Before you lies a book full of memories, anecdotes, successes, expectations, dreams and deeds.
A book with a lot of pride: the closure of the Willem-Alexander Power Plant may be a fact, but that did not end the story.
The power plant has made an unforgettable impression in the region and far, far beyond.

Originally, this book was published as a hardcopy in the Dutch language only, though you could also read it online, for free. Recently however, I discovered that it was not available anymore: I could not find it online, nor could I buy it, which wasn't a good sign, in my opinion. Had the publisher finally and litteraly closed the book? That could not be true.

Therefore I decided to translate it into English and make it easily accessible for almost anyone, because the story of the Willem-Alexander Plant is good. So good that everybody with some technical or environmental interest or background should read it. So I created an almost original PDF-copy, which you can download for free, in both the Dutch and the English language.

Moreover, I realised that the book might need a bit of updating, to put it in the centre of attention again. After all, the war in Ukraine, starting February 2022, has changed the energy market immensely again: so time to act! Therefore, I created a *separate* updated version, again both as a Dutch and an English version. The updated text was added as an epilogue at the end of the updated versions of the book.

You can now freely download the original Dutch version, the English translation of this original ànd the updated versions in both Dutch and English on www.coalgasification.nl.

Please feel free to send the updated versions to anyone who could be interested, especially to politicians that should help us move forward into an era with affordable energy that is also as sustainable as technically possible.

May 2023, ir. H.M.M. (Harry) Bosgoed
Independent consultant in Environmental Technology
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Contents

As councilor and party chairman of the former municipality of Haelen, later Leudal, alderman Paul Vogels was involved with the permits for the Willem-Alexander Power Plant. He and his fellow politicians also regularly formed the link between the plant and all of its neighbours. As alderman of the municipality of Leudal in 2010, he is still closely involved in the biomass project.

Limburg has something with energy

with pride

Everyone was happy with the coal gasifier that opened its doors in 1993 and was so much greener than traditional coal-fired power plants. I still remember my first visit to the plant in 1998. How impressed we were with the technological achievements!

VISIONARY

When in 2000 the tests with biomass co-firing started, many local residents and environmental groups were hesitant. Fear and irrational beliefs prevailed. With today's knowledge, we know how visionary and sustainable the project was. However, public opinion accepted biomass co-firing only in 2006. Although, in my view, the tests and investigations carried out in the meantime were valuable, years of development were lost in that 'battle'.

WIN-WIN

Limburg has something with energy. The location at the river Maas, in combination with the connection with "Slochteren" (the main source of natural gas in NL), were favorable factors for the supply of coal and gas at this location. The power plants provide a lot of employment, both inside the plant as outside. The felt pride went far beyond the Willem-Alexander Plant itself. When we succeeded with 70% biomass co-firing in 2011, it buzzed through the villages. 'We can do it! We can reduce the greenhouse effect!'

SPECIAL NEIGHBOURS

The Willem-Alexander Plant was not only a good neighbour for local residents. Also the nearby heron colony in the green surroundings of the plant flourished, despite all activity. The fact that these herons thrived was partly because of the hermetically sealed area where no hikers or fishermen were allowed. In my opinion, this too says a lot about the sustainability of the activities at the plant. Especially when know that heron colonies are quite rare in the South-east of The Netherlands. I think they will also miss the Willem-Alexander Plant.

ADDITION

All employees of the power station gave their heart and soul. I know that sick leave was virtually nil; engagement and vitality predominated. Also the openness with which local residents and interested parties were received, was commendable. The transparency, the commitment and perseverance are the sum of the success that has been created here.

Paul Vogels, alderman of the municipality of Leudal

Design phase

1988
1993

1988

CLEAN COAL TECHNOLOGY

Dutch authorities see coal gasification as an opportunity for more sustainable and reliable electricity supply. The discovery that you can create a combustible gas from coal dates back to 1783. Further development takes place place during the 1975 oil crisis. The petriochemical industry sees gasification as an opportunity to become less dependent of the crude oil supplies from the Middle East. The application in the electricity world is new. By means of gasifying coal, a pure fuel is created which emits almost only little harmful substances, much less than with direct coal-fired power plants.

1989

IDEAS AND INITIATIVE

SEP, the Cooperation of Electricity Producing companies in The Netherlands, makes the decision to build a coal gasifier. The Coal Gasification Demonstration Project for Electricity Generation, Demkolec for short, is established as an independent project organization. Buggenum will be the business location. The Shell process is chosen for the gasification of coal, in combination with the steam and gas turbine of Siemens. The plant is being designed with a capacity of 250 MWe and an efficiency of 43%. The construction involves an initial investment of approx. 850 million guilders.

DESIGN

Together with Comprimo, KEMA, Shell, Siemens and others, Demkolec starts from their head office in Nijmegen with the integration of all factory parts on the drawing board. That means integrating the skills and knowledge of both chemical and electrical engineers simultanuously. The Nijmegen period is characterized by designing, pioneering and working together from different disciplines. Construction is being prepared, permits are applied for and contracts with suppliers and subcontractors are signed.

1990

CONSTRUCTION

On October 31, 1990, construction of the first large coal gasifier in the world. Former Minister of Economic Affairs Affairs, Dr. J.E. Andriessen, kicked off the ground-breaking ceremony. Within three years time the complete power plant was built and commissioned within all safety and quality requirements. The highlight was the positioning of the gasifier and the syngas cooler, each about 500 tons, in July 1992. The total amount of work for design, production, assembly and start-up was calculated at 5 million Dutch guilders.

1991

STAFF

For commissioning of the plant approximately 150 employees were recruited: process engineers, mechanics, maintenance and support staff. They mainly come from the Maas and the Claus Power Plants of EPZ, the electricity production company in the south of The Netherlands. In the selection process, special attention was given to enthusiasm and motivation, rather than education and experience. Working in the new power plant would require people with new skills and mind set.

TRAINING

The recruited employees, though highly experienced in the field of conventional generation of electricity, still have a lot to learn when it comes to chemistry. Not only regarding process technology, but also in terms of safety control. In 1991 some eighty mechanical engineers follow a special, ten weeks course at DSM in Limburg, followed by company internships and commissioning training courses at home and abroad.

Design phase 1988 - 1993
From idea to construction

Clean coal technology for sustainable and reliable electricity

SEP, the Cooperation of Electricity Producing Companies, which manages the Dutch electricity grid in 1988, sees coal gasification as an opportunity for the future. While the production of the Maas power station, a conventional coal-fired power station in Buggenum, is increasing completed, the contours of the Willem-Alexander Power Station, which was then still called the "Demo KV-STEG", become visible. An innovative one coal gasifier (KV) with a steam and gas turbine (STEG) that exploits the benefits of coal while protecting the environment.

Coal is widely available worldwide, inexpensive and provides a decent yield as a fuel. Being with that coal is a good addition to the use of other fuels such as natural gas, uranium and petroleum, the Sep judges. The spread about different types of fuels is important to the ensure availability and avoid dependency. Wind and solar energy were not considered reliable at that time seen energy sources. An important disadvantage of coal, however, is that conventional combustion methods are associated with high emissions of sulfur dioxide and nitrogen dioxide.

THE ADVANTAGE OF GASIFICATION

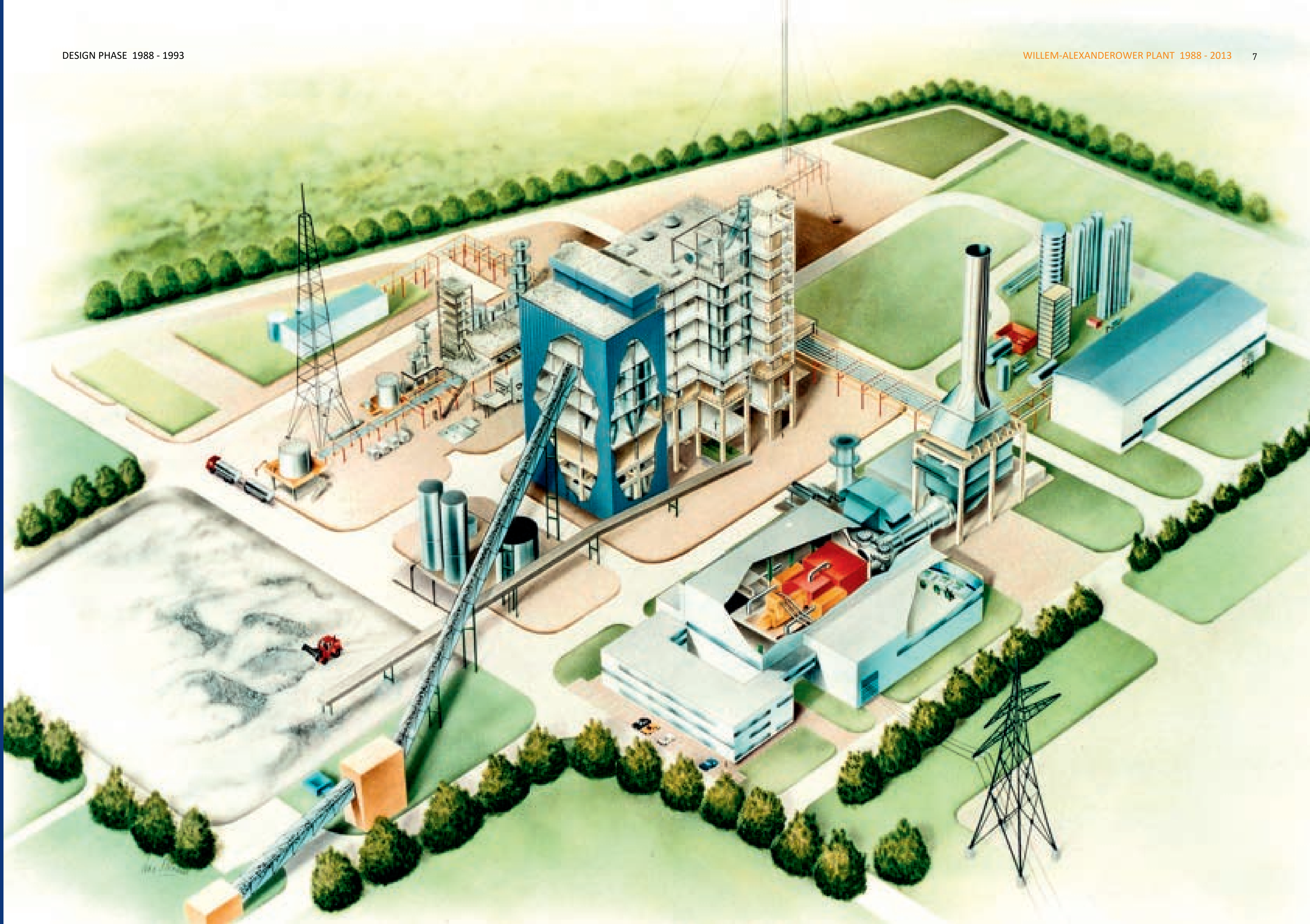
By gasifying coal and subsequently cleaning the produced syngas (coal gas) you get rid of sulphur, nitrogen and fly ash: this leads to the production of a pure fuel. Therefore, the emissions of sulfur dioxide (SO2) and nitrogen oxides (NO2) is much lower than in traditional coal-fired burners. Coal gasification is the answer to concerns people have regarding the quality of nature, surface waters, people, planet and buildings.

INTEGRATED DESIGN

From 1989, the first employees travel from Buggenum to Nijmegen, where the head offices of Demkolec and its project organization are located. Here the conventionally skilled employees - with lots of experience with standard electric power plants learn about the world of chemistry. Since Shell's gasification process has been chosen, the complete plant consists of five main parts: the gasification island, the steam and gas turbine, the air separation installation, the desulphurization plant and the wastewater treatment plant.

THE SECRETS WITHIN CHEMISTRY

Construction will be completed in three years. An immense job with many challenges. In the meantime, the staff is being recruited and trained, particularly in chemistry. After all, a coal gasification and refinery in a world of standardized coal-fired power plants is unique in its kind. The integration of the various systems has never been done before at this scale. The courses and internships are only the start of a continuous learning process.



Bustling with energy

From idea and design to construction and commissioning

Soon after the green light was given to realize the Willem-Alexander Power Plant,the project organization and business management organization. People were selected within the EPZ organisation, at the nearby Claus and Maas power station. Hennie Hermsen worked as a chef mechanical maintenance at the Claus power plant and was interested in the special project. Hennie: 'I wasn't the only one. Almost everyone wanted to get started. It was new, exciting, challenging."

"There was a vacancy for chief mechanical maintenance to assist in the commissioning of the new power plant', says Henry. 'A great challenge, because the integration of the various sub-factories had not yet taken place, anywhere in the world. We knew a lot about making steam, we took that knowledge and experience with us from the Claus and Maas power plant, but this was a different story. My colleague and I had both have the right papers and ambitions. Who was allowed to go? We literally drew straws. I was the lucky one!"

THE SECRETS OF CHEMISTRY

The head office of project organization Demkolec was located in Nijmegen. Hennie: 'We went in 1991 with about eight people 1992 with a van from Buggenum to Nijmegen to prepare for commissioning. The task for the maintenance team was to set up steam orphan methodologies, writing preventive maintenance plans and setting up a warehouse, including all spare parts, and workshops. Incredibly complicated, but huge interesting. The steam systems looked familiar to me, but the syngas reactor, the desulfurization plant and the air separation technology were new to us. Piece by Little by little we unraveled the secrets of chemistry. Everyone had an enormous will and drive to learn."

THE TIE CAME OFF

The two technical worlds in the Willem-Alexander Central are integrated, that of the electricity and the chemistry, literally came together in Nijmegen. Henry: "The Nijmegen period was special. We had to work together with a wide variety of people and organizations. The cultural differences were enormous. But once the ties were off with us, the more conservative ones electricity people, an open atmosphere was created. We went pioneer! Off the beaten track and existing thinking patterns. Demkolec was brimming with energy and ambition."

TO COLLABORATE

On October 31, 1990, the first pile was driven into the ground. Henry: "The construction lasted until 1993. In 1992 we moved to Buggenum to further prepare for commissioning on site. We worked with suppliers on the basis of Lump Sum Turn Key contracts for Engineering, Procurement and Construction services. Everything was coordinated by the design department of Demkolec. All the project leaders and representatives of the various disciplines worked together in a matrix organization. Characteristic was the continuous mutual cooperation to realise all complex innovations."

FIT FOR SURGERY

During this period, the colleagues from production and maintenance also went on internships at companies and suppliers like Air Products, NAM and the lignite gasifier RheinBraun. We got lectures and training in gasification technology. In the meantime the delivery date was in sight, though not all went perfectly smooth. The commissioners wanted a job well done, with as little remaining points as possible. The builders too of course, but wanted to finish the job a.s.a.p. A healthy tension that kept everyone sharp."

"We felt like teammates,
all with the same goal"

From the folding chair

Understanding the plant's central brain

A few months before commissioning, Jan Braam is asked by Shell to go to Nijmegen to strengthen the design team in the fields of measurement and control technology. Later he went to Buggenum as well, to help with the commissioning of the gasification island, within the complexity of the power plant. The process engineer from Oegstgeest however, also appeared capable in teaching the mechanical engineers. The original idea, to stay for three months only, therefore turned into seven years. And even after his retirement he continued giving tours for interested people from all over the world world. 'I was a Shell man in heart and soul, but I became a real Demkolec' over here.'

Shell had been working on the development of the gasification process since 1975. I myself specialized in automation, measurement and control technology,' says Jan. Buggenum was a big challenge. The power plant is designed as a highly integrated process, with some closed circuits inside, which however sometimes tended to act like a snake biting its own tail. It is however a very efficient concept, in which every calorie is used completely, but this made the plant rather vulnerable for disturbances too.

The different units are directly connected to each other. Therefore, if disturbances or large fluctuations occur somewhere, the complete plant could fail."

FOLDING CHAIR

Part of the solution for higher availability was found in an extra oxygen tank that was installed in 1996 as a buffer for the coal gasifier. Jan: 'This would reduce the fluctuations. If the air separation system responded to the oxygen demand from the gasifier, the process could still continue.' But Jan had already made lots of hours on overtime in the control room, before to this was decided. Many changes were made and implemented in the control systems of the entire plant. Jan: "Therefore I brought a folding chair, so I could easily get around between the various mechanical engineers, and could sit down to see on their screens how the systems would respond to new changes. It was a continuous improvement process in which all start-up problems were gradually overcome."

INSIGHT THROUGH CONTROL PLATES

"We made hundreds of changes to the systems, and that didn't make them easier. I discovered that the engineers knew very well where all of the thousands of measuring devices, pumps and valves were located, but not how everything responded to each other. What would be decisive at any point in the process for a valve to open or close? Therefore, I translated this information onto control pictures, which displayed the brains of the plant. The engineers were very enthusiastic: they were happy with their new insights.' Jan was then asked to make these control plates for the gasifier system for all five teams that worked there, to teach them even better. Then he also made them for all other systems within the plant. John: It was the first step towards

"I even spoke a few words of Chinese, with which I could correct the interpreter when he confused oxygen with nitrogen, haha!"

internal education, later done by Jo Salden. With this knowledge, we got the systems under control, the plant tripped much less so we could match production with electricity demands."

BREEDING GROUND FOR SUCCES

'It was very special that there was such an open atmosphere in Buggenum," says Jan. 'In such an intensive learning process, mutual trust is very important. This means that both the staff as the employees should accept that mistakes are made, but that they are also williing to admit them. Only then you will be able to learn. I think that the open and involved atmosphere was the breeding ground for the success that followed. Also the cooperation between the suppliers of the various parts of the plant went very well. This was partly due to the design of the project in the separate Demkolec organizations. It felt like teammates with the same goal, very beautiful and fruitful.'

INTEREST FROM ALL OVER THE WORLD

Jan never made a secret of the success of the power plant. Starting on the date of his retirement, he already showed some 2,400 people around at the Willem-Alexander Plant, for even twelve years. Professors, engineers, administrators and entrepreneurs from South Africa, Chile, England, the United States and China. Jan: 'They were all very impressed. Especially about the fact that there was almost no one walking around in the plant, since everything was monitored from the control room. Also the high level of safety and the excellent state of maintenance was considered exceptional. I always tried to match my story with the background of the visitors. Were they technicians, process engineers, administrators or investors? I even spoke a few words of Chinese, with which I corrected the interpreter when he confused oxygen with nitrogen, haha! But that was pure bluff! All together, Shell has sold about 22 coal gasifiers to China now. These are used to supply coal gas for the chemical industry. It's a nice idea that this was partly the result of my efforts!"

innovation

PRODUCTION PROCESS

COAL COMES IN FROM THE PORT INTO THE PLANT. THERE THEY GET GRINDED AND DRIED TO POWDER COAL. THE POWDERED COAL IS STORED UNDER NITROGEN GAS AND PRESSURIZED AND TRANSPORTED WITH NITROGEN. BIOMASS IS ALSO ADDED AS FUEL.

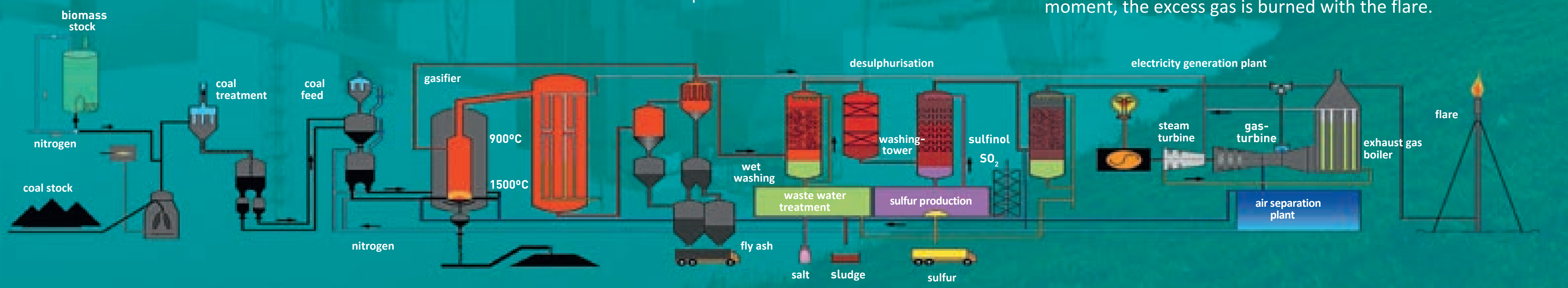
In the gasifier, coal is mixed with oxygen at high temperature and pressure: this creates coal gas. The non-flammable fraction of the coal (rock) solidifies and comes out as slag. At this stage, the flammable coal gas mainly consists of carbon monoxide and hydrogen but still contains various toxic contaminants as well. These contaminants are then removed in stages. Next, the gas is cooled in the syngas cooler. The heat released in this process is used to create steam.

After this, fly ash and fine dust are removed from the gas in two steps. Then the gas is washed with water: in this stage, all water-soluble compounds, such as chlorides and fluorides, are extracted from the gas. The used water is discharged into the wastewater treatment plant and purified to be reused. In the following desulfurization step, hydrogen sulfide (H2S) is withdrawn form the coal gas. More than 99% of the sulfur is bound and converted into pure sulphur, to be reused within the chemical industry. Only a very small part of the sulfur passes through into the residual gas afterburner and is emitted into the air as SO2.

The purified coal gas is then diluted with nitrogen gas and saturated with water vapor in the saturator, to obtain low NOX-emissions in the gas turbine, in which the clean coal gas is burned. The hot exhaust gases from the gas turbine are fed into the exhaust gas boiler and cooled down. The released heat is used to produce steam, that drives the steam turbine. The electricity production finally takes place with the generator. In the air separation plant we produce oxygen and nitrogen at very low temperatures from the ambient air. These gases become, like already mentioned, consumed again within the process.

The complete plant can therefore be regarded as
1) a gas factory, where clean gas is produced from coal, and
2) a gas power plant, where the produced gas is consumed to produce electricity. If in some instances the gas factory produces more gas than the power plant can handle at that moment, the excess gas is burned with the flare.

THE PROCESS OF COAL GASIFICATION



"It was extensive work with always something happening somewhere. But whatever happened: together we went all out to get it resolved again."

Each part a unique code

How to make 140,000 parts work together in one cycle?

When Jan Doensen and Peter Sahl in 1989 started at the Willem-Alexander Plant, nothing was there yet. Their first task was to write the operating instructions for the five sub-factories and the auxiliary and connection systems from a drawing. They checked if all valves, pumps, pipes and fans were installed according to plan during construction. The basis of their work were Piping & Instruments Diagrams (P&IDs): detailed drawings of all parts. "The challenge was that none of us had ever seen a P&ID before!"

The auxiliary and connection systems ensure the integration of the various plant installations. John was before engineer at the Maas power plant and Peter came as chief engineer of the Claus power plant. Peter: "The operating instructions we wrote before construction show what the the initial state is at the start-up of the control panel. You want to know for each valve whether it should be open or closed. Also the settings you need to know per pump and fan. A big job, where we spent several months with forty men."

SYSTEM AFTER SYSTEM

Peter continues: "During construction, we checked all auxiliary equipment connection systems. If there is a pipe or other connection was delivered, we checked the tightness. They became rinsed, blown through and sometimes leavened. Also the electric signals were checked manually. Do the sensors give the correct information to the control room? System by system the power station was prepared for commissioning."

NO LUXURY

Each part of the control panel has a unique code. That has a lot advantages in communication, maintenance and stock management.

Jan: 'We were given a thick pocket book. Happy sat understandable logic behind it and we had the book after it hardly needed for a while. have in the starting period we followed many courses. We knew nothing about chemistry and were not used to working with P&IDs. Because of the high degree of complexity of these power plants however, these drawings are not a superfluous luxury, so it worth learning!"

HIGH-SPEED TRAIN

Jan: "In the demonstration phase, we tried our work further to standardize. We got more and more insight into it the arrangements. This was partly thanks to advisor Jan Braam, who sat next to us in the control room. He had the patience to explain an arrangement to us point by point. In this way we gained insight into the train of thought behind all chemical, physical, physical and chemical processes. The more we learned, the better it worked keep the exchange running; and the better the start and was going to stop. It is not easy to catch a speeding train control. Especially when you consider that there are 140,000 parts here work on one cycle at a time.

SERIOUS WORK

'Working safely was also a major turning point for us,' Peter says. "Before maintenance could be carried out, the power plant had to be secured, which we managed with work permits. In practice, this meant a lot of forms had to be filled out, so a lot of patience was needed before you could send someone onto the job. With that we developed a system of awareness: it was serious work with these substances."

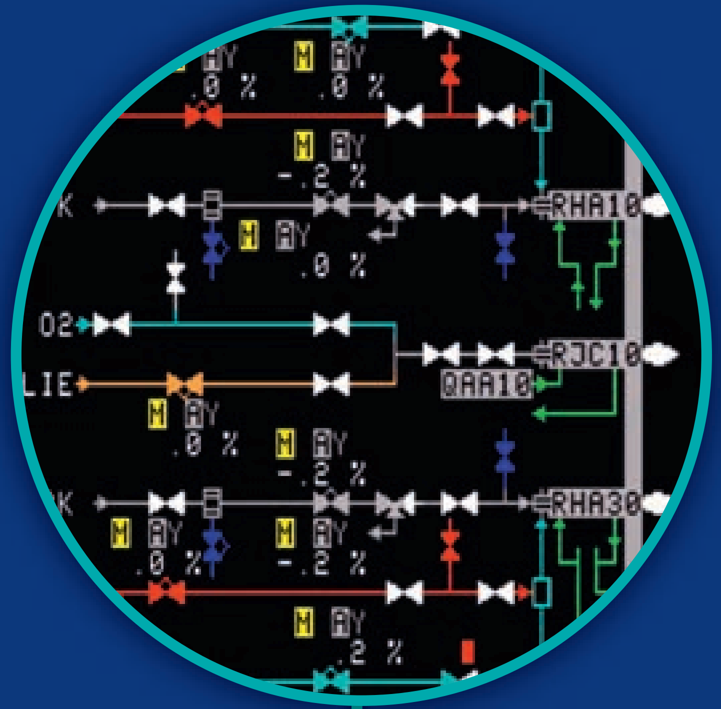
INCREASING RUNNING HOURS AND MEGAWATTS

Jan: 'Bit by bit we got the power plant under control. Every year we achieved more operating hours. Capacity ran from 120 megawatts in the early years to 200 megawatts in 2000 and even 242 megawatts in January 2013. During this phase we processed around 1,800 tons of coal per day and all factory parts were running at maximum capacity.'

Peter: "It was extensive work with always something happening somewhere. But whatever happened: together we went all out to get it resolved again."

Demonstration phase

1993 1998



1993

FIRST RUN

Construction is complete. Now it is our task to get this complex plant, with five integrated sub-factories, running. The first run is made on December 30, 1993. The blue flame is burning in the gas turbine!

Unfortunately, the run doesn't take more than one minute only, but the beginning has been made.

1994

OFFICIAL OPENING

On April 15, 1994, His Royal Highness Prince Claus, together with Mr G.D. Zon, project director of Demkolec, starts the operation of the world's largest coal gasification plant with a symbolic push on a button. At the same time, on a projection screen behind the Prince, the new name of the demonstration unit is shown: Willem-Alexander Plant, named after his son. This power plant must now prove to us that it is possible to generate clean electricity by gasifying coal in a sustainable way.

1995

COMPLICATED

There are many failures and the availability of the plant is too low. The integration of the five sub-factories is extremely complicated. One of the problems is that the sub-factories never before operated under varying loads, as is the case in the Willem-Alexander Plant. Loads vary between 50% and 100%, depending on demand of electricity. Speeding the plant up and down appears to be extremely complex.

1996

PIONEERING AND LEARNING

Improving the plant is a continuous job. Hundreds of changes in all sub-factories and measurement and control devices are carried out. These changes and conversions also make the power station even more complex. All mechanical engineers are updated with the new controls by a new internal training programme. The demonstration phase, originally planned until 1996, is extended til 1998.

SUCCES

The many changes have been successful. Part of the solution is found in an extra oxygen tank that is placed as a buffer before the coal gasifier. This decreases load fluctuations. A another solution consists of a combination of changes in the steam and gas turbine section. By welding little plates onto the blades of the burner mouth, the airflow in the combustion chamber is broken, resulting in less hum. The availability of the plant goes up.

1998

FIRST LONG RUN

From July 29 to October 24, 1998 the Willem-Alexander Plant makes its first run of more than 2000 hours. A world achievement! The plant is ready for commercial operation!

Demonstration phase 1993-1998

From change propositions to more insight and long runs

Operations are getting better

The commissioning of the plant is a complex matter. First of all, along with the suppliers become the individual sub-factories started up. The biggest challenge, however, is the integration of these systems into one cycle. There are hundreds of changes to the installations and measurement and control technology. Work continues for days and sometimes nights to run the center. And the keeper? That one wins!

The biggest problems occur at the air separation plant (LSI), the gasifier (VG) and the steam- and gas turbine (STEG). The STEG continues to hum, while the LSI is fast fails as a result of the fluctuating load resulting from the fluctuating demand for electricity. The Willem-Alexander Plant is designed as a highly integrated whole. The different units are directly connected to each other. That makes the center very efficient, but also very vulnerable. If there are any malfunctions or large fluctuations occur, the exchange can quickly fail.

CHANGE AFTER CHANGE

Until 2013, a total of 5,993 change propositions are submitted and carried out. The peak of these changes is in the demonstration phase. A large part of them relates to process improvement, but also with safety. Some 40% of all changes are related to the gasifier. The demonstration phase, originally planned until 1996, is extended until 1998.

INSIGHT ANS SECURITY

With all the changes in the subsystems, the complexity of the plant increases. And since there is no training program available yet for the first large-scale coal gasification plant in the world, an internal training program must be developed. There is a lot of attention for safety, chemistry and physical processes. Then, with the help of control plates, the mechanical engineers gain more and more insight into the theories behind the physical and chemical processes that take place at the plant. Control of the plant is improving gradually. Availability goes up, with a (temporary) highlight in the run from July 29 till October 24 1998, which lasts for more than 2,000 hours.

“Understanding something yourself is one thing, but to explain it to others is a totally different story”

Learn, train and share knowledge

The Power Plant as center of Excellence

The integration of five sub-factories into one integrated coal gasification plant was unique in the world. A technological challenge, especially at the time when the Willem-Alexander Power Plant was commissioned. The suppliers did not yet know how their subsystem would respond within the complexity of the total plant. How do you train people for operating something that has not been done before? Of which there are no books? Jo Salden and his colleagues started with regular courses, but soon developed their own teaching program. REWIC (part of the Dutch VAPRO training organisation) included parts of the material in their education program.

The first training courses started before the commissioning of the plant. Those were regular external training, in particular focused on chemistry. Jo Salden came as chief implement at the time - expert from the Claus power plant to the Willem-Alexander Centrale: 'The chemical world was completely new to us. We suddenly had to deal with distillation and regeneration columns and absorption processes. Different laws applied here. Not only in terms of content, but also in terms of safety. The risks are greater. We started working with internal work permits, very conscious and thoughtful. It required another approach. We had to rethink all things we thought we already knew.”

THE HIGHEST MARKS

In 1991, about eighty engineers went for ten weeks to DSM for the VAPRO B course. Joe: "I remember I'm glad everyone did their best. The diploma was a condition for working here in Buggenum, but the ambitions were much higher. The competition who is the best had numbers, exploded! Walked after passing the theory we do internships at companies where parts of our power station are located were in use. Many people were away from for a long time, some abroad. But it was super interesting and the commissioning was in sight.'

SLOGGING

“However, commissioning in 1993 was more complex than we had anticipated thought,” continues yo. "There were many disturbances. One of the This was due to the fact that the sub-installations are used normally under continuous load. In the Willem-Alexander Central this load varies between 50% and 100%, depending on the demand for electricity. In addition, the integration of the five factories quite complex. Stayed together with suppliers we tinker and slog. We made long days, with one goal in mind: a well-functioning plant.'

A COMPLETE INTERNAL TRAINING PROGRAM

Around 1996, the suppliers left. Their job was done, because the sub-installations worked separately and under continuous load - thing fine. However, the availability of the exchange was too low. Joe: "How could we increase the effective operating hours? The manuals of the installers were not sufficient more. With the help of internal HTS students we produced the training manuals ourselves. The air separation plant (LSI) was the first; the other four sub-factories followed. It was really pioneering. To understand something yourself is one thing, but explaining it to others is another story. We developed a complete integral training program, which also suited new mechanical engineers. It was captivating and valuable to play a major role in this as an instructor.'

FIRST LONG RUN!

Jo: "Meanwhile we got the LSI under control, as well the gas turbine, the gasification island and actually the complete plant! From July 29 to October 24, 1998 we made our first run above 2000 hours. We had learned a lot and were ready for commercial operation. Part of the solution at the LSI was an extention of its specifications. That was a real breakthrough. By broadening the theoretical specifications the practical availability of the total plant increased tremendously. How proud we were!”

At the center of interest

The succes of coal gasification in China is mainly due to Buggenum

Carlo Wolters worked at the Willem-Alexander Plant for 18 years: from 2003 to 2010 he was the plant manager. "Everything I know about managing factories I learned here" he says. "How do you always work safe and responsible, how to deal with the pressure to perform? It was there all the time on this plant. We wanted to prove ourselves and sometimes we even felt misunderstood. Many people had no idea what we were doing here. As a coal refinery in a world of power plants: this plant was unique."

In some organizations you sometimes see that a specific joint goal is missing. Not so at the Willem-Alexander Plant. Carlo: 'We were always facing big challenges. The future was never certain. This however also had a positive side: it created a strong bond between the people. The organisation was very close, the commitment was great. It happened many times that we started in the morning but didn't finish until the afternoon on the next day. Everything with just one goal: increasing the availability of the plant while assuring the highest safety level. We made no concessions on that point."

SAFETY ABOVE ALL

During operations in Buggenum, approx 2,000 tons of oxygen were produced daily. The risk was high, especially in combination with the gases and toxic substances that are present in the process. Carlo: 'A safe plant starts with the joint awareness of why everybody has to work safely. The risks must be clear to everyone. This creates an intrinsic motivation for working safely, which is very different from someone simply telling you what to do. From there we created high quality practical security standards that later were adopted by many other companies."

LOTS OF ATTENTION

Not just the efficiency and availability of the plant got lots of attention. Carlo: "The people living in the vicinity of the plant and lots of politicians also kept an eye. When we wanted to start co-firing biomass there was a lot of resistance. Therefore, we organized get-togethers with the community to better explain what we did. I think we were exceptionally open about the risks and the environmental effects. All questions and ideas were taken serious. This outside pressure actually helped getting even better. It's nice to see that the resistance has turned completely in recent years. The politicians and the community are now very positively involved and regret the closure of the plant almost as much as the people from inside."

AT THE CENTER

Carlo spoke about the success and the challenges of Buggenum at conferences in Europe and America. "Unlike many we also spoke about the critical aspects of this kind of plants."

Because we were convinced that we could all learn from this. I always came home with lots of ideas and fresh energy. As best performing coal gasifier we were at the center of the interest of engineers, politicians and companies from all over the world. What we did was revolutionary. The success of coal gasification in China is created with thanks to Buggenum. This interest and respect for our learning processes made us feel good.”

THE FUTURE OF COAL

“The electricity market has changed completely in the past two years,” says Carlo, who is now responsible for Asset Management and Performance Improvement of all Vattenfall power stations. ‘The enormous increase in wind turbines and solar panels in Germany and the economic recession caused an overcapacity in large parts of Europe. Low energy prices are the result. Moreover, shale gas production is increasing in America, which is a cheaper alternative and will also have an effect on European prices. On the longer term, I therefore see little future for coal-fired power plants in the international electricity market.”

CHINA

“But there is a future for the technology we developed,” continues Carlo. “In China there are a large number of gasifiers successfully in operation, while new ones are addes continuously. They are not used for the production of electricity, but the generated hydrogen and carbon monxide are used to produce ammonia and fertilizer. They are located in areas with huge coal reserves, that lack natural gas. The learning cycle of the Chinese is very fast. There are already dozens of coal gasifiers. A very interesting development, for which we have laid the basis at Buggenum!”

"The showpiece was a videowall consisting of seven 70 inch screens of 70 inches with which we hade a perfect process overview"

Measuring is knowing

Control room: more than 9,000 signals visualize a complex process

A high-quality coal gasification plant requires a first-class control room. Here, about 50 engineers worked day and night in shifts to monitor and control the process from coal to gas and electricity from start to finish. Pierre op het Veld and Paul Vossen worked from 1992 to 2013 as maintenance engineer and maintenance worker respectively, mostly behind the scenes to take care of the proper functioning of the control room itself. "Our continuous goal was to make the automation even smarter in order to get a good picture of the process."

'The senses of the power station', Pierre op het Veld calls the control room. Here you can see, hear and feel the operation of the remote center. With about 9000 analog and binary data you can follow everything in detail: the operation of pumps and valves, the temperature of the gas or water, the functioning of control valves, the air pressure or the weight of waste. Of course in close cooperation with the maintenance team at the factory."

NICE WORK

'It was most turbulent here when the power plant was started up after a stop period,' says Paul Vossen. 'It was exciting how fast the power station would run properly. Then you saw how important man is in the whole. He directs and cares ensure that processes run smoothly. I found it always nice when our technologists came up with something new, to translate that into the software so that the operators look good could work with."

NEW PROCESS AUTOMATION

Pierre: 'The most special project for me was the renovation of the control room. We started this in 2008 and in 2010 was the delivery. In close consultation with the users the entire MMI, the human-machine interface, was revamped. The MMI is the set of hardware and software that makes up the computer communicate with the user. The showpiece was one video wall consisting of seven 70-inch large screens with which we had a perfect process overview. In a glance. With that we were able to find the cause of a malfunction much faster.'Paul: You can't imagine, but the old operating system still had 80 MB hard drives. Things have moved quickly in automation!'

PROUD AND COMMITTED

Pierre: 'I have always been very proud of my work. What we were doing exactly was often too complex to explain to others, but it was clear to all that we were busy with using special technology. This was the first coal gasification plant in this size with a closed system and the integration of different technologies. Universities from all over the world came to see it. We were an example for coal gasifiers that were subsequently built in Spain and China." Paul: 'Everyone had an enormous drive to make this power plant a big success. It created a certain involvement which was characteristic for the entire organization."

Commercial phase

1998
2013

HIGH AVAILABILTY

1998

The Willem-Alexander Power Plant performs well, making it the first integrated commercial coal gasification plant in the world. Following instructions of the European Union the Dutch government starts with the privatization and liberalization of the energy market. In 2001 Nuon reliant Energy buys the Willem-Alexander Plant.

TESTS WITH CO-GASIFICATION OF BIOMASS

2000

In November 2000, Nuon will start a test program for co-firing biomass. Various sorts biomass, including grape seeds, chicken manure, scrap wood and sewage sludge. Since 2005 success has been achieved with co-gasification of clean wood pellets. In 2006 a silo of 1800 m3 built for storage of biomass. In principle, performance becomes up to 5% achieved; later up to 15%. With torrefied (thermally treated) wood pellets succeed in 2011 to gasify 70% biomass! unfortunately the availability of torrefied wood pellets sufficient for the needs of the Willem-Alexander Power station and can therefore not cope with the co-gasification be applied on a large scale.

LONGEST RUN

2006

From November 26, 2006 till April 12, 2007 the plant operates continuously for the longest period of time. The run spans 3,291 hours.

MAGNUM PLANT

2007

Nuon decides to invest in a modern coal gasification plant in the Eems Harbour in the Province of Groningen, in the North of The Netherlands, by example of the Willem-Alexander Plant.

CO_2-CAPTURE

2008

To reduce CO2 emissions even further, Nuon starts with a test for CO2-capture in Buggenum in 2008. Using *pre-combustion capture technolgy* the CO2 is removed *before* combustion of the coal gas. In 2011, the CO2 capture pilot plant is succesfully taken into operation. The test plant is capable of catching 90% of the produced CO2.

DELAY AND OVERCAPACITY

2011

For economical and environmental reasons phase 2 of the Magnum power plant - including the gasification and the CO2 capture systems - is postponed to the year 2020. Therefore, Buggenum loses its strategic value for Nuon. Next, there is an overcapacity of production of electricity in Europe, due to the construction of new power plants and the increase in windmills and solar panels. Less operating hours for fossil power plants and low energy prices are the result.

CLOSURE

2013

The Willem-Alexander plant closes on April 1, 2013. The plant has had 126,782 hours of electricity generation. Important know-how has been developed. This knowledge and technological innovations then travel throughout the world, to China and Korea for example. In areas with huge coal stocks and no natural gas, gasification plants produce hydrogen and carbon monoxide for the chemical industry for production ammonia and fertilizer.

Commercial phase 1998-2013

From green opportunity to shut-down

Technical showpiece with a price

When the Dutch government started privatizing and liberalizing the energy market in 1998, the Willem-Alexander Plant shines with pride. Although the sub-factories are still being improved continuously, the major technical problems are all solved while availability is good. In 2001 Nuon bought the power station. With efficiency and the environment on the agenda.

To bring global warming to a halt, the Dutch and European governments have ambitious targets regarding sustainability and CO_2 emissions. Nuon kicks off in 2000 with a test program for co-firing biomass in the Willem-Alexander Plant. This type of combustion significantly reduces CO_2-emissions, much more than with direct coal-fired or other fossil plants. The question, however, is which type of biomass is suitable for the gasification plant.

BIOMASS

With the help of MEP funding, which is used nationwide to improve the environmental quality of electricity production, various types of biomass are tested: from sludge of waste water treatment plants to grape seeds. Many types are not technically feasible, but good results are achieved with wood pellets. With torrefied wood pellets, the Willem-Alexander Plant is even capable of co-gasification up to 70%.

LESS ENVIRONMENTAL IMPACT, MORE PLANS

The plant has excellent availability and fullfills all high expectations as a demonstration project. There are plans to build a similar commercial plant: the Magnum power Plant in Groningen. Next, good results have been achieved with CO_2-capture. The test plant, which came into operation in 2011, was capable of catching 90% of the CO_2 *before* combustion of the coal gas.

THE TIDE IS TURNING

However, due to low availability of the torrefied wood pellets, co-gasification of biomass cannot be applied on a large scale. As a result, the Willem-Alexander Plant loses its strategic value as a knowledge institute. Moreover, with the increasing competition from wind and solar energy and the overcapacity of electricity in Europe, energy prices are falling quickly. Therefore, the technically advanced though more expensive power plant will no longer pay off. On April 1, 2013, the Willem-Alexander Plant closes its doors.

From brick to brilliant

Chemistry is in the plant ànd between its people

To prepare for the liberalization of the electricity market, Nuon initially focussed on the trade in electricity, without having its own plants. However, to be able to better respond to fluctuations in power needs, without being dependent on high prices, NuonReliant Energy buys the Willem-Alexander Power Plant in 2001. The unit is used as a control device to minimize the risks of grid imbalance.

The acquisition by Nuon also means the arrival of Odilia Rens, 35 years young, responsible as plant manager from 2001-2004 important for the Willem-Alexander Central. "The perception of outsiders regarding this power plant was quite skeptical at first. In Buggenum, 'only' 250 megawatts were supplied at high costs: a lump of brick only. But what I saw was an innovative and complex technology, incredibly motivated people and many possibilities: a brilliant that only had to grow.

DRIVE AND CREATIVITY

"The power we had to produce at Buggenum was determined at Nuon's head office in Amsterdam', Odilia continues. "The signal came straight into the control room. The visibility of the current demand gave tremendous insight and drive to do our work the best we could. In doing so, our creativity and commitment was put to the test continuously, since all technical problems were not yet solved completely. If you didn't have that drive, you wouldn't fit in the team here.'

CONFIDENCE IS GROWING

Odilia: 'Everyone was constantly working hard to get the most from the plant. That course however changed after the takeover by NuonReliant: from maximal to stable. By opting for slightly less megawatts, availability improved. This also ensured better contact with local residents. After all, starting and stopping caused a lot of noise. The relationship with local residents also improved because we started communicating more intensively. With newsletters and meetings. Not in some room, but with us - including a guided tour. This way we literally came closer together. Next, it also helped that we reduced our production targets in the environmental permit application. Confidence grew."

REORGANIZATION

Communication within Nuon also expanded. Odilia: "We had to put ourselves in the spotlights to show what we could achieve. There were very good years, like 2002, in which we were praised into heaven - but there was also a lot of uncertainty. Then, in 2003, Nuon bought Reliant Energy to become the owner of several extra power plants. This lead to a reorganization in which several services were centralized: some thirty employees of Buggenum had to look for another job. Odilia: "We had to prove ourselves again and again; after all, there were several other power plants now, that could do the job as well. So we had to further reduce on costs and work on success with, for instance, co-firing of biomass. That worked fine, since Buggenum had to function on continuous base loads only: other gas-fired power plants were used to easily align production with current demand."

140 BRILLIANT PEOPLE

In 2005 Odilia started her work as HR manager with Nuon. From the chemistry within the plant, to the chemistry between people! Therefore, Buggenum still has a special place in her heart. Odilia: 'Saying goodbye is difficult, but all our employees are highly skilled people: together they are 140 brilliants. I am convinced that with their positive attitude, their drive and creativity they all have very good perspectives on the labor market.'

“Our mission, to demonstrate that biomass could be co-fired on a large scale, has succeeded.”

Biomass: a green opportunity

For CO2 emissions to be reduced even further, Nuon started a test program for co-firing biomass in Buggenum by the end of 2000. The big question was whether/which biomass was suitable as an additional fuel for the coal gasifier. Process engineer Loek Schoenmakers: 'Every time, the results of calculations and tests were very exciting. We knew: it's make or break.'

The need to create an even cleaner production facility was very exciting. Loek says: 'Co-firing biomass significantly reduces CO2-emissions to a level that would fit within the sustainability targets of Nuon and the Dutch government. Therefore, we were subsidised for ten years by the Dutch government, to improve on the environmental quality of power production.”

TYPES OF BIOMASS

‘We started our search with all kinds of organic waste products, such as sewage sludge, chicken manure and scrap wood,’ Loek continues: 'These types of biomass are widely available but processing it was not feasible in our plant. The gas cooler, which cools the syngas down from 1500 °C to 250 °C, became contaminated and therefore exceeded the maximum permited outlet temperature. Other types of biomass we examined, such as coffee waste and grape seeds, were technically okay though too expensive or too risky with respect to delivery conditions.

GREEN SUCCES

‘In 2005 we started co-firing clean wood pellets,” continues Loek. “These are sticks of compressed wood, which worked perfectly. In the beginning we co-fired with 3 to 5% only, but in 2010 we achieved 15%. However, this percentage still had to be increased, since we wanted to secure additional environmental fundings. For this, the target had to go up to 50% or even 70%. So we had to look for an alternative with a higher energy content: for this we ended up with torrefied wood pellets. Because this product resembles the structure of coal quite well, co-firing turned out to be successful up to 70% of biomass. It was an extraordinary discovery: an innovation for the entire energy world.”

SILOS ANS SHIPS

‘In 2006, a large silo of 1,800 m3 was built at the port for storage of biomass,' Jack Brouns says. ‘Before that, we had to transport the biomass by truck and mix it - just in time - with crushed coal at the plant. Sometimes we had to use a much smaller, old, empty silo as a buffer. The trick always was to plan the supply in such a way that we did not have too much, but certainly not too little on stock.”

WE WERE ALMOST THERE

Loek continues: “Torrefied pellets were heated without oxygen till 250-300 °C. At this temperature all volatile components - that do not contribute to combustion - are released. It is a promising technology but availability of these pellets was a problem. We received some batches from the US for testing, but there was no large-scale production yet. Investors and buyers were actually waiting for one another. Who would take the first step? Nevertheless, our assignment to demonstrate that biomass could be co-fired on a large scale, was very successful.

Unfortunately however, the large-scale application of this type of co-firing did not take place at Buggenum. That's a shame, because it would have given us a better position, although it would not be a guarantee for succes either. There were many factors involved in the decision on whether or not the plant should be closed.' Jack: 'It's a real shame, but unfortunately we had no influence on this, since all power plants were facing very hard times back then. But I'm glad we have made our contribution to the development of knowledge on biomass co-firing. Maybe in the future this can still make a contribution to creating a greener world. Who knows?'

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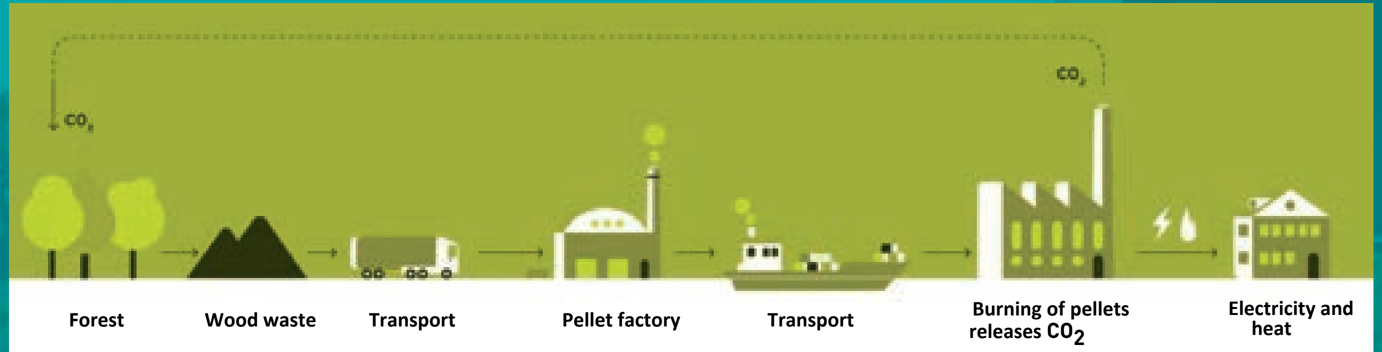
BIOMASS

BIOMASS IS AS OLD AS HUMANITY ITSELF. OUR DISTANT ANCESTORS COLLECTED WOOD FOR THEIR PRIMITIVE HOUSES TO HEAT AND TO LIGHT UP. THEREFORE BIOMASS IS ANOTHER NAME FOR NATURAL (RESIDUAL) MATERIALS THAT ARE USED FOR ENERGY PRODUCTION, SUCH AS WOOD, SHELLS, KERNELS OR STRAW.

A distinction can be made between raw biomass and processed biomass. Processed biomass was used in the Willem-Alexander Power Plant in the form of wood pellets. The specially processed wood pellets can be used to replace coal by co-firing it in coal-fired power plants. This ensures a lower net CO2 emission and cleaner and more sustainable production. Next, its use also reduces our dependence on energy resources such as coal, oil and gas. Biomass therefore contributes to our goal to reduce climate change since it is considered to be CO2 neutral. it is a reliable, sustainable source of energy which can provide the daily amount of energy needed is. Since it is always available, it can be a valuable addition to other sustainable sources that are weather dependent are, such as wind and sun.

PRODUCTION DIAGRAM BIOMASS PELLETS



"The CO2-capture process has long been used in the petrochemical industry. In the energy sector however, it had never been done before."

The technology of the future!

CO2-Capture: promising process to reduce the greenhouse effect.

Burning fossil fuels releases carbon dioxide: CO2. The emission of CO2 is the main cause of global warming. In 2008, Nuon started a test for CO2-capture at Buggenum. A technology that, when successful, would not only be used at Buggenum, but also at the newly planned Magnum power plant in the Eems harbour. Actually, the entire energy sector would benefit by making coal gasification (even) cleaner.

"The process of CO2 capture had already been used for some time in the petrochemical industry', says Marc Cuypers, who worked as a mechanical engineer on the commissioning of the CO2 plant at Buggenum. 'However, it had never been done in the energy sector. The Willem-Alexander Plant was ideally suited for the process, because the coal is not burned, but gasified. This enables us to capture the CO2 *before* combustion of the produced coal gas, called *pre-combustion capture*."

MODULAR CONSTRUCTION

The CO2 capture installation became the sixth sub-factory of the Willem Alexander Power Plant. The design was by CB&I Lummus and the construction was done by Spie and MCL. Marc: 'The plant was built with five modules. I still remember how the components came into our port. Mammoet's heaviest cranes and caterpillars had to to get them from the port to the construction site. We even had to put the gasifier out of operation during transport, to avoid any risk."

COMMISSIONING

Marc continues: "We worked on the commissioning with six colleagues from production. We controlled planning and construction, and checked all valves and fluid flows, next to testing all measurement and control technologies. A very nice job! Construction was completed at the end of 2010 and the research programs started in collaboration with ECN, TNO, TU Delft and KEMA. The total investments for Nuon were approximately 40 million euros. However, we obtained a subsidy of 10 million euros from the Ministry of Economic Affairs.

SUCCES

'The efforts and investments turned out to be worthwhile: we were able to catch over 90% of the CO2 released from the coal gas! With this result we showed that coal can be a clean fuel. Because "our" CO2-capture plant at Buggenum was a small pilot plant only, roughly 1% of the produced coal gas in the full-scale gasifier was sent to our pilot plant to be decarbonised. Research is currently done however to further increase these percentages up to 50, 80 and even 100%."

THE BIG QUESTION

But what to do with the captured CO2? Marc: 'In Buggenum we had no use for it, since it was 'only' a pilot plant. For large-scale applications however, it was the intention to store the captured CO2 in depleted natural gas fields, like in Groningen. After all, by extracting natural gas from these fields, the pressure drops from 60 to 5 bar: with instability and subsidence of land and buildings as a result. By squeezing CO2 into the "empty" natural gas fields , the pressure would rise again and the ground would be stabilised again. So you are not only processing h

"You don't just deal with the released CO2, you also solve the soil subsidence problem"

CO2, you can also solve the subsidence problem. Moreover, by injecting CO2, you could even 'squeeze out' the last bit of valuable natural gas. The public opinion, however, does not yet support this idea. The decision regarding the investment for a commercial gasification and CO2 capture plant in the Eems Harbour in Groningen have therefore been postponed to 2020, however partly due to economic aspects as well. Obviously, you have to be extremely careful with all risks involved, and know exactly what you are doing! Nevertheless, I personally think that some residents and environmental groups incorrectly consider these risks to be unacceptably high; I don't think they are much different from those involved with the storage of natural gas.'

TIME WILL TELL

Marc: 'Postponing construction of the Magnum coal gasification power plant was a big disappointment after our various succesful achievements. I am convinced we developed a good and clean technology. However, it requires large investments in a time with falling electricity prices.

Therefore time will tell. Who knows what decisions will be made in 2020, maybe based on even more developments in this field. The captured CO2 could also be fluidised to be transported to other locations. Anyway, our work has not been useless!'

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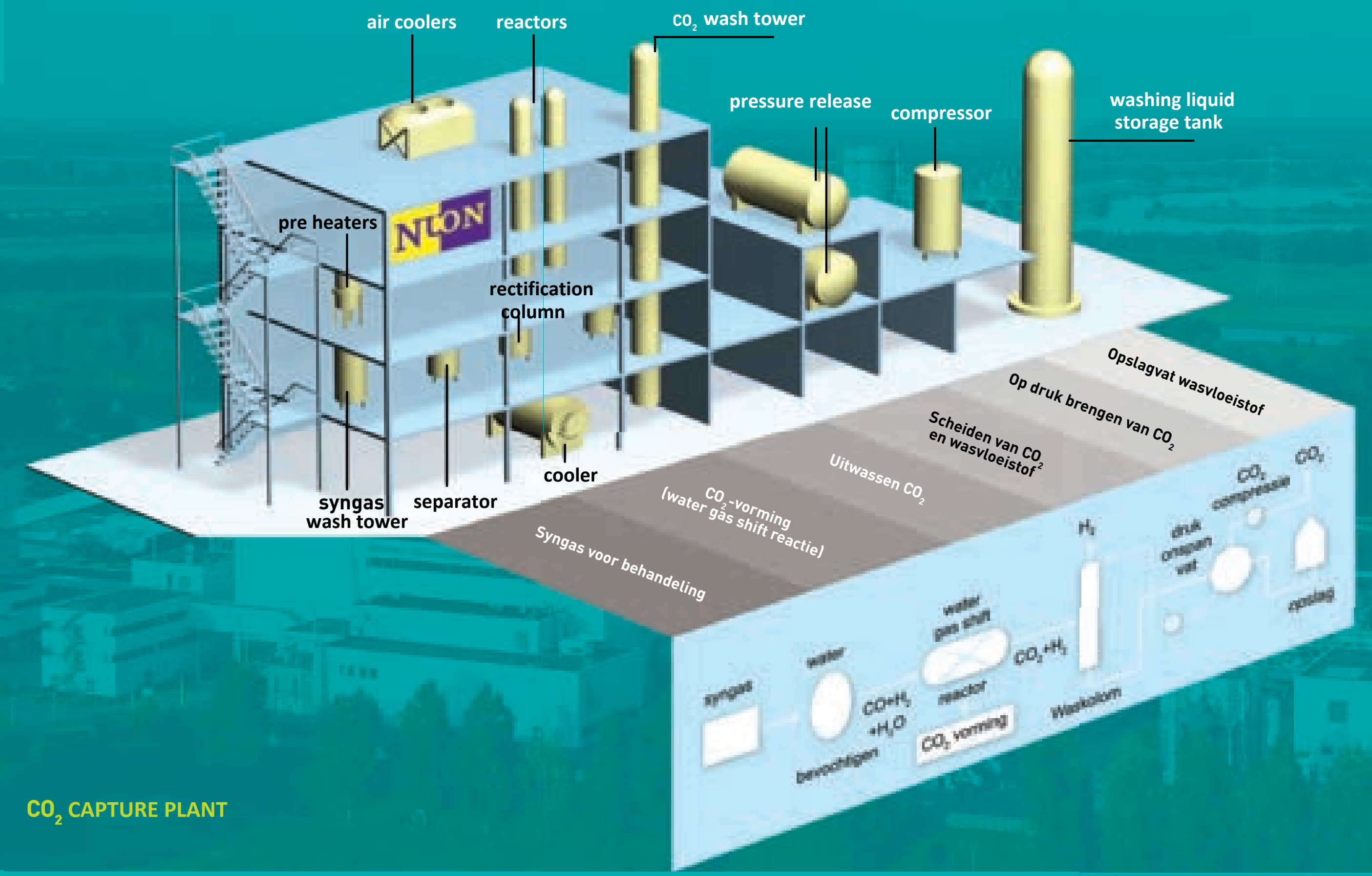


CO_2 CAPTURE PLANT

CO_2 CAPTURE

THE CARBON MONOXIDE (CO) PRESENT IN THE PRODUCED SYNGAS (COAL GAS), IS CONVERTED INTO CO2 AND (MORE) HYDROGEN (H2) IN THE CO2-PLANT. IN A CATALYTIC REACTOR THE TWO GASSES ARE CREATED BY MEANS OF A WATER-SHIFT REACTION. THEN, IN A WASH COLUMN, THE GASSES ARE SEPARATED FROM EACH OTHER. THIS IS POSSIBLE BECAUSE CO2 SOLVES IN LIQUID WHILE HYDROGEN DOES NOT.

The highly flammable hydrogen gas is collected and fed into the gas burner. After combustion of this newly formed fuel (H2) only water vapor (H2O) is emitted into the atmosphere by the chimney.

The captured CO2 can be transported, stored and/or used, to no longer cause global warming. The technique is called CCS: Carbon Capture and Storage.

The boys from the STEG

‘By now, we know the plant even better than its suppliers'

Good maintenance is very important in a professional factory. On average, we had some 22 maintenance engineers continuously on the job at Buggenum. The mechanical and electrical parts of the plant (electricity, automation and measurement and control technology) worked well together, according to Piet Camps and Frits Cleutjens. They should know, as maintenance engineers from the very beginning. 'The involvement of everyone was just great. Working overtime? Everybody was always there, especially when it came down to it.”

Piet and Frits know the plant inside out. No suprise, because they have had about every part at least once in their hands. The STEG, the steam turbine, the gas turbine: they can dream every part of it. Piet: ‘Everyone had their own focus area in the plant. If there was something wrong with the STEG, we were called in immediately.” The maintenance team unloaded malfunctions, ensured that parts were replaced and made changes and larger revisions.

REVISIONS

Frits: 'Piet's and my work followed up. During a revision for example, I first disconnected all electrical instruments with my colleagues from my department. Then Piet came in with his colleagues to disconnect the pumps and pipes, clean, renew and align them to re-install everything again. Then we followed them again to re-activate all instrumentation. You really needed each other, especially when there were problems. After all, you know more from two disciplines than only one.'

COMPLETELY INDEPENDENT

A revision was carried out every year. Then the service technicians from the suppliers were also involved, to overhaul their installations. Piet: 'When we went down for four months in the summer of 2011 and 2012, to save on costs, we cooperated with our own guys from Production to completely revise the total plant independently. That went great! By then, we knew the installations even better than the suppliers themselves. The start-up afterwards was flawless.'

UNRULY PRACTICE

'What's great about my work is that you never know what a day might bring. You have to investigate all kinds of problems and find their cause' says Frits. "The challenge is to solve something as good and quickly as possible. In the beginning of the demonstration phase, we had lots of problems with the STEG. It took months, years to optimise it.” Piet adds: “There was a lot of humming in the gas turbine. We tested many changes, together with our supplier Siemens. Around 1996 however, the solution was found. This consisted of a combination of changes. For example, we welded little plates onto the blades of the burner mouth, which broke the airflow in the combustion chamber. The buzzing stopped immediately.”

"Together we created a piece of technology with world fame"

World renowned technology

Thank you!

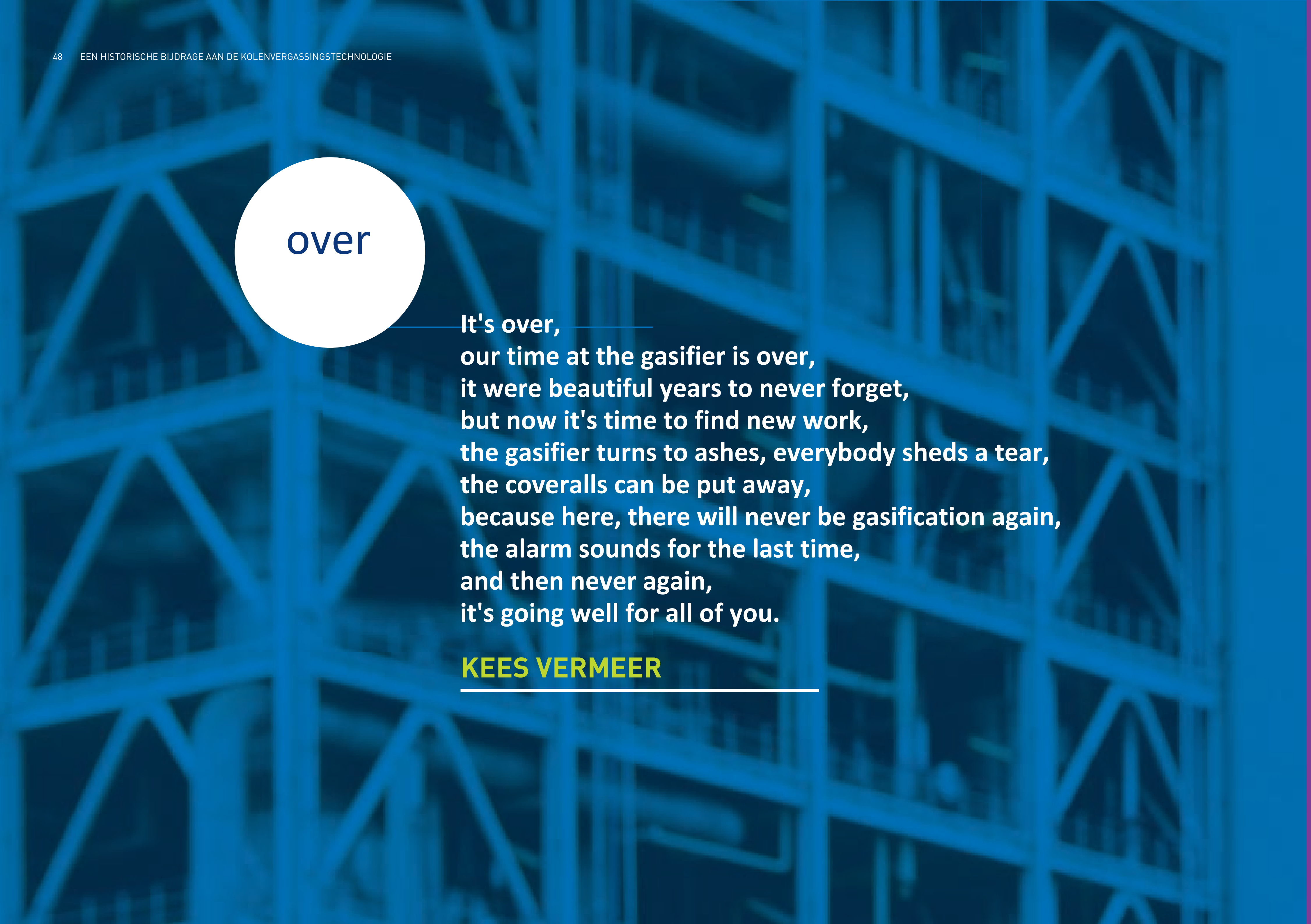
All employees, suppliers and other parties that committed themselves to this beautiful power plant deserve praise. High praise. We have created a piece of technology of world fame here. Every day we worked with dedication and commitment to development the process further and further. New insights and requirements were picked up, created, invented, tested and integrated. And every time we came a little closer to our final goal: creating a clean, sustainable and efficient power plant.

I also want to thank all local residents and everybody that was involved politically. Your trust, your questions and sometimes even your criticism enabled us to continuously improve on this development.
But now we have to let go of this beautiful plant. In the current Dutch political climate and the energy market in general, there is no place for a large-scale coal gasification plant, despite of our environmentally friendly options for biomass co-gasification and almost complete CO2 capture.
However, the know-how of what we have developed will continu to live on. For example at coal gasification plants in China already, where its clean gas is not is only used for power generation, but also as input for the chemical industry. So we have developed a technology that already travels the world. We may certainly be proud of that.

Therefore, I wish everyone a good future. Thank you so much for all your efforts and commitment.

Bye!

Marc Martens, Manager LAG Oost Nuon



over

It's over,
our time at the gasifier is over,
it were beautiful years to never forget,
but now it's time to find new work,
the gasifier turns to ashes, everybody sheds a tear,
the coveralls can be put away,
because here, there will never be gasification again,
the alarm sounds for the last time,
and then never again,
it's going well for all of you.

KEES VERMEER


Willem - Alexander Centrale
NUON
Part of VATTENFALL