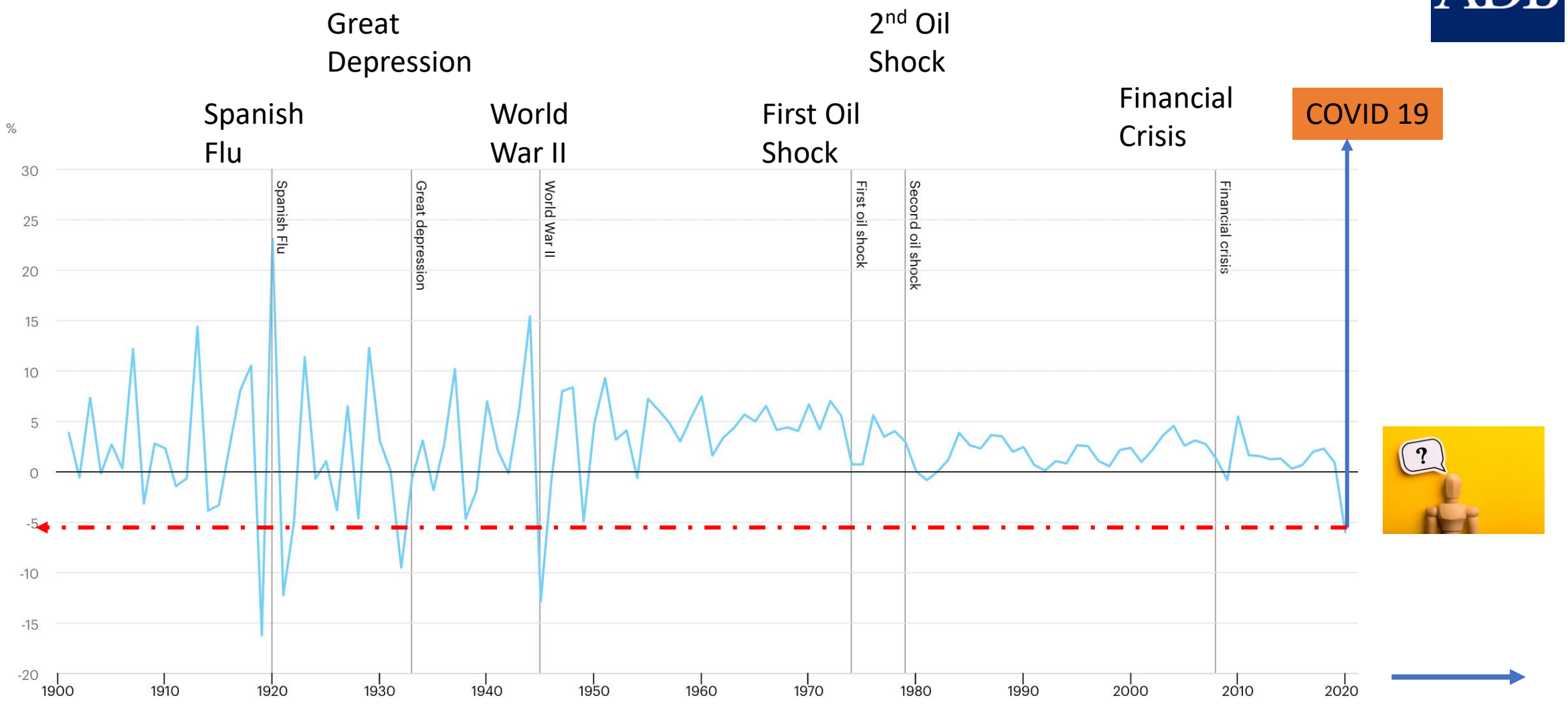
Green and Low-carbon Energy Enable Economy Recovery and CCUS in Asia

Jinmiao Xu

Energy Specialist
Sustainable Development and Climate Change
Asian Development Bank

Meiji University, Japan
21 January 2022

Rate of change of global primary energy demand, 1900-2020

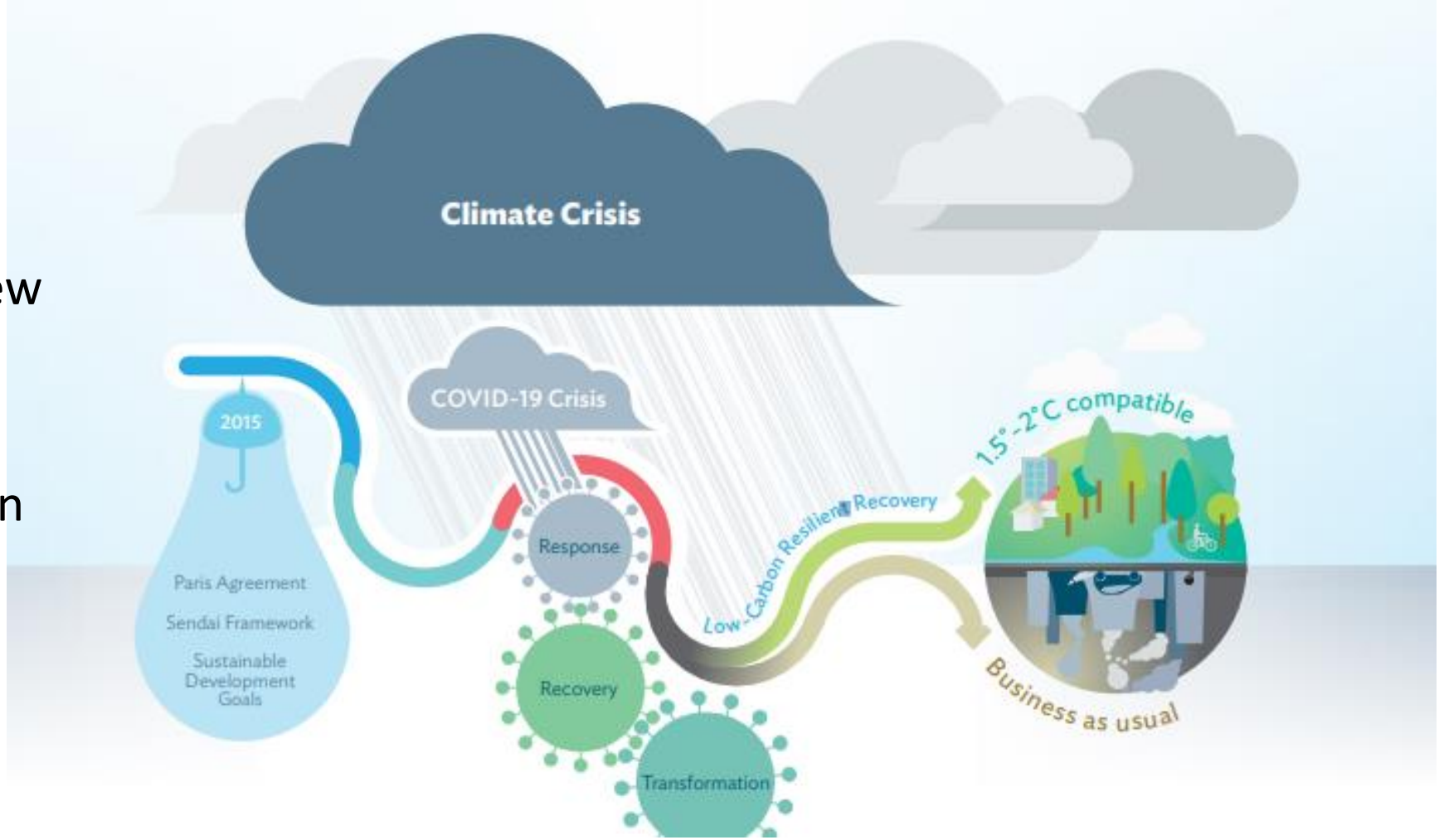


https://www.iea.org/data-and-statistics/charts/rate-of-change-of-global-primary-energy-demand-1900-2020

A Pathway to a Low-Carbon and Resilient Future

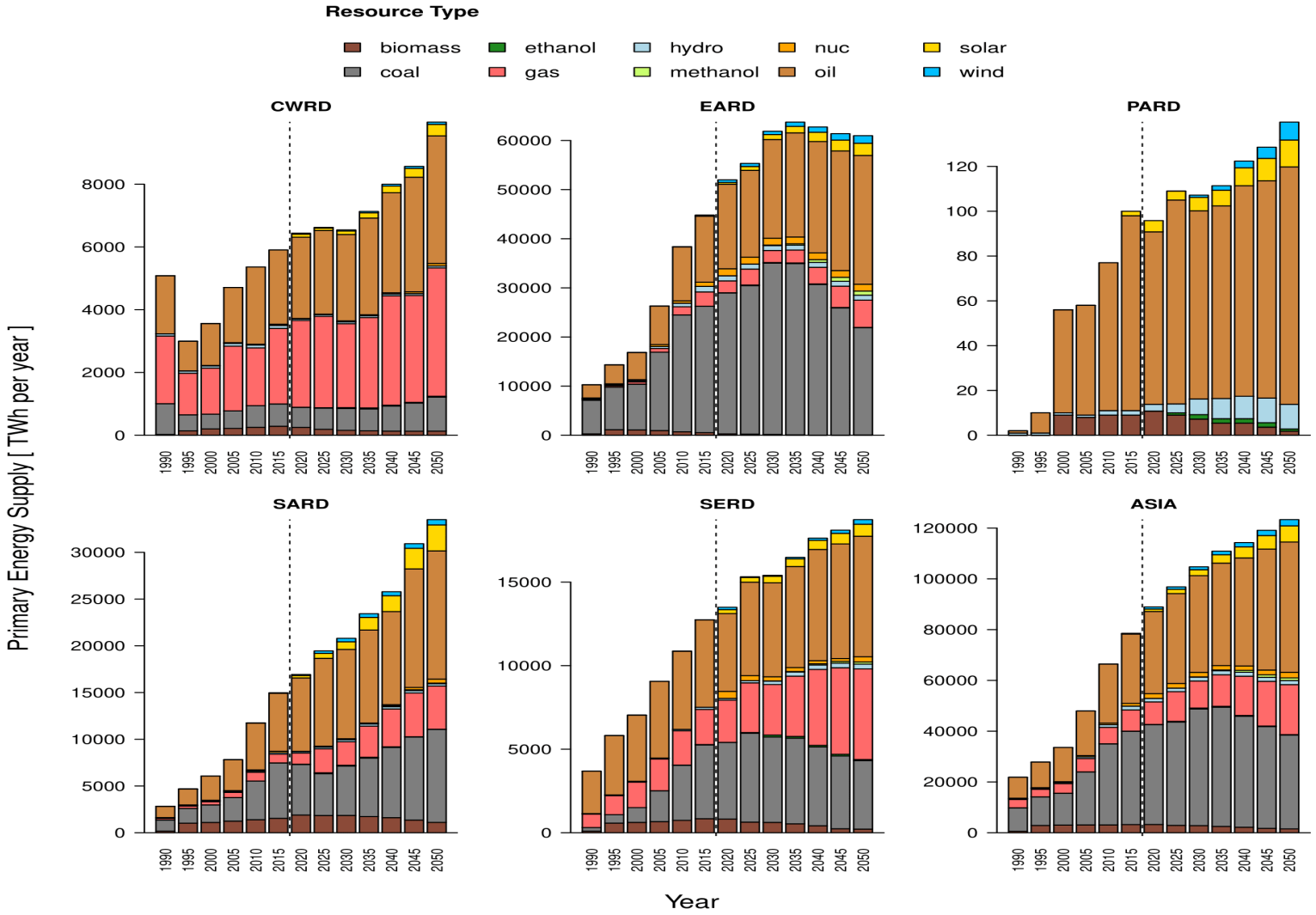
Strong Climate Action has a potential to

- **GENERATE** over 65 million new low-carbon jobs by 2030
- **DELIVER** at least $26 trillion in net global economic benefits
- **AVOID** 700,000 premature deaths from air pollution



Regional baseline assessment of energy supply and technology mix

Primary energy



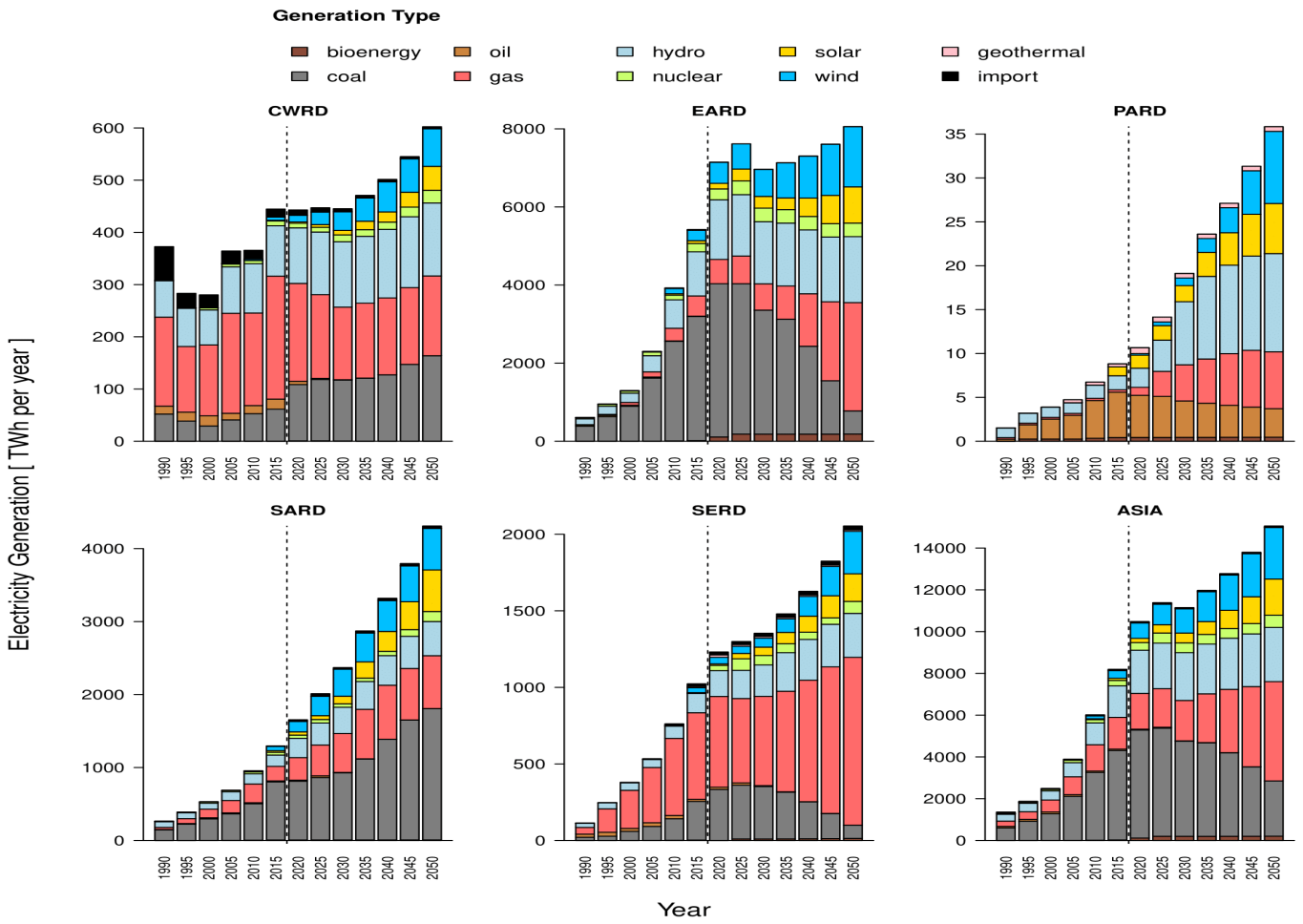
Source: TA 9690 baseline results (Results are indicative and subject to change)

- Fossil fuels (coal, oil and gas) are the predominant fuels until foreseeable future in the regions.
- Coal as a resource is expected to lose its importance in the mix.
- Oil is the single largest energy source of many regions in Asia
- Renewable is far behind the expected level of use in the region.
- Except Central and Southeast Asia growth of gas use is limited in the other regions
- East Asia region is expected to get its energy peak by 2040

CWRD- Central West Asia; EARD- East Asia; PARD- Pacific Region; SARD- South Asia; SERD- Southeast Asia; ASIA- Wholistic Asia and Pacific

Regional baseline assessment of energy supply and technology mix

Electricity generation



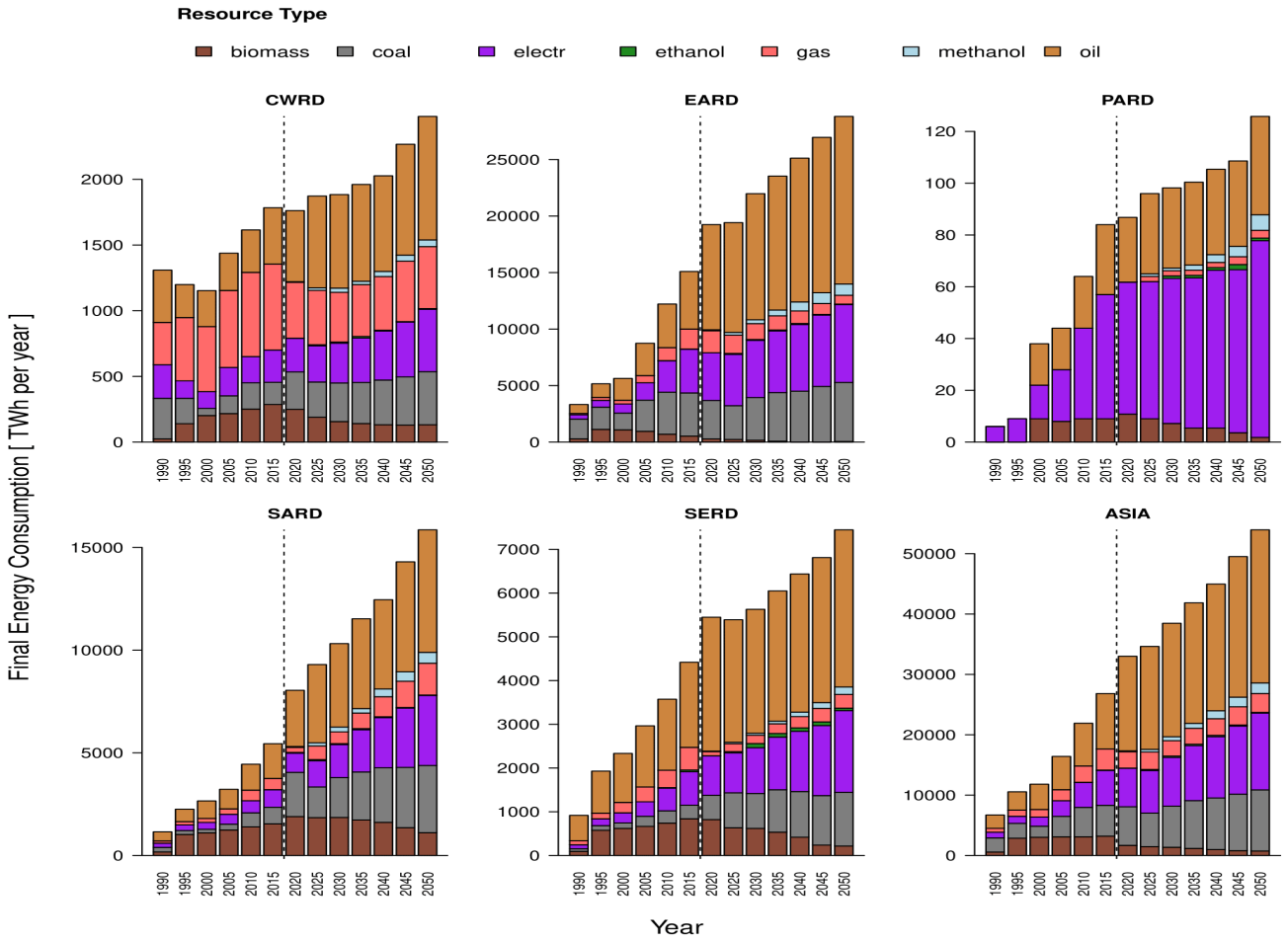
Source: TA 9690 baseline results (Results are indicative and subject to change)

- Fossil fuels (coal and gas) are the predominant fuels for power generation until foreseeable future in the regions
- Coal based electricity is expected to lose its importance in the mix
- Gas based generation is expected to be significant in many regions especially in Southeast Asia region
- Renewable is far behind the expected level of share mix in the region. However, excluding hydro RE share is even dismal in many regions.
- Wind energy is expected to have a larger share in the generation mix compared to solar
- On average renewable energy share is expected to be around 20% until 2050

CWRD- Central West Asia; EARD- East Asia; PARD- Pacific Region; SARD- South Asia; SERD- Southeast Asia; ASIA- Wholistic Asia and Pacific

Regional baseline assessment of energy supply and technology mix

Final energy consumption



Source: TA 9690 baseline results (Results are indicative and subject to change)

- Oil remains the major source of final energy in the region which is mostly consumed by the transport sector
- Pacific region has the highest share of electricity consumption compared to all other regions
- Electricity share in overall final energy consumption is well below 20% in all major regions
- Access to electricity in the region might be limited
- Growth of transport sector and its corresponding consumption of energy has out performed all other sectoral growth and energy consumption

CWRD- Central West Asia; EARD- East Asia; PARD- Pacific Region; SARD- South Asia; SERD- Southeast Asia; ASIA- Wholistic Asia and Pacific

Energy Sector is undergoing sea change irrespective of COVID

- Electrification is increasing in all the demand side activities – cooking, transport, heating and air-conditioning
- Electricity itself is moving towards massive decarbonization and fossil fuel power plants are concealing the space to renewable energy projects
- Low carbon fuel options are increasing in the form of Bio-fuels, E-fuels, Hydrogen, Ammonia
- More flexibility is introduced in the power system with a great importance on energy storage
- Decarbonization of industrial sector is gaining more importance

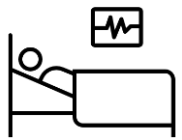
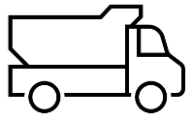
Effects of COVID 19 on Energy Sector

(i) declining commodity prices for fossil fuels  (including oil, natural gas, and coal) due to decreased demand globally; and a sudden surge in recent months creating market imbalance and uncertainties 

(ii) a decline in overall power demand, but with increased demand in the residential sector 

(iii) limitations in personnel mobility  that has slowed project development and implementation of new energy infrastructure.

Energy will combine with other infrastructure construction

	Support to Health Sector will ensure that the vaccine infrastructure is ‘green’ with renewable energy and low GHG refrigerants
	Support to agri-sector will involve installation of cold storage for the food stopping food wastage, generation of additional income by providing solar based pumping system, converting agri-waste into fuel
	Support to Transport sector means that flexi engines, e-fuels, Hydrogen, biofuels and electric vehicles are promoted so as to not only reduce the GHG emission but, also promote the local economy
	Urban sector may be helped by Municipal Solid Waste (MSW) and Waste Water based clean energy generation as well as energy efficient lighting

Recovery through Rejuvenation and Resilience

1

enhancing sustainable energy services,

2

improving energy sector resilience and security,

3

accelerating energy access to the poor and vulnerable, and

4

using advanced technology and cross-sector interventions

A Stepwise Approach to Designing a Low-Carbon and Resilient Recovery

- STEP 1: Define a clear vision for a recovery that leads to a climate- and disaster-resilient future.
- STEP 2: Understand the drivers for integrating low-carbon and resilience considerations into recovery.
- STEP 3: Identify opportunities for national and subnational policies and plans to support a low-carbon and resilient recovery.
- STEP 4: Develop an assessment framework for identifying and prioritizing a package of interventions that support recovery while promoting low-carbon and resilient development.
- STEP 5: Consider conditionality stipulations in cases where “brown”a recovery interventions are supported.
- STEP 6 Identify potential sources of financing for low-carbon and resilient interventions
- STEP 7: Identify supporting policy and institutional changes that will sustain low carbon and resilient development.

ADB Raises 2019–2030 Climate Finance Ambition to $100 Billion

In 2018, ADB committed to ensuring at least 75% of the total number of its operations support climate action and its own climate finance resources reach at least a cumulative $80 billion by 2030.

The additional $20 billion will provide support for the climate agenda in five main areas:

- new avenues for climate mitigation, including energy storage, energy efficiency, and low-carbon transport.
- scale-up of transformative adaptation projects. Projects in climate-sensitive sectors, such as urban, agriculture, and water, will be designed with a primary purpose of effective climate adaptation and enhanced resilience. ADB expects its cumulative adaptation finance to reach $34 billion.
- an increase in climate finance in ADB's private sector operations. This includes creating more commercially viable projects for both ADB and private investors. The expansion will be underpinned by improvements in operational efficiencies, a post-pandemic recovery in market demand for financing, new technologies and innovations in climate financing, and new areas of business for private sector climate operations. ADB intends to support these initiatives with $12 billion in cumulative private sector climate finance from its own resources and anticipated crowding in of an additional $18 billion to $30 billion.
- support for a green, resilient, and inclusive recovery from COVID-19, including through innovative financing platforms such as the ASEAN Catalytic Green Finance Facility and Green Recovery Platform, which are expected to leverage funds from capital mrkets and private sector investors for low-carbon infrastructure.
- support to advance reforms in DMCs to unlock actions through policy-based lending to support policies and institutions for enhanced climate resilience and climate mitigation.

ADB Energy Policy 2021

MANILA, PHILIPPINES (20 October 2021) — The Asian Development Bank (ADB) has approved a new energy policy to support universal access to reliable and affordable energy services, while promoting the low-carbon transition in Asia and the Pacific.

Policy Principle 1: **Securing Energy for a Prosperous and Inclusive Asia and the Pacific.**

Policy Principle 2: Building a Sustainable and Resilient Energy Future.

Policy Principle 3: **Supporting Institutions, Private Sector Participation, and Good Governance.**

Policy Principle 4: **Promoting Regional Cooperation and Integration.**

Policy Principle 5: **Integrated Cross-Sector Operations to Maximize Development Impact.**

ADB will facilitate the transition to sustainable, lower-carbon, and resilient energy systems by assisting DMCs in

(i) accelerating the deployment of renewable energy,

(ii) pursuing strategic decarbonization and the phase-out of coal,

(iii) increasing the climate resilience of energy infrastructure, and

(iv) ensuring a just transition.

Phase out coal & Coal just transition

Qualification	Ineligibility
Will promote the adoption of cleaner fuel sources and will support emissions reductions that mitigate health and environmental impacts	Not support coal mining, processing, storage, and transportation
Support the ***early*** retirement and decommissioning of coal resources to help DMCs achieve a planned phase-out of coal	Not financing new coal-based capacity for power and heat.
Support enhancement of power generation dispatch regimes to discourage the use of high-emitting, inefficient coal-fired power plants	Will refrain from supporting dedicated cross-border transmission lines where power generation is linked to coal-fired power plants
Foster a just transition that considers its impacts on people and communities	
Will also assist the decommissioning of coal-fired power plants and site redevelopment for new economic activity, including the removal and secure management of hazardous materials, restoration of soil and water quality, redevelopment of buildings, and upgrades of existing infrastructure	Will not participate in investments to modernize, upgrade, or renovate coal facilities that will extend the life of existing coal-fired power and heating capacity
Support DMCs in preparing long-term energy strategies and policies ; will assist energy planning	

CCUS Relevance in ADB Energy Policy

- CCUS can all play a role in transitioning the business areas that are more difficult to decarbonize, such as thermal power industry, cement sector, iron and steel sector, fertilizer, and glass manufacturing industry etc.
- Reaching neutrality by about 2050 would require extensive efforts on application of CCUS solutions to remaining coal and natural gas operations in the energy sector.

- ✓ Power plants,
- ✓ LNG import facilities,
- ✓ and industries (hard-to-abate)
- ✓ ~~Enhanced oil recovery~~
- ✓ Blue hydrogen with net GHG reductions

- Capacity development,
- Technical assistance,
- Finance,
- Regulatory advice,
- Development,
- Demonstration,
- Commercialization.

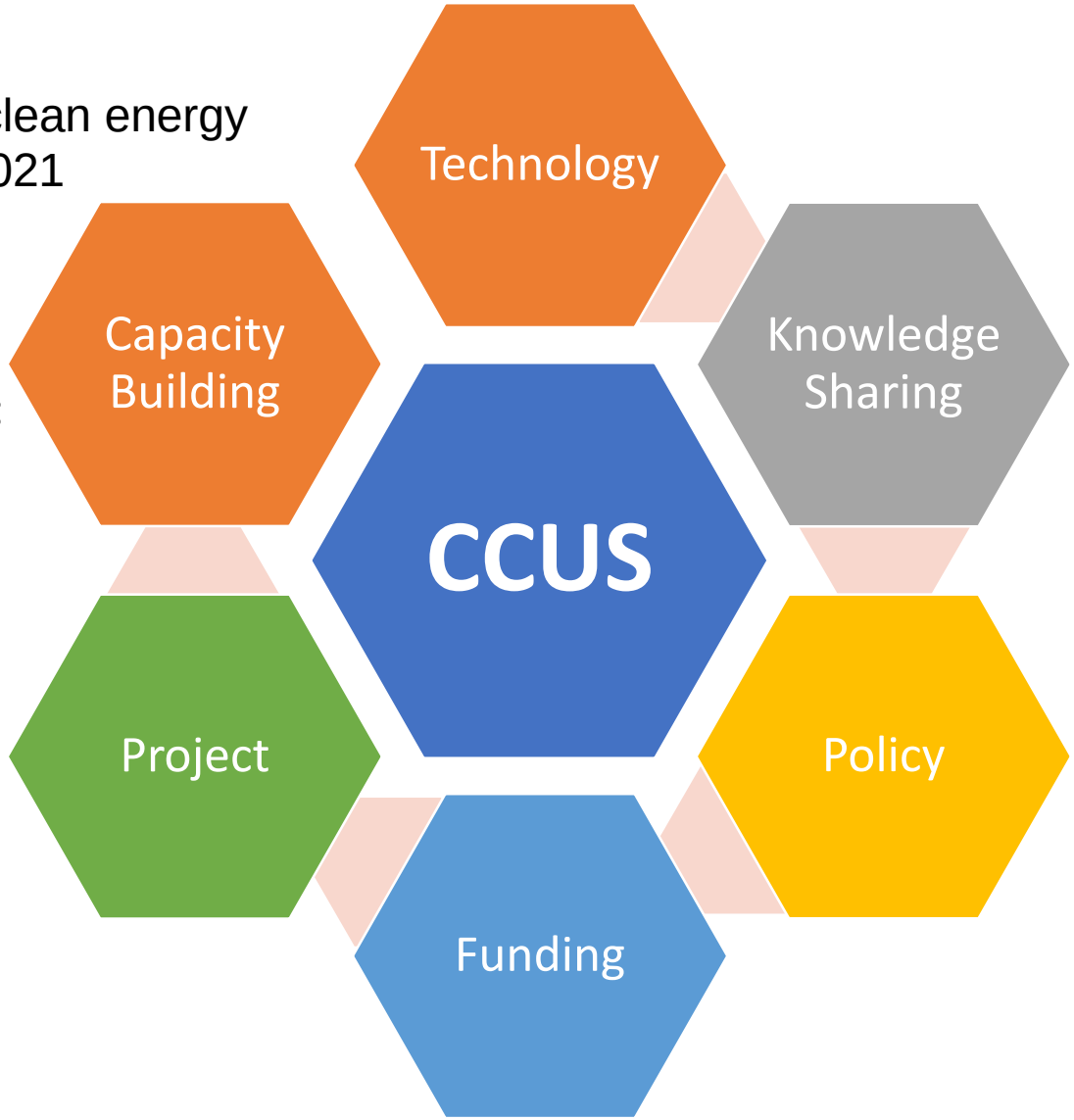
Source: Page ii, Page 28, 30, 77, 78 of ADB new energy policy.

ADB's Role in CCUS Deployment of Asia

Aligning UK international support for the clean energy transition _ Guidance, BEIS UK, March 2021

Additional Conditions for involvement in CCUS :

- Only support the Gas power sector
- No assistance to refineries
- No assistance to EOR / EGR / CBM
- Support to Petrochemicals on policy
- Support to hard to decarbonize sectors
- Support Common CO_2 infrastructure

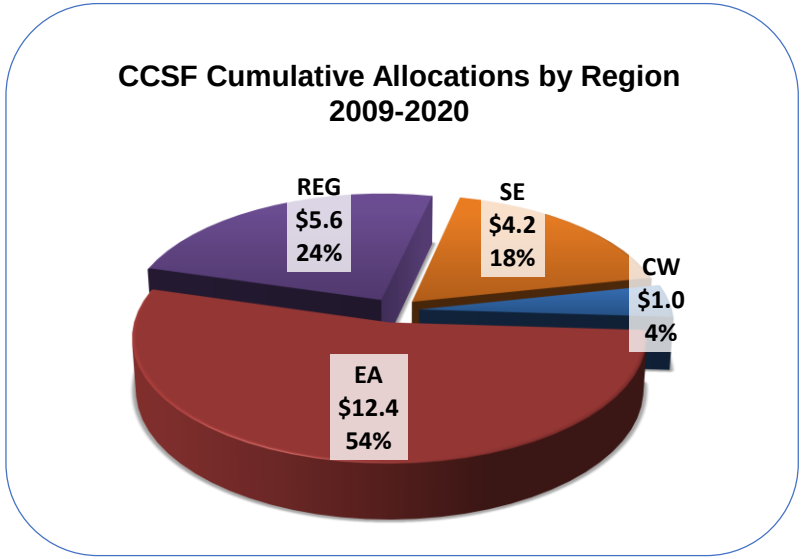


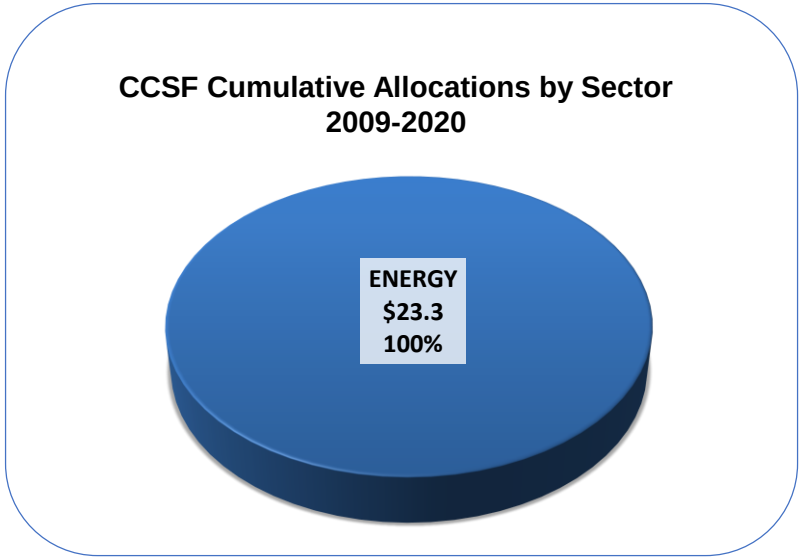
CCSF Allocations by Region and Sector

ADB's Strategy 2030:

Prosperous, Inclusive, Resilient, and Sustainable Asia and the Pacific.

(in $ millions)





REG - Regional
SE - Southeast Asia
CW - Central West Asia
EA – East Asia

ADB Supported CCS Projects by 2021 (Partial)

	Year	Technical Assistance Projects (already implemented/under implementation)	$ million	
1	2009	TA 7286-PRC: Carbon Dioxide Capture and Storage (CCS) Demonstration - Strategic Analysis and Capacity Strengthening		
2	2009	TA 7278-REG: Carbon Dioxide Capture and Storage (CCS) Demonstration in Developing Countries-Analysis of Key Issues and Barriers		
3	2010	TA 7575-REG: Determining the Potential for Carbon Capture and Storage (CCS) in Southeast Asia		
4	2011	TA 8001-PRC: Study on Carbon Capture and Storage on Natural Gas-Based Power Plants		
5	2012	TA 8133-PRC: Road Map for CCS Demonstration and Deployment (formerly Oxy-fuel Combustion Carbon Capture for Power Plants and Carbon Captured Storage Demonstration and Deployment Roadmap)		
6	2013	TA 8407-INO: Planning a Pilot Carbon Capture and Storage Activity		
7	2013	TA 8499-REG: Tianjin Integrated Gasification Combined Cycle Power Plant - additional financing		
8	2014	TA 8648-PAK: Determining the Potential for Carbon Capture and Storage in Pakistan		
9	2014	TA 8714-REG: Promoting Carbon Capture and Storage in the People's Republic of China and Indonesia		
10	2016	TA 9189-INO: PPTA Pilot Carbon Capture and Storage Activity in the Natural Gas Processing Sector in Indonesia		
11	2018	TA 9509-PRC: Promoting and Scaling Up Carbon Capture and Storage Demonstration (TA PRC)	1.2	
12	2018	TA 9686-REG: Integrated High Impact Innovation in Sustainable Energy Technology - Prefeasibility Analysis for Carbon Capture, Utilization and Storage (Subproject 2)	2+1.5	
13	2019	TA 9745-PRC: Promoting and Scaling Up Carbon Capture and Storage Demonstration-Feasibility Assessment of a Large-Scale Carbon Capture and Storage Demonstration Project and Development Support to Yanchang Petroleum Group (Subproject 2)	4.3	
14	2021	TA 6799-PRC: Research for Demonstration of Carbon Capture, Utilization, and Storage Technologies in Industrial Sectors of Yunnan Province	1.3	

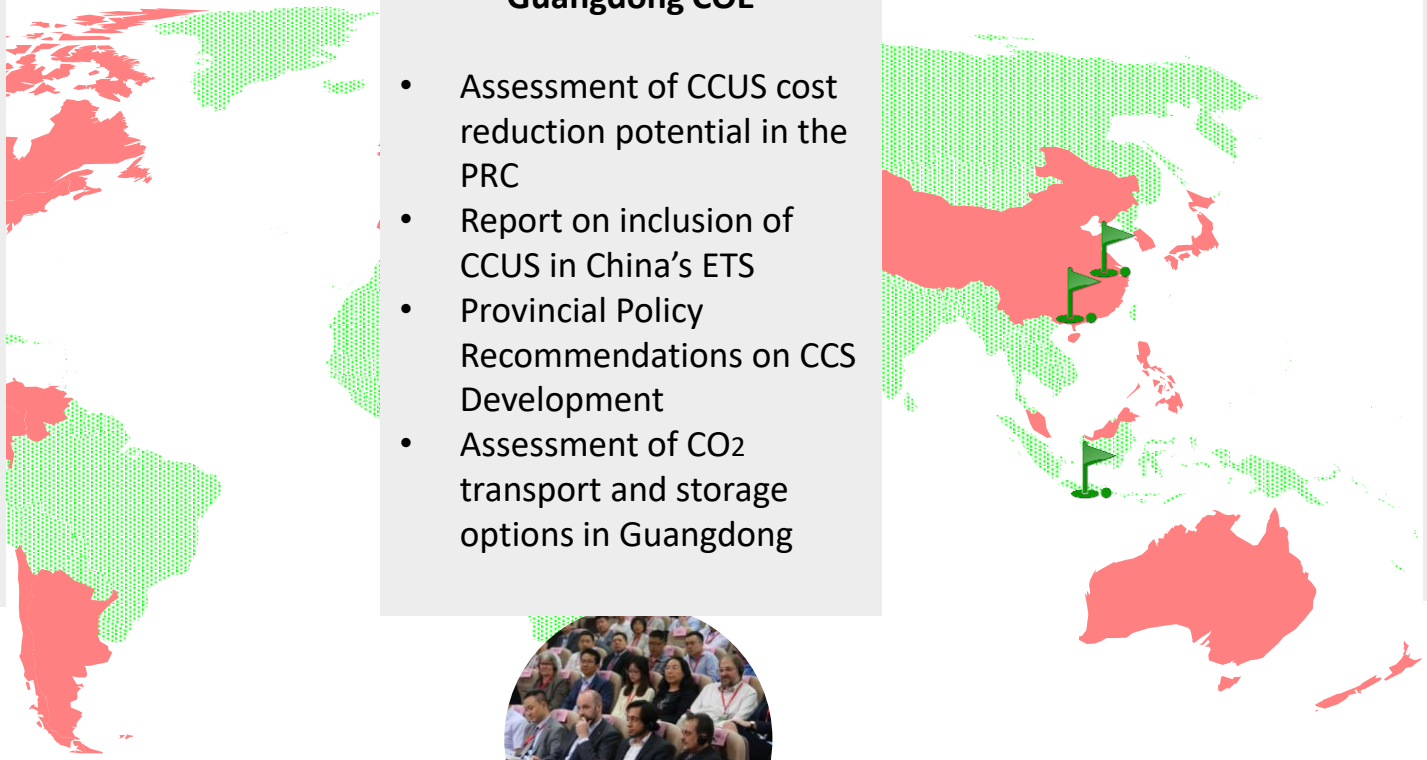
CCUS Projects in Asia

Indonesia COE

- Development of draft CCS regulation
- Nationwide screening and ranking of oil fields for CO_2 EOR
- Study on potential contributions of CCS to Indonesia's NDC's
- Technical inputs to Gundih CCS pilot project

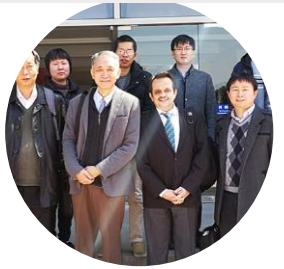
Guangdong COE

- Assessment of CCUS cost reduction potential in the PRC
- Report on inclusion of CCUS in China's ETS
- Provincial Policy Recommendations on CCS Development
- Assessment of CO_2 transport and storage options in Guangdong



Shanghai COE

- Assessment of geological storage potential for CO_2 in the PRC
- Assessment of national environmental & climate policy on selecting best available CCS technology for PRC power sector
- Establishment of industrial emission reduction pathway for CO_2



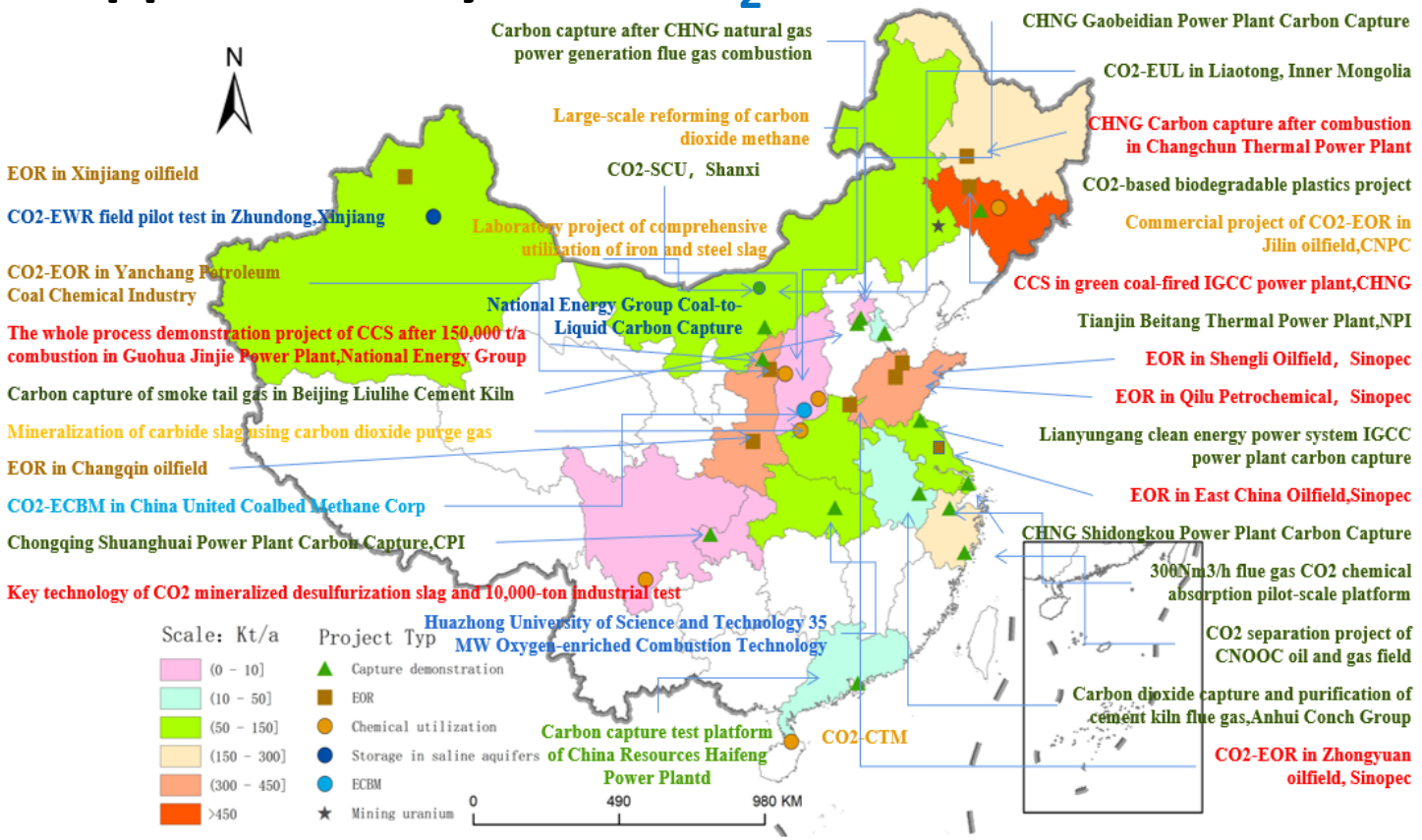
Establishment of 3 Centers of Excellence (COE's) in the PRC and Indonesia

Gundih CCS Pilot Project Indonesia

- ADB supported the government of Indonesia in feasibility study of a CO2 storage pilot project design
- The study involved capturing 30 ton / day CO2 from a gas processing complex
- The study involved assessment of
  - - preliminary design of CO2 Capture technologies
  - - well integrity
  - - Environmental assessment and
  - - Options for transportation of CO2
  - - Capacity building requirements

Overview of CCUS demonstration projects in China

- **35 CCUS projects with a capture capacity of more than 3 million t/a and a cumulative storage capacity of approximately 2 Mt CO_2.**
  - **CO_2 capture**: power (12), ceme (2), coal chemical industry and chemical fertilizer production.
  - **Transportation**: tank car.
  - **Storage:** saline aquifer.
  - **Utilization**: EOR, ECBM , EUL, Mineralization, chemical, biological etc.



China CCUS Demonstration Projects

Latest development

- **OGCI-CNPC:** Junggar Basin CCS hub in Xinjiang with a storage capacity of 0.2 to 3 Mt/a, and a storage capacity plan of 10 Mt/a by 2030.
- **Taizhou Power Plant:** a post-combustion capture demonstration project with a capture capacity of 0.5Mt/a, the largest carbon capture demonstration project in China with 70% costs.
- **Baowu Steel Group, Hebei Steel:** CCUS facility is under plan.
- **Conch Cement Plant**: CO_2 Deep Mineralization Maintenance experiment passed 72 hours of operation.

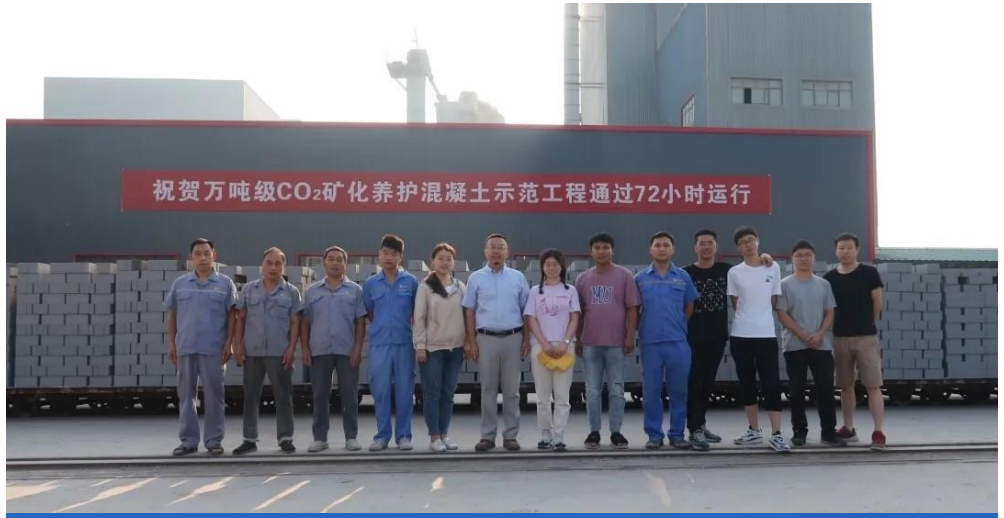
First CCUS Pilot project in Cement Industry of the World -Baimashan(白马山) Cement Plant in Wuhu 50,000 t CO2/a

Project Name:
Conch Cement Baimashan Cement Plant Cement Kiln Flue Gas CO2 Capture and Purification (CCS) Demonstration Project
Project scale:
Construction of a capture and purification production line with an annual output of 50,000 tons of industrial CO2 (an annual output of 30,000 tons of food CO2)
Operation Period:
2018-present

Cement production of China in 2018:
1.5 billion tons

CO2 emission of China's cement industry in 2018:
About 1.28 billion tons

First CO2 mineralization pilot project to produce concrete bricks on commercial size in the world



Project Name:
10,000 tons grade CO2 deep mineralization pilot project to produce curing building materials（CO2深度矿化制养护混凝土试点）

Project scale:
The pilot project will storage 10,000 t CO2/year and produce 100 million light weight solid concrete bricks.

Project Status:
The pilot project completed 72 hours trail operation in Henan, China on 29 August 2020.

Technology Provider:
Zhejiang University

Funder:
Ministry of Science and Technology, PRC.

Thank you

Jinmiao Xu

Energy Specialist, SDCC-ENE
jinmiaoxu@adb.org

Deliverable list of TA 9686_Regional

Carbon Capture Utilization and Storage Game Changers in Asia : 2020 compendium of technologies and enablers , February 2021

- https://www.adb.org/sites/default/files/publication/681531/carbon-capture-game-changers-asia-2020.pdf

Systematic Review of GHG Reduction through CO_2 Utilization in Petroleum Refinery, June 2021

- https://www.adb.org/sites/default/files/project-documents/52041/52041-003-tacr-en_2.pdf

CCUS Project Financing Considerations in Petroleum Refineries, August 2021

- https://www.adb.org/sites/default/files/project-documents/52041/52041-003-tacr-en_1.pdf

prefeasibility study on CCU in cement industry of India, August 2021

- https://www.adb.org/sites/default/files/project-documents/52041/52041-003-tacr-en.pdf

CCU prefeasibility study on food grade CO_2 in refinery sector of India, September 2021

- https://www.adb.org/sites/default/files/project-documents/52041/52041-003-tacr-en_0.pdf

Roadmap update for Carbon Capture, Utilization and Storage Demonstration and Deployment in the People's Republic of China, Editing and Publishing soon……