
Low-carbon Transition Pathways of Coal power under China's Carbon Neutrality

From Stranded Assets and Financial Risk Perspective

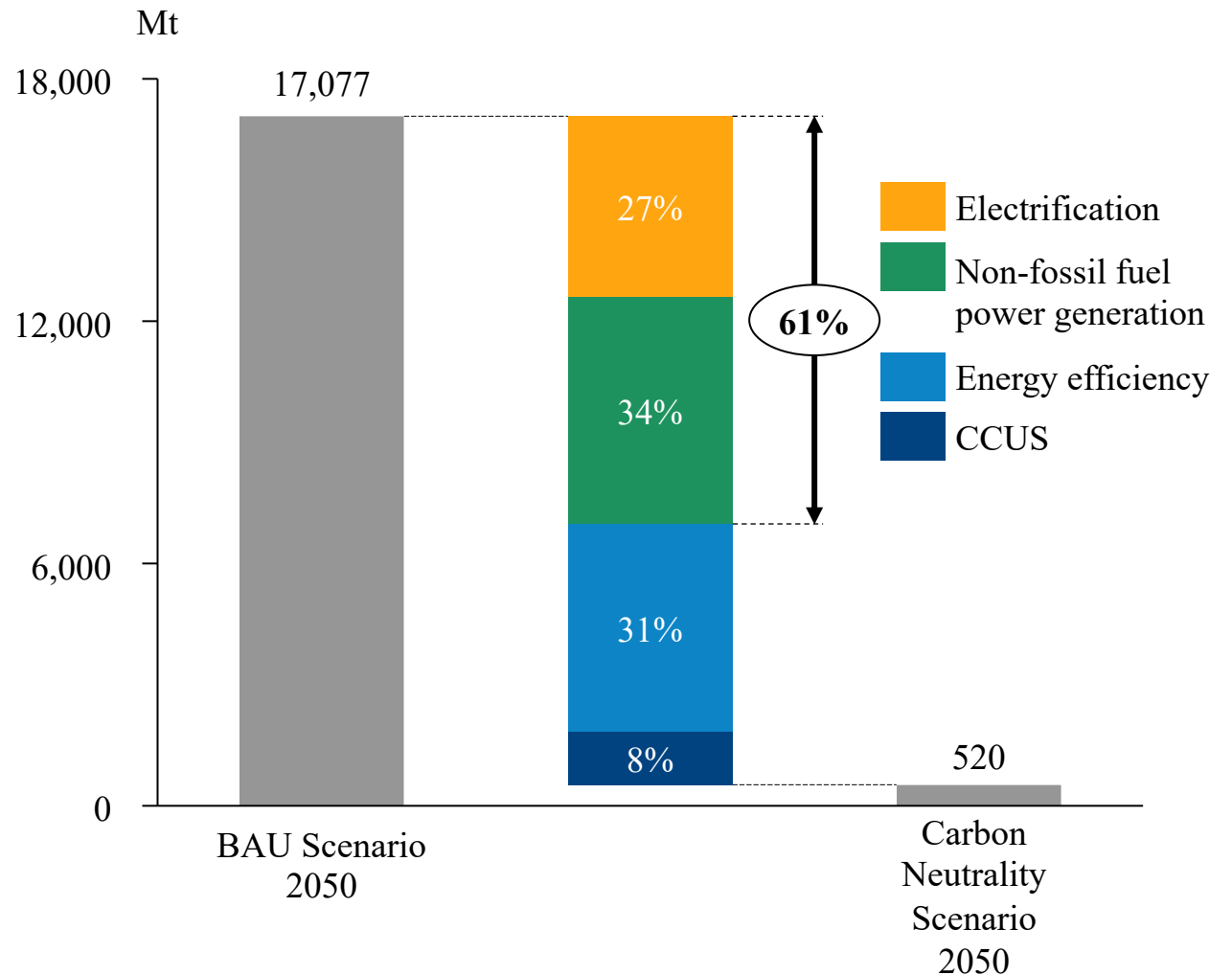
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Dec. 15, 2022

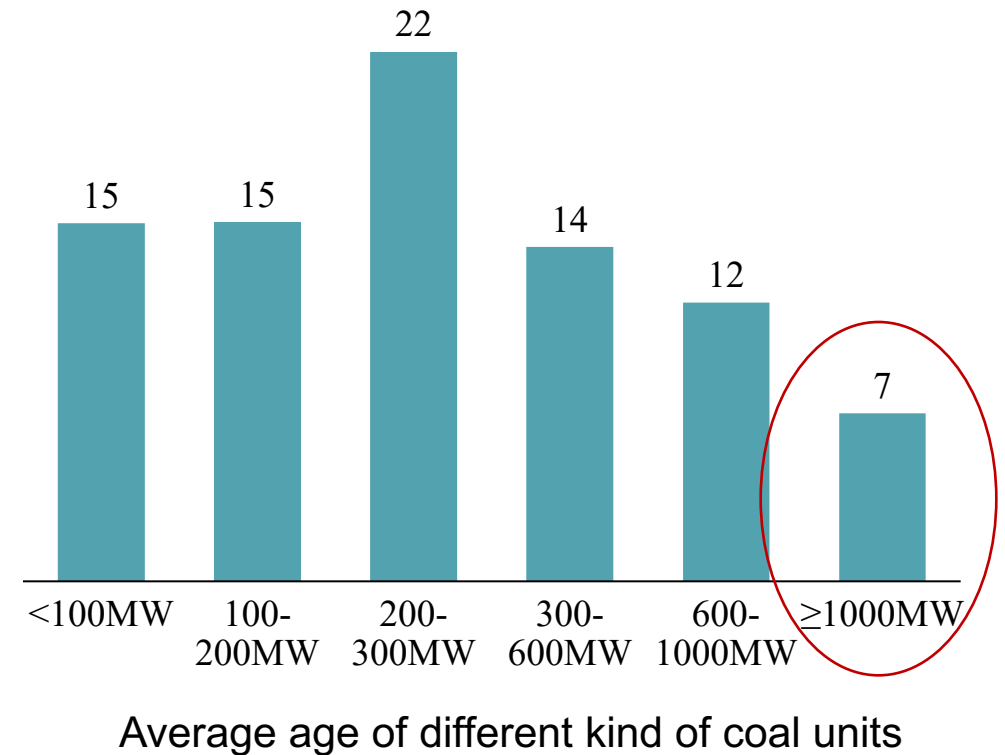
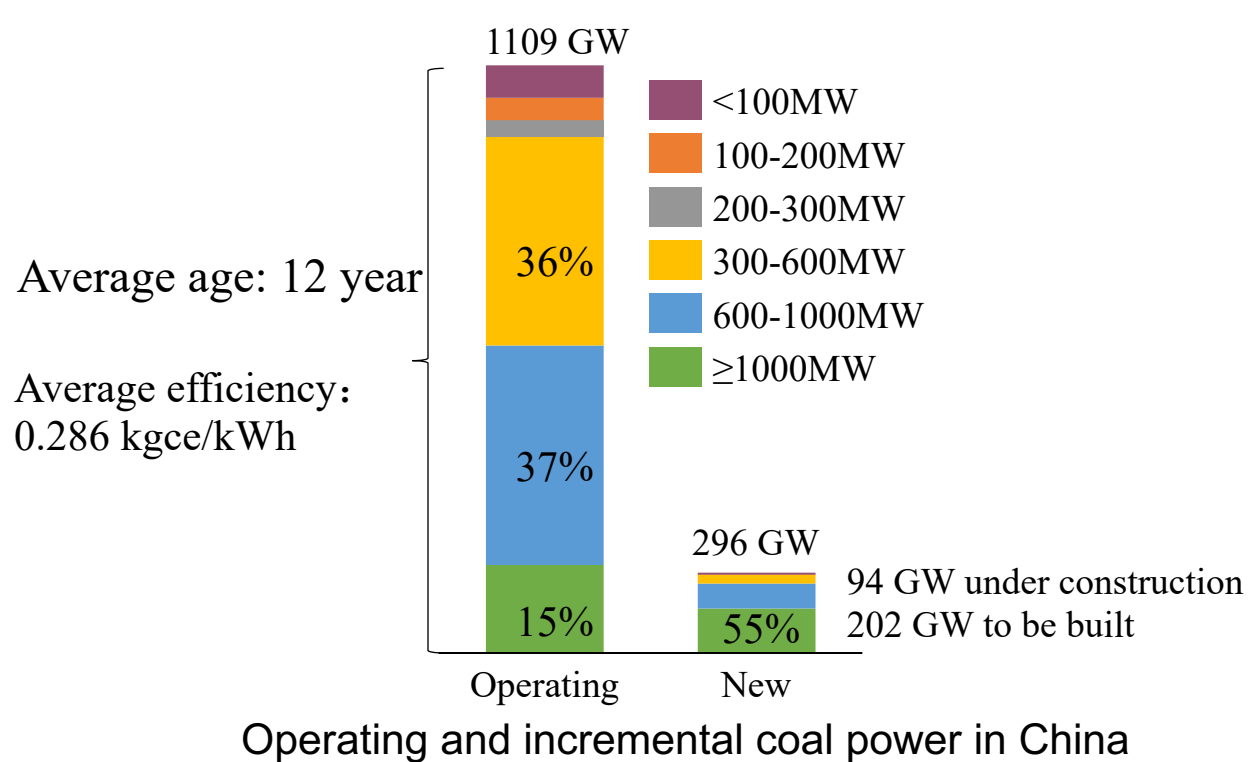
Power decarbonization, especially coal power, is one of the key pillars to achieve carbon neutrality, and will contribute 34% of total emissions reduction

- Power decarbonization, together with electrification, energy efficiency, and carbon sequestration, are regarded as the four pillars achieving carbon neutrality (IPCC, 2013; IRENA, 2019; IEA, 2020).
- With the improvement of the electrification rate, the process of decarbonization in the terminal sector will also be amplified (Liu et al, 2021).



Young and efficient coal fleet: Transition in a steady and orderly manner

China's coal power units is the youngest in the world (IEA, 2021). The average age of China's coal units is about 12 years, which is about half the world average.



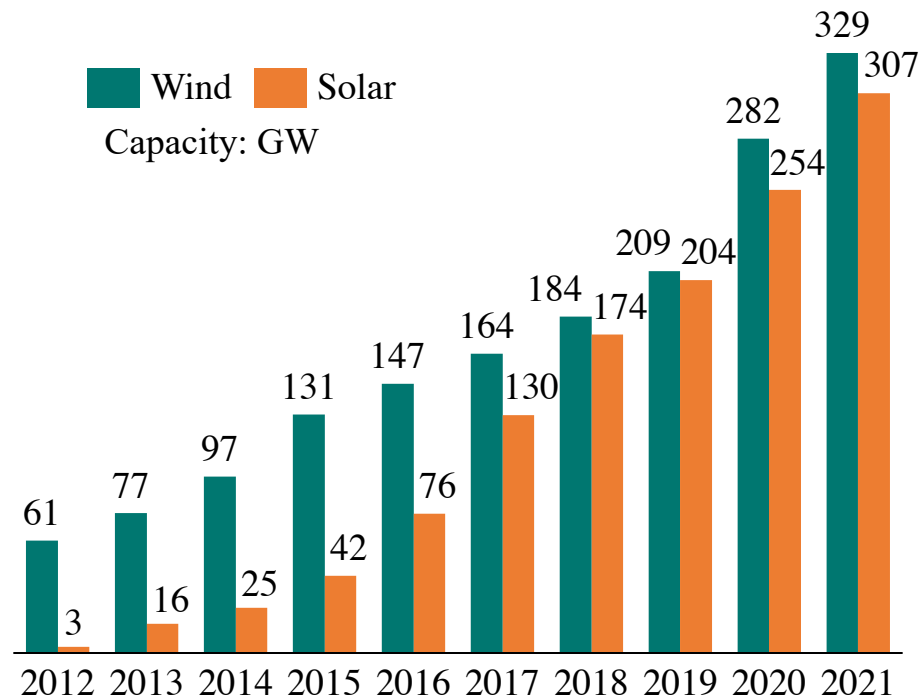
- keep national energy security and economic development as the bottom line
- safeguard China's energy security, food security, and the security of industrial and supply chains.....

—— Action Plan for Carbon Dioxide Peaking Before 2030

Low-carbon Transition of Power Sector: Construction before Destruction

Developing alternative first

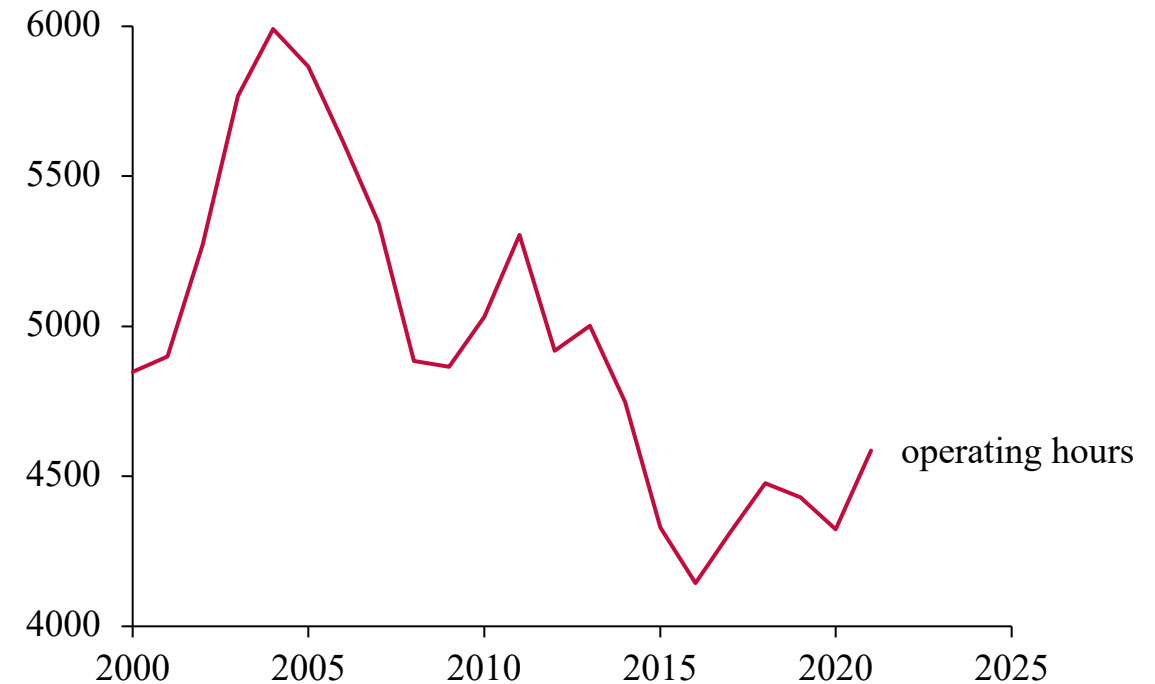
- Rapid development of renewable power generation
- achieve renewable grid parity



China's wind power and solar capacity

Phase down coal power orderly

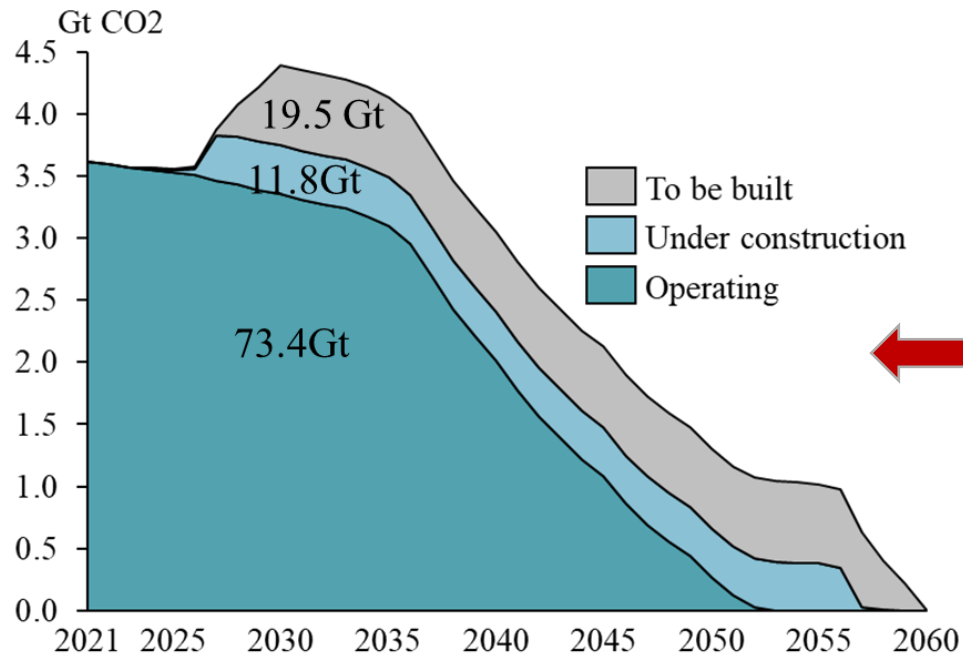
- Capacity proportion of coal power is less than 50% in 2021
- Full load hours show a trend of fluctuating downward



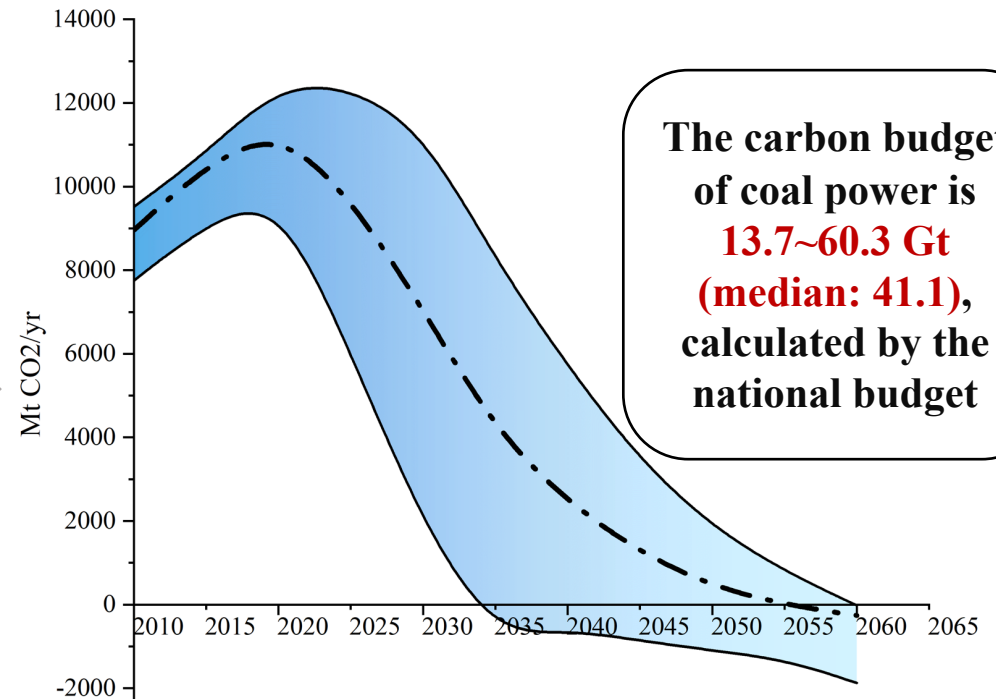
Operating hours of China's coal power

A contradiction between carbon budget and lock-in effect of coal power

- If no transition measures are taken, the cumulative emissions of China's coal power will reach 104.6 Gt. Only operating coal units will cause 73.4 Gt, far exceeding the carbon budget.
- In terms of emission proportion and decarbonization potential, coal power is critical to China's carbon neutrality.



Lock-in emissions of China's coal power plants



The carbon budget of coal power is **13.7~60.3 Gt** (median: 41.1), calculated by the national budget

China's carbon budget to meet the carbon neutrality and 1.5 °C target

3R transition pathway to phase down coal power



**Coal Power
Transition Pathways**

Retire early

The units that cannot be upgraded may be shut down before technical lifetime, and the qualified units shall be **converted to emergency standby power supply**.

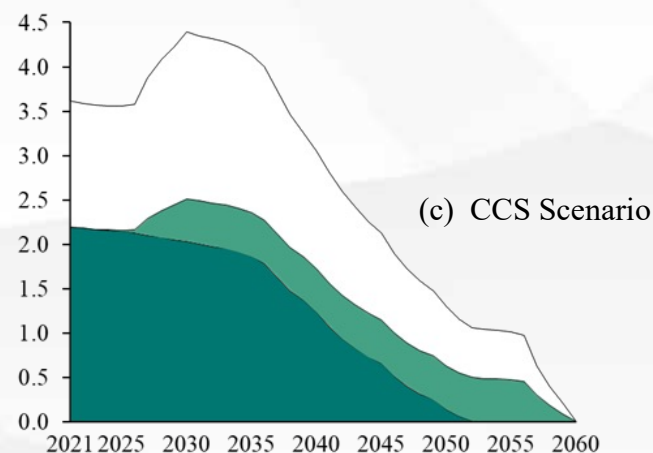
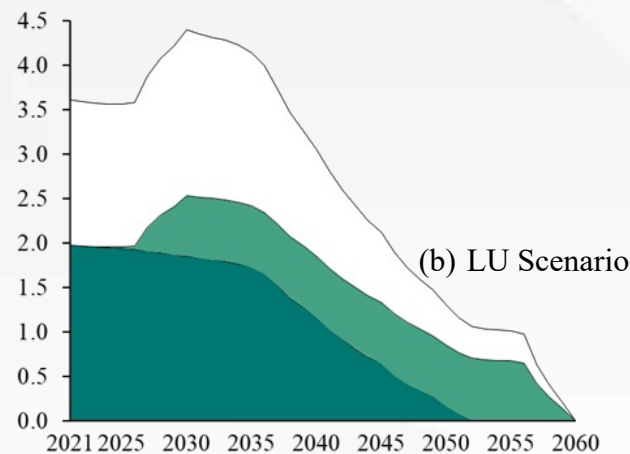
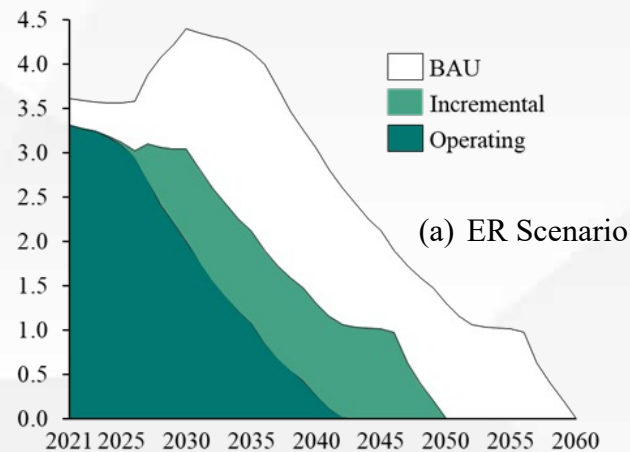
Repurpose

Coal units shall be repurposed to run less but more flexibly, or retrofitted to co-fire biomass or ammonia, which can provide important **peak capacity and load-balancing services**.

Retrofit (CCUS)

Coal-fired plants are equipped with CCUS to become a "**near-zero decarbonization unit**".

Retrofitted units with advanced technology and short service lifetime can be appropriately extended



Transition scenario design under carbon emission constraints of China's coal power

Scenarios	Description
BAU scenario	Operating lifetime of 30 years, generating hours remain at 2020 level
Retire early scenario (ER)	Operating lifetime of 21 years, other consistent with BAU scenario
Repurpose scenario (LU)	The generating hours are significantly reduced to 40~60%, and others are in line with the BAU scenario (units with capacity greater than 1000MW play the role of basic load, and generating hours remains 2020 level)
Retrofit CCS scenario (CCS)	IGCC, supercritical and ultra-supercritical units are retrofitted with CCS equipment, and operating lifetime and generating hours are consistent with BAU scenario

Stranded Assets: Market value loss of coal power plants

To achieve the climate goal, the remaining book value of high carbon assets when they are replaced or retired **before the end of their expected life**.

Remaining book value

Energy related infrastructure

Write-down, depreciation or conversion of asset value into liabilities

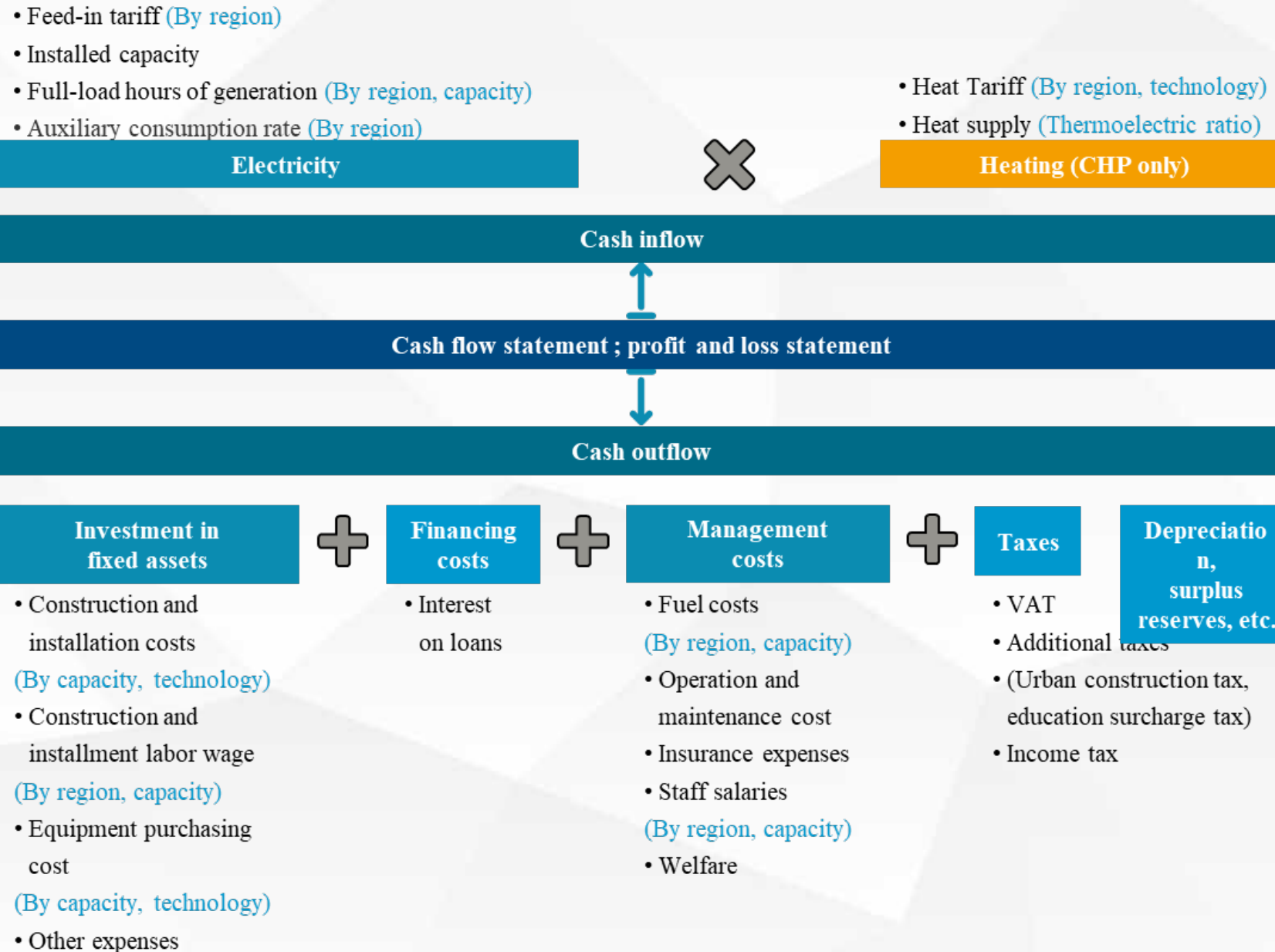
Market value loss

- Low carbon transition might lead to a decline in the revenue of coal power plants and face the loss of net cash flow.

$$Value_{SA} = NPV_{BAU} - NPV_{scenario\ i}$$

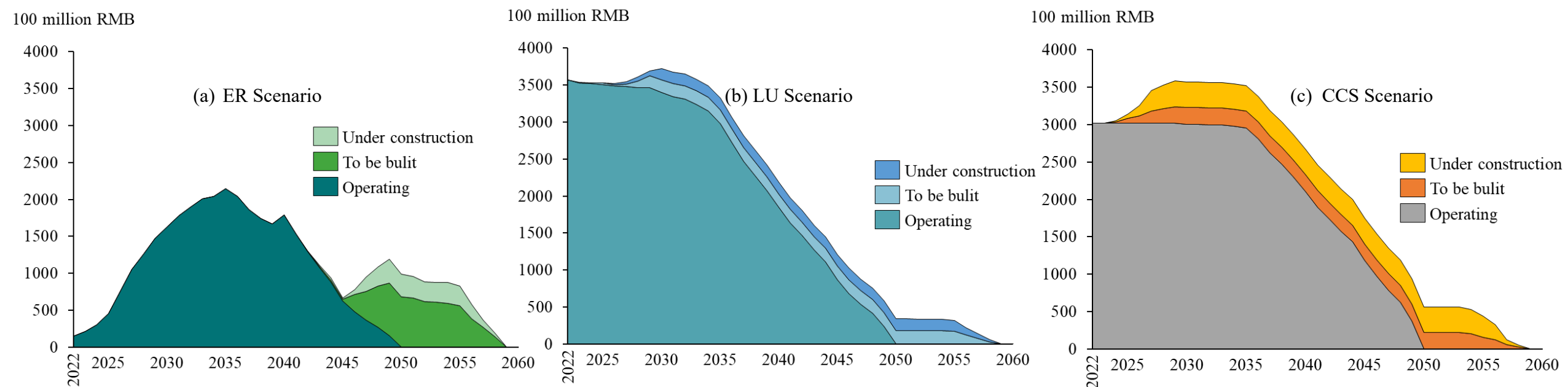
NPV (Net Present Value) is used to measure the change of market asset value of China's coal-fired power plants under different development scenarios, that is, the asset loss caused by the reduction of **net cash inflow** within the expected life cycle.

Plant-level financial accounting framework and database



Low carbon transition will lead to trillions losses of asset value

Three transition scenarios of early retirement (ER), flexibility repurpose (LU) and CCS retrofit (CCS) result in a decline of 1.42, 3.69 and 3.67 trillion RMB in the value of coal power assets.



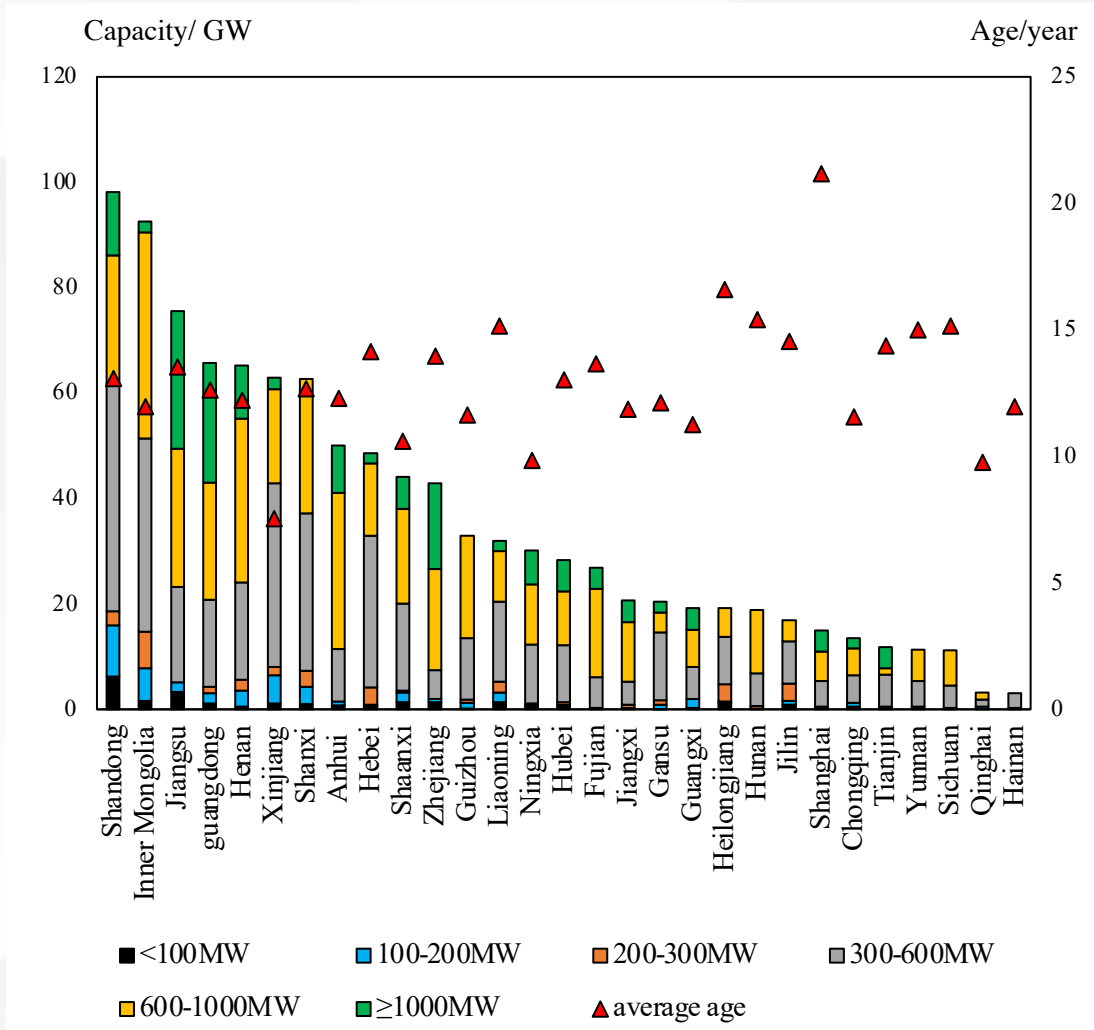
Annual stranded assets under three transition scenario

Low carbon transition will lead to trillions losses of asset value

In ER scenario, the larger the unit capacity, the higher the stranded asset losses;
On the contrary, the smaller units have the higher stranded asset risk under LU and CCS scenarios, of which the cash inflow is more affected.

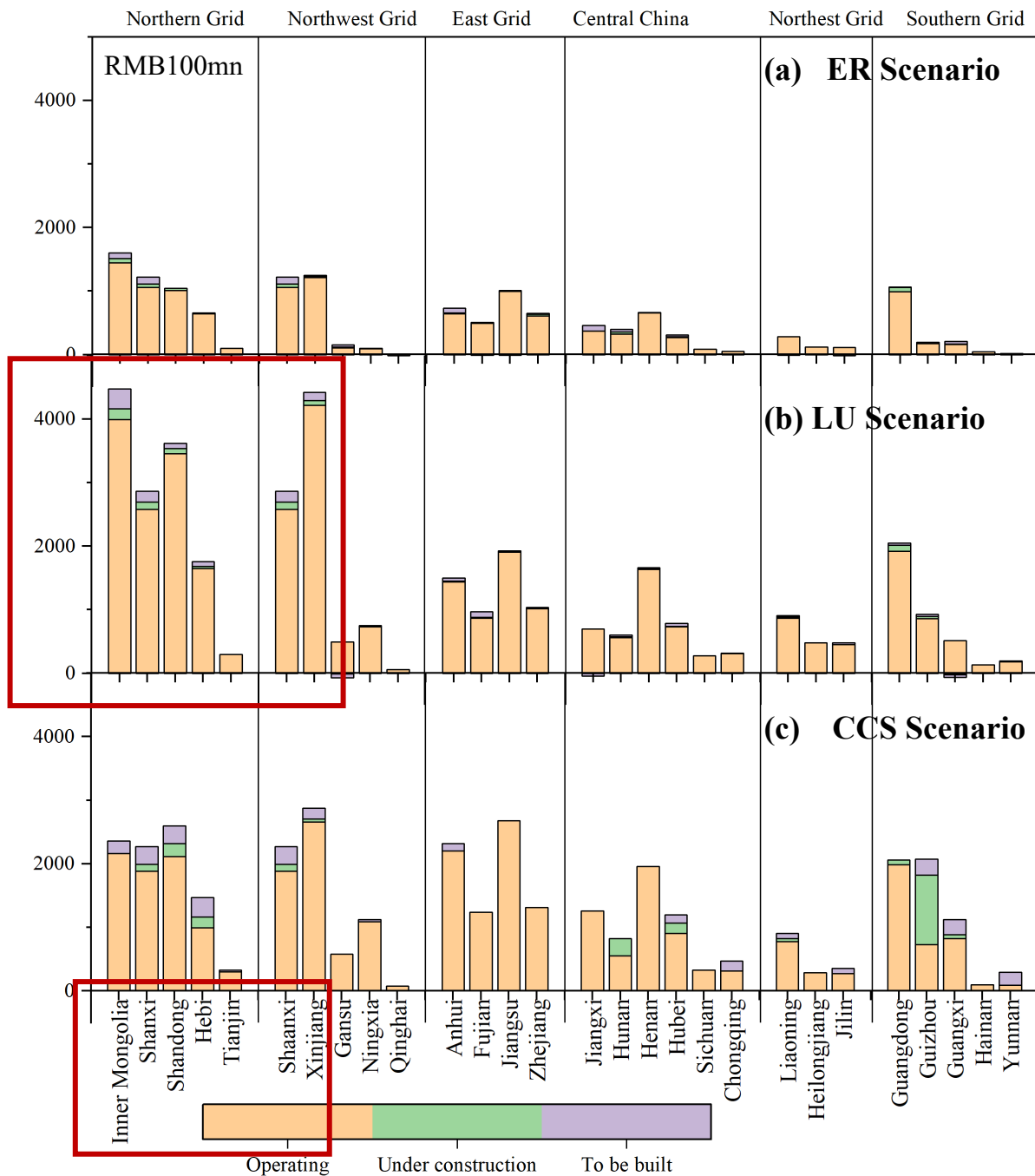
Loss of stranded assets of different units		(RMB100mn)					
		<100MW	100-200MW	200-300MW	300-600MW	600-1000MW	≥1000MW
Capacity (GW)		21.42	41.45	18.51	325.05	392.38	147.07
Age (yr)		15.14	15.59	22.40	14.04	11.81	7.73
ER Scenario	Operating	-855.72	223.29	230.00	4017.00	6547.80	2561.82
	Construction	61.44	2.43	—	43.25	71.91	128.61
	To be built	100.85	15.79	—	202.35	166.50	220.37
LU Scenario	Operating	934.79	1624.83	699.15	14400.00	13600.00	2769.93
	Construction	236.48	15.69	—	106.95	274.05	362.14
	To be built	168.89	21.45	—	209.17	245.38	340.53
CCS Scenario	Operating	14.84	42.46	0.00	5206.65	16800.00	9224.02
	Construction	660.97	0.00	—	466.01	331.61	461.12
	To be built	598.75	86.75	—	619.15	757.92	828.14

Large differences in coal power capacity, structure and average age among provinces



- 1) **Xinjiang** has the youngest coal power plants (average age is 7.5 years)
- 2) **Shandong, Inner Mongolia, Jiangsu** are provinces with the largest installed capacity of coal power, accounting for one fourth of the national total
- 3) East China Grid and Southern Grid (e.g. Jiangsu, Guangdong, Zhejiang) have a high proportion of large units

Regional difference of capacity structure and age

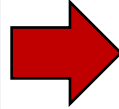


Unbalanced regional loss

- 1) North China and Northwest China power grids are more affected by low carbon transition
- 2) Xinjiang has the strongest response to the flexibility repurposing.
- 3) East China Grid and Southern Grid (e.g. Jiangsu, Zhejiang, Guangdong) are faced with capital demand during technical transformation pathways like LU and CCS

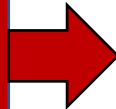
Classification decision & Regional choice

Shandong, Inner Mongolia
Higher losses for repurposing



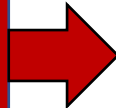
- long service life, low efficiency and poor profitability
- can be eliminated or upgraded in advance, or converted to standby units

Jiangsu, Guangdong, Zhejiang
Comparative advantage



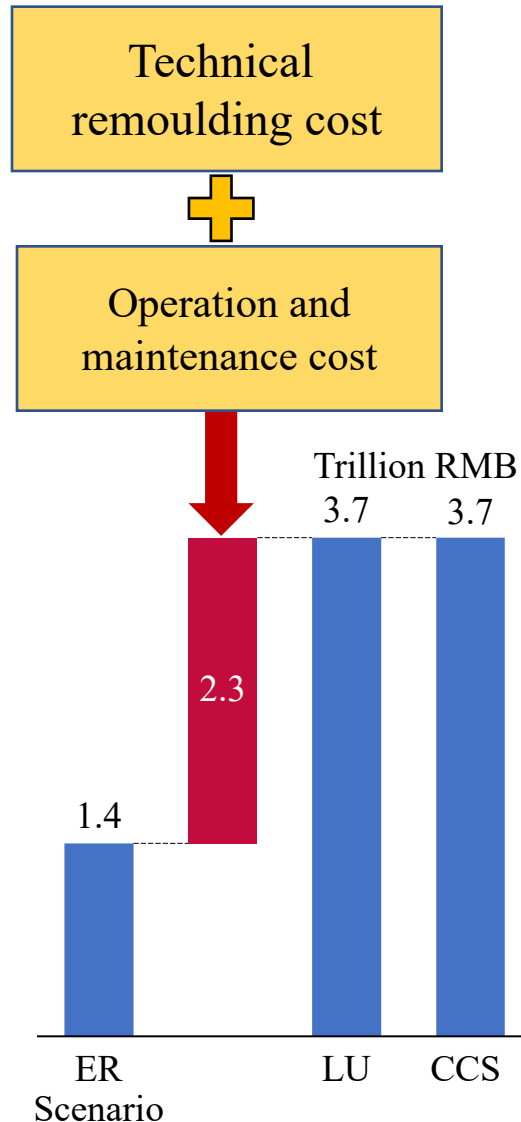
- larger units with more advanced technology
- be closer to power load
- Suitable for technical remodeling

New coal power projects
aggravate the risk of asset stranding



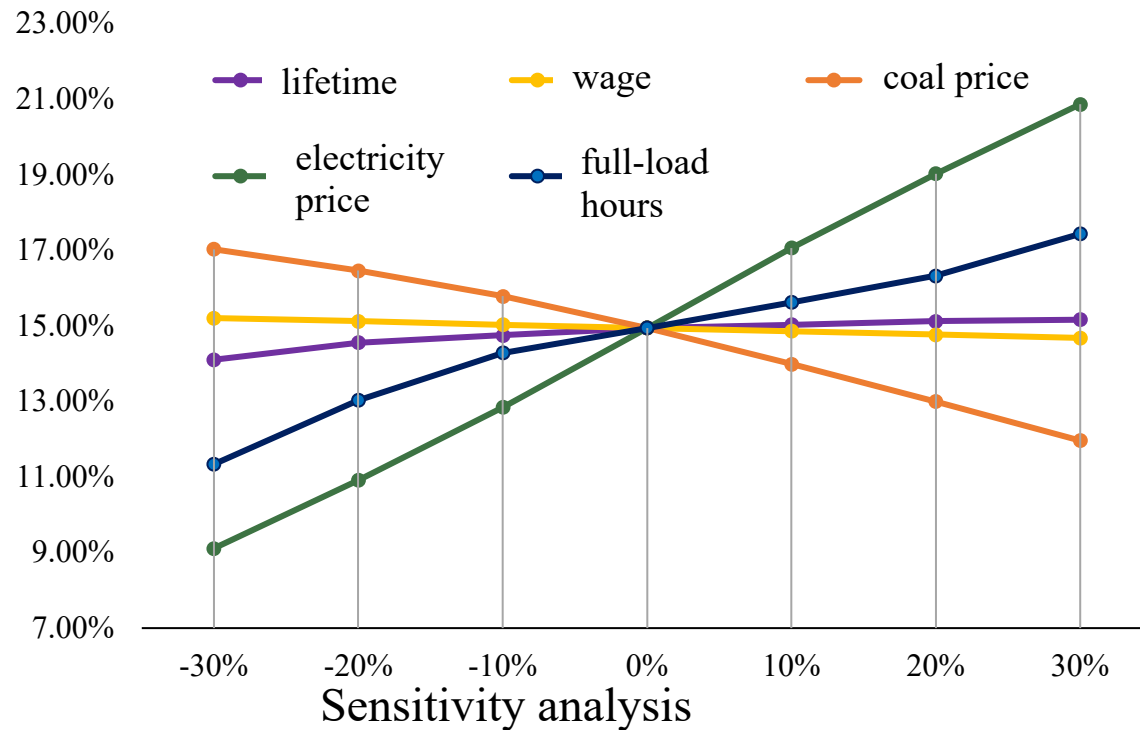
- prudent decisions on new coal power projects
- approval standards for new coal power projects

Accelerating repurposing and CCS retrofit needs more money



- ◆ This is an additional investment to upgrade flexibility equipment.
- ◆ The market value of security and flexibility services should be reflected through the electricity price market mechanism etc.
- ◆ Compared with early retirement, coal power installations in CCS and LU scenarios can guarantee **system adequacy and flexibility**.

Price factors have the greatest impact on the value of coal power assets



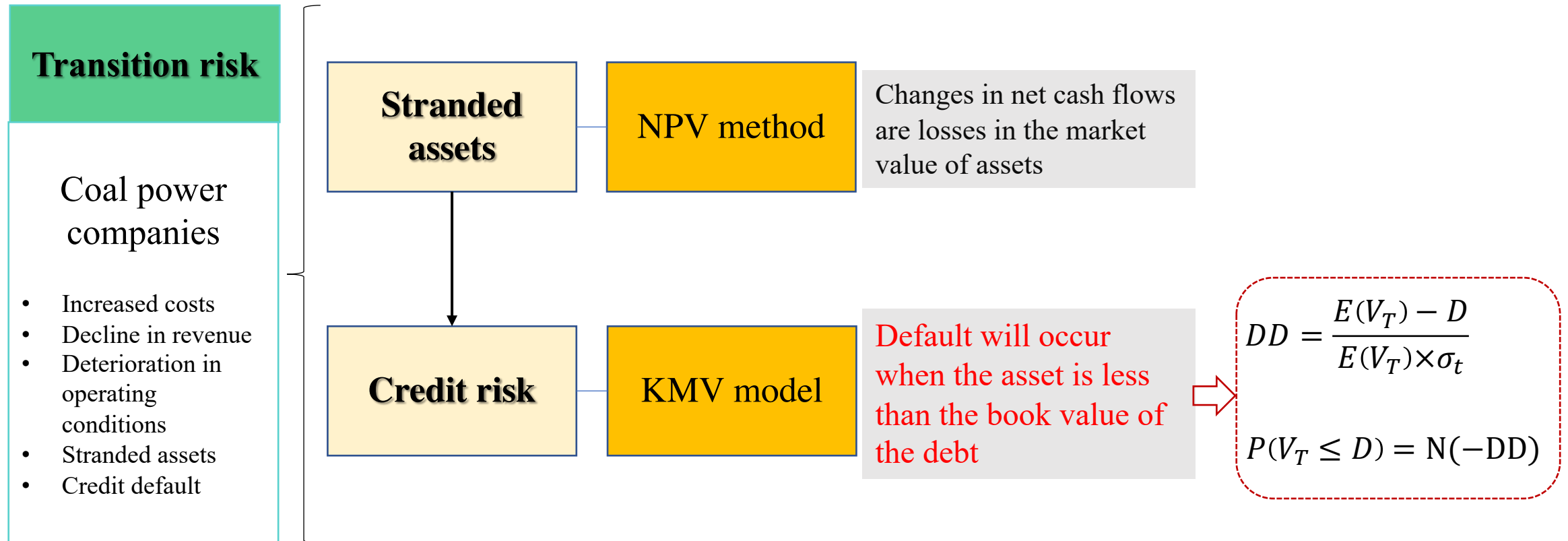
- it is found that three sensitive factors, namely, **electricity price, coal price, and full load hours**, have a greater impact on the net cash value of a coal plant.

Market-oriented Reform of Power Industry

- Linkage of coal price and electricity price
- Peak-valley electricity price based on demand response
- Spot markets for electric power
-

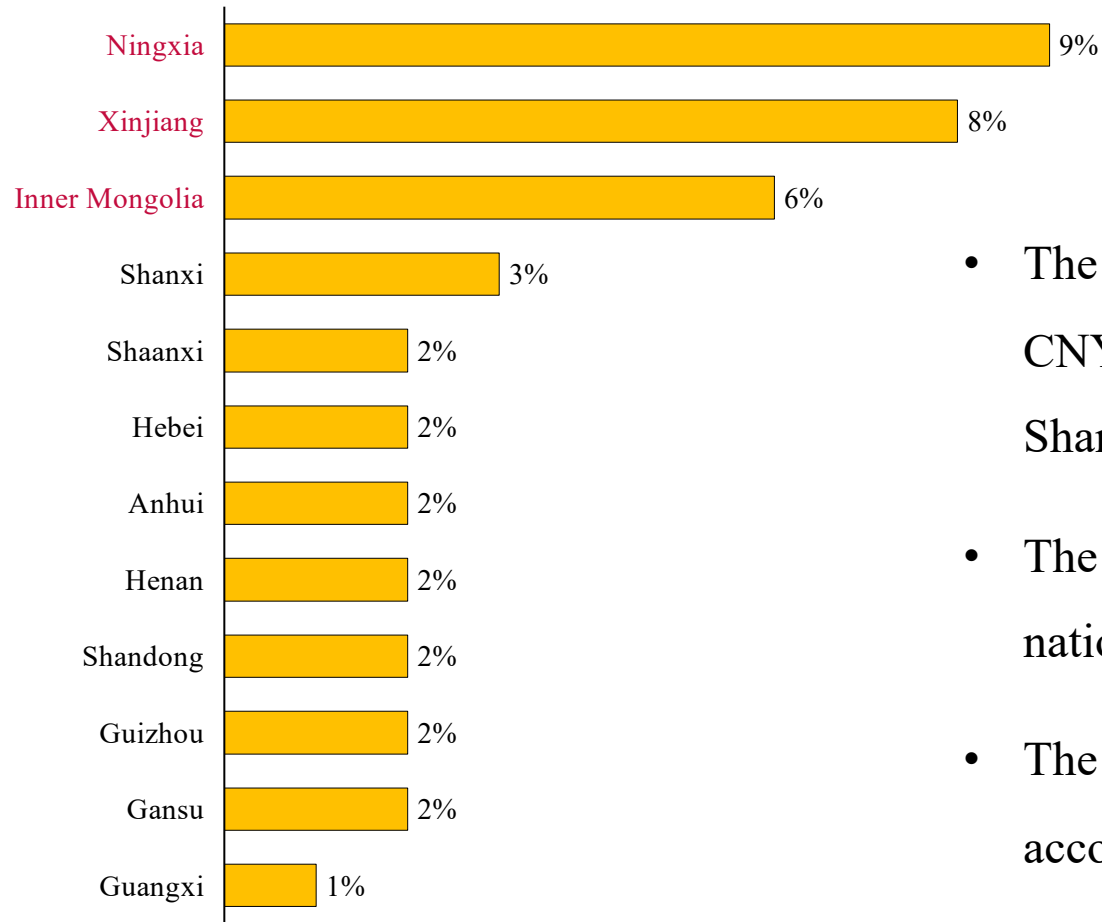
Insolvency: Stranded assets leads to credit default

The decline in asset value may lead to an increase in the default rate of loans, causing financial instability.



Research modeling of stranded assets and credit default risk

Over 70% of construction investment comes from bank loans



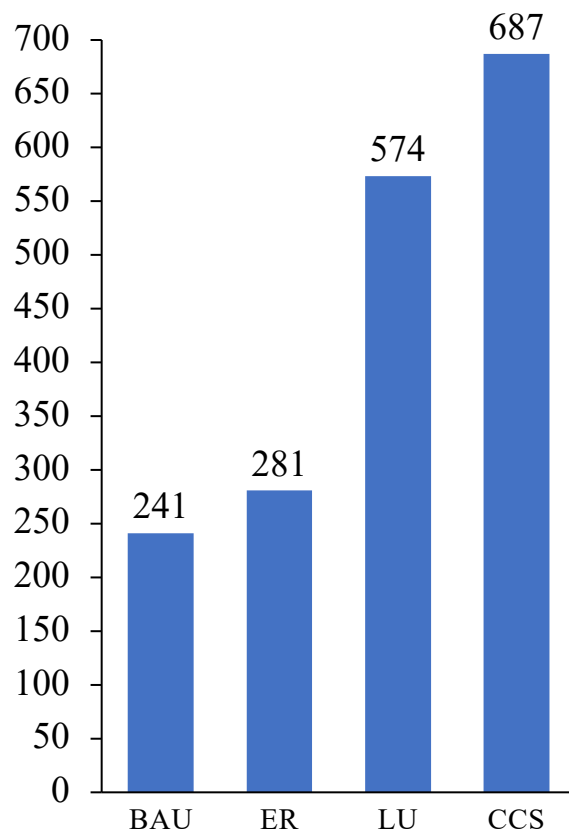
- The remaining loans for coal power plants are more than 80 billion CNY in several provinces, such as Xinjiang, Inner Mongolia, Shandong, Anhui, Jiangsu, Henan, and Guangdong.
- The total coal power credit accounted for only 0.8% of total credit nationwide in 2020
- The ratios of coal power of Ningxia, Xinjiang and Inner Mongolia account for as much as 9%, 8% and 6%.

**The percentage of remaining loans for coal plants
by province in 2019**

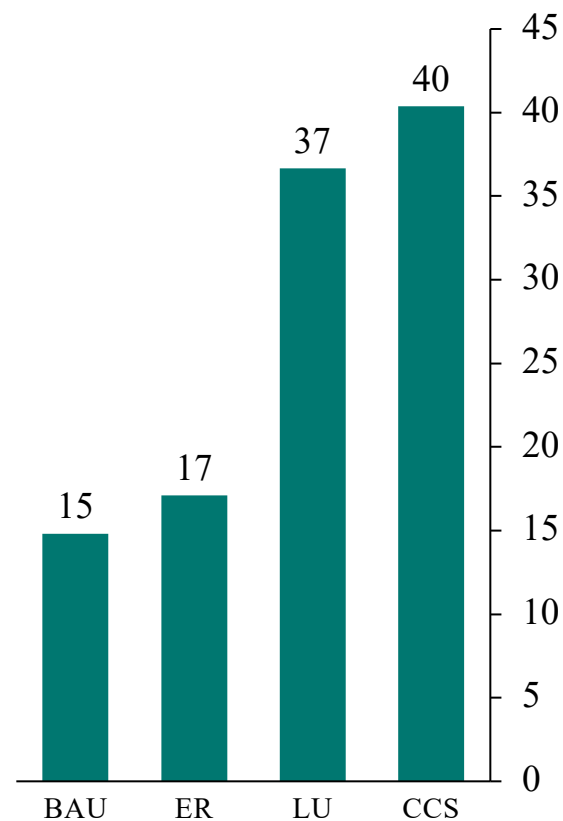
Credit default rate and expected loss might increase significantly

Low-carbon transition will bring about rising costs, falling profits and expanding financial losses in coal power. Then, the decline in the value of coal power assets will be transmitted as credit default risk.

Losses of credit default (billion CNY)

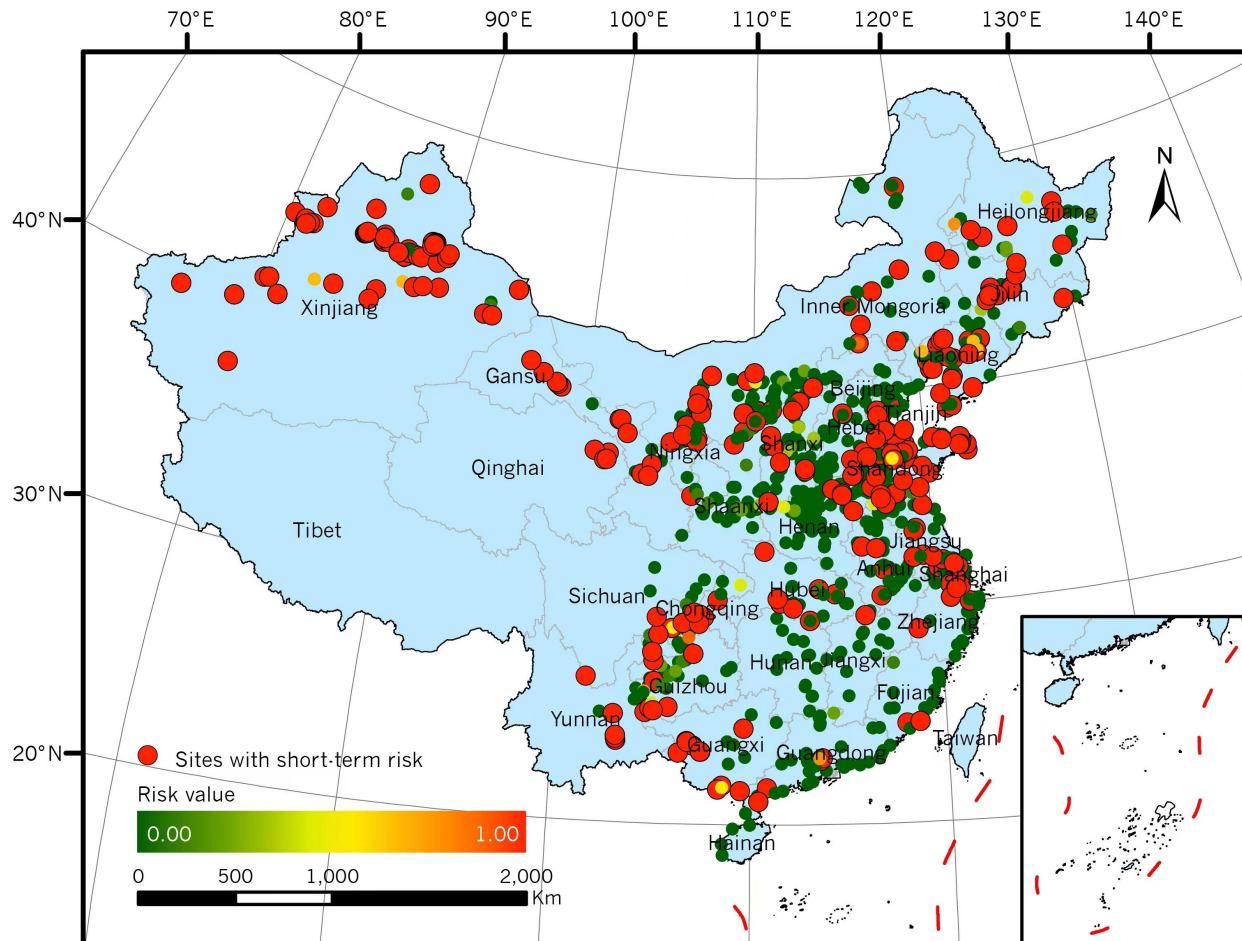


Expected default rate (%)



199 plants are unable to pay one's debt with all one's assets in BAU

Plant-level Credit Risk Map of China in BAU Scenario

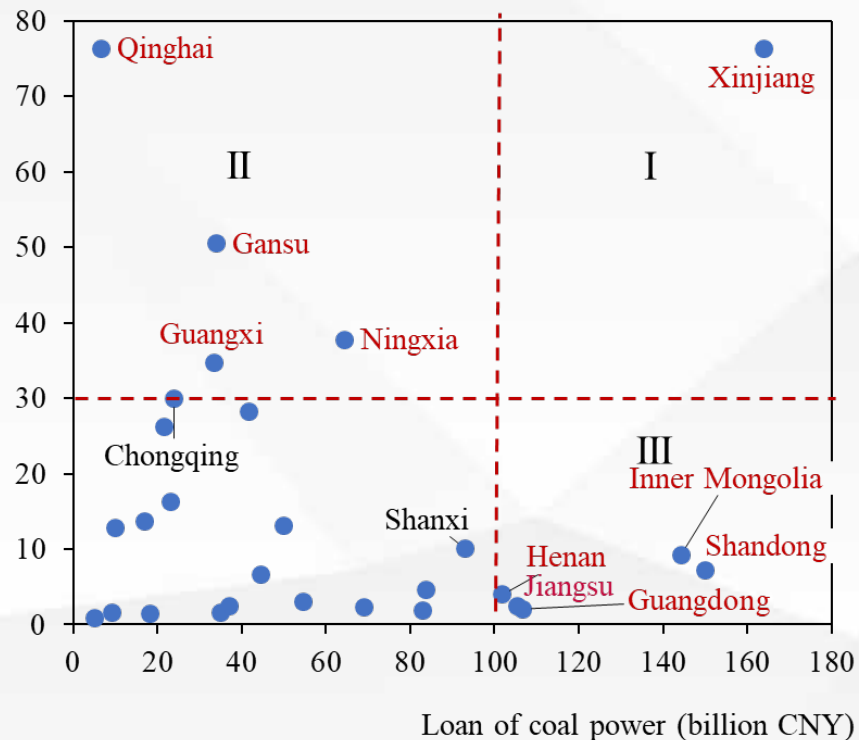


- Coal power credit defaults will become a common problem in China.
- There are 199 plants (17.5% of plants nationwide, 129.6 billion CNY) whose predictable credit defaults will occur in the short term.
- Under three transition scenarios, the number of these plants will increase to 405, 424 and 361 nationwide.

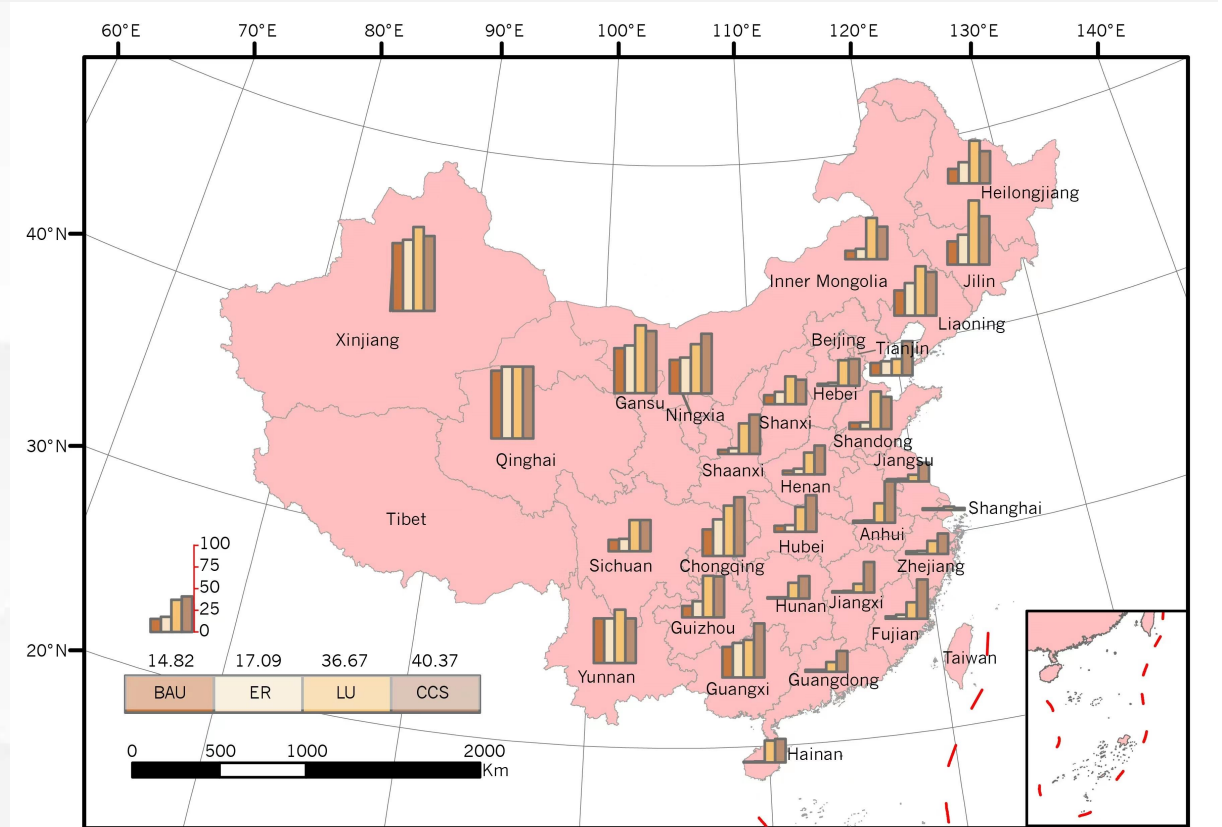
Xinjiang: Higher loan balance and higher probability of default rate

- Regional credit default pressure varies greatly
- Xinjiang has a large installed capacity of coal power and young units. The expected loss due to loan default is up to 866.6 billion yuan in Xinjiang, accounting for more than 1/3 of the national default loss.
- The probability of default in Qinghai, Xinjiang, Gansu and Yunnan provinces is also higher than 50%, so we need to pay more attention to the possible regional default problems caused by transition.

Probability of default (%)

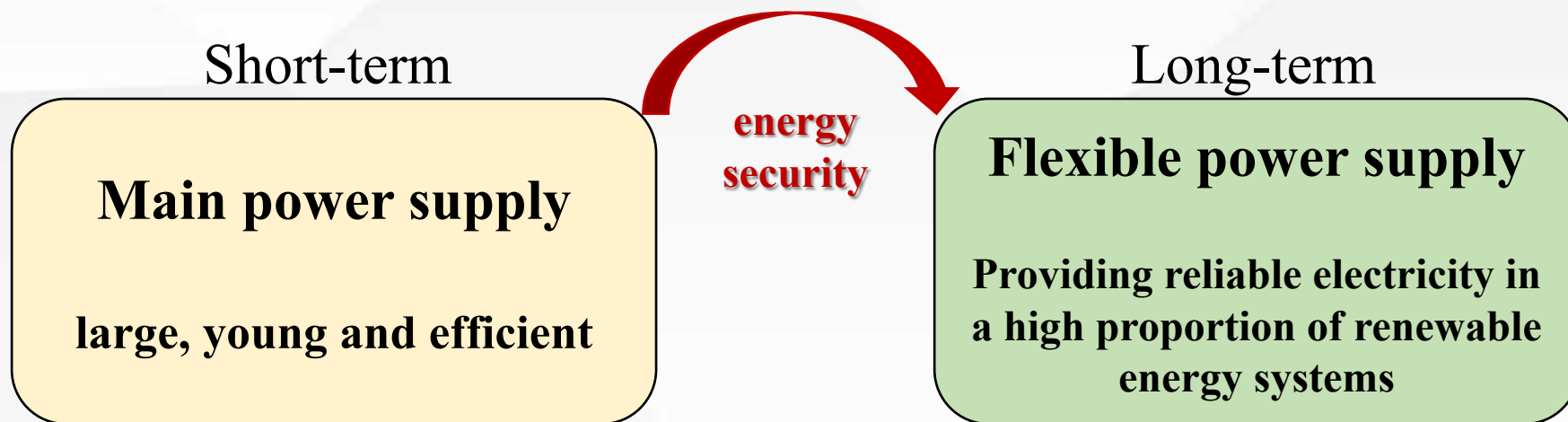


Provincial differences of credit default coal power in BAU scenario



provincial changes of credit default coal power under different scenarios

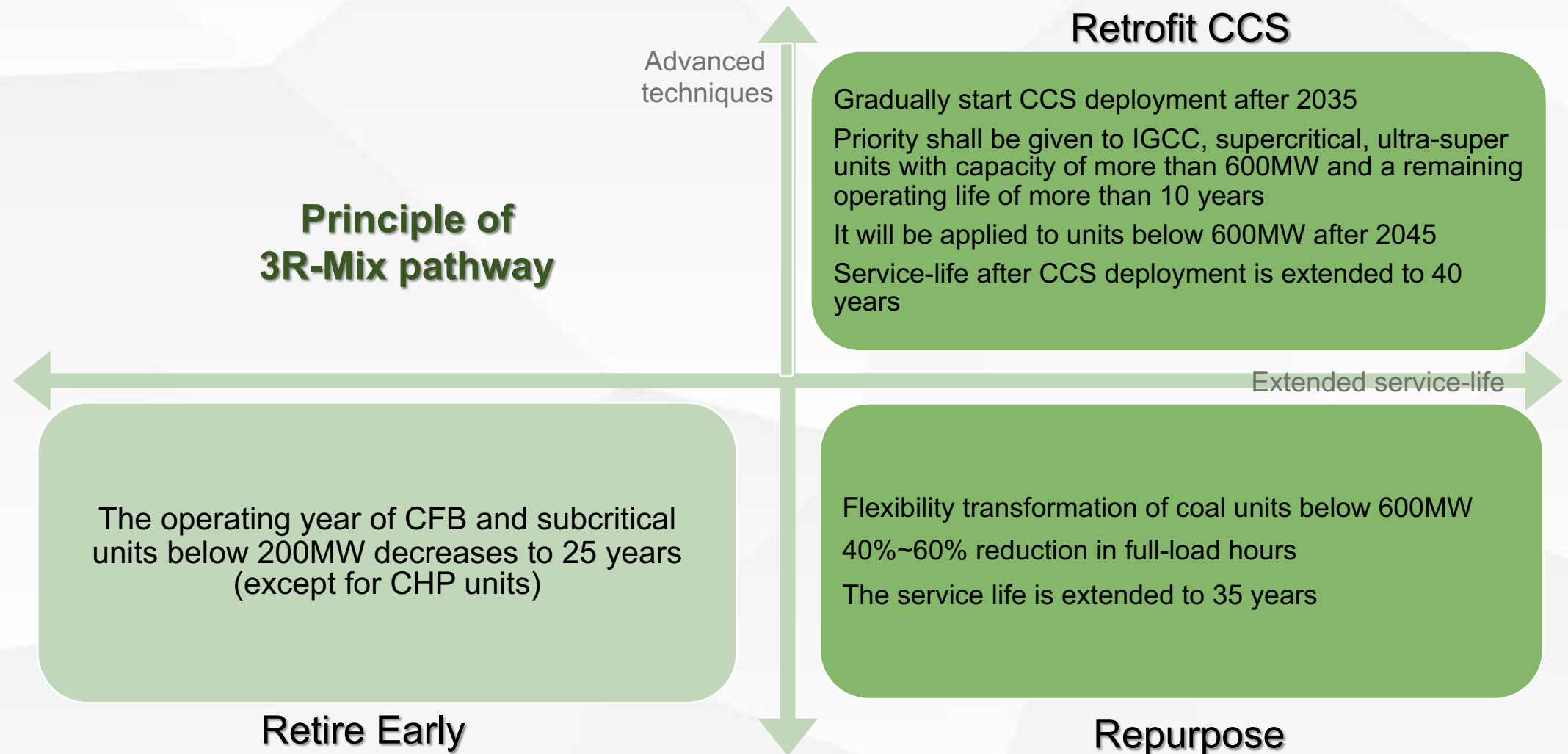
Some risks can be accepted and managed rather than stopped



Coal power transition will become a priority issue for carbon neutrality with the promotion of electrification process.

Identifying risks is only the first step. Through the **improvement of supporting systems**, we will reduce stranded assets and derivative risks of coal power, promote low-carbon transition safely.

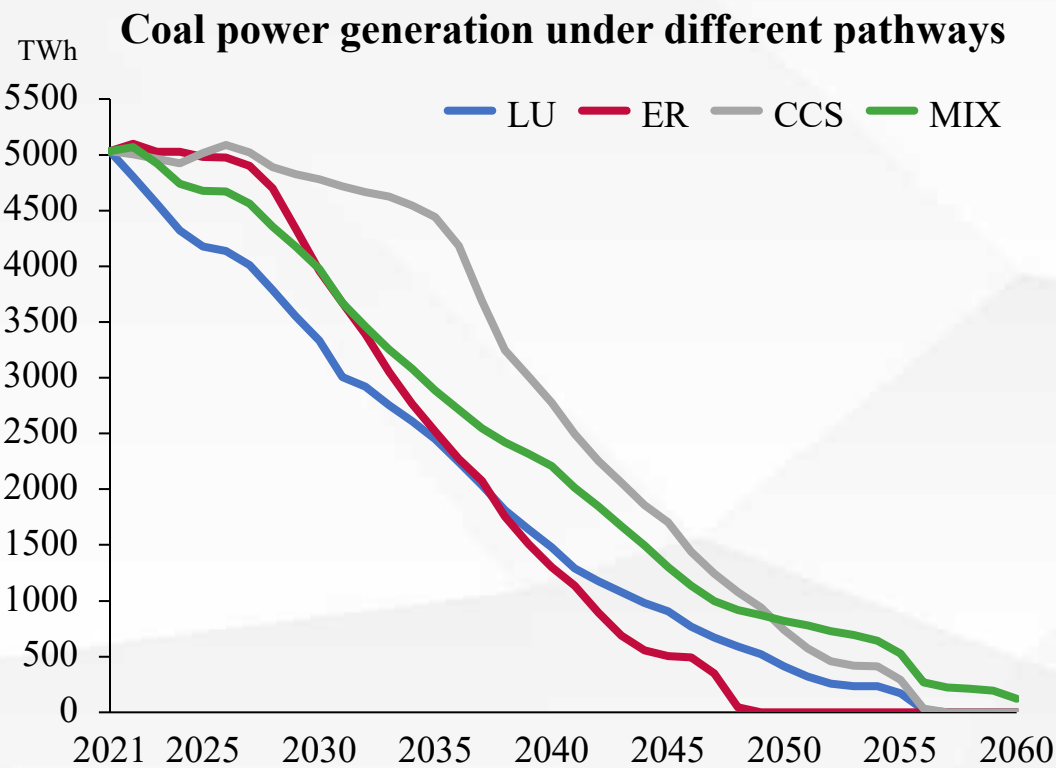
3R-Mix pathway to reduce transition risk



3R-Mix Pathway: soft landing of coal transition

3R-Mix:

- A small number of coal power plants with CCS will be retained in 2060
- The risk of stranded assets and carbon lock-in is lower than that of LU and CCS scenario



Lock-in and Stranded assets comparison in scenarios

	Carbon Lock-in (Gt CO2)		Stranded Assets (Trillion RMB)	
	Operating	Construction	Operating	Construction
ER	47.8	8.3	1.3	0.04
LU	48.7	6.2	3.4	0.09
CCS	48.5	4.2	3.1	0.19
MIX	48.2	6.6	2.6	0.10

Conclusions

- Working in a steady and orderly manner to reduce carbon emissions safely
- Attention to market-value loss of asset from the perspective of cash flow
- Early retirement has a great impact on supply security, while transformation measures have higher stranded assets, which also require investment funds and O&M costs
- Classification decision & Regional choice: MIX is a more balanced transition pathway
- Transition finance: Make up transition fund gap & Risk management
- Greater challenges are new coal projects

Supporting policies to promote the 3R pathway



Strengthen the risk management of coal power transition

risky assets list (coal-related loans, bonds, portfolio)



Speed up the power market reform

market-oriented electricity price reform, auxiliary service compensation policy.....



Suit one's measures to local conditions, classification decision



Support by transition finance

What policy suggestions have we made

The People's Bank of China: Transition finance support for coal power

- Huge capital demands of “**linkage of three transformation**”
- Security of the bank credit funds

Higher requirements for transition finance:

- 1) Meet the transition demand
- 2) Risk management to ensure the capital security
- 3) New financial instruments

The PBOC is organizing the formulation of transition finance standards in the four major fields of steel, coal power, building materials and agriculture.

PBOC Research Bureau
Dec. 10, 2022

Supreme People's Court: Attention to lawsuit cases of coal power transition

Loss of coal power enterprises may lead to more lawsuits for default of credit and bonds

- Coal power related credit litigation cases have begun to appear.
- The execution of the guarantee contract will also be affected by the depreciation of assets
- The practice of rigid payment was broken in coal power enterprise bonds.
- Lawsuit cases may be concentrated in key regions such as Xinjiang, Ningxia, Inner Mongolia, Shandong

“About implementation of the new development Philosophy Completely, accurately and comprehensively, Opinions on providing judicial services for actively and steadily promoting emission peak and carbon neutrality”

Supreme People's Court

Thanks for your attention!

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