PAKU Technology by Endev

Thermal treatment of sludge and phosphorus recovery process

14.6.2018

ENDEV BASIC INFO

- Endev is a Finnish cleantech company. The PAKU technology has been developed together with the Lappeenranta Technical University.

- The Endev team has over 100 years of combined experience in developing thermal processes for drying and combusting in energy and environmental applications

- Endev´s innovative PAKU solution has been developed for a local, **efficient and affordable** way of handling municipal sludge. The solution is an odorless, exothermic, and non-pressurized application which **does not require modifications to current wastewater treatment processes**. The solution is also applicable for treating biogas production digestate.

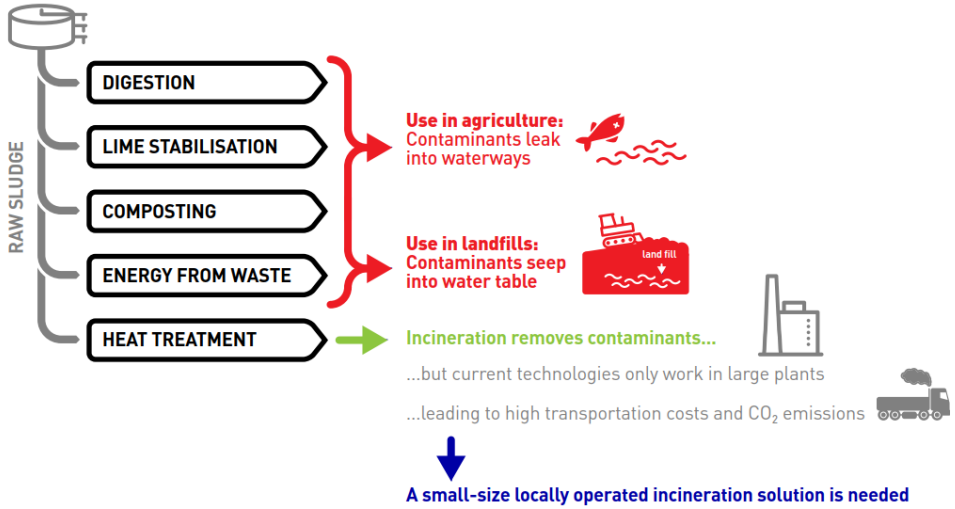
- Endev Ltd is owned by the founders, private investors and Lappeenranta University´s investment company Green Campus Innovations.

HANDLING MUNICIPAL SLUDGE IN THE EU AND GLOBALLY

- The EU fertilizer regulation proposal 2016 favors thermal treatment. Primarily guiding effect - no absolute restrictions.
- Later the largest European malt producer Viking Malt has prohibited the use of crops grown on sludge in their products. Similar instructions have come elsewhere as well for example from the Sustainable Agriculture Initiative SAI where companies like McDonalds and Arla are members.
- The development happens faster with market drivers than through regulation. The governing factors are first and foremost the precautionary principle, cost effectiveness and logistic challenges.
- **The most important reason for moving to thermal treatment / incineration is to prevent circulation of unwanted compounds, secondly stopping harmful nutrient circulation and thirdly extracting and utilizing nutrients (mainly phosphorus). Also in big cities the question of transportation and available land for landfill is remarkable.**

WHY WE CAN NOT CONTINUE THIS WAY

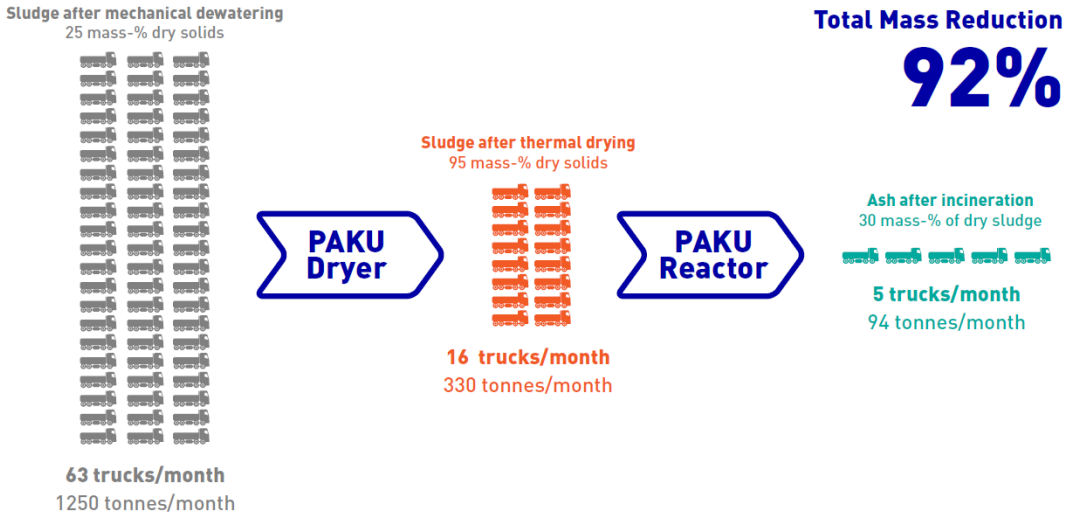
- Waste water treatment plants are not planned to remove unwanted compounds that come from households, dump sites, rain water and the industry.
- Medical residues and hormones already disturb for example the breeding of fish also in Finland.
- Microplastics are found in increasing numbers from aquatic life, food and even humans.
- Spreading sludge and its harmful components on land has unknown effects on organisms and the soil itself and is therefore a risk.



GREEN CAMPUS INNOVATIONS

PAKU – THE CLEAN SOLUTION

- The PAKU technology is a patented wastewater sludge nutrient and energy recovery facility developed by Endev Ltd and Lappeenranta Technical University.
- Due to the technology the mass of the sludge from the wastewater treatment plant is reduced significantly, over 90% of the mass disappears in the combustion.
- From the remaining ash 95% can be used in making fertilizers
- In the PAKU treatment microplastics, drug residues, hormones and some of the heavy metals can be removed.



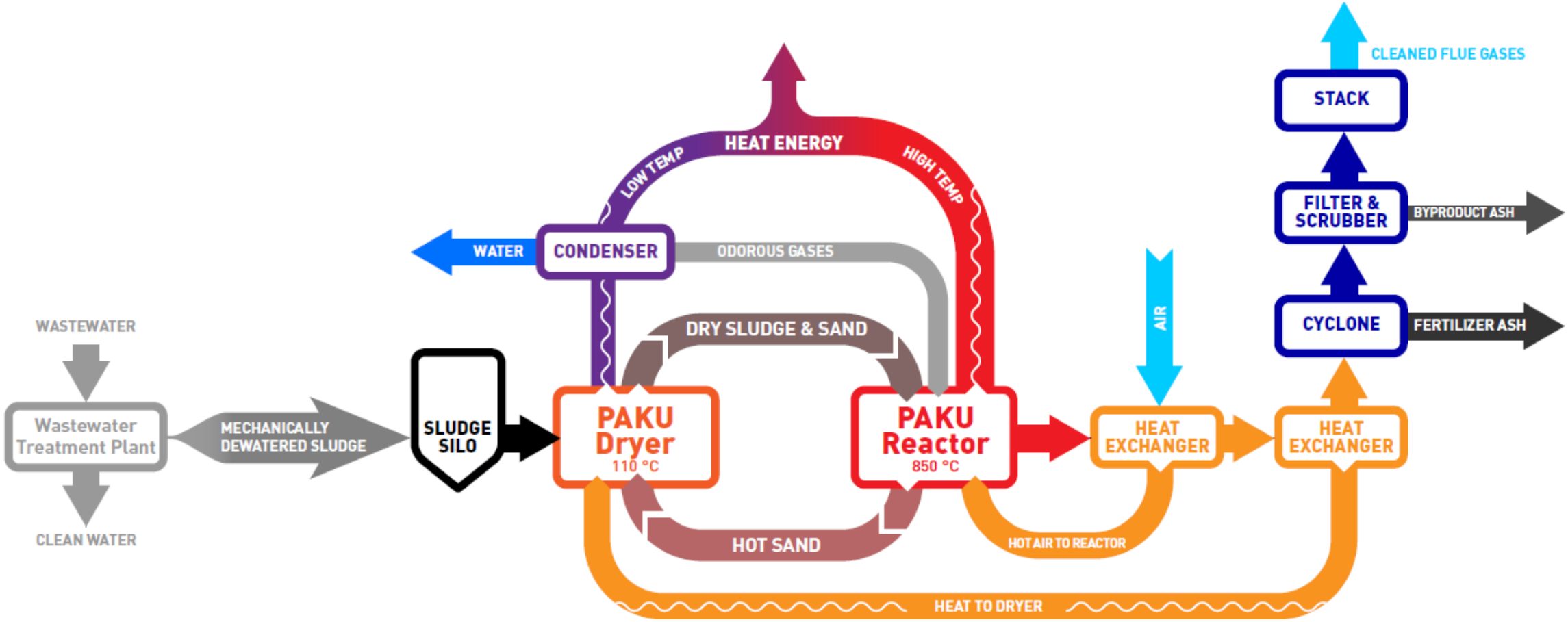
GREEN CAMPUS INNOVATIONS

THE PAKU TECHNOLOGY

- The PAKU solution consists of the **patented circulating mass dryer and reactor**
- The process will be fully automated and function 24/7
- With the PAKU technology both the sludge and the digestate from biogas production can be handled. In the future also industrial sludges could be utilized.

In the PAKU process the organic matter is burned in the circulating mass reactor in **over 850 ℃ for over 2 seconds**. The energy from the combustion is utilized in the circulating mass dryer where the sludge is dried to over 95 % dry matter content before being fed into the reactor. **The process is self sustaining when the dry matter content of the sludge is over 20 %.** The odorous gases from the drying are also fed into the reactor.

THE PAKU TECHNOLOGY



*A simplified picture of the PAKU process

GREEN CAMPUS INNOVATIONS

NUTRIENT RECOVERY

- Also nutrients are harmful when they end up in the wrong place such as bodies of water causing eutrophication
- In Finland around 40 – 50 % of the municipal waste water sludge has ended up in agricultural use
- Municipal waste water sludge contains for example medical residues, microplastics, drug residues, flame retardants and hormones
- When sludge is used in landscaping some of the nutrients and harmful components end up in nearby bodies of water with the rain
- In addition to the main nutrients phosphorus and potassium sludge ash also contains other nutrients such as calcium, magnesium, borium, iron, zinc, copper, manganese.
- With the PAKU technology a significant part (20%) of the nitrogen from the dryer condensate can be extracted

NUTRIENT RECOVERY

- In the future phosphorus can be gathered with urban mining from three main sources: cattle manure, municipal waste water sludge and bone-meat meal from butcheries.
- The problem is the harmful components in the sludge such as medical residue that cannot end up in fields, forests or bodies of water.
- With the PAKU technology the phosphorus can be utilized from the ash so that organic compounds and medical residue is destroyed.
- Studies of the ash are being made together with Natural Resources Institute Finland, Finnish Environment Institute and Finnish Food Safety Authority

UTILIZING THE ENERGY

- In addition to the nutrients the PAKU facility also recovers energy from the sludge
- Around 1 MWh of thermal energy is formed per ton of sludge
- The dry matter content of the sludge affects the quality of the thermal energy
- The heat can for instance be used in district heating
- In warm countries it can be used to produce district cooling
- Depending on the need the heat can also be used in buildings, to vaporize nitrogen or in biogas processes
- The PAKU technology is very cost efficient and with the profit from the energy production the facility's use and maintenance can be covered

THE MARKET FOR THE PAKU TECHNOLOGY

- In the western societies one person produces 0,2 metric tonnes of sludge per year. The sludge handling cost in Finland is around 60 €/tonnes. In many areas in Germany it is 80 €/tonnes and in some parts of China already closer to 40 €/tonnes. In all the mentioned countries the price is growing.

- Additionally densely populated areas push for a local and compact handling as the transport trucks do not fit in the traffic.

- The technology also has the potential to treat digestate from biogas production

- Other possible areas are industrial sludges (for example coal industry and forestry) and bioethanol production.

PAKU TO THE CITY OF ROVANIEMI

Starting point:

- The current sludge handling based on composting has become problematic for Napapiirin Energia ja Vesi (Energy and water company of the city of Rovaniemi - NEVE) due to odor problems and stricter regulation

Goals:

- End the current chemical cycle
- Utilize nutrients like phosphorus and nitrogen and prevent it from seeping into the environment
- Utilize the energy in the sludge
- Find a cost effective alternative because the payers are the citizens of the city of Rovaniemi

PAKU TO THE CITY OF ROVANIEMI

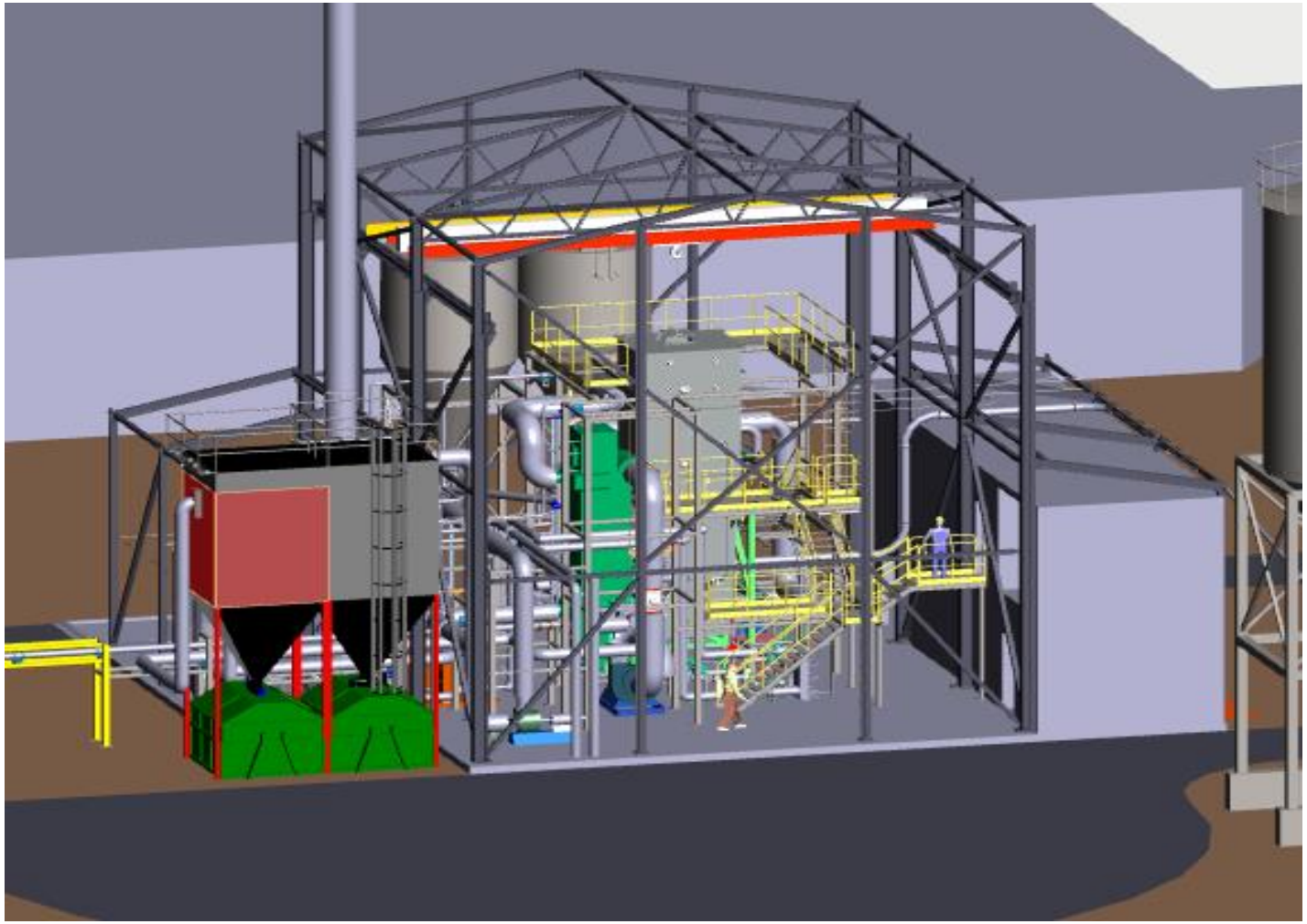
Solution:

- Build a PAKU facility close to the current NEVE (Energy and water company of the city of Rovaniemi) wastewater treatment plant.

Results:

- By heating the sludge to 850 degrees the harmful compounds are destroyed
- The odor problems disappear with the odorless sub atmospheric PAKU process
- The phosphorus rich ash can be utilized in the NEVE fertilizer factory as an ingredient
- The thermal heat is utilized in district heat and is enough to warm 300-400 houses
- With complying to future regulations no additional costs for handling the sludge are expected
- As a government key project it leads the way for the rest of Finland.

Rovaniemi PAKU plant



The test facility in Pyhtää

Became operational in february 2018

GREEN
CAMPUS
INNOVATIONS