



可再生能源成本下降，碳排放交易和经济增长：

处于十字路口的中国能源系统

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# Declining Renewable Costs, Emissions Trading, and Economic Growth: China's Power System at the Crossroads

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# Background 研究背景

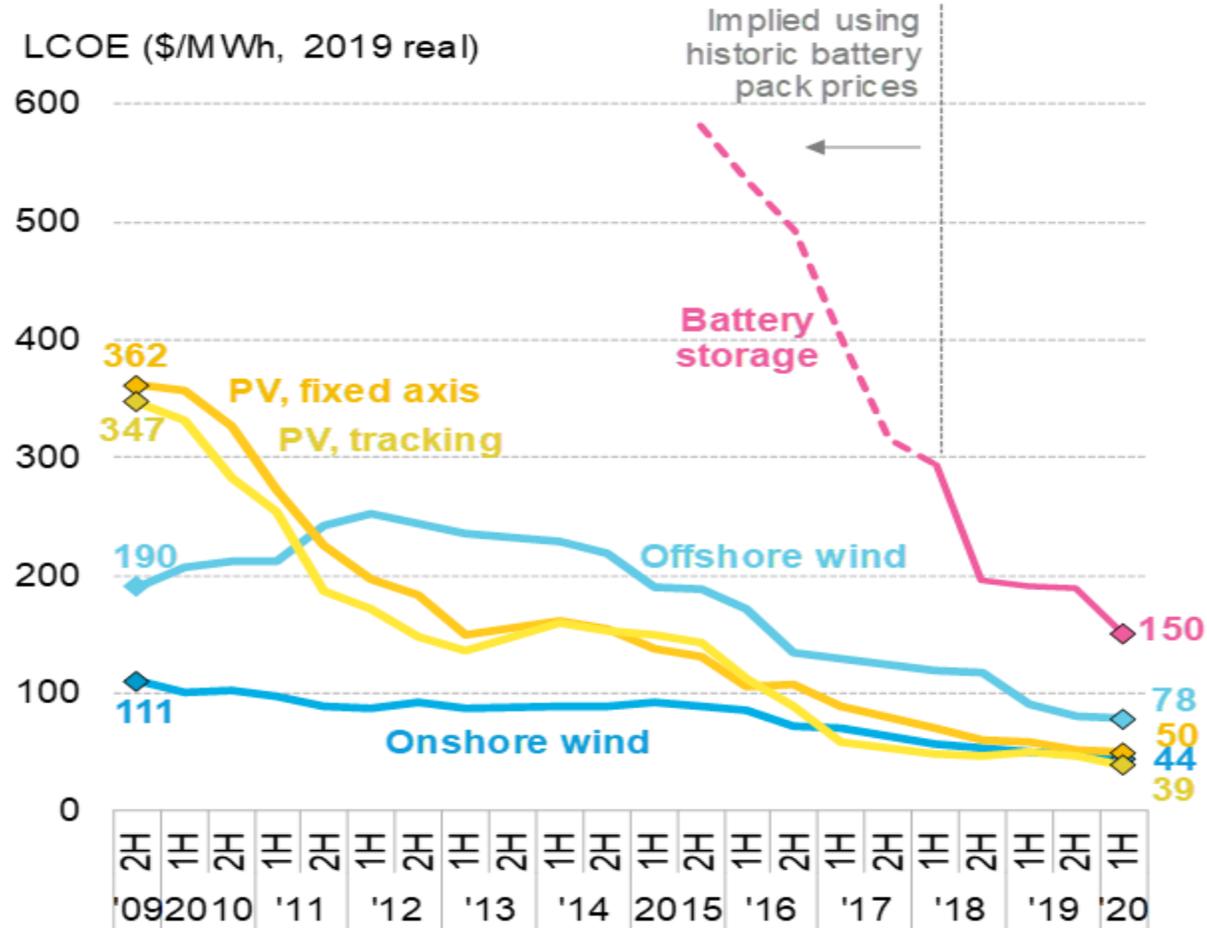
- Traditional economic perspective: 传统上的观念
  - mitigating climate change is likely to have a small but negative impact on economic growth if no social cost is considered 在不考虑社会成本情况下，减缓气候变化可能会对经济有小幅度的负面影响
  - Stern Report finds that the cost of inaction is higher than the cost of mitigation
- Climate change mitigation and economic growth is no longer at odds anymore 减缓气候变化和经济增长不再互相矛盾
  - Rapid decline of renewable energy costs
  - Increasing purchasing power for households and companies
  - Co-benefits such as air quality improvement (ongoing)
- Enhanced climate policies in China and around the world 中国和全球更强有力的气候政策
  - China's pledge of carbon neutrality goal by 2060 and to peak its emissions before 2030 demands more ambitious climate action
  - Green New Deal/Green Recovery gaining momentum in EU, China, and elsewhere

# Research Questions 研究问题

- Can China's clean energy transition accelerate and sustain economic growth and social benefits, especially under post-Covid recovery? 中国的清洁能源转型能否维持经济增长和社会效益，特别是后疫情时期？
- What does a new energy system mean for jobs, incomes, and productivity across the economy 更清洁的能源系统对全经济就业、收入和生产有哪些影响？
- Can these gains, combined with ETS revenue, ease the transition of workers and enterprises out of conventional energy 这些收益以及碳交易市场收入能够缓解传统能源被替代后相关企业和员工面临的转型问题？

可再生能源成本近年不断下降,在多数国家低于火电成本  
 renewable power is becoming cheaper than coal power in many countries

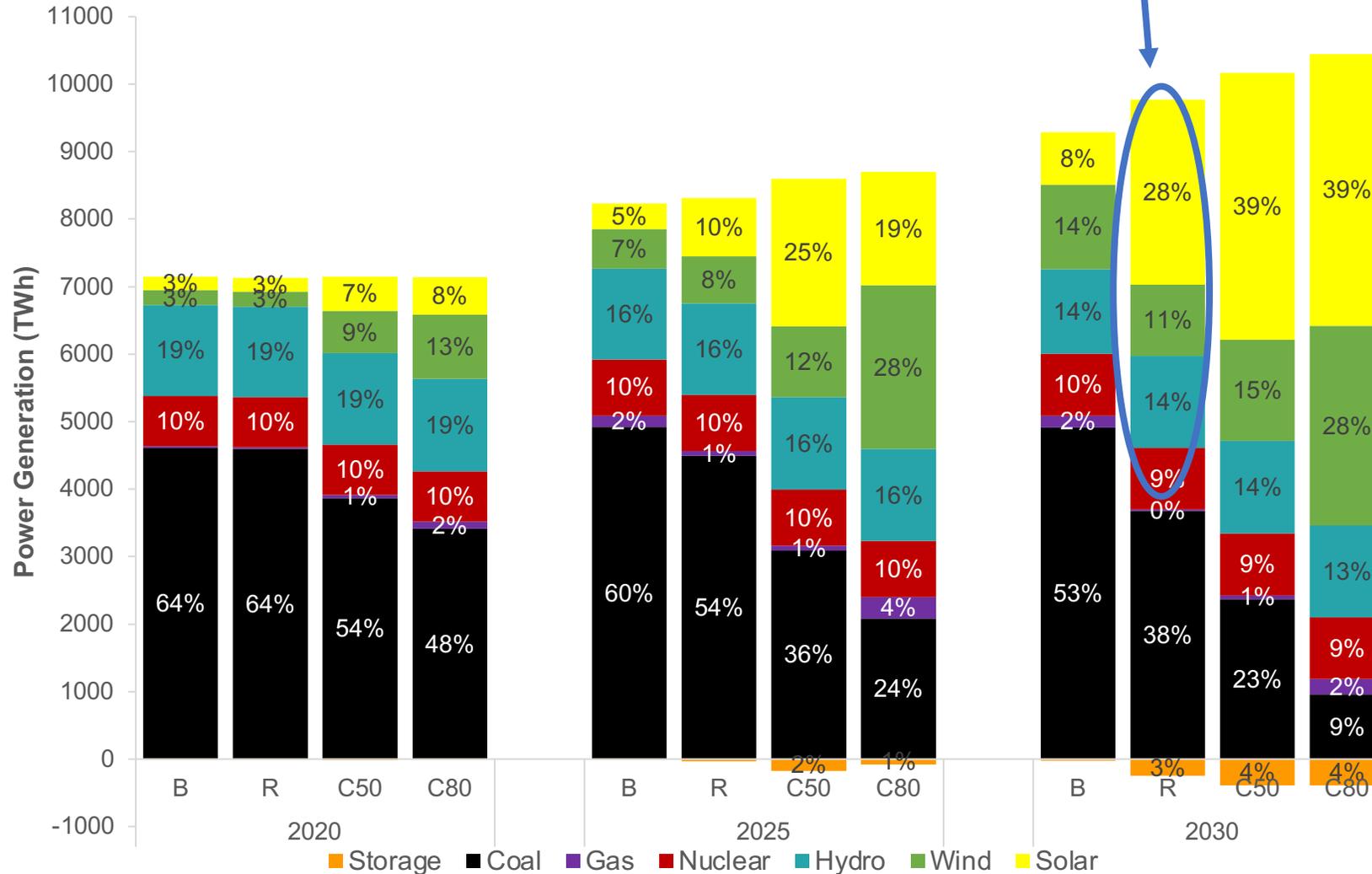
**Figure 2: Global LCOE benchmarks – PV, wind and batteries**



Source: BloombergNEF. Note: The global benchmark is a country weighted-average using the latest annual capacity additions. The storage LCOE is reflective of utility-scale projects with four-hour duration, it includes charging costs.

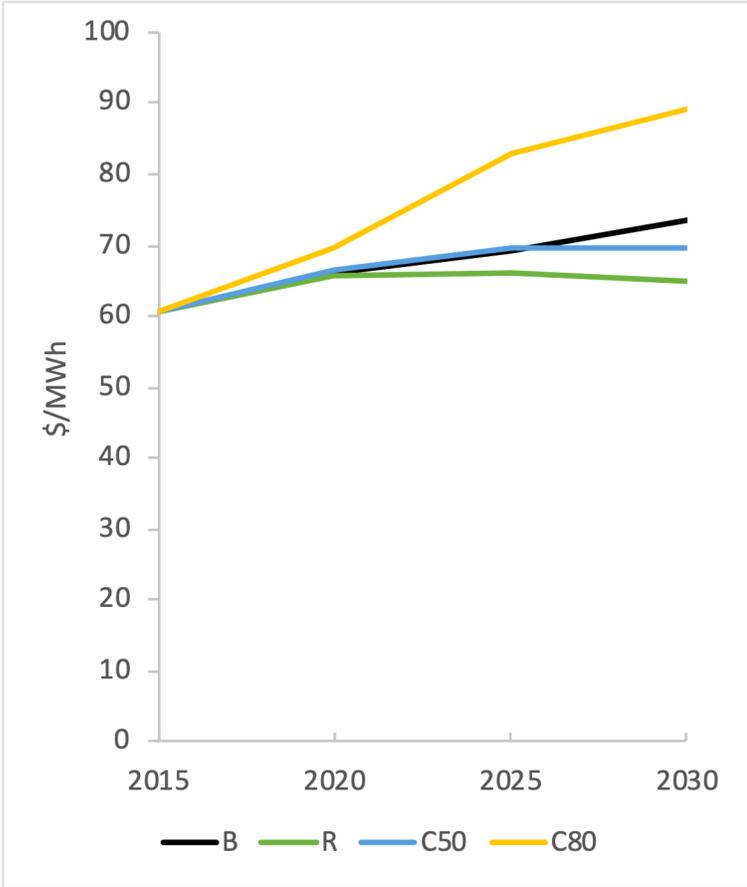
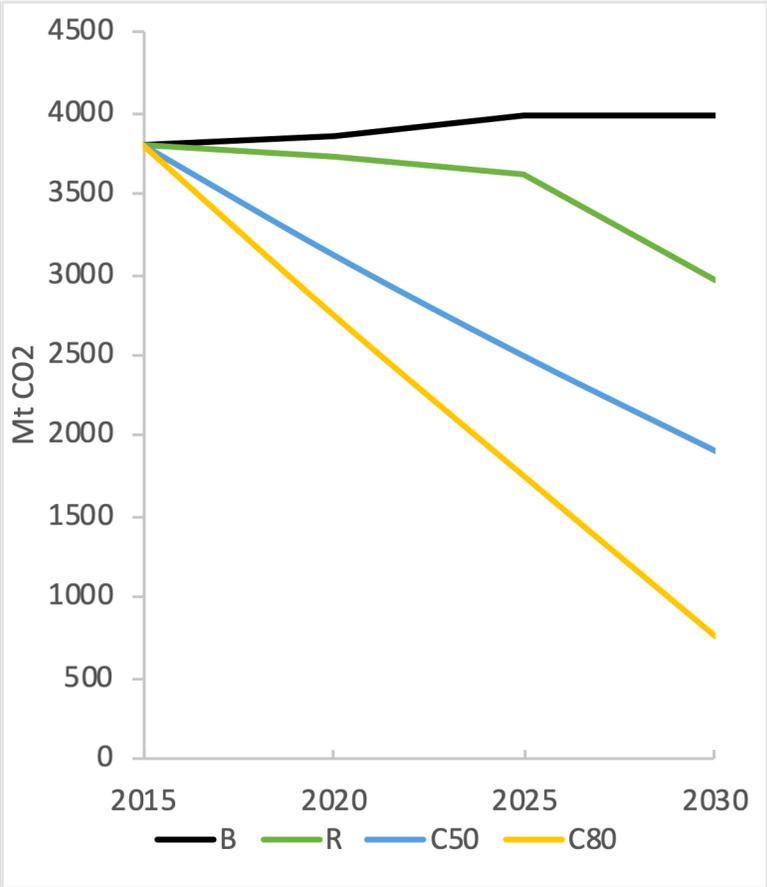
# R情景下，2030年非化石能源发电占比占62%

## China could reach 62% of clean generation by 2030 with lower cost than BAU



Source: He, Gang, Jiang Lin, et al. 2020. "Rapid cost decrease of renewables and storage accelerates the decarbonization of China's power system." *Nature Communications* 11(1).

# 可以以更低的电力系统成本实现50%的碳减排 lower total power system cost



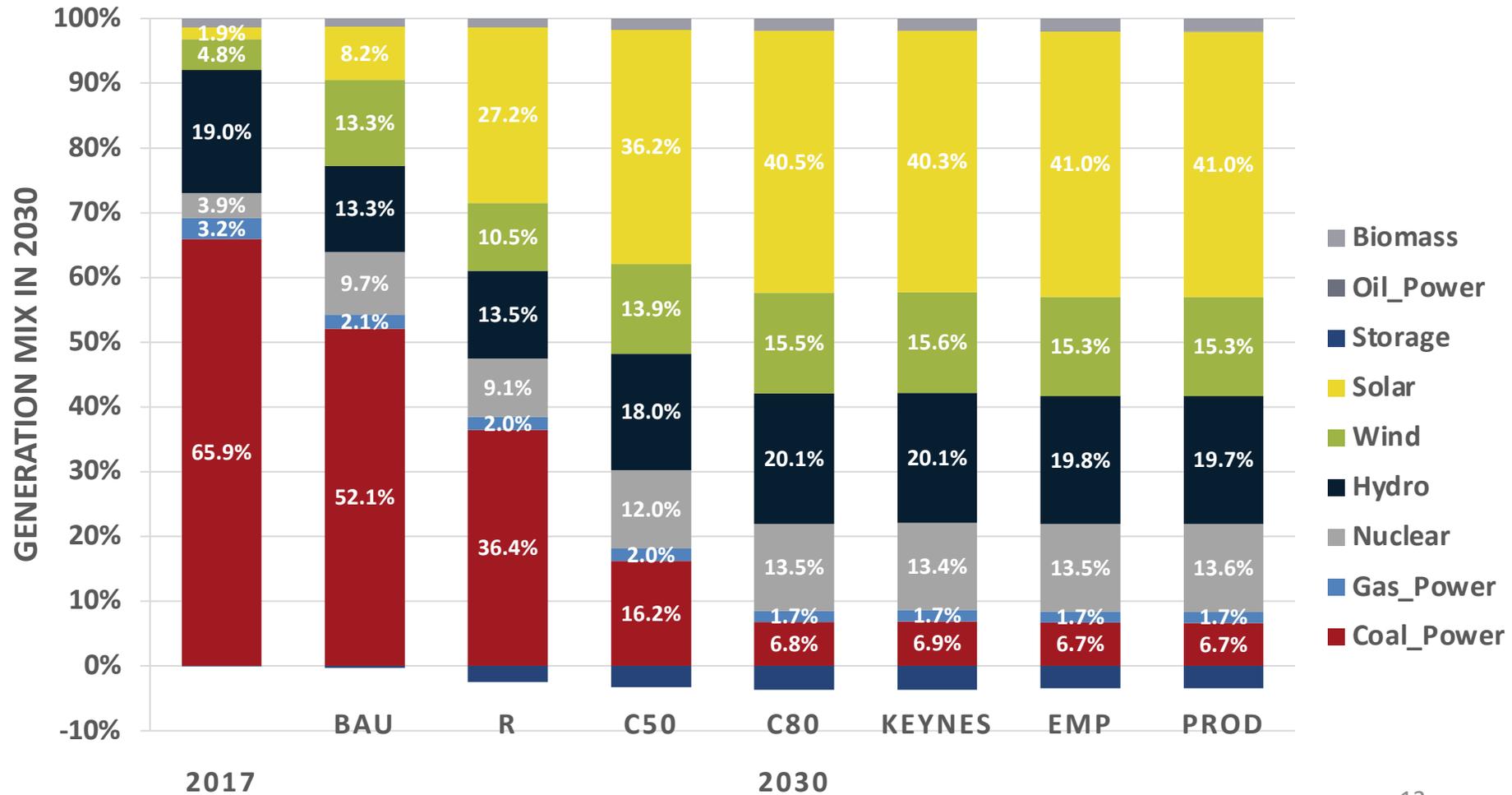
Source: He, Gang, Jiang Lin, et al. 2020. "Rapid cost decrease of renewables and storage accelerates the decarbonization of China's power system." *Nature Communications* 11(1).

# Scenarios 情景设置

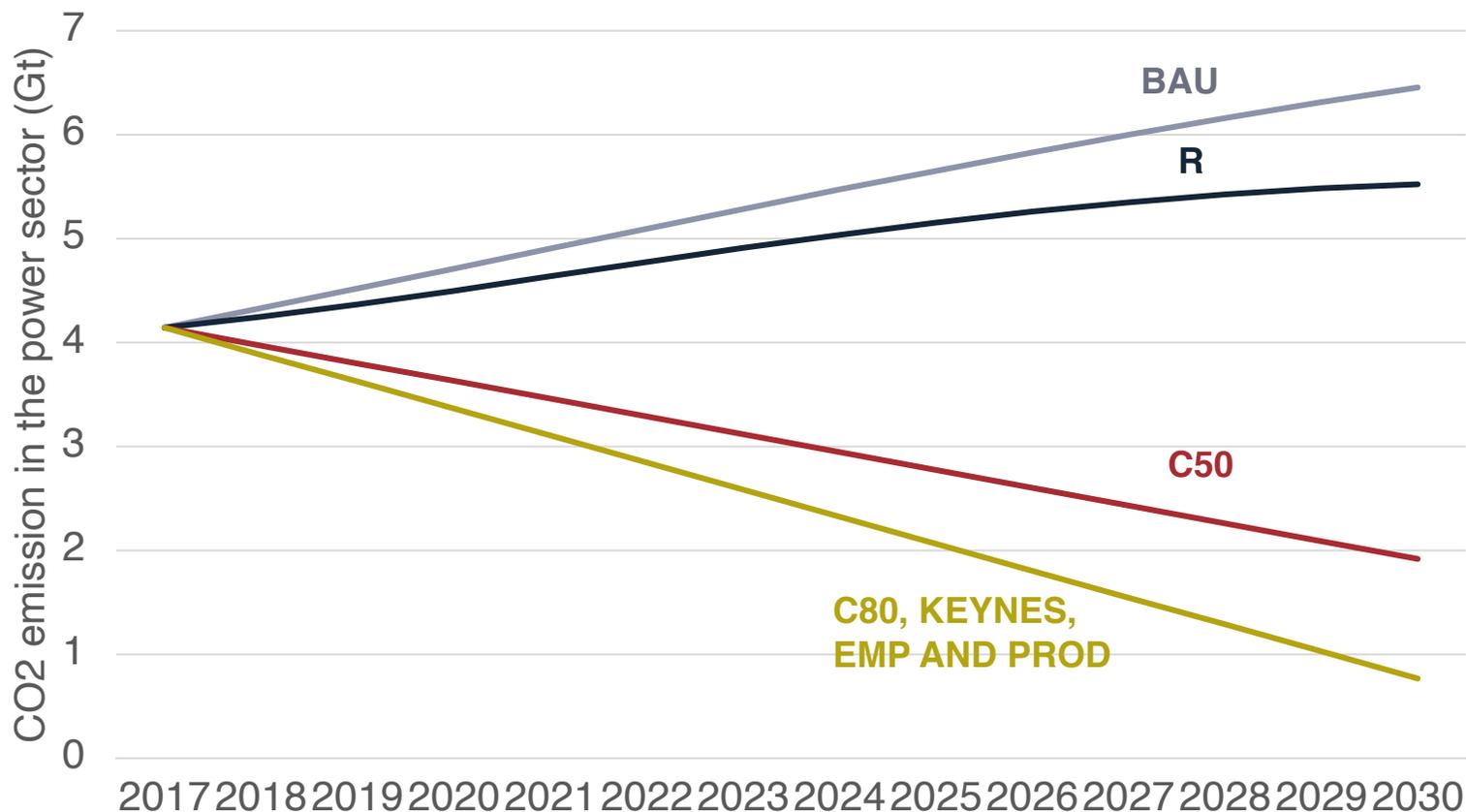
<b>Scenarios</b>	<b>Description</b>
<b>BAU</b>	Moderate productivity improvements in renewables
<b>R</b>	Rapid productivity improvements in renewables
<b>C50</b>	R + ETS limiting CO <sub>2</sub> emissions from the power sector to 50% of 2015 emissions level
<b>C80</b>	R + ETS limiting CO <sub>2</sub> emissions from the power sector to 80% of 2015 emissions level
<b>Keynes</b>	C80 + shifting expenditure from energy savings
<b>EMP</b>	Keynes + more accommodating labor market
<b>PROD</b>	EMP + energy productivity spillovers (0.1% TFP growth)

# Generation mix of the power sector in the base year (2017) and in 2030

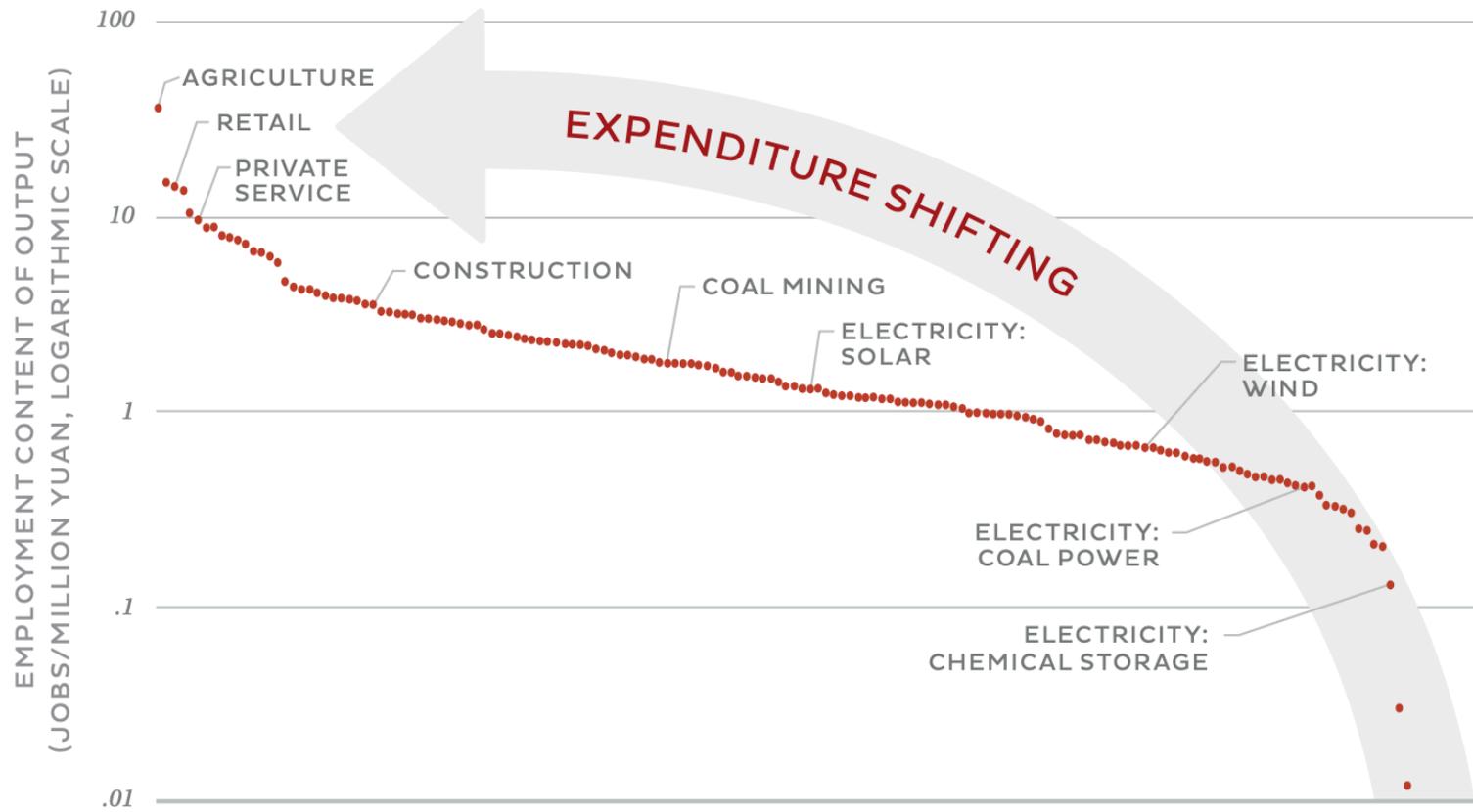
## 2017年和2030年电力供应的技术组合



Power sector CO<sub>2</sub> emissions in 2030 more than half of the 2017 level with more renewable integration  
发展可再生能源可使2030年电力部门碳排放相比目前水平减少一半以上



# Shifting expenditure to service will create more jobs 消费转移到服务部门可创造更多的工作岗位



Source: Author Calculations Based on Data from Input-Output Table 2017 and China Labor Statistical Yearbook.<sup>45,48</sup>

# Macroeconomic Impacts in China

(percent change from BAU in 2030)

## 宏观经济影响

	<b>R</b>	<b>C50</b>	<b>C80</b>	<b>Keynes</b>	<b>EMP</b>	<b>PROD</b>
<b>GDP</b>	0.77%	0.39%	0.09%	0.62%	5.91%	7.50%
<b>Consumption</b>	1.02%	0.58%	0.33%	0.86%	5.01%	6.41%
<b>Investment</b>	-0.92%	-1.33%	-1.76%	0.67%	7.89%	9.96%
<b>Exports</b>	0.51%	0.14%	-0.10%	-1.54%	3.34%	5.19%
<b>Imports</b>	-1.11%	-1.25%	-1.36%	1.21%	2.26%	3.30%
<b>Employment (million FTE)</b>	0.23%	0.13%	0.05%	0.11%	7.70%	7.98%

# Conclusions 主要结论

- Transition to renewable energy and ETS can deliver dramatic GHG reductions with net positive aggregate economic growth 可再生能源和碳排放交易不仅可以实现二氧化碳减排, 还可净正向促进经济
  - Energy cost savings for households and enterprises permit expenditure shifting toward more diverse, labor-intensive goods and services
  - Modernization of the energy system can be expected to yield productivity benefits via technology spillovers
- The economic benefits of renewable energy now substantially exceed their direct costs 可再生能源的经济收益远超出其直接成本
- Adoption of renewable technologies can proceed without the still-controversial interventions needed to recognize the social cost of carbon 发展可再生能源就可成本有效的实现碳减排
- Modernizing the electric power system can support a new generation of more diverse domestic job creation, facilitating an essential transition for millions of workers in the carbon fuel supply chain 发展可再生能源可创造更多样的工作岗位