

TerraNova® Ultra

The innovative path to sewage sludge utilization
Cost-efficient and forward-thinking



- economical
- environmentally friendly
- energy efficient
- proven and awarded technology






From sewage sludge to bio-char



TerraNova® Ultra for middle-sized and large sewage treatment plants



Sewage sludge utilization instead of expensive disposal: Recover energy and use nutrient matter

1. The situation

Sewage sludge in Germany: High costs without utilization

In Germany around 10 million tons of sewage sludge are resulting from efficient wastewater treatment per year¹. Sewage sludge represents energy- and nutrient-rich biomass with high water content. In spite of this, system operators have until now focused more on disposal than on value utilization, and they do so in the face of high economic and ecological challenges. The economically and ecologically sensible exploitation of sewage sludge, which has in the medium-term become necessary, still plays only a nominal role in practical application.

The need for action is revealed by just a few facts:

- Disposing of sewage sludge in Germany costs around 400 million Euros per year²
- The current predominant practice of burning sewage sludge has a negative energy and CO₂ balance³ – the term "thermal reutilization" is therefore a glossing-over.
- In most cases, incineration also rules out recovering nutrients and is by far the most expensive solution.
- The foreseeable ban on fertilizing farmland closes off a disposal channel that is currently used for around one-third of sewage sludge and is already controversial at the least due to pollution.

That means a method that will enable economic reutilization of sewage sludge is needed. This method, in comparison to the status quo, ideally should

- convince the system operators of the cost advantages
- avoid the emission of harmful substances to the environment
- enable efficient recovery of nutrients
- make the energy contained in the sewage sludge useable, instead of requiring extra energy for safe disposal
- be used in a decentralized way in order to minimize the amount of expensive and ecologically problematic sewage sludge transport
- be integrated with little cost and effort into any sewage treatment system without interfering with the treatment process

With its TerraNova® Ultra method, TerraNova Energy has developed a solution that meets all of these requirements.

This method is based on Hydrothermal Carbonization (HTC), which effectively dewateres biomass and "transforms" it into biochar.

TerraNova® Ultra can point today to successful long-term operation in many international sewage treatment plants. In addition, functionality and usage of the publically-sponsored and award-winning TerraNova® Ultra method has been studied and verified in many studies.

2. The technology

The TerraNova® Ultra technology: Sewage sludge + HTC = energy + nutrients – costs

The TerraNova® Ultra HTC-based system involves a technology that mimics natural coal creation and very significantly accelerates it.

To do so, sewage sludge is "carbonized" for two hours at a temperature of approximately 200° C and under a pressure of 20 to 35 bar, excluding air; this process transforms it into a fuel much like lignite coal.

This fuel, in contrast to sewage sludge, contains hardly any water. Thanks to its high energy content it can be burned to generate energy in lignite coal power plants or to lower the energy requirements in cement plants or waste-incineration plants.

As an additional product, HTC also yields the water extracted from the sewage sludge. This HTC filtrate is low in pollutants, sterilized, and nutrient-rich, because it contains a large proportion of phosphorous from the waste. The phosphorus is recovered as part of the process and can be used as particularly rich organic fertilizer, which has been proven in real-world comparisons with common commercial fertilizers.

In this way, the TerraNova® Ultra method meets all the criteria for economically efficient and ecologically sustainable use of sewage sludge.

¹ Two million tons of dry matter per year: Sewage sludge disposal in the Federal Republic of Germany, German Federal Environment Agency, 2012, p. 5

² Estimate of: Sewage sludge disposal in the Federal Republic of Germany, German Federal Environment Agency 2012, pp. 50, 51, 57

³ Sewage sludge disposal in the Federal Republic of Germany, German Federal Environment Agency, 2012, p. 22

3. The advantages

Particularly economical:

At 45 Euros/ton, reutilization is more economic than disposal by incineration, and the cost savings increase with the scale of the system.

The costs for disposal or utilization of sewage sludge depend on different variables. These include the size and the technological equipment of the sewage treatment systems, the type of dewatering chosen, and the accessibility of the incineration systems.

According to the German Federal Environment Agency, the costs for disposing of sewage sludge through incineration, are between 50 and 120 Euros per ton, depending on the type of incineration. With costs per ton between 25 and 45 Euros, agricultural disposal is cheap in comparison⁴. However, a political aim has been declared to close this disposal method in the foreseeable future.

Against this backdrop, sewage sludge treatment with the TerraNova® Ultra method is also economically the best solution due to its cost savings. Even at an annual sewage sludge accumulation of 8,000 tons (which corresponds to a system for approx. 100,000 inhabitants), the total cost (CAPEX + OPEX + Disposal of residues) is only about 45 Euros per ton of dewatered sewage sludge. The costs are even lower for larger systems, and by reusing the recovered phosphorus the economic efficiency is even greater.

That means that even today sustainable reuse of the sewage sludge based on the TerraNova® Ultra method is already more cost-effective than disposal by incineration in almost all cases.

CO₂-neutral energy – Savings in certificate costs

TerraNova® Ultra runs without releasing harmful climate gasses to the greatest possible extent. The biochar produced through HTC is a CO₂-neutral energy source because only the quantity of CO₂ that was taken out of the environmental cycle during the biomass growth phase is released when it is burned.

Therefore, during combustion of the biochar obtained through the TerraNova® Ultra method, recyclers can count on a CO₂ credit. Because its fuel value is similar to that of German lignite coal, biochar prevents the carbon dioxide emissions associated with lignite coal.

If a city with 100,000 inhabitants, for example, implements the TerraNova® Ultra method in its sewage treatment plant, annual emissions of CO₂ are lowered by 1,220 tons⁵

– which is more than one square kilometer of forest can extract from the atmosphere!

Particularly environmentally friendly.

Pollutants are cracked, burned, or filtered out – and nutrients are reused

Sewage waste always contains a great deal of toxic material. Alongside heavy metals, which are introduced to the sewage treatment system mostly through rainwater, there are highly toxic organic toxins such as dioxins and halogens, pathogens such as bacteria, viruses, parasites or worm eggs, and, in increasing quantities, pharmaceutical remnants that increasingly accumulate in the sludge due to ever-improving sewage treatment methods.

The TerraNova® Ultra technology runs under the exclusion of air at approx. 200° C and under a pressure of more than 20 bar. This process ensures that the toxins in the sewage sludge are destroyed or can be disposed safely.

- Non-organic toxic waste such as heavy metals are bound to the biochar and safely disposed through incineration in suitable systems.
- Organic toxic compounds, such as pharmaceutical residues, are largely chemically destroyed and lose their toxicity.
- The biochar is sterilized by the high temperature and the pathogens are completely killed off.
- No creation of dioxins.

Phosphorous - Recovery of a scarce, yet indispensable resource

While the demand for Phosphorous is continuously increasing for fertilization and food production for the world population, the natural resources are limited. Sewage sludge is one of the most important sources for recovered Phosphorous - yet barely used.

Within the TerraNova® Ultra process Phosphorous can be leached from the solid phase of the sewage sludge and extracted easily by the addition of natural minerals. The resulting product is a granulated Phosphate fertilizer that already complies to the newest fertilization regulations.

⁴ Sewage waste disposal in the Federal Republic of Germany
German Federal Environment Agency 2012

⁵ When substituted for lignite coal in, for example, cement plants, 0.36 tons of CO₂ per megawatt hour, the CO₂ debit of the TerraNova® Ultra method, are already taken into account

Particularly energy-efficient.

Sludge incineration takes energy –
TerraNova® Ultra makes sewage-sludge energy usable

As it is commonly done today, incinerating sewage sludge requires about the same amount of energy as can be released from the sewage sludge itself. This is because of the enormous amount of energy needed to vaporize the water in the sewage sludge. In the overall process, then, no energy is gained; instead, in many cases, additional energy must be fed in.

With TerraNova® Ultra, in contrast, approx. 90 percent of the water is mechanically extracted from the sludge in a highly efficient dewatering process. The end result, when the sewage sludge is burned, is an energy gain of 425 kWh per ton.⁶

Using a TerraNova Energy system at a sewage treatment plant for 100,000 inhabitants can therefore generate approx. 3,400 MWh of environmentally-friendly energy per year.

TerraNova® Ultra – a big step in the direction of energy autonomy for sewage treatment plants

Combined with sludge digestion, the TerraNova® Ultra method has three additional, unique, and inspiring advantages:

- The waste heat from the cogeneration plant alone can completely cover the process heat demand of the TerraNova® Ultra system
- It also increases the quantity of the biogas and therefore the power generated by the cogeneration plant by 10 percent, which can be used to feed energy directly to the sewage sludge treatment plant.
- Compared to the technology commonly used today, the energy efficiency of the entire sewage sludge treatment process leading up to safe thermal disposal can be improved by up to 80 percent⁷.

4. References

Recognized and awarded –
Researched and proven in real-world applications

The Hydrothermal Carbonization (HTC) method was described by the German chemist Friedrich Bergius in 1913, and for it he was awarded the Nobel Prize for Chemistry in 1931. Based on his work, the Terra Nova Energy engineers have developed HTC into an effective and energy-efficient method for sewage sludge reutilization.

The results achieved by taking this path impressed external experts as early as the design phase, which is why the TerraNova® Ultra method was sponsored early on by the Federal Ministry for Education and Research. In 2011, TerraNova Energy was also one of the winners of the environmental innovation program from the Federal Environment Ministry, and in the same year it won an award from the German Federal Government and the "Deutschland – Land der Ideen" (Germany – Land of Ideas) community initiative founded by the Federation of German Industry (German abbreviation: BDI) as a "Selected Landmark". As an example of a highlight of environmental technology and "Made in Germany" resource efficiency, the method was included in the Federal Environment Ministry's GreenTech atlas in 2012.

2015 TerraNova Energy was awarded with the renowned "Innovationspreis der deutschen Wirtschaft", the first innovation award in the world.

The TerraNova® Ultra method has proven itself through many years of continuous operation on many sewage sludge treatment plants of varying size. 2016 TerraNova Energy successfully set the first commercial TerraNova®Ultra plant in Jining/China in operation.

⁶ Sewage waste with 20% dried matter, upper fuel value of HTC fuel 16 MJ/kg (2.6 kWh/kg after dewatering), 75% mass efficiency and 130 kWh/ton processing energy requirement of the TerraNova Ultra method. The energy overage is reduced to approx. 220 kWh/ton when reutilizing digested sewage sludge.

⁷ *Ganzheitliche Energie- und Treibhausbilanz von Entsorgungsketten kommunaler Klärschlämme mit hydrothormaler Carbonisierung* (Comprehensive Energy and Greenhouse Balance from the Disposal Chain of Communal Sewage Waste with Hydrothermal Carbonization; Remy, Warneke, Lesjean, 2014)

Reutilization of sewage sludge in comparison:

State of the art technology

TerraNova® Ultra

Cost		< 45 EUR/ton
Negative energy balance		Positive energy balance
Harmful to the environment		Elimination of harmful materials Recovery of nutrients