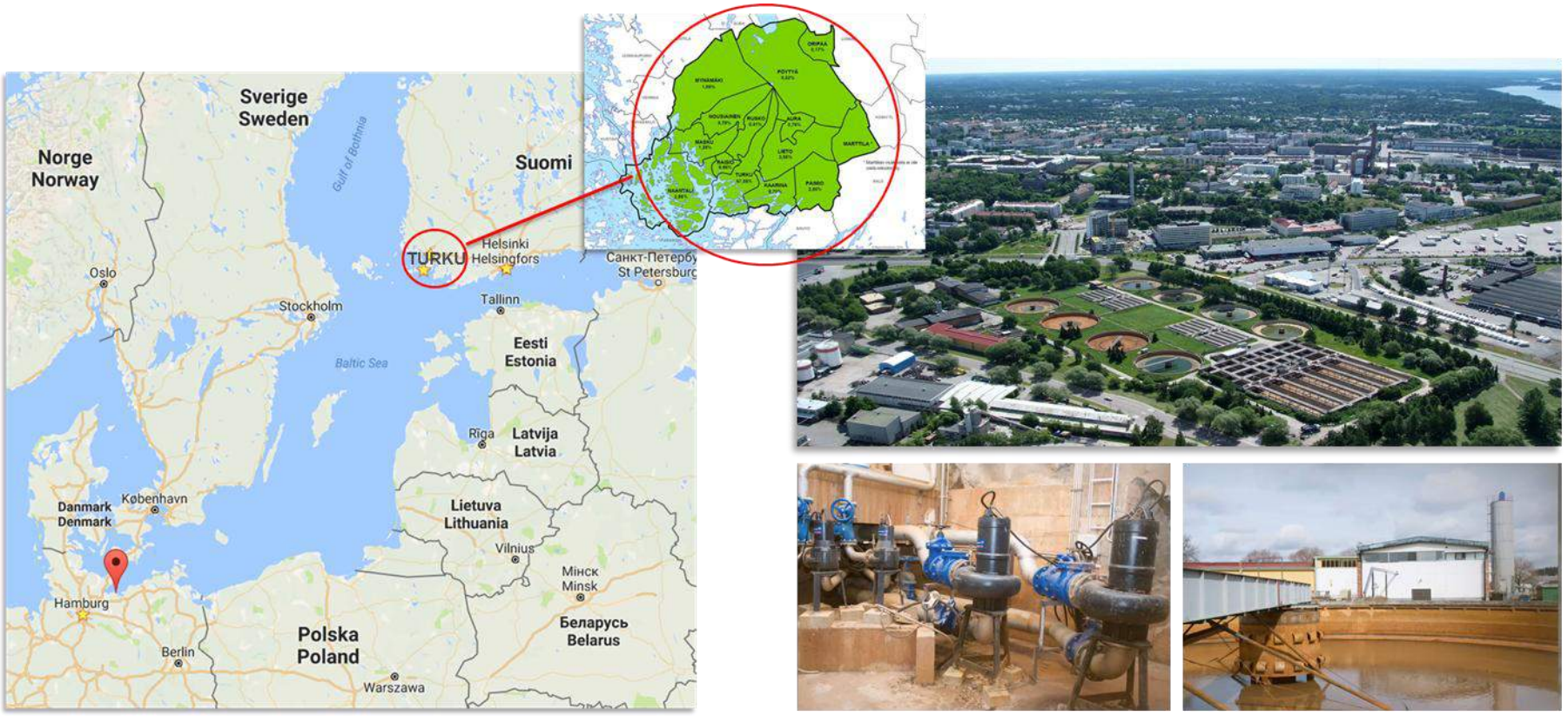
ENERGY MANAGEMENT AT KAKOLANMÄKI WASTEWATER TREATMENT PLANT

14. 2. 2017

Turun seudun puhdistamo Oy

KAKOLANMÄKI WWTP



- Wholesale company owned by fourteen municipalities in Turku region in South-Western Finland
- Turku Region Wastewater Ltd produces good quality and cost-effective wastewater treatment services to its owner municipalities

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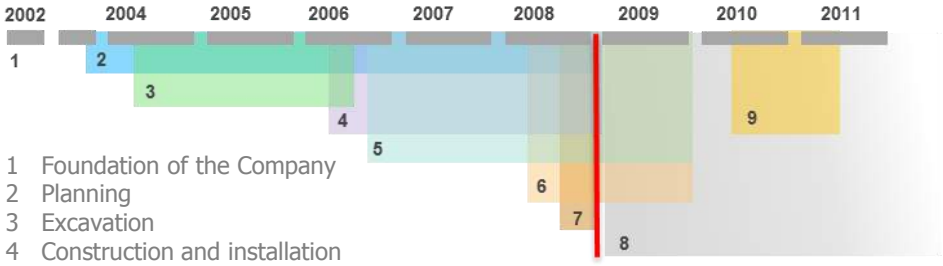
KAKOLANMÄKI WWTP



1 Foundation of the Company
2 Planning
3 Excavation
4 Construction and installation
5 Transfer sewers
6 Bypass water treatment
7 Plant Testing
8 Plant Operation
9 Renovation of the Merimiehenkatu Pumping Station

- WWTP is located in the solid rock of Kakolanmäki hill in the middle of Turku city
- WWTP treats 300.000 residents wastewater and industrial wastewater of the area, average 90 000 m3/d

INVESTMENT COSTS 145 M€ (2009)

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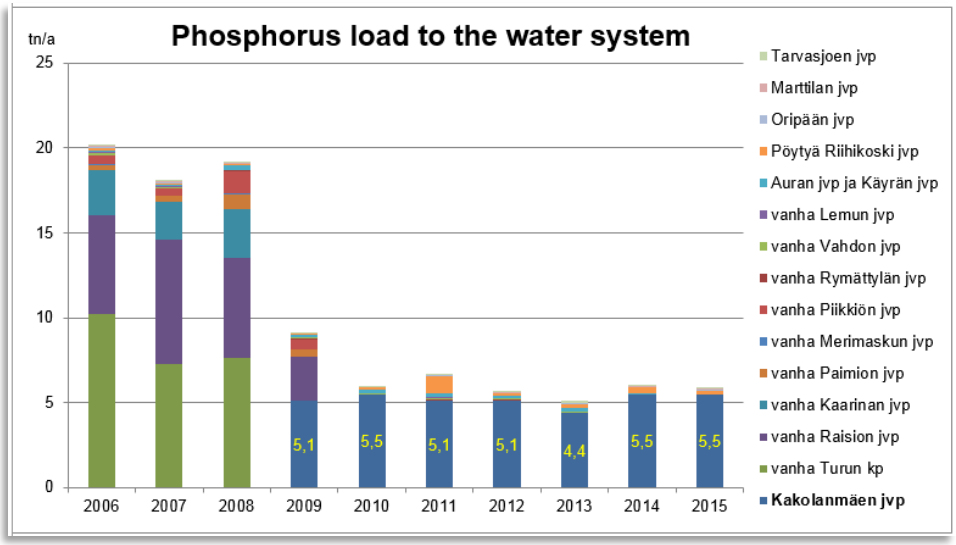
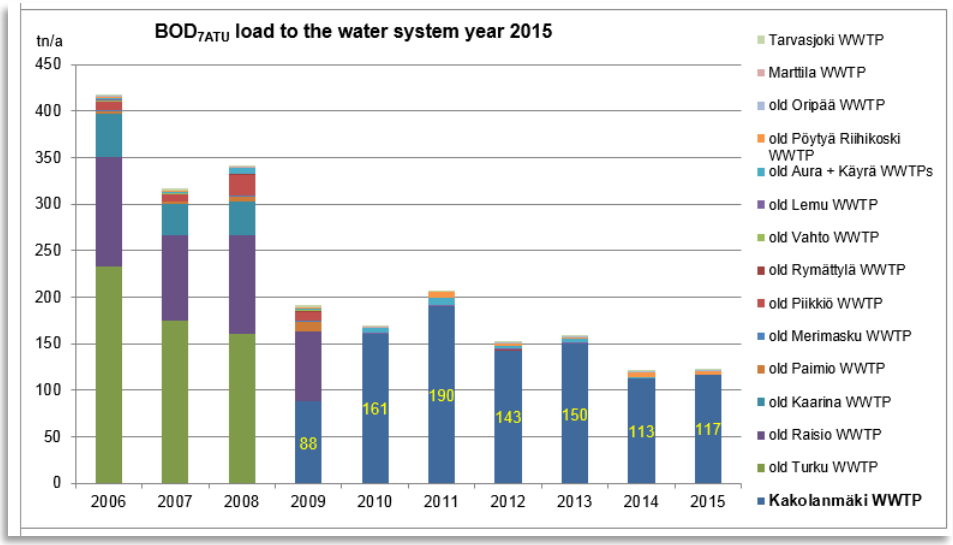
LOAD TO THE WATER





AMOUNT OF WASTEWATER	2011*	2012*	2013*	2014*	2015*	
m^3/d	94 500	89 600	83 100	81 700	88 600	
m^3/a	34 500 000	32 800 000	30 300 000	29 800 000	32 300 000	
CONCENTRATION [mg/l]	**2011***	**2012***	**2013***	**2014***	**2015***	**ENIVIRONMENTAL PERMIT***
COD_{Cr}	41	38	42	38	36	≤ 60
BOD_{7ATU}	5,5	4,4	4,9	3,8	3,6	≤ 10
Phosphorus	0,15	0,16	0,14	0,18	0,17	≤ 0,3
Nitrogen	9,1	15	13	13	11	-
Suspended solids	7,2	4,4	4,0	3,1	2,7	≤ 15
CLEANING EFFICIENCY [%]	**2011***	**2012***	**2013***	**2014***	**2015***	**ENVIRONMENTAL PERMIT***
COD_{Cr}	94	94	93	94	94	≥ 90
BOD_{7ATU}	98	99	98	99	99	≥ 95
Phosphorus	98	98	98	98	98	≥ 95
Nitrogen	81	73	77	79	80	≥ 75
Suspended solids	98	99	99	99	99	≥ 95

- **Phosphorus load** to Turku marine area has decreased approximately **72** percent or 13 t/a (2010-2015 vs. 2006-2008)
- **BOD_{7ATU}-load** to Turku marine area has decreased approximately **59** percent or 210 t/a (2010-2015 vs. 2006-2008)
- **Nitrogen load** to Turku marine area has decreased approximately **32** percent or 180 t/a (2010-2015 vs. 2006-2008)
- **Suspended solids load** to Turku marine area has decreased approximately 77 % or 510 t/a (2010-2015 vs. 2006-2008)

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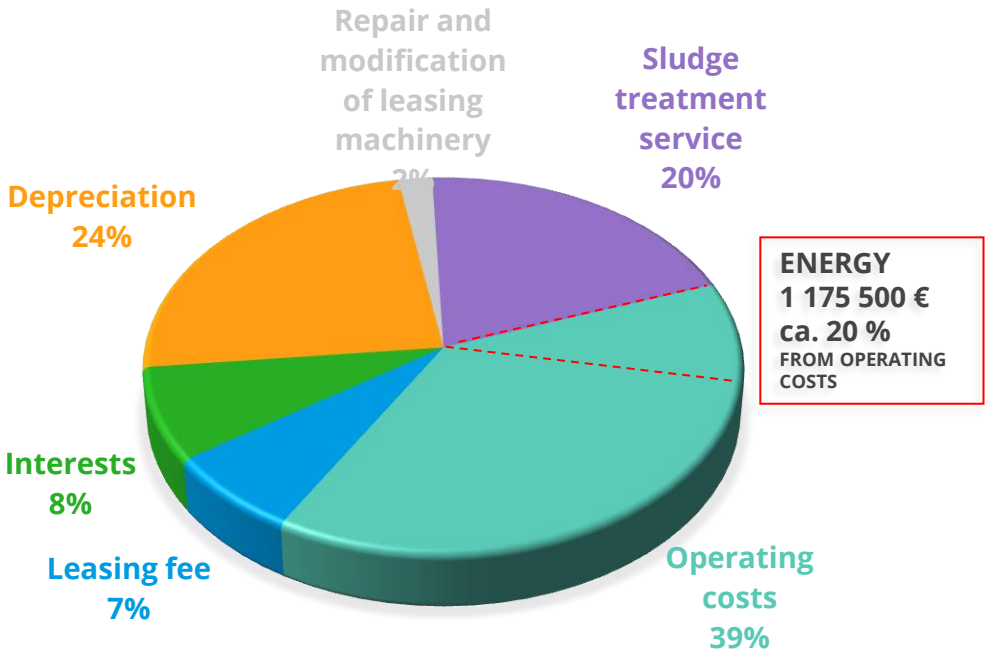
SERVICE FEE



- The plant is operated by WWTP's own personnel (11 employees)
- Fully automated (occupied only in the office hours)
- Maintenance, sludge treatment and laboratory services are produced by outsourced services

- Turnover in 2015 was 16,5 M€
- Average service fee for municipalities was 0,48 €/m3

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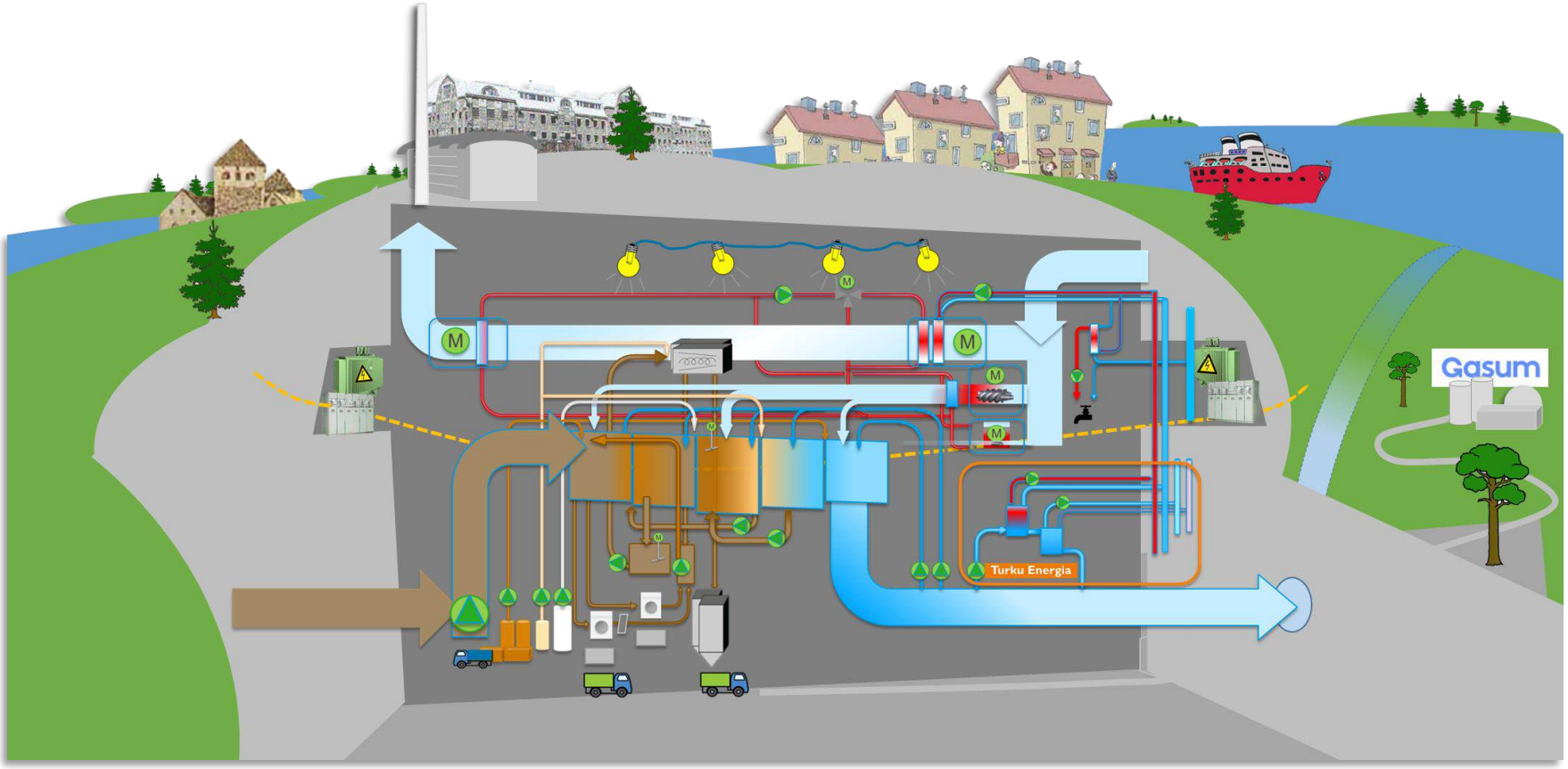
WWTP PROCESS



The volume of the cave treatment plant is about 500 000 m3, which includes 125 000 m3 water capacity

+ The solid rock surroundings offers stability to the process (temperature is almost the same year-round)
+ Space is cheaper under the surface of the ground than on the ground
- Efficient ventilation and lighting will increase operating costs, but…
+ "Out of sight, out of mind"

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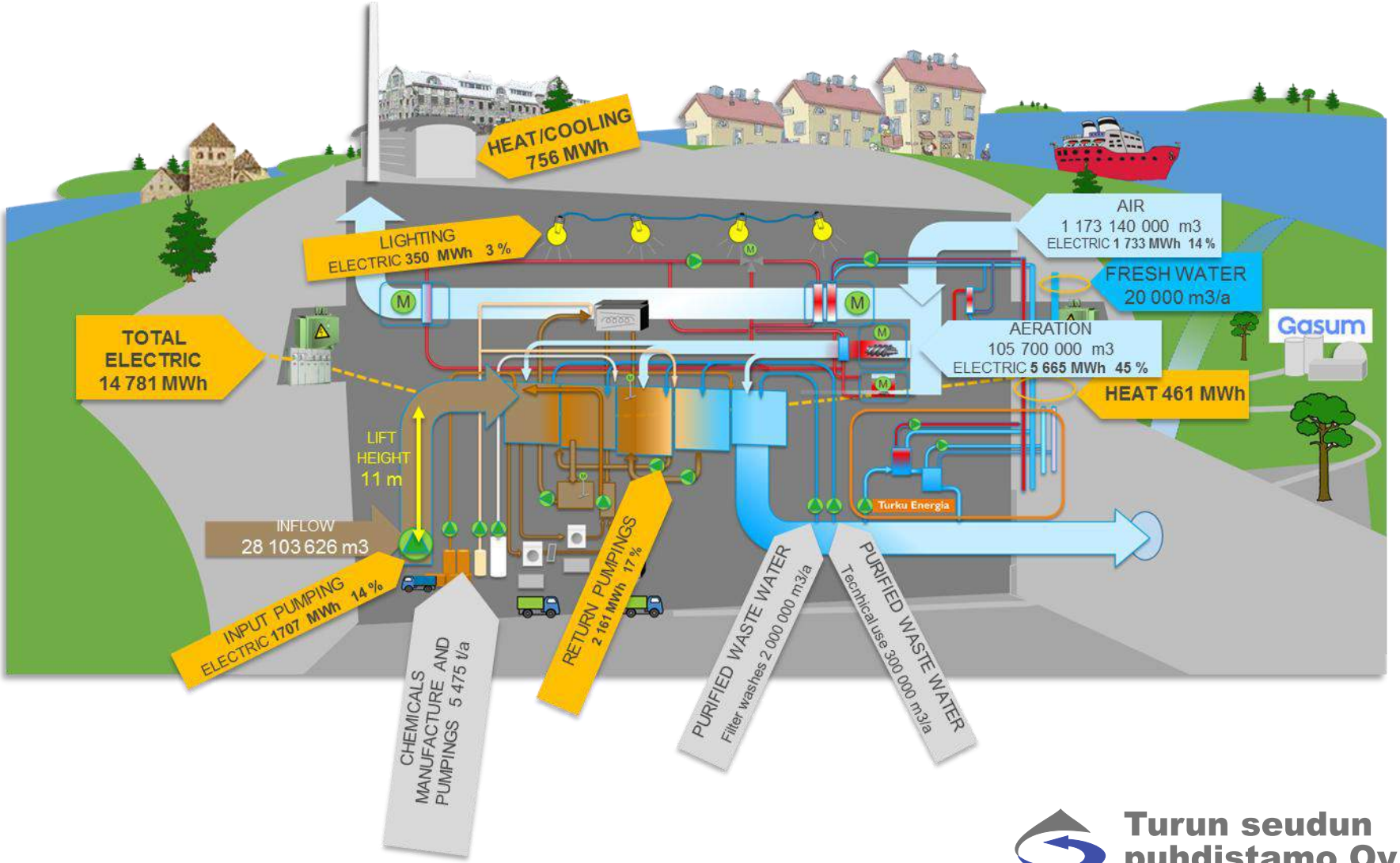
WWTP PROCESS: ENERGY 2016



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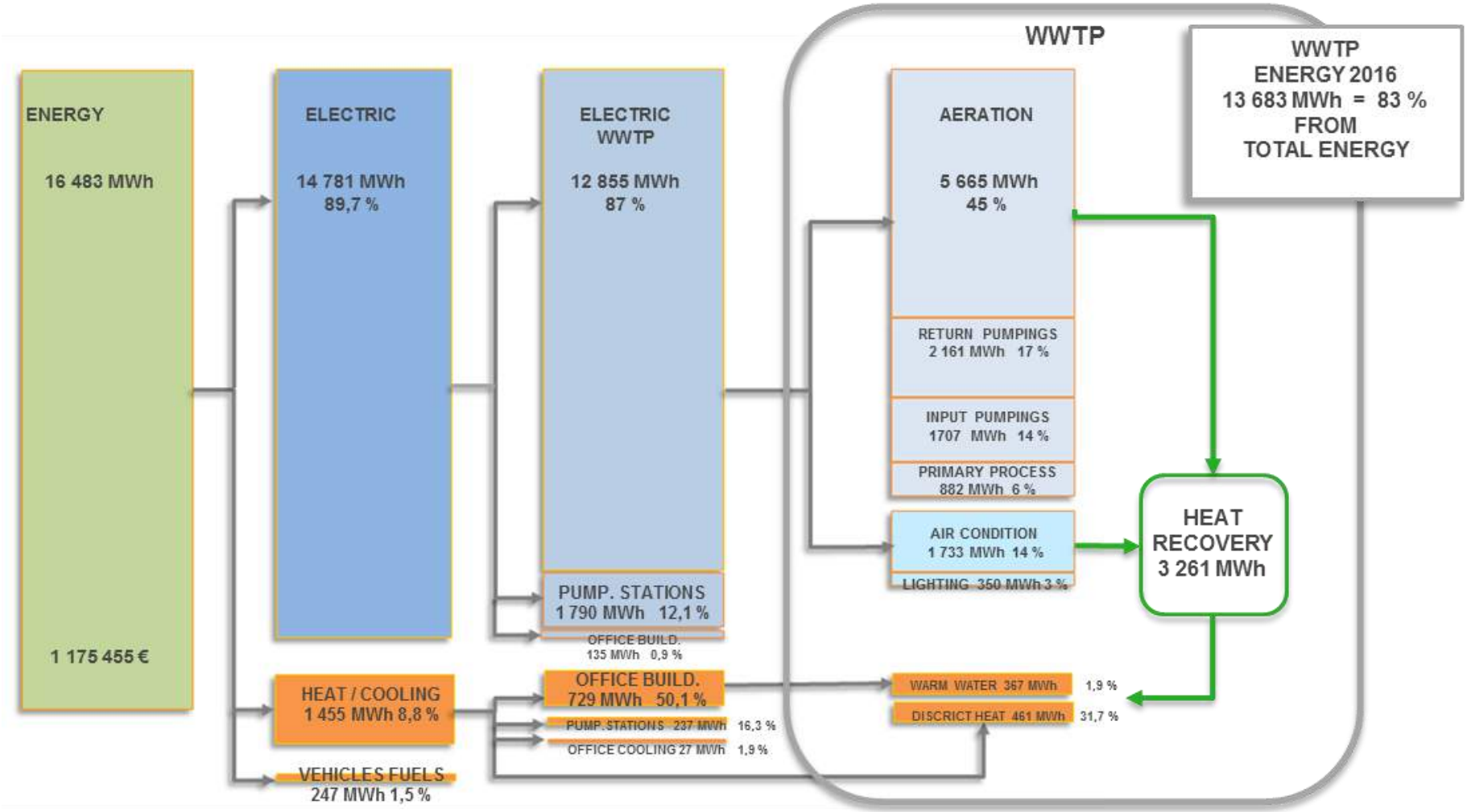
WWTP PROCESS: ENERGY 2016



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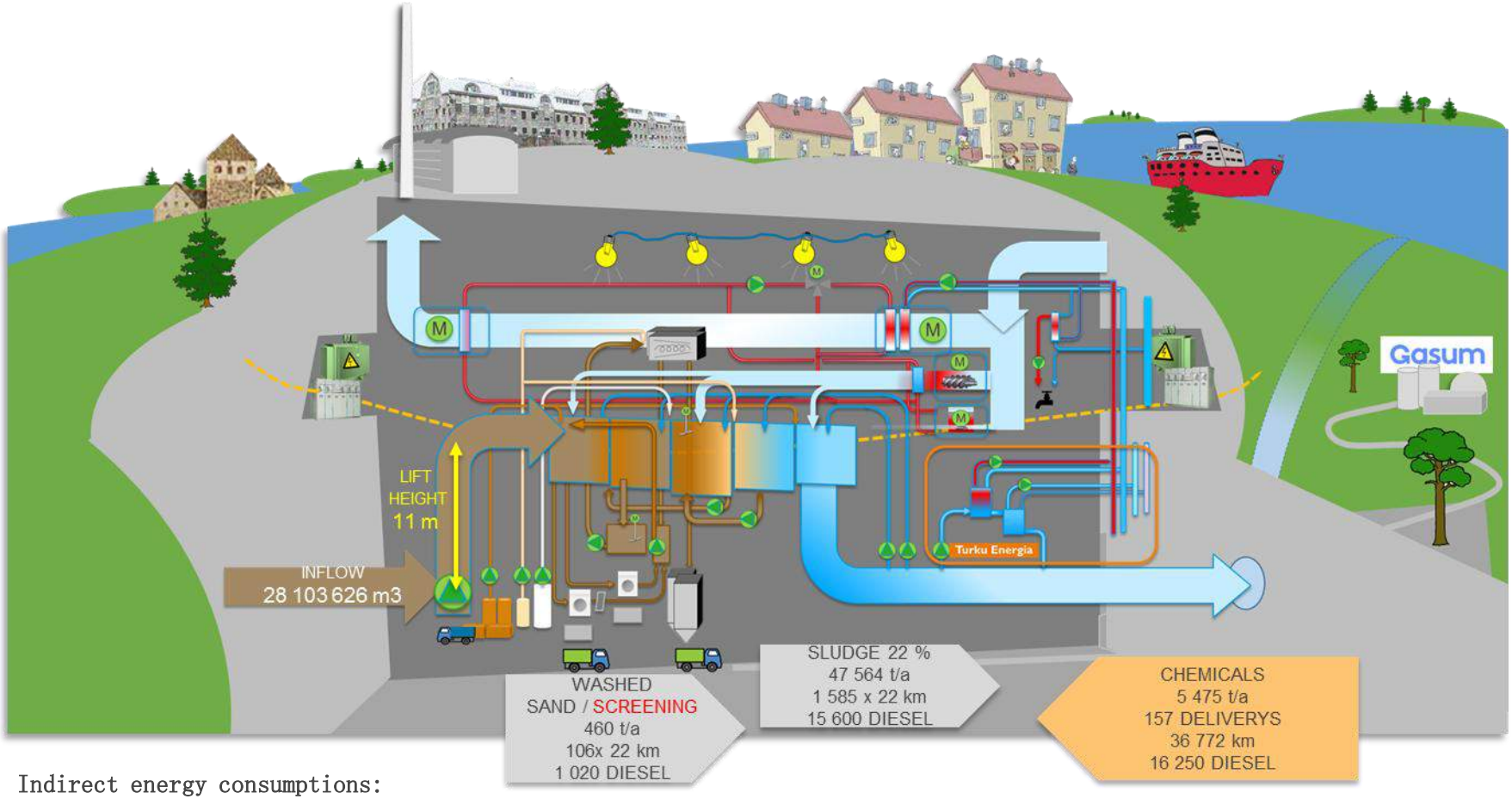
WWTP PROCESS: ENERGY



Indirect energy consumptions:

- Chemical production (energy & CO2)
- Deliveries (energy & CO2)

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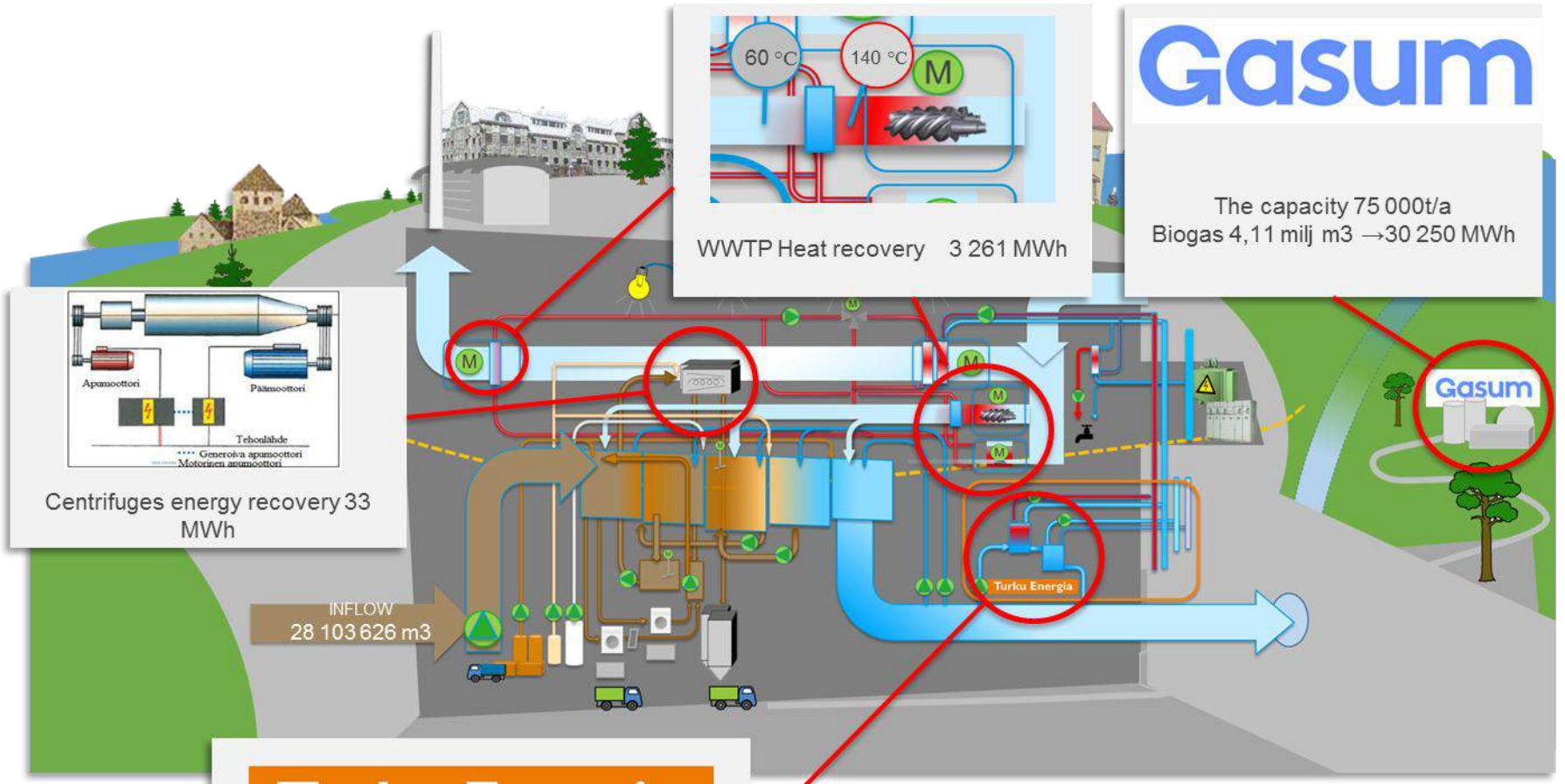
ENERGY RECOVERY: 2016



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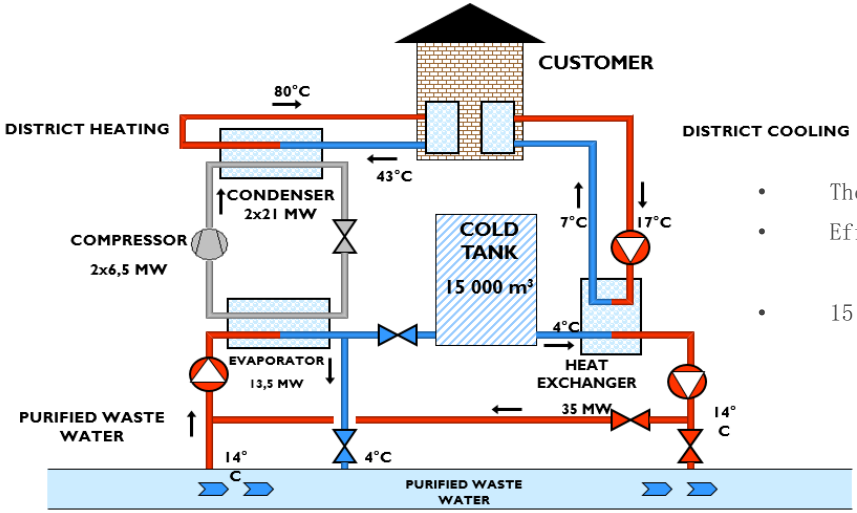
WWTP: HEAT PUMP STATION

The heat of the treated wastewater is used as renewable energy

Pumping station includes two heat pumps. In 2009 started "Daphne" and after good results "Sofia" in 2013.

220-300 GWh/a heat and 31 GWh/a cool means14% of all district heating and almost all district cooling in Turku city



- The Heat pump station takes out the heat from purified waste water (about 5-10°C) 20 000 C
- Efficiency is good: One unit of electrical energy produces three units of district heating two units of district cooling
- 15 000 m3 cold water storage, which evens out the daily variation of district cooling pro enables the momentary triple production of district cooling

Turku Energia

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GASUM OY BIOGAS STATION

- Gasum Oy owns and operates the biogas station (outsourced service)
- Termophilic digestion in Topinoja Turku
- The capacity of sludge treatment is 75 000 t/a (50 000 t/a from Kakolanmäki WWTP)
- The capacity of the biogas station is 4 MW
- 4,6 M m3 biogas / year →30 GWh energy / year

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WWTP'S ENERGY BALANCE 2016

WWTP energy consumption

Electricity		14 781 MWh
District heating		1 455 MWh
Fuel		247 MWh
	total	**16 483 MWh**

Energy production out of the waste water treatment processes

WWTP Heat recovery ventilation	3 261 MWh
TSE heat pump station district heating production (netto)	168 130 MWh
TSE heat pump station district cooling production (netto)	30 000 MWh
Gasum Oy	30 250 MWh
total	**231 641 MWh**

WWTP produces energy fourteen times more than it consumes

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WWTP: ENERGY EFFICIENCY PROJECTS

Even though Kakolanmäki WWTP is quite new, there is still a lot to be done for the good of energy efficiency:

Accomplished

- Inflow pumping "swan necks"
- Air condition optimizing
- Sand washer optimizing
- Aeration measuring and adjustments
- Aeration compressors efficiency
- Technical water pumping efficiency
- Raw mixed sludge pumping efficiency
- Raw wastewater pumping station efficiency
- Lightning optimization and efficiency

Projects in progress

- Waste heat recovery heat pumps
- Freshwater station risk minimizing
- Plug-in hybric on-call duty car
- e-bicycles
- Solar cells and panels
- Inflow pumping optimization

External

- Gasum biogas truck for sludge deliveries
- Gasum biogas station capacity increase and investments
- Energy efficiency and heat recovery projects with Turku Energia

Examination in progress

- Outlet purified water gravity energy recovery by turbine
- Solar cells and panels to pumping stations
- Heat recovery pumps to pumping stations
- Specific sand filter compressors
- Outlet air heat recovery
- Inflow pumping update
- Air condition impeller to direct drives and permanent magnet motors
- LED-lightning
- Lightning control
- Sludge recovery pumping optimization
- Optimal utilization of performance indicators
- Electric fork lift
- Biogas service car

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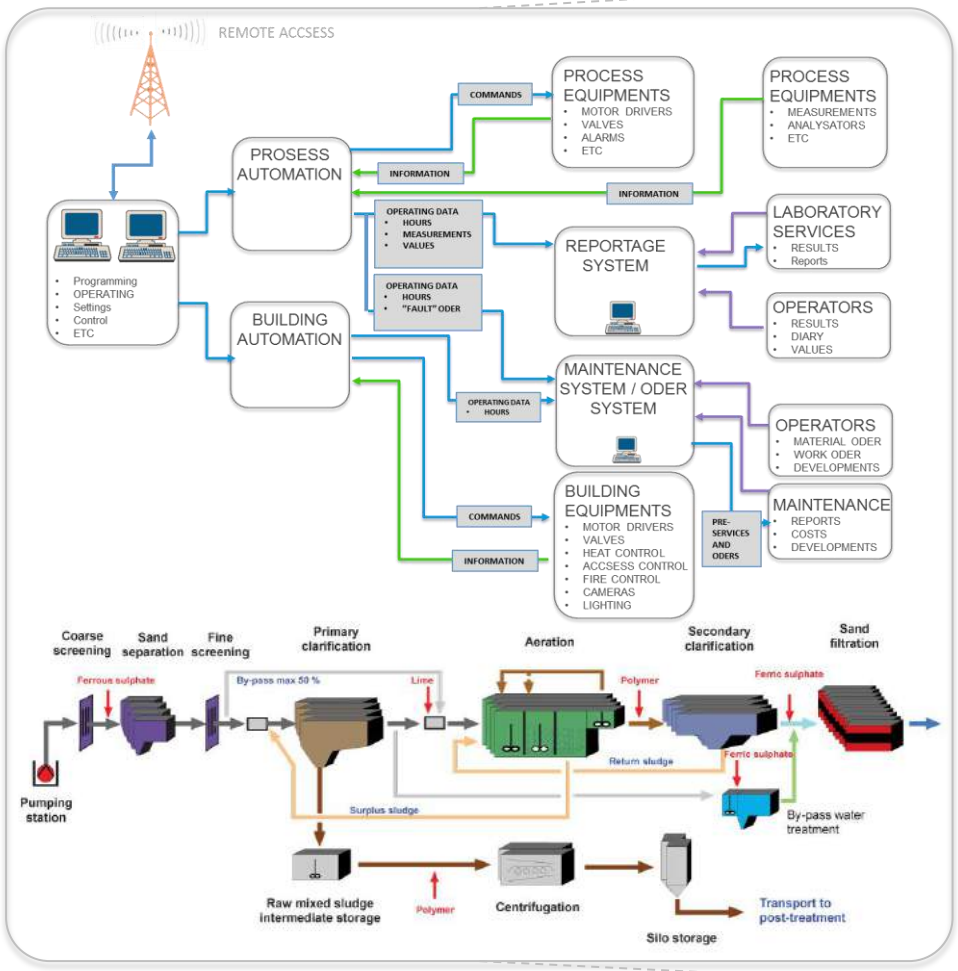
SYSTEMS AND PERFORMANCE



TEAM WORK

METERING
TREATMENT EFFICIENCY

ENERGY
- AMOUNTS
- COST

MAINTENANCE
- RELIABILITY OF OPERATIONS
- COST
- EQUIPMENT LIFE CYCLE

ENVIRONMENT
- CARBON FOOTPRINT

QMS
- RISK ANALYSIS
- SAFETY
- RESPOND
- EXCEPTIONAL SITUATIONS
- MEASUREMENTS OF QUALITY
- RELIABILITY
- ENVIROMENTAL PERMIT
- COST-EFFECTIVENESS

INFORMATION MANAGEMENT
- DATA PROCESSING
- STORAGE
- SECURITY
- BACKUP

DEVELOPMENT
- STAFF EXPERTISE
- EDUCATIONAL PARTNERSHIPS
- COOPERATION WITH THE INDUSTRY
- COOPERATION PROJECTS

→ NEW IDEAS

OUTPUT
Cost effective high-quality wastewater treatment services

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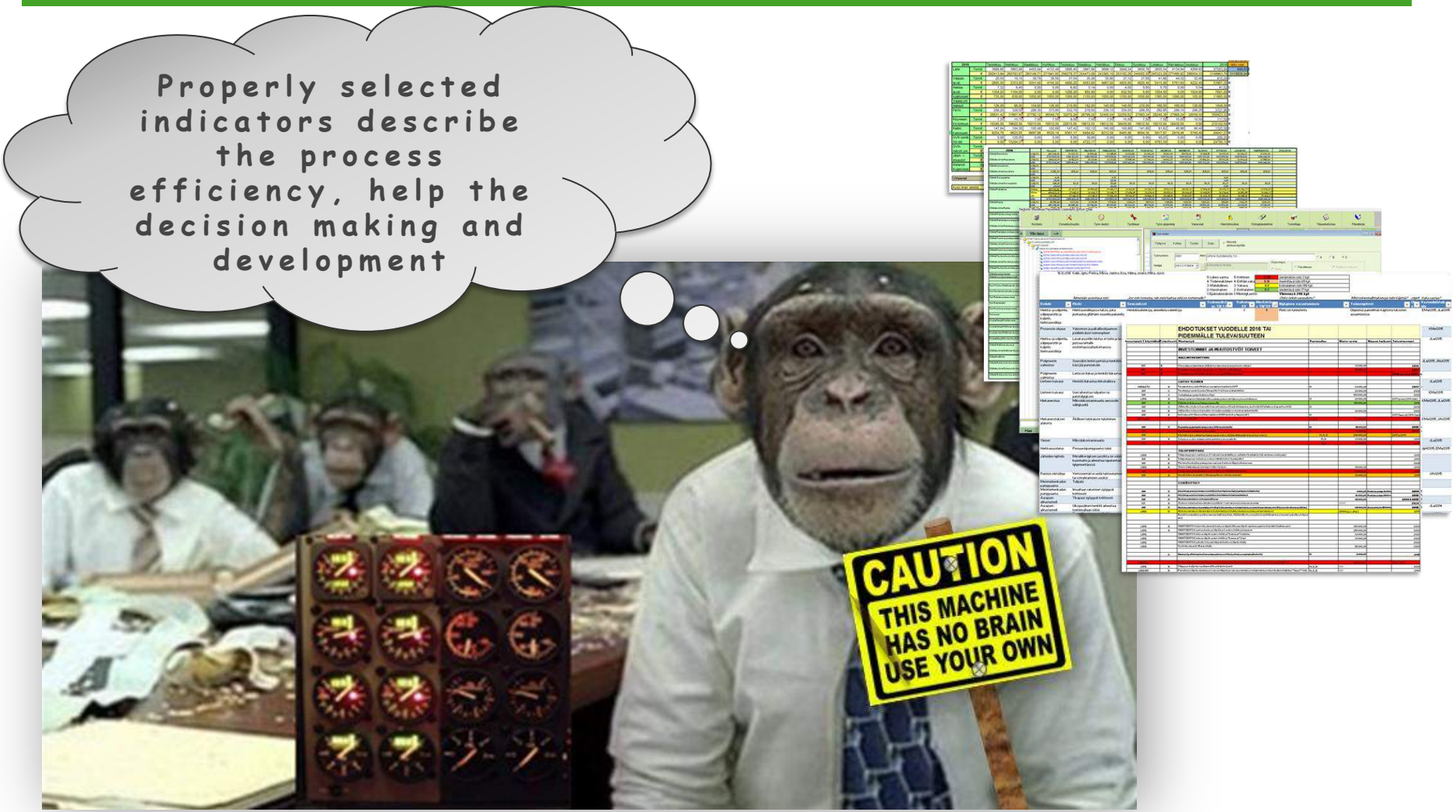
SUMMARY



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THANK YOU!
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