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HISTORICA

60 YEARS OF THE ESTONIAN ENERGY RESEARCH INSTITUTE

Ü. RUDI

Estonian Energy
Research Institute
Tallinn, Estonia

The Estonian Energy Research Institute has passed a complicated way of development during the 60 years of its activities. Different political and scientific factors have excised their impact on the development at different times. The beginning of the scientific activities dates back to the times when the first research institute outside universities was established as the Natural Resources Research Institute by the decree of the Head of the State Konstantin Päts in 1937 with the objective to develop applied research work in the field of the implementation of domestic mineral resources. In spite of several changes in the name and organisational and research structure of the Institute throughout the years of development, the research work has mainly been centred on the most important Estonian mineral resource - Estonian oil shale. Scientists of the Institute have given their significant share to the emergence and development of the oil shale power engineering, oil shale chemistry, and shale oil industry in Estonia.

The Estonian Energy Research Institute is the oldest national science institution with its history dating back to the year 1937 when on 3 July the Natural Resources Research Institute (NRRI) was established by the decree of the Head of State.

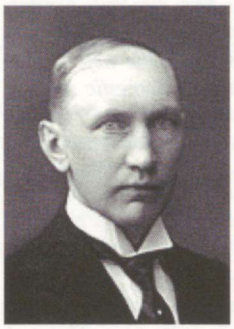
However, the Institute's functions commenced at the Special Assembly Meeting, held on 9 November 1937, in the premises of Tallinn Technical University at Kopli. The presence of K. Päts, several members of the government, numerous invited guests and journalists emphasized clearly the significance of the event.

Public authorities at the opening ceremony of the Institute: from the left: N. Viitak, Minister of Transport; A. Jaakson, Minister of Education; K. Päts, Head of State; K. Selter, Minister of Economy; O. Kask, Minister of Social Affairs

For the current work of the Institute, the Full Assembly elected the Council of 14 members. The right to nominate the chairman of the Council and the director of the Institute rested with the Head of the State. The members of the Council were not allowed to be elected among the employees of the Institute. The members of the Full Assembly formed 10 sections according to specialities and the current work was carried out in these sections, including:

1. Section of Geology and Pedology (Prof. J. Kark)
2. Section of Meteorology, Climatology and Hydrology (Prof. K. Kirde)
3. Biology Section (Prof. T. Lippmaa)
4. Forestry Section (Prof. A. Mathiesen)
5. Section Oil Shale Research (P. Kogerman)
6. Section of Peat Research (J. Hüsse, D.Sc.)
7. Section of Building Materials (Prof. O. Maddison)
8. Section of Inorganic Chemical Technology (Prof. E. Jaakson)
9. Section of Organic Chemical Technology (Prof. J. Kopvillem)
10. Section of Companies' Organisational Structure and Rationalisation (N. Viitak, D.Eng.).

However, under the name of the Natural Resources Research Institute, this institution could function only for a short time.



Academician Paul Kogerman who established the school of oil shale power engineering, Chairman of the first Council of the Institute

After the 1940 summer coup, like many other public organisations, the Institute was subject to **reorganisation**, implying that the organization prevailed, but the name and administration were replaced. In September 1940, the NRRI was transferred under the control of the ESSR People's Comissariat of Light Industry and the Institute was renamed to the Institute of Industrial Technology, then renamed again and became the Institute of Industrial Research (IIR), the first director Richard Mahl, later Jüri Annuson.

Johannes Hüsse, DPh (Nat.), the first director of the Institute in 1937-40

Under German occupation, though influenced by the war, the IIR pursued research within its scope, and its personnel remained almost the same.

In Leningrad, by the decree of the Government of the ESSR of 28 June 1944, the Central Institute of Industry Research of the ESSR (CIIR) (Director Oskar Kirret) was established. The CIIR was claimed the legal successor of the IIR, and the premises, laboratory equipment and other assets of the latter were transferred to the ownership of the CIIR.

In 1946, when the Academy of Sciences was reestablished, the CIIR, under the name of the Institute of Industrial Affairs of the ESSR Academy of Sciences, became its first institution.

Since energy research was the main activity of the CIIR, in 1952 it was renamed the Institute of Energy Research (IER) of the ESSR Academy of Sciences. In the 1960s, a campaign was launched in the Soviet Union, to separate engineering research institutes from under the Academy of Sciences. In 1963, the IER became the Institute of Thermophysics and Electrophysics (ITPhE) of the ESSR Academy of Sciences, thus remaining surbordinated to the Academy of Sciences. In the same year Lembit Vaik was appointed director of the Institute.

Under this name, the Institute functioned for thirty years. However, after the restoration of independence in Estonia, upon the decision of the Scientific Council of the Institute, the former name was adopted - the Institute of Energy Research of the Academy of Sciences, which complies with its main research trends. In 1987-1994 Paul Tamkivi managed the Institute. By the decree of the Government from 21 July 1995, the new Statutes of the Institute were approved. According to the Statutes, the Institute of Energy Research is a public scientific institution under the administration of the Ministry of Culture and Education (presently the Ministry of Education) as an independent non-profit public legal entity.

From 1994 till April 1997 late Harri Käär was the director of the Institute. After his decease Ülo Rudi was appointed executive director of the Institute.

During the years under the control of the Academy of Sciences, our Institute was a "donor" institution for several research institutes. Several laboratories and departments of the Institute acceeded to the Institute of Geology, Institute of Chemistry, Institute of Construction and Architecture, Institute of Cybernetics. At the same time opposite changes have occured. Since November 1996, the Institute's name is Estonian Energy Research Institute. This name, tenth in succession, clearly specifies the scope of the activities of the EERI.

The last swarming time was 1990 when the Institute of Ecology and Marine Research separated and the Institute of Energy Research became the centre of only technical sciences.

The Institute has preserved its rather heterogeneous scope of scientific interests from the beginning up to now. During the existence of the Institute, numerous investigations have been conducted in the field of oil shale, posphorites and peat research, applied physics, chemical technology, plasma technology, laser technology, aeromechanics, electrical engineering, thermal and electrical power engineering and energy economy. But the main research trends have always been connected with oil shale and oil shale power engineering.

Oil shale, the basic mineral resource in Estonia, has been the centre of research interests, involving two aspects: (1) as a valuable and highly potential raw material for industrial processing and (2) the most important fuel for the Estonian power engineering. Investigations based on the first aspect, were carried out during Institute's early period.

Systematic research of oil shale and its products in Estonia and began worldwide in 1925, initiated by Prof. Paul Kogerman, Head of the Oil Shale Laboratory in Tartu. However, when P. Kogerman was appointed Rector of Tallinn Technical University in 1936, the Oil Shale Laboratory was closed in Tartu, and oil shale research concentrated in Tallinn (TTU and NRRI).

In 1938-40, reasearch centred on retorting of diesel fuel and lubricates from oil shale and on the use of oil shale products for impregnating wood, particularly railway sleepers. The properties of the impregnation oil obtained in Estonia reached the quality standards of the best foreign products.

The establishment of the Soviet rule saw the expansion of oil shale research. For instance, research programmes covered the following: thickness of oil shale layers, the cracking process of shale oils, potential use of oil shale by-products.

During the German occupation, IIR's research efforts were focused on new oil shale fields at Kohtla-Järve, Sonda, and Jõhvi. Besides, old projects were continued, involving properties of oil shale ashes and catalyst aromatization for refining engine fuel and aromatic solvents.

In 1945-50, studies concentrated on oil shale phenols and carbonic acids and their potential applications. A method was developed to produce plastics from the lighter fractions of oil shale phenols. The work on carbonic acids was granted the

first Award of the ESSR in 1947. The government qualified this research and the experimental investigation of oil shale retorting with electrical current for underground gasification top priority and declared the research classified. Until 1950, the latter work carried out in cooperation with the Energy Institute of the USSR Academy of Sciences, was concealed. Then, the research group was transferred to the Institute of Chemistry. However, these investigations were closed in the late 1950s, because they were environmentally hazardous and non-prospective.

The investigations conducted in 1948-50 were focused on surface active substances and their retorting from oil shale. These substances were intended for emulgator, flotation agent, and soap production. This research was then continued at the Institute of Chemistry.

Commenced in 1950, in cooperation with the Institute of Chemistry, a new project, covering the retorting process with a solid carrier was classified, and then transferred to the Institute of Chemistry.

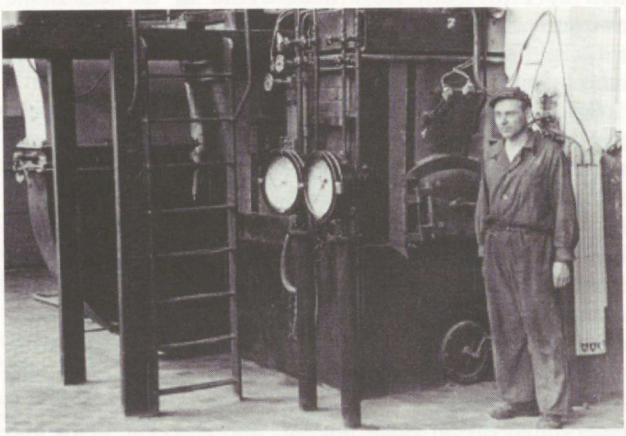
In cooperation with the Leningrad Polytechnical Institute, in 1952-56, research was focused on the pre-gasification of pulverized oil shale in fluidized bed as an alternative to the pre-gasification of lump oil shale in kilns.

In the 1950s, research on oil shale chemistry and processing continued at the Institute of Chemistry of the ESSR Academy of Sciences, headed by Prof. P. Kogerman who pioneered oil shale research.

Energy problems were not studied at the NRRI when it was established. During the war, the energy problems investigated involved the production of motor fuel from oil shale.

The development programme of the IIR comprised comprehensive energy research.

Oil shale power engineering and the related thermal engineering and oil shale chemistry projects were launched by H. Truu in the late 1940. These focused on the operation of boilers with mechanical grates and on the improvement of their performance. Then, new two-step semi-gasification furnaces and their modifications for the efficient burning of lump oil shale in small furnaces were centred on. For that purpose, special laboratory equipment was installed. In 1946, a proposal was made to use two-step semi-gasification oil shale furnace for lime kilns. The project was implemented at Vasalemma, Rakke and Tamsalu and in many industries and utilities.



5 Estonia's first semi-industrial fluidized bed furnace for burning oil shale in the Püssi PP in 1960

In 1949, investigations centred on the combustion of pulverized oil shale in two-step furnaces with fluidized bed. First, the pulverized oil shale particles floating above the plate with holes, where pressurized air is blown in, were pre-gasified at the medium temperature, and the coke residue was burnt. Second, the emitted gas was burnt, part of fly ash was removed, and the ash was

thermally treated for binding the major share of sulfur in the fuel. Then, the processes in the fluidized bed and those of gas combustion were analyzed in detail. The pilot tests carried out at the Püssi Power Plant in 1958-62 showed that in fluidized bed, complete burning of organic matter can be achieved. Introduction of the fluidized bed technology was hindered because no fuel preparation system was available. However, in 1962, due to the client's disinterest, the experimental work at Püssi was interrupted.

Still, supervised by R. Uuesoo and A. Martins, work on the fluidized bed combustion technology continued. New equipment, based on laboratory and theoretical research, was developed, and in cooperation with other organisations, new projects were launched. In 1970, source data were provided for technology transfer concerning a 70 MW boiler in the Baltic HPP to the fluidized bed combustion technology. In 1971-75, for the Slantsy Chemical Plant and in 1983-85 for Kohtla-Järve, similar projects were completed. Furthermore, the latter project comprised fuel preparation, accomplished in cooperation with the Tallinn Polytechnical Institute. Unfortunately, despite efforts, these projects were never realized. In 1986-89, a furnace for fluidized bed combustion of fine-grain coal was designed and put into operation on the Kaismaa collective farm. In 1992-93, a multi-use fluidized bed furnace for burning oil shale, milled peat, and wood chips was installed in the Põltsamaa boiler plant.

The results of long-term research show that pre-gasification in fluidized bed is the best technology for burning low-quality fuels with high ash content, such as oil shale. The new generation oil shale-based boilers in large power plants will benefit from the fluidized bed technology.

Another topic studied is oil shale combustion with liquid slag removal and physical and chemical properties of the pulverized combustion technology.

The oil shale research activities have been strongly influenced by the work of the Academicians Ilmar Öpik and Arvo Ots who have been the external members of the Scientific Council of the Institute for decades.

The problems of oil shale power engineering are tightly related to the economic analysis of energy supply.

Since 1952, led by L. Vaik, problems of **energy economy** have been centred on. First, general problems concerning the developments in power engineering, specifically those concerning urban and rural electrification, were the centre of interest. A review containing Estonia's energy resources (such as oil shale, peat, water, and wind) was drafted, defining the technical and economic variables of producing and using each energy resource. Energy networks were designed to supply electricity to small towns and Tallinn.

Next, major efforts were directed to using mathematical models and computing techniques for analysing and drafting fuel and energy balances. At that time, central planning was still prevailing. The first projects concerning the impact of energy production and use on the environment were launched. This work resulted in the development of the concept of energy development for Estonia until the end of this century and the first energy saving programme, titled Energy 2000.

In the recent years, a group led by H. Käär and V. Vares has analysed the prospects of using liquid fuel in Estonia. This work involved also an evaluation of future changes in liquid fuel consumption, state reserves, storage facilities and the funds required for this purpose. As a part of the project, a database was created comprising over 25 MW boiler plants and describing the current energy situation in Estonia relative to the development of national economy. And finally, a prognosis was developed concerning changes in pricing. The analysis also covered

cost-efficiency of using local resources (peat and wood) and a renovation project of district heating networks in regard to the efficiency of investments.

Led by L. Krumm, in 1974, a working group engaged in the control of electric power systems, was formed. Early research covered simplified models of steady states of electric power systems as well as the optimization of the state after major disturbances and the relevant calculation models and programmes. From 1981, in cooperation with Soviet organisations, theoretical investigations and methods of multi-step adaptive control and controllability of a unified power systems were developed. Mathematical methods were used to analyze system operation in the conditions of supply shortage, in those of major disturbances and in post-disturbance states. Programs were developed to implement the methods and algorithms used in the energy control system centres in Moscow, Lithuania, Estonia, and in the USSR Northwestern Unified Power System.

This research trend has gained specific importance especially today when the Estonian power systems are being prepared for the integration in the European power systems.

Now on the basis of these developments the main research trends of the Institute have been outlined:

- models for the analysis and prognosis of the Estonian energy economy
- theoretical basis and implementations for the power system control
- modern technologies for the combustion of oil shale and other solid fuels
- renewables and environmental issues
- theoretical aspects of the mechanics of dispersed flows and their implementation in power engineering
- implementation of plasma technology and chemical technology in the energy field

Further research work will be based on the set assignments in the field of fundamental studies and applied research and is mainly based on the two approved research programmes - "Energy 2000" and "Mechanics". The four subprogrammes of the latter (general energy problems; energy strategy, development scenarios and prognoses, price and tax policy, statistics and information systems; renewables and nuclear power engineering; environmental problems of the energy sector; energy sector in emergency situations).

Pilot testing of a component of the Marsian aerostat in the Laboratory of Dispersed Flows within the international programme Mars 94/96

Reorganisation of the science and R&D system, including legal, financial and organisational restructuring, is still going on, but its final outline can already be anticipated.

In the anniversary year of the Institute, the subordination problems seem to clear up. As in 1937, the Natural Resources Research Institute, the predecessor of our Institute, was finally subordinated to the Ministry of Economy, from the next year the Estonian Energy Research will also continue under the administration of the Ministry of Economic Affairs. The main responsibility of the Institute will be carrying out research work with the objective to provide dynamic development plans for the national fuel and energy supply with their continuous adjustment to obtain the national economic growth in accordance with the solution of environmental, social and security problems.

In the near future the main responsibility of the Institute will be the public advisory and consultation work for the governmental bodies and energy companies, and conducting necessary anlyses in the energy sector for the preparation of Estonia's accession to the European Union.