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Chapter

The Innovative Gaildorf Wind-Water Project Guarantees Reliability of Power Supply

Grażyna Frydrychowicz-Jastrzębska

Abstract

This chapter presents a pilot project, which is an innovative solution related to renewable energy sources (RES). It refers to the integrated system that covers a wind farm (4×3, 4 MW) and a pumped hydro storage PHS (16 MW). Environmental conditions and components of the system were characterised in structural and operational terms. The wind turbines that are part of the system are of considerable height (one of them is even the highest turbine in the world). This is partly the result of the hybrid construction of their towers. Around the bases, there are Bains, which function as a short-term energy storage with the total capacity of 160,000 m^3 of water. The turbines were installed 200 m above sea level, and this also has a positive impact on their operational parameters. The short-term energy storage is connected with the long-term energy storage located in a valley by means of a pipeline. The response time for switching between the energy generation and storage functions is 30 s. The innovative nature of the project is determined by the short-term energy storage. The investment is fully automated. The hybrid power plant began its operation in 2018.

Keywords: innovative project, renewable energy, wind farm, pumped hydro storage, hybrid towers

1. Introduction

The operation of RES systems is characterised by significant random fluctuations of the amount of the produced electricity. On the one hand, this is the result of variable external conditions (geographical location and thus the resulting climatic conditions, impact of time, both per day and per year) and on the other hand, the changes in the demand for electricity among recipients. These fluctuations have a significant impact on the effectiveness of the systems. There are unpredictable, abrupt changes of power within the entire system, which may lead to its complete failure [1–3].

The problem cannot be ultimately resolved using the hybrid renewable energy source (RES) systems.

The integration of the selected storage technology with the source and the specific network is necessary. The proper selection is, above all, determined by such factors as storage capacity (kWh), output (kW), number of cycles (charge/discharge), service life (years/cycles), depth of discharge (%), response time (ms-min), efficiency (%), investment and operational costs [1–3].

Parameter	Power	Operating time	Life cycle	Energy density	Power density	Cycle efficiency	Response time
Unit	[MW]	[h]	[years]	[Wh/l]	[W/l]	[%]	[s/min]
Value	100–1000	4–12	30–60	0.2–2	0.1–0.2	70–85	seconds to minutes

Table 1.
Parameters of the pumped hydro storage technology.

At present, according to the report drawn up by the Electric Power Research Institute, the most frequently used large-scale electric energy storages in the world are pumped hydro storages. They constitute 95% of all large-scale storage facilities [2–7]. They are characterised by very good parameters, particularly in the case of storage of significant energy resources in the long-term scale.

However, it is necessary to bear in mind the limitations in their applicability, resulting from their location. If at least one of the reservoirs is a natural reservoir, it facilitates significantly the implementation of the enterprise and reduces its costs. The energy storage efficiency in the case of the pumped hydro storage ranges between 65 and 85%, but of particular significance is the fact that the response time of such a solution does not exceed several minutes and is often limited to seconds.

Table 1 includes information regarding the parameters of the pumped hydro storage (PHS) technology [2, 7].

In the case of storage of energy coming from renewable sources, it is advantageous to introduce the integrated storage systems, often on two levels, the short-term and long-term, which fulfil the role of buffer systems and thus ensure the reliability of power supply. The introduction of the short-term battery-operated energy storage is a good solution. At present the manufacturers of RES systems make attempts at integrating them with energy storages in such a manner as to secure the energy excess on a current basis [1, 2, 6]. An interesting case of such a solution is the Greek Icaria which relies on the wind-water system with two water storages (3.1 and 1 MW), located in different towns [8].

In the considered solution, the role of short-term energy storage is fulfilled by water reservoirs in hybrid wind turbine towers. They have many advantages, especially important in RES systems (Chapter 2.3): can be used for conventional and renewable sources, have long life cycle (50 years) with deep discharge, possible applications of fresh and salt water, lower investment costs due to standardised solutions and power plant concept (economic factor) and environment friendly (ecological factor). The system has been operating for only 7 months, so the time is not long enough for an exact evaluation.

2. The Gaildorf project

2.1 Environmental conditions

In the year 2011, the Gaildorf town initiated a discussion forum related to the natural power storage project. The project gained support of the local community and Bundesministerium für Umwelt, Naturschutz und Nukleare Sicherheit (BMUB), which supported the RES technological initiative in Gaildorf from funds coming from the ecological innovation programme in the amount of EUR 7,150,000 [9].

It was necessary to carry out multi-criteria research aimed at the confirmation of the selected renewable energy source solution both from the point of view of

ecology and endangered species and detailed results of measurements regarding the wind energy availability [10–14].

While planning the location of wind farms, it is actually the evaluation of resources which seems to be the most difficult issue. It involves the evaluation of climatic conditions and the roughness of the terrain.

Another factor which remains highly significant with regard to the effectiveness of conversion is the impact of design parameters of the wind farm. However, the most important issue is the wind speed. The wind power as a function of its speed is expressed by the following relationship [10, 14, 15]:

$$P = \frac{1}{2}\rho A v^3 \tag{1}$$

where P is the wind power, A is the rotor blade area in m², v is the wind speed in m/s and ρ is the air density in kg/m³.

With regard to the wind potential in the region in question, all the following European requirements are respected:

- The duration of the wind speed monitoring in the selected location should not be shorter than 1 year.

- The measurements should be conducted at a minimum height of 30–40 m, whereby the extrapolation of results to greater heights is permissible. The extrapolation is performed by means of the power law, Eqs. (2) and (3), or the logarithmic law [14]:

$$\frac{v}{v_0} = \left(\frac{H}{H_0}\right)^{\alpha} \tag{2}$$

$$\frac{P}{P_0} = \left(\frac{H}{H_0}\right)^{3\alpha} \tag{3}$$

where H is the turbine height, other markings as before, whereby indexed values 0 are measuring values for extrapolation purposes:

- The assessment of the wind potential must take into account the topography (roughness classes, surface friction coefficient α) [10, 13], for instance, α is the surface friction coefficient, −0.14 for low grass, 0.25 for low buildings and 0.40 for a built-up area.

- The measurements must be performed by means of two wind metres at two different heights (the averaging time was determined at the level between 10 and 60 min).

The results of the conducted research regarding climate, local wind conditions and wind parameters, as well as the applied research method, measuring devices, certificates for the calibration of anemometers and also the duration of monitoring, and the manner in which the results of measurements were converted into long-term data should be contained in the report. This is the most important document which is the basis for the economic assessment [16]. As well as the aforementioned information, the report should also include the final estimation of the annual energy output (AEO). During the economic analysis of the feasibility of the wind project, the value of AEO is of key significance. The factor which determines the annual energy output ratio is the wind speed.

For the Weibull distribution, AEO is described by the following relationship [14, 17, 18]:

$$\text{AEO} = \frac{1}{2}\rho A v^3 \eta t \qquad (4)$$

where η is the efficiency (aerodynamic, mechanical, electrical) and $t = 8.760$ h/year, other markings as before.

The wind farm in Gaildorf is located at a site with average wind energy availability, and this is shown in the diagram presented in **Figure 1**. As can be seen, winds with speeds which exceed 60 km/h are, in principle, present in the periods between October and March. Their total duration is only about 60 h per year [19], but the winds with the speed reaching up to 38 km/h (10.6 m/s) occur within 25.5 days a year, and such a speed is optimal for the typical characteristics of the wind turbine [15].

As the wind rose shows, the winds from the West and South-West directions have the biggest potential for the location in question. Based on the meteorological data, it can be concluded that there is a significant variation regarding the availability of wind resources in time [19]; therefore, there is a necessity to store energy for the purpose of ensuring the power supply stability.

For example, **Table 2** includes the daily information regarding the wind speed in the region under consideration, on February 3 and April 3, 2019, at 3 h intervals, based on information given in [19].

In the further 7-day forecast, in February, the estimated wind speed values ranged between 6 and 13 km/h and in April between 10 and 18 km/h, respectively [19].
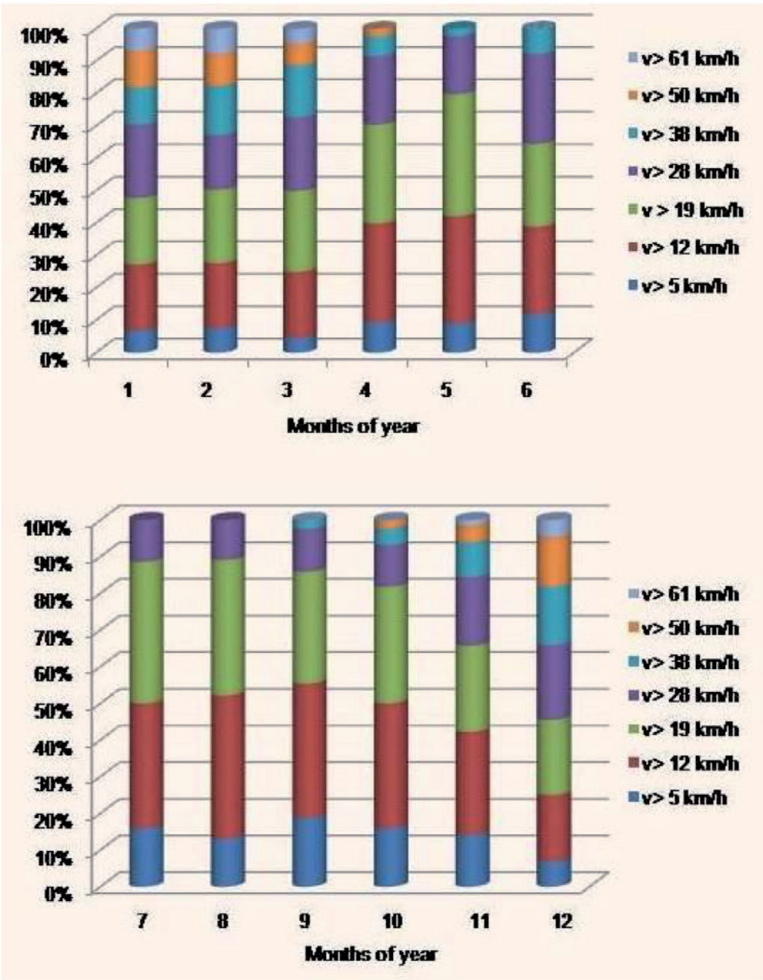

Figure 1.
The number of days with a specific wind speed during the respective months in Gaildorf, own study based on [19].

Day		Hour							
		2	5	8	11	14	17	20	23
February 3, 2019	Wind speed [km/h]	5–22	9–30	14–40	14–40	16–44	14–43	10–34	7–23
April 3, 2019		4–12	6–17	6–21	13–24	10–18	15–32	5–23	15–19

Table 2.
Wind speed in the region under consideration, on February 3 and April 3, 2019.

2.2 Wind turbines

In Gaildorf near Stuttgart, Bavaria, a non-standard wind-water energy solution was applied. A wind farm was established there in the year 2017 (**Figure 2**). The power of each of the turbines, with a rotor diameter of 137 m, amounts to 3.4 MW, which gives 13.6 MW in total for the entire system [20–23]. The farm consists of four electrically controlled turbines characterised by high performance. The hubs of GE 3.4-137 turbines are located in towers at a height ranging between 155 and 178 m. One of the turbines, since the moment of its installation, has been the highest turbine in the world. The total height of its tower and rotor wing reaches 246.5 m [20, 21, 23]. The heights of towers increased by 40 m are a consequence of their unique hybrid design (Chapter 2.3).

Additionally, the electricity production potential of the turbines was increased by their location on Limpurg Hills (the Swabian-Franconian Forest). In the case of the above-mentioned turbines (as marked in **Figure 3**), this allowed the following total heights to be obtained in relation to the sea level: W2, 501.5 m above sea level; W3, 489.5 m above sea level; W4, 489.5 m above sea level; and W5, 485.5 m above sea level [9, 22].

As has been mentioned in [10], an increase in the height at which the turbines operate is advantageous, as each additional metre of height of the location of the hub on the tower contributes to an increase in the annual energy output from 0.5 to 1%. The considerations must also take into account the impact of the ground roughness class [14].
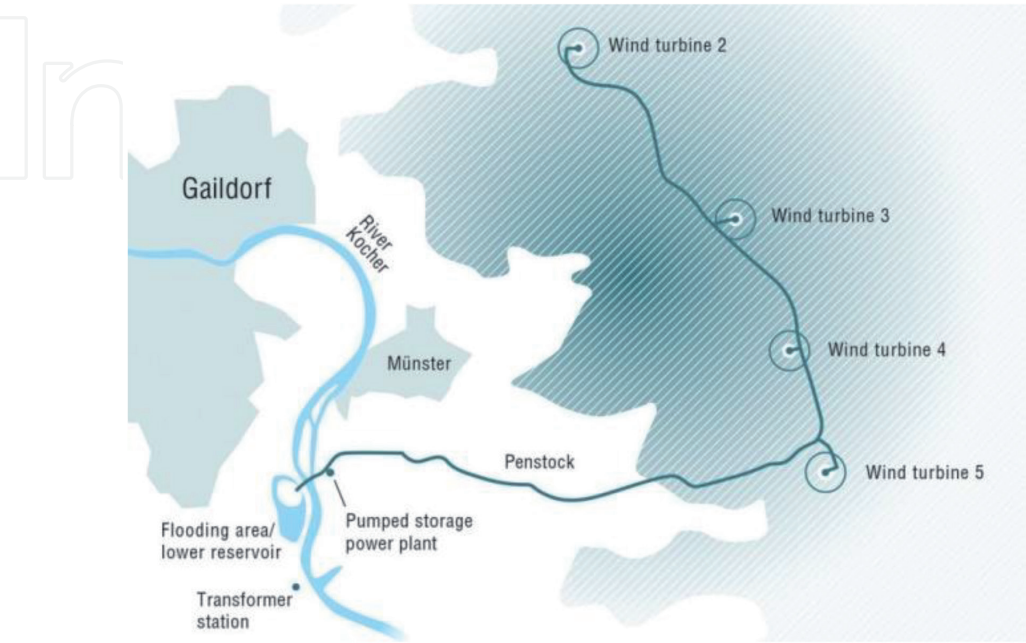

Figure 2.
Location of the wind-water investment in Gaildorf—the arrangement of wind turbines (Credit: Max Bögl).

Figure 3.
GE wind turbine from the 3 MW platform (Credit: GE Renewable Energy).

Parameter	Change in wind speed [%]	Change in wind power [%]
Change in height from 25 to 50 m	10	35
Change in height from 10 to 50 m	25	99

Table 3.
Change in wind speed and power with height.

Table 3 presents the impact of the turbine height parameters on the wind speed and its available power [14].

The significant heights at which the rotor hub is mounted also contribute to the reduction in turbulence and thus ensure a more stable operation of the turbine [10]. This is particularly important in the regions with quite small wind energy potential. The total electricity production by the system under consideration ensures about 42 GWh per year [9, 22].

With the cooperation between such companies as Max Bögl Wind AG and GE Renewable Energy Onshore Wind Deutschland on the Gaildorf project, the first wind farm in the world integrated with a hydroelectric power plant was initiated in the year 2016.

Table 4 contains selected specifications of turbines from the 3 MW platform, and **Figure 3** presents the GE wind turbine from that platform [16, 24].

The design solutions for turbines from the GE Platform with a unit power from the 3 MW series are the continuation of those from the GE 2 MW Platform, implemented since 2004; thus, proven elements have been applied. The turbines in question are three-bladed turbines mounted on a steel tubular tower, operating in the horizontal axis, with a variable speed, active control of the optimal deviation in relation to wind and advanced control of loads, as a result of the measurement of stresses and individual control of the blade angle of inclination [16]. The GE 3 MW Platform is adapted to operation with a broad spectrum of wind speeds, at standard and extremely low temperatures. It includes the 3.4 MW-137 m turbine which has best proven its value in class III. The direction of rotations of the rotor is clockwise. The solution involves the use of the electric adjustment of the drive and

Parameter	Value	Unit
Wind turbine power	3.2–3.8	MW
Rotor diameter	103, 130, 137	m
Annual electricity generation from wind	42	GWh
Turbine hub height above ground	150, 175, 178, 5, 199, 223	m HH

Table 4.
Design and operational parameters of GE wind turbines from the 3 MW platform.

Specifications of turbines of platforms II and III vs. wind class	Class no.	Wind speed	Wind classification
	IV	≥29.0–32.0	Violent, hurricane wind
	III	≥25.0–28.0	Hurricane wind
	II	≥21.0–24.0	Windstorm
	I	≥17.0–20.0	Violent wind

Table 5.
Specifications of wind turbines, taking into account their applications in specific wind classes (Credit: GE Renewable Energy).

the aerodynamic brake. The internal and external anticorrosion protection has been taken into account. Under normal operating conditions, the sound power level does not exceed 106–107 dB (A) (the solution for noise reduction has been developed) [16].

Table 5 provides the specification of wind turbines, taking into account their applications in specific wind classes [16].

Owing to the modification of the gear box, control and aerodynamics, it was possible to increase the capacity, including the power factor, the annual energy production (AEP) and the scope of application (for 50 and 60 Hz frequencies). It must be emphasised that GE, including the wind turbines, also supplies the software dedicated to them. At present, in the Predix system of the company, the Digital Wind Farm software which collects information from various fields has become applicable. As a consequence of application of appropriate software (including the network connection and the communication interface), it is possible to obtain the optimal operation of each of the wind turbines.

The operation takes into account the GE condition monitoring system (CMS) and the Supervisory Control and Data Acquisition (SCADA) anomaly detection services, which complement the standard package. The advanced monitoring system (GE Global Research) allows for the discovery of any faults and anomalies of the system before they occur [16, 24].

As a result of modernisation work regarding the electric infrastructure, it was generally possible to limit capital expenditures (CAPEX) for the output power. It turned out in effect that in parallel to an increase in the energy potential, it was possible to reduce the outlays for production and operation. The costs of fuel were reduced, and the emission of CO_2 into the environment also became smaller [16].

Figure 4 shows the specification of the GE 3 MW platform [24]. The presented models are characterised by the same drive system and electric system whereby they are subject to modification on a current basis in order to ensure the highest energy

Figure 4.
The specifications of wind turbines from the GE 3 MW platform (Credit: GE Renewable Energy).

Figure 5.
Installation of wind turbine blades on the tower in Gaildorf (Credit: Max Bögl (Holger Hessenthaler)).

generation possible. The GE 3.4-130 wind turbine has an annual energy production (AEP) higher by up to 30% than the previous version, i.e. 3.2-103 [16, 24].

Figure 5 presents the fixture of the GE 3.4-137 wind turbine rotor blades (GE Renewable Energy Onshore Wind Deutschland) in Gaildorf. During the installation, the EF 300 Plus electric torque multiplier (Alkitronic) was used [25]. The device is characterised by a small size; therefore, it proves its value in the case of bolted joints at spatially confined locations. It ensures consistent and precise projection of a selected torque owing to the intelligent, processor-controlled electronics. High-quality screws are used in the discussed solutions. Owing to appropriate procedures, it was possible to tighten the screws in four Gaildorf wind turbines with a torque of 550 Nm plus 180° (1248 screws in total). This process was performed by means of an electric torque multiplier; thus, the joints could be made much faster than in the case of using hydraulic systems [25].

## 2.3 Hybrid towers: innovative energy storage

The innovative pilot system applied in Gaildorf, in connection with the introduction of the Max Bögl Wind AG project, uses the foundations of wind turbine towers as upper reservoirs (short-term energy storage) in the pumped hydro storage solution.

On the columns of towers, it is possible to separate appropriate sections (**Figure 6**).

1. The hybrid tower is based on the ring concrete foundation cast in situ. This ensures the transfer of significant loads coming both from tower's own weight and transferred to the ground by the wind force.

2. The highly efficient concrete elements are manufactured in series. It is necessary to ensure particular accuracy of workmanship of the elements as a result of precise grinding with computerised numerical control (CNC).

3. For the prestressing of the concrete tower, an external system for high-strength steel was used. It takes over the tension forces of the tower, which prevents the creep of concrete elements.

4. Adapter is a connecting element between two components of the tower: the one made of concrete and the one made of steel. The integrated support elements enable the placement of a steel pipe, and at the same time, the pipe adapter ensures prestressing forces for the concrete tower.

5. Steel section is a flexible construction which consists of several segments in order to facilitate the transport of the tower elements. The steel elements are manufactured at the factory owned by Max Bögl Wind AG, Sengenthal.

The foundations of the hybrid towers function at the same time as water reservoirs which ensure the energy capacity at the level of 70 MWh. The tower, which is built of modules, is provided with reservoirs along a section running from the ground to the height of 40 m: the vertical active reservoir with a diameter of 16.8 m and height of the head up to 31 m and the passive reservoir with a diameter of 63 m and depth ranging between 8 and 13 m. In total, it is possible to store 160,000 m^3 of water in four towers [9, 22].

The active reservoirs, which consist of 27 prestressed concrete rings, were built using the LTM 11200-9.1 (Hercules) mobile 9-axis crane owned by Max Bögl and provided with a ballast weighing 202 tonnes. After the rings (with a diameter of
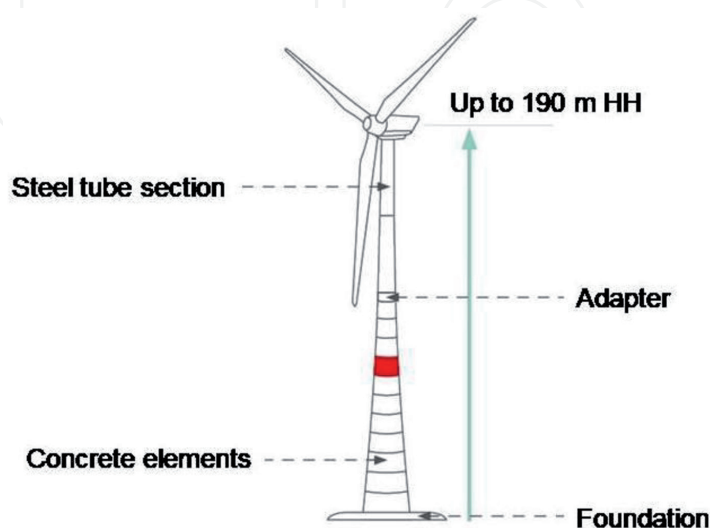
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Figure 6.
Structural sections of the turbine tower (Credit: Max Bögl).

16 m and height of 1.5 m) were mounted on one another, they were secured with steel ropes [26].

Additionally, it was necessary to use the Liebherr 630 EC-H70 self-erecting slewing crane for installation works performed at the height of 190 m [26].

The components of the towers are ultimately put together at the construction site (**Figures 7–9**) [9, 26].

The lower part of the hybrid tower including the short-term storage is presented in **Figure 10** [9]. At the same time, this is the upper reservoir of the hydroelectric power plant.

Among the unquestionable advantages of upper basins located in the foundations of the towers, it is necessary to mention:

Figure 7.
Putting together concrete rings at the construction site by means of the Liebherr 630 EC-H70 self-erecting slewing crane (Credit: Liebherr Plant Ehingen GmbH).

Figure 8.
Hybrid tower on the concrete foundation (Credit: Liebherr Plant Ehingen GmbH).

Figure 9.
Installation of the internal steel tower by means of a crane (Credit: Max Bögl).

Figure 10.
Lower part of the tower including the short-term storage (Credit: Max Bögl).

- The reduction in the investment costs owing to standardised solutions

- The standardised concept of the power station

- The minimum interference in the landscape

- The possible applications with fresh and salt water

- The long service life (50 years) at deep discharge

- The possibility of combinations for applications other than RES

Figure 11 presents wind turbines in Gaildorf mounted on towers [22].

Ultimately, the wind turbines were integrated with the network in the Gaildorf project in spring (2018). The wind farm began its operations [9].

The presented energy storage concept in the short-term scale is a completely new solution. The water to reservoirs in towers was supplied by means of the DN 1600–2500 diameter pipeline.

Figure 11.
Wind turbines on towers in Gaildorf (Credit: Max Bögl).

A particularly important factor for the operation of the system is the time of switching between the energy generation function and its storage function, which is 30 s [21]; this ensures quick response of the system to the current needs. The ability to store energy is characterised by 80% capacity.

The integration of wind turbines and the hydroelectric power plant as the energy storage is aimed at gaining independence from environmental and climatic factors.

2.4 Hydroelectric power plant

The upper water reservoirs (in the tower foundations) are combined with the lower one located in the Kochertal valley at a distance of 3.2 km (200 m in the vertical line) (Gaildorf-Unterrot) by means of a throttle. The design by Max Bögl Wind AG in its current form allows for differences in heights ranging between 150 and 350 m between the lower reservoir and the bases of wind turbine reservoirs [22].

For the needs of the investment, special DN 1800/DN and 1600/DN polyethylene discharge pipes (manufactured by Egeplast), running from the reservoirs, were designed. They were laid using a platform-based machine—PiPECrawler—intended for the installation of thermoplastic pipelines on an industrial scale (**Figure 12**). The machine guarantees three times higher operating speeds than those proposed in standard solutions and allows any unevenness and obstacles in the topography to be taken into account much more effectively.

Also its impact on the environment is reduced to the minimum.

The innovative PiPECrawler solution, which is an internal patent developed by Naturspeicher GmbH of the Max Bögl corporate group, has been honoured with the first "Development for Industry" award in the year 2019 [27].
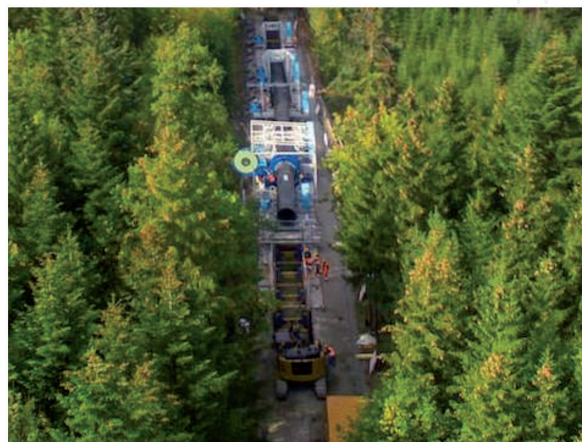

Figure 12.
The operation of the PiPECrawler in Gaildorf (Credit: Max Bögl).

The Egeplast polyethylene pipes had been installed since 2018. Then a steel distribution pipeline "trifurcator" was installed. This is a branch pipe which allows for the reaching of three turbine sets in the hydroelectric power plant. They were installed in the Gaildorf hydroelectric power plant in autumn (2018). This scope of works was the responsibility of Bilfinger VAM Anlagentechnik GmbH from Upper Austria [28, 29].

The bottom reservoir of the hydroelectric power plant is characterised by the natural appearance, owing to which it does not affect the landscape visually. In its case, the issue of water management must be considered comprehensively. It is not completely filled with water. It is necessary to maintain the spatial reserve of 30,000 m^3 on a constant basis, which ensures safety in the event of a flood, as the lower reservoir also fulfils the role of a retention reservoir.

The works related to the construction of the hydroelectric power plant were completed at the turn of 2018 and 2019. At the investment stage, it is optionally possible to include the storage capacity of 16, 24 and 32 MW in the system [22].

It must be emphasised that the hydroelectric power plant is fully automated.

In the case of demand for electricity, water flows downwards from the basins in the turbine towers, supplying the hydroelectric power plant located in the valley. During the peak demand for electricity, the water from the upper reservoirs is released to the lower Gaildorf-Unterrot reservoir by opening a special valve. Its flow drives the water turbines. When there is electricity surplus, the water from the lower reservoir is pumped through pipelines to the upper reservoirs in the foundations of the towers on the hill. These reservoirs are to function as a huge storage which complements both the networks and the wind turbines. The flow speed in the Gaildorf hydrosystem is estimated at 9.5 m^3/s. Electricity will be generated as a result of operation of wind turbines and water turbines.

During analysis of operation of the hydroelectric power plant, the evapotranspiration of water, which covers the process of volatilisation of the water into the atmosphere through plant transpiration and sublimation, was taken into account [30, 31].

Three reversible Francis turbines with the total power of 16 MW were applied in the Gaildorf solution. They are mainly used to drive the power generators in hydroelectric power plants with an appropriately high water fall. The special matching of the Francis turbines to the installation facility allows the efficiency exceeding even 90% to be guaranteed. The cost of manufacture and installation of the turbines is high, but their performance is very reliable. The Francis turbines are reversible devices. They can be applied in pumped hydro storages where the surplus of electric power is used to pump water from the lower reservoir to the upper one. The water
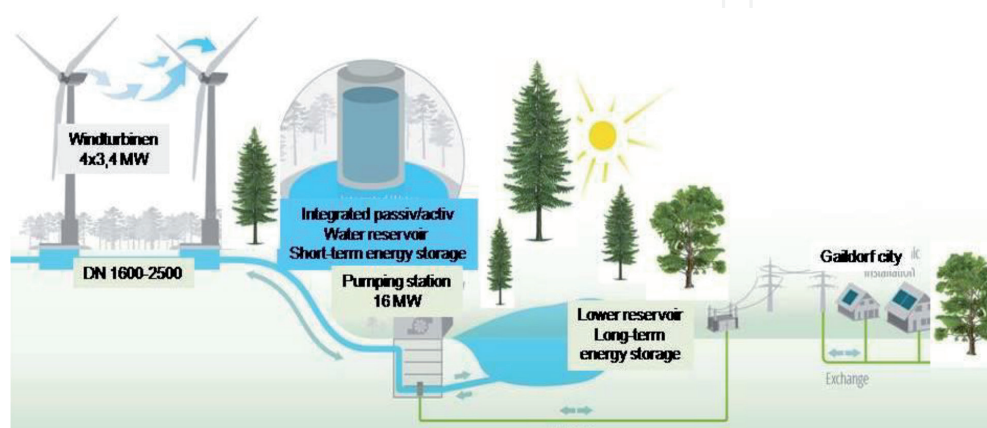

Figure 13.
Sketch of the wind-hydro system in Gaildorf (own study based on [22]).

turbines in this project are within the scope of responsibility of a German company bearing the name Voith Hydro [32, 33].

South of the hydroelectric power plant, a substation will be built to provide the connection with the existing 110 kV line of the BW operator.

The draft of the Gaildorf system, which covers all the components, is provided in **Figure 13**.

3. Conclusions

1. The faster and faster development of electricity generation technologies based on renewable sources and their popularisation requires system solutions which enable energy storage both on a short-term and long-term basis. Selected energy storage technologies should be integrated both with the RES source and the specific network.

2. In the case of the hybrid system, synergies between the technologies are of particular importance. The costs of planning and construction of the whole complex of facilities are lower than in the case of separate consideration of operation of the respective components, which surely is a fact that cannot be ignored.

3. The presented wind-water solution—the Gaildorf pilot scheme—is innovative in its nature and has not been used before. The water batteries designed and made by the Max Bögl corporate group located in the wind turbine towers are a kind of a short-term storage. It guarantees the highest efficiency of conversion of wind energy into electricity. It is also an element which consolidates the wind turbine with the pumped hydro storage in the valley (**Figure 14**) [22].

4. The introduction of a standardised solution, i.e. reservoirs in the foundations of turbine towers, is characterised by lower dependence on the location and higher reliability. The water battery is a new solution, a flexible miniaturised pumped hydro storage, which is an intermediate stage between the renewable energy source and storages on a broad scale. The standardisation of short-term storages does not require a single large reservoir; therefore, it does not require the adaptation of the facility to the location and the adaptation of the investment to the reservoir parameters. This often causes the reduction in the storage potential as was the case with the hybrid investment on the island of El Hierro. Neither does it require the use of a standard battery storage to complement the accumulation potential of the system.

Figure 14.
Arrangement of the components of the wind-hydro pilot project in Gaildorf (Credit: Max Bögl).

5. It must be emphasised that the innovative energy solution introduced in Gaildorf required the involvement of teams of experts from Germany and abroad in the works. The energy concepts developed by them must be considered both in the aspect of the energy transformation and the global climate change.

The broadly understood cooperation on the Gaildorf project and the final integration of the effects obtained by the teams will most surely contribute to the achievement of the objective set by Germany, i.e. the production of 45% of electricity from RES already in the year 2027.

6. The Gaildorf project combines energy storage with its generation by RES and control systems. The presented investment is a confirmation of the thesis by Jérôme Pécresse (senior deputy president of GE & CEO, GE Renewable Energy) about the growing interest in developments regarding RES, complemented by energy storages. Only such solutions guarantee rapid responses of the system to load changes and also full reliability.

Another project involving the integration of renewable energy sources, solar and wind energy and energy storages, is developed in the Indian Kadapa Hybrid Park, which will significantly improve the network stability.

Conflict of interest

The author declares no conflict of interest.

Notes/thanks/other declarations

Special thanks to Nancy Fürst from Max Bögl, Agathe Lefevre De la Houpliere from GE Renewable Energy and Meryem Yaman from Liebherr-International Deutschland GmbH for their photo contribution.

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