Task Meeting, IEA Bioenergy Task33

Updates on the Gasification Activities in China

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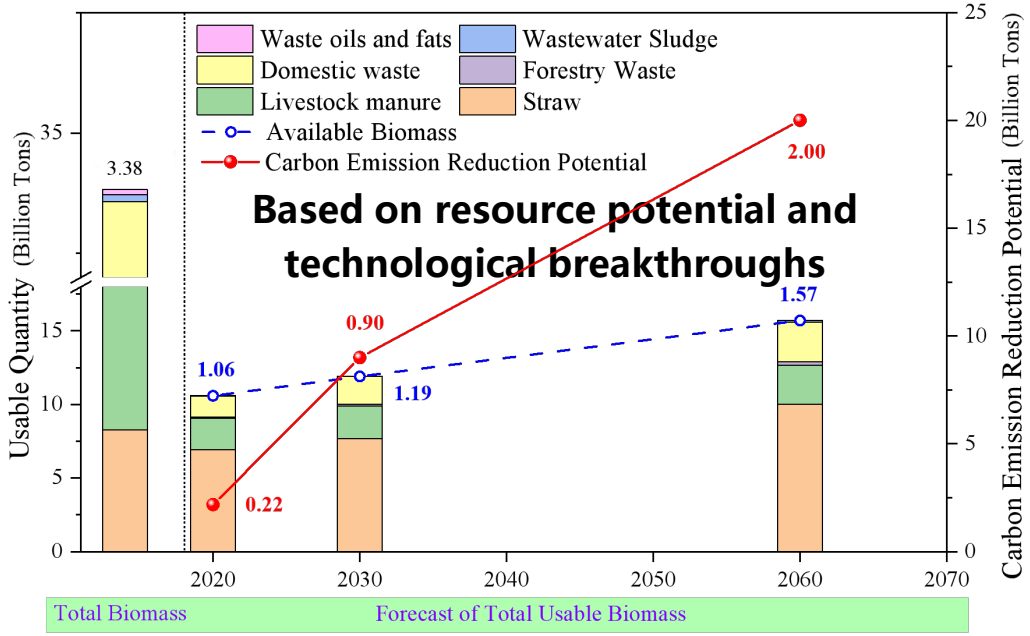
Content

Background

Biomass Availability and Utilization Potential in China



Total biomass resources, availability and carbon emission reduction potential in China —Potential of 3060 Zero-Carbon Biomass Energy"

Types of biomass	Available Energy Potential (10^8 tce)
Domestic waste	4.43
Sludge	0.85
Agriculture (Stalks)	2.24
Forestry waste	1.02
Industrial waste	2.10
Livestock manure	2.11(energy equivalent)

Biomass waste+New biomass+Emerging solid waste

- China has a huge biomass production, but its **effective utilization rate is limited**
- Biomass energy has significant **theoretical potential for emission reduction**
- Innovations in future biomass **types** and **technologies** will further enhance energy supply and carbon emission reduction potential.

Traditional Types of Biomass in China and Future Sources of Biomass

Background

Four-dimensional Driving Forces to Biomass Utilization

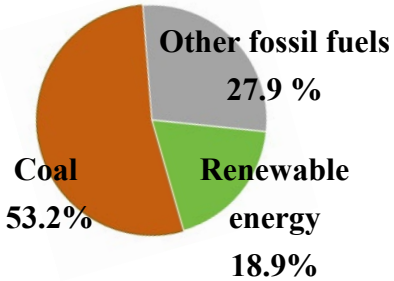
➢ Policy aspect-driven

A number of policy action has been implemented to promote carbon reduction

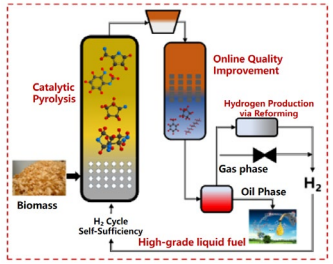
Since the National proposal of the 'dual carbon' goals issued in 2020

- 2024: China's first 'Energy Law' is issued
- 2024: The State Council's 'Action Plan for Energy Conservation and Carbon Reduction
  2023: Law on the Prevention and Control of Environmental Pollution by Solid Wastes
- 2022: Implementation Plan for Synergistic Effect of Pollution Reduction and Carbon Emission Reduction
- 2021: Carbon Peak Action Plan Before 2030

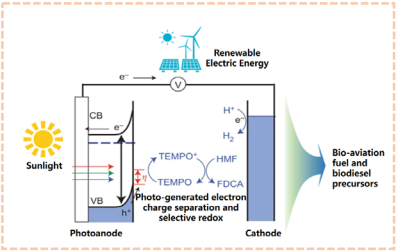
➢ Energy aspect-driven



China's energy structure (2024)



Flexible coupling with existing energy system



Complementary to renewable energy system

The energetic utilization of biomass/wastes in particular for oil/gas embodies energy security, controllability, flexibility, and resilience

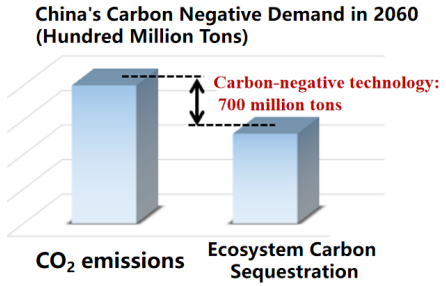
➢ Environment aspect-driven

Noticeable Environmental pollutants arising from irratioal use of biomass/ wastes

NO_x、SO_x、PM2.5

Eutrophication

Soil pollution

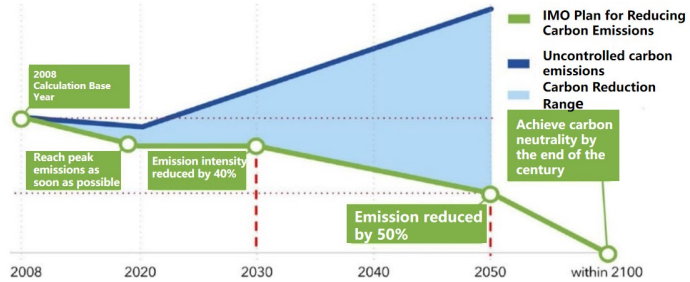


Dual Carbon Goals and Negative Carbon Demand

Strict environmental standards and carbon emission targets drive the clean and low-carbon conversion of organic solid waste

➢ Carbon Tax Trading aspect-driven

International Maritime Organization: Achieving Carbon Neutrality in the Shipping Sector by the End of This Century



Bio-methanol

- Green methanol has become the preferred energy source for decarbonizing shipping
- COSCO Shipping predicts that the demand for green methanol will reach 10-20 million tons per year by 2030.

Zero or even negative carbon-based biofuels (bio-methanol, SAF – sustainable aviation fuel) have become a priority solution

Green Methanol Production Route

Electrolysis of water
(green electricity)

Green H_2

A

Combustion

Flue gas

CO_2 (10-15%) 、CO、H_2O、NOx、SOx,etc

CO_2 Separation and Purification

MeOH

$3H_2+CO_2=CH_3OH+H_2O$

Biomass
(Green Carbon)

B

Anaerobic fermentation

Biogas

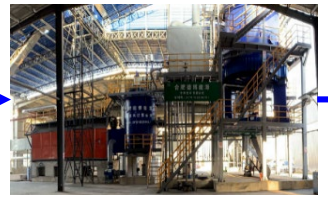
CH_4 (40-60%) 、CO_2 (40-60%)、H_2S (A small quantity)

Methane dry/wet reforming

MeOH

C

Pyrolysis gasification



Rough synthesis gas

H_2 (20-40%) 、CO (20-40%) 、CO_2 (20%) 、CH_4 (10%)

WSG

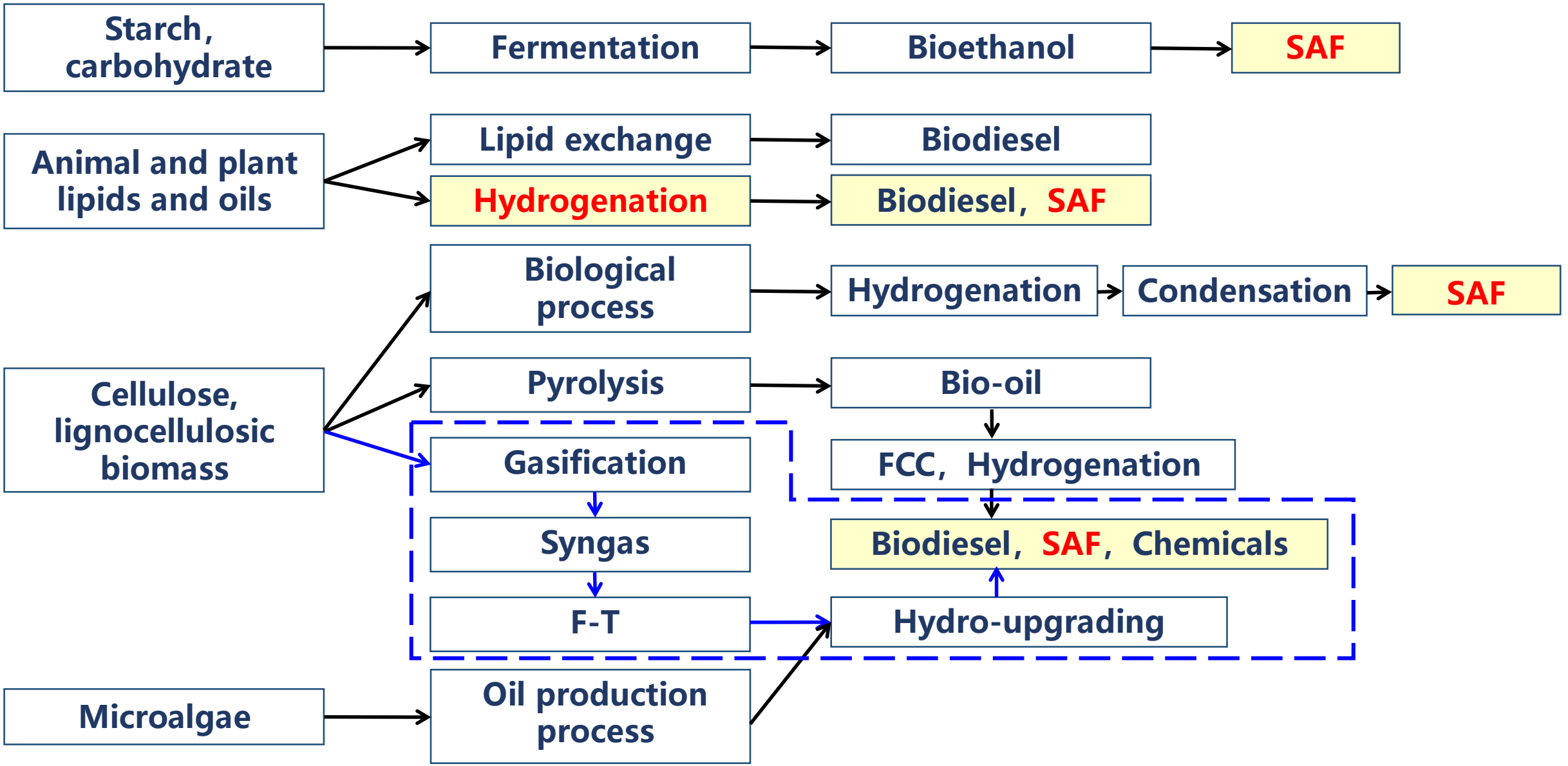
H_2: CO ≧ 2

High-quality raw gas

MeOH

The route of producing high-quality raw gas for green methanol via biomass gasification exhibits relatively high efficiency and more controllable large-scale costs, demonstrating its advantages.

SAF Production Route



Production Cost in China

Technical Route	Technical Maturity	Estimated Production Cost
Renewable carbon: Biomass direct combustion + flue gas CO_2 Green hydrogen: wind-solar hydrogen production Methanol production route: CO_2+ green hydrogen	✹✹✹	5,000-8,000 yuan per ton
Renewable carbon: CO_2, by-product of corn ethanol plants Green hydrogen: wind-solar hydrogen production Methanol production: CO_2+ green hydrogen	✹✹✹✹	More than 5,000 yuan per ton
Renewable carbon: Biogas (CH4, CO2 can be considered in future) Green hydrogen: None Methanol production: Biogas reforming + decarbonization +Synthesis	✹✹✹✹✹	3,500-4,000 yuan per ton
Renewable carbon: Biomass gasification Green hydrogen: None Methanol production: Biomass gasification synthesis gas production	✹✹	More than 4,000 yuan per ton
SAF： biomass gasification and F-T synthesis	✹✹	11,000 yuan per ton

Content

Current Status of the Green Methanol Production in China

Distribution of Representative Green Methanol Projects in China

- By the end of December 2025, China had **173 signed, registered, pending approval, and planned green methanol projects**, with a theoretical capacity of 53.46 million tons per year.
- The Taonan Wind Power Coupled Biomass Green Methanol Integrated Demonstration Project (50,000 tons/year) is the **first domestic biomass gasification synthesized green methanol project** to be put into operation.
- 8 ports where green methanol can be refueled.

12 of planned projects are under construction, and 3 have entered production

2. Green Methanol Production: Representative Projects

➢ Green methanol **projects in operation**:

Number	Company	Scale and technique route	Location	Status
1	CIMC Green Energy Low-Carbon Technology (Zhanjiang) Co., Ltd.	50,000 tons of green methanol per year (Phase I); Pure biomass gasification technology	Suixi, Zhanjiang, Guangdong, China	Pilot Operation
2	Shanghai Electric Co., Ltd.	50,000 tons of green methanol per year (Phase I); Wind power hydrogen production + biomass gasification	Taonan, Jilin, China	Pilot Operation
3	Goldwind Green Energy Chemical Technology (Hinggan League) Co., Ltd.	Green methanol (Phase I: 250,000 tons); Wind power hydrogen production + biomass gasification	Hinggan League, Inner Mongolia, China	Partial Operation

2. Green Methanol Production: Representative projects

➢ Green methanol projects **under construction**:

Number	Company	Scale and technique route	Location	Status
1	China Energy Engineering Corporation (CEEC)	500,000 tons of green fuel per year; Wind-solar hydrogen production coupled with biomass gasification	Kangping, Shenyang, Liaoning, China	Under construction
2	Gansu Runlong Hongneng Energy Management Co., Ltd.	250,000 tons of green methanol per year; Renewable energy electrolysis for green hydrogen production + biomass gasification synthesis	Guazhou, Gansu, China	Under Construction
3	Tianjin Saihong Environmental Engineering Co., Ltd.	100,000 tons of green methanol per year; Closed-loop Arundo donax biomass green methanol	Tianjin, China	Under construction
4	Shanghai Electric Group Co., Ltd.	250,000 tons of methanol per year (2027); Biomass steam+wind electricity	Taonan, Jilin, China	Under construction
5	LONGi Green Energy Technology Co., Ltd.	120,000 tons of green methanol per year; Pure biomass gasification technology	Xiangcheng, Xuchang, Henan, China	Under Construction
6	LANGE New Energy (Dafeng) Co., Ltd.	300,000 tons of green methanol per year; Biomass gasification (agricultural waste)	Dafeng Port, Jiangsu, China	Under Construction
7	Inner Mongolia Guyang Economic Development Zone New Energy Co., Ltd. (Xindao Energy Group)	200,000 tons of green methanol per year; Off-grid wind-solar hydrogen production coupled with biomass	Guyang, Baotou, Inner Mongolia, China	Under Construction
8	Liaoning Huadian Tieling Green Methanol Project	100,000 tons of green methanol per year; Wind power hydrogen production coupled with biomass gasification	Diaobingshan, Tieling, Liaoning, China	Under Construction
9	Debo bioenergy Ltd.	150,000 tons of methanol per year; Biomass steam+oxygen gasification	Ruijin, Jiangxi, China	Under construction
10	Yuanhuang Energy (Inner Mongolia) Co., Ltd	700,000 tons of green methanol per year; Biomass-based e-methanol	Otog Banner, Ordos, Inner Mongolia, China	Under construction
11	China Energy Engineering Corporation (CEEC) - Shuangyashan Project	200,000 tons of green methanol per year; Wind-solar hydrogen coupled with biomass gasification	Shuangyashan, Heilongjiang, China	Under Construction
12	SPIC Jilin Electric Power Co., Ltd. (Jidian Co., Ltd.)	197,200 tons of green methanol per year; Wind-solar green hydrogen coupling with biomass	Lishu, Siping, Jilin, China	Construction Initiated

The total production capacity of the green methanol project under construction is 3,067,200 tons per year.

2. Green Methanol Production: Representative projects

➢ Green methanol projects **signed a contract or approved (may be affected by market or policy factors)** :

Number	Company	Scale and technique route	Location	Status
1	Beijing Nengjian Technology Development Co., Ltd.; China Coal Construction Group	150,000 tons of methanol per year; Biomass steam + wind electricity + electrolysis of water	Yushu, Jilin, China	Signed a contract
2	LONGi Green Energy Technology Co., Ltd	180,000 tons of green methanol per year; Biomass gasification	Ganyu, Lianyungang, Jiangsu, China	Signed a contract
3	Liaoning Tieling Carbon Recycling Project	244,000 tons of green methanol per year (co-producing protein); Non-food biomass to green methanol	Tieling, Liaoning, China	Signed a contract
4	Horqin Zuoyi Middle Banner & China Coal Inner Mongolia Energy Co., Ltd	200,000 tons of green methanol per year; Wind-solar hydrogen coupled with biomass gasification	Hure Banner, Tongliao, Inner Mongolia, China	Signed a contract
5	Jilin Huajin Energy Co., Ltd.; Carbon Recycling International (Iceland)	270,000 tons of green methanol per year; Green power + biomass coupling	Yushu, Jilin, China	Signed a contract
6	China Coal Group; COFCO	200,000 tons of green methanol per year; Self-developed cattle manure gasification technology	Linxi, Chifeng, Inner Mongolia, China	Approved
7	Charoen Pokphand Group (CP Group)	1,500,000 tons of green methanol per year; Offshore wind power + biomass resources	Gulei, Zhangzhou, Fujian, China	Approved
8	China National Chemical Engineering Group (Zhongke Nengyuan Chemical)	300,000 tons of green methanol per year (Phase I: 100,000 tons); Wind-solar green hydrogen + biomass gasification	Minle, Zhangye, Gansu, China	Approved
9	Huadian (Keyouqianqi) Energy Co., Ltd	200,000 tons of green methanol per year; Wind-solar hydrogen production integration	Keyouqianqi, Hinggan League, Inner Mongolia, China	Approved
10	Goldwind Green Energy Chemical (Hinggan League) Co., Ltd	725,000 tons of green methanol per year (Phase III); Green hydrogen to green methanol	Hinggan League, Inner Mongolia, China	Approved
11	CIMC Green Energy Low-Carbon Technology (Zhanjiang) Co., Ltd	200,000 tons of green methanol per year (Phase II expansion); Biomass gasification	Suixi, Zhanjiang, Guangdong, China	Approved
12	Fuyang Chemtex Bioengineering Technology Co., Ltd	200,000 tons of green methanol per year; Biomass fluidized bed gasification technology	Linquan, Fuyang, Anhui, China	EIA Approved
13	German-related parties—Lianyungang, Jiangsu Project	800,000 tons of green methanol per year; Biomass gasification	Nantong, Jiangsu, China	Approved

2.2 Biomass to Green Methanol: Representative Cases

➢ **Case 1:** Shanghai Electric Taonan Wind Power Coupling Biomass Green Methanol Integration Project

Project overview:

Location: Taonan, Jilin, China

Production capacity: 250,000 tons/year

Renewable energy installed capacity: 680 MW

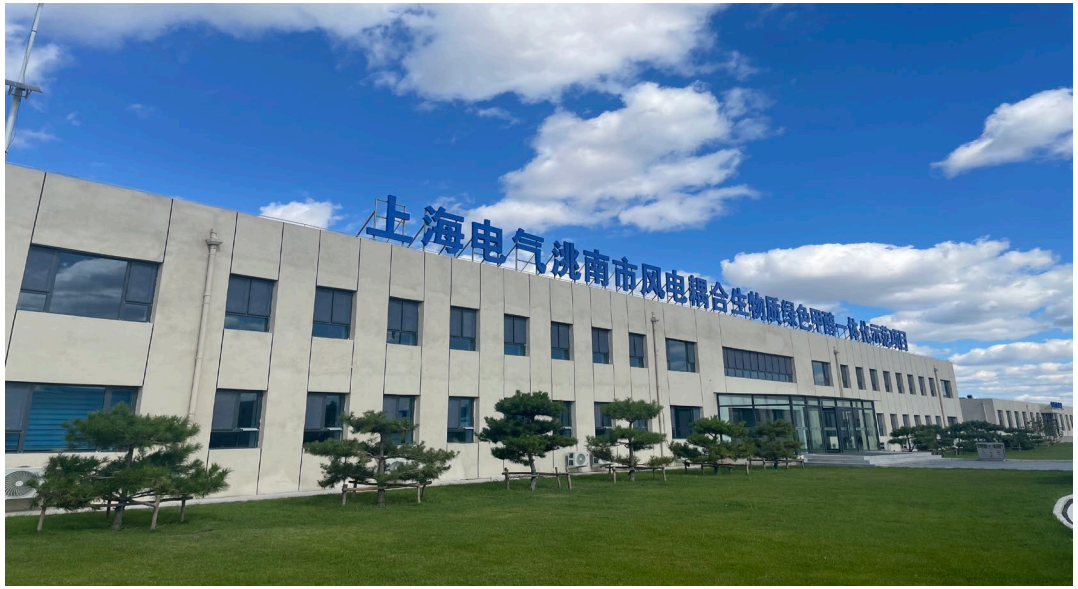
Biomass consumption: 800,000 tons/yr (straw)

Gasification performance:

- Fluidized bed gasification is used.
- Electrolytic hydrogen production device: 8,000Nm^3/h
- Hydrogen storage device: 10 tons
- Green methanol fuel meeting marine standards

Start to construct: March 2024.

Commencement of Production: July 2025



2.2 Biomass to Green Methanol: Representative Cases

➢ **Case 2:** The 50,000-ton/year biomass liquid fuel project of CIMC Green Energy

Project overview:

Location: Suixi, Zhanjiang, Guangdong, China

Production capacity: 50,000 tons/year

Land area: ~292,000 m^2

Process route: Biomass gasification + Fischer-Tropsch synthesis coupled with biomass direct combustion power generation (international first)

Gasification performance:

- Circulating fluidized bed (CFB) biomass gasification technology
- Innovative "mild gasification" coupled with "char self-catalytic cracking" approach
- Breakthroughs in uniform fluidization of multi-component particles, in-situ tar cracking, and alkali metal corrosion prevention

Commencement of Production: December 16, 2025

2.3 Biomass to Green Methanol: Representative Cases

➢ **Case 3:** SPIC Jilin Electric Power Lishu Wind-Solar Green Hydrogen & Biomass Green Methanol Project

Project overview:

Location: Lishu, Siping, Jilin, China

Treatment capacity: 197,200 tons/year (green methanol)

Wind power scale: 400 MW

Hydrogen production: 32,000 Nm^3/h

Gasification performance:

- Biomass entrained-bed gasification (43.94 t/h bio-carbon, 87.77 t/h syngas)
- Hydrogen storage facility: 208,000 Nm^3
- Storage facility: 10 MW / 20 MWh

Start to construct: October 2025

Expected production start: Second half of 2028

2.4 Biomass to Green Methanol: Representative Cases

➢ **Case 4:** LANGE New Energy Dafeng 300,000 t/y Green Methanol Project

Project overview:

Location: Dafeng Port, Yancheng, Jiangsu, China

Green methanol production: 300,000 tons/year

Technology route: Biomass gasification (mainly agricultural waste)

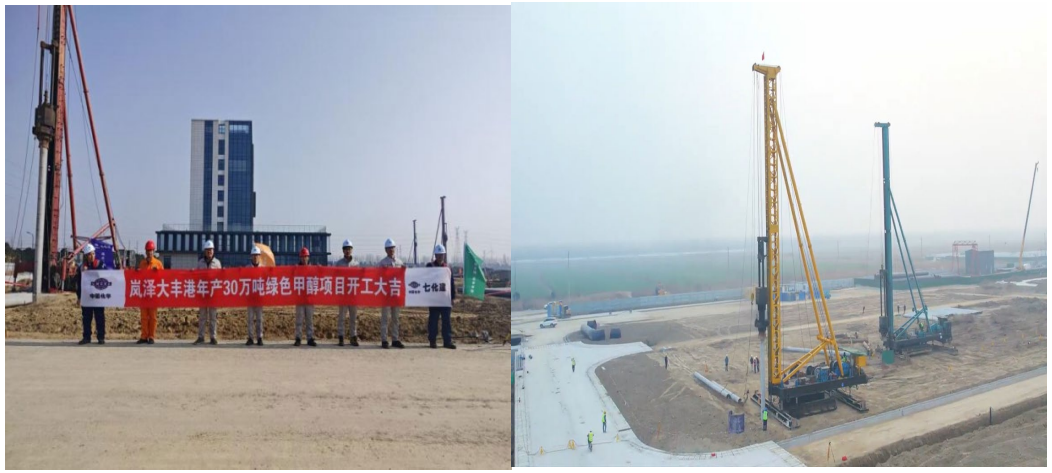
Gasification performance:

- ➢ Fixed/fluidized bed combined gasification
- ➢ Annual biomass consumption: ~500,000 tons
- ➢ **Pure biomass route** (no green hydrogen coupling)

Storage facility: 100,000 m³ methanol tank farm

Start to construct: May 2025

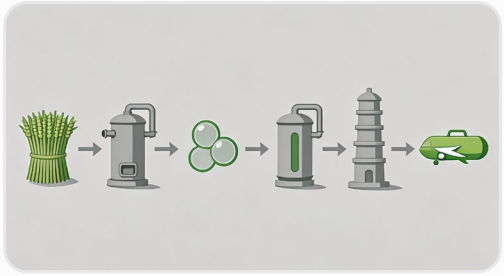
Expected production start: End of 2026



2.5 Biomass to SAF cases in China

Technical principle: From biomass to SAF

Biomass gasification - Fischer-Tropsch (G-FT) synthesis is a key technology for converting agricultural and forestry waste into high-quality liquid fuel. The core process is as follows: ① **Gasification**: At high temperatures, convert straw, wood chips, and distillers' grains into CO and H_2 syngas → ② **Synthesis**: Through the Fischer-Tropsch reaction, convert it into long-chain hydrocarbons → ③ **Refining**: Separate and process to obtain high-purity SAF. It can efficiently achieve "turning waste into treasure" and is the core technical path for the aviation industry to achieve carbon neutrality.



Comparison of the two major G-FT demonstration projects in China (The enterprise has announced its plan)

Key indicator	Lanze Energy • Luzhou Project (Sichuan四川)	China Energy Construction • Shuangyashan Project (Heilongjiang黑龙江)
Core route	Distillate from grains and wood → Gasification → Fischer-Tropsch one-step process	Straw + wind-solar green hydrogen → Fischer-Tropsch synthesis
Scale and Raw Materials	100,000 tons/year Utilizing the resources from distillery waste residue	Phase I 100,000 tons Abundant agricultural straw in Northeast China
Highlight /Commissioning	**Start construction: Apr. 2026 Plan to Operation: 2028**	**Start construction: Sep. 2025 Plan to Operation: 2027**

Open a new era of green aviation: The steady progress of the two demonstration projects indicates that China has fully mastered the core technology for large-scale and low-cost production of bio-based SAF, and has opened up the entire industrial chain path from "agricultural and forestry waste" to "aviation fuel". This provides solid technical support and production capacity guarantee for achieving the "carbon neutrality" goal and the green transformation of the aviation industry.

2.6 Challenges of Biomass to Methanol/SAF

Policy

The EU carbon tax

- **Execution method:**
  - Carbon emissions trading system (ETS)
  - Carbon border adjustment mechanism (CBAM)
- **Enforcement strength:**
  - Carbon tax prices.
  - The EU plans to gradually expand the scope of carbon taxes.

Market— cost + pricing

- **Imbalance between supply and demand:**
  - Insufficient green methanol production capacity
  - Green methanol has a high production cost
- **Future supply and demand changes:**
  - Methanol production increases, lead to oversupply
  - The demand for methanol will gradually shift towards green and low-carbon

Technology (full-chain green)

International cooperation is absolutely needed

- **Material**
  - Raw material distribution is scattered
  - Quality varies greatly
  - Limitations of normalization and preprocessing
- **Gasification (lessons)**
  - Technical bottlenecks in scale-up
  - The cooperation between gasification and synthesis unit (thorough removal of biomass tar)
  - Coupling with other renewable energies

Content

3.1 Coal-Biomass Gasification Demonstration Project

Project overview:

Location: Huangshi（黄石）, Hubei, China

Treatment capacity: 100,000 tons/year (agricultural & forestry residues)

Power generation: 20 MWe （biomass based）

Feedstock: rice husk, wood chips, straw

Gasifier type: Circulating fluidized bed (CFB) pressurized gasifier (0.3-0.5MPa)

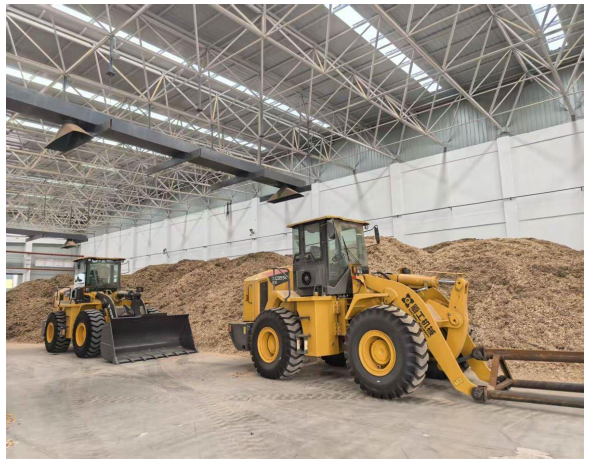
Gasification performance:

- Load regulation range: 30%–120%
- Overall thermal efficiency: >85%

Go into operation: Sep. 2025

This is the largest plant for biomass gasification to power.

Feedstock



Gasifier

3.2 Biomass Gasification Centralized Heating Project

Project overview:

Location: Hekou Economic Development Zone, Dongying（东营）, Shandong, China

Biomass treatment: 30 tons/hour

Annual steam output: 190,000 tons

Total investment: 51 million CNY

Gasifier type: Non-fixed grate biomass gasifier

Gasification performance:

- Coal replacement: 21,000 tons/year
- CO_2 reduction: 51,000 tons/year
- Annual heating cost reduction for enterprises: >4 million CNY (e.g., Huihai Pharma)

Go into operation: Dec. 2025

3.3 Biomass Char-Steam Cogeneration & District Heating Project

Project overview:

Location: Yiyang（益阳）, Hunan, China

Feedstock: 80,000 tons/year rice husks and straw (agricultural waste)

Steam output: 180,000 tons/year steam supply to nearby industrial park

Char output: 30,000 tons of biochar for steel insulation or carbon-based fertilizer

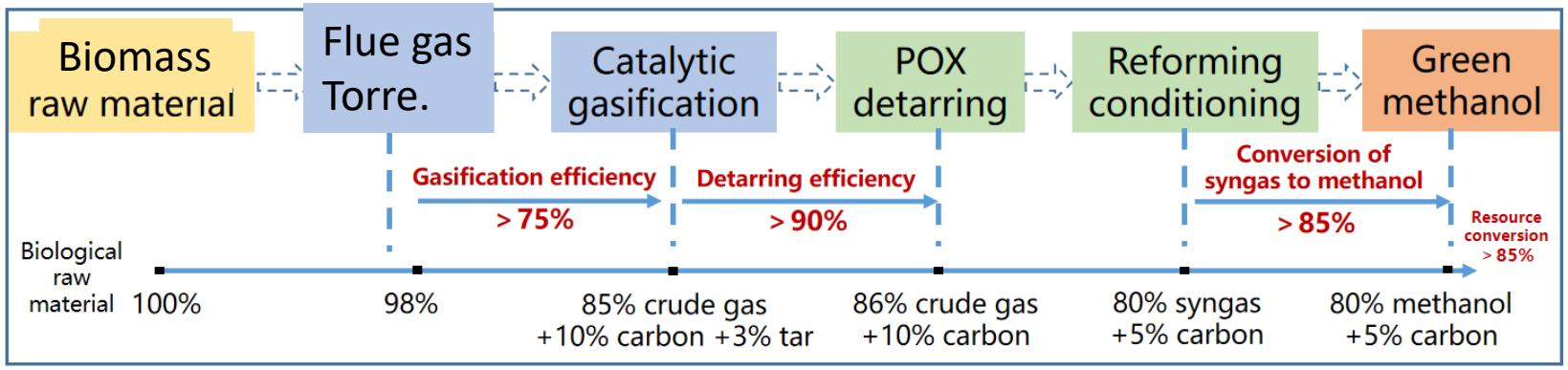
Gasification performance:

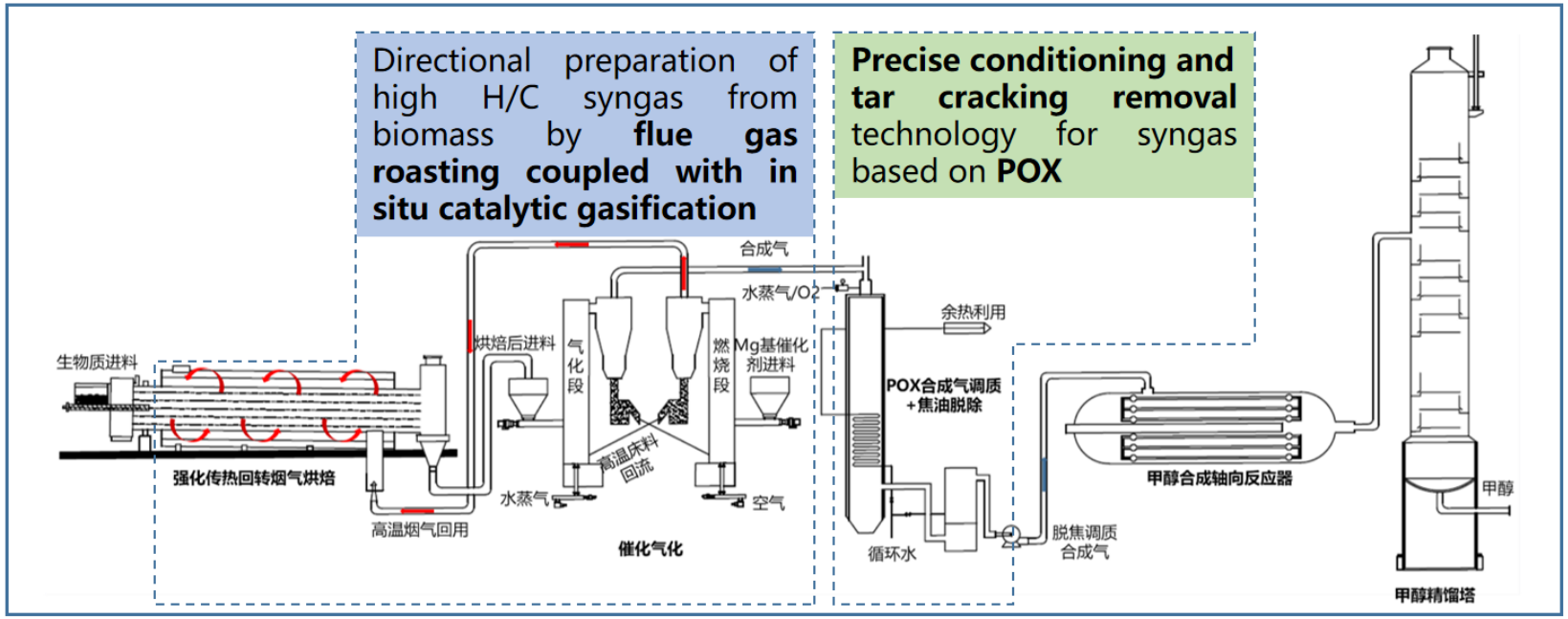
- Pyrolysis gasification generates both fuel gas and char
- Gas combustion supplies industrial-scale steam

Go into operation: Jan. 2025

Content

4.1 Torrefaction-gasification-tar removal integrated system





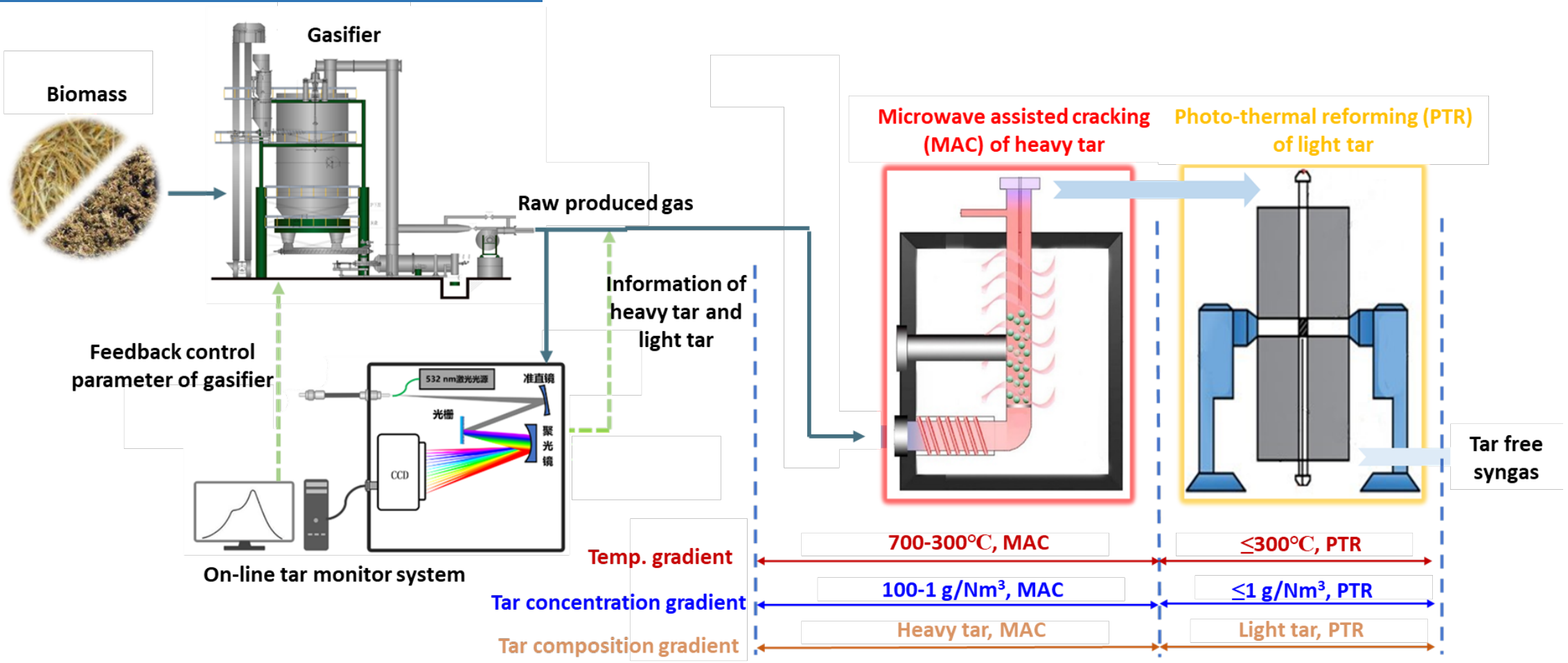
Advantages:

- DCFB produces high-temperature flue gas can be used in torrefaction unit, which saves energy and avoids pollutant emission.
- Catalytic bed material provides better gasification performance and achieve the in-situ carbon absorption.

Research Focus:

- Energy-mass flow in the integrated system.
- Development of the looping materials
- Tar removal.

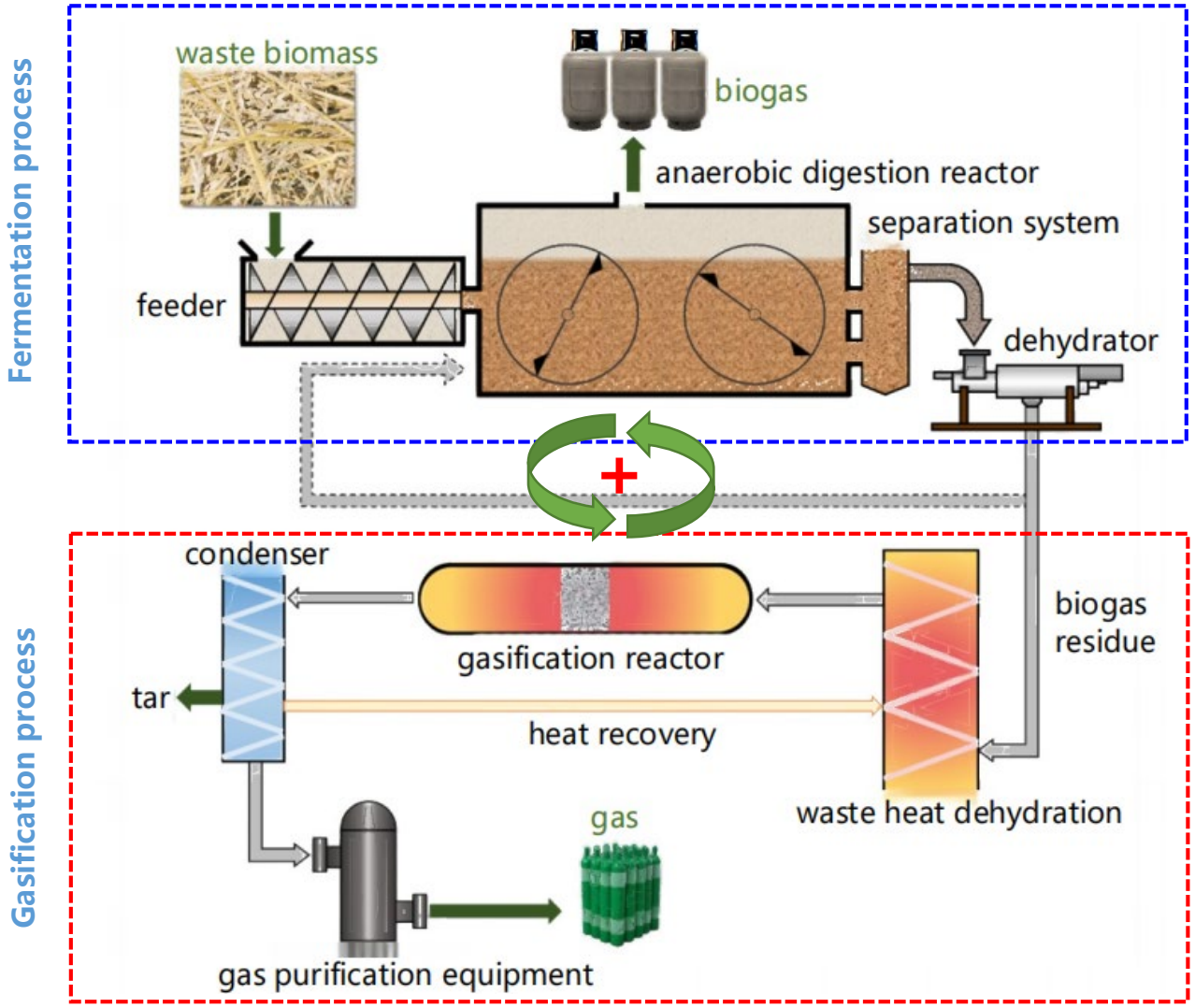
4.2 Tar Monitor and step-wised removal technology

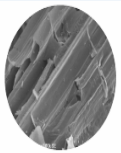
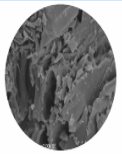


In-situ Raman technology is used for monitoring the main composition of **syngas** (H2, CO, CO2, CH4, O2, N2);
In-situ FTIR coupled with fractional condenser is used for monitoring **tar** components;
A feedback control system is used for smart control the **gasifier.**

Microwave assisted catalytic cracking is used for removal the **heavy tar** at high temperature;
Photo-thermal reforming is used for removal the **light tar** at lower temperature which doesn't need extra heat input.

4.3 Biomass Gasification integrated with Anaerobic Digestion

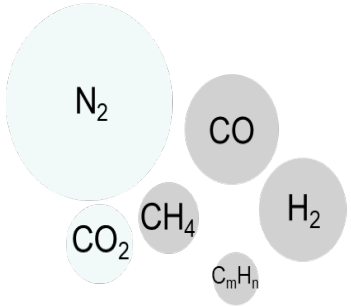


	apparent structure	Micro-structure	Activation energy (kJ/mol)	Syngas yield (Nm^3/kg)
Conventional gasification	 1kg Biomass		31.6	0.5
Anaerobic Digestion	 0.27m^3 Biogas 0.66kg digestate		-	-
Coupling Technology	 0.2m^3 Biogas 0.69kg digestate that was controllable decomposed		22.3	1.1

- In the coupling process, the activation energy of digestate decreased by 29%, syngas yield can higher than 1.1 Nm^3/kg, so the carbon utilization efficiency can be higher than 39%.
- Based on such part of work, we are happy to join the ITP (Hybrid Bioenergy Systems: Integrating Anaerobic Digestion and Gasification for Circular Energy)

4.4 MILD combustion of Biomass gasification gas

- Challenges in BGG combustion



Composition of BGG (GA = Air)

BGG

Low calorific value

About 3~14MJ/m³

Complex composition

Highly influenced by feedstock, gasification agent and gasification parameters

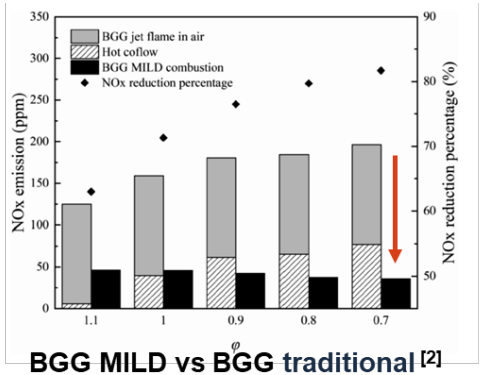
Enriched dilution

N_2 in BGG feedstock affects NO_x emissions.

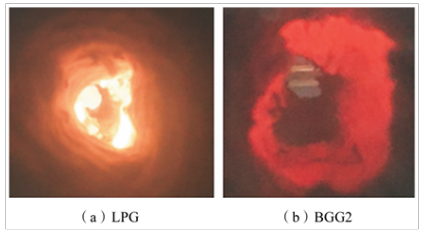
Issues in traditional combustion

- ✓ Difficulty in ignition
- ✓ Unstable combustion
- ✓ Low thermal efficiency
- ✓ Poor NO_x control

Perfect match



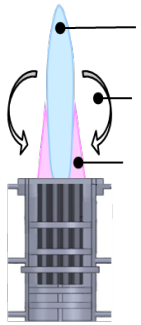
BGG MILD vs BGG traditional [2]



Fuel	CO/(mg · m⁻³)	NO_x/(mg · m⁻³)
LPG	373.1	239.3
BGG2	10.3	9.8

BGG MILD vs LPG traditional [3]

- Why MILD combustion works?



[5] Dally, *Combust. Flame*, 2004, 137, 418-431

MILD combustion by JHC burner

MILD combustion

High initial temperature

- Fuel preheating
- FGR
- Coflow

Enhanced oxidation

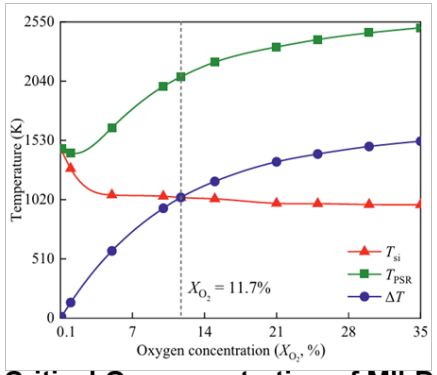
Distributed reaction zone

- High dilution
- Strong turbulence

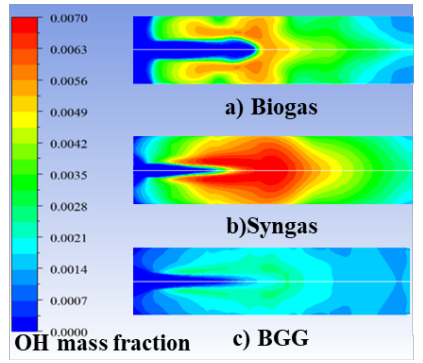
Lower T_{max}

Advantages of MILD combustion

- ✓ **Fuel flexibility**
- ✓ **Stable flame**
- ✓ **High efficiency**
- ✓ **Extremely low NO_x**



Critical O_2 concentration of MILD [4]

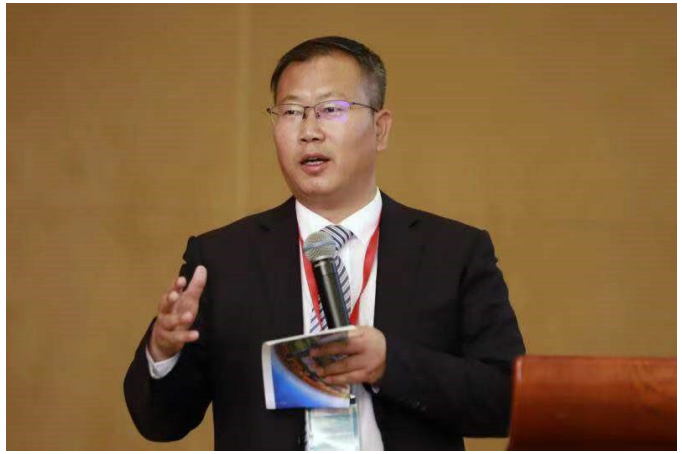


Dilution effect of BGG [5]

MILD combustion is an effective solution for clean and high-efficient use of BGG

Content

Research Team——TJU and TJCU



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Professor, Doctoral supervisor, Tianjin University/Tibet University

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- **IEA (International Energy Agency) China expert representative on biomass gasification**
- **Associate editor of *Biomass and Bioenergy***
- **Convener of ISO/TC255 Committee Group**

Prof. Chen focuses on the research of biomass waste to energy technology and environmental issues, and has presided over the national key research and development program projects, National Natural Science Foundation of China key projects, EU projects, etc. He is the director of Tianjin Key Laboratory of Biomass Waste Utilization, the director of Plateau Environmental Engineering and Pollution Control Autonomous Region Key Laboratory, and the president of Tianjin Institute of Sustainable Development. Prof. Chen has won two second prizes (ranked first) and one first prize (ranked fourth) of the National Science and Technology Progress Award, the third National Innovation Competition Award, the first prize of the ninth Overseas Chinese Contribution Award, and the Pandey Outstanding Contribution Award of the International Biological Process Society.

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- **Youth Science and Technology Award in Tianjin and Distinguished Youth Fund in Tianjin**
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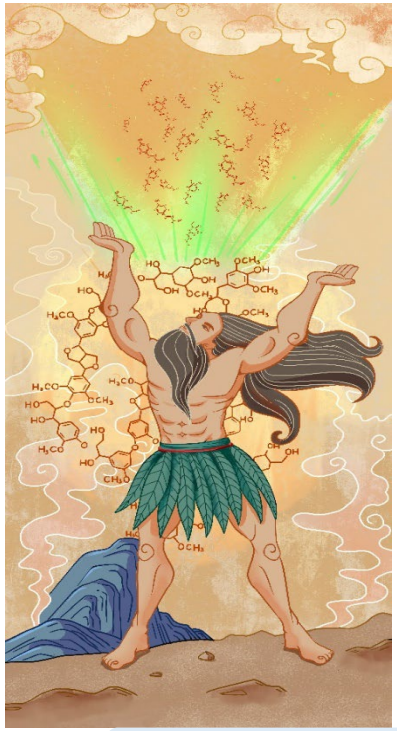
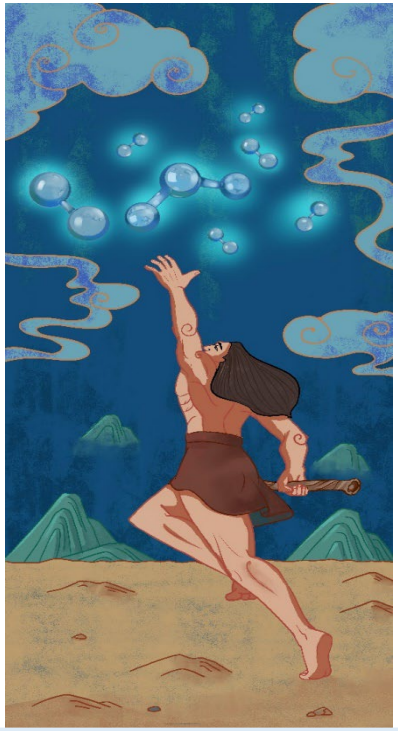
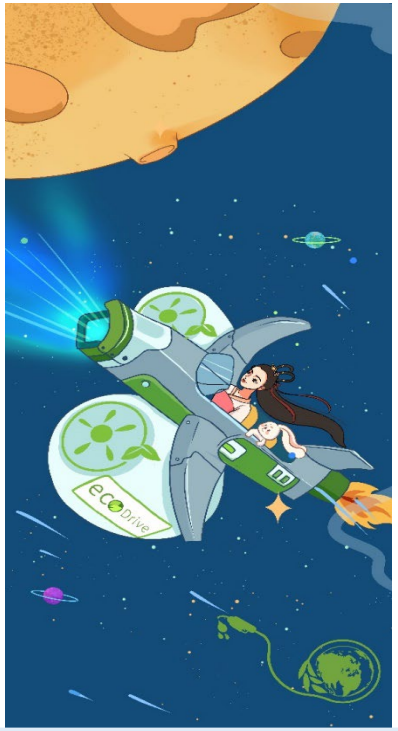
- **Journal of Chinese Academy of Engineering Young Communication expert**

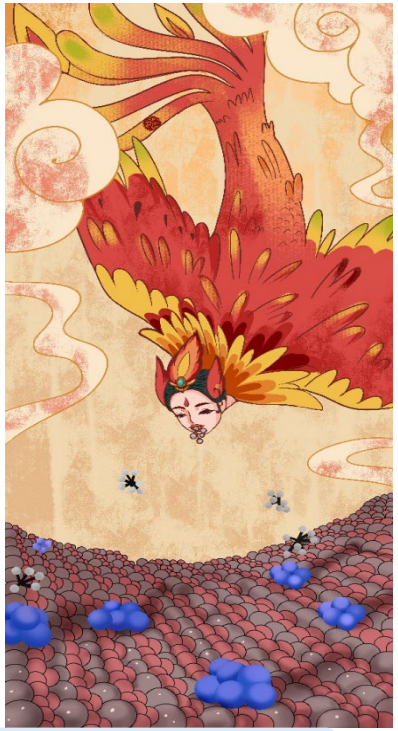
Research Team——TJU and TJCU

Welcome to visit at Tianjin University and Tianjin University of Commerce!









We combined traditional Chinese myths and legends with scientific research to form a distinctive research culture.

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IEA Bioenergy
Technology Collaboration Programme