



Photo 1. View of the new Łabędy SHP

## A black swan among SHPs in Poland – about a new facility on the map of Upper Silesia

**It is gratifying to see the current modernisation boom in the SHP industry, which is a direct result of the favourable investment climate. In the pages of "Energetyka Wodna", we recently told about a typical repowering project focusing mainly on the replacement of obsolete turbines. This time, we present a facility whose modernisation involved building everything from scratch, in a vastly improved design, of course. We are talking about the Łabędy SHP.**

The first small hydropower plant at the cascade inlet to Lake Dzierżno Duże was built in the early 2000s (mid-2002). The facility was built using the economic method on the basis of a building permit obtained in 2000 and was equipped with four propeller turbines of varying technical parameters, with a total installed capacity of 360 kW. These units were installed near the fourth cascade, on an I-beam steel structure con-

nected to the tin building structure of the SHP. Water was supplied to the facility by a steel pipeline. The power station as described continued to operate for years to come. Unfortunately, the technology of construction began to take its toll on the operation of the facility over time – greater failure rates of the hydrosets and increasingly cumbersome maintenance, which, together with other factors, eventually led the original owner to decide to sell. The SHP needed a major modernisation and recapitalisation to achieve the full potential of the site.

### The old gives way to the new

In 2017, the Łabędy SHP was subjected to an acquisition audit at the request of a potential investor. The study, carried out by specialists from the Instytut OZE, dealt extensively with technical, formal and financial issues, identified the steps needed to be taken and recommended upgrading to the construction of the new SHP, as the existing infrastructure did not

allow full use to be made of the opportunities offered by the waters of Kłodnica River in the cross-section of the cascade weir. Eventually, the facility changed its owner and came under the auspices of IOZE hydro for further development.

The technical modernisation concept carried out in the next step involved the demolition of the old plant and, in its place, the construction from scratch of the SHP equipped with modern high-efficiency generation technology, fully automated, whose stable operation will allow an acceptable return on the financial investment to be made.

Despite being a modernisation by design, the project has gone through the complete administrative process from obtaining an environmental decision, a water permit and conditions for connection to the power grid to obtaining a building permit. This was finally obtained in the spring of 2020 and during the following



Photo 2. Preparation stage for concreting the water supply structure for the turbines

year (a pandemic year, we should add, and therefore bringing with it a number of logistical or formal and legal difficulties), funding was obtained and the work began. The executive team carried out the demolition of the old SHP and associated infrastructure, and built a new facility in its place. The scope of work included, in addition to the erection of the power plant building with the necessary installations, the expansion and reconstruction of the reinforced concrete water intake, the reconstruction of the water supply pipeline to the turbine chamber together with the installation of fittings in the throttle chamber, and the renovation of the existing weir by replacing the closure system (including its lifting mechanisms) and its automation.

The above synthetic list does not adequately reflect the advancement of the hydro technical works carried out by the contractor's team, so it is worth giving the floor to the person directly supervising the work (report in box).

It is worth being aware that hydro technical construction has its own rules. Although the SHP construction site occupies a relatively small area, the effort that the construction team puts into maintaining it in the face of the many practical challenges associated with the specifics of the project is definitely worth noting, not only in the case of the Łabędy SHP (photo 2), but also in other numerous investments of this type. In addition, many issues only come to light in the course of the con-

struction work, so employees and contractors have to react on an ongoing basis and find solutions, e.g. structural or logistical ones, allowing you to move on to the next stage of your work.

*Before the modernisation, the SHP achieved a maximum instantaneous power of 70 kW, while the new solution already achieved 340 kW in the testing phase.*

Decisions of this kind are often taken under time pressure, involving issues at the intersection of different areas, e.g. mechanical, electrical, construction, so it is important for the contractor to have an interdisciplinary team of designers and specialists from many branches. Comprehensive project management is the recipe for successfully bringing a construction project to completion.

### **Szymon Głowacki**, site manager:

*Work on the Łabędy SHP facility proceeded smoothly despite complications related to the location of the construction site in the immediate vicinity of the frequently rising riverbed, which was a direct result of the unpredictable hydrological characteristics of the Kłodnica River. The river behaves like a mountain stream – after heavy rainfall or snowmelt, its current becomes rushing. Situations of this nature led, among other things, to a threefold necessity of reconstructing the water enclosure for the worksite associated with the water intake for the SHP or to frequent flooding of the construction site. In addition, the worksite was heavily waterlogged at all times – the low cohesiveness of the soil with its predominantly sandy fraction results in increased water migration, which caused numerous leaks, but was also the cause of the poor bearing capacity of the soil at the foundation level of the building. However, based on the results of the earlier CPT soundings, we prepared for the works by using longer sheet piles of tight walls and introducing additional soil reinforcement below the foundation level of the facility. Of the issues that had already surprised us in the course of the work, but which we also dealt with, was the different location of supply pipelines than was shown in the archived post-completion documentation produced by the surveyor. Following this, we made adjustments to the design of the water intake to optimally match the existing infrastructure.*

### **Tailor-made technology**

The achievable head of more than 6 m and flows of more than 6 m<sup>3</sup>/s, as well as the curves of the sums of flow durations, were the starting point for the design and manufacture of two 800 mm-diameter Kaplan turbines in a vertical arrangement and with radial inflow with a 360° (photo 3) spiral chamber. Water is piped into the turbines. The water in front of the turbines is separated into two chambers by a T-piece with an inspection manhole and is routed directly to the turbines via a spiral chamber of reinforced concrete construction. The entire system, including the reconstruction of the water intake, the water feed system to the turbines; the water drainage has been optimised to minimise losses in electricity production.



Photo 3. Kaplan turbine at different design stages, just before installation and inside the SHP building after installation

**Sebastian Wites**, chief automation officer at IOZE hydro: *The facility was equipped with a control and automation system dedicated to small hydropower. For the Łabędy SHP, we designed and manufactured a unique turbine regulator system. It is the only hydroelectric power plant equipped with PMG generators, not supported by an inverter. Generators of this type have a very high efficiency (up to 97%), significantly higher than asynchronous generators. In the case of a system equipped with a generator with permanent magnet excitation, there is no need to compensate for reactive power, which translates into major savings for the start-up equipment and operation of the facility (including avoiding the periodic replacement of worn-out capacitors, which pose a fire hazard when heavily used). The turbines at the Łabędy SHP are operated by two generators of 200 kVA each. The control and automation system, in addition to the basic functionality of optimising hydropower parameters, also controls the entire SHP facility, i.e. the gates of the main weir, the water intake and the trash rack cleaner.*

It is worth adding that the production results obtained from the old SHP installation may have been misleading, if they were taken into account in the design of the technology, as the available hydro technical potential actually offers the possibility of producing much more energy than

the achieved values for each year showed. However, it is not only the hydroelectric potential of the site and the advanced turbine technology, but also the control and automation system that determines the production results achieved by the power plant. The one implemented at the Łabędy

**Investor**, owner of SHP:

*Our cooperation with IOZE hydro began when we became aware of an opportunity to purchase a facility which, as it turned out from the audit, required the construction of a completely new infrastructure, but allowed us to take full advantage of the potential of the location. A multi-faceted collaboration with the consultancy, design and construction team has brought us to the point where we are now past the first commissioning of the facility and will be able to start permanent energy production after final testing. The new Łabędy SHP is a completely different – in the sense of incomparably better – class of control and operation, turbine technology, turbine efficiency, compared to what it was and what we know, especially as we own another SHP and have a comparison in terms of operation and maintenance. We are confident that with the new plant, we will use the river's full disposal potential. The solutions used are based*

*on advanced calculations and modelling. This makes them ideally suited to the location and our business objectives. To illustrate the differences, it should be mentioned that the facility achieved a maximum instantaneous power of 70 kW before the modernisation, while the new solution already achieved 340 kW in the testing phase.*

*It is worth mentioning that the individual approach to the client – i.e. to us and our needs – and the high level of care taken in the provision of services are of great value in the course of the entire project. As a result, we feel that the IOZE hydro team has taken care of all aspects required for the facility to operate within the optimum formal range (the facility is covered by 15 years of guaranteed Energy Regulatory Office support under the FIT/FIP tariff) and generate the maximum possible revenue.*



Photo 4. Old and new SHP

SHP stands out from others of its kind. In a few technical words, the main automation specialist of IOZE hydro talked about it. The technology implemented at Łabędy SHP is so promising and, above all, technically and financially sound that another project is already underway, also in southern Poland, in which permanent magnet induced generators with a total output of 900 kVA will be installed. The solution described here has numerous advantages and offers advantages over standard solutions.

#### Repower=comfort

The new facility on our country's hydro-power map is further proof that repowering has tangible benefits and is worth undertaking. With modern technology (embedded either in a completely new infrastructural setting or in a still well-performing SHP building), it is possible to increase revenue from electricity production while reducing operating costs. The

status of a new installation in the current support system gives higher electricity sale prices. However, it is important that the entire scope of the modernisation is chosen from the outset to ensure that the project is in optimum shape, not only formally but also technically. Everything has to blend together perfectly.

Referring to the statement of the owner of the Łabędy SHP, but also assessing the repowering process from the perspective of many successfully implemented investments, it is important to emphasise how easy the modernised facilities are becoming to operate. In the case of old plants, at least one person is employed to operate them, and often the owners of the plant are additionally involved in the day-to-day running of the plant, so that they have to subordinate their daily routine to the work of the plant. The need for constant supervision generates costs that are often inad-

equated to the production revenue generated. Modernised SHPs, on the other hand, are essentially maintenance-free (photo 4). Their correct operation is supervised by a dedicated control and automation system and remotely by IOZE hydro service technicians, who ensure that production continues at the highest possible value. Service personnel can be limited to part-time staff who periodically turn up to look after the facility, possibly turning up when necessary but not working there full-time. Repowering is not only a benefit in technological, financial or visual aspects, but also a comfort closer to human nature in working with the facility.

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Photos come from the archive of **IOZE hydro**.