



**ETELÄ-KARJALAN JÄTEHUOLTO OY DRY DIGESTION FACILITY AND
BIOGAS UPGRADING AND FILLING STATION DESIGN AND TURN-KEY
CONTRACT**

SPECIFICATION FOR DESIGN AND ENGINEERING

12.06.2018



SCOPE AND CONTENT OF THE CONTRACT

The object of the contract is a dry digestion facility planned and constructed to the Etelä-Karjalan Jätehuolto Oy waste management area. The facility will produce biogas that shall be processed to bio-methane suitable for use in transportation. Digestate is delivered to further processing. A filling station for upgraded biogas is part of the contract.

The whole installation is contracted as a turn-key contract. The contractor shall be responsible for principal designer tasks, special designs, construction and installation works, equipment procurement and installation, test runs and guarantee period obligations.

The contract includes the following design tasks:

- Principal designer duties as specified in RT 10-1118, excluding task A (Requirements review). The principal designer shall possess sufficient competence and apply for an approval from the Lappeenranta construction authority to act in the role of a principal designer. The approval shall be presented to purchaser before the contract is signed.
- The principal designer shall compile design principles for engineering sectors. The design guidance shall account for the special requirements of the production and technology as well as any environmental protection requirements specified by the related authorities.
- Energy calculations and energy certificates that are compiled for buildings for the building permit and deployment inspection.
- The explosion protection document including classification drawings and plans for areas and equipment
- Engineering sectors including geological (GEO), civil (RAK), HVAC (LVISA), process (PRT/THE), electrical, and automation engineering (SIA)
 - GEO:
 - Surface levelling plan
 - Water management plan
 - Drainage plan
 - Earthworks cross-sections
 - Filling and supporting material classification
 - Excavation plan
 - Compaction plan
 - Specification for soil works
 - Mass calculations
 - Depression calculations
 - RAK:
 - Specification for civil works
 - Piling
 - Pile map
 - Pile list
 - Cutting list
 - Steel pipe pile's internal reinforcements



- Concrete structures
 - Dimensional drawings
 - Structural calculations and rapport
 - Reinforcement drawings
 - Specific details (e.g. water-tightness)
 - Element production drawings
- Steel structures
 - Dimensional drawings
 - Production drawings
 - Structural calculations and reports
 - Assembly drawings
- LVISA:
 - Layout drawing for wells, pipes, and drainage
 - Well specifications
 - Water and sewage floor plans
 - Waste processing facility
 - Floor plan for ventilation system
 - Waste processing facility
 - HWA instrument list
 - Separate engine list
 - HWA control circuits
 - Heating plan
 - Connection diagrams
 - Heat circuits
 - PHS work description
 - PHS document/drawing list
- PRT/TEH:
 - Sizing principles
 - PI-diagram
 - Functional description
 - Process control circuits
 - Block diagram and mass and energy balance
 - Equipment situation plan
 - Pipe isometrics
 - Pipe support guidance
 - Equipment cards
 - Motor lists including information for electrical design
 - Process risk assessment
 - Operating and maintenance manual
 - List of critical spare parts
 - Facility marking plan
 - Automation reports plan



SIA:

- Work specifications
- Interlock and control diagrams
- Automation cabinets
- Layout plan
- Circuit diagrams
- Bus principle diagram
- Bus diagrams
- Ex – diagram harmonisation
- Ex - device list, including a list of requirements
- Grounding plan for instrumentation
- Instrumentation field box plan
- Cable lists for instrumentation
- Safety document for electrical works
- Specification of used markings and abbreviations
- Power distribution and grounding plans
- Main diagrams
- Distribution and grounding level drawing
- Grounding diagram
- Main and substation plans
- Main drawings
- Station layouts
- Main stations
- Group stations
- Safety lighting station
- Power socket stations
- Level drawings
- Area cabling plan
- Buildings
- Circuit diagrams
- Process engines
- HVAC engines
- Pneumatic and motor valves
- Measurements
- Emergency stop circuits
- Emergency lighting
- Lighting plan
- UPS system
- Calculations
- Cabling plans



- Cable lists
- Support guidance

- Preparatory tasks at the construction site
- Management of the construction site.
- Responsibility for construction work
- Procurement and installation of equipment, training and responsibility for the facility operation until guarantee tests are completed.
- Document management and preparation of operation and maintenance manual.

DESIGN GUIDANCE

General

Process sizing and the level of the equipment is conducted in accordance to this document. The design guidance given here must be considered as minimum requirements. Proposing lower quality than required will mean that the purchaser disqualifies the tender.

Placement of new buildings and pipes as well as the connections between various parts shall be carefully planned in order to provide a unit that is easily accessible and easy to maintain.

Design and implementation shall follow Finnish legislation, regulations, and applicable EU-directives, especially the following:

- 2006/42/EU – Machinery Directive
- 2014/68/EU – Pressure Equipment Directive
- 2014/34/EU – ATEX Directive
- 1999/92/EU (ATEX 137)
- 2014/35/EU – Low Voltage Directive

Additionally, the following standard applies:

- SFS-EN 60079-0 Explosive atmospheres – Equipment – General requirement

Description of the operations

Etelä-Karjalan Jätehuolto Oy receives approximately 20,000 tonnes of sorted bio-waste and sewage sludge annually. The facility shall however be scaled for 25,000 tpa capacity. Sewage sludge and bio-waste are processed in separate lines into hygienized and mechanically dewatered digestate. The products are delivered for further processing e.g. to a composting facility. Produced biogas is purified and processed into bio-methane suitable for use in vehicles. Upgraded biomethane will be distributed in a biogas filling station built at proximity of the waste management facility.



The facility receives waste primarily during week days, between 7 AM and 8 PM. Biowaste is delivered by compacting garbage trucks that are unloaded from the back of the truck. Side-unloading garbage trucks shall not be accounted for. Additionally, biowaste can be delivered by trucks. Sewage sludge is delivered by trucks. Occupational safety regulations apply to waste reception. To ensure cleanliness of waste reception, the unloading area shall be located indoors, and a concrete reception bunker shall be built under the floor level.

For the maintenance periods and for the unexpected situations the plant shall be equipped with spare reception premises for the both waste streams. The holding volume shall be for 2-weekday capacity.

The maximum daily received load is 160 tonnes per day and the facility's reception capacity shall account for this. It must be noted that loads are not equally distributed during the 7 AM to 8 PM working time and the daily volume can be met within 4 hours.

The received biowaste shall be crushed into particle size suitable for digestion. The biowaste is fed to the crusher with suitable equipment like grab or applicable conveyor. Front-loader feeding is not accepted.

Crushed biowaste is transferred to hygienization via magnet. Separated metals are collected to a separate platform and subsequently delivered to metal re-use collection. The purity of the separated metal shall be adequate without any further treatment by purchaser. After crushing, metal separation, and hygienization; the biowaste is processed anaerobically.

Sewage sludge is treated on a separate line and similarly than with biowaste, hygienized before anaerobic processing.

Hygienization is here defined as 1-hour batch treatment at 70 °C. Generating the thermal energy needed for the hygienisation process is part of the delivered facility and contract. As an alternative, digestion can be done at above 50 °C, but the contractor is in all cases responsible for obtaining Evira's approval for the procedure. Evira is an authority that regulate and monitor the production of fertilisers and soil improving agents.

Hygienized wastes are fed to the parallel digestion stages using suitable equipment. Digesters must be gastight and watertight and the selected material must have a lifetime of at least 30 years. Digesters shall be adequately insulated and owe sufficient mixing equipment.

Biogas generated from the digestion reactors must be transported to a bio-gas storage, where a sufficient overpressure (>20 mbar) is produced.

The contractor is free to propose any biowaste and sludge dry digestion technology. However, the following individual processes must be included in the facility:

1. Reception of sludge
2. Reception of bio-waste
3. Crushing of biowaste
4. Separating metals from crushed biowaste



5. Alternatively:
 - a. Hygienisation and a mesophilic dry digestion process OR
 - b. A thermophilic dry digestion process
6. Mechanical dewatering of hygienized digestate from biowaste line and storage tank for reject water
7. Biogas storage
8. Biogas purification
9. Boiler unit
10. Emergency flare
11. Treatment of odorous gases
12. Biogas upgrading unit
13. Pressurisation unit for biomethane
14. Storage for pressurised biomethane
15. Fuelling station for pressurised biomethane

Additionally, the contract includes civil works, piling and construction work. The purchaser is only responsible for the construction of filling and levelling layers at parts of the construction site before the contract work is started.

The contract shall include at least the following buildings / structures:

1. Waste reception and handling building
2. Spare reception premises
3. Control building
4. Dewatering building or a suitable premises in the process building
5. Biogas upgrading unit
6. Outdoor storage area for mechanically dewatered digestate



BASE INFORMATION

Waste quantity and quality is shown in the Table below.

TABLE 1. Base information table

		Biowaste	Sewage sludge	Total / average / max
Planned volume	tn/a	6,300	13,700	20,000
Range	tn/a	6,000 – 9,000	11,000 – 16,000	25,000
Total Solids content	%	28	23	25
Range	%	25 – 30	18 – 28	
Total Solids load	tn TS/a	1,764	3,151	4,915 (max 6,250)
Ratio of organic matter (VS/TS)	%	80	73	76
Load of organic matter	tn VS/a	1,411	2,300	3,711 (max 4,750)
Nitrogen concentration	kg/tn	8	8	8
Phosphorus concentration	kg/tn	3	4.6	4.1
Temperature	°C	0...20	2...20	

An additional specification compiled by HSY is available for biowaste (Table 2). *Source* 'Pääkaupunkiseudun sekaja biojätteen koostumus vuonna 2015'.



TABLE 2. Estimate about household biowaste content.

Waste component	Percentage by mass
Food waste	24.9
Residues of food manufacture	44.6
Weeds and branches	0.6
Other garden waste	12.8
Coated paper and cardboard	0.2
Biodegradable paper and cardboard	11.6
Plastic bags	1.1
Biodegradable plastic bags	2.3
Other plastic	0.3
Other biodegradable plastic	0
Glass	0.1
Metal	0.1
Hazardous waste	0
Diapers, sanitary napkins	0.9
Animal excrements	0.3
Rocks and ceramics	0
Other unknown or nuisance substances	0.1



REQUIREMENTS

The facility's operation and individual processes shall be planned in accordance with the requirements specified in the relevant environmental permit, tender invitation documents, Finnish legislation, regulations, applicable standards and directives. All equipment must be type approved and have a CE-marking.

Operational requirements for individual processes are listed below:

1. Reception of sludge
 - a. 3 vehicle loads of sewage sludge may be delivered on daily basis.
 - b. The reception system capacity shall manage the daily sludge volume received within 4 hours.
 - c. Sludge is received to a separate reception silo/bunker built under the floor level.
 - d. The reception area shall be indoors. A truck (design length > 12 m) must be fully indoors for unloading and it must be possible to close the door while the vehicle is inside.
 - e. The sludge reception silo/bunker must be water-tight. The concrete class for the construction is XA2. C35/45 concrete is to be used, with sulphate resisting cement and enhancement with Xypex Admic C 1000-NF additive.
 - f. Injection hoses must be placed both inside and outside to the immediate vicinity of the work joints of concrete constructions.
 - g. The reception silo/bunker must be equipped with localised odorous gas removal.
 - h. Sludge transfer from the reception silo shall be either by a grab, conveyor, or by other equivalent system.
2. Reception of biowaste
 - a. The daily reception capacity shall be designed for 8 compacting garbage truck loads of biowaste.
 - b. The whole amount of daily biowaste can enter the facility within 4 hours.
 - c. Biowaste is received into a separate reception silo/bunker; built under the floor level.
 - d. The reception area shall be indoors. A compacting garbage truck (vehicle designed length > 12 m, min free length 13 m) must be fully indoors during unloading. The door must be closed when the vehicle is inside.
 - e. The biowaste reception silo/bunker must be water-tight. The concrete stress class for concrete constructions is XA2. C35/45 concrete must be used, with sulphate resisting cement and enhanced with Xypex Admic C 1000-NF additive.
 - f. Injection hoses must be placed both inside and outside to the immediate vicinity of the work joints of concrete constructions.
 - g. The reception silo/bunker must be equipped with localised odorous gas removal.
 - h. Biowaste transfer from the reception silo shall be either by a grab, screw-container or other equivalent system.
3. Crushing of biowaste
 - a. The equipment delivered for biowaste crushing must tolerate the stress and wear caused by biowaste impurities. The permitted maintenance interval should be longer than 2 weeks. Maintenance must be possible to accomplish without external contractors, by 2 facility employees and during maximum of 6 hour period.



- b. The contractor is free to specify, whether a screen is used after crushing or not. If screen is required, the type and separation capacity should be informed in the offer documents.
4. Separating metals from crushed biowaste
 - a. Metal must be separated before biowaste hygienisation and anaerobic treatment.
 - b. Metals are transferred to a specified container (at least 1 m³).
 - c. The contractor shall ensure that the system is a complete and no additional treatment is needed for the delivering the metals to recycling.
5. Main process - alternatively:
 - a. Hygienisation and a mesophilic dry digestion process OR
 - b. A thermophilic dry digestion process
 - c. A 25 g raw sample taken after from waste after the dry digestion process is not allowed to be positive for Salmonella.
 - d. E. Coli max 1000 cfu/g.
 - e. Produced biogas must be fully recovered for use.
6. Mechanical dewatering of digestate from biowaste treatment line
 - a. Mechanical dewatering must work without constant presence of the operator.
 - b. The Total Solids content of dewatered digestate must be over 25 %.
 - c. The description of the system must state the solids recovery rate and the quality (at least TS %) of reject water.
 - d. Reject water must be free of visible particles, a 1-mm screen size is preferred.
 - e. Reject water is delivered to a storage tank with at least 7 day holding capacity.
 - f. Dewatered digestate is transferred to a silo that is located outdoors and the digestate can be handled with front-loader.
7. Post-treatment of digestate from wastewater sludge treatment line
 - a. Digestate is transferred to a silo that is located outdoors and the digestate can be handled with front-loader.
 - b. Digestate is mixed with peat to produce digestate with TS >25 %.
8. Biogas storage
 - a. Biogas storage is dimensioned for 4 hour biogas production.
 - b. The storage shall produce at least 20 mbar overpressure to the whole biogas system.
 - c. Storage shall be equipped with protective device against overpressure and vacuum.
 - d. Condensate water separating from biogas is conducted to a location that is approved by purchaser (for example to the process)
 - e. The biogas storage is located on concrete platform and shall have three membranes.
 - f. Storage shall have an air blower, which is connected to electricity supply with a plug. During the interrupted electricity supply the system is equipped with diesel-aggregate with sufficient power to operate the blower.
9. Biogas reclamation and cleaning
 - a. No humidity (+2 °C)
 - b. O₂ < 0.5 %



c. $\text{H}_2\text{S} < 150 \text{ ppm}$

10. Boiler

- a. The boiler shall have a thermal production capacity sufficient for waste hygienization and heating of the buildings.
- b. Fuel can be biogas or other biofuel. In the case of biogas the boiler must have a dual-fuel burner (biogas / lightweight oil) for the startup period. Fuel oil storage must correspond to the requirements of local fire authorities and have least 3 days storage capacity.

11. Emergency flare

- a. Measured for at least 2 x the biogas production capacity.
- b. Closed model, so-called open flare is not acceptable.
- c. The flaring cannot cause an odour nuisance.

12. Treatment of odor gases

- a. Odorous gases must be collected from each processing space and treated to achieve maximum odour unit concentration of $2,000 \text{ OU/m}^3$ and maximum ammonia concentration of 5 ppm.
- b. The contractor shall ensure that odorous gases are collected sufficiently to maintain indoor concentrations for ammonia and hydrogen sulphide below 8 h MAC (maximum allowed concentration) values.
- c. The odour treatment must be available more than 98 % of the annual hours.

13. Biogas upgrading unit

- a. The upgrading unit must produce biomethane suitable for transport fuel.
- b. Upgraded gas must also comply with the following requirements.

Compound	Limit value
Methane (CH_4)	$\geq 97 \text{ \% conc}$
Carbon dioxide (CO_2)	$\leq 3 \text{ \% conc}$
Oxygen (O_2)	$\leq 0.5 \text{ \% conc}$
Sulphur (S)	$\leq 23 \text{ mg/Nm}^3$
Hydrogen sulphide (H_2S) + carbon based sulphides (COS)	$\leq 5 \text{ mg/Nm}^3$
Particles	$\leq 1 \text{ }\mu\text{m}$
Water (H_2O)	$\leq 32 \text{ mg/Nm}^3$
Ammonia (NH_3)	$\leq 20 \text{ mg/Nm}^3$

14. Compressor unit for upgraded biomethane

15. Storage for pressurised biomethane, storage volume of at least 700 kg CH_4 .

16. Fast-fill station for bio-methane (both light and heavy vehicles). Equipped with a payment terminal. Finnish Gas Association's instructions for natural gas filling stations apply.

STRUCTURES / BUILDINGS

1. Waste reception and handling building

- a. The snow load is $2,75 \text{ kN/m}^2$.
- b. The wind load value for calculations is 21 m/s.
- c. Buildings are constructed to have constant temperature higher than $5 \text{ }^\circ\text{C}$.



- d. Flooring in different premises shall account for the stress from heavy vehicles and the specified use. Ucrete-coating shall be used in areas, where floor is repeatedly exposed to waste. Otherwise an acrylic-based product may be used.
 - e. Floors must be constructed with a sufficient inclination ($> 1\%$) for cleaning purposes.
 - f. Wastewater (cleaning waters, water spills etc.) is directed to the construction site periphery via oil and sand separation. The purchaser shall approve the capacity and design flow.
 - g. The building internal height must be sufficient to allow waste unloading directly to silos/bunkers.
 - h. Free lifting height for compacting garbage trucks is at least 8 m and for trucks 12 m.
 - i. The unloading area must have a sewer and $\frac{1}{2}$ " washing hose with sufficient length to go around a garbage truck or truck. Water must be warm and the pressure at least 3 bar. There must be sufficient water supply for 30 minutes of continuous washing.
 - j. All equipment must have sufficient maintenance clearance and necessary platforms built by workshop that has certified ISO 9001:2008 quality system.
 - k. The colours of buildings and large constructions are exposed to approval by the purchaser.
 - l. Ventilation system shall have heating for incoming air and the air that is collected from all locations where are odours is delivered to odour treatment system.
 - m. The electricity cabinet shall be located in the reception and processing building. The area shall be sectioned as a separate fire area.
 - n. Water supply from the community can have low pressure at the connection. This must be considered for fire protection systems and for processes using tap water.
 - o. Railings and platforms must be galvanized steel or better.
 - p. The building shall have its own service manual.
2. Control building
- a. The snow load is $2,75 \text{ kN/m}^2$.
 - b. The wind load value for calculations is 21 m/s.
 - c. Building has heating system for normal office conditions.
 - d. The building must have a separate control room sufficient for at least 3 persons.
 - e. The building must have a separate kitchen and dining room for at least 3 persons.
 - f. The building must have a dressing room with a separate exits for clean and dirty sides. The both sides must be equipped with at least 5 lockable wardrobes.
 - g. The dressing room must include a washbasin and a washing machine.
 - h. A toilet, shower, and sauna must be accessible from the dressing room.
 - i. The sauna must be equipped with an electric heater.
 - j. Wet space floors shall be constructed with ceramic tiles.
 - k. The building's intake air is directed to a heat recovery system through an activated carbon filter.
 - l. The building shall have its own service manual.
 - m. Control building can be integrated into process building if Supplier can show satisfactory design to prevent the odour and other nuisance from the control premises.
3. Dewatering building
- a. The tenderer may propose a separate building for mechanical dewatering, if this is a cost-effective solution.
4. Reserve waste unloading area in cases of maintenance or plant disturbances



- a. At least 2 m high concrete walls covering the waterproof asphalt area, equipped with sewer system. Design capacity 2 weekdays. Separate areas for sewage sludge and bio-waste.
5. Outdoor storage area for dewatered digestate
 - a. Waterproof asphalt, equipped with sewer system. Holding capacity for 2 months.
6. General infrastructure
 - a. Areal design (lightning, pavements, rainfall water management etc.) and construction works covers the designated area for biogas plant as well as the filling station area.

OTHER REQUIREMENTS

1. Machine work specification is provided as a separate annex 4.2.
2. The electrical motors are mostly equipped with frequency converters. The contractor must provide an explanation if some motors are offered without FC.
3. The biogas plant SCADA system must be build based on the technology common suppliers, e.g. Omron, Siemens, Valmet Automation, Honeywell or ABB.
4. Minimum requirements for the SCADA system
 - b. The system shall include all individual processes, even if individual processes are equipped with independent control logics.
 - c. The system shall include building's automation.
 - d. The system user interface must be in Finnish.
 - e. A firewall protected remote connection shall be provided for the monitoring station.
 - f. The purchaser shall have a licence for the system after the guarantee period is over. This must include system modifications and expansion.
 - g. The system must be duplicated and have a sufficient back up system.
 - h. The delivery shall include an UPS capable of sustaining the control system for at least 30 minutes.
 - i. The system shall collect measuring and other data (e.g. operation hours) for the period of 10 years. Data storage space shall be provided for that period. Collection intervals can be longer after one year to reduce the storage space.
 - j. The system must display all collected data in a graphic form. All measurements must be available for archive reports.
 - k. The automation designer shall design a backup copy so, that reference values and settings are preserved even if the system crashes, the equipment is physically damaged or during a power outage. Stored measurement data must also be backed up.
 - l. The system must include an integrated GSM-alarm system. The alarm system must allow for various alarm levels and multiple recipients. The user must be able to adjust individual alarm levels or remove these from use. Critical alerts must be defined by the user. Additionally, the user must be able to configure critical alerts that require acknowledgement from a primary phone number and are forwarded to a secondary number, if acknowledgement is not received in a configure time.
 - m. No part of the delivered system may be protected with passwords or safety measures that are not handed over to the purchaser.