

# Dnieper Hydroelectric Station (DniproHES). The Story of the Largest Investment in the Electricity Industry in Europe in the Early XX Century

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**Abstract**—In the paper the history of Dnieper Hydroelectric Station (DniproHES) is studied. The influence of the DniproHES building process on the European electricity industry is shown. The challenges faced by the chief engineer Ivan Alexandrov and construction head Aleksandr Vinter are highlighted. The unique technical practices are considered. The creation of architectural embodiment of the dam is shown.

**Keywords**— *Dnieper Hydroelectric Station, DniproHES, GOELRO, history of science, history of electricity, electricity industry, Aleksandr Vinter, Gleb Krzhizhanovsky, Vesnin brothers, investments, aesthetics of investment projects.*

## I. INTRODUCTION

A quarter of a century after the end of the First World War can be called without exaggeration the Era of the Great Electrification! Thermal and hydroelectric power plants were actively built in many countries. In the two largest world countries, electrification has become a major project. These were the United States of America and the USSR. A larger US project involved the creation and operation of the Federal Development Corporation, which included the construction of 35 large hydropower plants in the Potomac, Hudson, Mississippi, and Missouri. The smaller but earlier GOELRO project focused on the construction of 30 power plants. Ten of them were to produce hydropower. According to the GOELRO project the construction of the largest hydroelectric power plant was planned on the site of a cascade of Dnieper rapids [1].

A significant scientific contribution to the study of the history of this project, the origins of technical, architectural and construction solutions were made by foreign and Ukrainian scientists: A. Rassweiler, R. Conquest, Theodor von Lau, S. Mocherny, A. Chinyakov, A. Dembovsky, I. Alexandrov, A. Vinter, B. Vedenev, P. Rottert, V. Vesnin, etc.

The purpose of this article is to study the history of a large infrastructural investment project of electrification of Ukraine on the example of Dnieper Hydroelectric Station (DniproHES) in order to adapt and use the principles of the project in modern conditions.

## II. DNIPROHES CONSTRUCTION

There are a lot of myths and legends connected with the DniproHES construction. It is claimed, for example, that the first project of DniproHES was prepared by engineer Heinrich Graftio. Already in 1905 it was proposed to Emperor Nicholas II. However, the Emperor underestimated the prospects of hydropower. In 1913, Bishop Simeon of Samara and Stavropol reported to the earl Orlov-Davidov: "Have mercy on your coming to keep God's world in your possession and to destroy the sedition at conception" [2].

Why did the bishop consider the construction of the Samara dam a sedition? Because at the same time churches and cemeteries would be flooded. Throughout human history, this has been considered blasphemy. Perhaps the emperor refused to build DniproHES for the same reason. It is worth noting that the project of engineer Heinrich Graftio involved the construction of three consecutive dams. Thus, flooding would occur in a relatively small area.

In 1920 the same Gleb Krzhizhanovsky, whom Bishop Simeon called an apostate, headed the commission to develop a state plan GOELRO. This plan was designed for 10-15 years. It provided for the construction of thirty district power plants with a total capacity of 1.75 million kW, including ten hydropower plants. As far as can be judged, initially the plan did not provide for the construction of such a grand structure as DniproHES [3].

Increasing the scale of the project while reducing the number of dams is not due to higher electrical capacity. There, the numbers almost coincided with the slight advantage of the Graftio project. The main goal was to increase the possibilities of navigation. One large lock 300 meters long provided a larger tonnage of river barges and greater speed of their passage. The author of this project was Ivan Alexandrov. He was appointed chief engineer of the project.

Aleksandr Vinter, a former student of the first set of the Kyiv Polytechnic Institute, headed the construction (in 1901 he was arrested for distributing proclamations and then

expelled from the institute for political unreliability. The same fate befell his teacher, the first director of the KPI, Viktor Lvovich Kiprychev) [4].

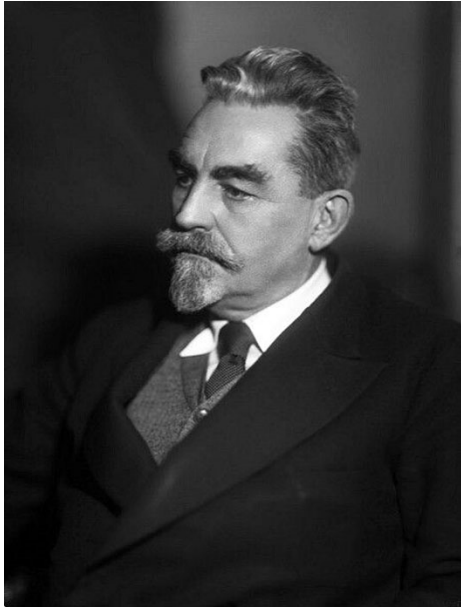


Fig. 1. Aleksandr Vinter – the head of the DniproHES construction

General Electric and Simmens have proposed their construction plans. However, the price of the first contestant was too high. The second had no experience in building large hydraulic structures. After considering all the options, it was decided to build DniproHES independently. It is worth noting that the involvement of foreign engineering consultants was inevitable – the amount of domestic experienced engineering staff was still small.

The world experience of construction of hydroelectric power plants was actively used at designing. In particular, the following structures were carefully studied: the Queenston on Niagara, the Isle of Malin on the Sagenei River, and La Gabel on the St. Lawrence River. Hugh Cooper has been appointed as the project's lead consultant [5].



Fig. 2. Construction of the intersection between the Dnieper's banks

On March 8, 1927, the first builders' brigades arrived in Oleksandrivsk (Zaporizhzhia). On November 8, the official laying of the dam was carried out.

We should pay tribute to Alexander Vinter. First of all, he dealt with household issues. On the right bank was built a public dining room, designed for eight thousand lunches a day. Dining room equipment was purchased in Germany. By 1928, five settlements were built for builders on the right bank of the Dnieper and one on the left. A total of 658

houses, dormitories and barracks, an outpatient clinic, a filtration and fire station, winter and summer theaters, a school, kindergartens and much more were built.



Fig. 3. Construction of formwork for concrete laying

Alexander Vinter had a straightforward and sharp character. He walked in high boots. He followed absolutely everything and checked with his own hands. He gave instructions on the smallest details. He arranged scandals when if saw some ugliness. He demanded that the local executive committee ban the sale of vodka. When workers searched Vodka in the surrounding villages, Vinter sent a telegram to the government of the Ukrainian SSR: "Please ban the sale of vodka in the whole area." Alexander Vinter had no family. He turned gray during the DniproHES buildings [6].

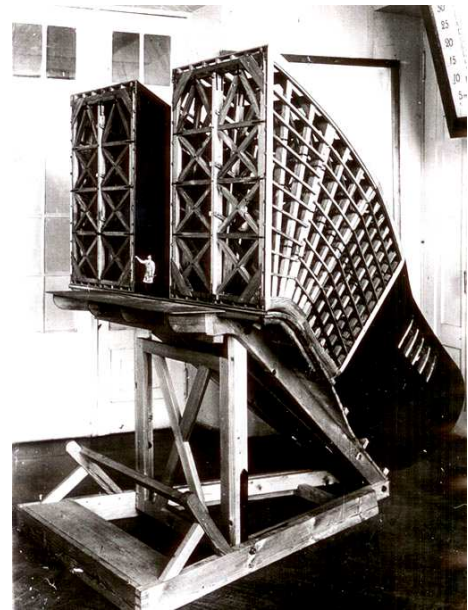


Fig. 4. Model of the suction turbine

As for the working conditions of the builders, there is no need to argue about how difficult they were. Now only a glass of water could seep into the pottery – huge concrete tunnels in the womb of DniproHES, which indicates a very high quality of concrete. It still wouldn't be tall, because the builders of DniproHES kneaded him with their feet all year round. American consultants even fought over how long people would endure such hard labor.

In addition to housing and the domestic sector for providing construction materials here were built: concrete, slag-cement, repair and mechanical plants, a coke plant, a

steel mill, a chemical plant, an alloy and woodworking plants with a total number of employees of 17,000 people.

Although the technical equipment of the project was obviously insufficient (for objective reasons). Modern technological methods were used in the construction. For example, there was a model shop in the woodworking plant. Here elements of constructions, technological equipment were worked on the models and so on.

Although General Electric did not become the general contractor for the project, five electric generators were purchased from it. The sixth one was built by domestic plant «Elektrosila». Nine turbines were also purchased in the United States from Newport News, as there was no experience in building turbines of this capacity.

The project of turbines and generators was proposed personally by Cooper - instead of two stages of construction and use of turbines with a capacity of 30,000 kW, one stage of construction was implemented with unique in world practice turbines of 60,000 kW, which brought the total capacity to 540,000 kW. Since turbines of this size could not be delivered assembled, Vinter proposed for the first time in world practice welded construction. Later, this practice began to be used around the world [7].

In general, the installation of turbines and electric generators is the most interesting story in this project. The problem was with the inch system used in the USA. Therefore, the installation of turbines and generators was performed in each unit according to an individual project and individual technology.

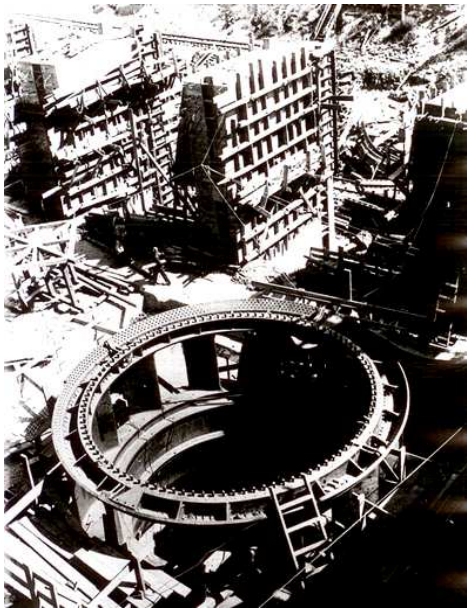


Fig. 5. The ring of the turbine unit during installation

The Electrotechnical Committee alone invested the equivalent of \$ 400 million in the project, of which about \$ 20 million was in the household sector and \$ 50 million in ancillary production. In addition, the railways built about 200 kilometers of railways, rivermen – two large berths with port cranes, public utilities in Zaporizhzhia laid more than 20 kilometers of water pipes.

In November 1927, 13,000 people worked on the construction site. In October 1931, the number of workers was 43,000. In 1932, the number of builders reached 63,000,

which was almost three times the total population of Oleksandrivsk before construction began! Workers moved to Zaporizhzhia with their families. Therefore, the number of built schools was constantly growing, and by 1932 they were already built 12 of them.

As women who moved with their men also needed work, a garment factory (now it's called Selena), two bakeries, and other businesses were built.

The expansion of the need for tools of various kinds required the unification of the existing small mechanical workshops on the basis of the so-called "Kopa Plant" into the one big mechanical plant, which during construction was significantly expanded and modernized (now it's called AvtoZAZ).

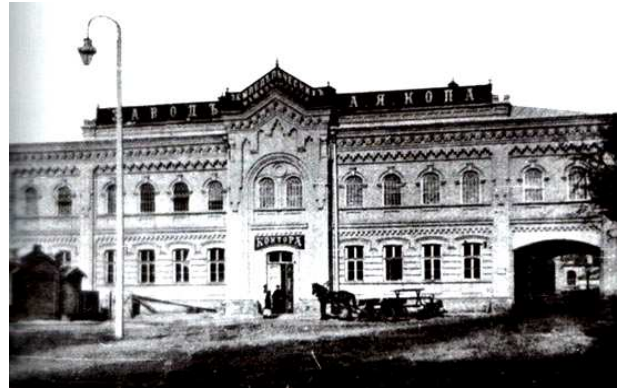


Fig. 6. Kopa Plant, Oleksandrivsk

The architectural embodiment of the dam needs a separate story. According to Khan-Magomedov, the Vesnin brothers, Zholtovsky, Shchuko and Gelfreich, N. Gundobin, N. Troiky and Dubovsky took part in the closed competition with an open, non-anonymous submission of projects. A. Chinyakov's book "Vesnin Brothers", published in 1970, is also mentioned a project of Americans group led by engineer Cooper. According to the last author the project of the Americans was discussed very violently, which Khan-Magomedov, unfortunately, does not even mention. All this suggests that there may have been other participants.

The first question: who and why announced the competition? The project of the DniproHES turbine hall was executed in the architectural bureau of the Moscow representative office of Dniprobud by a group of architects consisting of: V. Vesnin (head), N. Collie, G. Orlov, S. Andrievsky, V. Korchinsky. Alexander Vesnin was not formally a member of the group, but participated in the work. It is absolutely clear that the idea of the competition for the facade of this house could not come from Vesnin brothers. Moreover, this event was, in fact, an insult to them. It turned out that the world-famous architects could not cope with the basic task – the facade of an industrial building, which looked absurd.

Approximately the same situation was found two years later by young architects Savelyev and Stapan. In 1932, they were removed from the design and replaced by Shchusev, allegedly for his inability to cope with the facades. In fact – for the inability or even unwillingness (this story is still dark and not studied at all) to stylize constructivist facades under the "classics". The process of stylistic reorientation has been led since the spring of 1932 by Schusev and Zholtovsky. They also developed the first samples of the new style. In

1930, however, Vesnin still managed to defend his project, albeit with obvious heavy losses.

The competition for the facade of the turbine hall was not an internal competition, which is sometimes announced to find the best solution within one workshop, where all architects are usually like-minded. Several architects "from outside" were invited to participate. Occupying at that time the first places in the architectural and official hierarchy, that is, the closest to the government. At the same time - the ideological opponents of the Vesnin brothers, in addition, never engaged in industrial design. Among other things, this meant that the competition was expensive and held in consultation with senior management.

Surprisingly, the reason for the artificially created artistic conflict among the Soviet architectural elite was the facade of an industrial building, although huge, but almost inaccessible to view, except from a very long distance. And does not play any urban role. And in general, this was almost the last competition for an industrial building (if, of course, a competition for one facade, where the conflict unfolded exclusively around the decor, in general can be considered an industrial competition).

In the projects presented by the greatest masters of the old "academic" school – academicians I. Zholtovsky and V. Shchuko, and in the project executed by the American consultants of Dniprobud under the direction of engineer Cooper, two diametrically opposite concepts of architecture of an industrial building were imprinted. In the American project all attention was focused on the development of the structural and technical side of the building and completely ignored the artistic and aesthetic requirements for its architecture.

In the projects of both academics, the engineering structure was on the last place. It was carefully hidden under rich architectural decoration, executed with great skill in the Italian Renaissance style by Zholtovsky and more modern "modern" in Shchuko.

The wide public discussion of the projects, held in January 1930, was very heated. In response to Cooper's statement that he "would rather lie alive in a coffin than see this station in style represented by group of Vesnin". Ginzburg sharply and reasonably criticized the American project in his speech. At the same time, Academician Shchusev, defending Zholtovsky's project from fierce criticism from architectural youth led by I. Leonidov, noted that if it had been done fifteen years ago, it would have been carried for it, but now it is really not on time. He resumed that in the current situation these projects are not suitable [8].

Constructivism, of course, did not win "this round" in the struggle against the "Neo-Renaissance school." Judging by Vesnin brothers project, he lost hopelessly. But the Vesnin brothers themselves won, at least for a while, victory in the carpet struggle for a place in the architectural hierarchy and real bureaucratic power. They won at the cost of obvious artistic degradation.

In fairness, they fought without the slightest chance of winning – in a professional sense. The days when real fair

and open artistic competition was possible in the USSR are gone. In the same 1930, the persecution of the beloved student of the Vesnin brothers, the world-famous Ivan Leonidov, began. Khan-Magomedov writes, that Vesnin brothers were no longer able to protect him from constant attacks. Perhaps they only managed to save his life. Very soon them as well as Ginzburg were not even able to defend constructivism in words, and were forced to swear allegiance to the new artistic ideology in their speeches at various "creative meetings" and articles.

### III. CONCLUSIONS

Thus, on the example of the construction of DniproHES, we can observe in historical retrospect the so-called "Investment multiplier" – when a large infrastructure project is a kind of locomotive of economic growth in the region as a whole. The investment multiplier of the DniproHES project can be estimated as 10 to 1. Thus, the total investment directly or indirectly related to the construction of DniproHES reaches the equivalent of 4 billion US dollars at the time – which today is more than 80 billion modern US dollars.

In general, the DniproHES project can be considered a clear embodiment of large-scale infrastructure projects of the energy era with the active involvement of foreign large corporations and specialists, with the creation of a regional urban industrial and residential complex, which gave Zaporizhzhia a unique and original "face" and a powerful industrial and energy cluster.

### REFERENCES

- [1] Anne D. Rassweiler, «Soviet Labor Policy in the First Five-Year Plan: The Dneprostroi Experience». *Slavic Review* Vol. 42, No. 2 (Summer, 1983), pp. 230-246
- [2] Paul R. Josephson "Industrialized Nature" and "Pyramids of Concrete: Rivers, Dams, and the Ideological Roots of Brute Force Technology." Prologue and Chapter 1 in *Industrialized Nature: Brute Force Technology and the Transformation of the Natural World*. Washington, DC: Island Press, 2002.
- [3] Serhiy Lukyanenko, "Construction of Dniyrogos: How it really was" Access: <https://misto.zp.ua/article/articles945.html>
- [4] Serhii Radohuz "Training of teaching staff of Kyiv Polytechnic Institute at the turn of the XIX-XX centuries", *Ukrainian Studies Almanac*, vol. 17, p. 297–300, 2017.
- [5] Harold Dorn. "Hugh Lincoln Cooper and the First Détente", *The Johns Hopkins University Press, Technology and Culture*, vol. 20, p. 322-347, 1979.
- [6] Mykhailo Kalnytsky, "To the 100th anniversary of the GOELRO plan. As a former KPI student, Alexander Winter built DniproHES". Access: <https://focus.ua/archivist/471829-k-100-letiyu-plana-goelro-kak-byvshij-student-kpi-aleksandr-vinter-postroil-dneprogos>
- [7] Solomon M. Schwarz, *Labor in the Soviet Union*. New York: Frederick A. Praeger, 1952. XVIII - 364 pp.
- [8] Dmytro Khmelnytsky. "Mysteries of Dniyrogos. The strange victory of the Spring brothers". Access: <https://archi.ru/almanac/91223/zagadki-dneprogosa>
- [9] S. Shevchenko, A. Koval, D. Danylenko, et. al., "Energy Crisis and Electricity Reform of Ukraine - First Results", *2020 IEEE KhPI Week on Advanced Technology*, pp. 526-529, October 2020.