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ONLINE PANEL DISCUSSION



The Future of Gas

SESSION 1: Security of Supply

DAY 1: SEPTEMBER 21 2022, 09:00-10:30 CEST

Leading experts discuss the issues
facing China and Europe

- imports • storage • markets
- flexibility • cooperation

Octavian Stamate - Counsellor Energy and Climate Action

Matteo Tanteri - Chairman & CEO, SNAM China

Rudolf Huber - President, LNG Europe

Jan Stambasky - Vice-President, R2Gas



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SESSION 2: CCUS and the Gas Sector

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- innovation • economics • industry
- infrastructure • deployment

Simon Göss – Independent expert, Carboneer

Benoit de Guillebon – Project Lead, **PYCASSO**

Kevin Tu – China Expert, Agora Energiewende

Lauri Myllyvirta – Lead Analyst, **CREA**

François Issard – International Energy Consultant and China expert



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energy to inspire the world

The future of gas – Security of Supply in China

Matteo Tanteri, Snam China Chairman and CEO

September 21st 2022

- **Where we left... what happened in China in the last year**
 - The 14th 5 year plan
 - Gas outlook
- **The evolution of infrastructures**
 - The rise of Pipechina
 - Increase of storage capacity
- **Links between EU and Chinese markets**
 - Supply from Russia
 - LNG

The Overall 14th 5Y Plan

Specific targets were set for 5 areas, covering 14 items

Area	Items	Current	Target 2025	Variation
Energy Security	Annual comprehensive production capacity of energy (bln Mtce)	>4.08*	>4.60	12.7%
	Annual Crude Oil Production (mln tons)	199	200	0.5%
	Annual Natural Gas Production (bcm)	>207.6	>230	>10.8%
Energy Transition	Total Installed Capacity of Power Generation (billion kW)	2.38	3	26.2%
	CO2 emissions/GDP (Carbon Intensity)	-18.8% from 2015-2020	-18% in 5 Years	-
	% of Non-fossil Energy Consumption	15.90%*	Ca. 20%	25.8%
	% of Non-fossil Energy Power Generation	32.59%	Ca. 39%	19.7%
Energy Efficiency	% of Electric Energy at End-use Consumption	-	Ca. 30%	-
	Energy Consumption/GDP	9.20% during 13° 5Y Plan	-13.5% in 5 Years	-13.5%
	% of Flexible Power (i.e., storage stations)	-	24%	-
	Demand-side responsiveness (% of max electrical load)	-	3%-5%	-
Innovation Capabilities	Investment in Energy R&D	-	7%+	-
	New Key Technological Breakthrough Areas	-	Ca. 50	-
General	Annual Living Electricity Consumption per Capita (kWh)	775.62*	1000	28.9%

Targets for Pipeline and Storage, no specific targets for LNG



Area	Items	Current	Target (2025)	Var
Natural Gas	Annual Natural Gas Production (bcm)	>207.6	>230	>10.8%
	Oil & Gas Pipeline (km)	175,000	210,000	20.0%
	Gas Consumption (bcm)	Ca. 330	420-460	27-39%
	Natural Gas as % of Total Energy Consumption	8.4%	-	-
	Natural Gas Storage Capacity (bcm)	15	55-60	267-300%
Energy Transition	Natural Gas Storage as % of Natural Gas Consumption	Ca. 4.8%*	Ca. 13%	171%
	Proportion of Non-fossil Energy Consumption	15.90%*	Ca. 20%	25.8%
	Proportion of Non-fossil Energy Power Generation	32.59%	Ca. 39%	19.7%



energy to inspire the world

*2020 Data instead of 2021

Sources: H2 14° 5Y Plan and desktop research

Internal

Pipeline

- By 2020, NG pipelines in China is about 79,100 km and PC operated ca. 60%. There is a huge gap compared to the targets set by NDRC in 2017: **104,000 km in 2020 and 163,000 km in 2025** (NG pipelines only)
- 145 Plan seems more conservative with respect to the targets set by NDRC
- The plan mentions to «**accelerate the construction and interconnection of long-distance natural gas pipelines**»

LNG & Storage

- By 2025, **55-60 bcm of storage capacity** in total will be built in Northwest, North, Northeast, and Southwest
- The plan mentions to «coordinate and promote the construction of **UGS, LNG receiving stations**, and other gas storage facilities» to enhance «natural gas **storage and peak adjustment capabilities**»

Energy Transition

- **Promote diversified utilization of biomass energy**, including biomass & biogas power generation and biomass clean heat energy **according to local conditions**
- **Biomethane will be encouraged in all major crop production and husbandry areas**
- Biomass is considered as a **key technology** to be developed

The Hydrogen 14th 5Y Plan

Conservative targets, emphasis on H2 infrastructures and multiple applications

2025 Targets

	CO2 Emission Reduction	Current	Target (2025)	Variation
		Not Applicable	1-2 million tons/y	-
	RE Hydrogen Production	100k tons/y	100k-200k tons/y	0-100%
	FCEV	>9,000	50,000	455%
	HRS	>131	A Batch of	-

Hydrogen Infrastructures

Infrastructure Layout	Storage & Transport.	HRS
- Industrial by-product H2 production near industrial sites - Green Hydrogen production in areas with rich wind, solar, and hydropower resources	- Industrialization of cryogenic liquid H2 storage and transportation, explore solid state, cryogenic high pressure, and organic liquid methods - Pilot projects in H2-blended NG pipelines and pure H2 pipelines	- Renovation and expansion of current fueling stations to hydrogen refueling station - Integrated H2 stations incorporating H2 production, storage, and refueling

Hydrogen Applications



Transportation Application

Complementary Development of FCEV + Lithium Battery EV

Heavy Truck FCEV

Fuel Cells in ships, aircrafts, and other fields



Storage Application

Renewable Energy Consumption

Wind & Solar Power Generation + Hydrogen Storage Integrated Model



Diversified Application

Localized Fuel Cell distributed heat & power cogeneration facilities

Back-up power in infrastructure

Power grid peak regulation



Industrial Application

Fossil Fuels Substitution

High quality heat source

Hydrogen Metallurgy

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Strategic Role of Biomethane

Jan Stambasky
Vice-President

ENERGY POST
21st September 2022

European “Independencey”

Is this the Security of Supply we desire??

➤ **Annual imports of 3 630 TWh (2021)**

- 41% from Russia (three major pipelines: Nord Stream, Yamal, Brotherhood)
- 23.5% Norway
- 20.5% LNG regasification

➤ **Only 10 countries do not import Russian natural gas**

- Belgium, Croatia, Cyprus, Denmark, Ireland, Malta, Portugal, Spain, Sweden, United Kingdom

➤ **Baltic countries and Finland import 100% ...**

- Even the Netherlands with its gas reserves imports 8.5% (32 TWh)

Green Gas Potentials vs. Imports

Gas for Climate Report

- Biomethane AD (agro, waste): 62 bcm
- Biomethane gasification: 33 bcm
- Biomethane PtG: 15 bcm
- Green electricity Hydrogen: 160 bcm
- Blue (CCS) Hydrogen: 18 bcm
- Potentially on new sites: 124 bcm

➤ **Total:**

288 – 412 bcm

➤ **Annual imports of non-EU gas: 337 bcm (2021)**

- Total EU consumption: 412 bcm

➤ Nord Stream 1&2

- 2x 27.5 bcm

➤ Yamal

- 33 bcm

➤ Brotherhood

- 33 bcm

Strategy for Domestic Green Gas

- Green gases deliver more than energy...
- ... all the advantages have to be acknowledged!
- Green gas industry can be a pillar of EU energy security
 - Particular green gas type potentials are comparable with major gas pipelines capacities
 - Entire biomethane potential completely surpasses current imports of Russian natural gas
 - Biomethane and hydrogen can entirely avoid EU gas imports
- Clear domestic economic & security synergy
 - Keeping the existing gas grid in function, with green, domestic, & secure high quality fuel
- Multitalented industry needs multiple strategy



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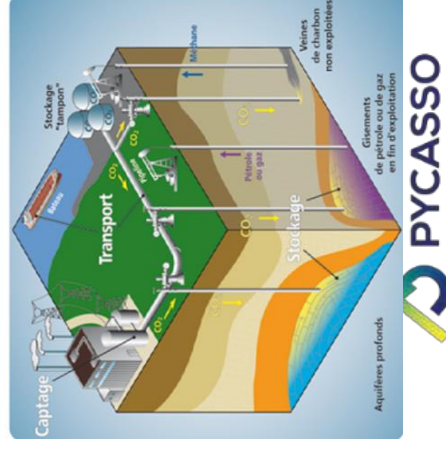
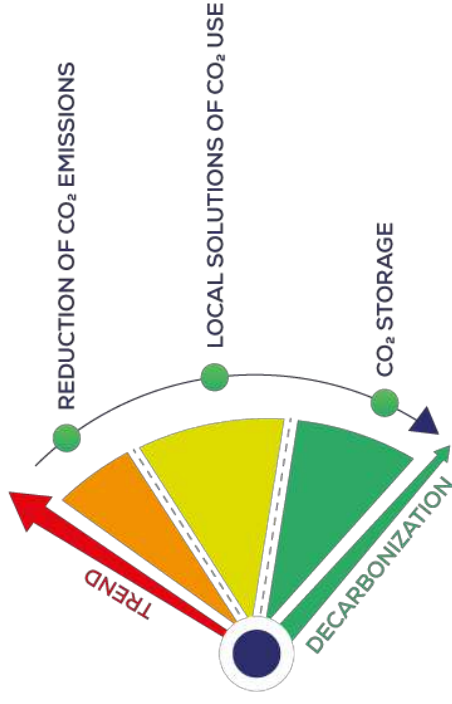
PYCASSO*: a territorial decarbonization project

*PYrenean Carbon Abolition through Sustainable Sequestration Operations

PYCASSO, A TERRITORY PROJECT

How can reservoirs, which supplied France with gas for 60 years and the industrial basin built around it, be part of the decarbonation solution of the industrial activity of Bordeaux-Toulouse-Saragosse-Bilbao territory?

By providing a mutualized territory service of valorization and CO2 storage for the next 50 years.





The key points of PYCASSO project

- Spread and diverse emissions
- The industrial Lacq basin with a strong culture of mutualization
- Safe and sustainable underground storage capacities and local skills in geosciences
→ The successful experiment of the ROUSSE pilot (2010-2013)
- A transport network by interconnected gas pipelines
- The possible link with a dawning H2 sector
- The appropriation by territory stakeholders

PYCASSO emitters club

Strong interest of local marketers in the project

Landes & Girondes

2 emitters (1,1MT CO2/an)

Pyrénées Atlantiques

4 emitters (500 kTCO2/an)

Euskadi

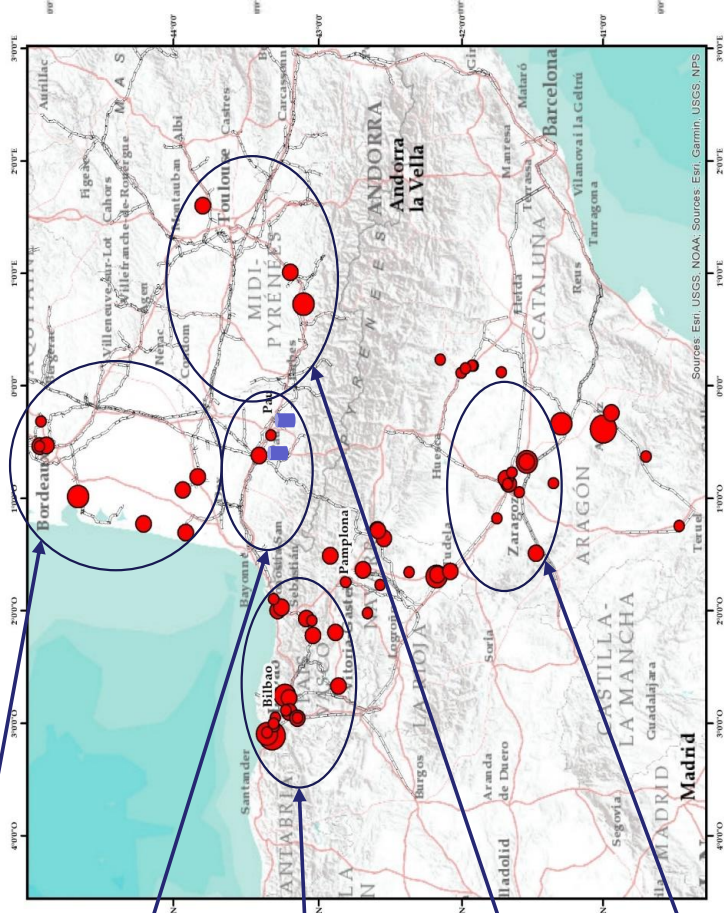
5 emitters (3,8MTCO2/an)

Occitanie

2 emitters (680 kTCO2/an)

Aragon

1 emitter (1Mt CO2/an)



CO2 equivalent

Members of the emitters club

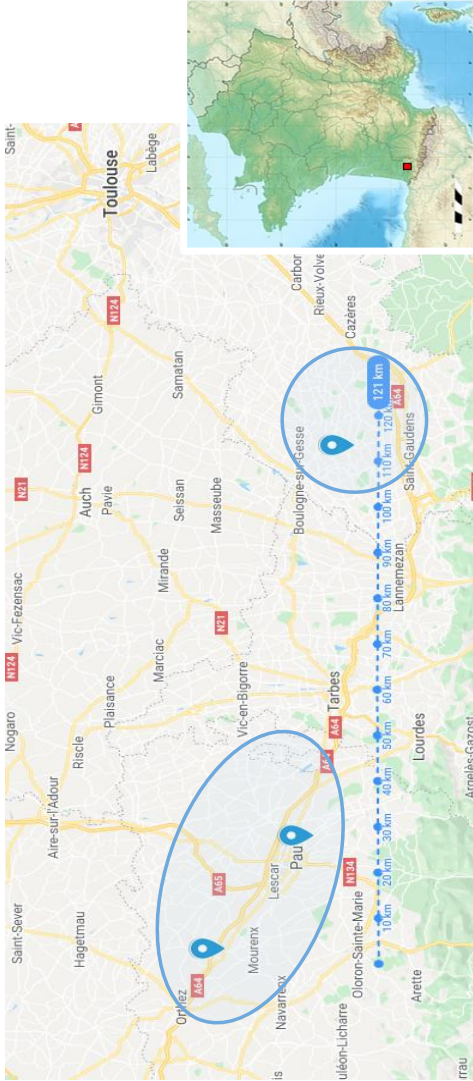
France :

~ 2 280 kT CO2/an

Espagne :

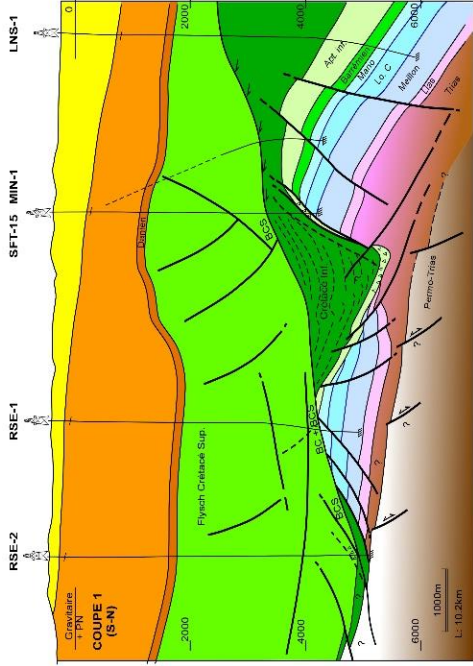
~ 4 800 kT CO2/an

Well-known storage capacities



ROUSSE 1

In 2011-2013, 50kt of CO2 were successfully injected into depleted field (30 bars) at 4 500m depth



Field Name	Lacq	Meillon	Rouse	St Marcet	Auzas-Proupiary	Parentis
Reservoir Depth (m)	3200	3800	4600	1200	1900	2000
Initial and abandonment Pressures (b)	650	460	480	140	200	220
CO2 Storage Capacity in Mt	435	160	12	22	2,5	16

Diffuse CO2 emissions throughout the territory

Key CO2 transportation issues:

- Need for optimized multi-modal and mutualized transport



Train

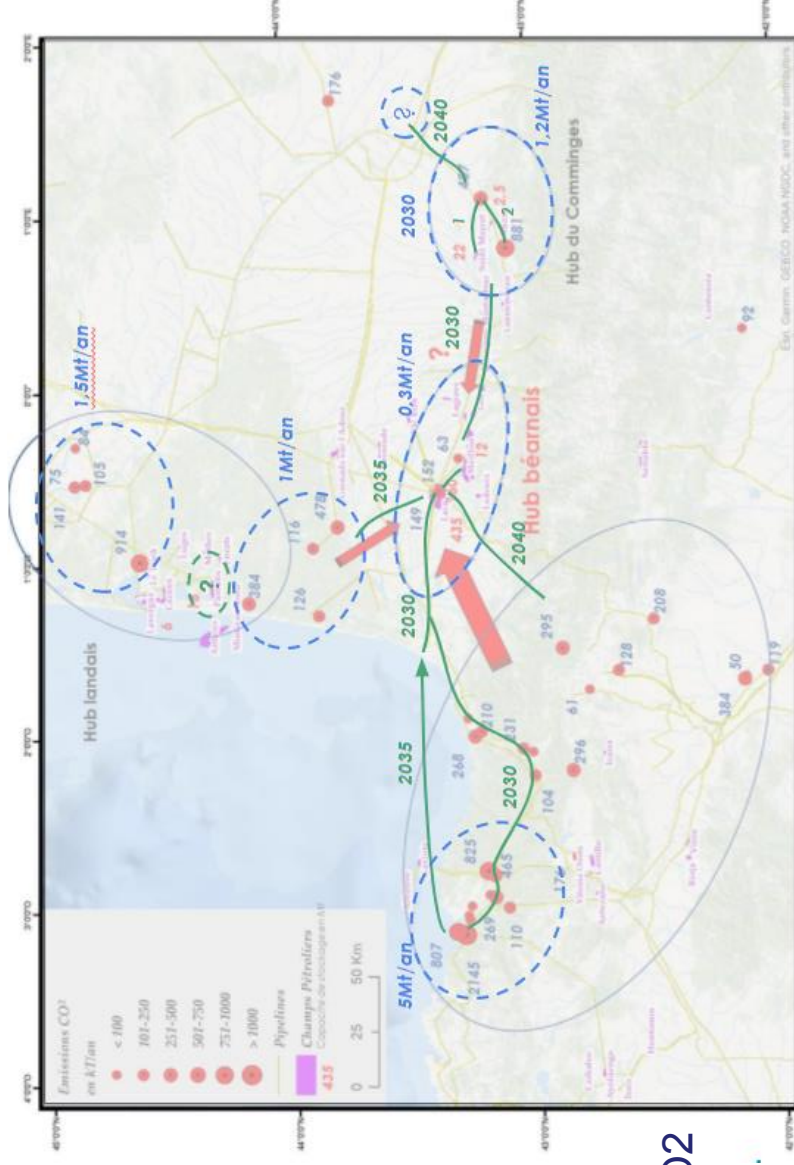


Pipes (existing or new)

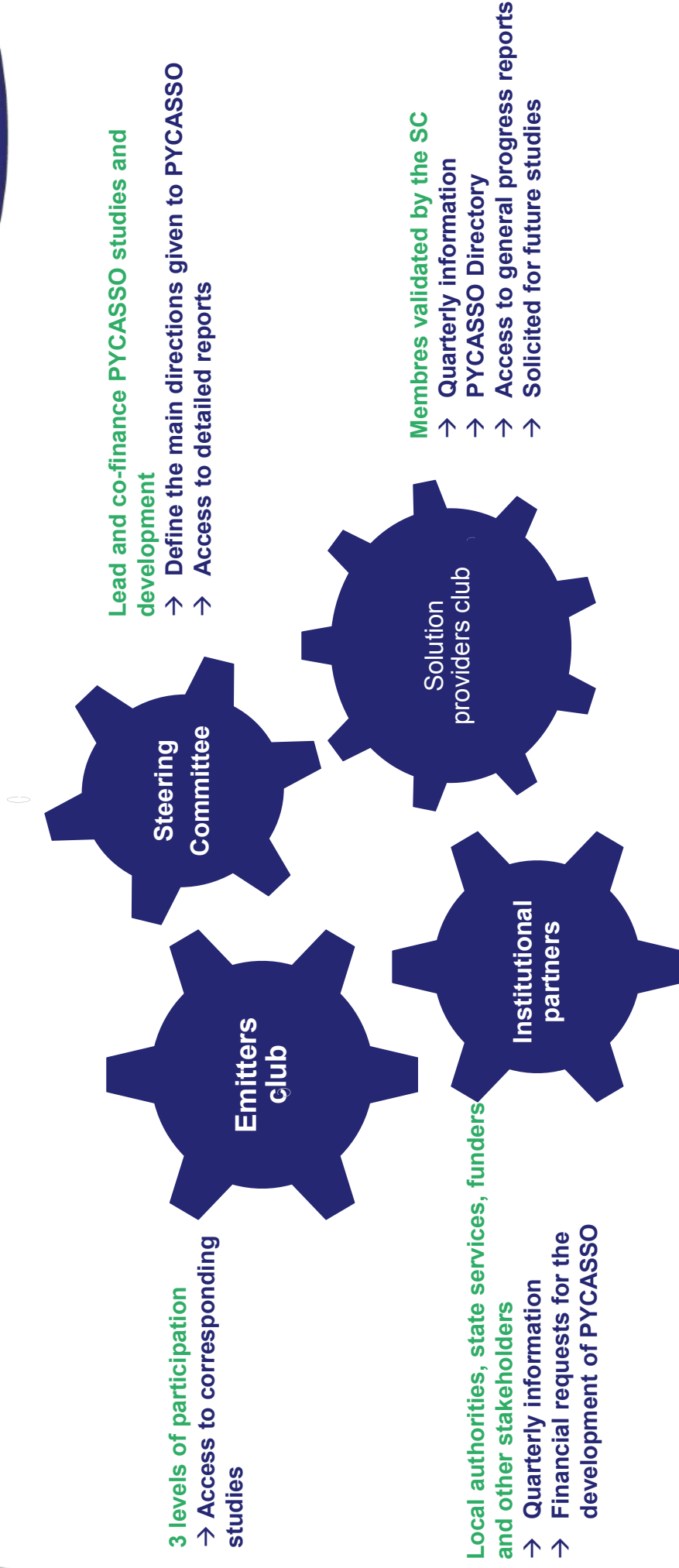


Boat et CO2 terminal

- Development of onshore cross-border CO2 transport



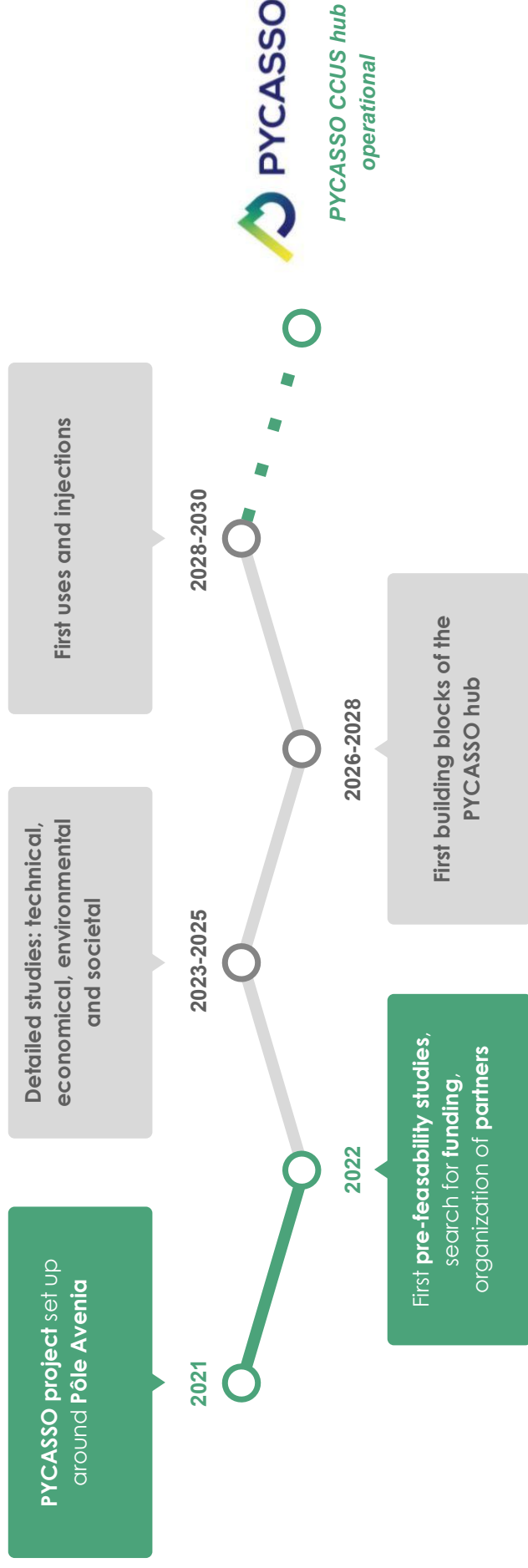
PYCASSO ecosystem



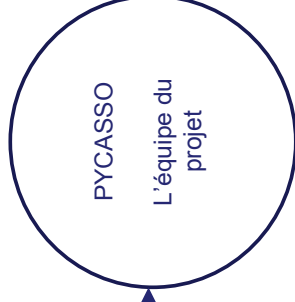
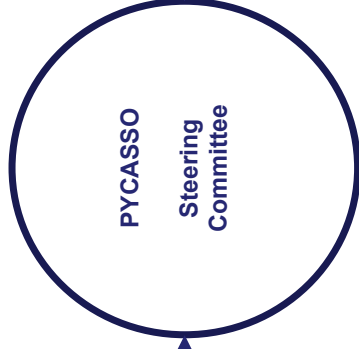
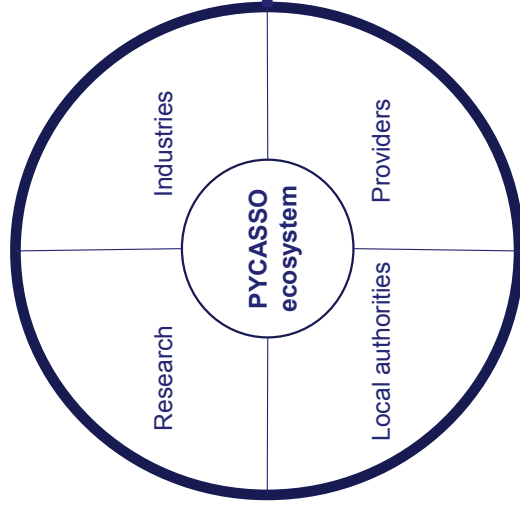
PYCASSO ecosystem



PYCASSO – The main steps...



PYCASSO: governance and operational



Benoit de Guillebon
Project leader



Mallorie Navarre
Project leader – Industriel



Lionel Huang
Project development leader



Marc Blaizot
SC President



... and all AVENIA's team !



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CCUS在中国的前景 Prospects of CCUS in China

涂建军 Kevin Jianjun Tu

Agora 能源转型论坛 | Agora Energiewende

北京 BEIJING

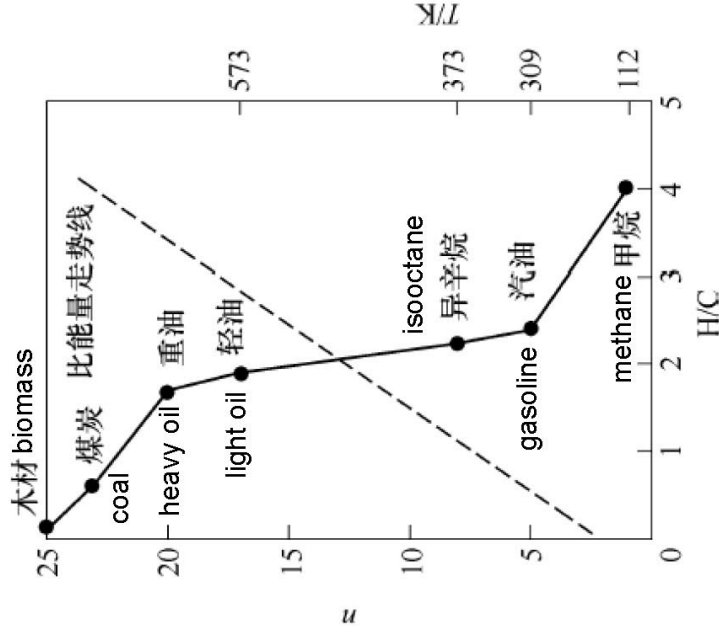
SEPTEMBER 21, 2022 年9月21日



从能源转型的角度看CCUS的地位 The role of CCUS in energy transition

人类使用能源资源变迁规律

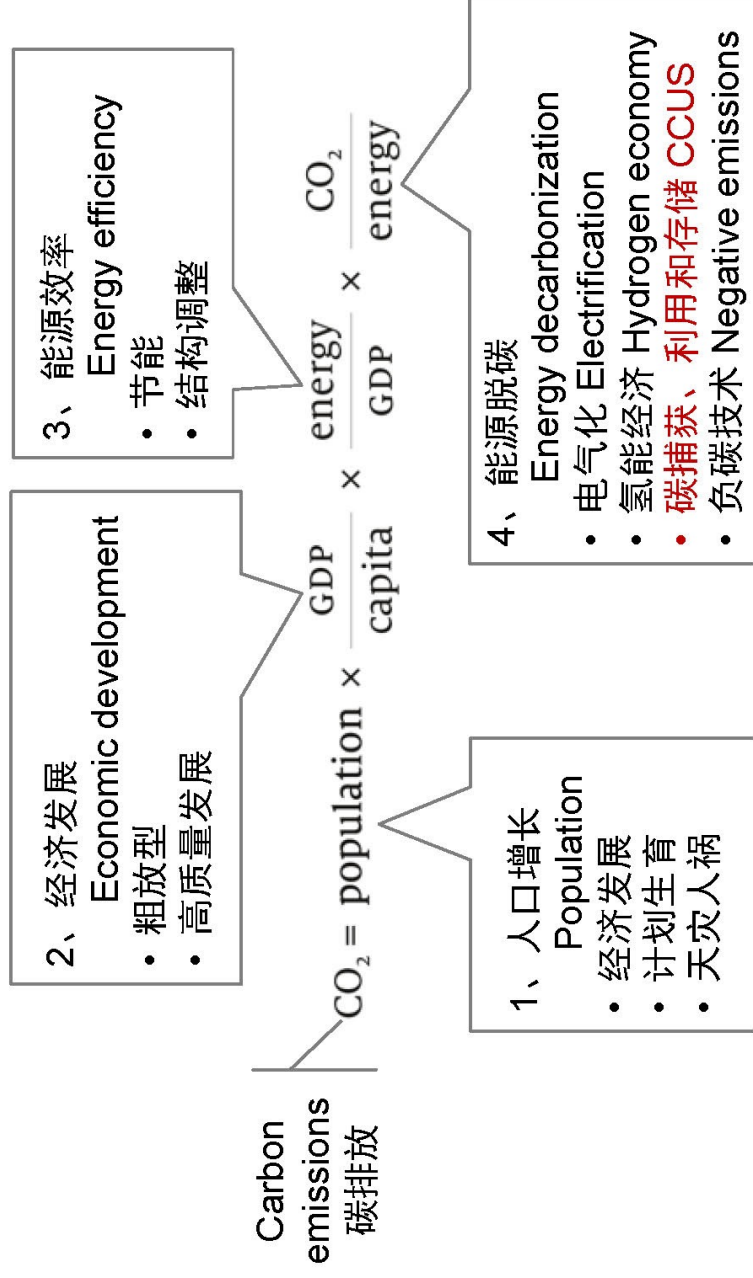
Evolution of dominant energy carriers



Source: Hydrogen energy and economy.

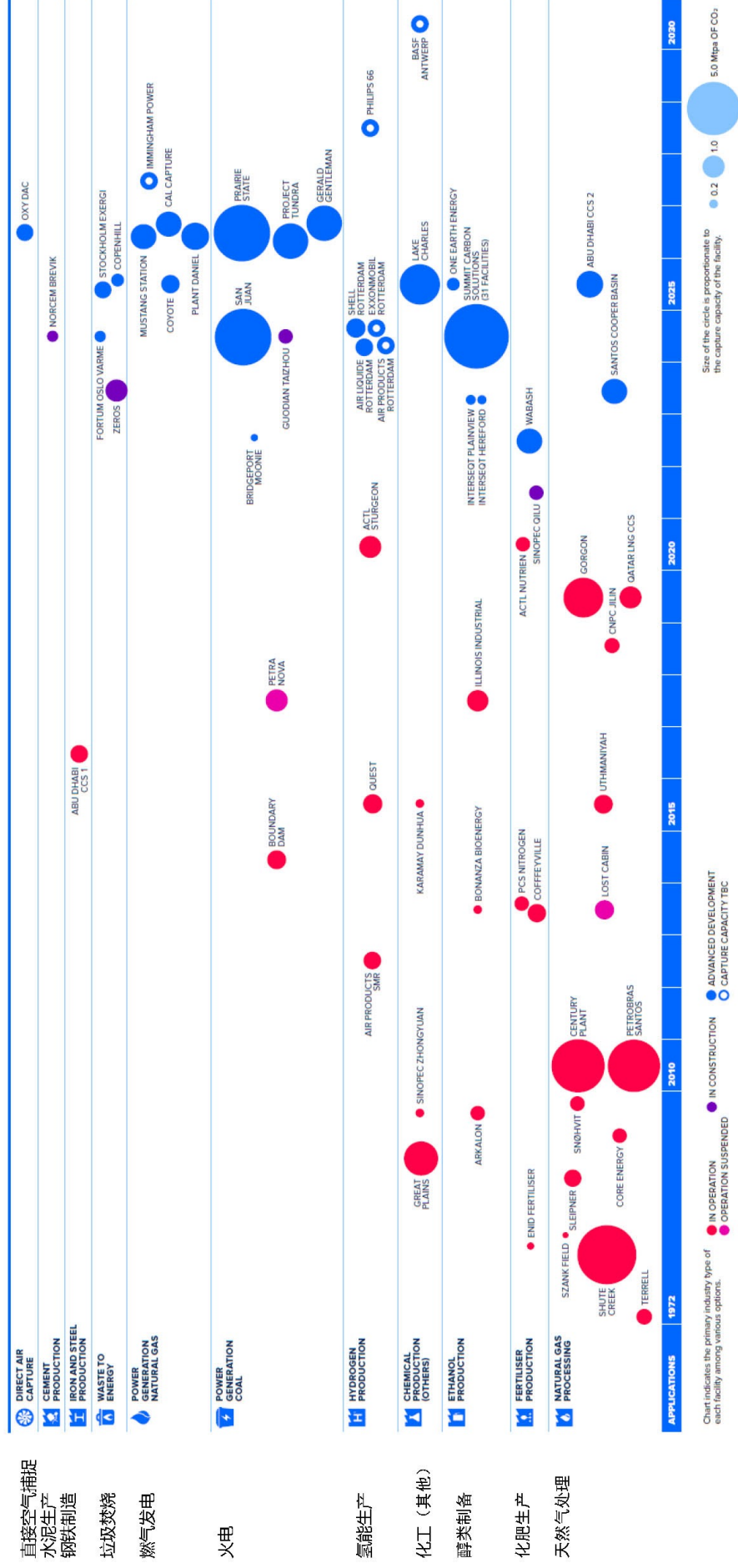
碳排放影响因素分析：Kaya公式

Decomposing carbon emissions with Kaya Identity



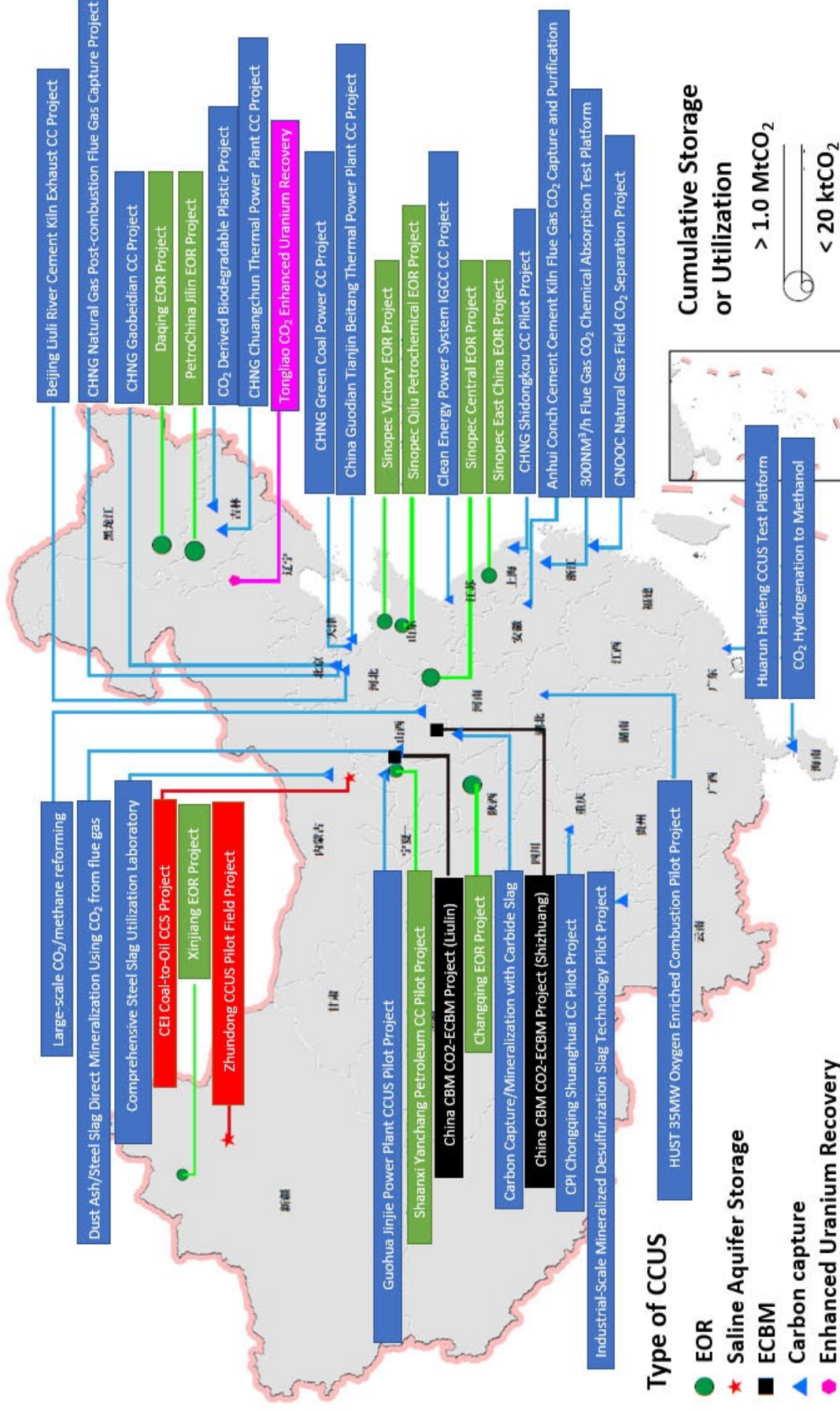
CCUS是实现净零排放的最后手段吗？ CCUS = the last resort of achieving net-zero emissions?

全球范围的CCUS应用的多样性不断增加 Increasing diversity of CCS application across globe



Source: Global Status of CCS 2021.

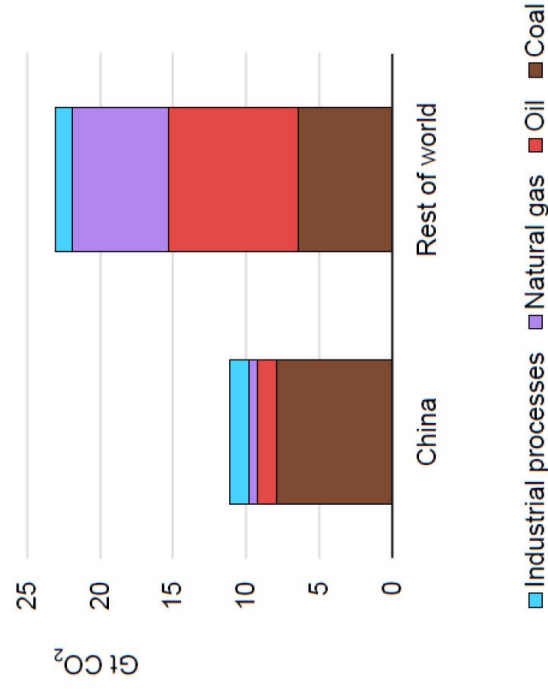
中国CCUS项目分布图 Map of CCUS projects in China



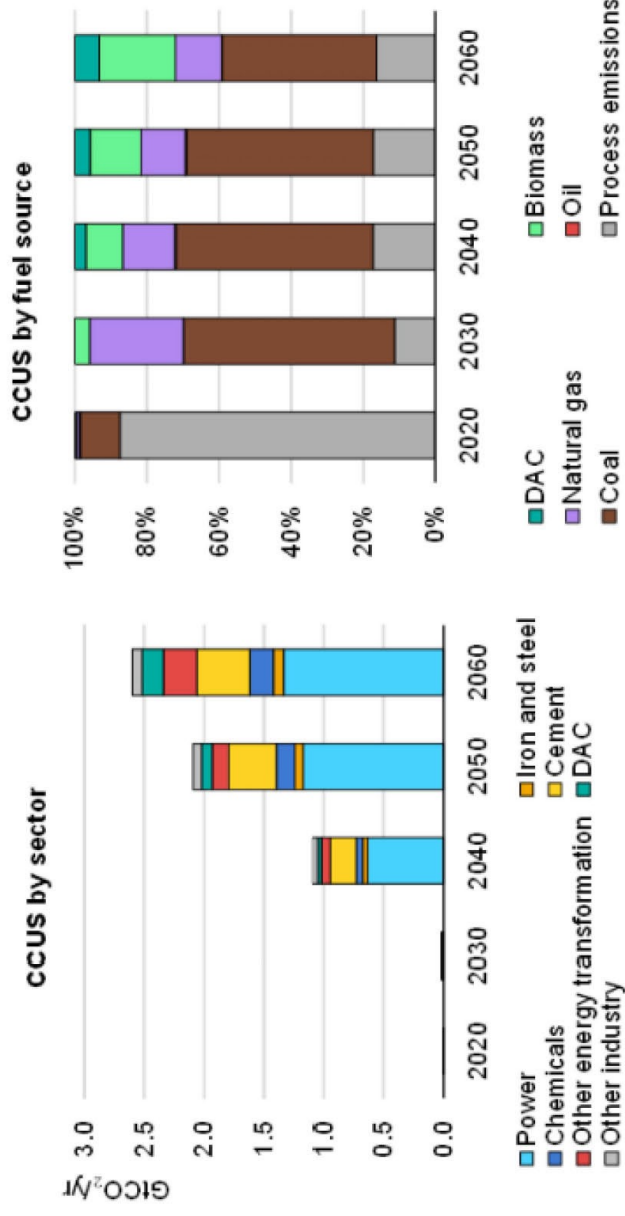
Source: Adapted from China's CCUS Annual Status Report 2021 – China CCUS Pathway Research, July 2021.

IEA: CCUS focuses initially on reducing emissions from existing assets but plays a growing role in removing carbon from the atmosphere via BECCS and DAC with storage

→ Energy sector CO₂ emissions: China vs. rest of world 2020



→ CCUS deployment by sector and source of emissions in China in the APS



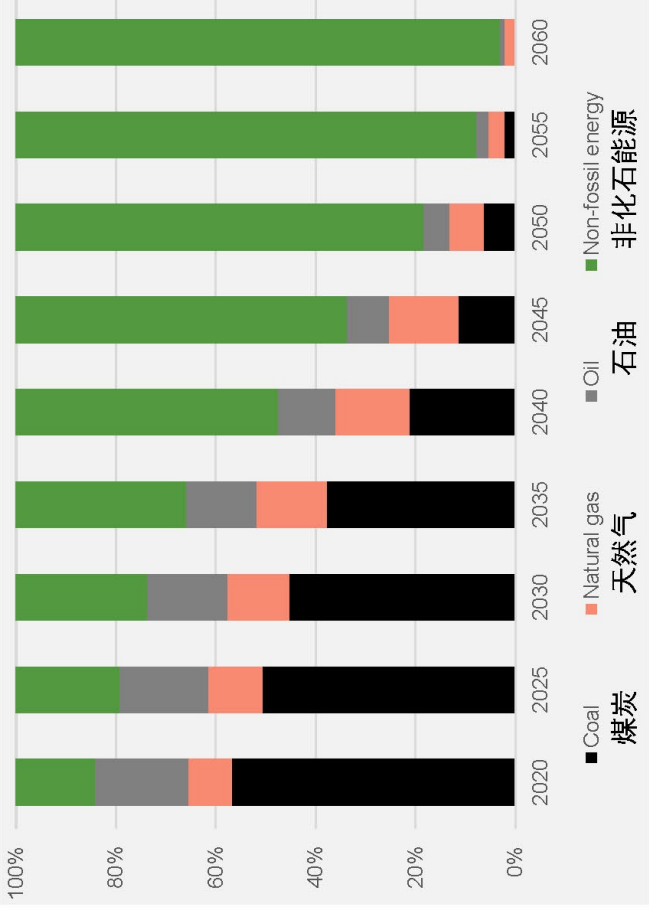
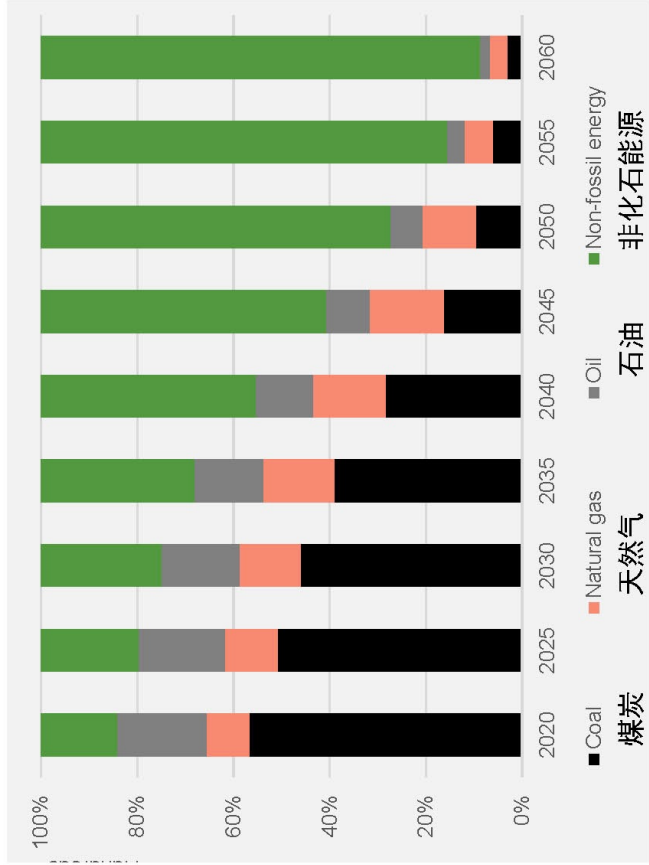
Source: IEA (2021) An Energy Sector Roadmap to Carbon Neutrality in China.

ERI of NDRC: While fossil fuel especially coal dominates China's energy mix, the future of fossil fuel in an increasingly carbon-constrained China is not necessarily promising



→ 基准情景下中国一次能源结构变化 Fuel shares in China's primary energy consumption in the baseline scenario

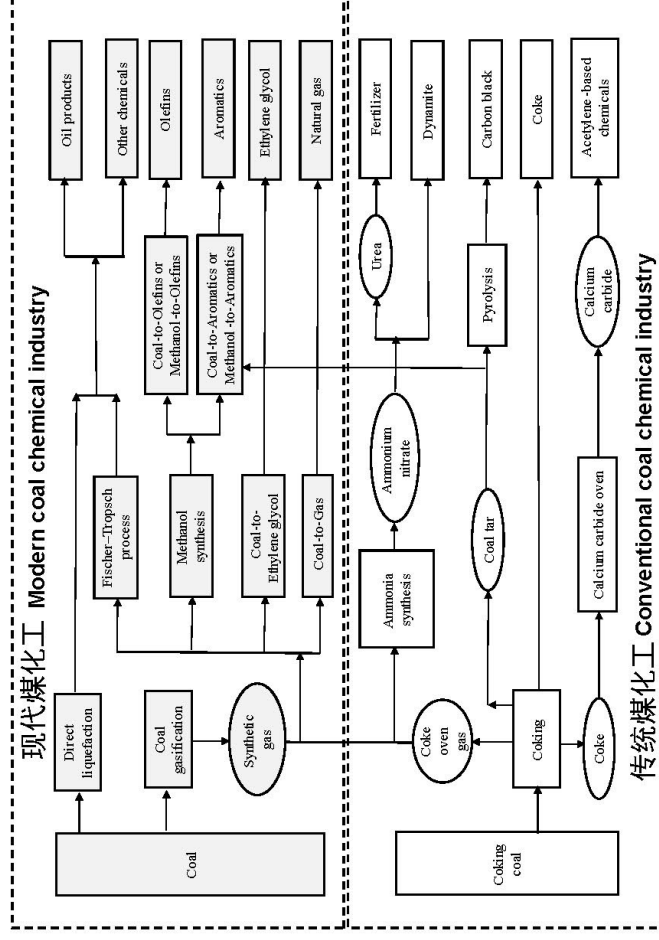
→ 碳中和情景下中国一次能源结构变化 Fuel shares in China's primary energy consumption in the carbon neutral scenario



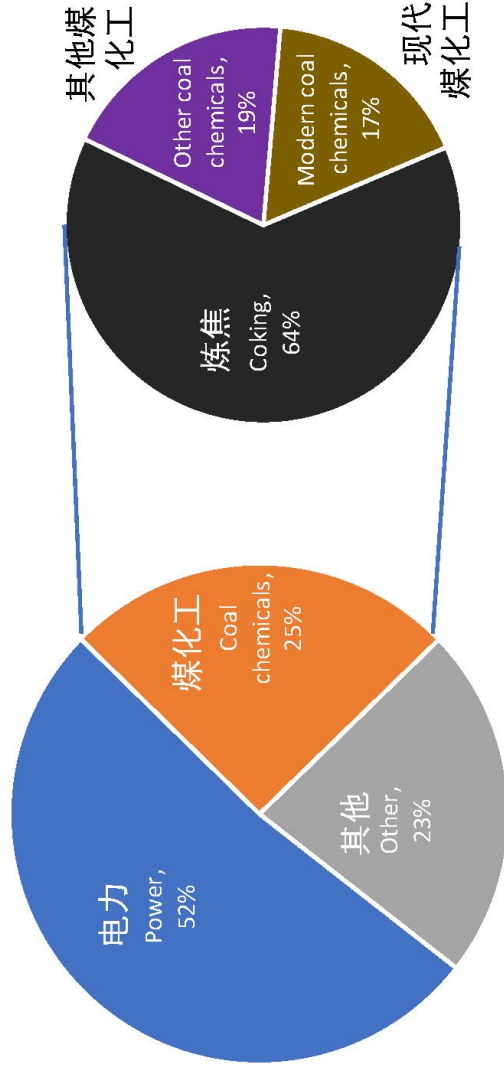
来源：中国宏观经济研究院能源研究所（2022）《中国能源转型展望报告2022》。ERI of NDRC (2022) China Energy Transformation Outlook 2022.

中国煤化工行业是双碳目标的重点关注领域 The Chinese coal chemical industry possesses unique challenge for China's dual carbon targets

→ 中国煤化工行业的流程图 Simplified flow diagram of the Chinese coal chemical industry



→ 中国部门煤炭消费情况 Coal consumption by sector in China



Source: Kevin Tu (forthcoming) The future of the Chinese coal chemical industry in an increasingly carbon-constrained world. CGEP of Columbia Univ: New York.

There is a limited set of no-regret applications in all sectors that need renewable hydrogen to become climate-neutral.

Green molecules needed?	Industry	Transport	Power sector	Buildings
No-regret	- Reaction agents (DRI steel) - Feedstock (ammonia, chemicals)	- Long-haul aviation - Maritime shipping	Renewable energy back-up depending on wind and solar share and seasonal demand structure	Heating grids (residual heat load *)
Controversial	High-temperature heat	- Trucks and buses ** - Short-haul aviation and shipping - Trains ***	Absolute size of need given other flexibility and storage options	
Bad idea	Low-temperature heat	- Cars - Light-duty vehicles		Building-level heating

* After using renewable energy, ambient and waste heat as much as possible. Especially relevant for large existing district heating systems with high flow temperatures. Note that according to the UNFCCC Common Reporting Format, district heating is classified as being part of the power sector.

** Series production currently more advanced on electric than on hydrogen for heavy duty vehicles and buses. Hydrogen heavy duty to be deployed at this point in time only in locations with synergies (ports, industry clusters).

*** Depending on distance, frequency and energy supply options

结论 Concluding remarks

- 在本世纪中叶净零议程的推动下，CCUS在中国以及世界其他地区的受重视程度会不断升高。Net-zero targets by mid-century are expected to benefit CCUS-related initiatives in China and beyond.
- CCU在碳减排工具包中的优先级要高于CCS，但如何实现其经济性将面临重大挑战。Priority of CCU should be higher than CCS to mitigate hard-to-abate CO₂ emissions, but how to achieve economies of scale for key CCU routes is still an open-ended question.
- CCUS在中国能源行业的前景具有巨大的不确定性，该技术在高碳价地区的规模化部署将为中国CCUS的发展注入动力。Deployment of CCUS projects at scale in regions with high carbon prices is key for prospects of CCUS in China and beyond.



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Incentivizing CCUS through carbon markets

Simon Göß, The Future of Gas – CCUS for the gas sector, 21.09.2022

Our Services

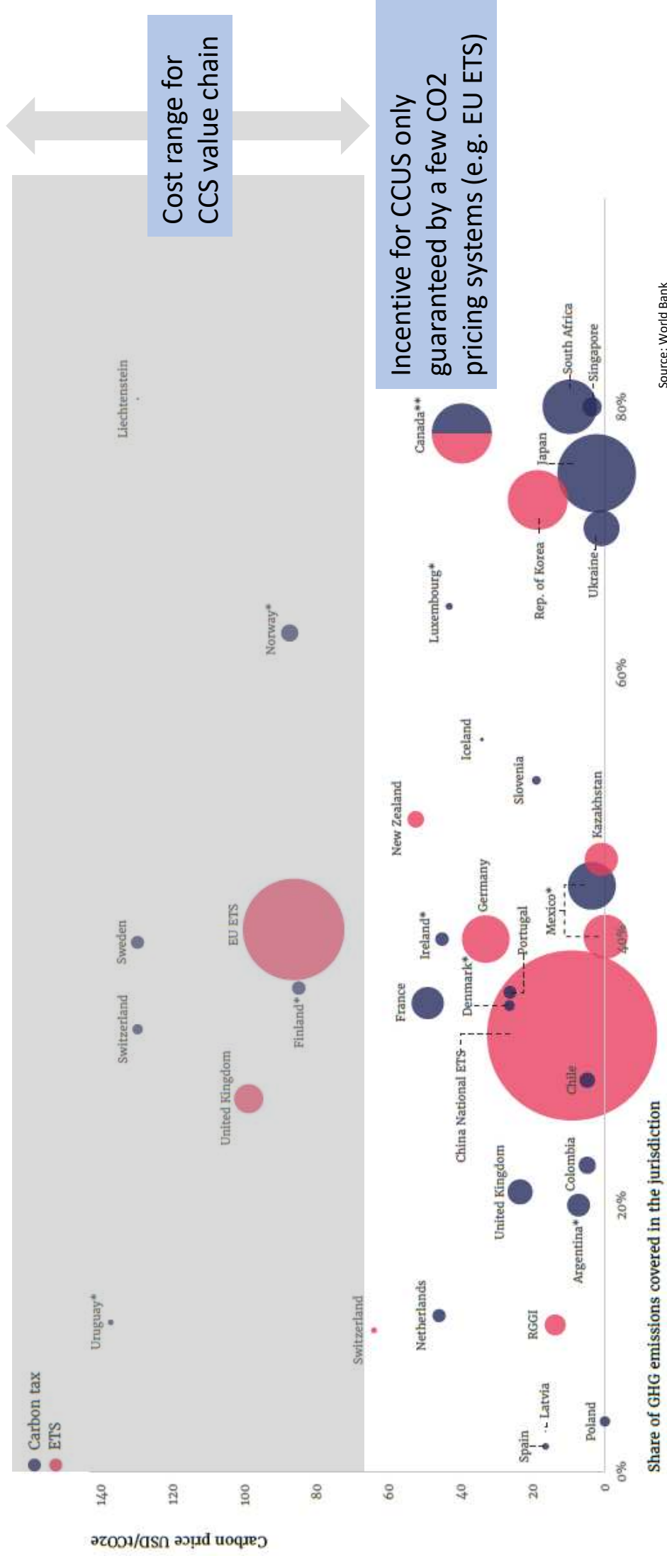
Compliance CO2- markets	Climate neutrality and carbon removal	Training and education
• Strategic alignment of your company with the European CO2 markets • Preparation and implementation of your commitments • Market access and services on the compliance markets	• Strategy development for climate neutrality and carbon dioxide removal • Development and restructuring of your climate portfolio towards neutralisation • Access to high-quality carbon removal credits	• Training on energy and carbon markets, carbon removal and climate neutrality • Transfer of know-how through strategy workshops • Expert speakers

Instruments to incentivize CCUS

- › Numerous options to support scale-up
- › Complex interaction of instruments with existing market mechanisms

Instrument	Mechanism	Examples
Financial support	Grants and loans	US, EU (Innovation Fund), UK, Norway
	Tax breaks	US (45Q)
	Contracts for Difference	NL
CO2-pricing	CO2 tax	Many countries
	Emission trading system	EU (EU ETS), China, California
	Carbon border adjustment mechanism	EU (in preparation)
Regulation	Emission standards	Canada
	Legal requirements	Australia
	Regulated infrastructure	UK
Other options	Public procurement / auctions	EU, US, Sweden
	Reduction of financing risks (loan collateralization, risk sharing)	Australia

Level of CO2 prices in different countries



Cost range for
CCS value chain

Incentive for CCUS only
guaranteed by a few CO2
pricing systems (e.g. EU ETS)

CCS partly covered under EU ETS

Art. 12 (3a) EU ETS Directive (since 2009)

- › Obligations to surrender allowances do **not** apply to emissions captured and transferred for permanent storage

Art. 49 Monitoring Regulation (since 2017/2018)

- › Fossil carbon emissions used in the "production of precipitated calcium carbonate in which the CO₂ used is chemically bound" are deductible.

Proposal of the EU Commission in the Fit for 55 package (in 2021)

- › Extension of deduction eligibility for all permanently chemically bound CO₂ emissions in the EU ETS Directive.

EU Innovation Fund supporting CCUS

- › Financial support for energy transition technologies, incl. CCUS
- › Financed through income from EU ETS: 38 bl. EUR von 2021-2030

Small-scale projects (1. Call)

Projects between 2,5-7,5 mil. EUR

Total funding: 100 mil. EUR

30 projects (including 2 CCUS)

Evaluation of the 2nd call in autumn 2022

Large-scale projects (1. und 2. Call)

Projects over 7.5 mil. EUR

Total funding: 3 bl. EUR

24 projects (of which 11 CCUS)

Start of the 3rd call from fall 2022 (3 billion EUR)

Sustainable Carbon Cycles (new regulations on EU level coming)

- › Targets and strategy for carbon cycles, CCUS and carbon removal at EU level

Carbon Farming

- › 310 million metric tons of land- and nature-based negative emissions by 2030.
- › Development of new support mechanisms for carbon farming
- › Standardization of Monitoring, Reporting, Verification (MRV)

Industrie, CCUS, technological removal

- › Industry reporting obligations from 2028
- › 20% of carbon in chemical and plastic products from non-fossil sources by 2030
- › 5 million tons/year of technical carbon removal and storage by 2030
- › Dedicated funding programs for industrial CCUS and CDR applications (Horizon Europe)

Carbon removal certification

- › Regulatory framework for certification of various CDR technologies
- › Focus on MRV processes also for industrial CCUS
- › Proposal for CDR certification in the EU (end 2022)

Main take-aways

Many options to incentivize CCUS

Carbon markets already give price signals to industry

Additional support mechanisms needed as well (EU Innovation Fund)

Regulations with big effect on CCUS and carbon removal upcoming

carboneer

Thanks for your attention!

Any questions?

c a r b o n e e r



simon@carbioneer.earth

[LinkedIn](#)

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