



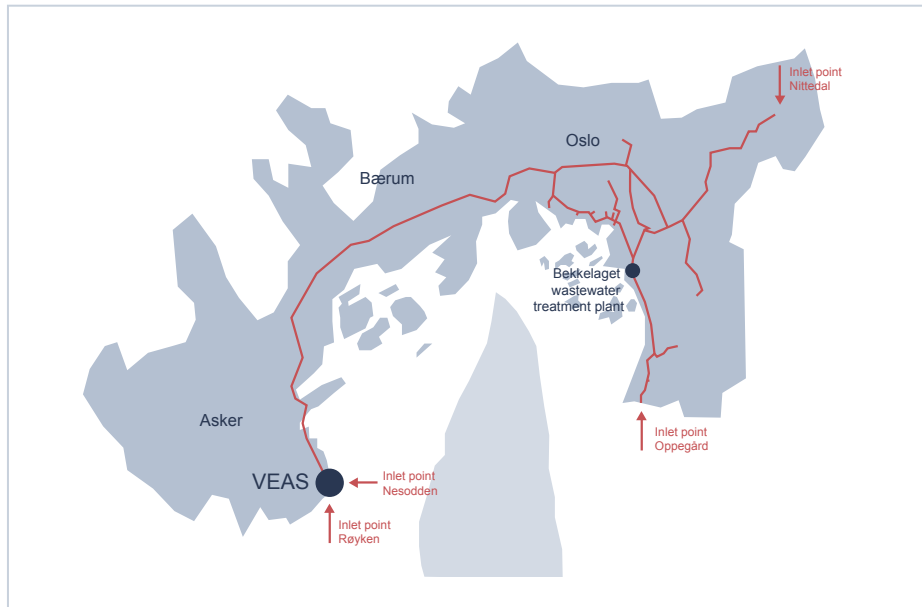
FROM SEWAGE TREATMENT PLANT TO BIOREFINERY

VEAS IN BRIEF

VEAS (Vestfjorden Wastewater Company) is Norway's largest wastewater treatment plant and is owned by the municipalities of Oslo, Bærum and Asker. Wastewater from the owner municipalities, equivalent to 750,000 persons, is transported via the VEAS tunnel to the treatment plant at Bjerkås in Asker. VEAS also cleans wastewater from Røyken and Nesodden municipalities.

The plant is located in the mountain and operates around the clock, all year round. In addition to effective water treatment, VEAS contributes to nutrients being brought back into circulation through the production of stabilized, sanitised and sewage sludge (VEAS-soil) with added calcium and a nitrogen solution used in agriculture. Raw gas formed from the sewage sludge is used today to produce electricity and heat used in the plant, but VEAS is building a new manufacturing plant for liquefied biogas.

At full operation, VEAS will be able to produce biogas equivalent to approximately six million litres of diesel, while reducing climate emissions by more than 15,000 tonnes of CO₂ equivalents per year.



MAXIMUM SOCIETAL BENEFIT



What ambitions should we set ourselves in a region that keeps growing? At VEAS, we have chosen to answer this by formulating three clear strategic visions:



In 2040 we shall not release any unwanted substances. There will be only clean water discharged into the sea and products without heavy metals, micro-plastics or other harmful substances and we will accomplish this without having injuries to our staff. In 2040 we shall go from generating costs to generating income. If we are able to exploit the resources in wastewater and other waste, we will transform VEAS into a surplus business, an urban factory for the benefit

of residents who are currently paying taxes for our services. Our overall goal is to provide maximum societal benefit. We monitor developments in society and assess opportunities and challenges. We need to document, develop and test technology in order to provide increased resource utilisation and reduced resource consumption. We also need to identify which product requirements exist and whether new markets can be developed. VEAS also wants to take a distinct role as a contributor to society and as a good neighbour. We also want to be an attractive partner for the research and education communities and the supply industry.

These three visions balance ambitious purification goals with opportunities in the circular economy. Meanwhile, VEAS will adapt to the changing needs of its owners and society. Are we prepared for this today? No, like most others, we have a lot to contend with, but our resilient visions and the designation of a clear direction has given a new initiative throughout our organisation. Our visions

and goals challenge all aspects of today's VEAS and will require considerable change and restructuring in many areas. However, when we succeed, we will become a biorefinery where wastewater is transformed into a plethora of useful products that benefit residents.

2018 was a good and educational year for us. VEAS has set milestones in the work to achieve our strategic visions, and we are now in the process of looking at the company structure and the organisation of the various activities at VEAS. This work is expected to be completed during 2019.

After years of large restoration projects and lower capacity, VEAS has delivered satisfactory purification results last year. In the autumn of 2018, we started a large upgrade project in which our last two of eight process halls will be rebuilt to include nitrogen removal. The project will be completed in 2021. In conjunction with the major projects, we are systematically working on continuous improvement throughout the entire process line.

In December 2018, we started the biogas upgrade project. The new plant will be finished in the spring of 2020 and will then deliver 60 GWh of liquid biogas (LBG), equivalent to six million litres of diesel. The market will primarily be public transport, large vehicle fleets and industry.

By reducing the use of external consultants, increasing in-house competence and thinking about cost-saving solutions, we have achieved an operating profit in 2018. VEAS has knowledgeable staff with an outstanding perseverance and high spirits, and with the solid foundation laid down in 2018, we will evolve further over the coming years. It will be an exciting journey!

Ragnhild Borchgrevink
Managing director

DIGGING FOR GOLD IN THE SEWER

Wastewater becomes green value creation for VEAS

"I need to show you something!" That says it all.

Rune Holmstad points to a single A4 sheet of paper, which hangs on the wall next to the computer in his office. The American scientist Richard Buckminster Fuller once said:

"Pollution is nothing but the resources we are not harvesting. We allow them to disperse because we've been ignorant of their value."

"We like to say that it is value management we are doing here. VEAS is not only a sewage treatment plant, but a factory that extracts the resources in wastewater," says Holmstad, a senior project manager in the Strategy and Development department at VEAS.

"This is the least sexy raw material that exists, but we can do some exciting things with it in the future," he says.

Green value

"Most people don't think about what happens after they flush, but the majority realise that it's good that it's not going straight into the fjord," he says. Going forward, VEAS will do much more than make sure the water that ends in the Oslo fjord is clean. It will also contribute to the green shift. Brown wastewater will be transformed into green value creation. "We're still going to clean the water and we're going to get better at it. In addition, we have a raw material that can be processed into interesting products. The world will be more resource efficient. Nothing will go to waste, and we're going

to contribute to a circular economy," he says.

"How can we turn this raw material into gold?"

"Maybe not gold exactly, but into valuable products. That is what they did in the old days, when they had an outhouse and used what was there to fertilise the field. We do the same thing on a much larger scale and in a more technologically advanced manner. Nutrients that the body has broken down can be reused."

"How?"

"Wastewater has enormous nutrient and energy potential. The processes in our facility can capture and exploit this potential. Allowing billions of bacteria to further digest this "residual food" into biogas and bio-fertilisers is probably the most sustainable and resource-efficient way to process the waste," says Holmstad.

Fuel for the future

To date, VEAS has produced and used biogas to create heat and electricity for its own use. 40-50 percent of energy needs are met. But now, all the biogas will be developed into biofuels.

"Norway and the world will become fossil free in the future. And this is our contribution," he says.

"Liquid biofuel alone cannot replace fossil fuel," explains Holmstad. We need a diversity of energy sources, such as electricity, hydrogen, biodiesel and liquefied biogas.

Carbon dioxide from sewage

VEAS is betting on biogas production and in 2020 a new plant producing



Valuable sludge. The project manager in the Strategy and development department, Rune Holmstad, shows the sludge that goes into the digestion tank to be turned into environmentally friendly biogas.

liquefied biogas will be ready. In the next phase, VEAS will look at how to utilise the CO₂ gas that is separated from the methane.

"It is a resource, even if we have too much of it. They manage to do it in the Netherlands," he says.

"If you manage to clean the CO₂ gas well enough, there is nothing to stop it being used in food production. In the future, one can imagine the carbon dioxide you drink in soda and beer coming from here," he says.

"Another idea is to use CO₂ in greenhouses or in controlled algae cultivation. Imagine if we could produce a biomass that can be used for fuel or fish food at the other end! If we manage to do this on a large scale, it could help reduce the import of soy and palm oil with a large climate footprint," he says.

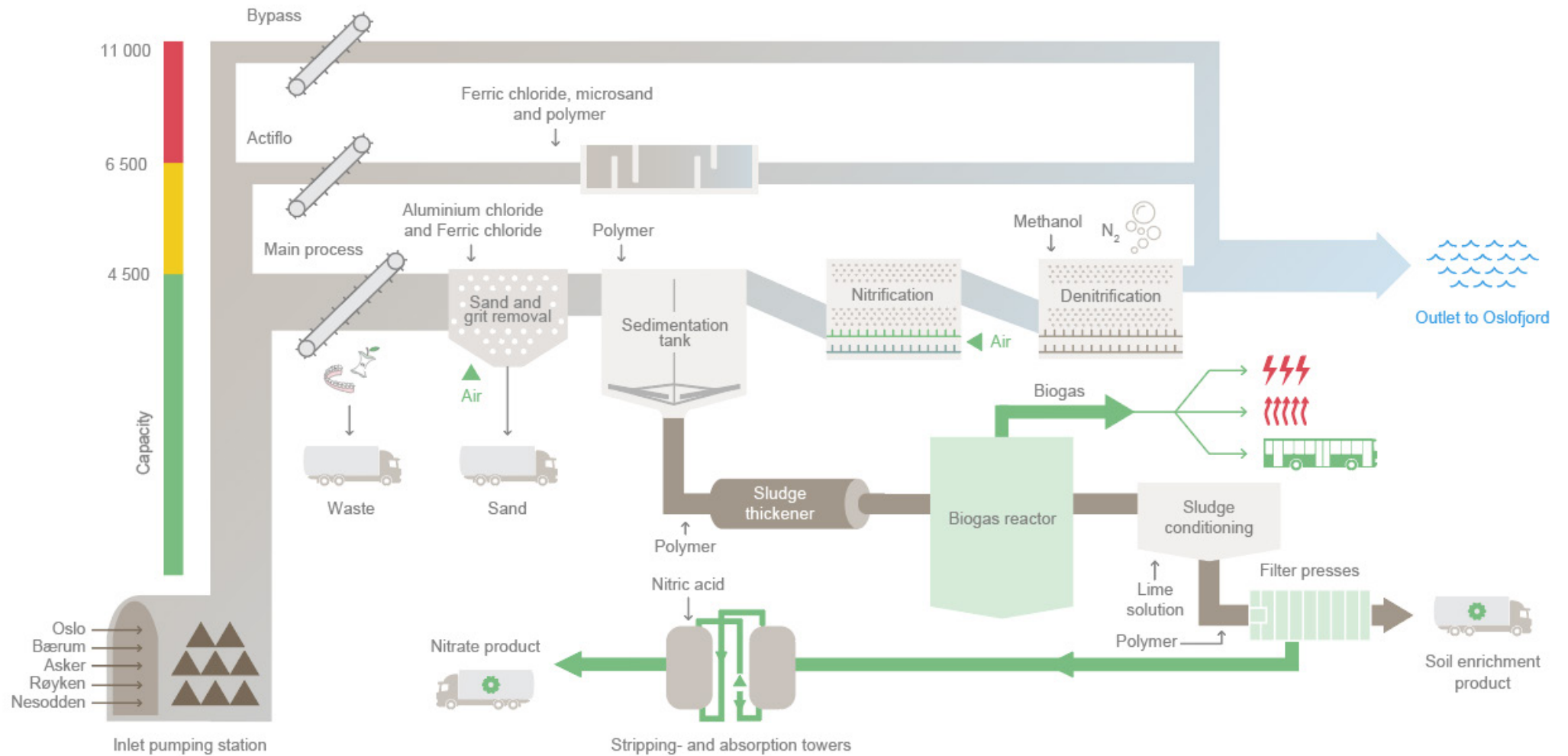
Pure fertiliser

After the biogas has been recovered, we are left with bio-residual matter, sludge, which contains both nutrients and organic materials. Today, lime is added and it is dried. We make VEAS-soil, which

is used on fields to grow grains. In this way, nutrients are brought back into circulation as fertiliser and organic materials and are used for improving soil structure.

"At the same time, we know that the bio-residual matter also contains small amounts of substances that we may not want back in circulation, such as micro-plastic, medicine residues and detergent residues," says Holmstad. "The Norwegian policy is to use bio-residual matter for soil enrichment, based on the fact that its value is high, higher than the risk," says Holmstad. However, we have a dilemma when choosing a sustainable solution for the future. Should we strive to make even better soil and fertiliser products from the bio-residual matter, or should we harvest the valuable substances, maximise the energy potential and destroy the rest? What is sustainable in an overall perspective? We wish to take fact-based decisions and contribute to a circular economy," he concludes.

VEAS WATER TREATMENT PROCESS



VEAS' main plant and rain-water treatment plant, with maximum treatment capacity.

KEY FIGURES 2018



FINANCES

17,8

Revenue from sales of products and services (NOK million)

223,7

Transfer from the owners to operations (NOK million)

54,6

Transfer from the owners to financing (NOK million)

-231,5

Operating costs excluding depreciation (NOK million)

11

Result (NOK million)

82,2

Investment for the year (NOK million)



PRODUCTION

87,6 mill. m³ =

87 600 000 000 litres
Purified wastewater

36 912

VEAS soil, tonnes

4 568

Nitrogen solution, tonnes

10 881 000 Nm³
(amount)

70,7 GWh
(energy content)
Biogas

16,9

Electricity from biogas, GWh

20,5

Heat from biogas, GWh

110,9

Delivered to district heating, GWh



RESOURCE CONSUMPTION

35,61

Electrical power, GWh

7 000

Fuel oil, litres

14 786

Drinking water, litres

20 634

Chemicals, tonnes



RESIDUAL PRODUCTS

1 123

Trash from gratings, tonnes

248

Sand, tonnes

VEAS' SERVICES COST YOU NOK 1.26 PER DAY.

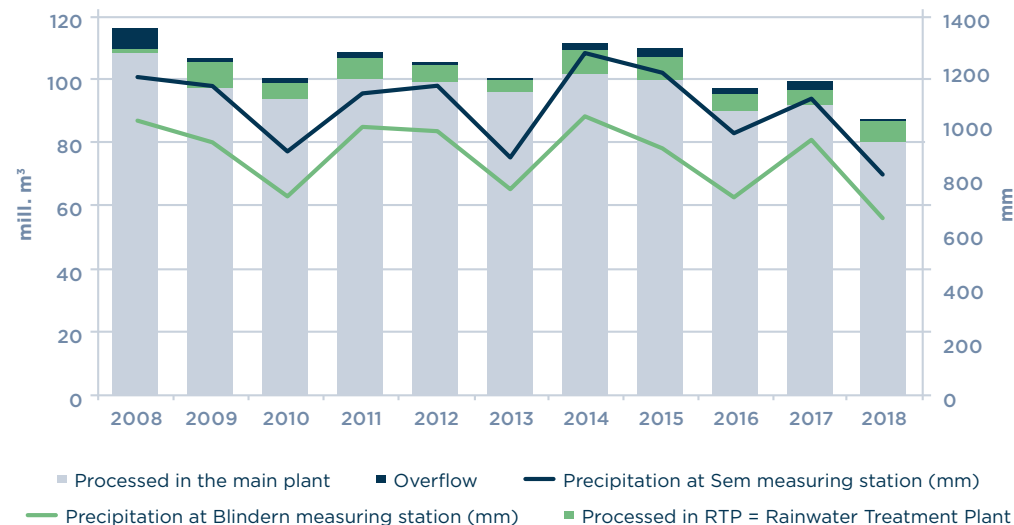
PURIFICATION REQUIREMENTS AND RESULTS 2018

Parameter	Requirement		Result	
	Wastewater Treatment Regulations excluding overflow	Discharge permit including overflow	Excluding overflow	Including overflow
	%	%	%	%
NITROGEN	70	65*	68,5	68,3
PHOSPHORUS	90	90	91,9	91,7
COD**	75		86,8	86,5
BOC₅**	70		90,4	90,1

* The County Governor of Oslo and Akershus gave an exemption from treatment requirements in 2018.

** Organic substance measured as: COD = Chemical Oxygen Demand and BOC₅ = Biological Oxygen Consumption over 5 days.

DEVELOPMENT IN AMOUNTS ADDED AND PRECIPITATION 2008-2018





VEAS
En renere Oslofjord

veas.nu