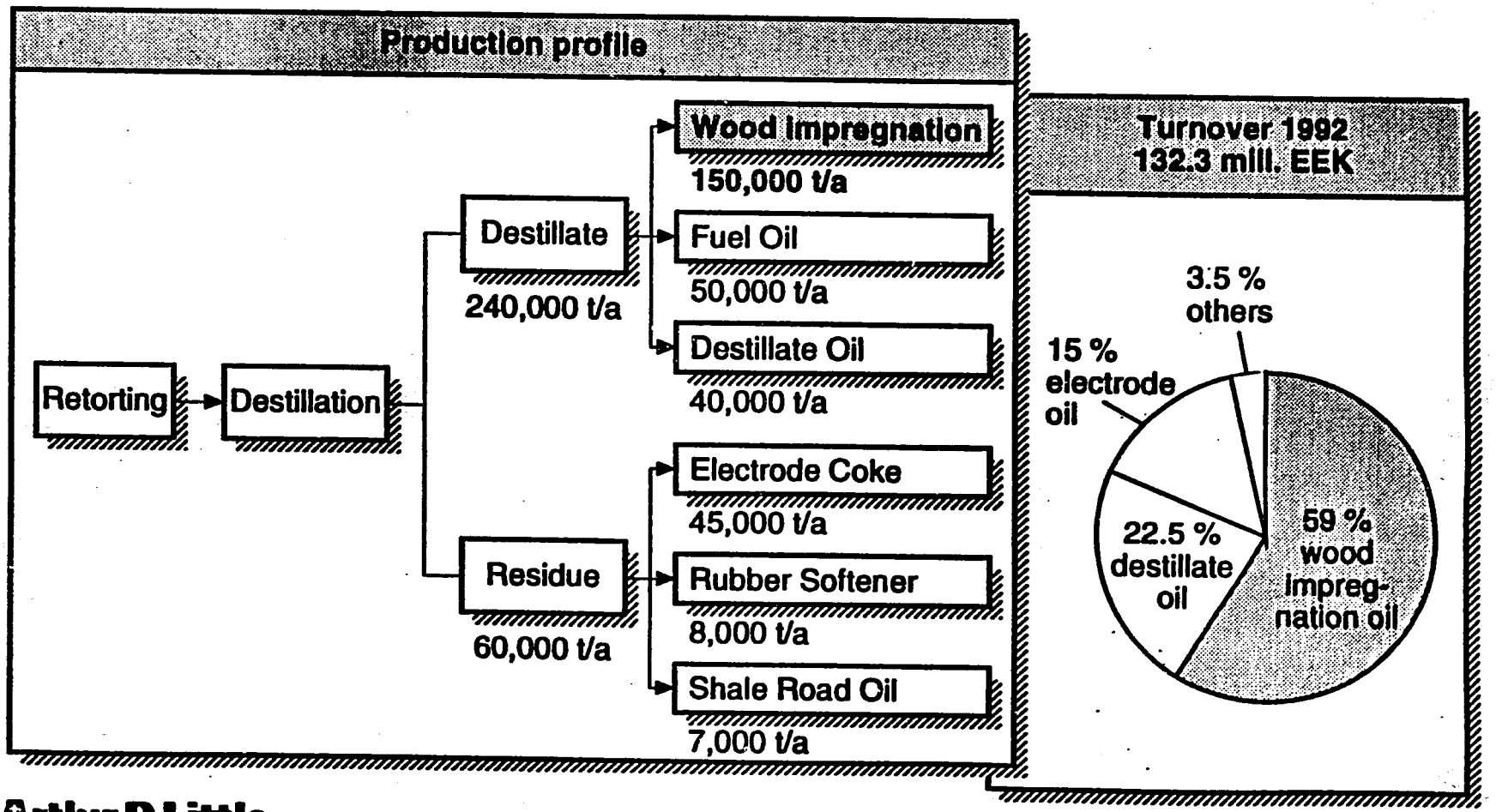
Kohtla Järve

- Wood Impregnation Oil
- Fuel Oil
- Rubber Softener
- Destillate Oil
- Electrode Coke
- Shale Road Oil

➡ 300,000 t processed in 1992

➡ 132.3 mill. EEK turnover

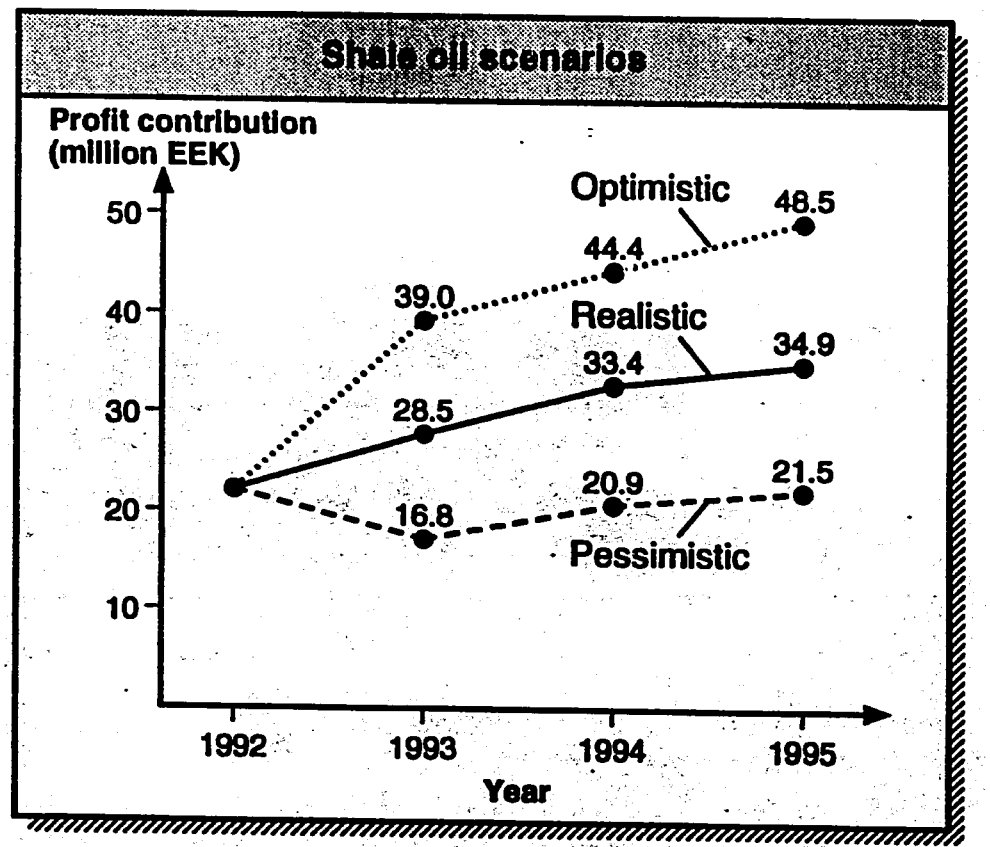
Pölevkivikeemia's major product is wood impregnation oil, a heavy fuel oil with low sulphur content and a viscosity premium



Arthur D Little

KFWw 1416

Current shale rock price of 39 EEK/t (~ 3 US $) allows for a profitable operation, but . . .



- Prices are supposed to remain stable
- The PC 3 of the scenarios result from different outputs
- Utilisation (330,000 t/a = 100 %)
  - Optimistic: 75-80 %
  - Realistic: 60-65 %
  - Pessimistic: 50-55 %
- Profitability of the shale oil operation is highly dependent on labour cost and shale rock price

Arthur D Little

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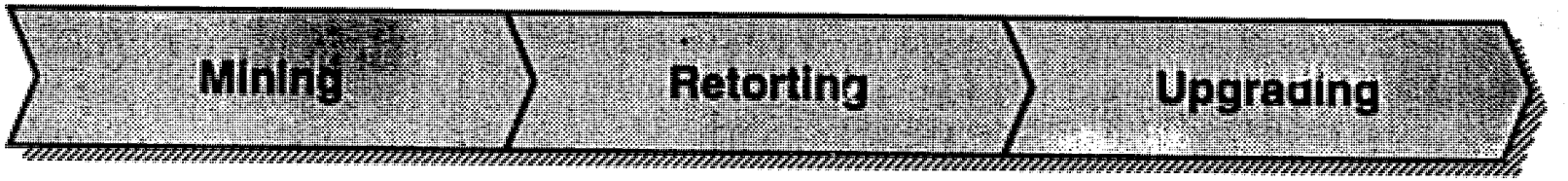
KFWc 1417

. . . to ensure long-term sustainability of shale-oil refining a detailed assessment of all processing steps is required



Mining

Cost of mining has to be investigated. Low mining cost may be achieved by

- new equipment
- selecting profitable mining sides
- build up new mining structure

Retorting

Introduction of new retorting technology may result in

- higher yields
- better quality
- lower energy costs
- fewer environmental damage

Upgrading

Introduction of upgrading processes will

- maximize value-added of all fractions
- provide a product in demand in the Baltic

➡ Every step has to be fitted into a processing program meeting the requirements of an integrated Estonian energy master plan

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KPWhr 1418

The price for shale is crucial to the profitability of all following shale-oil operations

Mining

- Mining costs are closely related to equipment favoring large, powerful equipment
- Blasting costs are dominated by the used explosive, usually a mixture of NH_4NO_3 and fuel oil
- Handling costs will be inccured for loading and transporting the shale rock from the mining site. Depending on the local situation different systems (conveyor belt, trucks . . .) may be more economic
- Crushing costs have to be assessed, taking into account that every retort technology needs a special particle size. Several crushers are available
- New transportation equipment and infrastructure may save considerable money

KFW/w 1419

Improved retorting technology could have a major effect on the economy of shale-oil refining

Retorting

- A wide variety of shale retorting technologies are available (Lurgi Ruhrgas Retorts, Tosco II Retorts or ATP retorts)

- ATP retorting technology is in operation in Australia on a small scale demonstration plant. This technology has several advantages
  - Yield is up to 20 % (ø 15.5 % right now)
  - Product quality improved
  - Better use of energy. Retorts are self-sustaining and provide additional energy
  - Environmental problems can be solved avoiding the dump of polluted ashes

- Investments to build a 2 mill. t/a oil shale processing plant will reach 100-150 mill. US $. Payback of such an investment is hardly feasible

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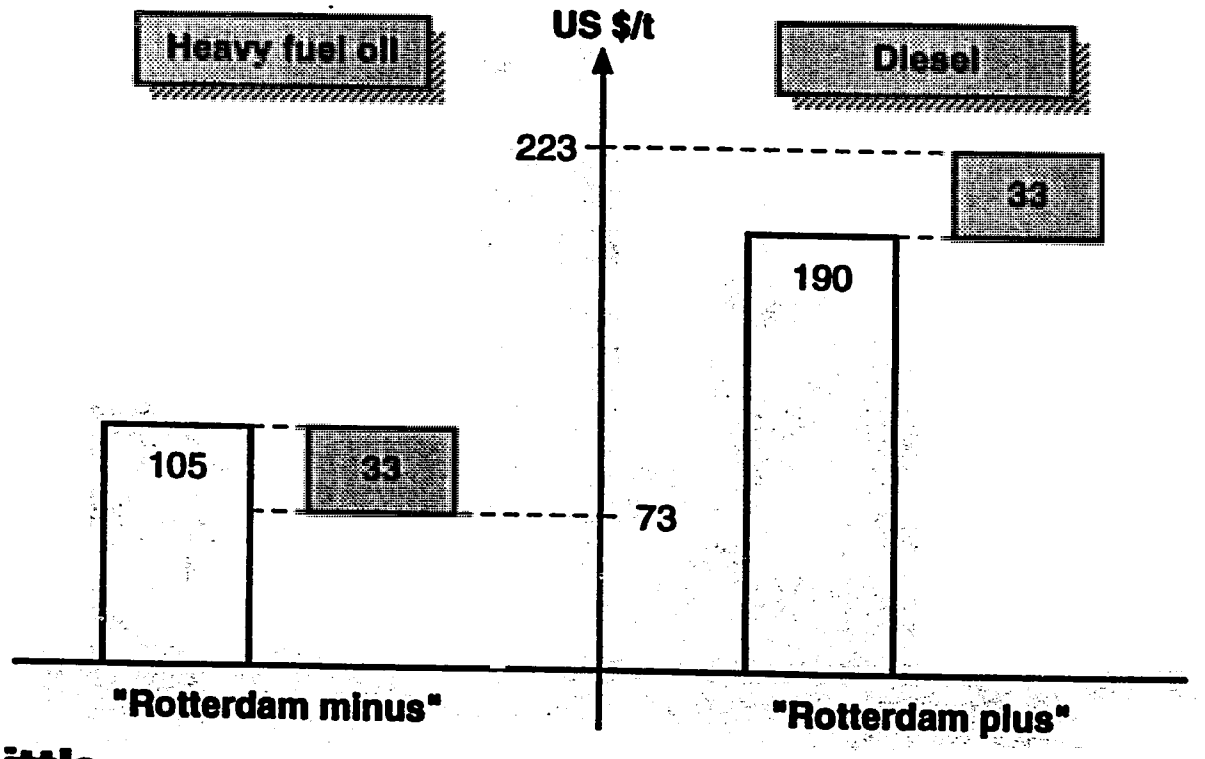
KFWiw 1420

Not only the value-added is maximized by saving the "quality give away" but also the inversal of the product flow line for light products allows a higher margin

Upgrading



Arthur D Little

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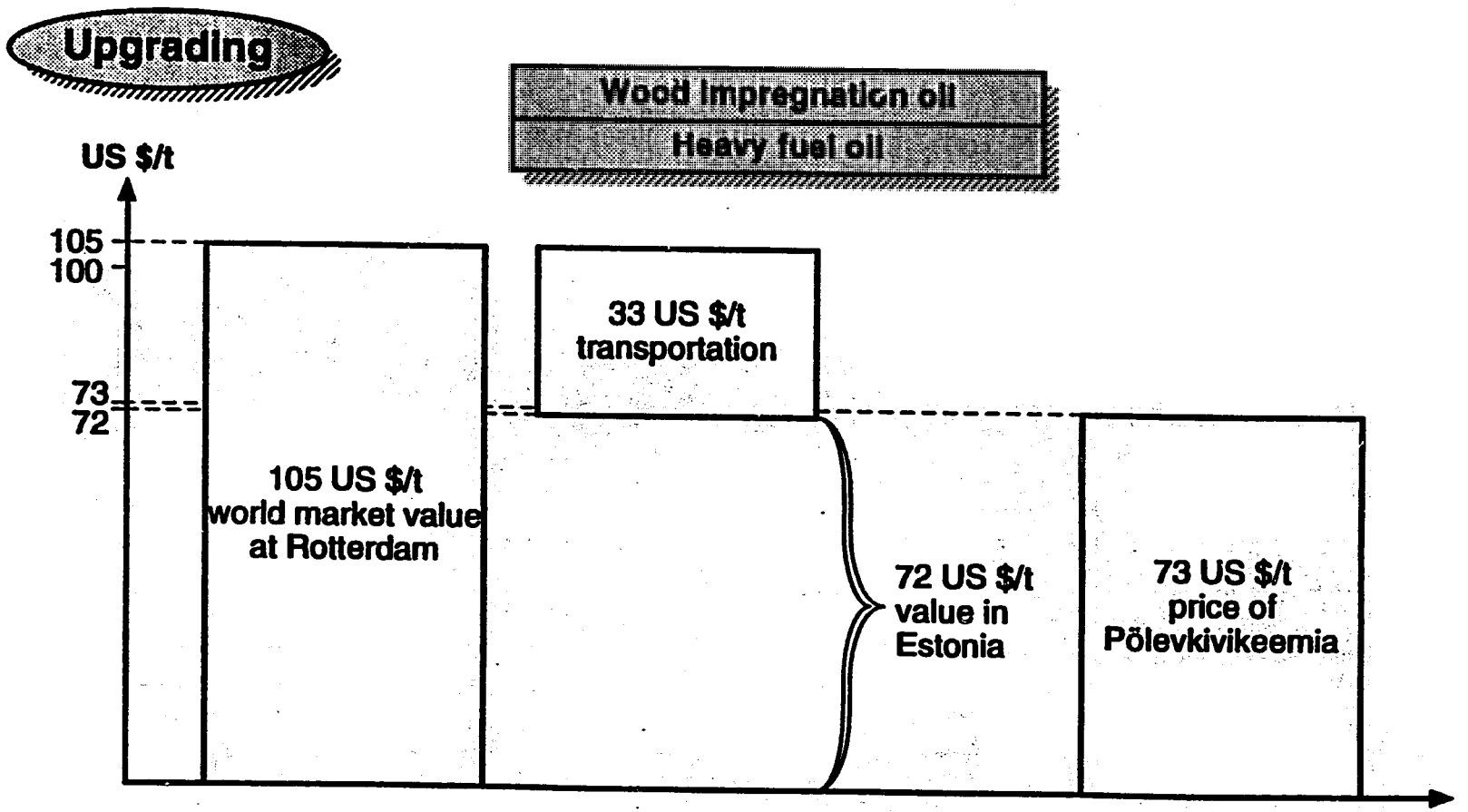
KFWw 1421

The current pricing of fuel oil reflects the value of the product along the product flow line



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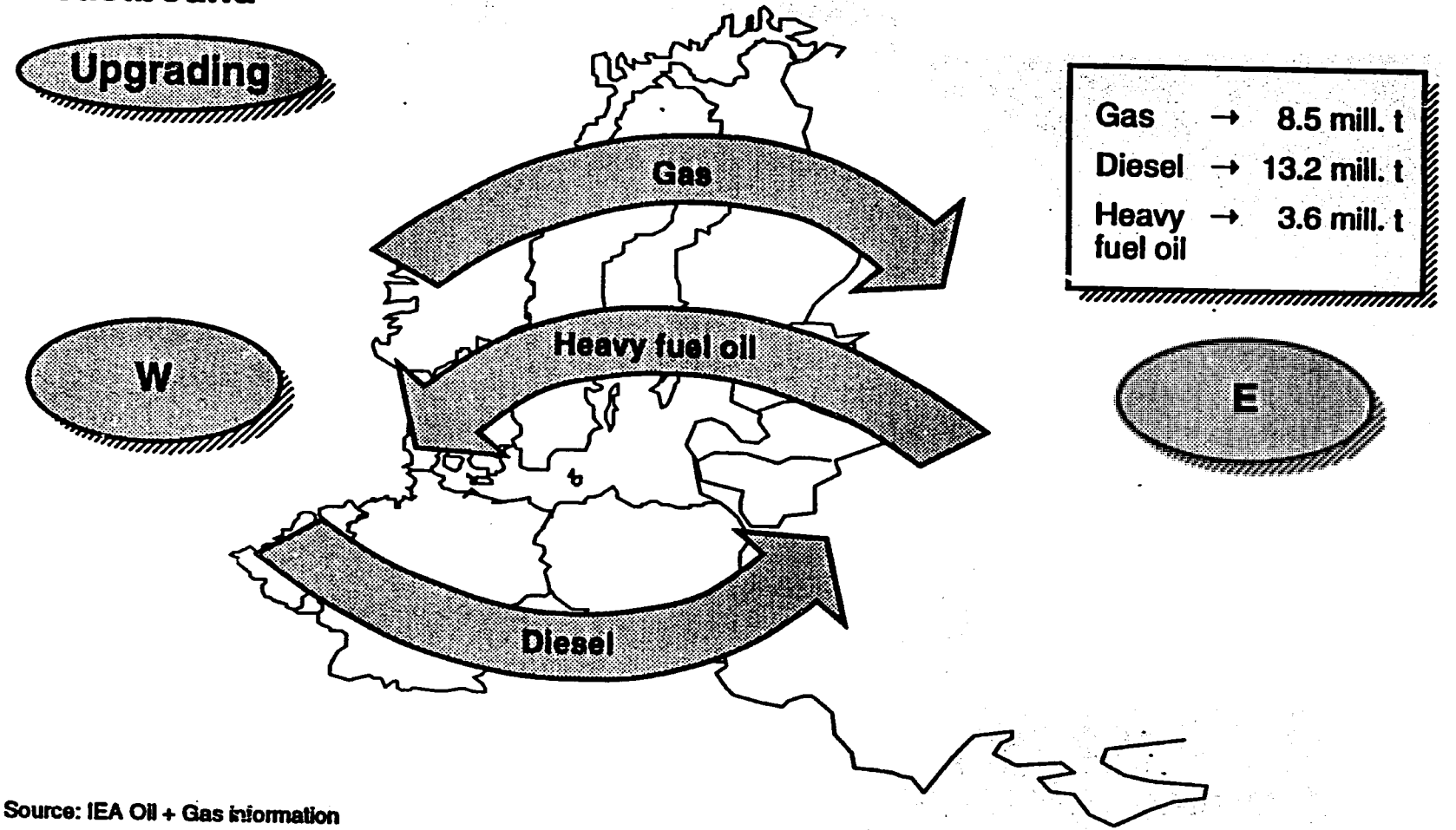
KFWw 1422

Heavy fuel oil flows from east to west, while the product flow-line of diesel is eastbound



Source: IEA Oil + Gas information

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KPWw 1423

The upgrading of shale oil to diesel requires rectification and hydrogenation. Hydrogen supply on site will prove to be difficult and requires sizeable investment

Upgrading

Diesel processing

Rectification

- Seperation of both fractions is possible*
- The diesel fraction will yield 50 %
- With little adjustment even the BTX-rectification column may be used for rectification

Hyrogenation

- Due to the characteristics of the diesel fraction a hydro raffination is needed
- High oxygen content of Estonian shale oil is causing severe problems, up to now hydrogenation has not been successful in lab-scale
- Research is done on this field at the chemical institute at Tallinn

* Source: Hydrierwerke Zeitz

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