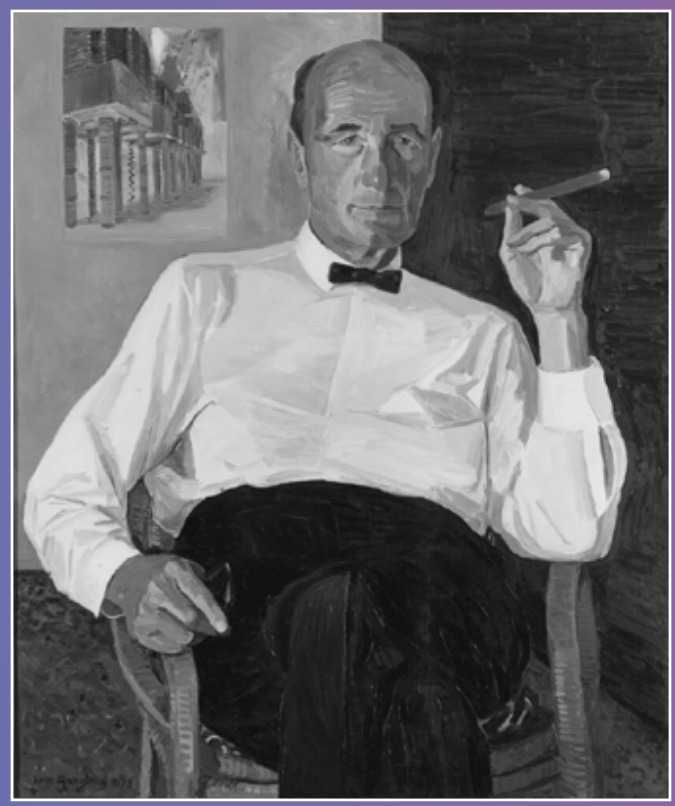
A Tribute to the Memory of

Uno Lamm

(1904–1989)



By Dr h.c. Bo Normark

Royal Swedish Academy of Engineering Sciences (IVA)

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Uno Lamm

(1904–1989)

Presented at the 2021 Annual Meeting of the
Royal Swedish Academy of Engineering Sciences

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Contents

Uno Lamm at his workdesk.

Foreword

Each year the Royal Swedish Academy of Engineering Sciences (IVA) produces a booklet commemorating a person whose scientific, engineering, economic, or industrial achievements were of significant benefit to the society of his or her days. The person to be recognized in the booklet must have been born at least 100 years ago. The commemorative booklet is published in conjunction with the Academy's Annual Meeting.

This year we acknowledge Uno Lamm, the "Father of High Voltage Direct Current, HVDC" for his crucial efforts to the development of technology for transmitting electrical power over long distances. During decades, he convinced his managers, colleagues, authorities, and politicians of the potential of his visions and thus laid the foundation for Sweden's early world-leading position and many years of great commercial success in building grids spanning vast geographical areas.

We wish to extend our sincere thanks to Dr h.c. Bo Normark for the time and effort he, assisted by Gunnar Flisberg, has dedicated to this year's commemorative booklet.

Tuula Teeri
President of the Academy

Camilla Modéer
Chairperson of the Medals Committee

Laying of HVDC cable to Gotland 1954.

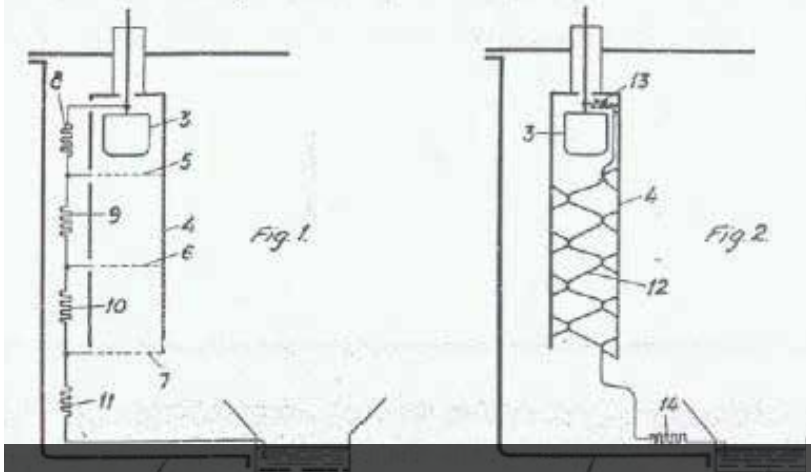
The author's perspective

I arrived in Ludvika in 1971 as a newly graduated engineer, looking to work with a technology I had barely heard of before: High Voltage Direct Current (HVDC) power transmission. The technology arose because the need for electrical power strongly increased throughout the century, but transmission of alternating current over long distances entailed considerable losses. These losses could decrease significantly if the transmission was done with high voltage direct current instead. However, that meant that newly generated alternating current had to be converted to direct current, which after this long-distance transmission would have to be converted back to alternating current again. The problem was the lack of technology for such conversion. Uno Lamm is the embodiment of the technology that solved this problem, and he rightly received the epithet "The Father of HVDC."

I ended up staying there for 30 years, and have had ample opportunity to reflect upon that time, especially while authoring this commemorative publication. What met me was a company culture that I far later realized originated in the pioneering time when the operation was led by Uno Lamm. So what is it about? I think it starts with a number of concepts that are frequently used today, an innovative environment that creates entrepreneurs. This environment is characterized by inclusion and cooperation, where initiative-taking is being encouraged, even if it doesn't always turn out right, while being

passive is a negative thing. Uno Lamm had the ability to visualize what the organization would achieve and made the employees feel proud to be part of an important change. I learned early on that "The world can live without HVDC, but it will be better with HVDC." Thus, the market has to be created, but in the long run, this means that the potential market is very large — it's the entire market for power transmission! During Uno Lamm's time, the conditions to build complete HVDC facilities didn't really exist, as a very important component was missing. To be able to do this, one needed a controllable component, which in the first generation of HVDC facilities consisted of mercury-arc valves (a controllable electrical component where mercury is a key ingredient). Great effort was devoted to the development of this component, but simultaneously, extensive theoretical calculations were being made to map out the properties of a complete HVDC facility. So decades were devoted to selling the idea of how useful this new technology for HVDC transmissions was, long before one could even build these facilities! One can assume this was the reason why he successfully continued developing this technology for over 20 years before the first order was placed! This method of working survived its creator, Uno Lamm, and I myself got to experience two further technology changes where we sold the usefulness of new generations of technology long before the products were ready. The market was simply created in parallel with the product development. We could refer to earlier experience and point out that "it will cost more than expected and take more time, but the market is a lot bigger than we first thought." This created a positive, technology-friendly environment, but also a good ability to assess the market potential

Till Patentet N:o 69848.



PATENT № 69848.

BESKRIVNING

OFFENTLIGGJORD AV

KUNGL. PATENT- OCH REGISTRERINGSVERKET.

ALLMÄNNA SVENSKA ELEKTRISKA AKTIEBOLAGET,

VÄSTERÅS.

Anordning för att förhindra baktändning vid metallånglikriktare.

(Uppfinnare: U. Lamm.)

Klass 21:g 14.

Patent i Sverige från den 16 februari 1929.

Patent "Arc Back"; Early prototype mercury arc valve.

of the next generation of technology. In my first job, I was assigned to develop HVDC technology based on thyristors (a power semiconductor) under the guidance of one of Uno Lamm's "disciples." From the very start, we calculated the thyristor performance that should reasonably exist in about 5 years and planned HVDC facilities based on that platform. This progressive work method was strengthened by the fact that from the very beginning, Uno Lamm endorsed an international team, and not least collaborations with potential end clients — and at certain times, strategic alliances for technology and market development. This legacy was also managed well by the organization long after he left the Ludvika operations and moved to the United States.

Uno Lamm's legacy, with the ability to "look into the future," focus on the ultimate usefulness, work inclusively with people from other environments, and seek strategic collaborations, has been crucial in the working life of many of those who, through the years, have worked in the HVDC field after Uno Lamm.

That the HVDC technology is experiencing a new golden age right now, driven by the expansion of a renewable energy system, was not a thought that existed in anyone's mind when the technology was developed, but it would probably have suited the subject of this publication, Uno Lamm, quite well. The market is far bigger than both Uno Lamm and his successors thought as late as in the 2000s. Not least, Uno Lamm would have been happy about the present-day Swedish entrepreneurs in other fields of tech-

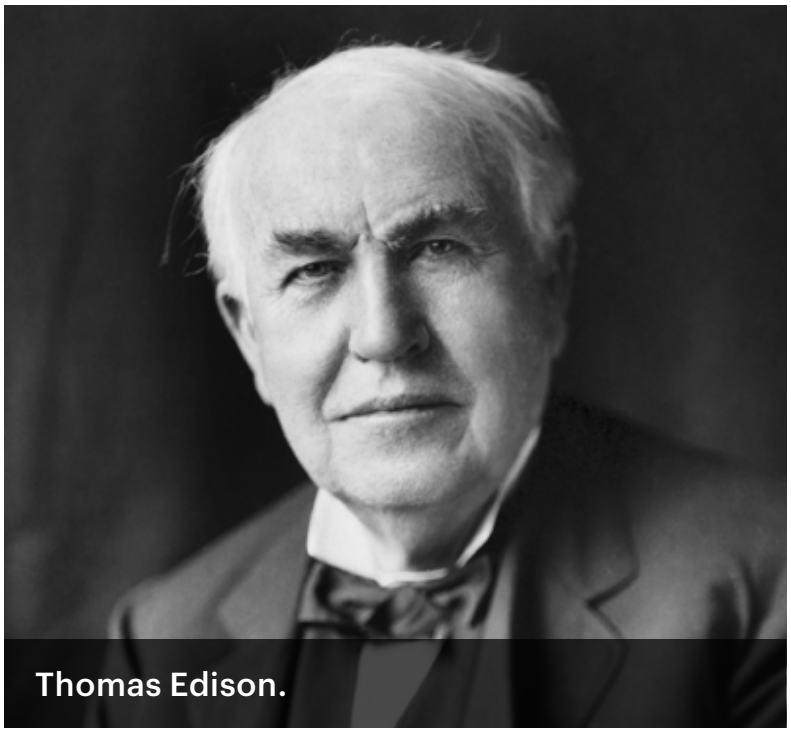
nology creating new industries based on his basic recipe of understanding the development potential in market and technology combined with strategic alliances in the value chain. Uno Lamm succeeded in acting as an entrepreneur in a large company where he created an entirely new industry. But he was also a lot more, a complex thinker who felt anxious and even responsible for thinking about the survival of mankind, and who inspired an author to write an epic that later received the Nobel Prize.

The technology battle between alternating current and direct current

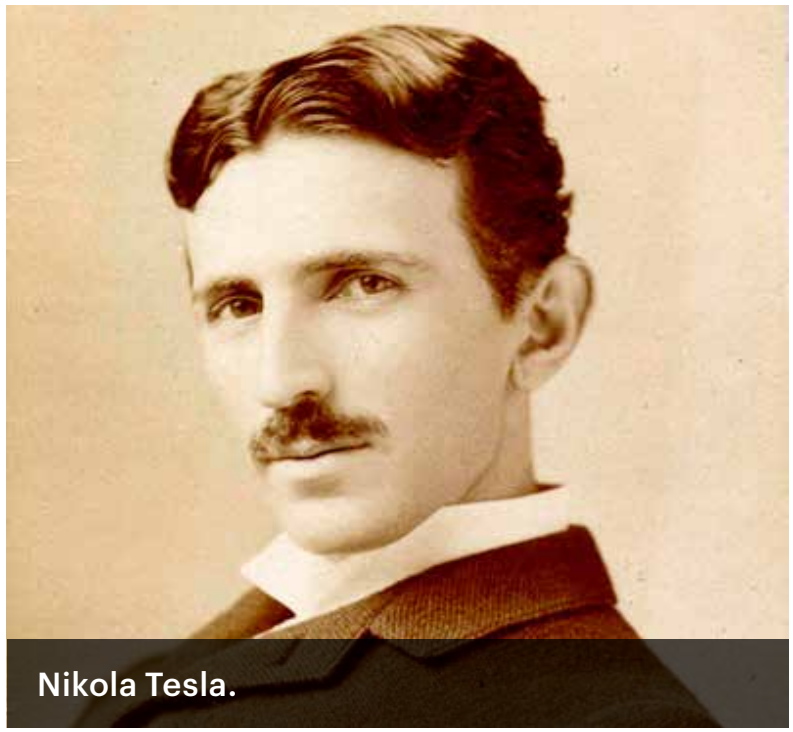
One simply cannot speak about Uno Lamm, the creator of the HVDC technology that solved the fundamental problem with direct current and who made HVDC a commercial success, without going back to the 1880s and "The Battle of the Currents" that was fought between two giants in the world of inventors — Thomas Edison and Nikola Tesla. Edison was the originator of the direct current system that was universal when electricity was first introduced. Edison invented the light bulb that was instrumental in creating a clear market for electricity. It was both relatively inexpensive and delivered high light output. But he also invented generators and batteries, and in this way built a complete system based on direct current. Changing the voltage, however, was both very difficult and very expensive, which was a big disadvantage when one wanted to build larger systems and transfer the electricity over long distances.

Tesla was the one who developed components for an alternating current system. The alternating current had clear advantages since the motors were simpler and more robust, and it was considerably cheaper to change the voltage levels — and enabled to transport the electricity over longer distances.

This led to "The Battle of the Currents," which became a big display of smearing



Thomas Edison.



Nikola Tesla.

the opponent's technological solutions, and here any means was permitted. But the “Chicago World's Fair” in 1893 became something of a breaking point, as Tesla was contracted to supply the fair with electricity. Three years later, in 1896, a power plant was built by the Niagara Falls, and here, too, alternating current won the battle.

The rest, as they say, is history. Alternating current would completely take over the market for both the production, transferral and consumption of electricity. But direct current would have its revenge, and one of the main characters in the play to make this happen was the subject of this publication — Uno Lamm. Later, we will look at what the technology battle looks like today.

Uno Lamm at a converter station in Mellerud.

The young Uno Lamm

Uno Lamm was born in the year 1904 in Gothenburg, as the third of five children. His father, Fredrik Lamm, is described as a competent electrotechnical engineer and teacher at the Chalmers University of Technology.

Just like the other members of the family, Fredrik L. had diverse cultural interests. His fondness for the arts might have been at least as great as his love for technology. With his 39 years in the council of the Orchestra Society, he contributed greatly to music. He himself was a rather good violinist, but he also had a great deal of knowledge in various other areas of the arts, like architecture, painting, design and interior design. All of his children received music lessons.

Uno's mother, Aino, was from a distinguished Gothenburg family, and her father, August Wijkander, came to lead the Chalmers University for 30 years. Uno Lamm's early influence by technology became apparent when he later told a story of how he, while on a trip to Central Europe with his father, came into contact with the mercury-arc valves that were the key to the HVDC technology that he later succeeded in turning into a commercially viable product.

As an adult, Uno strongly opposed Nazism and communism and was very engaged in social matters. The foundations for this were most likely laid during his upbringing, which he described as follows:

"Growing up in the liberal society of Gothenburg, I remember well how at the start of the century, the idea was cultivated that all humans have equal worth and the right to vote in electing our leaders. They worked to give all children the right to go to school and improve their own lives. The care for the poor and the weak was also on the liberal agenda, and they entertained the good faith that by abolishing poverty, all crime would then cease to be. They also tried to see where to draw the line for the government's power over its citizens, and they were clear advocates of free enterprise."

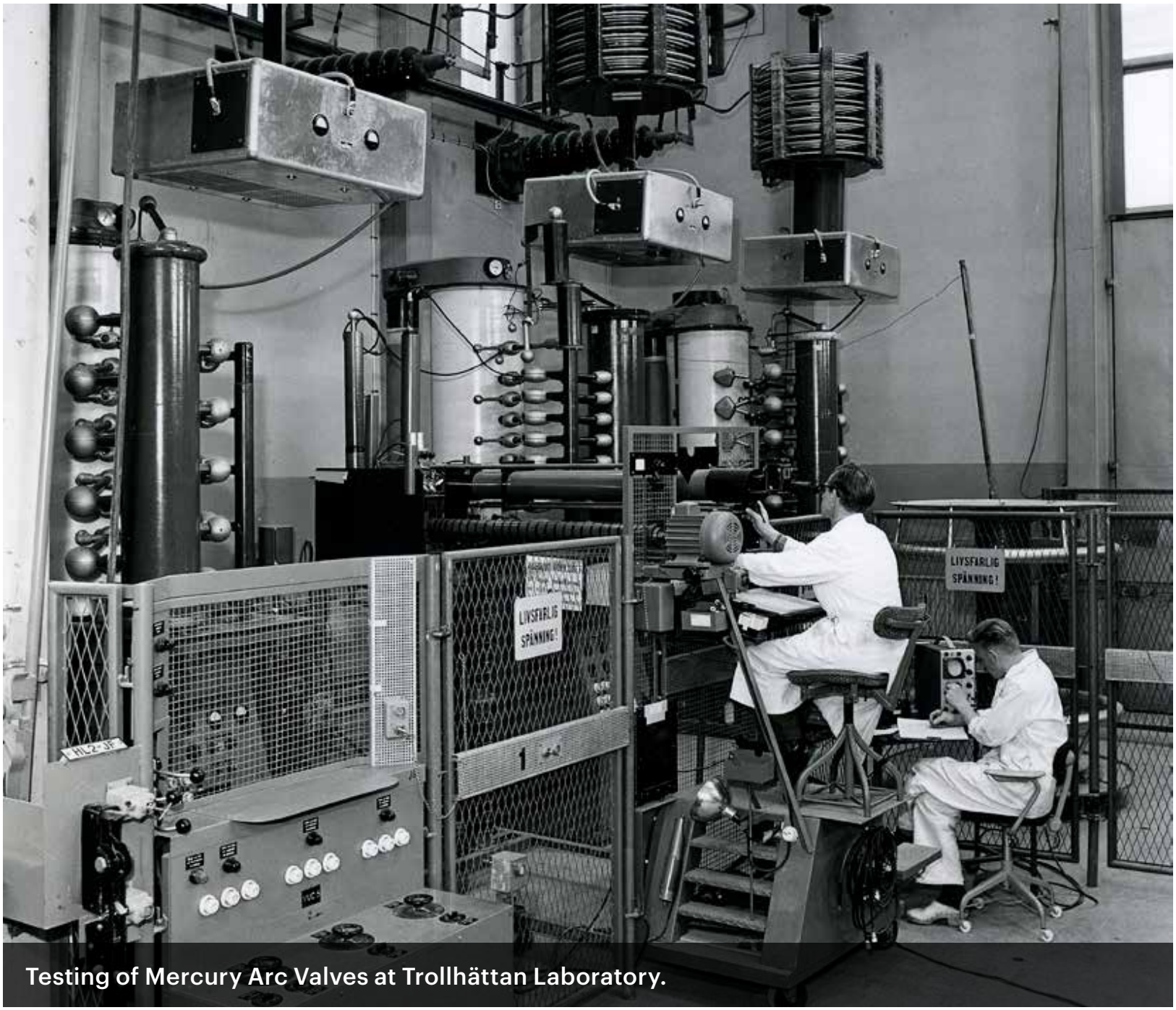
The engineer

Uno Lamm studied at KTH Royal Institute of Technology, perhaps not surprising considering the very strong position his father had at Chalmers. It was a reasonable choice to escape expectations and to have a possibility of a freer life. His studies went well, and he graduated in 1927 at age 23. He immediately was accepted to join the trainee program at ASEA which gave young engineers a 12-month introduction to the company, something they still offer today. He was allowed to interrupt his trainee period to do military training.

Uno had apparently already made an impression: when he returned to ASEA in 1928 to continue the trainee program, the Ludvika site manager, Karl-Erik Eriksson, had other plans for Uno. He suggested that the young trainee should leave the program and instead tackle an acute technical problem.

The mercury-arc valves that had been developed over a long period of time had a crucial technical weakness called “backfiring.” In short, this meant that the valves that were to conduct or block electricity in a controlled manner could instead start conducting electricity suddenly and uncontrollably. Uno accepted the challenge, which came with an increased monthly salary from SEK 200 to SEK 250, and started working with converters for industry.

Uno Lamm wrote of this:



Testing of Mercury Arc Valves at Trollhättan Laboratory.

"Karl-Erik asked me if I wanted to handle it and get rid of that phenomenon. I worked on it for 35–40 years without ever being able to remove the backfire phenomenon. My only consolation was that none of the competitors were able to do it either, and its nature is probably such that it's a matter of being able to reduce the probability of it, reduce the frequency of it."

Here, he describes a central aspect of the field of engineering. Nothing will ever be perfect, but one has to be able to judge what is necessary to be able to deliver something that's 'good enough,' and the importance of getting to market quickly. The mercury-arc valves were far from perfect when they came on the market, but they "got the job done." The software industry has taken this mindset to new levels today, where they provide the market with products that are demonstrably not yet fully developed, but that still give them a stronghold in the market.

From 1929, Uno Lamm led ASEA's mercury-arc valve development. At the time, the valves could only handle a voltage of about 2,500 volts, and transformers for higher voltages were needed for transmission of electrical power over long distances. Uno Lamm was fascinated with the possibility of using the mercury-arc valves for higher voltages and came up with the idea of inserting grids at regular intervals in the anode porcelain, whose potential was controlled by external resistors. This patent became the cornerstone of ASEA's ability to build HVDC based on mercury-arc valves. In parallel with the development of the mercury-arc valves, Uno Lamm continued his research, and in 1943

he defended his doctoral dissertation at KTH on the transducer, a measuring device for direct current. He even coined the term “transistor” for a network of resistors that would have the same function as a transducer. When William Shockley received the Nobel Prize in 1956 for his discovery of the transistor, he said he had heard a Swede using the word, and he thought it fit his invention well.

After World War II Sweden needed a quick expansion of its electricity transmission system. The consumption of electricity doubled every decade, and hydroelectric power was expanded in the Lule river, far north in Sweden, while the consumption was in southern Sweden. Could this electricity be transmitted by HVDC at a lower cost and less losses in comparison with alternating current? It's an interesting fact that Uno Lamm considered it too much of a gamble because the technology wasn't sufficiently proven, while the manager of Vattenfall, Waldemar Borgström, was bolder. Instead of the HVDC approach, the choice was the world's first 400 kV alternating current system. To gain commercial experience with HVDC, they would have to find a different application. As the first reference facility for HVDC, Vattenfall and ASEA agreed on building a transfer to Gotland, with a capacity of 20 MW at 100 kV. At the time, they used electrodes that were laid in the sea as conductors, and so they only needed one cable. The contract, which was approved by the Parliament in 1950, was of course a great incentive for the staff of ASEA's Ludvika facility, who now had a concrete goal. So after around twenty years' development work to manufacture a rectifier with sufficient capacity for high-voltage direct current transmission, ASEA received an order for the HVDC Gotland project in 1950. It became the

first modern, fully marketable high-voltage direct current system at its completion in 1955. Uno Lamm himself led the start of the Gotland project, which had a lot of disruptions in the beginning, but soon enough the operation was satisfactory, and Vattenfall took it over. Gotland's electricity prices were cut in half when they got access to cheap hydroelectric power. At the official inaugural dinner, the power went out, and Uno Lamm later said that the most discouraging thing was the habit and speed with which the waiters pulled candles from their pockets and lit them. It indicated a frequent occurrence.

With this, Uno Lamm probably felt that he had achieved his goal of a properly functioning facility. The HVDC technology was commercially established, and the operation results were good. At the same time, he also stated that he had failed in his original task to eliminate the problem of backfire of the mercury-arc valves. But he quickly moved on to the next big task in 1955, when he became the manager for ASEA's project to develop Sweden's first commercially viable nuclear reactors.

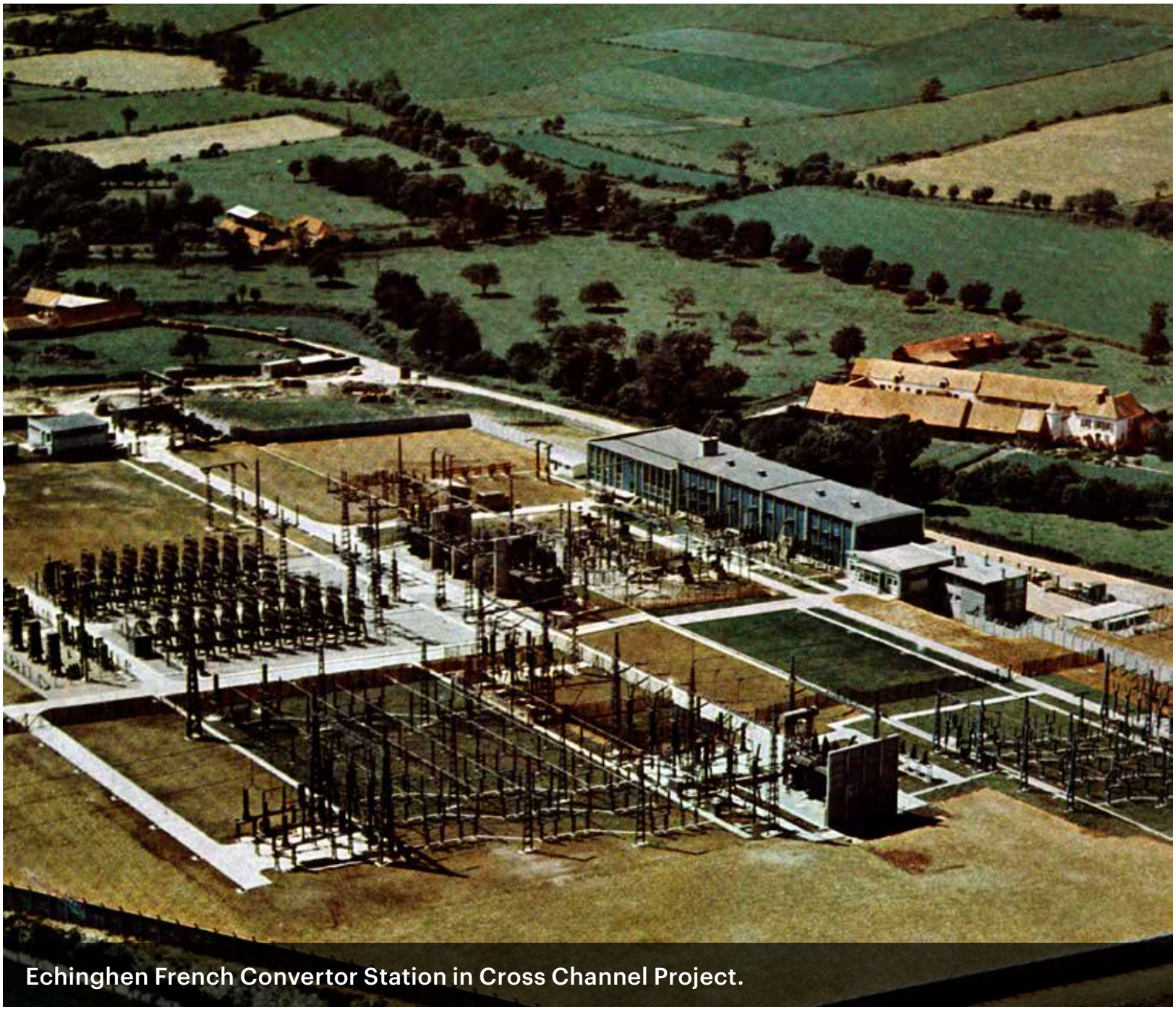
In the late 1950s, the HVDC technology still appeared to be very peculiar, and there was only one single supplier on the market. Uno Lamm did something that at the time was very creative: he gave English Electric a licence for the Cross Channel project, thereby creating a competitor. This also gave rise to the first market boost, and between 1960 and 1970, nine HVDC transmissions with mercury-arc valves were built — 7 by ASEA, and 3 by competitors like English Electric, who could build facilities, but were wholly reliant on their mercury-arc valve licences from ASEA.

A fun fact worth mentioning is that one of those projects was the Sakuma project,

which was to tie together the 50 Hz and 60 Hz parts of Japan's grid, and which became especially profitable. Aware of the risk of technology leaks to Japan, a starting price for the negotiations was set that even internally within ASEA was considered to be outrageous. However, they didn't need to bargain much, and the agreed-upon price of 60 million SEK was sufficient to let the profit from this project pay for all development from 1927 to 1954. Other projects also showed good profitability and paid ASEA's dividend for many years. In other words, one can say that the bold, long-term investment in Uno Lamm's ideas had paid off, at least financially.

In 1961, ASEA chose Uno Lamm to work with General Electric Company's Pacific DC Intertie Project, which combined long alternating current and high-voltage direct current systems to transmit electrical power from the hydroelectric generators in the northwestern US and British Columbia to consumers in southern California. In many respects, the project was unique and became a splendid example of Uno Lamm's ability to not only handle the technological challenges, but also to build a network in order to sell and complete the project.

The Pacific Intertie was a key project, not only because of the transmitted effect and the long distance, but also because of the strategic importance. The project demonstrated that a significant part of a megacity's power supply could come from remote hydroelectric sources. It became a display of how to build strategic networks to create a market for new technology. Ironically, it also turned out to be the final HVDC project to be built with mercury-arc valves, which were Uno Lamm's technological entry to the



Echinghen French Convertor Station in Cross Channel Project.

HVDC technology. The first contact to discuss the project was made in 1959. Uno Lamm moved to San Francisco in 1965 to be able to run the project, both politically and industrially. It took several years of lobbying towards both members of Congress and the two customers, LADWP (Los Angeles Department of Water and Power) and BPA (Boneville Power Authority) to strike this gigantic deal with what was, for the United States, a completely new technology. ASEA, under the management of Uno Lamm, had made the strategic decision to transfer the technology to GE in 1962 to get local support, and to create greater confidence in the technology. This was the second time they entered into a strategic collaboration with a competitor to widen the market. The collaboration with GE would later come to have a crucial influence on the transition to the next generation of technology based on thyristors. Initially, the LADWP were very negative towards HVDC and wanted 500kV alternating current instead. ASEA had, in large part due to Uno Lamm's personal lobbying which was supported by President John F. Kennedy, stimulated a private business group to build the link privately. The competition from this private group made LADWP accept the project in order to keep control over the transmission. The order was brought in in 1965. At this point, ASEA was managed by a number of skilled engineers trained in the spirit of Uno Lamm. ASEA supplied the rectifier components, while GE supplied the conventional alternating current devices, like transformers and capacitors, and developed the concept of “equipment specification” which would later become the standard for all projects. The transmission was started in 1970, but later got hit by an earthquake which destroyed a large part of the facility, which was then rebuilt.

It's worth mentioning that thanks to the lower electricity prices Los Angeles got due to the link, the price of the link was brought in every year for the next 30 years. But it also opened a lot of eyes to the financial importance that long distance electricity transmission links can have in the power system.

The Pacific Intertie would, as mentioned, become the final facility built with mercury-arc valves, because simultaneously with the transfer being put into operation, a new generation of valves were being developed. The mercury-arc valves were replaced with thyristor valves. Through the licensing deal, ASEA got access to GE's thyristor technology. Paradoxically, ASEA had more success in developing complete converters based on thyristor valves, and actually knocked GE completely out of the HVDC market soon after the technology change. One could probably attribute a great deal of that to the “Uno Lammian” company culture. Instead, the competition in the field of HVDC would come from Siemens/BBC because ASEA was forced to pull out of the Cabora Bassa project for political reasons — but that's a different story!

The fitter Harald Jansson was sent to Rjukan to block production of heavy water.

Uno Lamm, so much more than a skilful engineer

It is often assumed, baselessly, that engineers are highly professional and far from other, softer, values and areas. Uno's father, with his great interest in and knowledge of music, was a great example of the opposite. In Uno Lamm's case, music didn't engage him much, but he had a great interest in social issues, including political stances and the building of industries. Here are a few examples from an abundant selection.

During his working life, Lamm registered 150 patents and wrote approximately 80 technical articles. He also wrote a number of articles about social issues that were published in Swedish newspapers and other magazines, and that often criticized the Swedish government. Lamm was seen as an unshakable anti-Communist, and he admired some of the positive features of the US economy.

During World War II, when Lamm went to Nazi Germany to carry out ASEA's business, he was criticized by his superiors for his anti-Nazi attitude, like refusing to do the Nazi salute at the patent hearings. That was not his only time taking a stance against Nazism, however. You might have heard about, or seen, the film “The Heroes of Telemark,” which is about how Norwegian resistance fighters blew up the heavy water production facility in Rjukan, Norway towards the end of the war. However, few people know that Uno Lamm

was involved. Industrial converters were supplied to track feeding for trams and trains and to the process industry. ASEA happened to be the supplier of the central converter power supply for Norsk Hydro, for the production of hydrogen and heavy water. Heavy water could potentially be used to manufacture an atomic bomb. When the facility was to be started, the fitter from Ludvika, Harald Jansson, deliberately delayed the process on Uno Lamm's order so that the Germans wouldn't have access to the facility for producing atomic bombs. It would be reasonable to assume that Uno Lamm's strong anti-Nazi stance was based on him recruiting one of his most important colleagues, Dr. Erich Uhlmann, in 1938. Dr. Uhlmann was of Jewish descent, and he and his family were rescued from Germany at the last possible moment prior to the war. He was, without a doubt, a theoretical giant who became the ultimate complement to Uno Lamm, who was a specialist himself in the key component of mercury valves. In general, it was one of Uno's strengths to be able to build a team that collectively had all the needed skills. Uhlmann also became the first recipient of the IEEE Uno Lamm High Voltage Direct Current Award in 1981, which was instituted to honour the pioneering efforts of Uno Lamm.

Uno Lamm, in his own words

A number of Uno Lamm's lectures have been written down. Here, he describes in his own words the collaboration with colleagues and customers, and he describes in detail how the development work was conducted. He highlights a large number of people in his environment by name, who he believes have made great efforts. His thoughts and actions are also shown in several of his statements, which give a clear image of a team and network builder who collaborates well with customers.

The collaboration between the Swedish industry and public customers has been emphasized as a success factor in many contexts, not least in post-war Sweden, and Uno Lamm describes this too in detail. It's not all about HVDC, either. It's interesting that the same type of collaboration takes place today on a purely commercial basis, and not necessarily controlled by national borders.

Today we talk about “strategic alliances” that, in addition to delivery agreements, also sometimes include ownership. A prime example, the Swedish battery manufacturer, Northvolt, has a comprehensive strategic collaboration with VW, BMW, and Scania that involves both partnerships and very extensive delivery agreements.

So, back to Uno Lamm, and first an example of how he was smart enough to recruit people with complementary knowledge:

Pacific Intertie Valve Hall.

"While working on the system technology for converters, we had the indispensable benefit of Harry Forsell, who later became a professor at the Royal Institute of Technology, KTH, and who was an electrical mathematician of an unusually high class. He had the ability to find mathematical solutions to problems, but also to present the results in a way that they could be directly used by engineers who themselves were not mathematicians of any higher degree, like myself. Later on, we got another one just like him who was able to advance even further, and that was Erich Uhlmann."

"Being able to work silently for a while until you feel convinced and then approaching your superiors and asking for funding for continued work is a great thing. That's why we in Ludvika's management established a system, also after the budget was created, where the laboratory manager received a grant that he could use for whatever he wanted without having to report inadvance to what he wanted it for."

Another episode Uno Lamm describes is a lecture night at the Engineer's Association at KTH planned to be devoted to discussing a proposed direct current device invented by von Platen. Uno Lamm writes that he had no faith in the idea that was based on movable parts and that he preferred the static solution made with mercury-arc valves. Uno Lamm says:

"I had planned on contributing to the discussion, but when I left Ludvika, I still hadn't been able to start the device. I walked out during the lecture and called the

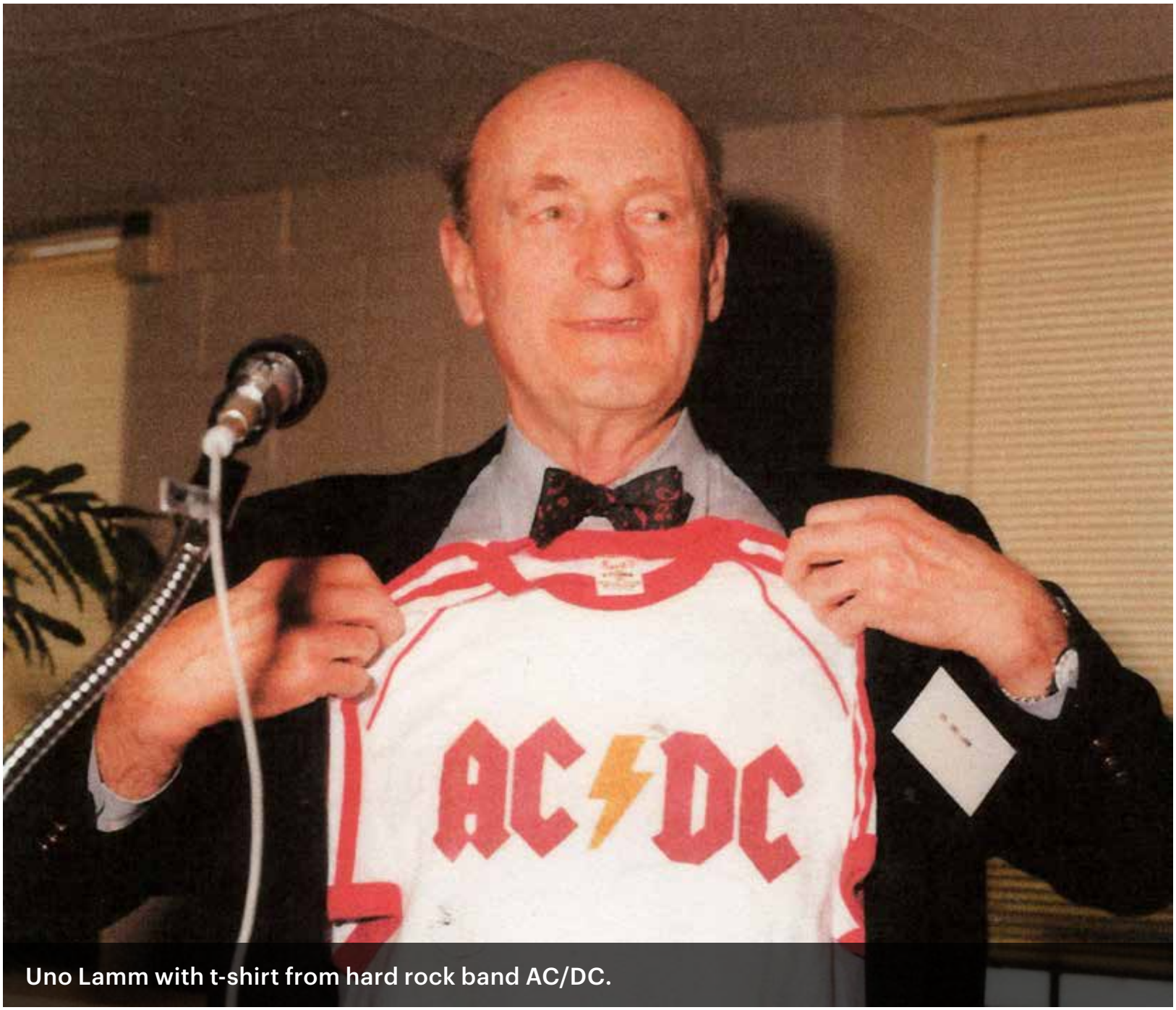
test room manager, Jan Plön, who was very competent. He happily reported that he had managed to start it. I entered the lecture hall and made a discussion contribution where I explained why I thought we need a pure current valve and not a synchronously run contact device. When I woke up in my hotel room the next morning, I unfortunately found on the first page of the newspaper 'High-voltage direct current also from ASEA.' I thought that was too damn bad, because it was von Platen's night, and was supposed to emphasize the fine job he had done, so I really felt bad."

He goes on to describe an interesting value chain that consisted of Boliden having large amounts of selenium as a by-product of copper mining. To be able to sell the selenium, Boliden paid ASEA to develop a product that used selenium. This is how the selenium converter that became an important product to ASEA came to be. The commercial breakthrough got a flying start when the General Director of Telestyrelsen, Håkan Sterky, signed a long-term delivery agreement with ASEA. The agreement was on the condition that they were able to meet a given specification. Uno Lamm says about this:

"Something like that is incredibly stimulating and developing for the industry, both for the psychological trust, but above all because it makes the company's management understand that we're on a profitable path." In other words, they created a value chain from raw material to finished product, something that feels highly relevant today, when we see how the battery industry is currently growing in Sweden.

Uno Lamm describes the procurement of the first HVDC connection to Gotland as follows:

“The negotiations with ASEA had come far enough that a finished contract proposal was ready when we gathered in the office of the General Director, Åke Rusck. Rusck sat there, pen in hand, hovering above the contract. But then he moved the pen away, leaned back, turned to me and said: 'Listen, Lamm, are you sure this is really going to work?' 'No,' I said, 'I've never said that for sure. We still don't have anything that actually works, but we're seeing some really great chances that it will conquer the final big difficulties.' Rusck laughed at that and said, 'That's the same question I got, and the same answer I gave.' Then he put the pen down on the paper and signed it.”



Uno Lamm with t-shirt from hard rock band AC/DC.

The social critic

It is of special interest to take part in Uno Lamm's contribution to the public debate, as it gives a good insight into how Uno himself acted in his industrial role. It is clear how his starting point was a strong belief in and respect for the individual.

Uno Lamm was always interested in social issues and actively participated in the Swedish political debate, not least after his emigration to the United States. That he was most often critical was obvious, but his criticism wasn't specifically pointed at what he thought was wrong with the development in Sweden, it was broader. In his 1980 book "Livsmiljö i förändring" ("Life environment in change") he compiles his observations and comments on the development in Sweden and the world. He takes on mostly everything here, and one central theme is "collaboration." The starting point is that Lamm sees collaboration as a key factor of progress and success, both for society and business. He makes an interesting division of collaboration on different levels.

He defines the first form of collaboration as *collaboration for livelihood purposes*. This refers to the collaboration that can arise between capitalism and the market economy on one side and the socialist system on the other. He argues strongly for why companies should be allowed — and even encouraged — to make large amounts of money. As an example, he points out how Sweden's previous industrial development took place thanks to foreign companies investing in our natural resources, which then created the capital

that would allow Swedish interests to take over the influence. He is, however, careful to emphasize that it requires mutual respect between the political system and the capital. He writes: *"Let me emphasize that when I defend free enterprise, it is of course not because I believe that those who lead it are better people than the leaders of our society. But the business leaders must, in their daily work, act such that they survive their competitors with each product type, and seek to maintain and increase their market shares."* He also extends his reasoning: *"People talk more and more often now — both in Sweden and in the United States — about contempt for politicians. In this context, it is an unfortunate word, but it's important to more generally realize how deficient democratic leadership selection works. The democracy as such would be strengthened by a more realistic view of this problem. It is not contempt we need, but attention to and understanding of the difficulties of politics."* This comment feels highly relevant today!

The other *collaboration form is within the different levels of society*, the nations and the local units — in other words, what we call the political system and its executive bodies. Here, he makes a far-reaching argument about the very foundations of democracy, as well as how democracy has developed in Sweden, and he becomes very critical. His criticism feels familiar even today. It targets how the parliament members distance themselves from their voters, that politicians often never have had a "real job," and that they act in the short term. Lamm writes: *"Over the past few decades, we've seen how often our leading politicians act without the feeling of responsibility for the freshness of democracy that should be one of their primary concerns. As usual, the reason for this is*

that such consideration feels like an obstacle to their own interest in power. These feelings can be so interwoven that they are hard to separate. It is so much more unfortunate in our time, when society has taken on a much larger and more complex role than previously. This complexity should demand an even greater consideration for the long-term significance of the political decisions." He draws comparisons between the United States and Sweden, and finds that the development is similar, but that Sweden "ended up further downhill." The greatest difference, Lamm thinks, is that in the United States, more attention has been paid to the weaknesses of democracy and that the debate on the state of society is a lot more lively.

The third form of collaboration, he sees in the form of collaborative bodies, in which groups of people or companies can *join together to safeguard their special interests*.

Here, Lamm carries out very comprehensive reasoning around the role of trade unions. He describes a movement that has "grown beyond its true role," — in other words, a movement that has got too much power, to the point that the power balance, which he approves of, has tipped over too far towards the unions. But he also praises the unions for their positive views on rationalizations, their stance against Nazism, and their wise ombudsmen.

He wrote this during his time in the United States, and there's no doubt that he thought a lot about what he experienced during his active time in Sweden. He must be said to have been a master both in creating collaborations with both state and private companies, but also with parts of the political system. And in the theme of collaboration, he saw

a key to success for both industry and society. Today, this feels extremely modern even if we use a different language, like strategic alliances. Both in business and the political system, the aim is now to take this theme of collaboration to a different level by increasingly introducing a European and international dimension. Uno Lamm's political input, including his book, had very little impact on the Swedish political debate, but his reasoning from the 1980s has many arguments that feel very relevant today.

Uno Lamm's comments on how one should choose a leader are worth thinking about and tells a lot about his values. Here, he reasons:

> *"Teleometrics International, a research institute in Texas, studied 1,600 top leaders to see if there was any connection between success and their leadership. They found that the 13% who reached the best results had shown more compassion and sought advice from their colleagues. They knew the art of listening, and not only to their superiors. There was a clear difference in these human aspects between this group and the less successful leaders."*

It's not really a secret that you can often find relevant research that reaches different conclusions, but it says a lot about how Uno Lamm viewed leadership that he chose to mention this report in particular.

“Thinking big,” Association Atom-Noak u.p.a.

The atomic bombs that dropped on Hiroshima and Nagasaki in 1945 dramatically showed what enormous powers humankind has managed to unleash in these two cases in order to destroy other humans. This led to the founding of the association Atom-Noak u.p.a. One of the founders was Uno Lamm, and he was the one to formulate the crucial question: *“Why has life (in the rest of the universe) not developed far beyond the current human plane? Why are we not receiving messages from higher beings through outer space?”* Lamm responds: *“The atomic bomb. When life on the various celestial bodies reaches a certain level of intelligence, the secret of nuclear fission is discovered and life eradicates itself, a new star bursts into life.”*

Since humans on Earth seemed to now have reached the immediate vicinity of this point in their evolution, it was time to act. In his book “Livsmiljö i förändring,” Uno Lamm has described the society's creation and what it wanted to achieve. From the book:

> *"The association Atom-Noak u.p.a. was created to discuss which possibilities of extraterrestrial transportation that the extraction of atomic nuclear energy should*

open up. The society was founded by Gösta Rydbeck, Gunnar Dahlby and myself, all active within ASEA. No spaceflight had yet taken place at the time, even if high-flying explosives had been used by the Germans during the war. That humans had learned to extract the enormous amounts of energy that were bound in the interior of the atoms made it obvious to us that sooner or later, one would discover a source of fuel for travelling to other planets, and maybe even other solar systems."

They didn't stop there, but continued pondering how one could save humanity by creating an extraterrestrial colony. Fittingly enough, the spacecraft which would make the journey would be called the Ark. So the engineers started thinking:

"With the enormous intensity of nuclear energy, one could imagine that a considerable part of the nuclear fuel brought on board would be converted into energy and used to power the craft through ejection. But at the same time, one needed matter to eject! So the question arose about how much of the fuel material on board should be used for energy in order to eject the rest of the matter. We found "mirabile dictu" that the best would be to lead the reactions so that all fuel would be converted into energy, and with the ejected-nothing. The craft, the Ark, would then utilize the fuel supply in the best way possible and be run by what physicists call radiation pressure. We actually applied for a patent on such

a principle, but were doubtful about the patent office's ability to uphold our rights, since someone else potentially could have copied our idea, and already left Earth in their own spacecraft!"

There was obviously no lack of creativity, and the expression “thinking outside the box” can hardly be better illustrated. The next comment in Uno Lamm's book says a lot about his self-confidence:

"We never built any spacecraft, but let the Americans and Russians make pioneering efforts so far based on trivial chemical reactions."

The discussions in the association, according to their records, breathed a rather great pessimism about the development on Earth, and the horrific scenario formulated by Uno Lamm didn't seem all that unrealistic. The association's discussions thus came to focus on something other than building a spacecraft. Back to Uno Lamm's report:

"I can't go into detail about all the speculations that were processed in Atom-Noak, often reinforced by “lecturers” from different sciences and cultural fields. The basic idea was always a transplant of the valuable elements of our civilization on Earth. That there exist other planets in the universe that can house living beings is a more generally accepted hypothesis nowadays. Before a transfer, one question is highly

important: what in our culture is the right thing to carry on?" That question dominates Atom-Noak's records over the years."

They undeniably asked big questions. Harry Martinsson was invited to the association on several occasions, where their plans were discussed in detail. It is very reasonable to assume that Martinsson's space epic, Aniara, was inspired by the discussions that took place within Atom-Noak. The association continued to meet, but was dissolved after Uno Lamm's death in 1989. And in the end, maybe Aniara was the most enduring of the discussions that took place in the Atomic Ark, and was part of the motivation for Martinsson receiving the Nobel Prize in Literature in 1974 *"for writings that catch the dewdrop and reflect the cosmos."*

Back to the technology battle between alternating current and direct current

We started this publication by describing how “The Battle of the Currents” in the late 1800s ended with a total victory for alternating current. But how does it look today, more than 100 years later, and above all — how is the technology of power transmission, the field where Uno Lamm's HVDC technology started challenging the prevailing alternating current technology after a tentative start in the early 1950s? The answer is that from a tentative beginning, the big breakthrough has come in the later decades, and the revenge is strongly tied to the dramatic change in our electrical production system. There are two fundamentally different markets that in the end are both tied to the expansion of renewable electricity production.

One trend is represented by the exploitation of large hydroelectric resources located far from the consumption centres, the greatest examples of this being the largest hydroelectric power plants in the world: the Itaipu plant in Brazil and the Three Gorges plant in China. Both have a total power of approximately 20,000 MW.

Incidentally, China has by far the largest use of HVDC technology today, which accounts for about 30% of the total power transmission capacity in the country. It is also where we can find the absolute largest power transmission line in the world all categories, that

Changji – Guquan worlds longest and most powerful transmission line.

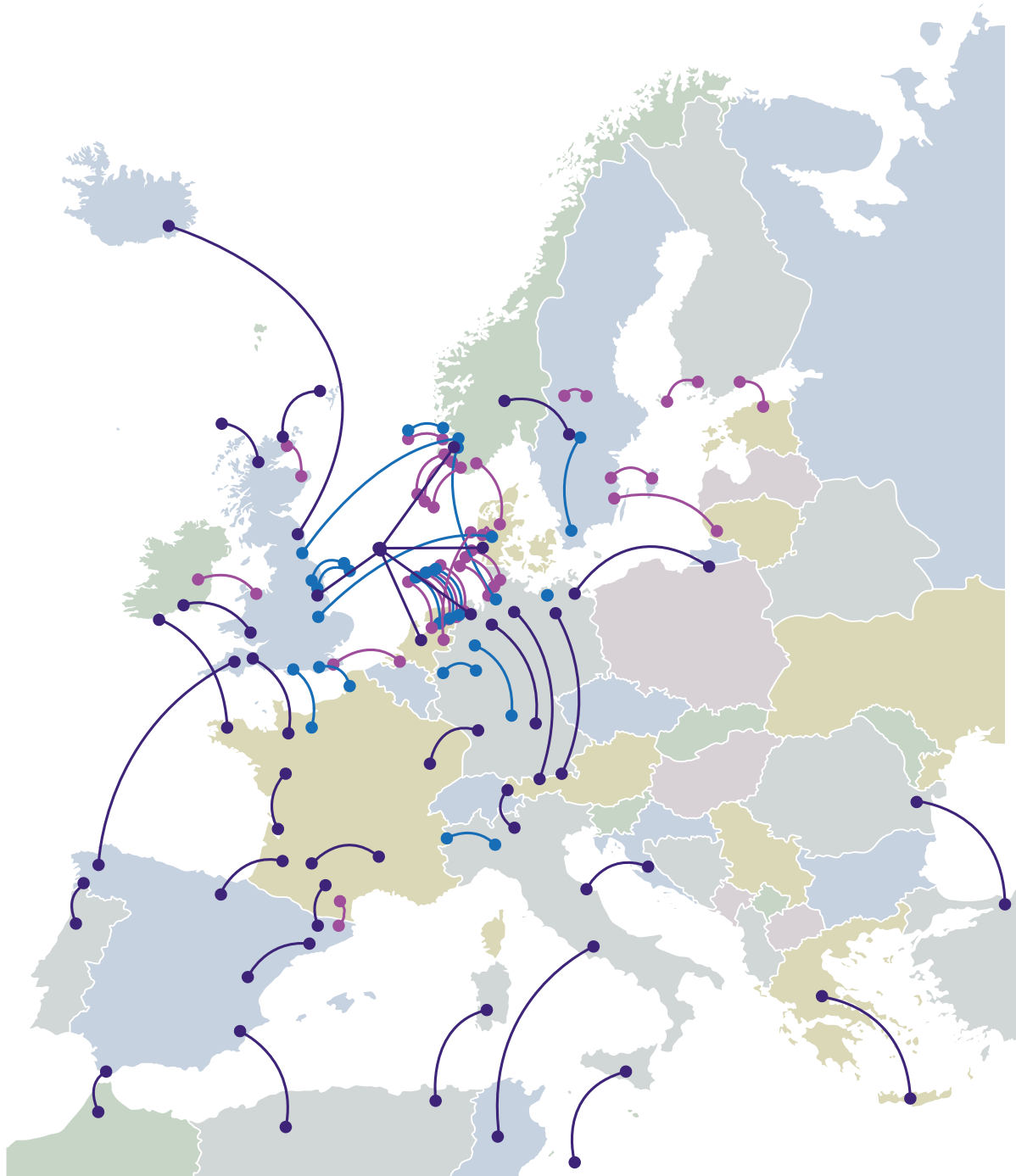
transmit power of 12,000 MW in one single line over a distance of more than 1,860 miles.

The second largest application of the HVDC technology is found in Europe, where a powerful expansion of renewable electricity production causes HVDC technology to be used partly to transfer electricity from remotely located wind power to consumption centres, partly to connect electricity grids over large geographical areas in order to share balancing resources and even out the renewable electricity production through a large geographical spread.

The fact is that approximately equal amounts of money are invested in HVDC lines as in alternating current lines in Europe today. An advanced, offshore grid that enables a

HVDC projects in Europe.

- Operating (as of 2019)
- Under construction (as of 2019)
- Planned/under consideration



continued powerful expansion of renewable energy is being built at a rapid pace. So one can rightly say that the direct current technology has got its revenge, and Uno Lamm was the pioneer and the entrepreneur that started this movement.

But how has Ludvika fared, the place where Uno Lamm worked for 30 years on the development of the HVDC technology? The answer is “absolutely excellent,” something I as an author have personally experienced. The HVDC technology has gone through several stages, and at times its existence has been threatened.

But somehow, the pioneering spirit and openness to impressions and knowledge from the outside world that Uno Lamm created has lived on. They have gone through several dramatic technological shifts, lived through a dramatic fusion with the largest competitor, which resulted in Ludvika getting the global responsibility for the HVDC technology, and they still succeed in gathering world-class technology knowledge. Today, the HVDC operations are the backbone of the Ludvika facility engaging most of the 2,500 employees. Uno Lamm's importance was manifested at the inauguration of a new HVDC office in 2013, when it was also stated:

> *"The complex has been named after Dr. Uno Lamm, who started the development of the technology in the late 1920s, and who often is called 'The Father of HVDC technology.' To further honour their pioneers, the conference rooms in the building's visitor centre are named after prominent HVDC profiles, and several of them were present at the inauguration."*

A peek into the future, in the spirit of Uno Lamm

But what about direct current in other low voltage applications, like in the home? More and more appliances are already being supplied with direct current — just think about how many devices today even have built-in batteries. LED lighting uses a lot less electricity and runs on direct current. All electronics that we use today run on direct current. The global standard USB (Universal Serial Bus) contains data transfer and power supply in the same connector. The system is manufactured in incredibly large amounts and can therefore be made very cheaply.

The latest generation of USB connectors can handle up to 200W, which allows you to power most of the appliances in a home. Solar panels, as well as other second-generation electric car chargers, run on direct current. The sharp increase in the utilization of direct current will drive technological development and lower the costs of direct current systems.

So if you take on Uno Lamm's “forward-looking” approach, you can reasonably assume that the use of direct current technology will dominate in the homes, and in the long run also in industry and electricity distribution. That scenario would surely have appealed to Uno Lamm!

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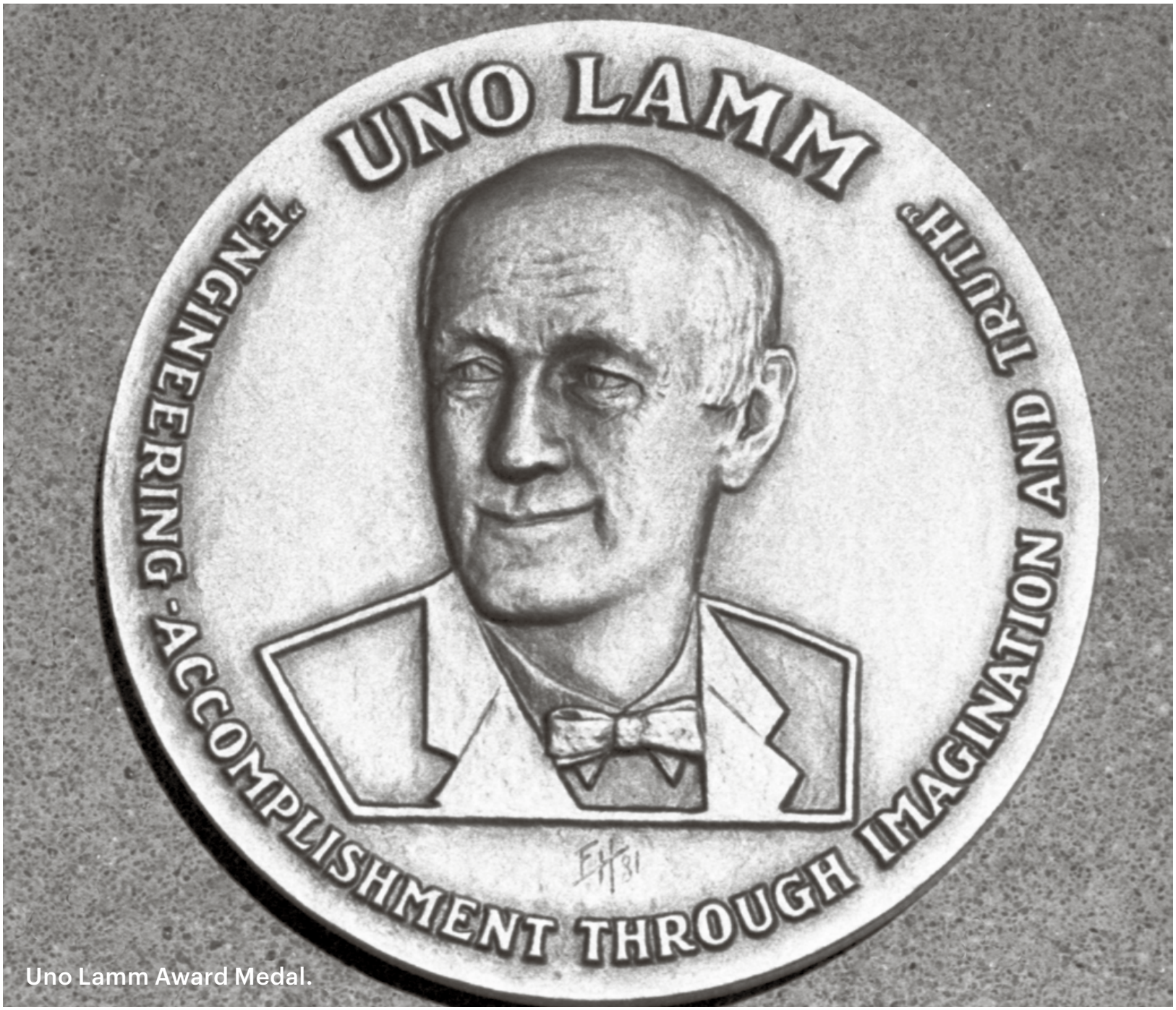

Uno Lamm Award Medal.

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