

SkyClean

Carbon capture and bioenergy



Let's clean up Earth's atmosphere

The carbon negative paradigm shift

Solving the climate crisis cannot be achieved by reducing CO₂ emissions alone but also requires large-scale application of technologies that can remove CO₂ from the atmosphere. To achieve this, we need a low-cost technology with a huge potential, preferably one that also supplies multiple hard-to-abate sectors with carbon-neutral fuels.

SkyClean is precisely such a technology. The SkyClean process uses pyrolysis to create biochar as well as bioenergy from plant waste. Biochar is a stable material with the dual advantage of effectively removing and storing CO₂, while also serving as a soil enhancer for agriculture. SkyClean's bioenergy production represents a valuable revenue stream, effectively making SkyClean the only commercially viable carbon capture and storage technology available.

Ready to scale and deliver

Stiesdal Fuel Technologies has developed the SkyClean process to create a fully automated unit that can be manufactured by industrial processes. At the core of the technology is a robust pyrolysis reactor capable of transforming almost any kind of biogenic feedstock into biochar and biofuels. The biofuels can be supplied in the form of gas, bio-oil, and optionally as downstream refined products such as methanol.

All components of a SkyClean unit are designed for mass production, facilitating rapid ramp-up. With its combination of industrialized low-cost components and relatively low-tech setup, SkyClean is the lowest cost large-scale carbon capture and storage technology available. Adding to this is the soil improvement potential of biochar, which ultimately begs the question: "When can we get started on cleaning up Earth's atmosphere?"

"The lowest cost, large-scale climate mitigation technology"



Fully automated pyrolysis production: Stiesdal SkyClean has developed a fully automated process plant capable of transforming almost any kind of biogenic feedstock into biochar and biofuels. The above image is from the 2 MW SkyClean plant in GreenLab, Skive.



Pyrolysis treats multiple types of biomass: SkyClean pyrolysis can convert almost any type of organic waste into valuable biochar and fuel products. The list of suitable SkyClean feedstocks includes all the major types of waste from agriculture and forestry, enabling the application of the concept on a truly global scale.



Energy value stream: SkyClean pyrolysis produces gas and other energy products that can replace fossil fuels with carbon-neutral green energy.



Biochar value stream: SkyClean pyrolysis produces high-grade, tar-free biochar suitable for spreading on farmland. Once stored in the soil, SkyClean biochar is a tradeable stable carbon sink.

Delivering high-impact climate action

How SkyClean works

The core of SkyClean is a pyrolysis process in which organic waste from agriculture and forestry is converted into biochar, gas, and oil by subjecting it to high temperatures without the presence of oxygen.

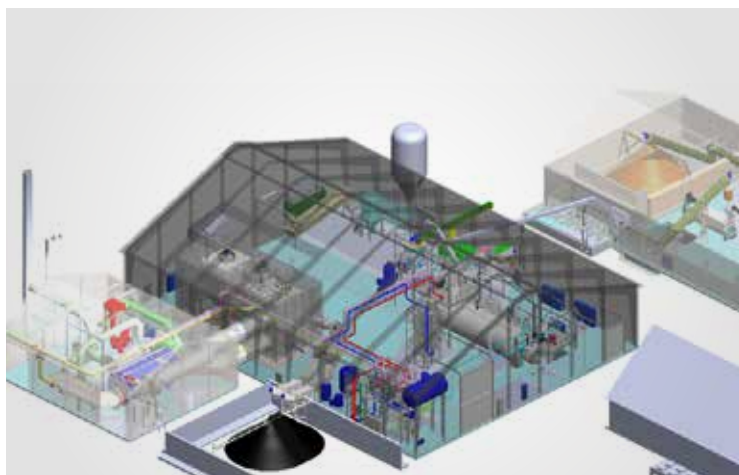
Dry plant material typically contains approximately 50% carbon that plants have extracted from the atmosphere in the form of CO₂. In the process, half of the carbon content of the biomass is converted to biochar, and thus effectively removed from the atmosphere, while the other half is converted into carbon-neutral oil and gas, applicable as green fuel in various economic sectors.

Robust and reliable pyrolysis

SkyClean pyrolysis plants are designed for reliability. The operating temperature is kept at a maximum of 650° degrees Celsius. Feedstocks are dried and pelletized, facilitating a smooth and controlled production as well as a uniform biochar product.

20 MW standard pyrolysis units

The standard SkyClean pyrolysis unit size has a capacity of 20 MW, calculated as the hourly calorific value of the biomass that the plant processes. A 20 MW unit will process approximately 40.000 tons of dry feedstock annually.



Certified biochar

SkyClean Biochar has been certified by the European Biochar Certificate (EBC), which is a voluntary industry standard for biochar in Europe.

Tar-free: SkyClean's specialized thermal conversion process results in a tar-free biochar that is monitored as part of the EBC certification process.

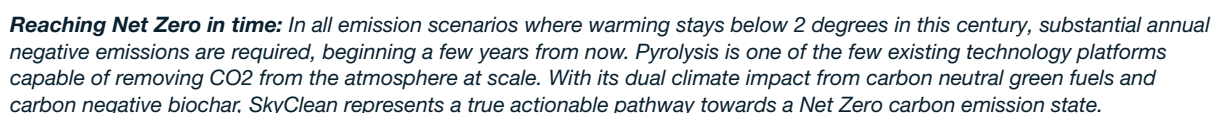
No toxins: With regard to heavy metals and toxic substances such as dioxins and dioxin-like PCBs, SkyClean biochar is certified below all relevant threshold values.

Long term carbon sink: The high-grade quality of SkyClean biochar ensures that 75-90% of the biochar carbon will persist after soil application for more than 1000 years, independent of the soil type and climate.

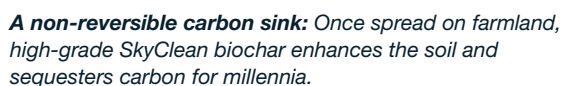


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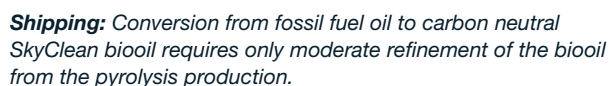
Source: UNEP Emission Gap Report 2017



The production of SkyClean biochar is audited under the EBC Carbon Sink Certification, where the carbon content of the biochar is monitored, and the full carbon footprint of production and delivery is deducted from the biochar's carbon sink value. This ensures a credible high-value product in the carbon dioxide removal (CDR) market.



The heat, gas and oil produced by the SkyClean process substitute fossil fuels and represent a stable, locally sourced energy supply. Combined with the carbon negative effect of biochar, SkyClean's fuel products are a pathway to game-changing, net zero emissions for hard-to-abate sectors like transportation, agriculture, and industry.





SkyClean green fuel processing options

SkyClean unlocks the biogenic carbon in the feedstock biomass and converts it into green fuel. SkyClean has 3 downstream processing options:

Option 1, production of gas. The pyrolysis gas can be used to replace natural gas for heating and industrial processes. The pyrolysis gas can also be used to heat a boiler and extract energy as steam for industrial processes.

Option 2, production of bio-oil. Gas can be cooled to produce thick bio-oil that can be used as a substitute for heavy fuel oil or processed in a refinery to produce different fuels. This method can convert up to 50% of the gas into liquid fuels.

Option 3, fuel production via methanol. A third method for processing gas involves heating it to around 1000°C in a 'cracker'. This splits the long carbon chains into smaller pieces, resulting in a synthesis gas. By adding extra hydrogen to the mixture, methanol can be produced for various purposes, including the production of aviation fuel and plastic.

40.000

Tons dry feedstock required annually for a 20 MW plant

15.000

Tons biochar in annual production from a 20 MW plant

40.000

Tons CO₂. Total annual climate effect of a 20 MW plant

The Stiesdal approach

At Stiesdal, we define ourselves by our ability to innovate with impact.

The Stiesdal Company was founded with the purpose of developing and commercializing technologies that have major impact on mitigating climate change. This purpose is fundamentally rooted in a conviction that more needs to be done, and that real impact can be achieved through innovation.

The creation of jobs is an additional and highly important purpose of the Company. Our aim is to positively impact and benefit local communities and to think job creation into our activities.

We pursue innovative solutions that are suitable for industrialization in the belief that cost reduction is the strongest single driver of clean technology implementation.

Our approach is therefore the same across all our technologies. To achieve true impact, we always strive for game-changing levels of cost reduction. We continuously challenge ourselves, questioning what it takes for every aspect of every technology to become the cheapest without sacrificing on safety or performance.

We know from experience that volume and scale are the ultimate cost-cutting factors, which is why we optimize all our solutions for standardization and modularization to achieve streamlined industrial processes and mass production.

No new technology leaves our design offices, laboratories or workshops without a clear strategy for industrialization. If an innovative technology promises to make meaningful impact on the decarbonization of society, it must be ready-to-scale from the very beginning. This is the path that gives innovation true impact. And this is what lies in our DNA.



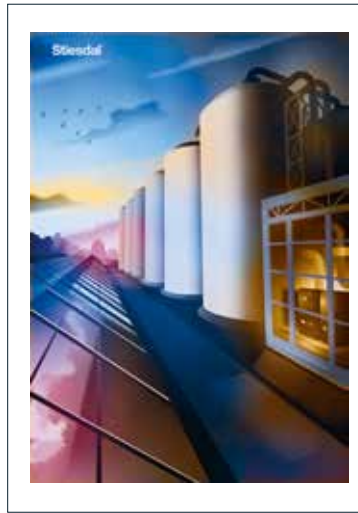
“Innovation with impact. It is in our DNA”



Stiesdal Offshore

Target: Unlimited low-cost offshore wind energy made globally available.

Means: The modular Tetra foundation concept, the world's first industrialized floating wind foundation.



Stiesdal Storage

Target: Firm power and energy security from renewables.

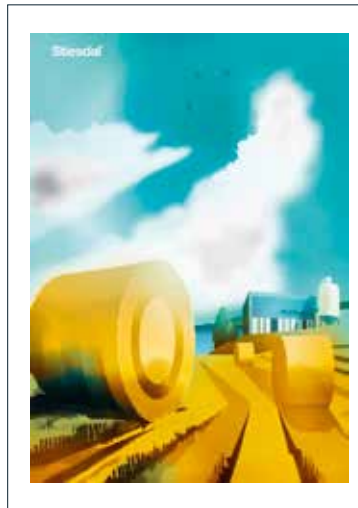
Means: The GridScale thermal energy storage system with 10 hours to 10 days capacity.



Stiesdal Hydrogen

Target: Application of renewable electricity across all sectors.

Means: The HydroGen electrolyzer unit for low-cost green hydrogen production.



Stiesdal SkyClean

Target: Affordable carbon capture and sequestration.

Means: The SkyClean system combining green fuel production and carbon capture and sequestration.



Stiesdal®

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