

Ensure a sustainable future
by replacing fossil carbons
with biocarbon

Dr. Gang Xin, CTO and co-founder



24-25 janv/jan 2024 Nantes FR



→ l'événement Biotransition / the Biotransition event

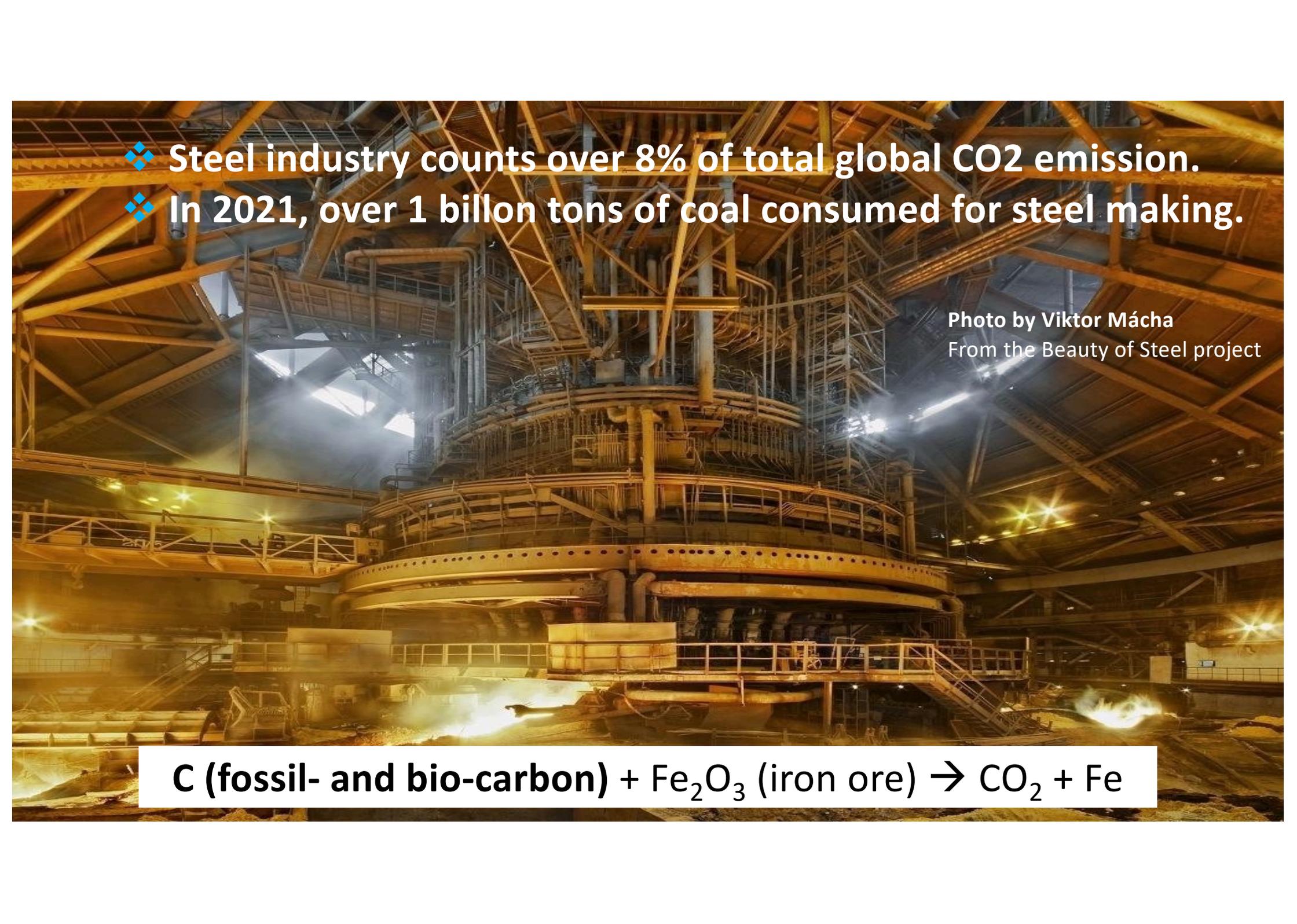
- 
- ❖ Steel industry counts over 8% of total global CO₂ emission.
 - ❖ In 2021, over 1 billion tons of coal consumed for steel making.

Photo by Viktor Mácha
From the Beauty of Steel project



Steel Industry Pain Points

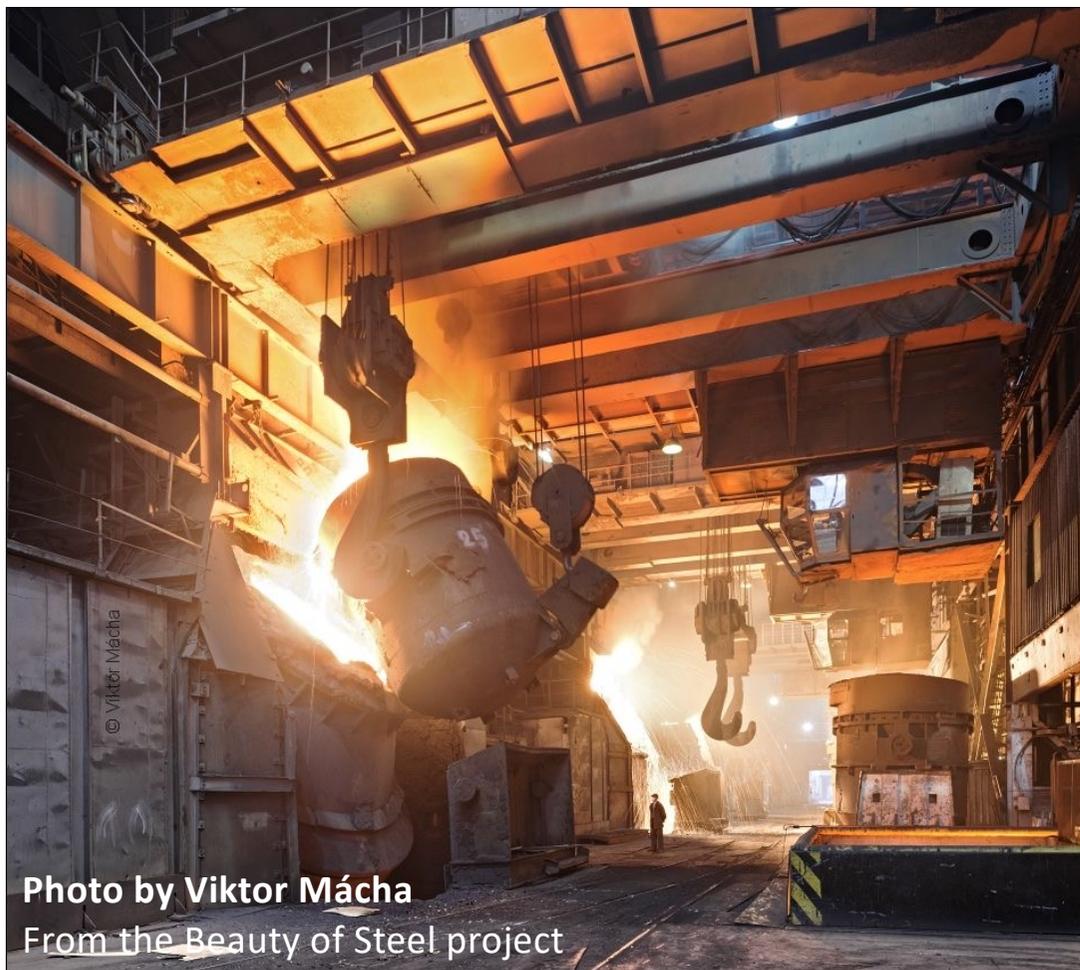


Photo by Viktor Mácha
From the Beauty of Steel project

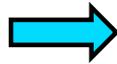
- ❖ Free allowances in the Emission Trading System (ETS) are phasing out
- ❖ Carbon Border Adjustment Mechanism (CBAM) has phased in
- ❖ Converting to green hydrogen as reductant is the main trend but very costly
- ❖ Carbon Capture and Storage (CCS) from exhaust gas is an alternative but not an ultimate solution

Biocarbon Replaces Coal for Direct Decarbonization

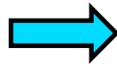
~300 million m³ sawmill by-products
~1950 million m³ energy wood
produced globally



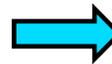
Energy wood



Biochar/biocarbon powder



Charcoal chunk



220 million-ton biocarbon pellet potential
with the total available forest residues



❖ Each ton of biocarbon can reduce 3.3 tons of CO₂ emission and can replace 1-1.3 tons fossil carbon

Fossil Carbon Usage in Steel Making Processes

PCI coal as reductant

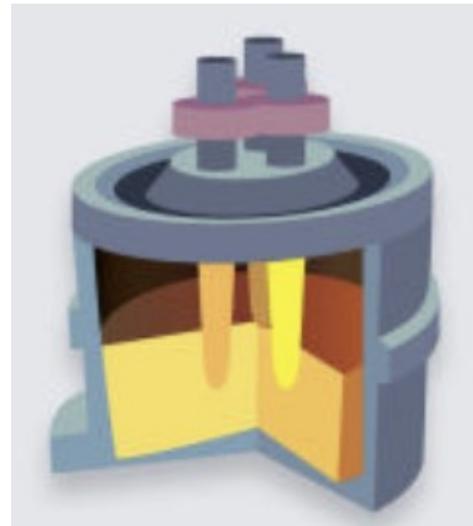
Charge coke as reductant



Blast furnace

In BF process, 0.6-0.7 ton fossil carbon to make 1 ton steel → **900 million ton per year**

In EAF process, 12 kg fossil carbon to make 1 ton steel → **6 million ton per year**



Electric arc furnace

PCI coal as slag forming agent

Charge coke as carburizer

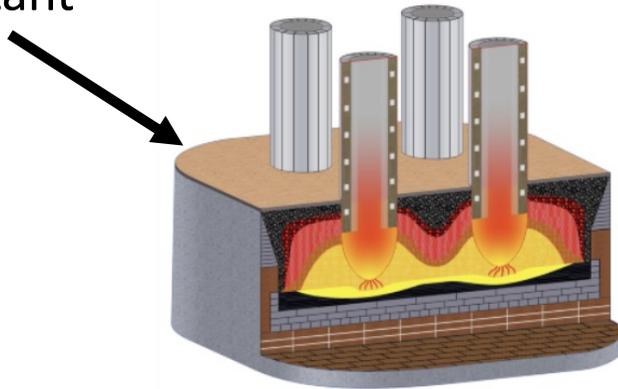
Fossil Carbon Usage in Ferroalloy Processes

Ferroalloy industry is 5% of the entire metallurgical industry market size.

Some ferroalloy making processes, such as FeSi, FeMn, FeCr, Al, cannot use hydrogen/natural gas as reductant.

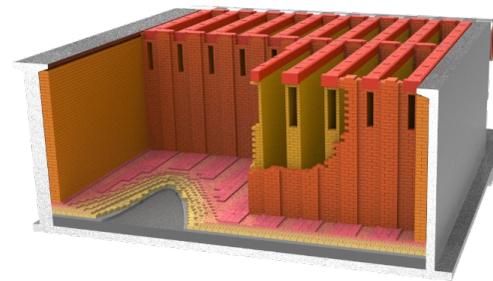
Total fossil carbon usage in ferroalloy industries → **80 million ton per year**

Charge coal/coke
as reductant



Electric submerged arc furnace

Calcined petroleum coke
(CPC) as packing material



Anode baking furnace

Product Series Meet Different Needs Cross Metallurgical Sectors



The advertisement features a green background with the WAI logo in the top right corner. The main title 'WAI Injection biocarbon' is prominently displayed. Below the title, three buttons are arranged horizontally: 'Injection biocarbon' (green), 'Charge biocarbon' (blue), and 'Biocarbon premium' (purple). A central image shows a pile of dark, cylindrical biocarbon pellets. Below the image, the text 'φ6MM' is visible. At the bottom, a white box contains contact information: '• ADD: Carl 15 gate 19, 3150 Tolvsrød', '• Mobile: +47 99469080', and '• Website: www.waies.no'. The footer includes the WAI logo and the text 'WAI Environmental Solutions AS' flanked by navigation arrows.

WAI Injection biocarbon

Injection biocarbon Charge biocarbon Biocarbon premium

φ6MM

- ADD: Carl 15 gate 19, 3150 Tolvsrød
- Mobile: +47 99469080
- Website: www.waies.no

WAI Environmental Solutions AS

Injection Biocarbon (IBC)

IBC is designed for meeting requirements for steel industry.

- ❖ Target market: blast furnaces in steel industry
- ❖ Market size: > 900 million ton/year but shrinking

Charge Biocarbon (CBC)

With superior physical and thermal strength, CBC is formulated for meeting long-term needs in metallurgical industries.

- ❖ Target market: electric arc furnace in steel and ferroalloy industries
- ❖ Market size: > 100 million ton/year and increasing

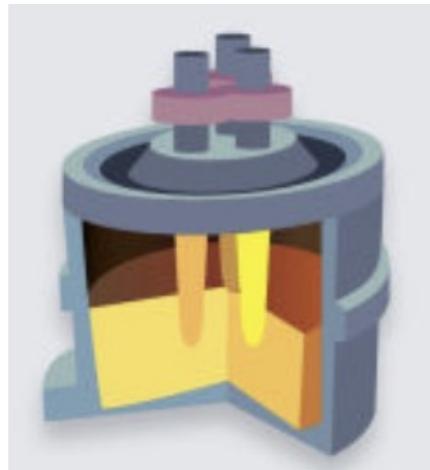
Biocarbon for Fossil Carbon Replacement

Carbon negative bonus: carbon storage when used as carburizer in EAF



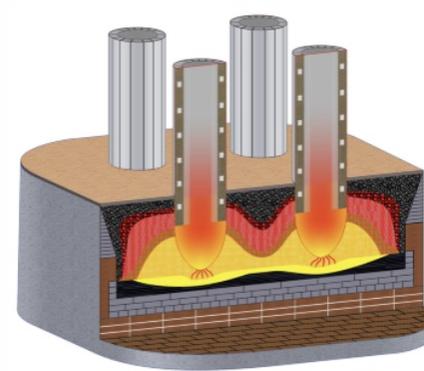
BF

**Injection Biocarbon
Charge Biocarbon**



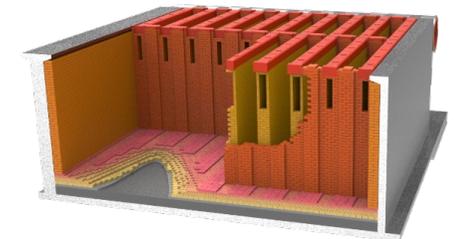
EAF

**Injection Biocarbon
Charge Biocarbon**



SAF

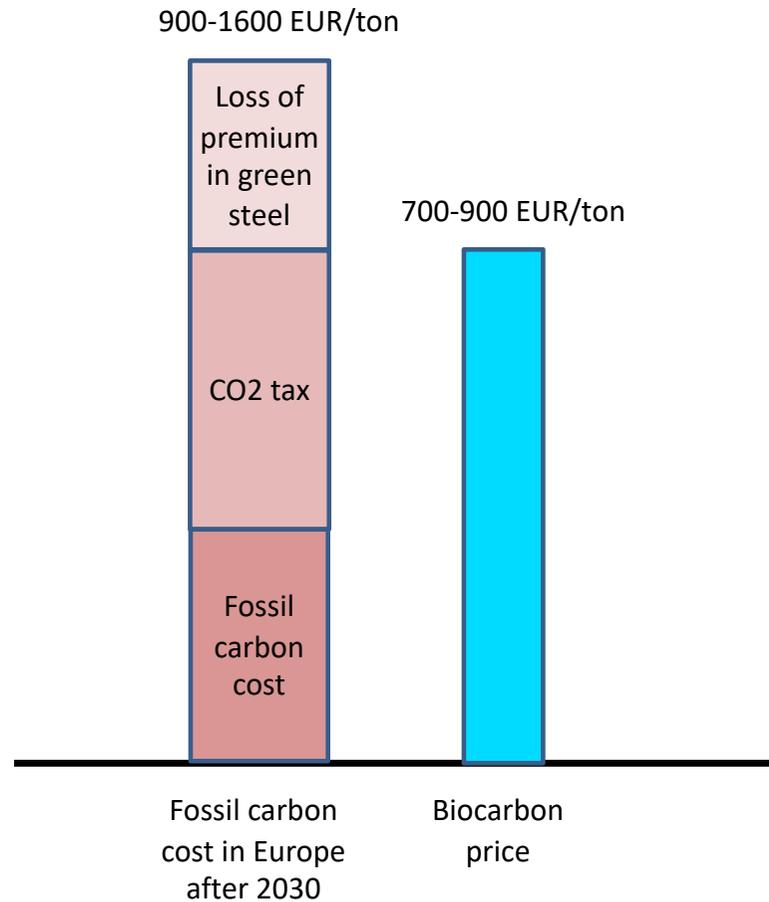
Charge Biocarbon



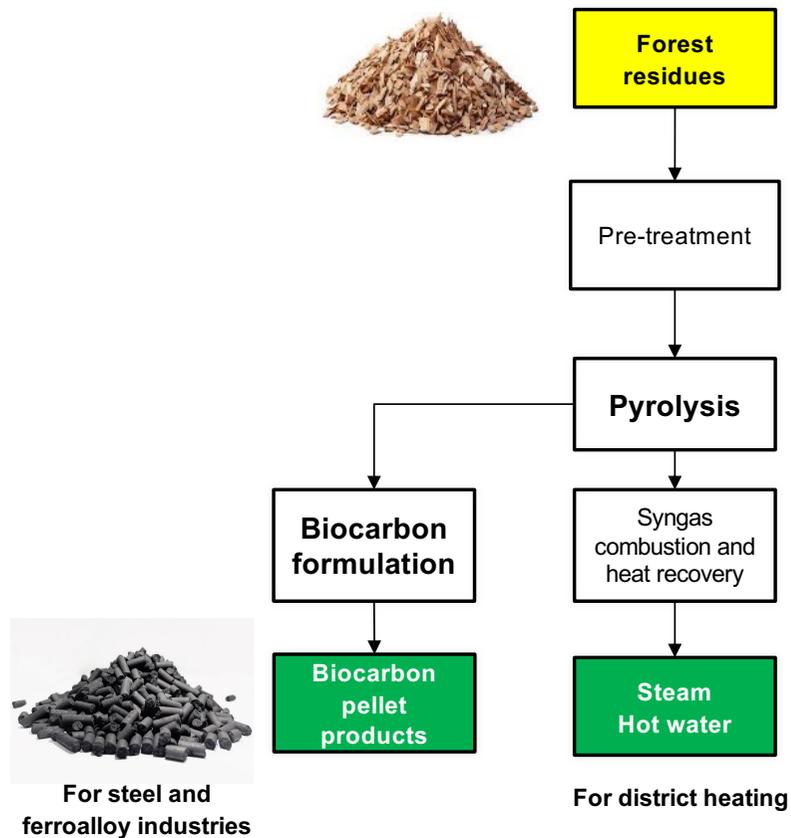
Baking furnace

Charge Biocarbon

How Biocarbon Reflects Its Value in Steel Industry Decarbonization



CarbonWorks® Process for Lignin-Rich Biomass Valorisation



WAI core technologies



WAI pyrolysis technology convert biomass to biocarbon & syngas at high capacity and high energy efficiency.



WAI biocarbon formulation technology produces tailor-made products for steel and ferroalloy industries.

CarbonWorks achieves:

- ✓ Material recycling
- ✓ Energy recycling
- ✓ Product for steel and ferroalloy industries
- ✓ Lower emission than biomass combustion
- ✓ Higher value creation than biomass combustion

WAI Applies Internal Heated Pyrolysis for Biocarbon Production.



Pilot pyrolysis: :
product
Commis

- For
- Inte
- Car
- Flex
- High

4-ton biocarbon from Norwegian spruce sawdust

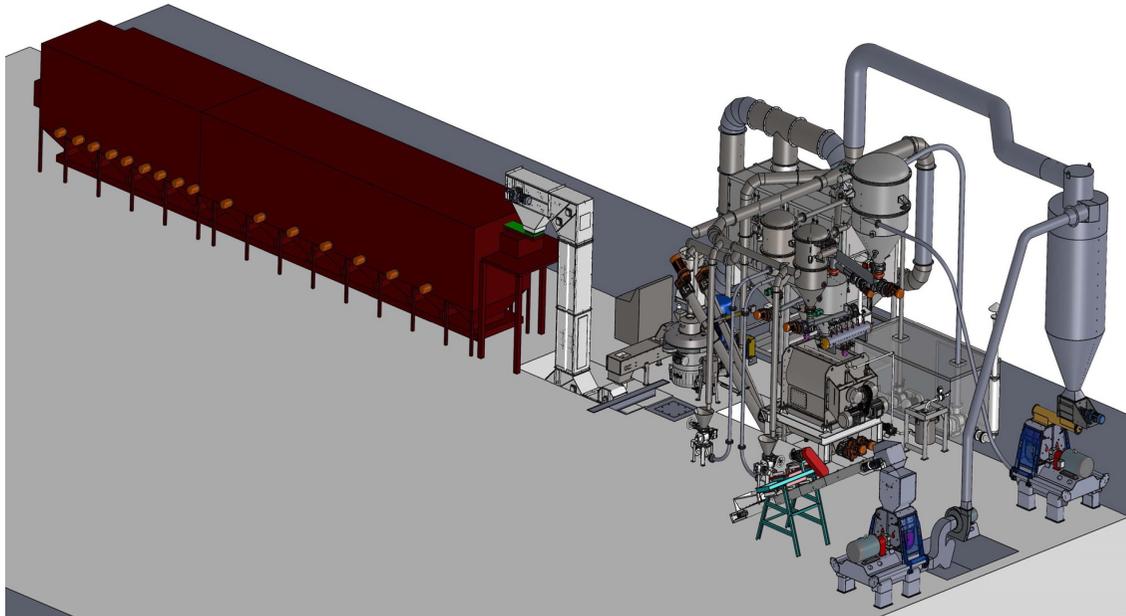
ton/year biocarbon
capacity
: 2026

tion

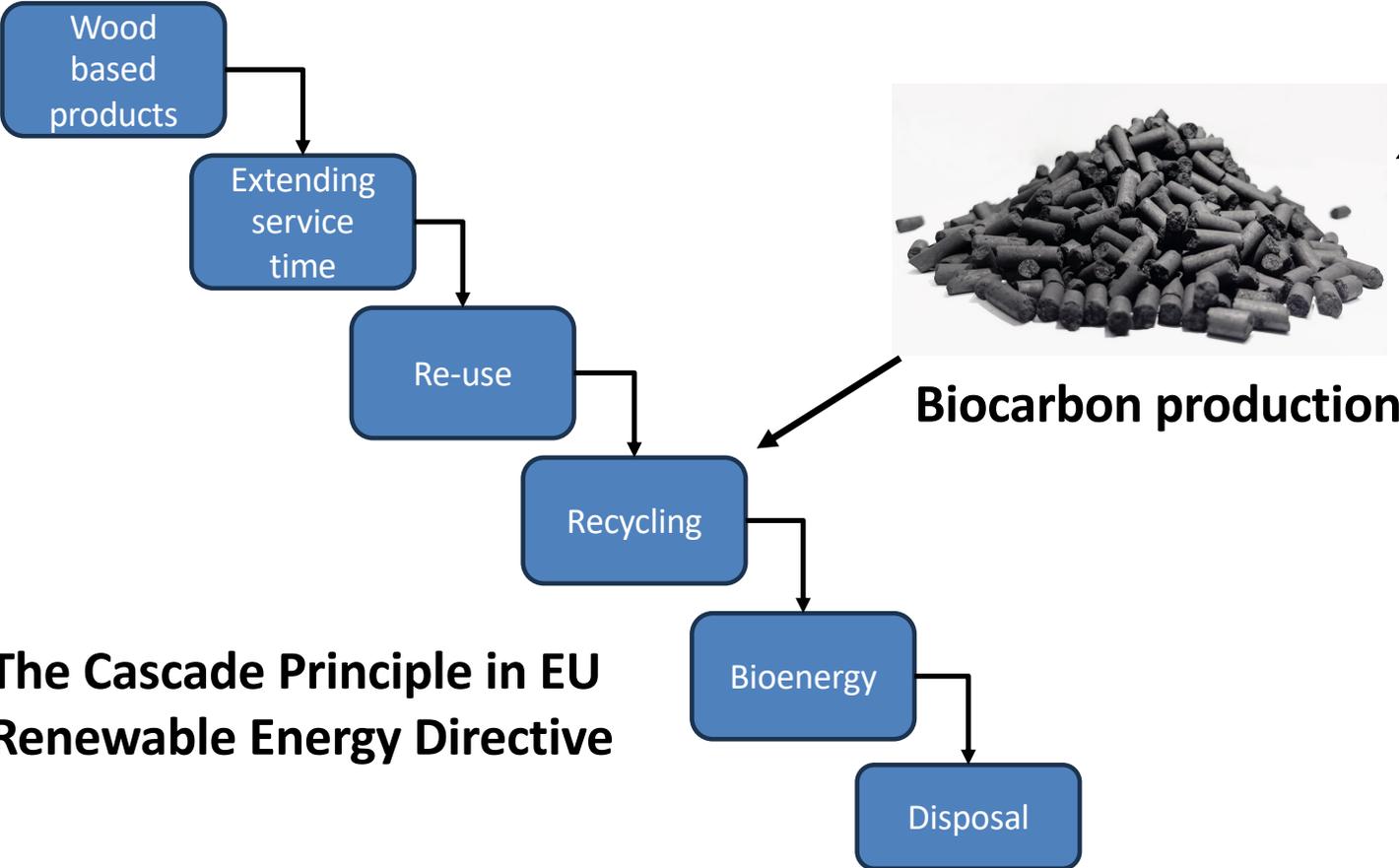
5-ton biocarbon was produced in the 3rd week of January 2024.

Biocarbon Densification Developed for Meeting Tough Metallurgical Demands

- Compression strength, thermal strength, durability, reactivity in furnaces, resistance to moisture, bulk density
- Combination of grinding, mixing, pelletizing and hardening steps
- Unique binder recipes for different product series
- Can process different carbonized materials (biochar, biocarbon, charcoal)
- High capacity, standardized design for fast implementation
- Full scale demo plant (10000 ton/year capacity) to be commissioned in 2024

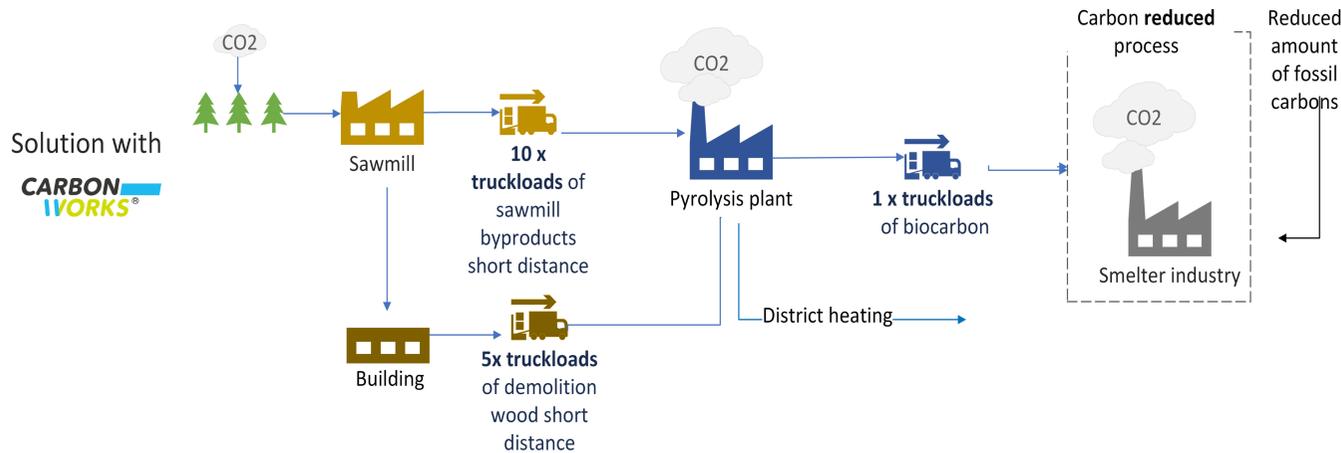
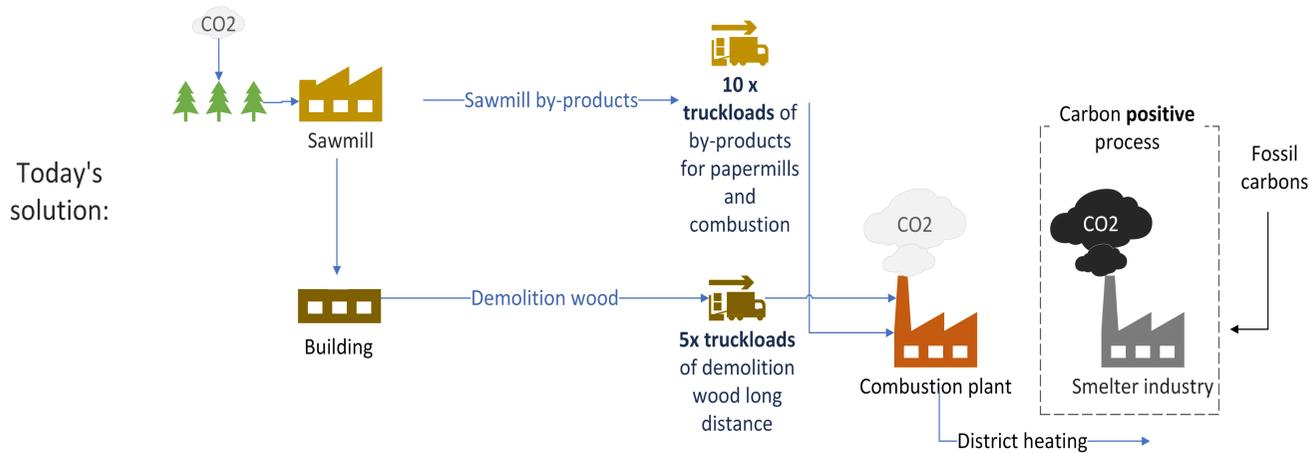


Sustainability of Biocarbon Production – Feedstock Sustainability



The Cascade Principle in EU Renewable Energy Directive

WAI's Empowerment across the Entire Value Chain

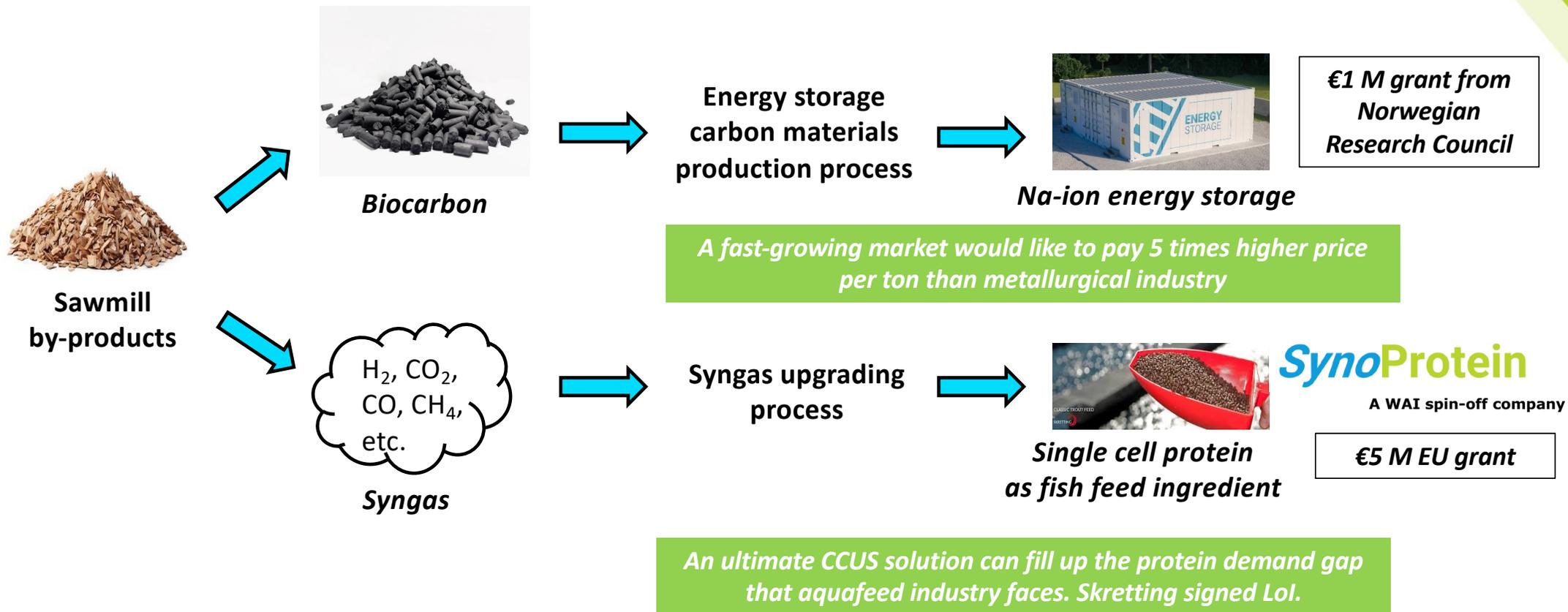


WAI pyrolysis plant directly help to:

- ❖ reduce truck traffic by recycling by-products close to the source
- ❖ improve sustainability by realizing material recycling via biocarbon production
- ❖ create higher value creation from feedstocks, direct economic benefits to sawmills and waste wood handling companies if they become shareholders

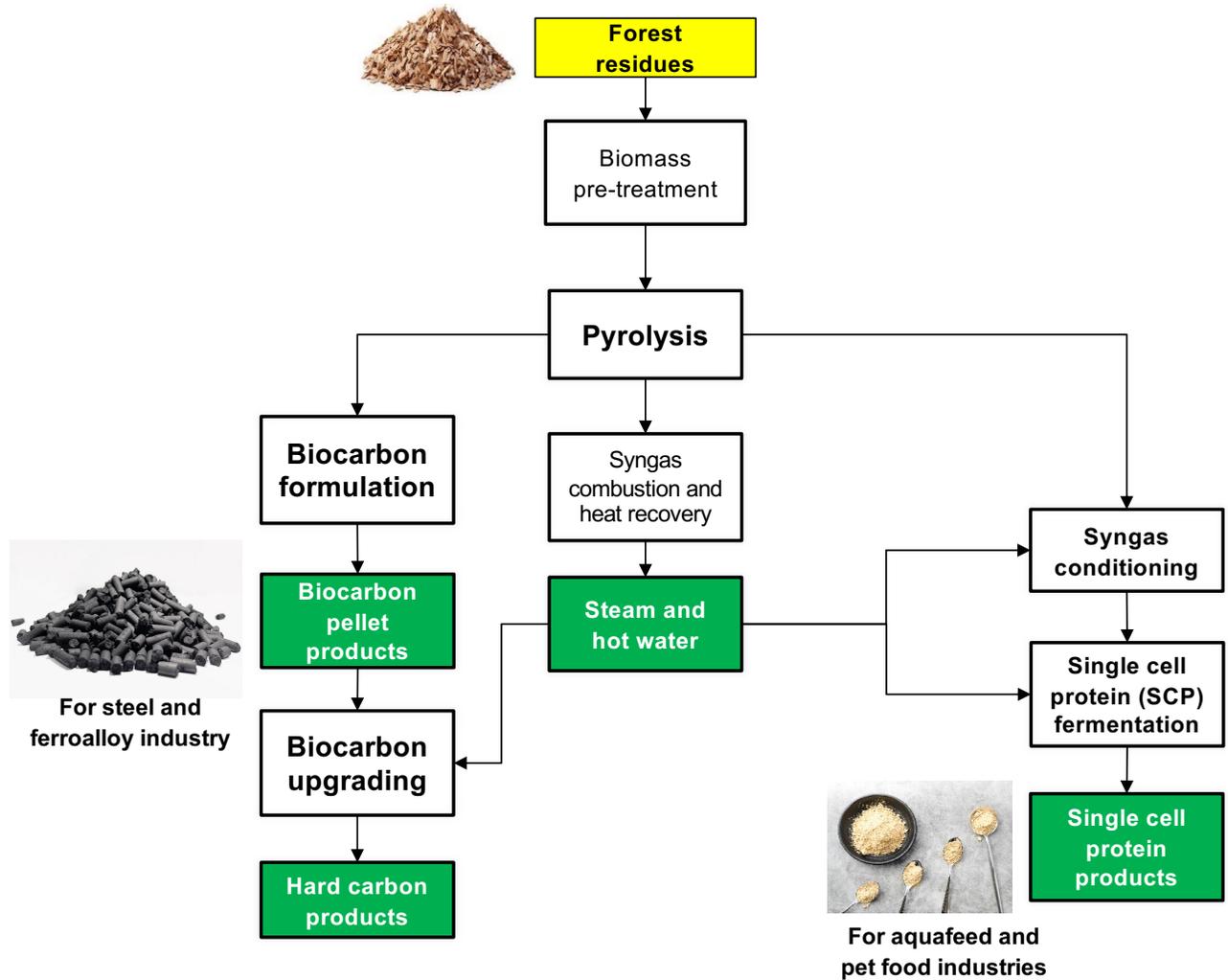


Elevated Value Creation for Forest Residues



❖ WAI secured € 6 million grants for developing high value carbon products.

CarbonWorks Plus - SynoProtein® Process



WAI pyrolysis technology convert biomass to biocarbon & syngas at high capacity and high energy efficiency.



WAI biocarbon formulation technology produces tailor-made products for steel and ferroalloy industries.



WAI biocarbon upgrading technology upgrades biocarbon to biobased hard carbon products for Na-ion and Li-ion batteries.



SynoProtein syngas conditioning combines thermal and biological processes to guarantee high purity of syngas to SCP production.



Our unique bacteria use H₂, CO₂ and CH₄ as feedstocks for protein production and **SCP formulation process** produces high quality SCP pellets for AquaFeed and pet food markets.

WAI is a Norwegian Biobased Carbon Material Technology Company

- Founded in 2017
- A team of 9 highly motivated engineers, scientists and businesspeople
- Headquarter in Tønsberg, Norway and a branch in Suzhou, China
- Focus on forest residue to biocarbon conversion



Steinar Danielsen, M.Sc.
Co-founder & CEO

40-year experience with 20 years in waste handling.



Gang Xin, Ph.D. in Env. Eng.
Co-founder & CTO

25-year experience from IPR, R&D to large scale systems.



Long Lin, Ph.D. in Env. Eng.
CSO

Post-doc at U. of Alberta, rich experience on biogas, composting and wastewater.



Cecilie Sandtrø, M.Sc.
Director of Projects

22-year experience in oil refinery with Exxonmobil on process chemistry.

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gang@waies.no



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