

Gotland I, an Engineered Power Jewel in the Baltic Sea

The story behind the proud rise, years of service, and sacrificing end of the world's first HVDC link, as a former Vattenfall employee sees it.

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How light and electricity came to Gotland

Gotland is a 3 200 square kilometer wide limestone island in the middle of the Baltic Sea and the home of about 57 000 people. According to the sagas the island was doomed to rise above sea level each morning and sink back at night. Tjelvar broke the curse by bringing fire to the island and keeping it burning through the night. His son Havde married Vitstjärna and these two became the first settlers. For centuries, light from the fire was not just the insurance against sinking, but also the only available alternative to light up people's dwellings.

In modern time, in the year 1851, the city council of Visby found themselves engaged in a debate about the terms for pubs and restaurants to serve alcoholic drinks. Should such rights be linked to certain obligations of common interest, to supplying streetlight in particular? After two years of discussions and several expert and legal consultations it was finally decided that 18 light-points should be paid for through the fees of liquid rights.

The streetlight question repeatedly returned to the city council. Was there really a need, besides the legendary curse? Which technical solution is the most efficient and can we afford it? Periodically the debate went intense, but so it did in many European cities. In Visby the first streetlights were petrol lamps, later replaced by gas operated systems. Towards the end of the 1900th century the battle changed. Gas stood against electricity until, in December 1904, after a diesel operated electricity generator had been set up in the town, electricity finally triumphed.

This description of how electricity came to Gotland is inspired from the book "Elektricitet på Gotland" by Torgny Rosvall¹, a well-respected island-born electrical engineer. Electricity arrived in Gotland before Vattenfall, in the middle of the 20th century, started to look into the possibilities of linking Gotland to the nationwide electricity network of Sweden. Also thereafter Gotland has been shaping its own history although Vattenfall's influence has increased following the establishment of GEAB in 1978. Vattenfall holds a majority position in the energy and distribution company. Research and development has for many years been present, mainly driven by the fact that the island has proved to be a uniquely suitable place for testing new equipment and solutions.

¹Torgny Rosvall born 1919, dead 2014:"Elektricitet på Gotland", in Swedish, ISBN 91-85716-86-3

The 1954 DC link to Gotland – a result of foresight thinking

Gotland I, an engineered masterpiece jewel

Few technical innovations reach success without a set of strong and tuned drivers. Demand is crucial, but economical, technological, and political dimensions are equally important. Gotland I had them all! When the world's first HVDC link was inaugurated in 1954, it marked the start of something new, but among all it changed electricity supply on the isle of Gotland.

The 96 km long cable linked Västervik on the mainland of Sweden to Ygne on Gotland and was in place from 1953. The link could from 1954 supply 20 MW at a time when the maximum load on the island was 10 MW and the yearly consumption 50 GWh. The start was not without problems, but soon they were overcome and in hindsight Gotland I served its purpose well for 32 years.

That Gotland I marked a change for the local electricity customers can be verified by the author of these lines. The family moved to Gotland in 1954, and my mother and father discovered that the price of electricity there was twice the price on mainland Sweden. We children were told not to leave lamps on, be quick to shut the door of the refrigerator and select the listening to the radio. These rules faded away after the DC cable went operational and the tariffs were reduced.

The background to the DC effort

The Swedish State Power Board, today the limited company Vattenfall AB, but already from the beginning shortened to Vattenfall, was created to exploit the state-owned water resources of the main rivers. The construction work began in south Sweden, but the main water resources were in the north, and soon engineers found themselves occupied with thoughts about how to bring electricity from the north to the south. Both alternating (AC) and direct (DC) current transmission lines were considered. Long AC lines lead to phase shift problems and long DC lines tend to get high losses. For decades researchers argued about the best choice. AC was chosen for the growing regional net, but from 1920 ABB (then ASEA), kept testing DC for transmission. Consequently, both alternatives were developed in parallel for decades. When in 1952 the longest AC line for 400 kV in the world connected Harsprånget in the north to Hallsberg in mid-Sweden, a distance of 1000 km, it was merely a sign that AC, for the time being, was ahead in the race.

Sweden was not directly involved in the Second World War, but the war set the terms for Swedish trade, development, and political agenda. The development of domestic hydro resources became a guarantee against disturbances of coal and oil import. A united parliament supported the view, and the country's belief in a better future based on new technology and industry development was strong. Equal economical options to all parts of the country were important and guided the parliament towards the decision in 1946 to create one single grid transmission organization. Vattenfall was given the administrative and operational responsibility, but all major producers had legal rights to use the common grid. This mindset also opened up thoughts about including Gotland in the country-wide electricity development.

The price of electricity on Gotland becomes annoying

The lack of exploitable hydro power resources made Gotland dependent on imported coal and oil. The price of electricity was higher than elsewhere in Sweden. On the island Gotlands Kraftverk AB supplied power from its main station at Slite to all customers outside the town of Visby. The town had its own utility, Visby Elverk, but with the exception of some diesel engines the city had to rely on purchased power.

Already in 1941 Theodor Gardell, a parliament member from Gotland, had raised his voice and questioned the price of electricity on the island. Fair electricity prices became an issue in the

parliament. Finally, in 1947 Torsten Nilsson², minister of energy, announced that Vattenfall was studying the possibility to use an underwater DC link to connect Gotland to the main land.

Vattenfall starts considering a cable solution

A few weeks later, on February 4, 1947, the Board of Visby Elverk met to discuss. They outlined three alternative options. 1) Keeping on buying power from Gotlands Kraftverk at Slite. 2) Investing in a new steam-based power plant at Visby. 3) Developing the option to buy power from mainland Sweden through a cable. The Board concluded that all three possibilities should remain opened and that contact with Vattenfall should be established to learn more about the cable-case.

The reactions in the management of Gotlands Kraftverk must have been a mixture of surprise and disbelief. Losing Visby Elverk as a customer would be a hard blow, but are their alternatives 2 and 3 really feasible? At the same time the management is in a delicate and squeezed position. The shares of Gotlands Kraftverk are controlled by Skandinaviska Elverk, whose mother company is ABB (ASEA), and ABB has a clear interest in alternative 3.

Finally, on September 19, 1947 the involved parties meet. Bo Rathsman from Vattenfall confirms to representatives from Visby Elverk, Gotlands Kraftverk, and Skandinaviska Elverk that a project study is ongoing, but still in an early phase.

ABB and Vattenfall had years of joint DC research

When the Minister of Energy in January 1947 declared that Vattenfall was studying a cable solution to Gotland, he must have had direct contacts with Vattenfall, as the internal project study was signed February 18, 1947. Vattenfall had, however, during years discussed DC technique with ABB and even carried out joint research for long distance DC transmission over land.

The DC research team was led by Dr. Uno Lamm from ABB, and the work was closely followed by the General Director of Vattenfall Waldemar Borgquist, who himself was a brilliant electro engineer. Vattenfall had a problem and ABB might supply a solution. As early as 1943 Vattenfall and ABB agreed to test equipment, and a few years later a prototype AC/DC converter based on mercury ion valves was set up in Trollhättan. For the testing an extra phase line on a north-bound line out of Trollhättan was used, before the current was converted back to AC again.

To save money it was suggested to use only one phase line and to close the circuit via the earth. The theory, however, needed verification through practical tests, but other electricity systems like telephone cables, electric trains, trams or even large industries might influence such tests. The solution to solve the dilemma says something about the belief in engineers and industrial development in the 1950s. Trains were halted, telephone systems paused, and several large industries shut during the minutes of the great test. Imagine such a proposal today!

Neither Vattenfall nor ABB were unprepared to take on the challenge to connect Gotland to the mainland via a DC cable, when the Minister raised the issue. The focus of the ongoing development had “only” to shift from transmission over land to the bottom of the Baltic.

Gotland I – the world’s first full-scale HVDC project

The outline of the project, Gotland I

At the mentioned meeting of September 19, 1947, Vattenfall and ABB presented a cable proposal for 100 kV and 10 MW, with the Baltic Sea completing the circuit. In a later project phase a second

²Torsten Nilsson was Minister of Communication and energy matters were handled there.

cable would allow 200 kV between the two poles, which would increase the power to 20 MW, and a possible further step could increase the voltage and thus even give more power. Cost estimates were in the order of 9 million, 7 million, and 2 million SEK³ for the three steps. The first step could be operational during 1955. Vattenfall's Bo Rathsman, however, underlined that several technical matters still needed verification. He also made it clear to the participants that the information should be treated as confidential. Any comment to the press should lie strictly within an officially written statement from Vattenfall and ABB.

In January 1949 Vattenfall and ABB presented a developed project study. The chosen cable stretch was Västervik – Ygne (favoured before Nynäshamn – Visby), the voltage level set to 100 kV and the power designed to 20 MW. During 1949 the plans were verified through tests in Trollhättan, in Ludvika, and at the chosen locations for the converter stations. In 1950 the parliament – as part of the state budget decision for Vattenfall – decided to immediately write off the investment capital, thus making it possible to give Gotland comparable prices with mainland Sweden. In hindsight a remarkably generous state support paid for via Vattenfall's budget and thus ultimately also its customers. The representatives from Gotland were pleased, but there was, however, a clause in the contract between Vattenfall and the buyer of the power, Gotlands kraftverk, that several years later would float to the surface and surprise some. The guarantee of mainland price levels was limited to 15 years.

Manufacture and assembly

The project is rolled out with all the technical, economical, and practical questions that are associated with a world class pioneering project. The mercury ion valves in their complex glass containments are manufactured and trimmed together as functional units. Controls and equipment are tested, verified, and linked together. A radio link between Västervik and Ygne is an essential part of the system control. The DC cable is fabricated in lengths of 7 km, which are joined together to the full length in Stockholm. The cover of the cable is armed with iron straps, which close to the shore lines are spun in doubled layers. To the specific DC matters come of course also normal AC matters, such as new power lines, switch yards, and conventional controls.

The HVDC cable was in place from the summer of 1953. The return path through the sea had its own technical problems. To avoid leak current access to the lead cover (or the protective iron layer of the cable), which would cause corrosion, the "electrode ponds" are placed some 10 km from the landing points of the cable. Corrosion is active at the anode, the positive pole. In the construction work of the ponds nothing can be joined together with metal. Ceramics and old-fashioned wood based assemblies are used.

Gotland I in operation

A magnificent inauguration

On March 7, 1954, construction work had reached a stage when the first kWh could be sent from the Swedish mainland to Gotland. The work on the current-converters was ongoing, but one converter package was available and allowed the first energy to be sent over by using reduced voltage level. In July the work on the two stations had caught up and higher voltage and power could be tried. The official inauguration took place on May 26, 1956. The host was the General Director of Vattenfall Åke Rusck. Among the guests were not only former General Directors Gösta Malm and Waldemar Borgquist, but also a future one, Erik Grafström, at the time Undersecretary of State. Among the 200 invited also the MD of ABB Åke Wrethem and Dr. Uno Lamm were seen.

³ 9 million SEK corresponds to 1 million €. Consumer index indicates a factor 20 for conversion to today's money.

The latter informed about the project together with Sture Ekefalk from Vattenfall. The speakers praised the pioneering and epoch-making work and the cooperation between Vattenfall and ABB.

The startup period is not without problems

In the beginning disturbances occurred. They caused irritation as the power cuts in general were total. In his book Torgny Rosvall describes how the staff of the power station at Slite in the absence of modern control equipment learned and managed to build up simple and robust new routines to restore power. When the DC link came back, the synchronizing of the systems should be handled before the thermal power could return to its hibernation stage. Although irritated, the population of the island was pretty stoic and awaiting. After a while the situation changed to the better and faults became rarer. An issue that caused some discussions over the years was the electrode ponds and the currents they caused in the sea. The current could harm fish stocks and it caused corrosion on ships in the neighborhood of the stations. Electrical fields in water create ion-movement between different metals of a ship, e.g. the hull of steel and the propeller shaft of bronze. This can be solved technically, but it still creates debate.

The DC link with its two manned converter stations in Västervik and Ygne became part of Vattenfall's regional organisation Motala Kraftverk (later renamed Vattenfall Östsverige).

Gotland I is upgraded in the late 1960s

Gotland an indirect customer of Vattenfall and negotiations for a new period

Up till 1965 Vattenfall kept supplying power to Gotlands Kraftverk, the main operator on the island. Vattenfall delivered the electricity at Ygne at mainland Sweden's tariff level plus additional costs for the operation of the DC link, in line with the signed agreement of 1949. At the time of completion of the link it supplied all power, but from the mid 1960s local power stations had to fill up to cope with consumption. When the contract terminated in 1965 Gotlands Kraftverk indicated that they wished a solution which made it possible to transmit power via the DC link to Gotland from the hydro plants of Voxnan AB, a sister company within the group of Skandinaviska Elverk.

Gotlands Kraftverk saw the need to invest, but also the option to economize the operation of all power plants of the group. This was a reason to change the contracting principles for the DC link. Gotlands Kraftverk suggested an upgrade of the capacity of the cable. This happened to coincide with an ABB wish to test a new step in the development of HVDC technique. The negotiators Folke Forshed and Lennart Lundberg from Vattenfall demanded that parts of the costs for the upgrade should be covered by Skandinaviska Elverk on behalf of ABB. This became the base for the signed agreement. The DC link was leased to Skandinaviska Elverk, while Vattenfall continued to operate the converter stations.

Another new technological step of HVDC

With an upgrade to 30 MW Gotland I thus took another step in the history of HVDC development. New current converter packages based on thyristor technique were put in series with the existing mercury ion converters. At the same time the voltage level of the cable was increased. The work was completed in 1970 and got an unexpected introduction period. This year Sweden experienced a shortage of water and thus reduced hydro power capacity. The cable was reversed and Gotland for a period supplied mainland Sweden with 30 MW thermal power.

About an incident with no consequence

The relations between Vattenfall and Gotland were calm during the 1960s. Perhaps an event, without historical significance, can illustrate the calm passage of days. A now retired Vattenfall

employee can here reveal that S/Y Gatenshielm, which was the two-masted sailing vessel of the Sea Scout corps of Visby, in August 1961 was cruising northbound outside Ygne, when a sudden thunder struck. In the stormy and changing winds the ship was carrying too much sail, and as the Volvo-Penta engine refused to start the situation became critical. It remained only to carefully steer up close to the wind and find an emergency anchor place more close to shore and fix the sails there. We managed to find a water depth of 10 – 20 m and let go the anchor. After a while the reduced sails could be set again. The strong but manually operated capstan, however, showed difficulties to bring in the anchor chain. I saw after a while that a cable was hooked on the anchor a few meters down in the water. With efforts and some creative thinking we managed to get a rope under the cable, hold it up in order to free the anchor and get it back on board. Finally the cable could be dropped back to the bottom. Back in the port of Visby we did not say anything as no electricity disturbance had been heard of.

A new situation for power supply from 1970

Weather, views, and foreign deeds – all test the energy course

Around 1970 the energy issue took a twist on the political arena. The book “Silent Spring” by Rachel Carson in 1962 – as an example - questioned the future of industrialized societies. Other followed, and soon a movement of questioning protesters developed. In Sweden the political unity about the future energy supply disappeared as both new hydro and nuclear extensions were under attack. Yet, energy consumption kept growing and on top of this also a few unexpected other events tested the system.

The weather brought severe water shortages 1969-70, with consequences for hydro power. The price of oil rose sharply because of the Six-Day War in 1967, and the October War in 1973 even struck on supply lines. Both electricity and oil were periodically rationed in Sweden and in Western Europe. In spite of a politically imposed price regulation it was impossible to break the upward price spiral. The power companies were challenged as new ideas about how to supply energy for the future emerged. Plans of the power industry came under attack from visions about new energy options, and new mindsets were introduced. The industry ought not just to supply customers, but rather market “Negawatts” on the same terms as “Megawatts”.

From the early 1970s a dramatic shift in the planning of new energy projects took place. New ventures were more questioned, took longer time, and some stalled, and yet the pressure on energy companies to supply the daily needs of their customers remained. Politicians were squeezed and the society a lot more unsure of its future route of energy supply. The difficulties remained for decades.

Energy supply on Gotland - once again - in focus

Gotland I kept on delivering, but its capacity of 30 MW was serving a shrinking proportion of the needs of the island. Both that and the price of energy were widely discussed. Fees on electricity went up on mainland Sweden, but on Gotland they rose more and the future for the business community on the island was worrying. In 1970 Nils Franzén, a member of the parliament from Gotland, argued that electricity customers on Gotland would face 40 – 55 % additional charges at a time when Vattenfall was not increasing their tariffs as the situation was only temporary. Vattenfall had - at this time - little to do with the price of electricity on Gotland and the stated facts were not the complete truth, but it nevertheless opened up a new debate. Mr Franzén and local politicians realized that the once given promise of “comparable prices with the mainland” had become obsolete. Vattenfall found itself in a renewed relation to Gotland.

From the historical perspective the debate during the 1970s is a déjà vu of the discussion 20 years earlier, but for one changed factor. Then, around 1950, all agreed on the future energy policy of the country, and the problem of electricity prices on Gotland was easy to single out and discuss. Now, in the early 1970s, Sweden's energy future is under fire, shaky and disputed, and the problem of Gotland becomes an irritating and not wished-for issue on country level. Politician's from Gotland, however, did their best to raise their voices above the noise from the country level. In 1975 a request in the Parliament demanded that Vattenfall should – once again – guarantee the electricity supply to Gotland. The debate praised Vattenfall's equalizing tariff policy and held that against the cost-based philosophy of the present supplier of electricity to Gotland, the Skandinaviska Elverk.

Vattenfall is relinked to the energy matters of Gotland

Various project studies are made by Vattenfall during the 1970s

Vattenfall was not directly involved in the debate about future electricity supply to Gotland. Many energy studies, however, were made in the general search for alternatives and options for Sweden's new long-term energy future. One happened to involve Gotland. A possible coal-fired plant on Gotland (in the Tofta area not far from Ygne) in combination with a new cable to/from the island was studied. Vattenfall had from 1975 set up a new department for thermal power operation, and any power unit on Gotland would search synergies with other thermal units.

In May 1975 the parliament decided to allow two additional nuclear units to the eleven already decided upon, but following an election in September 1975 the majority swung and with it the energy map of the future. While the fog lingered over the future energy road, politicians from Gotland saw a chance to approach the new Minister of Energy Olof Johansson. The fact that a legal process about the price of electricity on Gotland had stalled made it possible to argue for immediate initiatives from the Government. The value of the problem had increased by time and both the economic and the political risks at stake were pressing.

Gotland – once again – an issue in Parliament

On the island the industries were worried. The largest, Cementa, used about half of the electricity consumed on the island. The price was important, but so was the future quality of the supply. The continuous process with its different grinders and heating stations is relying on a stable smooth electricity supply. Variations in voltage or frequency cause deviations in time or temperature at various points in the process and thus affect the quality of the final product. A few other industries had similar concerns and the local politicians knew it. When the Member of the Parliament Per-Axel Nilsson from Träkumla in May 1976 asks the responsible Minister of Energy Rune Johansson⁴ about the future for the electricity supply of Gotland he gets a reply indicating that the Minister has reasons to believe that Vattenfall is already engaged in negotiations with the Skandinaviska Elverk. The aim is to reach a suitable solution and allow the new order to begin from January 1, 1978. The comeback of Vattenfall is this time not triggered by R&D technical matters, but rather administrative political matters.

Vattenfall deepens the cooperation with Gotland

Following the election in 1976 it was the new Minister of Energy Olof Johansson who on July 8, 1977, at a press conference on Gotland could announce that Vattenfall and Skandinaviska Elverk had reached an agreement. Vattenfall had bought the assets of Skandinaviska Elverk on Gotland

⁴ Rune Johansson was Minister of Industry, which included energy matters.

and had, in partnership with the commune of Gotland, set up a new distribution and energy company, Gotlands Energi AB.

Behind this simple statement from the Minister were hidden hours of hard work from many involved partners. Gotlands Kraftverk owned production and distribution on rural Gotland and was owned by Skandinaviska Elverk, which was owned by ABB, in its turn controlled by the Wallenberg family. They were key players. Visby Elverk was responsible for the electricity supply in the town and owned by the commune of Gotland. As the operation of the thermal power at Slite was partly linked to the Cementa process, also the largest industry on Gotland had a say. Finally, there was also Vattenfall, the facilitator and incoming part of the energy future of Gotland.

Vattenfall had to find a sustainable and reasonably economic structure for the electricity market of the island and, in bilateral negotiations with each party, sew together an acceptable package. From Vattenfall the regional Director in Motala Nils Holmin and the Director of economy Jöran Holdo coordinated the evaluation work and the negotiations on Gotland. The key to a completion of the package, however, lay in the discussion between Vattenfall and Skandinaviska Elverk about the value of the assets on Gotland. The dialogue had its ups and downs. Vattenfall's Director of power business Sven Lalander and the MD of Skandinaviska Elverk Ulf Glimstedt had difficulties finding a suitable deal. Towards the end of the discussions were also present - for the State of Sweden – the Minister of Energy Olof Johansson and – for the owner of Skandinaviska Elverk – Dr. Marcus Wallenberg. About these final talks Sven Lalander several years later made a stark and straightforward comment purporting that “the two discussing individuals were very different personalities and one of the two was clearly a more experienced negotiator.”

A new era with GEAB, new cable links, and the famed end of Gotland I

Vattenfall and the commune of Gotland joint owners of GEAB

The discussions between Vattenfall and the commune of Gotland were easier. Once the solution with Skandinaviska Elverk was settled, the new distribution company could be shaped through a merger of Visby Elverk and parts of Gotlands Kraftverk. The shares of GEAB were split by 75 % to Vattenfall and 25 % to the commune of Gotland. The preparations for the startup of GEAB from January 1, 1977, were ongoing through the autumn of 1977. Some production assets were incorporated into Vattenfall's thermal power division. As the first managing Director Sten Söderström was recruited, who came to lead a successful GEAB for many years.

Vattenfall invests in the energy supply of Gotland

The politically imposed deal about the future electricity supply of Gotland did not stop with the purchase of assets from Skandinaviska Elverk at 160 milj SEK⁵. To this came the added cost of assuring “comparable prices with mainland Sweden” worth at least 360 million SEK and a refurbishment of some acquired assets at an extra 100 million SEK - at least. After the nuclear referendum in 1980 Vattenfall decided to invest in a second DC link to Gotland. This made it possible to reduce the operating thermal costs on the island, but it still constituted a short-term cost of at least 100 million SEK.

The new HVDC cable Gotland II supplied 130 MW at 150 kV and was based on thyristor converters. The dimension of the cable was a lot larger than Gotland I, almost a decimeter in diameter and the weight about 30 kg per meter.

⁵ As an indication for conversion from 1977 to present values use the factor 10, which derives from consumer index.

The new link went into operation in 1983 and the inauguration took place on November 21. The link suffered a number of faults and the numbers did not improve as expected. This was annoying as each fault meant a full black-out for Gotland. The capacity of the cable was higher than the maximum load of the island, thus no spinning reserves were present. As the author of these lines was now head of Vattenfall Östsverige I felt the pressure of the media lines “Vattenfall shuts down Gotland”. After almost two years of operation the statistics kept indicating at least one shutdown per month, possibly two. The situation was becoming unbearable.

One cable becomes a package solution

In March 1985 the Board of Vattenfall held its meeting in the regional office in Motala. General Director Jonas Norrby wished to inform the Board and asked me, then responsible for Vattenfall Östsverige, which included Gotland, to describe the situation and the possibilities to improve it. The Director of Planning Tage Hytén followed up and hinted about an option to solve the problem through doubling the link at a cost of around 200 – 300 million SEK⁶. Jonas Norrby concluded that the issue was important and that a prepared suggestion would appear at the next Board meeting. This did not happen. One board member, a strong profile and local politician from Gothenburg, Göran Johansson cut the debate short by saying that it would be a waste of time to listen to this again. He claimed that it was obvious that the situation was not sustainable and that Vattenfall had no other option than to double the cable connection. He proposed that the two rapporteurs should leave the room and write a decision document that the Board could agree upon before leaving. Gotland III was decided.

Gotland III was constructed as a minus-pole and closed the circle via Gotland II as its plus-pole. This was not unique, but the demand to allow each of the two links to be capable of using the sea as an earth-line in case of a fall-out of one of the cables was a challenging quality requirement. As each of the cables could carry maximum load to the island, the system would – in theory – secure deliveries in most situations. To this was also added the advantage that the sea is only used occasionally.

The “de-auguration” ceremony of Gotland I

The need to improve the supply situation quickly meant that Gotland III was a prioritized construction. On the critical line was the permission license to build and lay a cable in the sea. To simplify the legal process, it was decided that Gotland III should “replace Gotland I”. Thus in 1985 a rare and special “de-auguration” was held at Ygne before the necessary scrap-work on Gotland I was initiated. Although the ceremony was forward-looking it, of course, also had elements of nostalgic meetings between individuals and the recalling of many memories of the pioneering work behind Gotland I. Some 50 “old-timers” from the 1950s assembled, including Dr. Uno Lamm. The final shutdown of Gotland I was carried out by the very same operator, David Johansson, - now retired - who 32 years earlier had started up Gotland I for the first time.

The circuit of Gotland I had irrevocably been opened and the life-time of a world class pioneer invention and a technical jewel in the Baltic Sea had reached its end.

After text

Awaiting Gotland III and the double-link operation

The electricity situation on Gotland during the years leading up to the completion of the doubled link was far from perfect. Some improvements in performance were recorded, but also in the last

⁶As an indication for conversion from 1985 to present values use the factor 5, which derives from consumer index.

year before completion a couple of total blackouts occurred. Customers complained of course, but generally speaking the people on Gotland were rather well informed and thus tolerantly awaited the promised future, in contrast to tourists and summer house owners, who with less knowledge reacted more spontaneously. The personnel of GEAB and Vattenfall deserve admiration for all their service efforts and performed duties throughout these years.

Vattenfall had put its reputation at stake with the new solution and, to some extent, the regional director his honor. In numerous media interviews I had promised that there would soon be light to be seen in the tunnel. Gotland III went into operation – together with Gotland II – on November 18, 1987, and almost all service troubles ended.

Gotland remains a testing site and the HVDC-light technique is a proof

In the 1980s wind power started to grow on the island, mostly through private initiatives. Vattenfall built an early large wind power unit of 2 MW and a research station. Wind power has continued to expand. On a good day - if the wind is blowing - it is quite possible that the island may be self-sufficient and even export power to the main land.

In the 1990s the specific problems arising from wind power locations on the island led up to another milestone project development in the history of DC transmission. Towards the turn of the century the world's first commercial installation of HVDC light technique was set up on Gotland, but that is another story. This is another example of a prosperous cooperation between ABB, Vattenfall, and GEAB. The technique has presented a fantastic development during this century.

Through its unique electricity situation Gotland has come to take part in several other important steps in the history of electricity. Its outstanding contributions to the development of both HVDC and HVDC light during the 20th century are undisputed, but they are not the only ones. Also during the 21st century R&D on Gotland is continuing and is for the time being focused on smart grid issues.

Stockholm, April 27, 2017

Stig Goethe



This text is a specially edited translation of a somewhat longer Swedish text commenting on Vattenfall's R&D on Gotland up to the turn of the century. The aim of this text is to highlight glimpses of the factors behind, the work on, and the life of the world's first commercial HVDC-link Gotland I.

The author of the lines is Stig Goethe, a retired employee of Vattenfall, who was raised and went to school on Gotland. SG served 37 years in Vattenfall in various positions before he retired from Vattenfall AB in Dec. 2001 as vice president. SG has over the years held several international positions related to the future of electricity development.

During the work on the original Swedish text valuable comments have added quality to the article. Among others the author wishes to thank Carl-Erik Nyquist, Lennart Lundberg, Nils Holmin, Helge Jonsson, all former upper management colleagues of Vattenfall AB, and Per Norberg, professor and colleague.