



Biomass Clean Cooking & Heating in Rural China

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BIOENERGY
INTERNATIONAL

Opportunities for biomass deployment in Asia

Aug. 29, 2023, Online



Clean Cooking & Heating

Technologies &
Products

Policies &
Standards

Case Studies

Suggestions



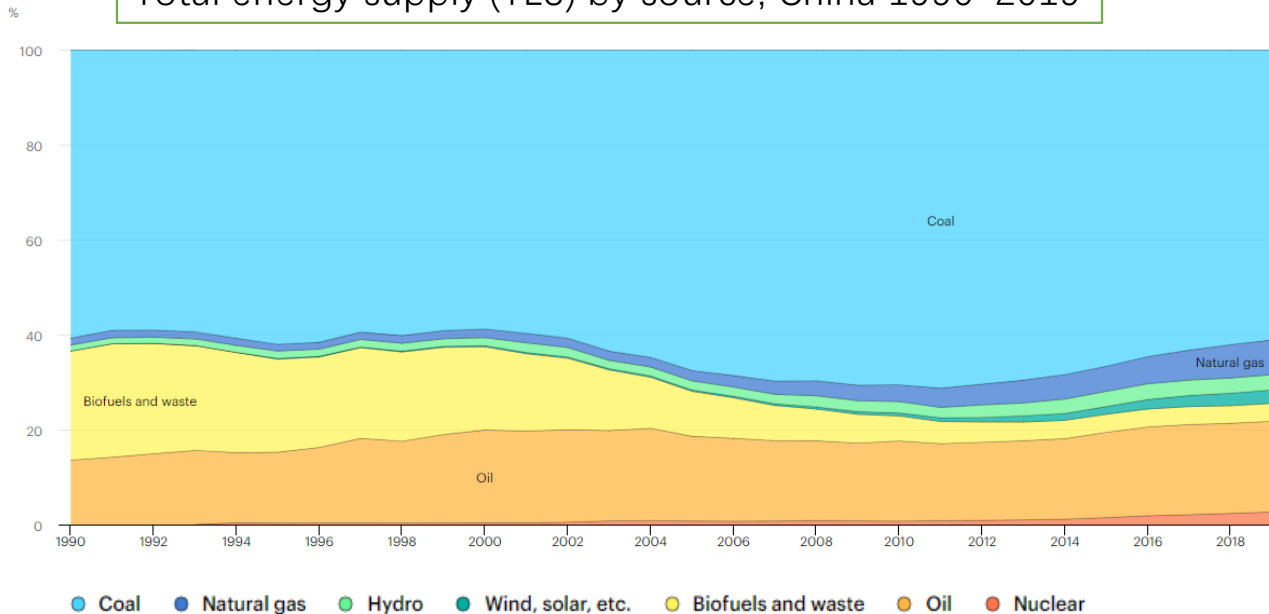
Part I

Background, Technologies & Products

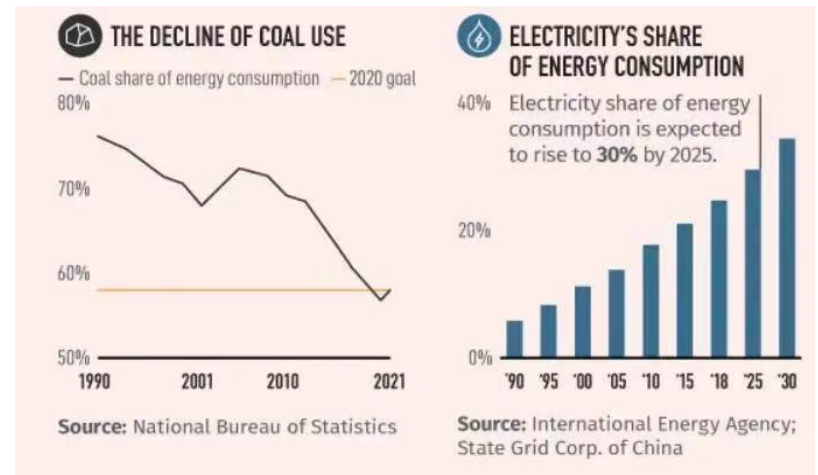
Energy Situation in Rural China

Changes in the Energy Structure in rural China.

Total energy supply (TES) by source, China 1990-2019



IEA. All rights reserved



visualcapitalist.com

Total Energy Consumption
Equivalent: **5.24 billion tce**

Coal Ratio:
56.0%

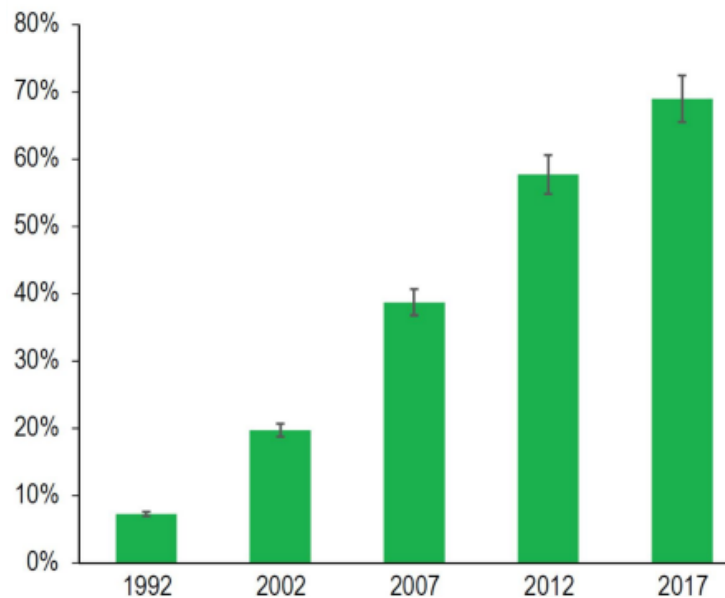
Clean Energy
Ratio: **25.5%**

Renewable Energy
Ratio: **14.2%**

2021 data

Living Energy Situation in Rural China

The national average clean cooking energy source fractions for 1992-2017



◆ The transition to modern energy sources for cooking in rural households is very notable.

Guofeng Shen, et al, National Science Review, 2022;

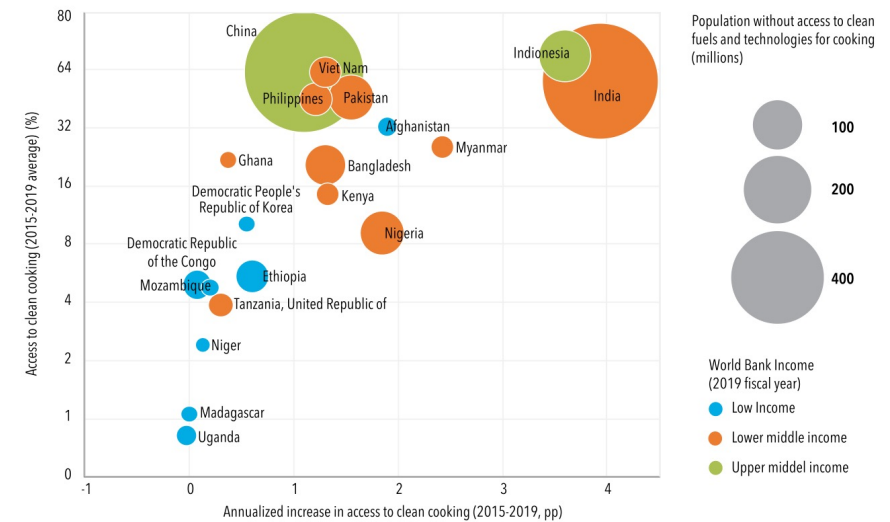
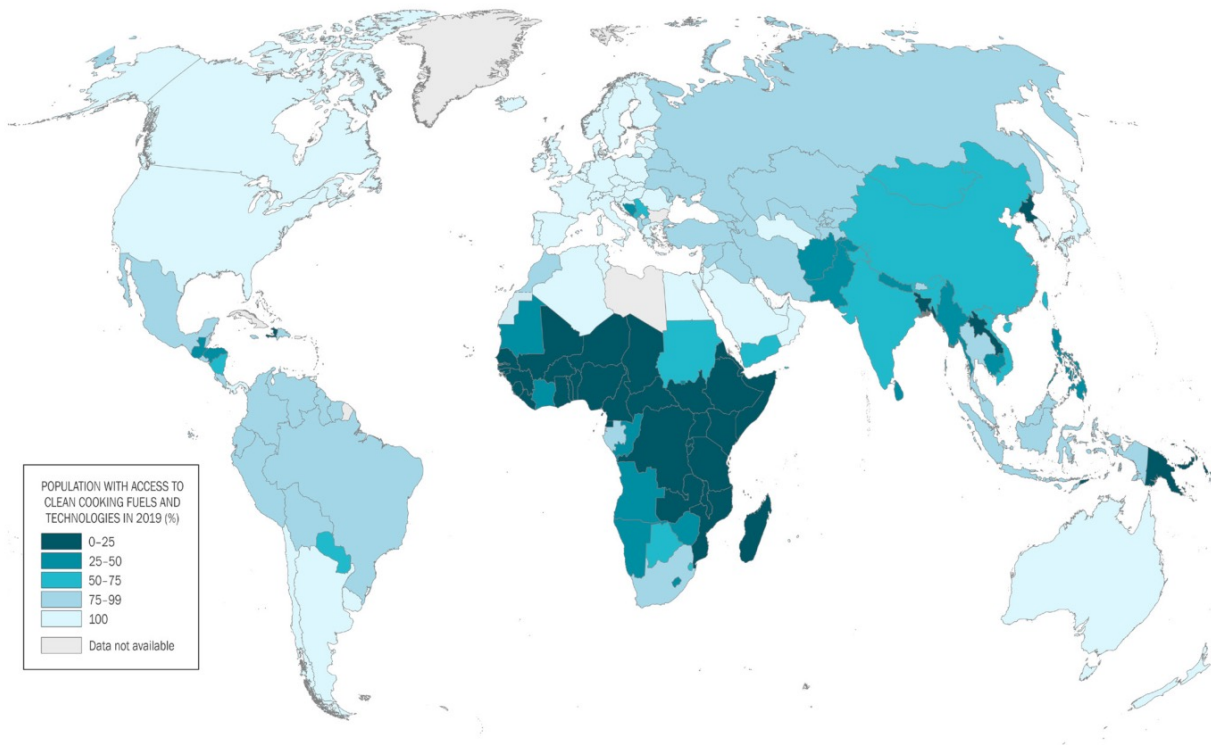
The spatial distribution of the clean cooking energy source fraction across the country.



◆ The dominance of clean energy sources like electricity and gaseous fuels for cooking was evident in most provinces.
◆ In the less developed western areas, coal and biomass were still dominant fuels that were used frequently for cooking.

Cooking & Heating Situation in Developing Countries

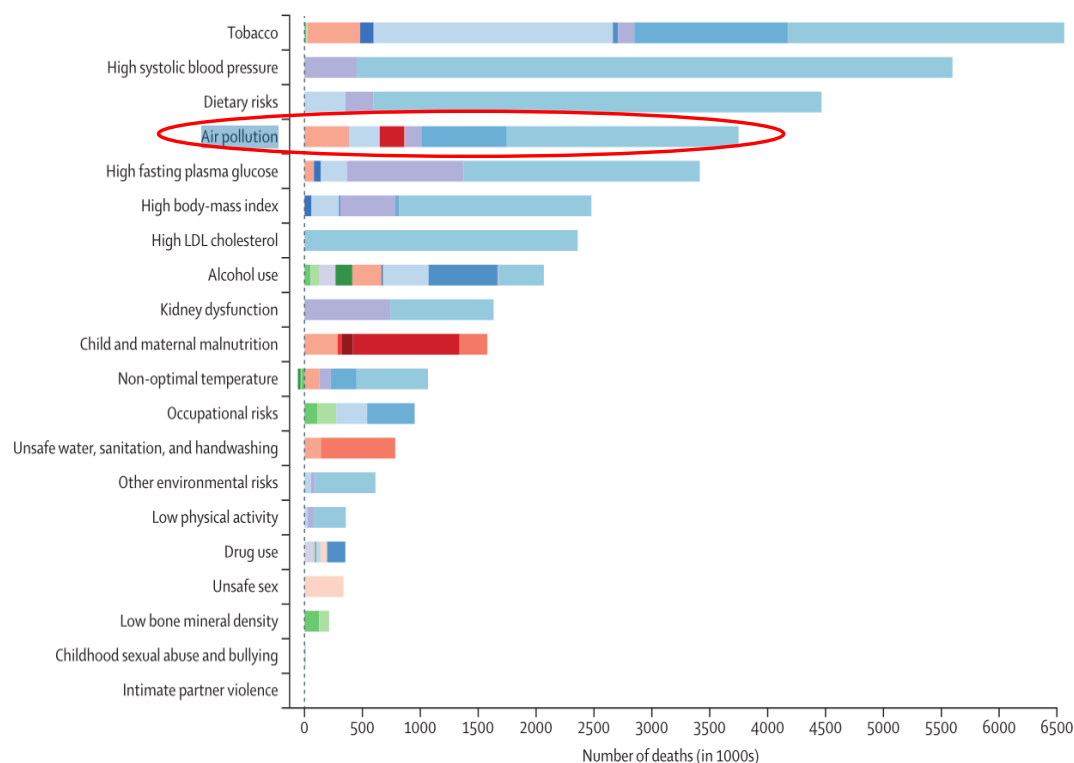
Percent of population with access to clean cooking fuels and technologies by country, 2019



Country / region	Population	Clean energy access rate (2019)	Solid fuel rate (2019)
China	1.44 billion	64%	36%
Philippines	12 million	47%	53%
Vietnam	92 million	65%	35%
Bangladesh	160 million	23%	77%
Pakistan	208 million	49%	51%
Mongolia	3.06 million	52%	48%

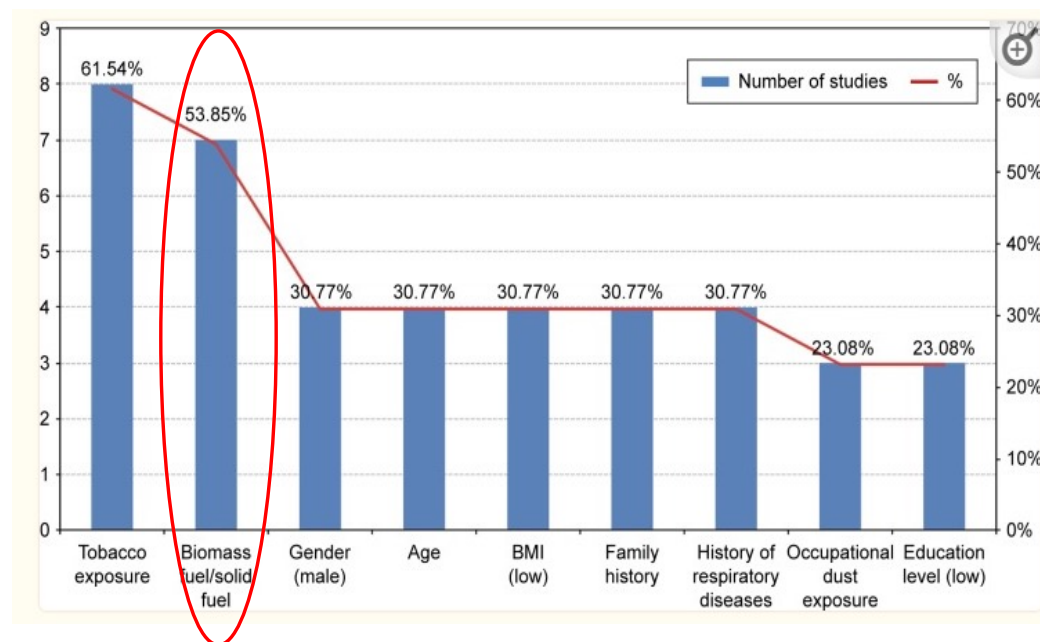
Burden of disease in developing countries

Global attributable deaths from risk factors for males in 2019



GBD 2019 Risk Factors Collaborators (2020). Global burden of 87 risk factors in 204 countries and territories, 1990-2019: a systematic analysis for the Global Burden of Disease Study 2019. *Lancet (London, England)*, 396(10258), 1223–1249. [https://doi.org/10.1016/S0140-6736\(20\)30752-2](https://doi.org/10.1016/S0140-6736(20)30752-2)

Risk factors of COPD in China



Zhu B, Wang Y, Ming J, Chen W, Zhang L. Disease burden of COPD in China: a systematic review. *Int J Chron Obstruct Pulmon Dis*. 2018;13:1353-1364. Published 2018 Apr 27. doi:10.2147/COPD.S161555

What's your
daily fuels
for cooking
and heating
?



Nature Gas



Electricity



Ethonal



The General Overview of Clean Cooking & Heating in Rural China

Plenty of Biomass Resources in China

- Residue of agricultural crops: more than **800 million tons**
- Residue of forest & orchard waste: more than **1000 million tons**
- There have been **2000 manufactories** of biomass solid fuel in China
- Annual production of biomass solid fuel is above **20 million tons**



Cooking & Heating in developing countries

UGANDA, NEPAL, KENYA, LAOS, CAMBODIA.....



Cited from Phnom Penh (GIZ) , Ganesh Ram Shretha (CRT)

Cooking & Heating in developing countries

CHINA IN PAST



AIMS

Change ?



Emission Reduction

Energy Saving

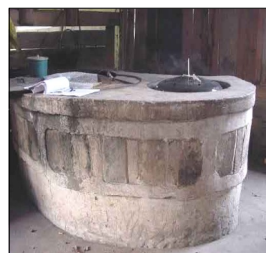
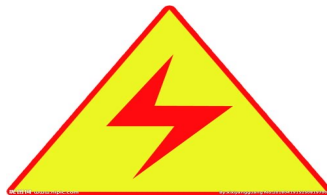
Health Protection

2.493 tons CO₂ reduction per ton Standard Coal Replacement

Energy Transformation and Clean Energy Access



Clean Fuels
replacement



Clean
cooking and
heating
Models



2

Clean Cooking & Heating Models in Rural China

Clean Cooking and Heating Modles in Rural China

■ Nature gas and Methanol as the fuel



Nature gas



Natural gas cooking stove



Wall mounted gas boiler



Natural gas heating stove



Natural gas heater



Umbrella natural gas heating stove



Methanol



Methanol cooking stove



Methanol heating stove



Methanol heating boiler



Methanol heating stove

Clean Cooking and Heating Modles in Rural China

■ Electricity as the fuel



Electromagnetic furnace



Infrared microwave oven



Electricity boiler



Electric radiator



Warm air blower



Electric foot warmer



Regenerative electric heating



Air source heat pump



Electric heating water cycle bed



Electricity heating stove

Clean Cooking and Heating Models in Rural China

■ Coal and Biomass as the fuel

Coal



Honey coal stove



Blue-coal stoves



Clean coal stoves

Biomass



Biomass pellet stove



Biomass heating stove



Biomass hot blast stove



Clean Cooking and Heating Modles in Rural China

■ The types of biomass fuels

Free



Straw



Corn cob



Firewood

Need to pay



Biomass Pellets



Biomass Briquettes



Biomass Chips

Clean Cooking and Heating Modles in Rural China

■ The types of coal fuels



Fine coal



Raw coal



Coal Briquette

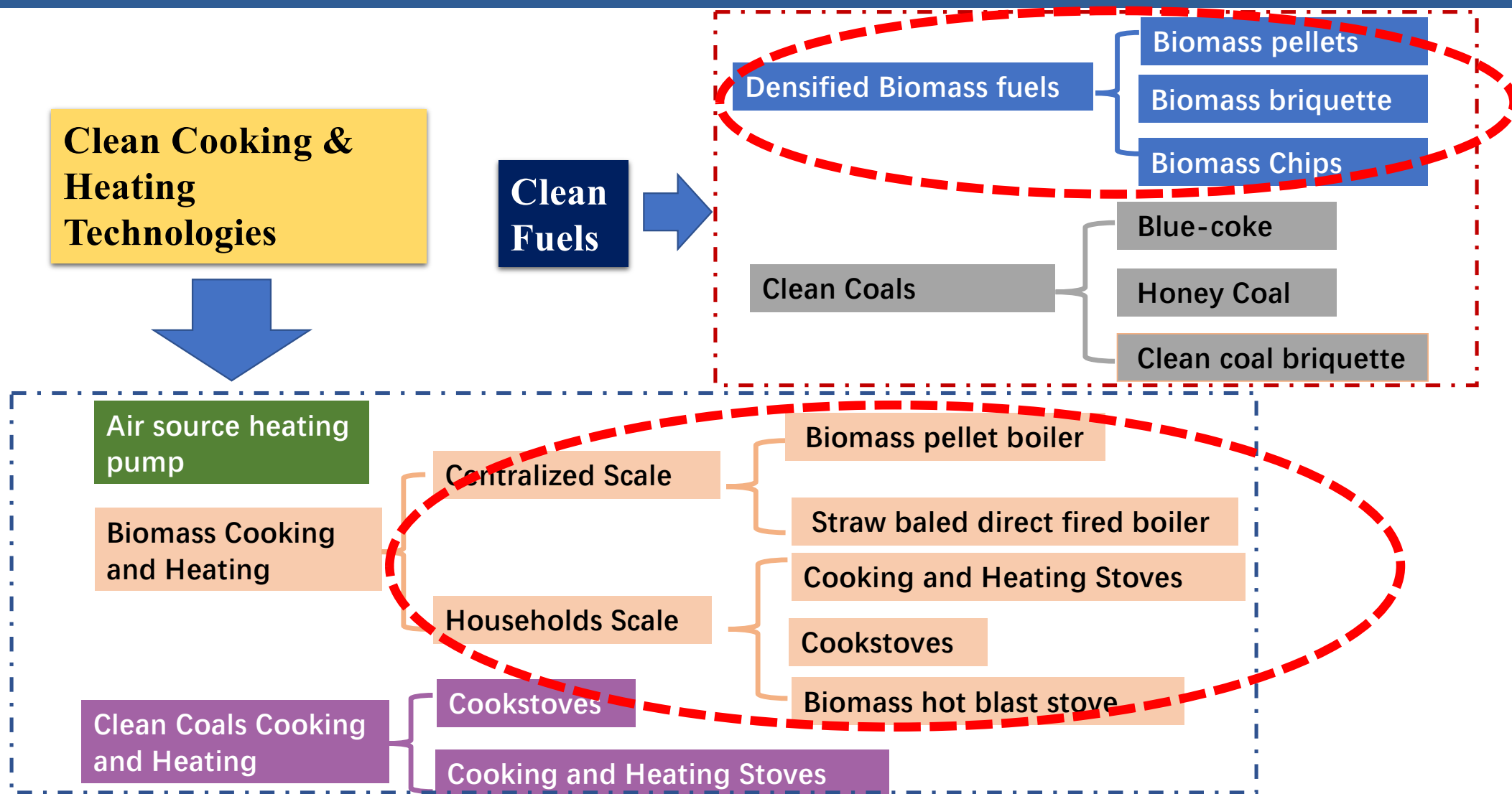


Honeycomb coal

3

Typical Clean Cooking & Heating Technologies in Rural China

Typical Clean Cooking & Heating Technologies in Rural China



Typical Clean Cooking & Heating Technologies in Rural China

No.1 Biomass Pellets Making Technologies

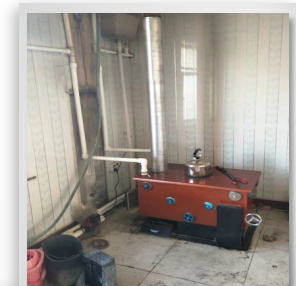
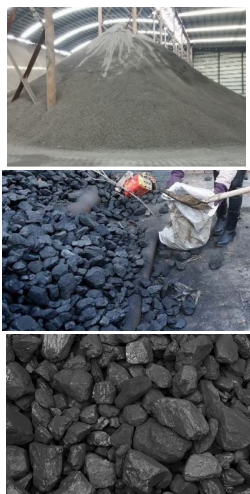
- Residue of agricultural crops: more than **800 million tons**
- Residue of forest & orchard waste: more than **1000 million tons**



- There have been **2000 manufacturers** of biomass solid fuel in China
- Annual production of biomass solid fuel is above **20 million tons**

Typical Clean Cooking & Heating Technologies in Rural China

No.2 Clean Coal Making Technologies



神木新闻
http://www.sxm.gov.cn

Typical Clean Cooking & Heating Technologies in Rural China

No.3 Clean Household Biomass Stoves Technologies

(1) Classified by Using Function

Cookstoves



Cooking and Heating Stoves

Cooking and radiant heating stove



Cooking and water heating stove



Biomass hot blast stove



Typical Clean Cooking & Heating Technologies in Rural China

Cooking stoves



Typical Clean Cooking & Heating Technologies in Rural China

Cooking and Heating Stoves

Cooking and radiant heating stove



Cooking and water heating stove



The Type of Clean Heating Technology in Rural China

(2) Classified by heating model:



Water heating stove



Radiant stove



Hot blast stove



Wall-hung stove



Kang (bed) stove



Typical Clean Cooking & Heating Technologies in Rural China

No.4 Clean Biomass Centralized heating Technologies

Fuels Type:

Pellets, Briquettes, Chips



Boilers Type:

Biomass Pellets Boilers



Typical Clean Cooking & Heating Technologies in Rural China

No.5 Clean Biomass Centralized heating Technologies

Fuels Type:

Straw Bale



Boilers Type:

Straw baled direct fired boiler





Part II

Policies System of Clean Cooking and Heating in Rural China

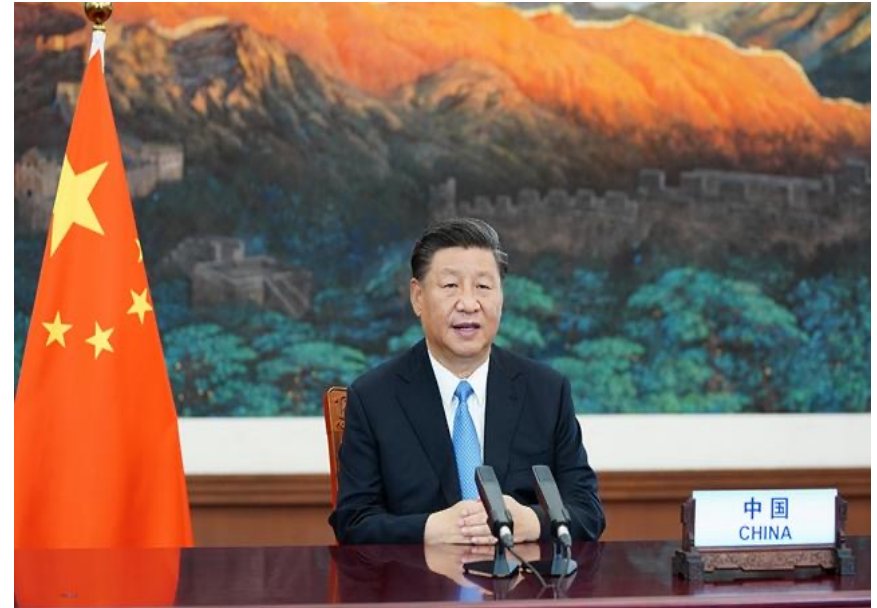


Peaking Carbon Dioxide Emissions

Carbon Neutrality

China has set its long-awaited carbon neutrality target, with President Xi Jinping announcing that China will comply with the **net-zero carbon dioxide** ambitions by 2060.

—— United Nations General Assembly in New York ,Sept. 22, 2020



In meeting the climate challenge, no one can be aloof and unilateralism will get us nowhere. Only by upholding multilateralism, unity and cooperation can we deliver shared benefits and win-win for all nations.

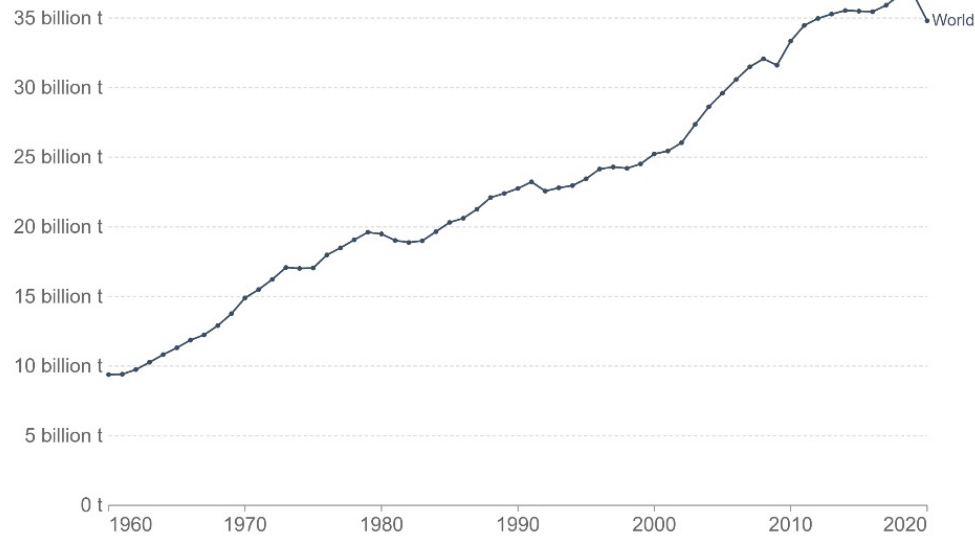
China welcomes all countries' **support for the Paris Agreement** and their greater contribution to tackling climate change.

—— Climate Ambition Summit, Dec. 12, 2020

The CO₂ Emission Situation

Annual CO₂ emissions

Carbon dioxide (CO₂) emissions from the burning of fossil fuels for energy and cement production. Land use change is not included.

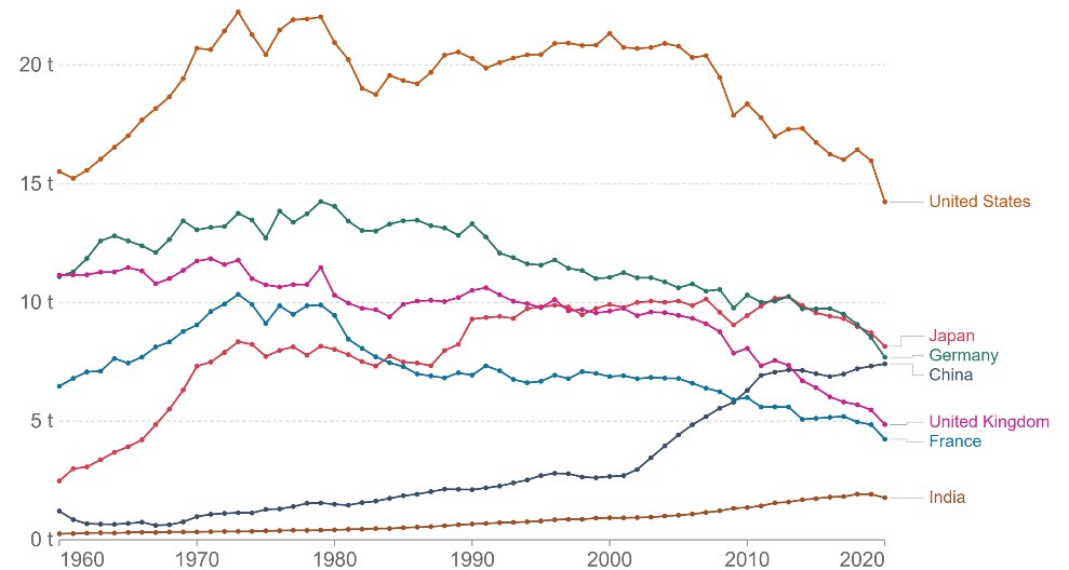


Source: Global Carbon Project
OurWorldInData.org/co2-and-other-greenhouse-gas-emissions/ • CC BY
Note: CO₂ emissions are measured on a production basis, meaning they do not adjust for emissions embedded in traded goods.

Annual CO₂ Emission of world

Per capita CO₂ emissions

Carbon dioxide (CO₂) emissions from the burning of fossil fuels for energy and cement production. Land use change is not included.



Source: Our World in Data based on the Global Carbon Project
OurWorldInData.org/co2-and-other-greenhouse-gas-emissions/ • CC BY
Note: CO₂ emissions are measured on a production basis, meaning they do not adjust for emissions embedded in traded goods.

Per capita CO₂ Emission of some countries



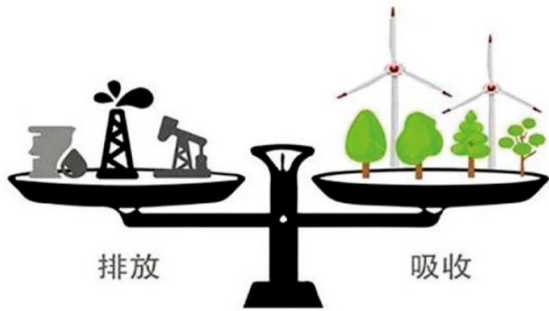
Theory of “Two Mountain”



We need both **green waters and green mountains**, and **gold and silver mountains**. It's better to have green water and green mountains than gold and silver mountains, and green water and green mountains are gold and silver.

---September 7, 2013, when Xi Jinping answered questions from students at Kazakh, Steiner, Zal and bayev University,

碳中和
Carbon Neutral



Carbon neutralization pathway

Carbon
substitution

carbon
emission
reduction

carbon
sequestrati
on

carbon
cycle

Saving energy

improving energy efficiency

artificial carbon transformation

forest carbon sink

Policies System of Clean Cooking and Heating in Rural China



Digestion for Biogas



Pyrolysis for Syngas



Distillation for Liquid fuels



Combustion for Cooking and Heating

Policies System of Clean Cooking and Heating in Rural China

■ Heating energy consumption and pollutant emission in northern China

	Energy Consumption (Standard coal)	Emission of the main Air Pollutants (PM SO _x NO _x)	Carbon Dioxide Emission Ratio (A total of 1 billion tons)
City	100 million tce (9 billion square meters of building)	25%	1/3
Country Town	100 million tce (5 billion square meters of building)	25%	1/3
Village	140 million tons of tce (0.7 million households)	50%	1/3

Policies System of Clean Cooking and Heating in Rural China

■ Pollution caused by raw coal



Air pollution



Haze



Harm to human body

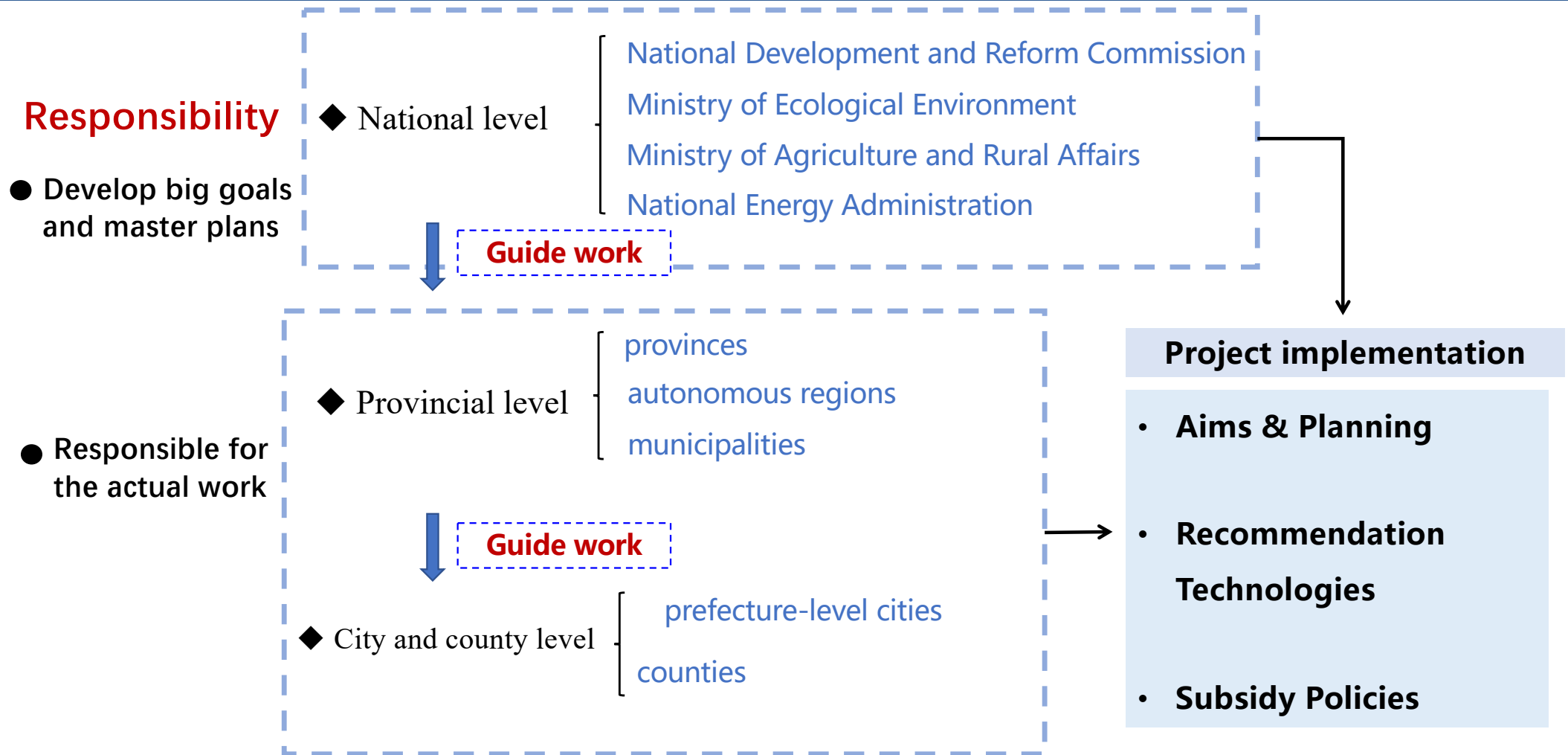


Water pollution



Harm the respiratory system

Policies System of Clean Cooking and Heating in Rural China



Policies System of Clean Cooking and Heating in Rural China

Recommendation Technologies

Electricity

Air source hot air heat pump

Air source hot water heat pump

Biomass

Centralized heating

Biomass Pellets Boilers

Straw baled direct fired boiler

Decentralized heating

Biomass heating stove

Biomass water heating stove

Biomass Kang stove

Natural gas

Natural gas wall-hung boiler

Geothermal

Geothermal Heating System

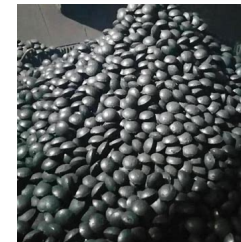
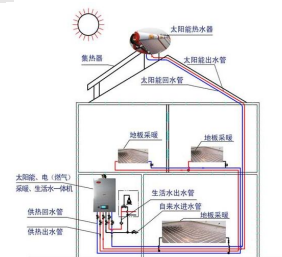
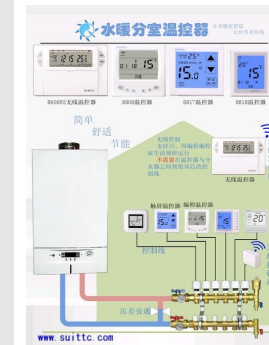
Solar energy

solar heating system

Clean coal

Honey Coal, Blue-coke, Coal Briquettes

Cooking & Heating Stove



Policies System of Clean Cooking and Heating in Rural China

Typical Policies supporting Biomass Clean Heating

1

Clean Winter Heating Plan in Northern China (2017 - 2021)-NDRC [2017] No. 2100 (2017.12)

For those in remote mountainous areas that cannot temporarily replace scattered coal heating by clean heating, it is necessary to focus on the use of "clean briquette + environmentally friendly stoves", "**biomass briquette fuel + special stoves**" and other modes to replace scattered coal heating.

2

Notice on further clean heating work-NDRC [2019] No. 1788 (2019.12)

Concentrated heating with biomass or decentralized heating with '**biomass briquette + special stove**'

3

Beijing-Tianjin-Hebei and its surrounding areas, Fenwei Plain, 2020 – 2021 autumn and winter air pollution comprehensive control action plan-MEPC [2020] No. 61 (2020.10)

In mountainous areas where there is no alternative to clean energy, 'clean coal + energy saving and environmental protection furnace' and '**biomass briquette + special furnace**' are allowed to be used for heating.

4

Notice of National Energy Administration on Renewable Energy Heating-NEB [2021] No. 3 (2021.2)

Promotion of household **biomass heating** according to local conditions

5

The bioeconomy during the 14th Five-Year Plan period (2021-25)-NDRC [2021] No. 1850 (2021.5)

Support the county to carry out biomass clean heating instead of coal-fired, steady development of municipal solid waste incineration cogeneration, promote biogas, biomass briquette and other **biomass**

Policies System of Clean Cooking and Heating in Rural China

The 14th Five Year Plan for Renewable Energy

- ❑ **Developing biomass energy for clean heating.** Reasonably develop biomass boilers for heating, mainly based on agricultural and forestry biomass, biomass briquettes, etc. **Encourage the use of large and medium-sized boilers for centralized heating.**
- ❑ **Carrying out biomass energy clean heating demonstration.** Carrying out pilot demonstrations of biomass energy clean heating in rural areas. **Promoting "biomass pellets +household stoves" and centralized biomass boiler heating**

Clean Heating Background & Objectives in China

Subsidy Policies

Source of subsidies

--Three-tier subsidy mechanism

Subsidy of central government



Provincial financial subsidies



Municipal and county financial subsidies

Subsidy content

● Equipment subsidies

- ◆ **Natural gas** heating equipment ,about **4000 RMB** subsidies.
- ◆ **Air source hot water heat pump** , about **7000-10000 RMB** per household.
- ◆ **Straw baled direct fired boiler**, about **500,000 RMB** subsidies per project.
- ◆ **Biomass pellet stoves**, about **2000-4000 RMB** subsidies per household.
- ◆ **Coal-fired stoves**, about **1500-3500 RMB** subsidies per household.

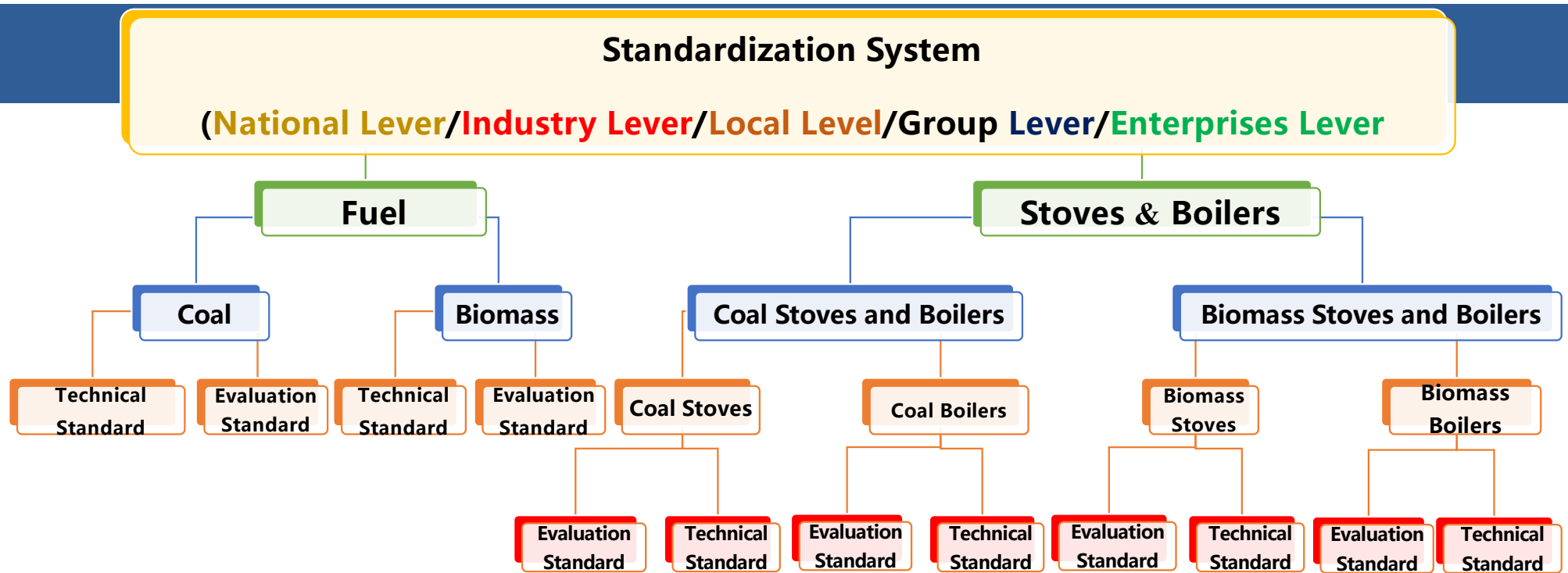
● Fuel subsidies

- ◆ **Natural gas**: about **0.45 RMB/m³**
- ◆ **Electricity**: **0.1-0.3 RMB/kw h**
- ◆ **Clean coal**: **300-600 RMB/t**
- ◆ **Biomass pellet**: about **600 RMB/t**



Part III

Standards System of Clean Cooking and Heating in Rural
China



Fule Standardization

- TS:**
- ✓ Strength
 - ✓ Salorific value
 - ✓ Composition
- ES:**
- ✓ Testing method
 - ✓ Standard limit

Stoves & Boilers Standardization

- TS:**
- ✓ Thermal efficiency
 - ✓ Emissions
 - ✓ Heating power
- ES:**
- ✓ Testing method
 - ✓ Standard limit

Standardization construction of biomass stoves

Current fuels standards --- Biomass fuel standards

	Standard name	Standard	Standard type
Technical Standard	Specification for densified biofuel	NY/T 1878-2010	Agricultural standards
	Technical conditions for densified biofuel molding equipment	NY/T 1882-2010	Agricultural standards
	Quality classification for biomass briquette fuel	NB/T34024-2015	Energy standard
	Quality classification for biomass solid briquetting fuel	NY/T 2909-2016	Agricultural standards
Evaluation Standard	Densified biofuel—Methods for sampling	NY/T 1879-2010	Agricultural standards
	Densified biofuel--Test methods	NY/T 1881-2010	Agricultural standards
	Proximate analysis of solid biofuels	GBT 28731-2012	National standard
	Determination of calorific value for solid biofuels	GBT 30727-2014	National standard
Public Standard	General testing rules for solid biofuels	GB/T 21923-2008	National standard
	Densified biofuel-Terminology and definitions	NY/T 1915-2010	Agricultural standards

Examples of Important Indicators :

Specification for densified biofuel ---NY/T 1878-2010

- ✓ Density: $\geq 1000 \text{ kg/m}^3$
- ✓ Moisture: $\leq 13 \%$
- ✓ Ash: $\leq 6 \%$
- ✓ Net calorific value: $\geq 16.9 \text{ MJ/kg}$
- ✓ Percent reduction: $\leq 5 \%$
- ✓ Potassium: $\leq 1 \%$
- ✓ Sulfur: $\leq 0.2 \%$
- ✓ Chlorine: $\leq 0.8 \%$

Standardization construction of biomass stoves

Current fuels standards --- Residential Coal standards

	Standard name	Standard	Standard type
Technical Standard	Division of variety and grading for coal products	GB/T 17608-2006	National standard
	Commercial coal quality—Civil bulk coal	GB/T 34169-2017	National standard
	Commercial coal quality—Civil briquette	GB/T34170-2017	National standard
Evaluation Standard	Densified biofuel—Methods for sampling	GB/T 214-2007	National standard
	Test method for analysis of coal ash	GB/T 1574-2007	National standard
	Proximate analysis of coal	GB/T 212-2008	National standard
	Determination of calorific value of coal	GB/T 213-2008	National standard
	Determination of carbon and hydrogen in coal	GBT 476-2008	National standard
	Quality evaluation and control guide for commercial coal	GB/T 31356-2014	National standard
	Ultimate analysis of coal	GB/T 31391-2015	National standard

Examples of Important Indicators :

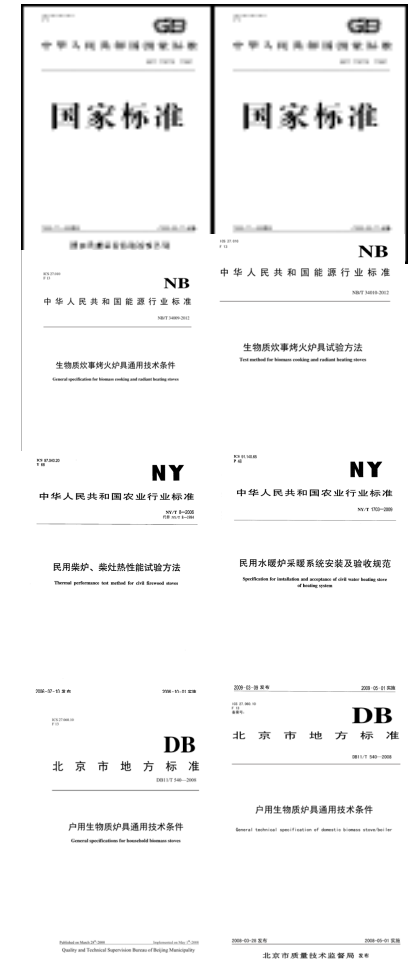
Commercial coal quality—Civil briquette --GB/T34170-2017 (Honeycomb coal)

- ✓ Cold compressive strength: $\geq 600 \text{ N}$
- ✓ Calorific value: $\geq 21.00 \text{ MJ/kg}$
- ✓ Volatile matter: $\leq 10 \%$
- ✓ Total Sulfur: $\leq 0.5 \%$
- ✓ Phosphorus: $\leq 0.1 \%$
- ✓ Chlorine: $\leq 0.15 \%$
- ✓ Arsenic: $\leq 20 \mu\text{g/g}$
- ✓ Mercury: $\leq 0.25 \mu\text{g/g}$
- ✓ Fluorine: $\leq 200 \mu\text{g/g}$

Standardization construction of biomass stoves

Standards for biomass heating Stoves

Standard name	Standard	Standard type
Thermal performance test method for civil firewood stoves	NY/T 8-2006	Agricultural standard
General technical specification of domestic biomass stove/boiler	DB11/T540-2008	Local standard
Biomass briquette stoves	DB13/T1407-2011	Local standard
Test method for biomass cooking& heating stoves	NB/T 34008-2012	Energy standard
Safety operation rules of household straw gasifier	DB32/T 2145-2012	Local standard
General technical conditions for biomass cooking and heating stoves	NB/T 34007-2012	Energy standard
General technical specification of domestic biofuel cooking stove	NY/T 2369-2013	Agricultural standard
Test method for biomass Kang stove	NB/T 34016-2014	Energy standard
General specification for biomass Kang stove	NB/T 34017-2014	Energy standard
Civil clean combustion furnace	DB13/T2125-2014	Local standard
Technical conditions of small biomass hot blast furnace	NB/T 34040-2017	Energy standard
Test method of small biomass hot blast furnace	NB/T 34041-2017	Energy standard
Test method of clean heating stove	NB/T 34005-2020	Energy standard
Technical Conditions of Clean Heating Furnace	NB/T 34006-2020	Energy standard
Technical conditions of cleaning cooking and radiant heating stoves	NB/T 34009-2021	Energy standard
Test method for cleaning cooking and radiant heating stoves	NB/T 34010-2021	Energy standard



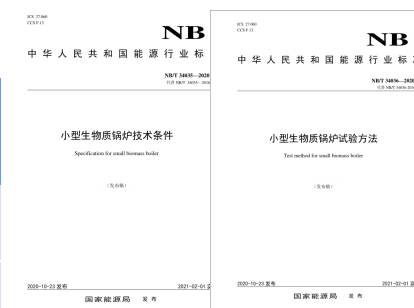
Standardization construction of biomass stoves

Biomass boiler standards

Standard name	Standard	Standard type
Technical specification for the biomass boilers using cooled vibrating grate	NB/T 42117-2017	Energy standard
Technical specification for the biomass chain and travelling grate stoker boiler	NB/T 42118-2017	Energy standard
Biomass molded fuel fired boilers	NB/T 47062-2017	Energy standard
Specification for preparation of feasibility study report on densified biofuel heating projects	NB/T 34039-2017	Energy standard
Technical Conditions of Small Biomass Boiler	NB/T 34035-2020	Energy standard
Test Method for Small Biomass Boilers	NB/T 34036-2020	Energy standard

emission standards at present

Atmospheric pollutant	Smoke/(mg/m ³)	Sulfur dioxide/(mg/m ³)	Nitrogen oxides/(mg/m ³)	Smoke blackness
NB/T 47062-2017	50	30	150	1
NB/T 34035-2020 (key areas)	50	50	300	1
NB/T 34035-2020 (other)	30	30	200	1



Standardization construction of biomass stoves

Standards of Coal Cooking & Heating Stoves/boiler

Standard name	Standard	Standard type
Technical specification of domestic improved stoves and kangs for firewood and coal	NY/T 1001-2006	Agricultural standard
Full requirements of civil coal-fired heating furnace case	DB11/T587-2008	Local standard
Test method for household coal stoves	GB/T 6412-2009	National standard
Test method for the performance of civil kang	NY/T 58-2009	Agricultural standard
Specification for installation and acceptance of civil water heating stove of heating system	NY/T 1703-2009	Agricultural standard
Civil coal-fired stoves	DB52/T590-2010	Local standard
Emission standard of air pollutants for boiler	GB/T 13271-2014	National standard
General technical specification for civil water heating coal stove	GB/T 16154-2018	National standard
Test method for performance of civil water heating coal stove	GB/T 16155-2018	National standard



emission standards at present

Standard	Stove Type	SO ₂ mg/m ³	NO _x mg/m ³	Smoke mg/m ³	CO %	η %
GB13271-2014	Coal-fired boilers in use	400	400	80	/	/
	New coal-fired boiler	300	300	50		/
	Key areas	200	200	30		/
GB/T 16154-2018	Water heating stove	≤100	≤150	≤50	≤0.2	/
NB/T 34006-2020	heating stove (Excellent)	<100	<150	<30	<0.1	>75
	heating stove (Qualified)	100-200	150-250	30-50	0.1-0.2	65-75
	heating stove(Unqualified)	>200	>250	>50	>.2	65<



Part IV

Case Studies

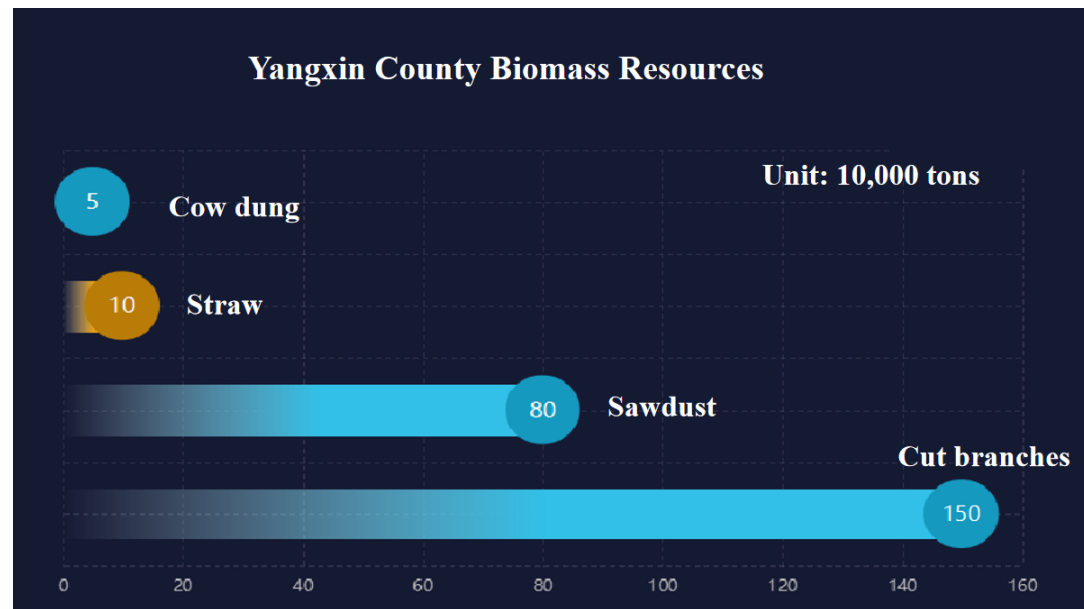
Case Study I

Biomass Cooking & Heating Project in Yangxin County, Shandong Province

◆ Abundant biomass resources

Background

- Towns: 8
- Villages: 854
- Households: 95 thousands
- Heating time: 4 months/year



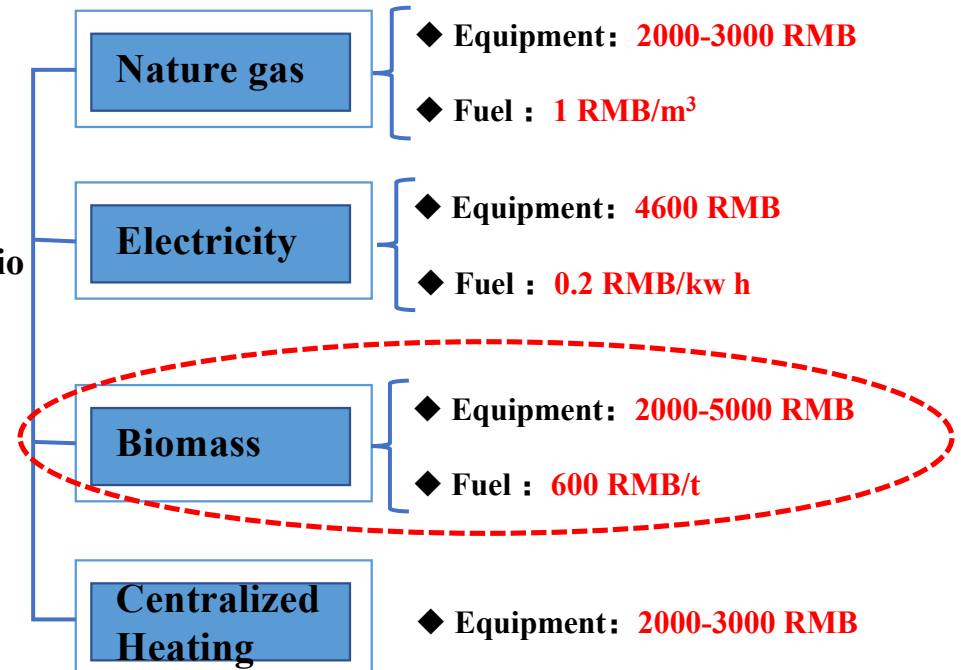
Case Study I

Policies supporting Clean Cooking & Heating



● Recommendation Technologies

Subsidy policy

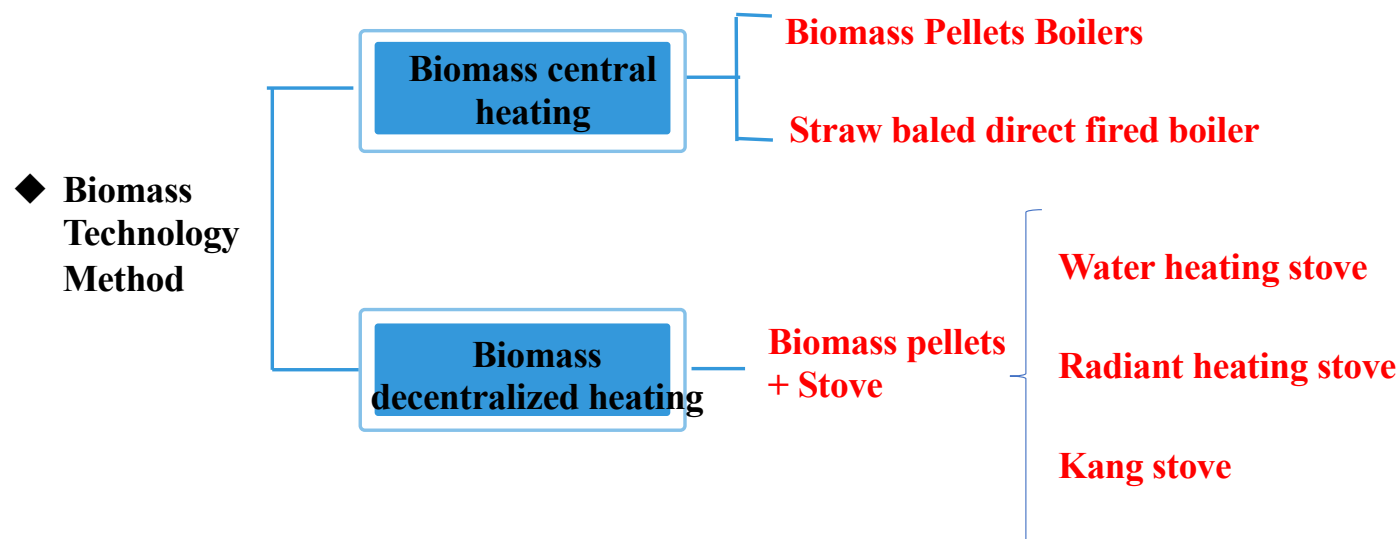


Before 2017, **coal was widely used as energy for cooking and heating** in rural areas

Case Study I

Biomass Cooking & Heating Project in Yangxin County, Shandong Province

Recommended Technologies



	2018	2019	2020	2021
Cumulative number of renovated households	25,034	46,320	81,903	95,646

Account for the total households
95.2%.

Case Study I

Biomass Cooking & Heating Project in Yangxin County, Shandong Province

Benefits



Social Benefit

- Each year, by utilizing agricultural and forestry wastes, replacing **350,000t** of **coal**, reducing **CO₂** emissions by **872,550t**.



Environmental Benefit

- The air quality was greatly improved from 2017 to 2020. PM_{2.5} decreased from **70 µg / m³** in **2017** to **55 µg / m³** in **2020**, which was reduced by **21.5 %**.



Economic Benefit

- Compared with electricity and natural gas, the cost of biomass **renovation cost** is reduced by **38 %** and **32 %** respectively, and the **use cost** is reduced by **52 %** and **51 %** respectively.

Case Study II

Laowan Household stoves in Changwu County, Shanxi Province(2020)

Background

- ❑ Promoted biomass briquettes stoves:
14,200 sets
- ❑ Briquettes made from branches of fruit tree
- ❑ Total Investment:
58.69 million RMB

Effects

- ❑ Energy saving: **24%**
- ❑ Operating cost saving:
975RMB per year
- ❑ CO₂ reduction:
78,000 tons/year



Case Study III

Xunda Cooking Stoves Project in Myanmar- “Small Stove Change Big Climate”

The Friendship Bridge between China and Myanmar

Background

On March 8, 2016, Xunda Group Co., Ltd. successfully won the bid for 10000 sets in the bidding of the National Development and Reform Commission's donation gift project to deal with climate change - Myanmar clean stove project.

Effects

On March 28, nearly 40 officials and technicians from related departments in 14 provinces of Myanmar were trained in the use and maintenance of clean stoves. Clean stoves used in Myanmar results in great Contribution for greenhouse gas reduction.



“XUNDA” stoves

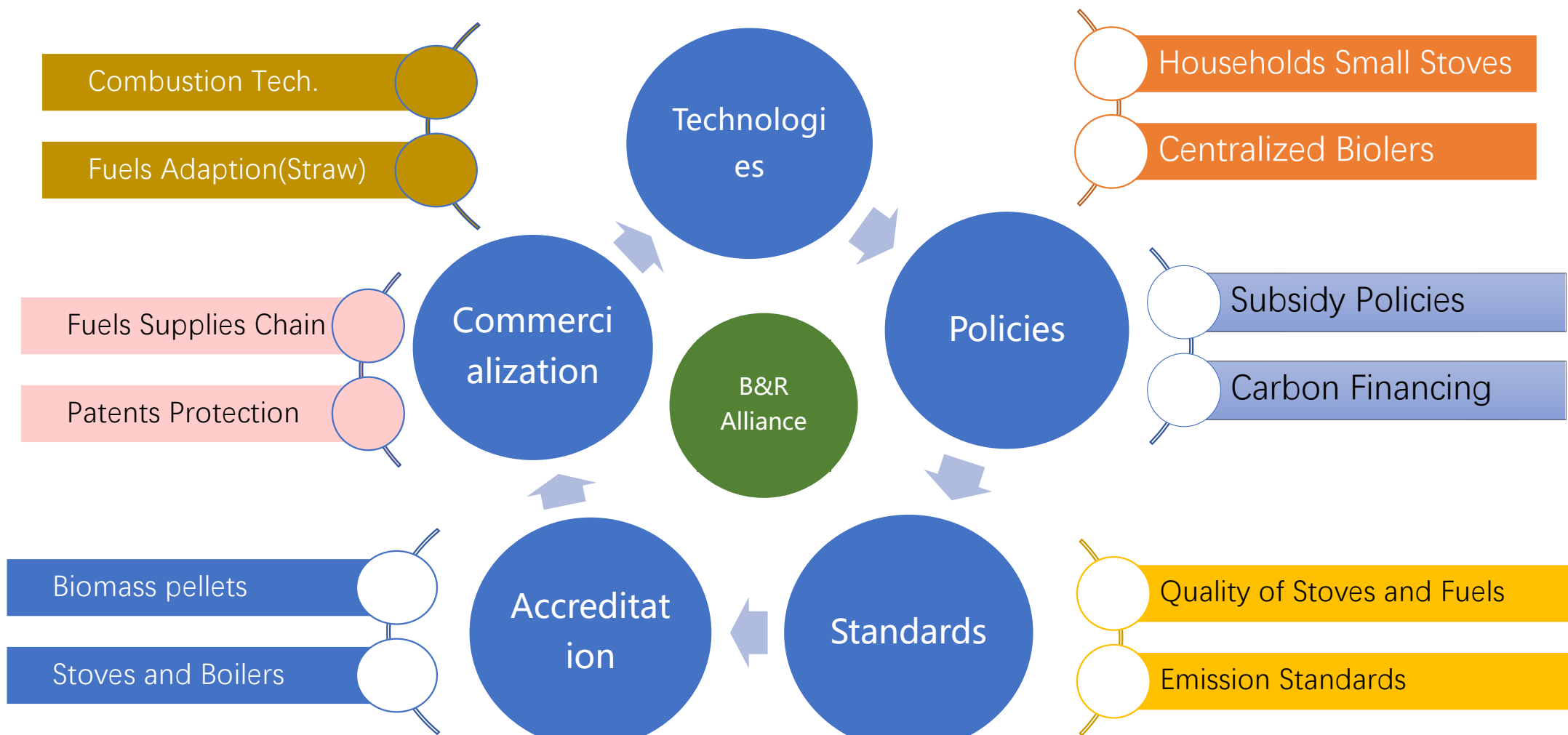


Part V

Suggestions

筹建“一带一路”清洁燃料与炉具联盟

Suggestions for Establishing the B&R Alliance on Clean Fuels & Stoves





Welcome to BUCT, Beijing, China

International Cooperation Forum on Clean Cooking and Heating with Biomass

Date 19th - 21st October, 2023

Venue Conference Center, Beijing University of Chemical Technology

Approved by : Ministry of Education

Supervising by:

- ☐ Rural Energy and Environment Agency, Ministry of Agriculture and Rural Affairs
- ☐ Foreign Environmental Cooperation Center, Ministry of Ecology and Environment

Organizer: Beijing University of Chemical Technology

Co-Organizers:

- ☐ China Association of Rural Energy Industry
- ☐ China Biogas Society
- ☐ China Agricultural University

Thanks for listening



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