Solutions for environmental projects

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Water treatment equipment

Water demand increases with the development of industry and cities. At this stage, we can notice the decrease in clean fresh water sources around the world. There are a lot of different technological equipment in the world that perform the function of water treatment. Technological process and technological equipment are selected depending on the pollution of water and hygiene requirements for purified water.

Water treatment equipment

- Mechanical water filters are intended for cleaning the water from various sediments (sand, clay, etc.) traveling through the water pipeline and from trivalent iron. Filter operating principle: the filter filters water through a filler Aqua sand and Antracite. Back-flow water is used for regeneration (restoration of filtering properties when it becomes dirty).
- Water deironing filters are used to remove various sediments (sand, clay, etc.) from water, as well as trivalent and bivalent iron (rust and dissolved iron), ammonium and manganese. The filter filters water through a natural calcium carbonate filler. Only water is used for regeneration (restoration of filtering properties when it becomes dirty).
- Water softening filters are used to remove calcium and magnesium from water, as well as traces of bivalent iron. The filter filters water through a specially designed material - cationite, and uses water and salt solution for rinsing.
- 5-stage reverse osmosis system. Intended for preparing top-quality drinking water. Cleans water from: Chlorine >; 97%; radioactive elements >;90%; potassium and magnesium>;96%; petroleum products >;98%; nitrates and nitrites >;83%; aromatic hydrocarbons >;98%; heavy elements >;97%; bacteria >;99%.

Technological equipment, depending on its efficiency and water pollution, can be installed on-site in the constructed technological building or container.

Mechanical wastewater treatment plants

Mechanical treatment is a group of devices which treats wastewater mechanically from suspended matter. In practice, it is widely used prior to biological treatment, floatation, membrane, in order to intercept sediments and sand.

Primary pre-treatment plant - it is a complex unit consisting of automatic screens, grit separator, silt press, fat separator. This device is widely used in wastewater treatment facilities as a part of primary treatment chain. Depending on that, they might vary in their size and appearance, as well as the equipment necessary for the composition. The grit separator in the unit could be aerated and no. The sand and silt could be supplied to containers automatically via screw. Thus, silt and sand are dewatered. These devices are quickly and easily installed.

Automatic screens - suspend all the solids contained in the wastewater and remove them automatically by spinning them into the press bunker, where sediments are compressed and washed if needed. Inside the presses there are screws installed that helps to press screenings and push them via pipe towards the container.

The grit separator - the device is intended to remove the sand from the wastewater and dewatering it automatically transported it to the container. The purpose of the grit separator, while separating sand to dewater it as much as possible to minimize moisture and wash off the organic compounds stuck to the sand in order the sand would not decompose and would not give the unpleasant odour.

Tertiary treatment plant – is intended for additional treatment of treated wastewater, where is necessary to significantly reduce the insoluble materials, as well as to reduce the BOD and COD. Micro sieve filter is the important part in tertiary wastewater treatment process. All sewage enters inside of the sieve and is strained a through the sieve drum. The drum is fitted with the sieve with a mesh size of 17 to 80 mic. size. Sieves may have different efficiency, depending on the demand and wastewater contamination of suspended particles.

Biological wastewater treatment plants

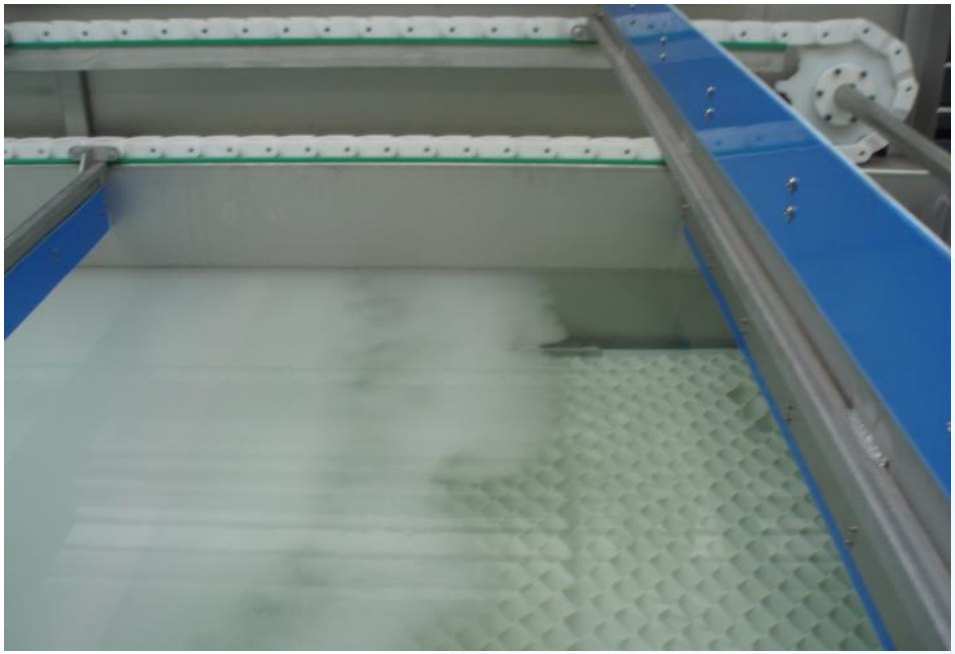
The wastewater treatment takes place in biological, multi-precast reactor. Regarding to the wastewater amount, type, concentration the bioreactor is divided by walls into following zones: anaerobic, denitrificative, nitrificative and secondary clarifier. Mechanic, stirring devices and aeration, intensively and continually stirs the wastewater consistency in the bioreactor. Pumps and airlifts direct the wastewater consistency into different zones. This method allows activating the wastewater treatment process. The sludge and the oxygen concentration are different in the bioreactor zones. Accordingly, in the activation zone, the sludge concentration may differ from 4-6 g/l, the oxygen from 2,5 - 3,5 mg/l. The air blowers ensure the air feed to the bioreactor by supplying the suppressed air through bottom, membrane, aeration elements. In the secondary clarifier, the most advanced method applied to the separation of treated wastewater though suspended sludge. This process is rather complex in a hydraulic matter. During this process, the sludge rises to the top, where it forms into compounds, afterwards becomes heavier, and therefore descends to the bottom. The water separation process takes place exactly through this descending layer of sludge. The technological process does not change no matter if the wastewater treatment plant is big or small. Although the components such as sludge treatment, pre-treatment plant, automation level, etc., may vary. We might suggest various sludge treatment methods for the excess sludge, depending on customers' demands. The excluded excess sludge from the bioreactor falls into the sludge capacity – the thickener, it is thickened by gravitating method to 2% of dry materials, and the excess water is brought back to the beginning of the biological treatment. Additionally, after gravitating thickening, the sludge might be dried with presses up to 20% of dry materials. After additional drying, the excess water is brought back to the beginning of the biological treatment, whereas dried sludge is taken to landfills for utilization or it is used for other purposes.

Flotation (DAF) wastewater treatment

Floation (DAF) cleans the wastewater generated by the industry. After the flotation process reduces wastewater pollution:

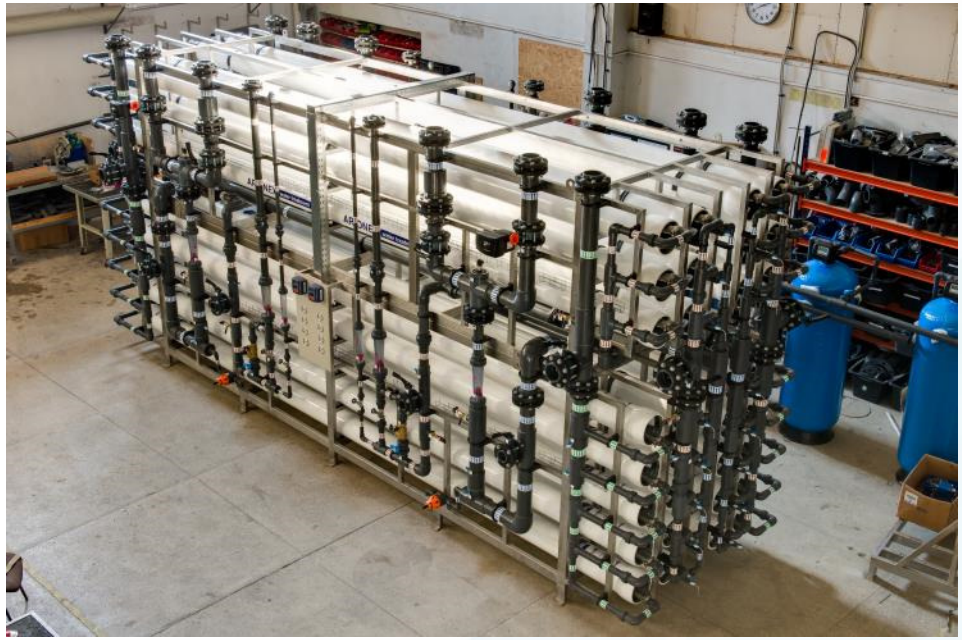
- BOD5 from 50 – 80%;
- COD from 50 – 80%;
- SS from 50 – 95%;
- Fat from 50 – 95%;
- Common P up to 95%.

The wastewater flows into the pumping station, where the manual screenings are installed to stop large sediment. Pumps are fed into a rotary sieve, where the particles larger than 1 mm are separated. Withheld screenings while pressing through automatic screw are fed into the container. Afterwards the effluent flows into a separate yield and concentrations balancing tank. From this capacity, pumps inject the wastewater into the tubular mixer. In the mixing tank, the valves are installed and flocculants, coagulants dosing pipelines are in mounted, they are all connected with the dosing tanks. Such mixing with chemical reagents required to bind pollutants into flakes. The sewage flows through the mixer to the floater. The mixture of the suppressed air with bubbles is fed to the floater as well. Small bubbles entering the wastewater rise up of the pollutants bounded into flakes to the surface where they are mechanically removed from the surface with the raker. The raker scraps away pollutants that are diverted after to the sludge collection tank from which with a special transport are taken for further utilization. In the sludge tank there is a mixer installed, which ensures sludge stirring. Suspended materials descended at the bottom of the floater, that bubbles failed to bring to the surface, are directed to the sludge collection tank through the valve mounted at the bottom. A separate compressor provides the air supply to the floater. The water, required to prepare water and air mixture is taken from the floater, which is fed into the pressurized container. From this tank, the air-water mixture is fed into the floater, in this way air bubbles are formed.



Membranes for Waste Water Treatment

Membranes designed for treatment of heavily polluted industrial waste water are increasingly applied for treatment of domestic waste water. It is the most complex and the most expensive waste water treatment procedure resulting in particularly high treatment indices. Membranes are often used when no other waste water treatment methods (biological, flotation, etc.) could be applied. It is advisable to combine membranes with other treatment systems, planning their application as the last stage of treatment. In this way they provide additional treatment of waste water until the required parameters are achieved.
A membrane is a semi-permeable material with particularly small pores separating water molecules from impurities dissolved in water. Water molecules flow past through the membrane, whereas impurities are caught by it. Different membranes are selected each time: this depends on the type, concentration, and quantity of waste water to be treated.



Membranes are divided into four groups based on pore size: micro-filtration; ultra-filtration, nano-filtration, reverse osmosis. The key difference between them is the size of the retained molecules (impurities). The type of membrane is selected based on the type of the waste water to be treated and the analysis of the impurities prevailing in them.
Several different membrane types may be used within a single system. This is done in order to retain bigger molecules during the first phase and then retain smaller molecules during the second phase. This method enables to reduce the price of the technological equipment and to extend the lifetime of membranes significantly.

Reverse osmosis (RO) ensures the highest level of treatment involving elimination of all trace elements and impurities with clean and pure water as the final result. Special detergents are used for flushing the membranes designed to eliminate any impurities from the surface of the membrane. A flushing system is installed for flushing of the membranes.

Sludge drainage and desiccation equipment

Technological processes produce waste called "excess sludge" which needs to be processed in order to use it in further processes. Depending on the requirements, different technological equipment and solutions may be selected for sludge drainage in order to meet the requirements. Flocculants are additionally inserted into water in order for them to be able to pass through sludge more easily. Sludge is transformed into flakes and water is able to pass through it more easily during the technological process. Flocculants are dosed through an automatic flocculant dosing station.

Sludge is formed during the following technological processes

- In wastewater treatment equipment.
- In biogas power plants.
- After the flotation process.

Depending on the need, sludge can be prossesed through

- Compression – process during which sludge is drained up to 6 % of dry residue. Compression is usually carried out through a belt press. It is a simple device where sludge is added and drained by using the belt and the gravitation method.
- Drainage – process during which sludge is drained up to 25 % of dry residue. Drainage is carried out depending on the sludge type: in the filtpress or decanter. Filtpress is a device similar to the belt press, however it contains several belts. When sludge appears on the belt, it is transported into a roller system where it is pressed between rollers, thus undergoing a pressing process. The decanter, also known as a centrifuge, is a device containing two simultaneously rotating cylinders, however one cylinder is rotating one step slower than the other. This way water is extracted from the sludge.
- Desiccation – process during which sludge is dried up to 6 % of dry residue. Drying is a complex process during which sludge on the belt is heated and water is evaporated from it. It is the final process to prepare sludge for incineration or use it in fertilizer processing.

Biogas production, fallow equipment

These are biological equipment that bacteriologically separate organic matter under anaerobic conditions. Methane separated during separation is used as fuel for production of electricity and heat. It is a cheap and effective energy that can be used for personal needs or supplied to a network, as well as an environmentally-friendly, cost-effective and viable fuel that can be obtained from the following raw materials:

- Animal manure and slurry.
- Wastewater treatment plant sludge.
- Food industry waste, agricultural products, corn silage.
- Green waste (grass, leaves) and other organic raw materials.
- Biodegradable waste sorted from landfills.

Operational process

Raw materials are supplied to a biogas power plant through pipelines from a waste source (farm, production workshop) or transported with trucks. All waste enters the collection tank where the biomass is mixed and stored. The biomass is periodically supplied from this tank through pumps to the bioreactors. Substrate in the reactor is maintained for some time, therefore it is necessary to refill the reactors every day, and remove the used biomass. The reactors contain mechanical stirrers that maintain a homogeneous mass and do not allow it to be layered, thus sediments do not accumulate in the bottom of the reactor and are pushed towards the exhaust vents. The reactor continuously performs the anaerobic process, maintains a mesophilic or thermophilic environment and continuously maintains proper temperature. Reactors are heated - heat is emitted by cogeneration power plants by burning biogas. Biogas emitted during the anaerobic process accumulates in the upper parts of the reactor and enters the gas storage facility due to the pressure. Gas is cleaned of additives and sulfur compounds through mechanical and chemical filters. Biogas reserve is accumulated in the storage facility. Accumulated biogas is burned in internal combustion engines (cogenerators) that rotate an electric generator, thus producing electric power. Engines are cooled with water that heats up during engine cooling and produces heat. Processed biomass can be used for the production of concentrated fertilizer or compost. In this case, the substrate is separated and the thick fraction is composted or granulated. The liquid part is used to fertilize fields.

Composting equipment

One of the methods to process organic waste is to compost them. Different compost can be obtained after the composting cycle, depending on the raw materials or waste that we want to compost. Composting helps us to properly and in a controlled manned

Composting methods

- Open, when composting occurs in open piles in the fields. This composting method requires large areas. The composting cycle occurs in the natural environment. Unpleasant smells are produced during this process, which can cause issues with the society.
- Closed, when composting occurs in closed tunnels. This composting method does not require large areas. The entire cycle is well controlled according to the set time parameters. The process is carried out under anaerobic or aerobic conditions, depending on the technological cycle. Proper substrate moisture is continuously maintained. If necessary, the substrate is watered. Air removed from the tunnels is cleaned in biofilters, therefore no unpleasant smells are emitted into the environment.

Compost use

- For the fertilization of green zones, recultivation of forests and restoration of the plant layer.
- For filling landfill polygon piles.

Which waste and raw materials are suitable for composting

- Sludge which is produced after wastewater cleaning and fallow processes.
- Biodegradable fraction which is sorted from household waste in a waste sorting plant.
- Food and vegetable waste from catering facilities.
- Green waste (leaves, grass, sticks, etc.).
- Animal manure.
- All other organic waste suitable for fallow.

Waste sorting equipment

Waste is a material or object which is discarded by its owner. It can be of various types, dimensions and compositions:

- Household: everything that is thrown into a trash bin in our homes.
- Secondary: paper, glass, plastic, metal.
- Green: grass, sticks, leaves.
- Hazardous: drugs, chemicals.
- Household objects: furniture, windows, bicycles, textile waste, etc.
- Construction: concrete, blocks, etc.

Household waste is collected with special vehicles and delivered to a waste sorting plant where the waste is sorted according to its type. All waste brought in special vehicles is dumped in an unsorted waste area installed inside a building, where waste is loaded into a crusher or bag shredder. The purpose of the latter is to shred the contents of a bag and crush the waste to a fraction of 300 mm to the extent possible. After the waste is crushed, it is transported to a cylinder separator where waste is separated according to its fraction. Waste that is smaller than 80 mm passes through the cylinder mesh and is directed towards an electromagnetic separator to trap iron and towards a turbulent current separator to trap metal without iron. After undergoing metal filtering, all waste is directed towards a container where it will no longer be sorted. Waste larger than 80 mm enters the transporter and is carried into the 3 D device where it is sorted into two groups according to weight and size. One waste group is transported on conveyors to an area where it will be hand sorted by people who separate plastic, glass and metal from all the waste. After the waste is hand sorted, it is passed through a paper separator, thus separating paper which is sorted and removed from the general waste flow. The remaining waste is placed into a container where it will no longer be sorted. The second waste group is placed in an electromagnetic separator for trapping iron, then it is transported to an air separator where plastic and aluminium cans are removed from the general waste with the help of air. Remaining waste is directed towards a glass separator where glass is separated from the general waste and the remaining waste is then directed towards a container where it will no longer be sorted. Secondary waste which is biodegradable and suitable for further processing is moved from the air separator to the waste processing equipment.

Waste Incineration Plants

Different waste management regulations are applicable in different countries. Each country selects its own waste management method.

One of the methods is incineration of the collected waste at a specifically equipped plant. The electricity and heat produced during this incineration process are successfully applied for the city's utility needs as a source of renewable energy:

- ❖for production of hot water;
- ❖for household heating;
- ❖for production of electricity.

Such plants are widely operated around the world and help us reduce the amount of non-recyclable waste disposed of in the natural environment. Incineration plants are built in big cities generating large amounts of waste or such a single plant is built for servicing several towns located in a close range.

Incineration plants are safe and have no adverse impact on the environment because they are equipped by strictly following safety requirements. Any particles released within the process of incineration are retained by specially equipped filters.

Advantages of an incineration plant

- ❖Safe waste processing
- ❖Low operating costs
- ❖Maximum energy efficiency
- ❖Fast return of investment
- ❖Occupies a small territory
- ❖Does not emit unpleasant odours
- ❖Reduced gas emissions
- ❖There is no need for landfills

Facilities for Gas Extraction from a Landfill

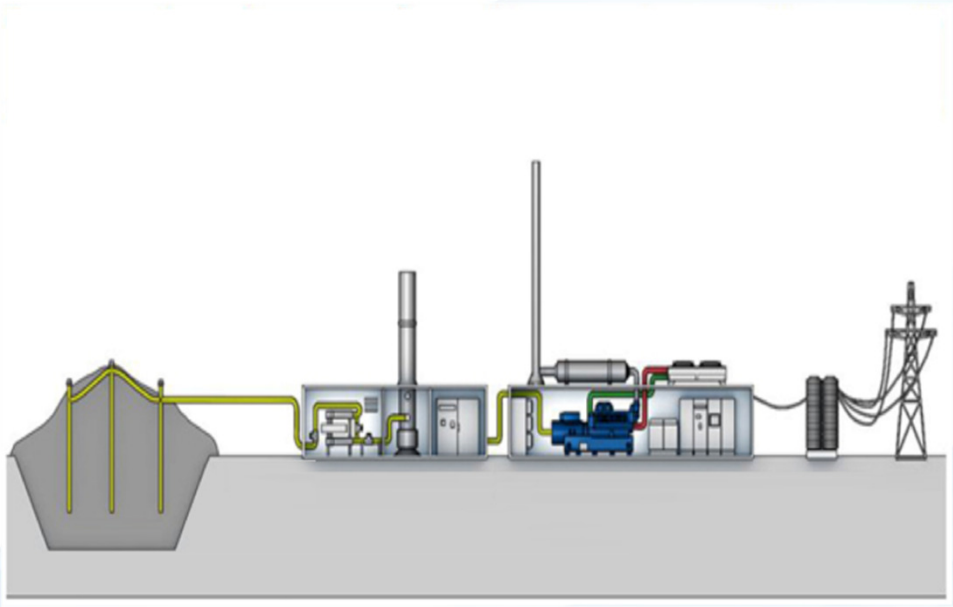
It has been a long-standing practice that all domestic waste should be brought directly to a landfill without recycling it and making piles of it. At that time nobody stopped to think about any potential hazards we would face and what negative impact this decision could have on the natural environment.
It was decided to extract gas from landfills and to use it as a form of renewable energy for production of electricity and heat in order to preserve the environment and reduce gas emission to the environment.

Any pile on a landfill consisting of unsorted waste is a huge biochemical reactor. Waste of vegetable and animal origin start decomposing due to anaerobic conditions inside of it resulting in production of biogas also known as landfill gas. Such processes start while the landfill is still operational and continue decades after it is closed. Therefore, these are long-term day-to-day processes. The composition of landfill gas may include many different trace elements. Certain concentrations thereof are toxic and dangerous.

Technical parameters of landfill gas: 1 m3 of gas

- Potential production of 1.5 kWh of electricity.
- Potential production of 2 kWh of thermal energy.

Landfill gas equivalent in comparison to natural gas is 0.8 m3.



At present there is a solution for gas extraction from a landfill. Wells could be drilled deeper into the pile in order to collect gas to be fed to a gas treatment plant where the gas would be treated and such treated gas could be fed to a generator. The gas would fuel the generator and it would produce electricity and heat to be supplied to the city's utility facilities.

IT, Automation, SCADA

It is necessary to automate the technological processes in order to reduce production and management costs and stabilize the production process. Installation of technological equipment management system results in saving not only costs (less staff is needed, thus the wage budget is reduced accordingly) but also in a more stable and more reliable technological process (automatic devices control operation of the equipment).

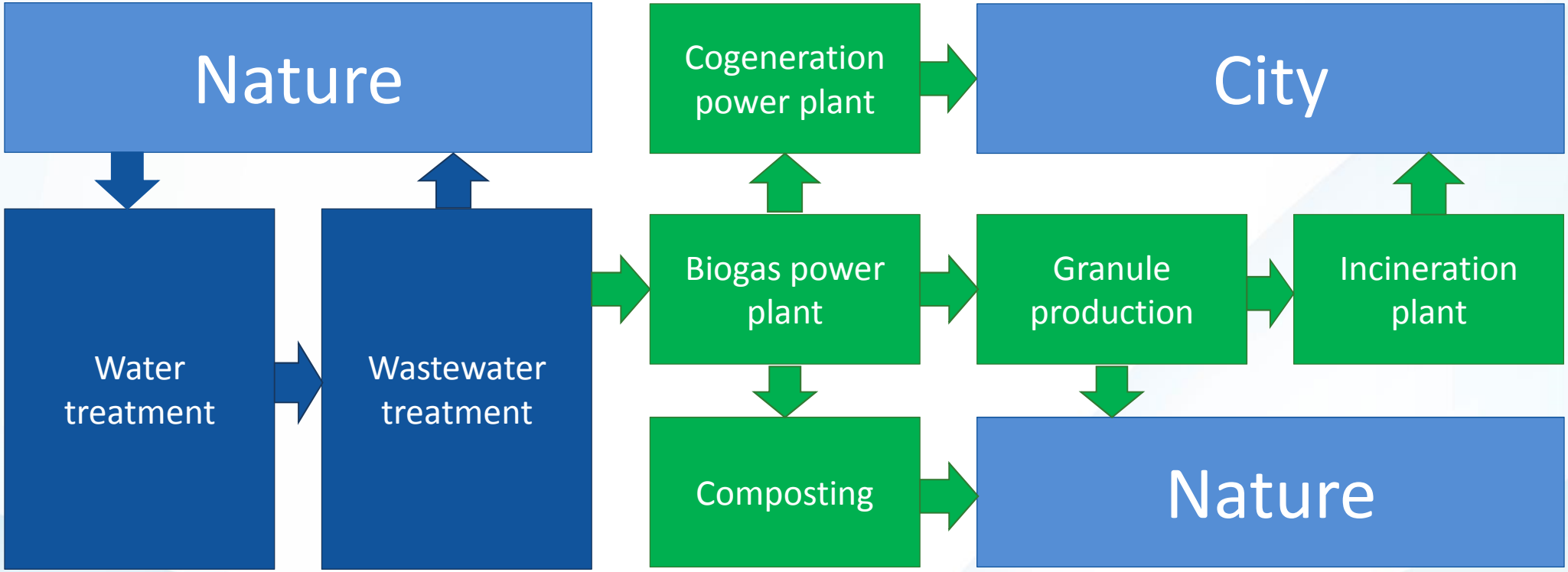
The whole technological equipment is integrated into a joint system. An algorithm is developed for the entire or a part of the equipment setting certain regulations for the equipment and how it should operate under certain conditions. This information is uploaded to the controller which is the heart of the entire process. The latter receives signals from individual devices and sensors, processes them, and sets further operation parameters for the equipment.

The information accumulated by the controller is transmitted to visualization program SCADA, which enables real-time: monitoring, control, management, collection, archiving, and displaying the data on operation of the technological equipment or the technological process on the computer. The operator is able to view the status of the equipment as well as change operation of the equipment without leaving the operator's control room. The program informs the operator about a faulty device by issuing a visual and audible signal.

Installation of SCADA software

- ❖On waste water treatment plants
- ❖On waste water pumping stations
- ❖On water purification plants
- ❖On waste processing plants
- ❖In the energy sector
- ❖At production companies

Water – wastewater management scheme



Proposed waste management scheme