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## **CALORIFIC VALUE AND AMOUNTS OF OIL SHALE DELIVERED TO POWER PLANTS FROM MINES AND OPENCASTS IN 1968-1997**

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*The paper provides the information about the fuel supply of Estonian oil shale fired power plants over the years 1968-1997. The data about the amounts and calorific value (as determined in the calorific bomb) of oil shale delivered to Estonian power plants by mines and opencasts are presented.*

Effectiveness and reliability of oil shale fired power plants are depending on oil shale quality, especially on its calorific value. The average calorific value of oil shale consumed by power plants depends on the quality and quantity of fuel supplied by mines and opencasts and has been changing over the years. The retrospective investigation of calorific value of oil shale delivered to power plants by different suppliers of fuel (mines and opencasts) allows to give some forecast on the expectable changes in fuel quality for the nearest future. Such a forecast will favor the activities on planning fuel supply and exploitation of power plants.

Oil shale for power production has been delivered since 1968 to Estonian power plants from twelve mines and four opencasts, situated in the region of the Baltic oil shale deposit. Three of them are situated in Leningrad district (Russia), the others in Estonia. Due to exhaustion of oil shale resources the following mines were closed: *Käva-2* (in 1972), No. 2 (in 1973) and No. 3 (in 1975), in which high-quality fuel for power production was mined.

Baltic Power Plant and Estonian Power Plant have been the biggest consumers of oil shale over the years. Oil shale for power production has been delivered to Baltic Power Plant and Estonian Power Plant totally by twelve mines and four opencasts (Figs 1 and 2).

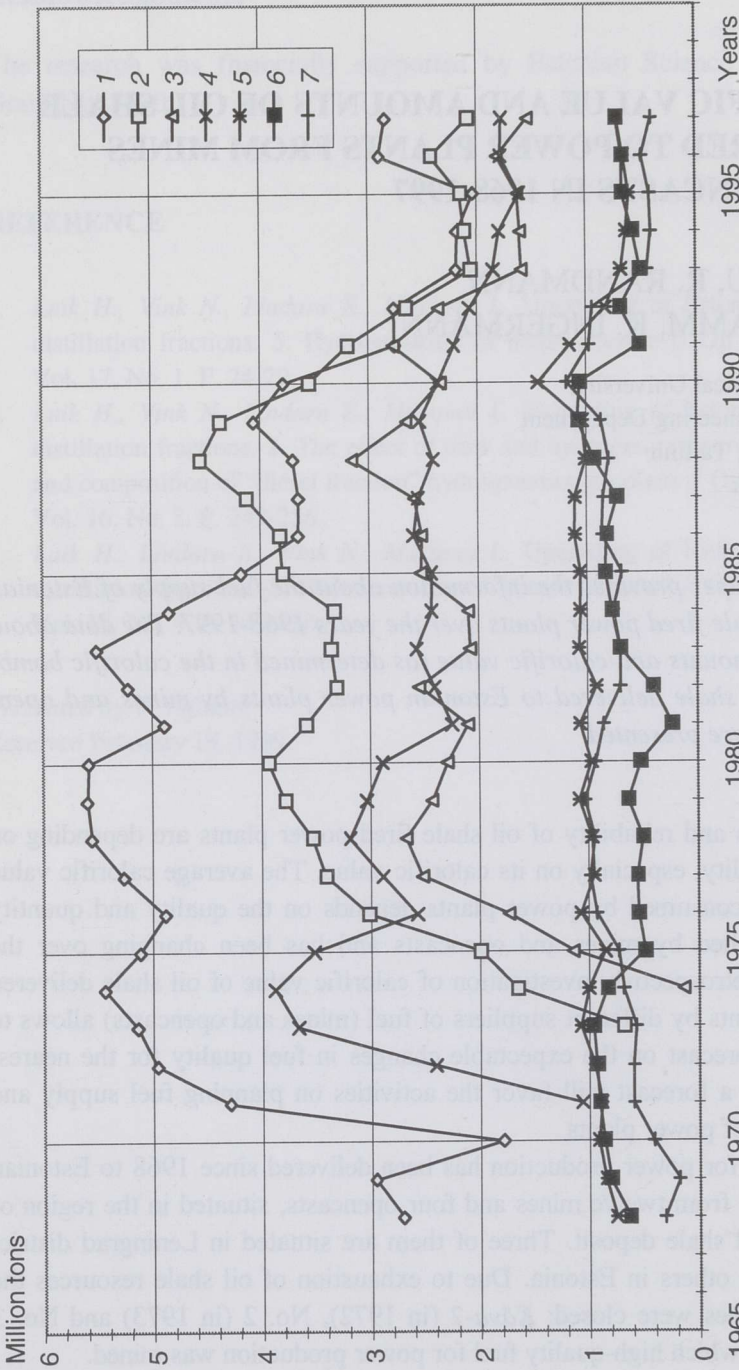


Fig. 1. The amounts of oil shale delivered yearly by mines and opencasts to Baltic Power Plant and Estonian Power Plant. Legend: 1 – *Sirgala* opencast, 2 – *Estonia* mine, 3 – *Aiduna* opencast, 4 – *Narva* opencast, 5 – *Tammiku* mine, 6 – *Viru* mine, 7 – *Ahtme* mine

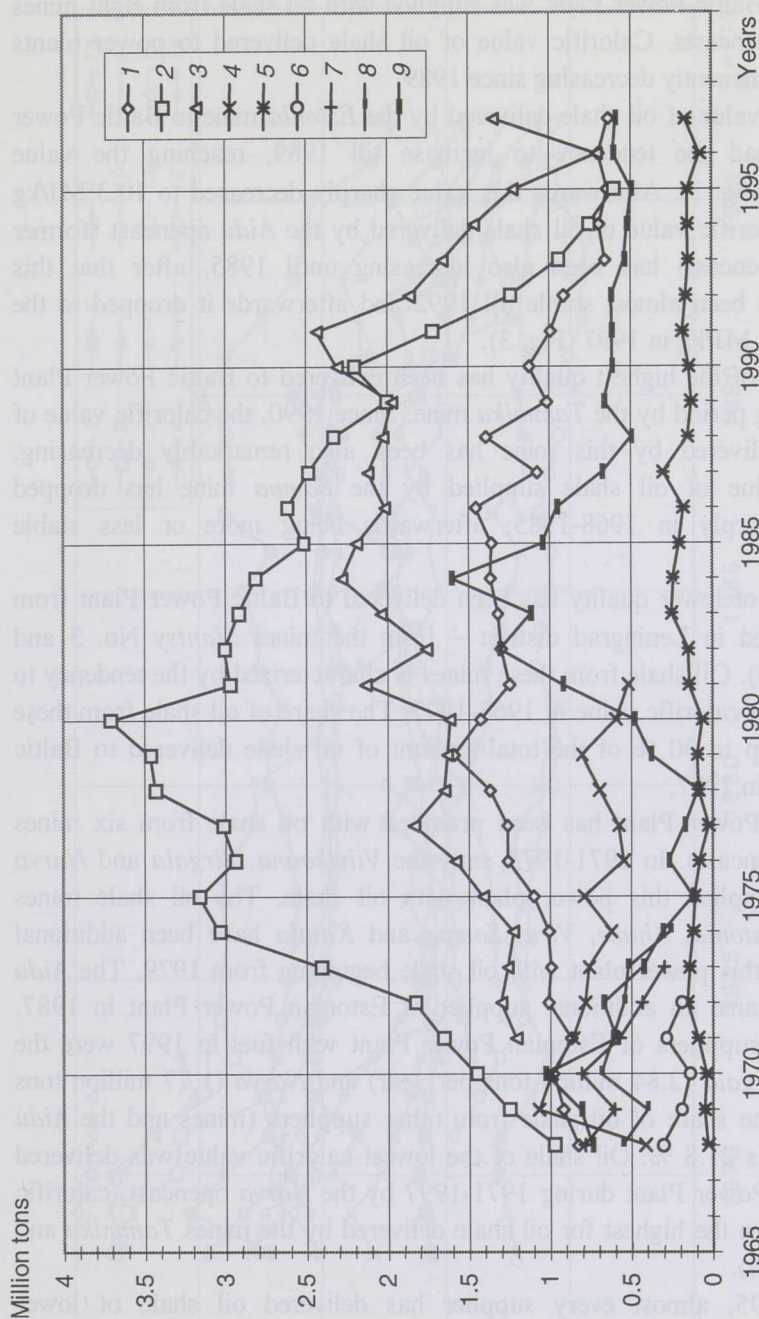


Fig. 2. The amounts of oil shale delivered yearly by mines and opencasts to Baltic Power Plant and Estonian Power Plant. Legend: 1 – Kohila mine, 2 – Viivikonna opencast, 3 – Leningrad mine, 4 – Slantsy mine No. 3, 5 – Kirov mine, 6 – Käva-2 mine, 7 – mine No. 2, 8 – mine No. 4, 9 – Sompä mine

In 1997, Baltic Power Plant was supplied with oil shale from eight mines and three opencasts. Calorific value of oil shale delivered to power plants has been permanently decreasing since 1989.

Calorific value of oil shale delivered by the *Estonia* mine to Baltic Power Plant has had the tendency to increase till 1989, reaching the value  $\approx 12$  MJ/kg (Fig. 3). Afterwards this value sharply decreased to 10.3 MJ/kg in 1997. Calorific value of oil shale delivered by the *Aidu* opencast (former *Oktoobri* opencast) has been also increasing until 1985, after that this indicator has been almost stable till 1992 and afterwards it dropped to the value of 10.3 MJ/kg in 1997 (Fig. 3).

Oil shale of the highest quality has been delivered to Baltic Power Plant during a long period by the *Tammiku* mine. Since 1990, the calorific value of oil shale delivered by this mine has been also remarkably decreasing. Calorific value of oil shale supplied by the *Sompa* mine has dropped relatively sharply in 1968-1985; afterwards being more or less stable (Fig. 3).

Oil shale of lower quality has been delivered to Baltic Power Plant from mines situated in Leningrad district – from the mines *Slantsy* No. 3 and *Kirov* (Fig. 3). Oil shale from these mines is characterized by the tendency to have lowering calorific value in 1968-1997. The share of oil shale from these mines was up to 30 % of the total amount of oil shale delivered to Baltic Power Plant in 1997.

Estonian Power Plant has been provided with oil shale from six mines and four opencasts. In 1971-1978, only the *Viivikonna*, *Sirgala* and *Narva* opencasts supplied this power plant with oil shale. The oil shale mines *Tammiku*, *Estonia*, *Ahtme*, *Viru*, *Sompa* and *Kohtla* have been additional suppliers of this power plant with oil shale beginning from 1979. The *Aidu* opencast became an additional supplier of Estonian Power Plant in 1987. The biggest suppliers of Estonian Power Plant with fuel in 1997 were the opencasts *Sirgala* (2.84 million tons per year) and *Narva* (1.77 million tons per year). The share of oil shale from other suppliers (mines and the *Aidu* opencast) was 21.8 %. Oil shale of the lowest calorific value was delivered to Estonian Power Plant during 1971-1997 by the *Narva* opencast, calorific value has been the highest for oil shale delivered by the mines *Tammiku* and *Kohtla* (Fig. 4).

Since 1995, almost every supplier has delivered oil shale of lower quality; in some cases the decrease in shale calorific value has been quite sharp. It may be caused by less fastidious demands of power plants presented to the fuel suppliers.

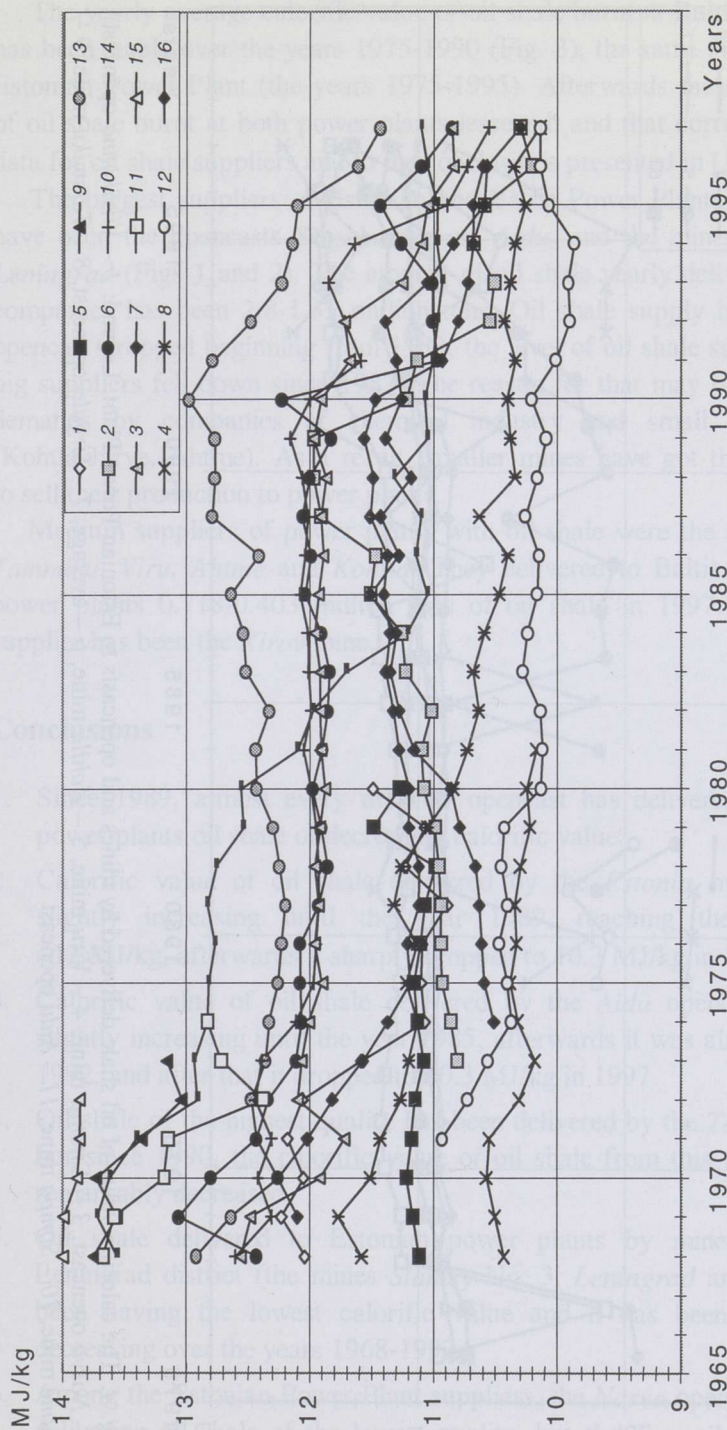


Fig. 3. The calorific value of oil shale delivered by mines and opencasts to Baltic Power Plant. Legend: 1 – Viivikonna opencast, 2 – Estonia mine, 3 – Kohtla mine, 4 – Slantsy mine No. 3, 5 – Sirgala opencast, 6 – Ahtme mine, 7 – Aidu opencast, 8 – Kirov mine, 9 – mine No. 2, 10 – Viru mine, 11 – mine No. 4, 12 – Leningrad mine, 13 – Tammiku mine, 14 – Sompä mine, 15 – Käva-2 mine, 16 – average

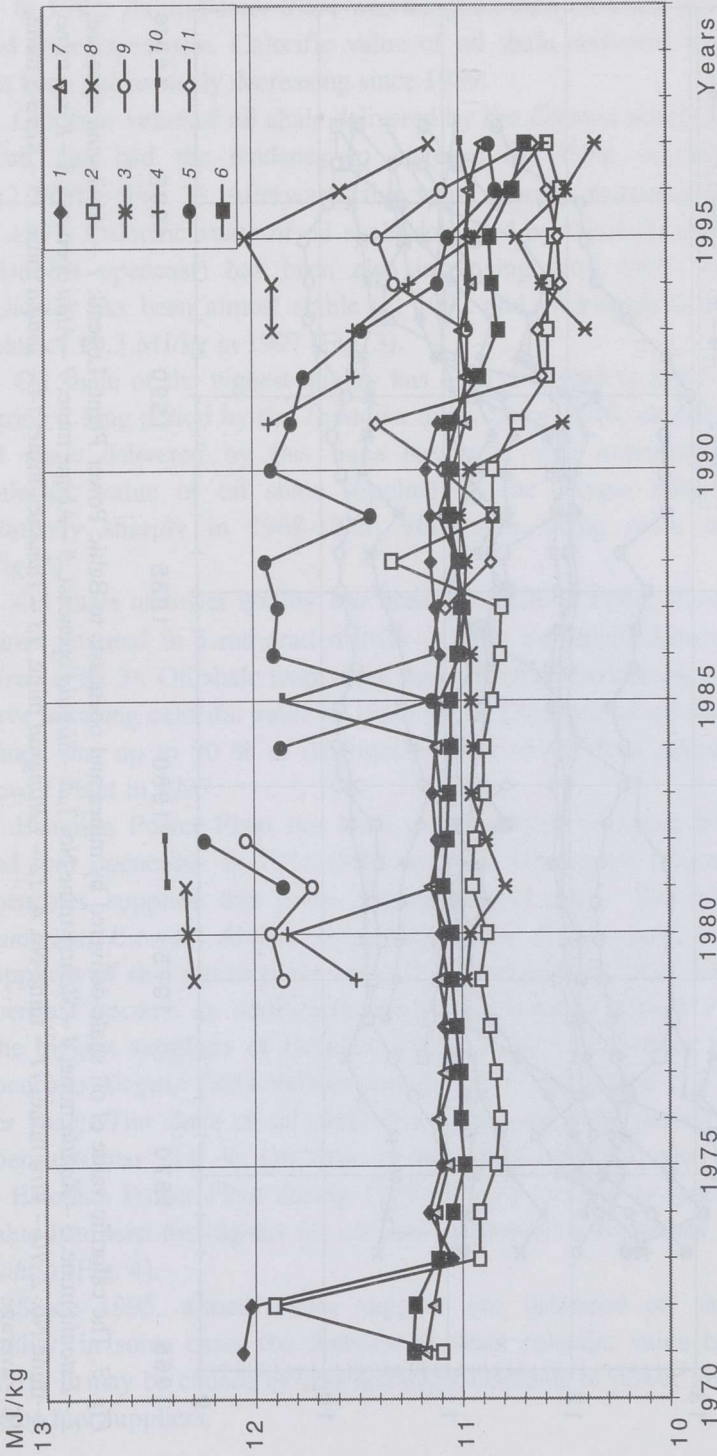


Fig. 4. The calorific value of oil shale delivered by mines and opencasts to Estonian Power Plant. Legend: 1 – Viivikonna opencast, 2 – Narva opencast, 3 – Estonia mine, 4 – Viru mine, 5 – Kohila mine, 6 – average, 7 – Sirgala opencast, 8 – Tammiku mine, 9 – Ahtme mine, 10 – Sompma mine, 11 – Aidu opencast

The yearly average calorific value of oil shale burnt at Baltic Power Plant has been stable over the years 1975-1990 (Fig. 3), the same is valid also for Estonian Power Plant (the years 1975-1995). Afterwards the calorific value of oil shale burnt at both power plants lessened, and that corresponds to the data for oil shale suppliers and to the conclusions presented in [1].

The biggest suppliers of Estonian and Baltic Power Plants with oil shale have been the opencasts *Sirgala*, *Narva*, *Aidu*, and the mines *Estonia* and *Leningrad* (Figs 1 and 2). The amount of oil shale yearly delivered by these companies has been 2.8-1.35 million tons. Oil shale supply by the *Sirgala* opencast dropped beginning from 1983, the level of oil shale supply by other big suppliers fell down since 1987. The reason for that may be reduced fuel demands by companies of chemical industry and small power plants (Kohtla-Järve, Ahtme). As a result, smaller mines have got the opportunity to sell their production to power plants.

Medium suppliers of power plants with oil shale were the mines *Sompa*, *Tammiku*, *Viru*, *Ahtme* and *Kohtla*. They delivered to Baltic and Estonian power plants 0.718-0.403 million tons of oil shale in 1997. The smallest supplier has been the *Kirov* mine.

## Conclusions

1. Since 1989, almost every mine or opencast has delivered to Estonian power plants oil shale of decreasing calorific value.
2. Calorific value of oil shale delivered by the *Estonia* mine has been slightly increasing until the year 1989, reaching then the value  $\approx 12$  MJ/kg, afterwards it sharply dropped to 10.3 MJ/kg in 1997.
3. Calorific value of oil shale delivered by the *Aidu* opencast has been slightly increasing until the year 1985, afterwards it was almost stable to 1992, and after that it dropped to 10.3 MJ/kg in 1997.
4. Oil shale of the highest quality has been delivered by the *Tammiku* mine, but since 1990, the calorific value of oil shale from this mine has also remarkably decreased.
5. Oil shale delivered to Estonian power plants by mines situated in Leningrad district (the mines *Slantsy* No. 3, *Leningrad* and *Kirov*) has been having the lowest calorific value and it has been permanently decreasing over the years 1968-1997.
6. Among the Estonian Power Plant suppliers, the *Narva* opencast has been delivering oil shale of the lowest quality, but the *Tammiku* and *Kohtla* mines have been delivering oil shale of the highest quality.

7. Since 1995, almost every supplier has delivered oil shale of decreasing calorific value. It may be caused by less fastidious demands of power plants to the fuel suppliers and increasing number of power generation units working at power plants in underload conditions.
8. The biggest suppliers of Baltic Power Plant and Estonian Power Plant with oil shale have been the *Sirgala* opencast, the *Estonia* mine, the *Narva* opencast, the *Aidu* opencast and the *Leningrad* mine. The delivered yearly amounts of oil shale were in the range of 2.8-1.35 million tons.
9. The yearly amounts of oil shale delivered to power plants by the mines *Sompa*, *Tammiku*, *Viru*, *Ahtme* and *Kohtla* have been medium ones, the amounts ranging from 0.718 to 0.403 million tons per year in 1997.

## REFERENCE

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