EGCA 2018, Umeå, Sweden

9. Waste water management

9A. Present situation

Indicator		Unit	Year of data
Percentage (%) of total annual generated waste water load, connected to waste water collecting system + urban waste water treatment plants (UWWTPs)	90.6 (100)	%	2014
No of WWTPs	19		2014
Total Design Capacity (p.e)	138 890	p.e	2014
Total Load Received by WWTP (p.e)	105 929	p.e	2014
Total annual generated waste water load of the city (in p.e.)	100 973	p.e	2014
Treatment level which is applied in each uwwtp: secondary or more stringent; in this case, type of treatment: nitrogen and/or phosphorus removal, disinfection etc.	Tertiary at UWWTP (Ön) and WWTP Sävar; all others secondary		2014

**Refers to directly connected to waste water collecting system; remaining 9.4% with separate waste water solutions are indirectly connected via collection of sewage sludge.*

In Umeå, the municipal company UMEVA is responsible for water production, wastewater treatment and waste management. UMEVA is certified according to ISO 9001, ISO 14001 and OH-SAS 18001.

The municipality area is 2 396 km^2 and there are 19 WWTPs (Table 1). Ön's wastewater treatment plant (UWWTP) is the largest plant, serving Umeå urban area, and receiving about 12.7 million m^3 of wastewater annually from households, industries and a large hospital. UWWTP Ön is currently being expanded to a capacity of 166 000 p.e. reaching complete commissioning in October 2015. Removal of phosphorus and BOD reaches 94%, the organic content is utilized for biogas production and heating of the UWWTP facilities. Tertiary treatment is applied at UWWTP and WWTP Sävar, secondary treatment at all other WWTPs. The sludge from all smaller WWTPs is transported to the UWWTP for treatment.

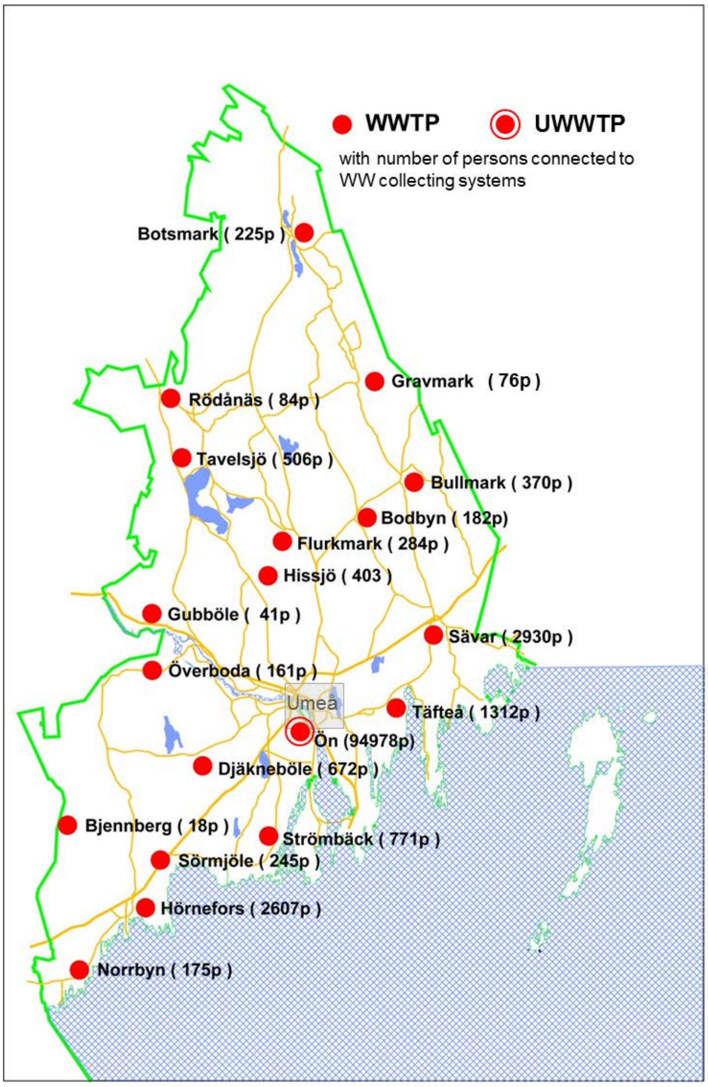

Figure 9A1: WWTPs in Umeå municipality and numbers of persons connected to waste water collecting systems in 2014.

WWTP	Design capacity (p.e.)	Load (p.e.)	Sludge treatment
Bjännberg WWTP	70	10	To Öns UWWTP - digester
Bodbyn WWTP	150	52	To Öns UWWTP - digester
Botsmark WWTP	600	59	To Öns UWWTP - digester
Brattby WWTP	300	5,6	To Öns UWWTP - digester
Bullmark WWTP	600	217	To Öns UWWTP - digester
Djäkneböle WWTP	600	214	To Öns UWWTP - digester
Flurkmarks WWTP	1 000	151	To Öns UWWTP - digester
Gravmarks WWTP	120	21	To Öns UWWTP - digester
Hissjö WWTP	600	253	To Öns UWWTP - digester
Hörnefors WWTP	9 100	1 299	freeze-drying and composting
Norrbyns WWTP	400	92	To Öns UWWTP - digester
Rödånäs WWTP	150	43	To Öns UWWTP - digester

Strömbäcks WWTP	1 000	479	To Öns UWWTP - digester
Sävar WWTP	5 000	1 148	To Öns UWWTP - digester
Sörmjöle WWTP	800	98	To Öns UWWTP - digester
Tavelsjö WWTP	1 000	312	To Öns UWWTP - digester
Täfteå WWTP	1 000	417	To Öns UWWTP - digester
Överboda WWTP	400	85	To Öns UWWTP - digester
Öns UWWTP	116 000	100 973	To digester

Figure 9A2: Waste water treatment plants in Umeå municipality 2014.

Around 90% of total load of waste water to the municipal WWTP is treated at Ön's UWWTP; therefore **the primary focus from now on is on the UWWTP**.

Challenges include the Nordic weather conditions, with temperatures down to -30°C, requiring all processes to be located indoors, thus increasing operational costs. Ground frost makes it necessary to dig the collecting system deeper into the ground. Snowmelt in spring leads to overflow in the treatment plant and collecting system. Additionally, Umeå is sparsely populated requiring long pipe distances.

A1. Provide an indication of the fraction (%) of the total annual generated waste water load of the city coming from population and from industry (also specifying type of industry, when information is available). The most advanced treatment level at UWWTPs (primary treatment, secondary treatment, tertiary treatment.

2014 incoming BOD amount to the UWWTP was 100 973 p.e., of which 4,383 p.e. (3.4%) from industry (mainly dairy). (In Sweden 1 p.e. = 70g BOD_7/day).

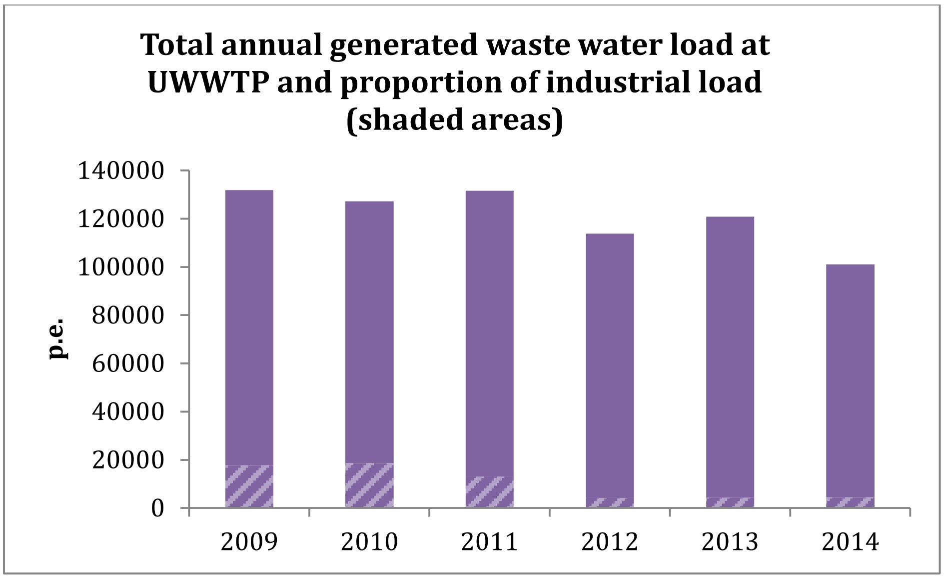

Figure 9A3: Total annual generated waste water load at UWWTP and proportion of industrial load.

Load from industry decreased in 2012 because the local dairy started an own phosphorus treatment facility to further purify outgoing process water before discharge to wastewater network.

A2. Proportion (%) of total annual generated waste water load, not connected to waste water collecting systems, and explanation of the type of waste water treatment applied to this fraction (reference to individual or other appropriate systems, i.e., IAS).

90.6% of Umeå's population is directly connected to municipal collecting systems. The remaining 9.4% of Umeå municipality is indirectly connected to the collecting system, with separate waste water solutions based on sludge separation and filtration or septic tanks, which are collected and treated at UWWTP. In Sweden, sludge collected from private waste water solutions is classified as waste and therefore a municipal responsibility. No other company is allowed to collect and treat the private waste water sludge.

A3. If the city is located in an EU Member State include data on waste water treatment obligations according to the UWWTD (based on city's size and nature of the area of discharge).

UWWTD demands urban wastewater to undergo at least secondary treatment, normally biological treatment, and sets up demands for the quality of treated wastewater. Obligations according to UWWTD are implemented in national legislations and local principles.

UWWTP complies with the requirements in UWWTD; for secondary treatment and highest concentration BOD; 15 mg/l and COD; 70 mg/l. All 19 WWTPs comply with national and local requirements, except for nitrogen removal, where northern Sweden has a dispensation from Europe and UWWTD due to hampering climatic conditions and the lack of oligotrophic recipients.

A4. Waste water collecting systems: main type of collecting system (combined/separated) and annual proportion (%) of COD-loads discharged via storm water overflows.

The complete collecting system is separated. In 2014, 0.03 % of incoming wastewater was discharged due to storm water overflows. No samples for COD determination from overflow are taken, but estimated average COD load due to discharge via storm water overflows in the collecting system was 2,3 tonnes COD, corresponding to 0,34 % of outgoing COD quantity from the plant.

A5. UWWTPs: Organic design capacity (p.e.), most advanced treatment level, annual incoming and discharged loads (t/a) of BOD5, COD, Ntot and Ptot and treated waste water amounts (m^3/a) of all UWWTPs serving the city. If the city is located in an EU Member State, indicate whether the UWWTP complies with the treatment requirements under the UWWTD.

The former UWWTP was designed for 116,000 p.e. and built for tertiary treatment. Since the commissioning of the new UWWTP in September 2014 the designed capacity reaches 166,000 p.e. Total volume of incoming wastewater 2014 was 12 716 000 m^3.

	Influent (t/a)	Effluent (t/a)	Removal rate (%)
BOD_7	2580	121	95
COD_{Cr}	6736	681	90
P-tot	73	4,7	94
N-tot	501	499	0

Figure 9A4: Removal rates for BOD_7, COD_{Cr}, P-tot and N-tot at UWWTP 2014 (in compliance with treatment requirements under UWWTD).

A6. Annual amounts of generated sewage sludge (t/a) and description of treatment/disposal pathways (% of total amount).

Total sewage sludge 2014 was 2138 tons (dry weight). 100% of sludge was used as sealing material at the Dåva landfill.

A7. Provide data on annual energy consumption for wastewater treatment in Kwh/year/p.e., if available.

Annual energy consumption: 39.5 kWh/year/p.e. 54% of biogas produced by microbial digestion of sewage sludge was used for heating of UWWTP facilities.

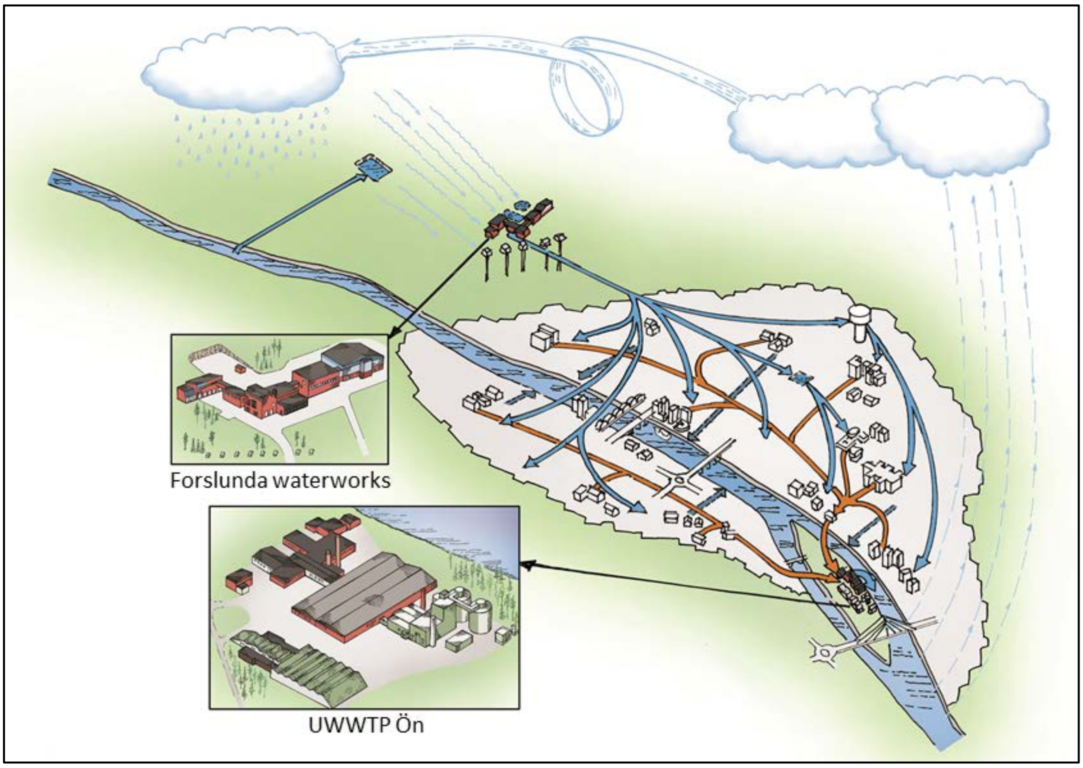

Figure 9A5: The cycle of water in Umeå from Forslunda waterworks to the waste water treatment plant at Ön.

9B. Past performance

Measures implemented and which most effective; reference to non-expired deadlines for compliance with UWWTD. Particular reference to capacity building, measures for maintenance, management and restoration of waste water collecting systems and UWWTP.

New UWWTP

In order to manage the growing number of connections resulting from the expansion plans of Umeå municipality and to deal with the more stringent environmental requirements, a new UWWTP has been constructed starting in 2012 and with complete commissioning in October 2015 (costs were approx. €53 million). Reconstruction of the plant included a new influent part, new sand and fat collectors, and a pre-sedimentation step. The biological step was expanded and the oldest part of the plant was converted into a new after-polishing step as a final sedimentation. The capacity in all steps increased, as well as the time it takes the sewage water to pass the plant, resulting in a higher degree of purification. The designed capacity of the new plant is meeting the expected requirements for the year 2030; certain parts are designed to handle the expected load for 2050.

Besides increased treatment capacity, the expansion also included a new facility for reception of fat and organic waste slurry, and gas engines in order to utilize biogas for production of electricity. The generation of heat and electricity from biogas is estimated to make the plant largely self-sufficient with both electricity and heat. The long-term goal for UMEVA is to be energy neutral, which is a major investment in the environment.

Figure 9B1: The new UWWTP at Ön in August 2015.

Parameter	Unit	Amount
Person equivalents	p.e.	166 000
BOD_7	kg/day	11 620
Tot-P	kg/day	340
Tot-N	kg/day	1750
$Q_{average}$	m^3/day	43 200
$Q_{dim.}$	m^3/h	2 100
Q_{max}	m^3/h	6 500

Figure 9B2: Design loads for the year 2030 for the new UWWTP.

The new UWWTP has considerably higher emission requirements. The outgoing water, for example, should be even cleaner now, despite increasing population. Instead of monitoring emissions quarterly, sampling will be conducted weekly. Other requirements stated in the permission for the new UWWTP regard the quality of upstream work.

Before the reconstruction work for the new UWWTP, the latest improvement had been a sludge treatment facility for digestion, commissioned 2002, which is one of the most effective measures to improve waste water management. A chemical precipitation optimization was made in 2009.

Maintenance of collecting system

Figure 9B3: Maintenance work.

A systematic review of waste water collecting systems capacity is under way to aid future capacity decisions utilizing modelling parts of collecting system, for example, flow measurements.

UMEVA works systematically with separation of additional water for reduced overflow and to improve the waste water treatment process. Plans for prioritized reinvestments are also made annually. In 2009, a strategy for the renewal of water- and waste water pipes for the period 2010–2020 was established. The need for renewal of waste water pipes is calculated to about 2000 meters/year. In 2014 renewal was 2.51 km. A new method when renewing pipes, using controlled drilling instead of digging an open pit, resulted in reduced CO_2 emissions by about 30% (from 80 kg/m to 23 kg/m).

Capacity studies, flow analysis, active managerial collecting system and marketing are some tools used towards the targets. Precipitation data is collected mainly from the Swedish Meteorological and Hydrological Institute's gauging station in the city, but also from UMEVA's own meters placed at numerous pumping stations. The operation- and maintenance system, VA-Banken (GIS-based), is used as experience bank.

UMEVA conducts maintenance based on statistical data using an accurate register in GIS, accepted praxis and long experience. At documented critical stretches in the collecting system, regular flushing is conducted at intervals from 1 to 24 months. From these activities, status updates are received and irregularities detected. The collected data supply input for refinement of recurring flushes, but are also used for future development and innovation for a fundamental change of the collecting system.

Energy saving and optimization

A major objective for the reconstruction of the new UWWTP was to optimize energy efficiency. After commissioning the first part in September 2014, energy consumption decreased by 15%. However, this value is expected to increase again after the commissioning is completed.

To date, biogas produced from digestion of sludge has been used for heating. There was an overcapacity of gas due to a facility for drying sludge pellets (now removed because of technical and working environmental difficulties), leading to 46% of the produced biogas not being used in 2014. In October 2015, new gas engines producing electricity were put into operation to better utilize the biogas. The objective for UMEVA is to become energy neutral regarding heating and electricity in the facilities at Ön.

During 2014 more energy-effective pumps have been installed in several pumping stations, resulting in a decreased energy consumption of up to 20%.

Further measures to reduce energy consumption include the use of heat exchange between incoming and outgoing sludge, as well as using the heat from the outgoing purified waste water.

Upstream work and awareness raising campaigns

Continuous and systematic upstream work is an important measure to improve the quality of incoming waste water, for example, by minimizing the presence of unwanted substances such as metals and residuals of pharmaceuticals. This way, the waste water treatment can be optimized with regard to environmental standards. UMEVA works with information campaigns towards both industries and households to inform about water, wastewater and waste to increase knowledge in environmental issues.

Figure 9B4: (A) and (B) The grease recycling funnel fits standard plastic bottles. The full bottle can be disposed of in the regular waste bin. (C) "Love your toilet"- Learn more about what should not be thrown into the toilet. (D) Campaign at Arts Campus about how to paint environmentally friendly by avoiding paints containing cadmium.

Arts Campus/Cadmium

A chemical inventory revealed high levels of cadmium in the influent water. Potential sources of cadmium release include art paints containing cadmium. Therefore, information campaigns are conducted annually at the Umeå University Arts Campus to inform art students about the importance of not using paints containing cadmium.

Cooking fat

The ”Grease project” is a cooperation between UMEVA, the municipal housing company Bostaden, a consulting firm, and university students, aiming to inform inhabitants of how to correctly dispose of cooking fat. All participants receive a grease recycling funnel.

Carwash campaign

The “Carwash Campaign” has been praising residents in Umeå who wash their cars in a car wash instead of in the street every spring since 2007. Now, the campaign has spread to the whole country through the organisation Svenskt Vatten (Swedish Water), informing even more citizens about how they can help improve storm water quality.

School education

Every year UMEVA offers all schools in the municipality two 60 minutes classes tailored to fourth grade students. The first class is about waste and recycling, the other about water and sewerage. The aim is to increase the children’s awareness of these subjects to influence their families to act in a more environmentally responsible way.

Information leaflets and brochures

UMEVA work continuously to raise awareness of water- and waste management issues. For example, in September 2014 UMEVA sent out an information brochure to all households in the municipality about what UMEVA is doing and what the citizens can do to reduce water consumption and what they can do to improve for example the waste water quality.

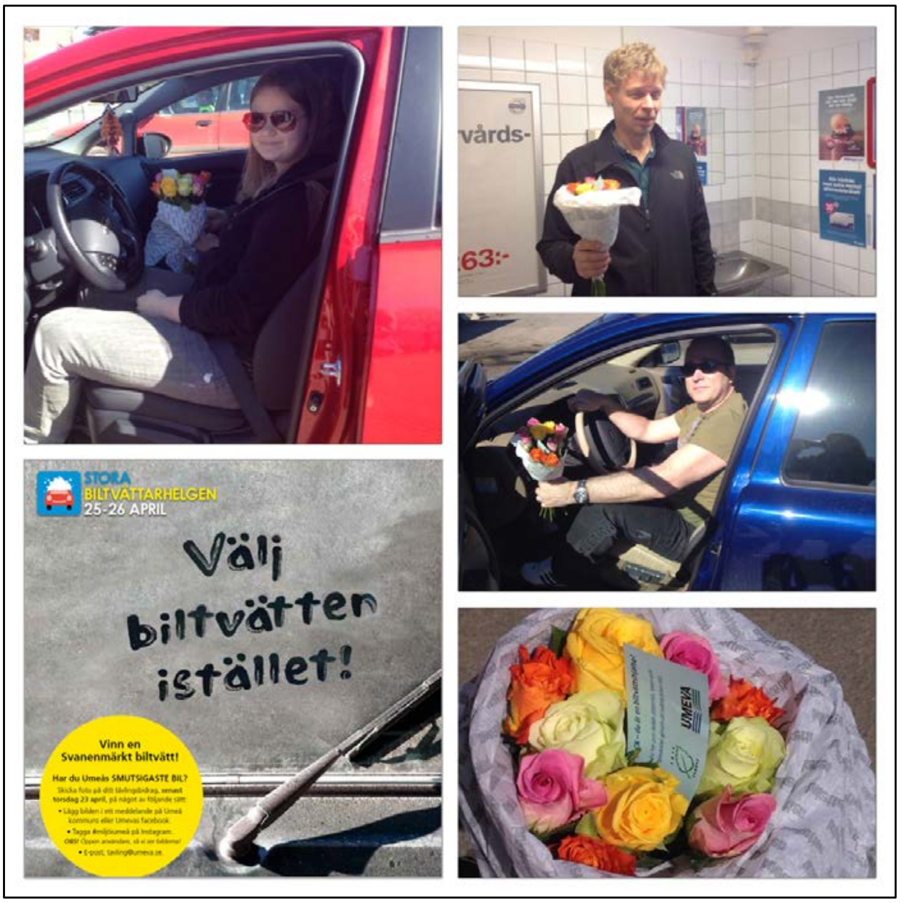

Figure 9B5: Celebration of citizens washing their car in a car wash instead of in the street, and “Dirtiest car contest 2015” with a chance to win an environmental friendly car wash (bottom left).

9C. Future plans

Figure 9C1: Ön (meaning "The island") with the new UWWTP and Umeå city centre in the background.

The new UWWTP increased the capacity and improved the performance of wastewater treatment substantially. However, in the future there will be higher demands of complying with certain environmental requirements, such as purification of nitrogen and phosphorus recovery. Also, UMEVA prepares for the strategic objective of the City of Umeå – reaching 200 000 inhabitants in 2050.

Future measures to improve wastewater treatment include:

- Implementation of an action plan to improve monitoring and control of overflow
- Decrease rainwater inflow into waste water collection system from private properties
- Connection of separate sewages from transformation areas and smaller WWTPs to UWWTP
- Use full capacity of gas engines for energy production so that the utilization of self-generated biogas can increase to 90% by 2016
- Develop a strategy to meet the cyclical principle of phosphorus utilization from sludge
- Continue informing citizens through upstream work, awareness raising campaigns, education etcetera

C1. Improvement / maintenance / management of collecting systems

The City of Umeå is currently working on a strategy regarding the development of water and waste water in a growing city. This strategy aims to demonstrate the city's holistic approach concerning environmental issues in general and water/waste water in particular. Besides the key objectives of benefitting continuous sustainable growth, predicting future investments and costs, and facilitating cooperation, the strategy will also be used as tool to prioritize the work of directly connecting the remaining 9.4% of the population to wastewater collecting systems.

A sum of € 320 000 was allocated to implement an action plan (2015–2017) to expand monitoring and improve control of overflow. Measuring equipment will be installed at 26 points in order to inventory the distribution network and to increase the monitoring resolution. The extent of overflow will be reduced wherever it can be justified, depending on the recipients' susceptibility and number of persons connected (environmental and health parameters).

C2. Improvement of connection to collecting systems (*inter alia*, additional % of p.e. forecasted to be connected)

UMEVA continuously inventories pipes/waterspouts in different residential areas to identify if rainwater ends up in the wastewater collecting system. If this is the case, house- and property owners are devised to disconnect groundwater drainage and drainage pipes from the system.

C3. Improvement of design capacity, treatment level and treatment performance of UWWTPs (indicate if these go beyond the requirements in the Directive)

The UWWTP has recently been upgraded to handle the expected loads for the year 2030, partially even those of 2050, see Figure 9B2 above.

C4. Improvement of connection to UWWTPs (*inter alia*, additional % of p.e. forecasted to be connected)

Transformation areas: Summer cabins are in a growing extent used for year-round living. Increasing loads on the rather simple sewage systems (sludge separation and filtration or septic tanks) result in many point releases and a high amount of effluents. Due to the higher capacity at the new UWWTP, it is now possible that cabins and their sewage can be directly connected to the municipal collecting systems.

Pumping wastewater from smaller WWTPs to a larger WWTP with sufficient cleaning capacity will decrease operational costs, as well as the burden on the actual recipient. For example, WWTP Täfteå (approximately 1300 persons connected) is at risk of being overloaded, environmentally impacting its rather susceptible recipient – the Baltic Sea. The wastewater from Täfteå will therefore be pumped to UWWTP starting spring 2016. Fewer but larger WWTPs also means that higher cleaning demands can be met at a lower cost due to fewer plants having to be adapted.

C5. Improvements of further environmental and economic aspects of waste water treatment (e.g. removal of micropollutants, pollution prevention, energy efficiency at UWWTPs, sludge treatment and disposal, treated waste water re-use, use of integrated constructed wetlands).

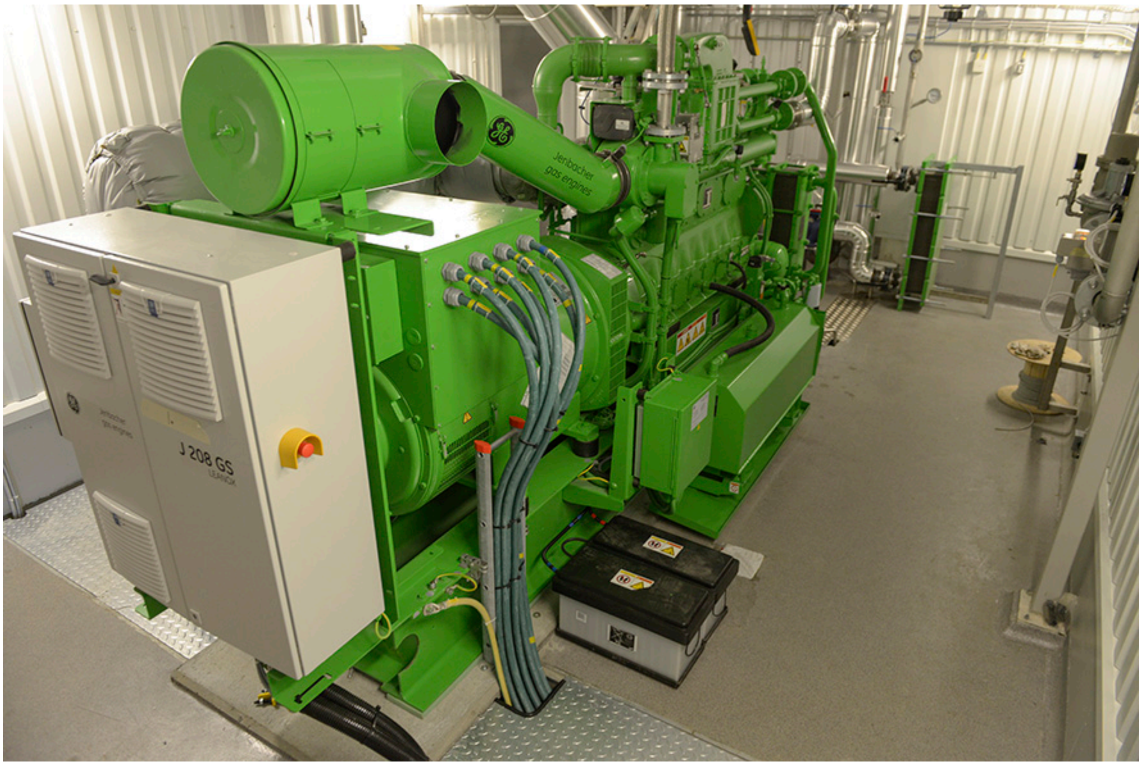

Figure 9C2: New biogas engines at Ön UWWTP.

Gas engines

In order to use the new gas engines to full capacity, UMEVA plans to receive external substrate with a higher energetic quality for microbial digestion, such as pumpable canteen kitchen waste and glycol from de-icer used to defrost airplanes. Nordic weather conditions would lead most likely to a steady supply of de-icer during wintertime.

Sludge

Dewatered sludge is currently used as sealing material in the covering of Dåva landfill. Even though UMEVA´s vision is to utilize nutrients from the sludge produced at UWWTP to meet the cyclical principle of phosphorus utilization, there is neither a national legislation at the moment, nor an economic market to use the sludge as fertilizer (small amount of agriculture in the region, but on naturally fertile soils). However, as the capacity of Dåva landfill will be reached by 2020, a strategy has to be established within the next five years. Pilot studies regarding recovery of phosphorus via combustion have been started.

9D References

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UMEVA´s web page**,** *Framtidens avloppsrening i Umeå*
http://umeva.se/vattenavlopp/avlopp/avloppsreningsverk/framtidensavloppsreningiumea.4
.1f19cd52130398d83ff80001811.html

UMEVA´s Carwash campaign, film
http://www.youtube.com/watch?v=oaCI57yOZss

Information folder to all households
http://www.umeva.se/download/18.4c5367bf14849e79f597b31/1411043520304/Umeva_2
014_folder_A4_slutversion.pdf