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Karbon CCS Technology

Next-generation Carbon Capture

ADB

ASIA CLEAN ENERGY FORUM 2022

Innovative and Integrated Solutions for a Low-Carbon and Resilient Future

14–17 June

Agenda

1. Introduction to Karbon CCS Ltd
2. Karbon Technology
3. Example Projects under Development
4. Demand for CO_2 is Large and Growing
5. Asia Emits 53% of Global CO_2
6. Life of Industrial Assets can be Extended
7. Conclusions and Next Steps

1. Introduction to Karbon CCS Ltd

- Karbon has developed a proprietary and patented carbon capture technology.
- Its founders have been developing carbon capture technology since 2003, investing $50 million and spending over 100,000 engineering hours.
- The technology captures CO_2 from exhaust gas, together with SO_x, NO_x, carbon monoxide, mercury, methane and particulate matter.
- It captures CO_2 from gas-fired and coal-fired power plants, steel mills, aluminium, fertiliser and cement plants, and large combustion engines such as ship engines.
- It produces high-purity CO_2 suitable for Enhanced Oil Recovery (EOR), and for a broad range of present and future industrial uses.

The all-in cost of capture is as low as $30 per tonne of CO_2 – the lowest in the industry

The Karbon Team has Decades of Experience

Henrik Fleischer (1959)

- Founder & Chairman (Karbon CCS)
- MBA from Vienna University
- Royal Norwegian Naval Academy, Commanding Officer of a missile-carrying fast patrol boat
- Norwegian rep for Mitsui & Tokyo & Singapore Shipyards,
- Shipowner

Dr. Louis van Pletsen (1960)

- CEO (Karbon CCS)
- MBA from the University of Notre Dame, USA
  ADP from London Business School, UK
  DCom Economics, South Africa
- Partner of Denham Capital Management
- Managing Director of the International Energy Group

Dr. Dong-Shik Shin (1932)

- Chairman (Karbon CCS & Karbon Korea)
- Seoul National University
- Korea's first Senior Economic Secretary
- Chairman of KOMAC

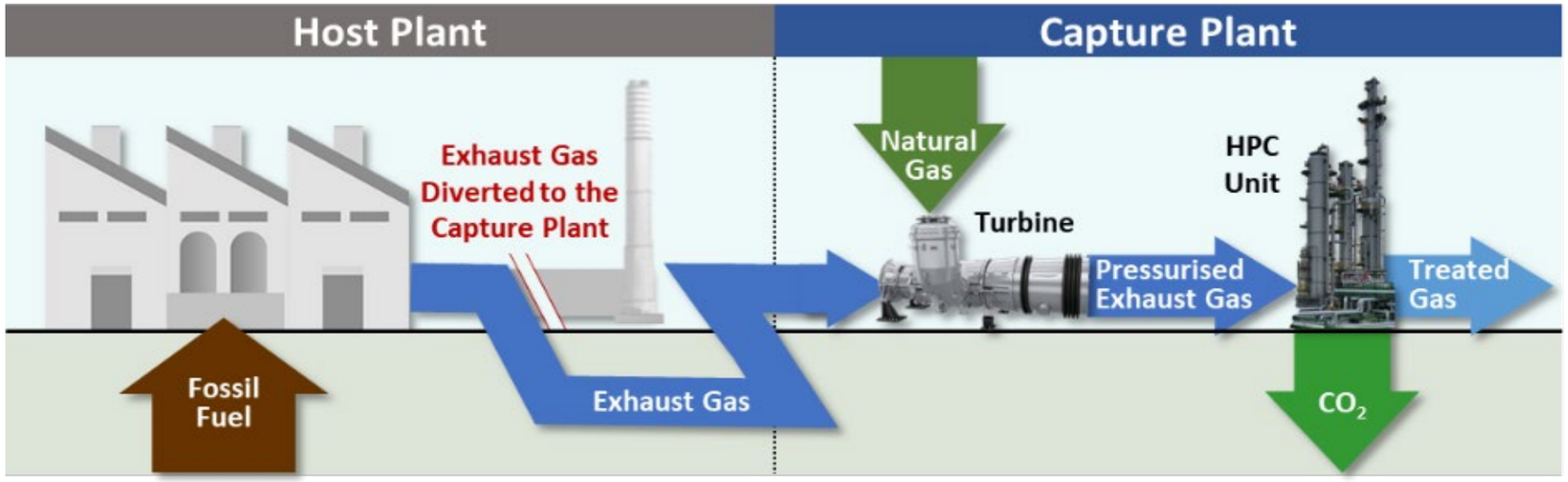
Jun-Yeon Byun (1954)

- CEO (Karbon Korea)
- Korea University
- Vice President of KEPCO
- Chairman of Vision Power

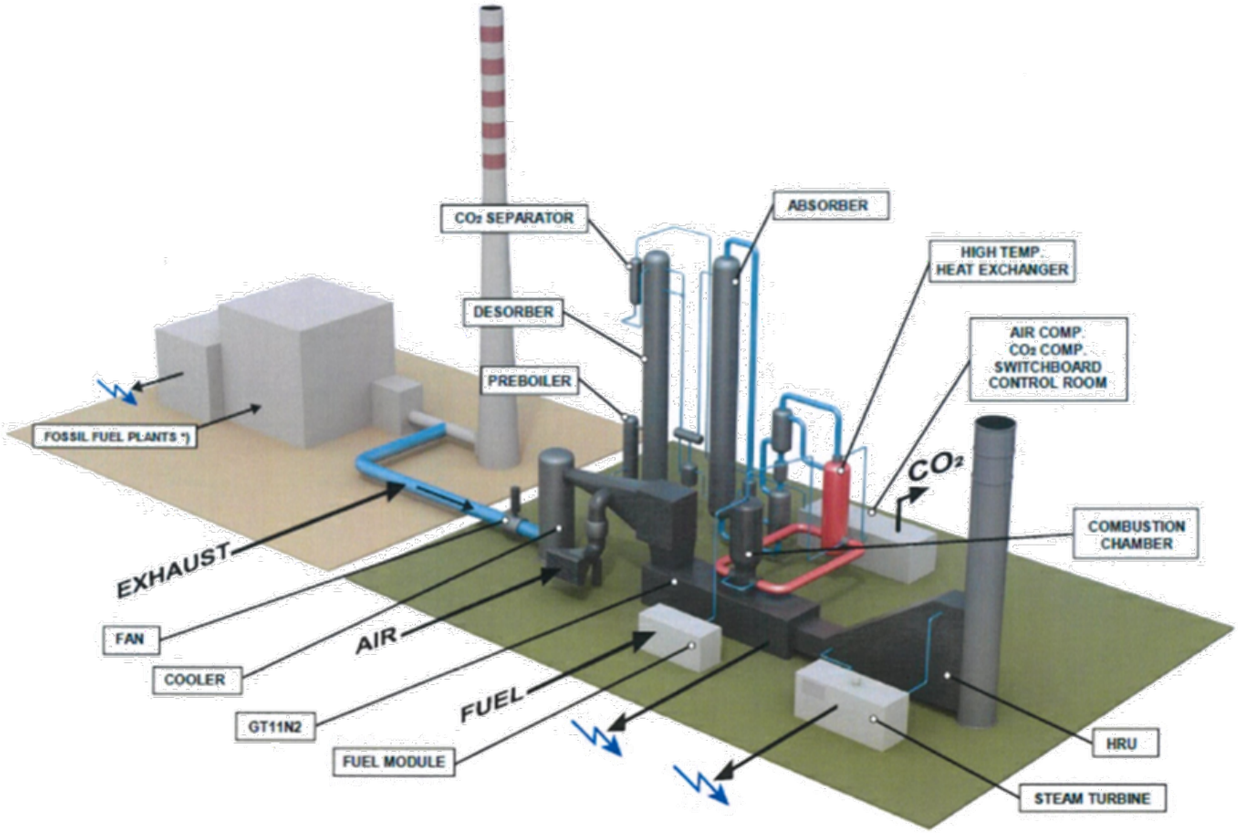
Technical, industrial, commercial and finance executives with expertise in energy, fabrication of carbon capture plants, shipbuilding, chemical processes, turbine technology, emissions trading, and structured finance

2. Karbon Technology

- Karbon pressurises flue gas with proprietary and patented technology which uses a gas turbine.
- CO_2 is extracted with the hot potassium carbonate (HPC) process.
- All components and processes are off-the-shelf and/or have undergone extensive testing.
- Karbon capture units are installed next to host plants, and operate independently without interrupting or impairing their operations.



Main components of a pressurised Karbon plant



Footprint of a Karbon 20,000 tpd absorber is 100 m^2, vs. 440 m^2 for a corresponding amine absorber

Karbon Technology is Patented

- European Patent Office issued an International Preliminary Report on Patentability in 2020.
- Patent applications in 18 jurisdictions, including USA, EU, India, China and South Korea.
- Freedom to Operate - different from all other patented carbon capture technology.
- Other patents protect Karbon Marine technology for ships and smaller power plants, including in the USA, the UK, South Korea, Norway and Germany.
- The inventors have over 20 patents in carbon capture, floating production vessels, and oil field development.

The patents provide broad and deep protection

The Principals of Karbon are Experienced with Patents

Description	Publication	Publication Number
A carbon dioxide capture system comprising a compressor and an expander and a method of using such system	21-Oct-21	WO2021210989
Carbon dioxide capture system comprising a gas turbine	04-Mar-21 22-Jan-21 13-Jan-21 05-Jan-21 12-Sep-21	US20210060478 IN202017043480 EP3762130 CN112188925 CA3144034 AU2018412443 WO201917272
Method for CO_2 separation from thermal power plant combustion gas	31-Dec-15	WO2005045316
Method and system for salvage of vessels	24-Jun-15	EP2885201
Thermal power plant with CO_2 sequestration	06-Mar-15 03-Dec-12	HK1158289(A1) DK2300129(T3) BR112013002035
Method and plant for capturing CO_2	31-Dec-14	WO2014207035
Oil sand production without CO_2 emissions	03-Jul-14 11-Jan-11	US2014182835(A1) CA2709604(A1) CA2709604(C)
Method and plant for purification of exhaust from diesel engines	25-Feb-10 23-Feb-10	WO2010020684(A1) NO20083628(A) NO329851(B1)
Method and plant for CO2 enrichment	18-Feb-10	US2010037771(A1)
Fremgangsmate og anlegg for innfanging av CO_2	03-Jul-09	NO20080022(A)
Low CO2 thermal powerplant Termisk kraftanlegg med lavt CO_2 utslipp	29-Jan-09 07-May-08 02-Nov-07	US2009025390(A1) CN101175899(A) NO20075585(A)
Method and plant for transport of rich gas	17-Apr-08	US2008087328(A1)
Combined storage facility for CO_2 and natural gas	11-Jan-07	US2007006920(A1)
Purification works for thermal power plant	11-Jan-07 19-May-05	US2007006565(A1) US7559977(B2) WO2005045316(A2) WO2005045316(A3)
Low CO_2 thermal powerplant	12-Oct-06	WO2006107209(A1)
Method and plant for transport of rich gas	04-May-06	WO2006046875(A1)
Low emission thermal plant	04-Aug-05	US2005166569(A1) US7328581(B2)
Method and plant for separation of CO_2 from the exhaust from combustion of carbonaceous fuels	01-Apr-04	WO2004026445(A1)
System with a guide frame for petroleum production risers a guide frame for risers riser buoyancy elements and a semi-submersible production platform	05-Oct-00	WO0058598(A1)

Description	Publication	Publication Number
Submerged disconnectable anchor buoy and ship	24-Jun-99	WO9930963(A1)
Skip	21-Sep-98	NO983704(A)
Feste av en forankringskabel til en tlp-plattform	14-Aug-98	NO983742(A)
Forankring av tlp-plattform	14-Aug-98	NO316018(B1) NO983741(A)
Tlp-plattform	14-Aug-98	NO316267(B1) NO983740(A)
Flexible risers with stabilizing frame	21-Aug-97	WO9729944(A1)
Production vessel with sinusoidal waterline hull	21-Aug-97	WO9729940(A1)
Variable buoyancy sub-sea element	23-Jul-97	GB2309213(A) GB2309213(B)
Arrangement for böyelasting	19-Jun-95	NO952451(A)
Connecting buoys to vessels	28-Mar-95	NO300726(B1) NO933444(A)
Floating heavy lift crane arrangement	12-Sep-94	NO178757(B) NO178757(C) NO930865(A)
Anordning for utsetting og innhiving av livbaat eller lignende.	31-May-90	NO165953(B) NO165953(C) NO885334(A)
Fremgangsmaate og anordning for tilveiebringelse av skyvkraft og pitch- demping for et oppankret og/eller dynamisk posisjonert skip.	14-Aug-89	NO164826(B) NO164826(C) NO880608(A)
Kompensatoranordnin g ved stigeroer fra havbunnen og opp til en flytende konstruksjon.	03-Nov-86	NO156299(B) NO156299(C) NO851753(A)
Kompensatoranordnin g ved stigeroer fra havbunnen og opp til en flytende konstruksjon.	24-Jun-85	NO153700(B) NO153700(C) NO834766(A)
Anordning for utsetting av livbaater, saerlig for offshore-konstruksjoner	09-Dec-83	NO150833(B) NO150833(C) NO821911(A)
Stabiliseringsanordni ng for en halvt neddykkbar marin konstruksjon.	05-Nov-82	NO811504(A)
Fremgangsmaate samt system for sjoesetting av et redningsfartoey	11-Aug-80	NO143839(B) NO143839(C) NO790406(A)
Fremgangsmaate ved bygging av en offshore-plattform og innretning til bruk ved utfoerelse av fremgangsmaaten	20-Mar-80	NO147336(B) NO147336(C) NO783178(A)
Flytende produksjonsanlegg.	04-Sep-79	NO147098(B) NO147098(C) NO780745(A)
Utsettingsanordning for en redningsbaat	09-May-79	NO793163(A)
Redningssystem for dykkere under trykk fra en flytende konstruksjon	09-May-79	NO143140(B) NO143140(C) NO773819(A)
Anordning ved en flytende konstruksjon	09-May-79	NO773816(A)

Technology Proven in Test Facilities

Facility Värtan Power Plant, Stockholm, Sweden

Date 2007-2008

Result Captured 99%+ of CO_2
NO_x < 5 ppm, SO_2 ≈ 0

Auditor Norwegian Energy Institute IFE

Facility Consol Energy Test Facility, USA

Date 2009-2011

Result Successfully captured CO_2
from 10 grades of US coal

Auditor PFBC Environmental Energy Technology

Hot Potassium Carbonate is proven effective at capturing CO_2 and other contaminants

Karbon Technology is Superior to Amines

Lower cost Karbon captures at $30/tonne vs over $50/tonne for amines. HPC absorbents are 85% cheaper than amine absorbents.

Less energy Karbon requires only 1-2 MJ of energy per kg of CO_2 captured pending application, vs 3-4 MJ per kg required by amine-based processes.

Non-toxic HPC is inert, non-toxic and requires minimal replacement over time. Amine solvents are corrosive, toxic, and possibly carcinogenic, and require replacement and destruction at additional cost.

Smaller footprint Karbon requires about 67% less land, as amine processes have more steps and require equipment to handle and incinerate used absorbents.

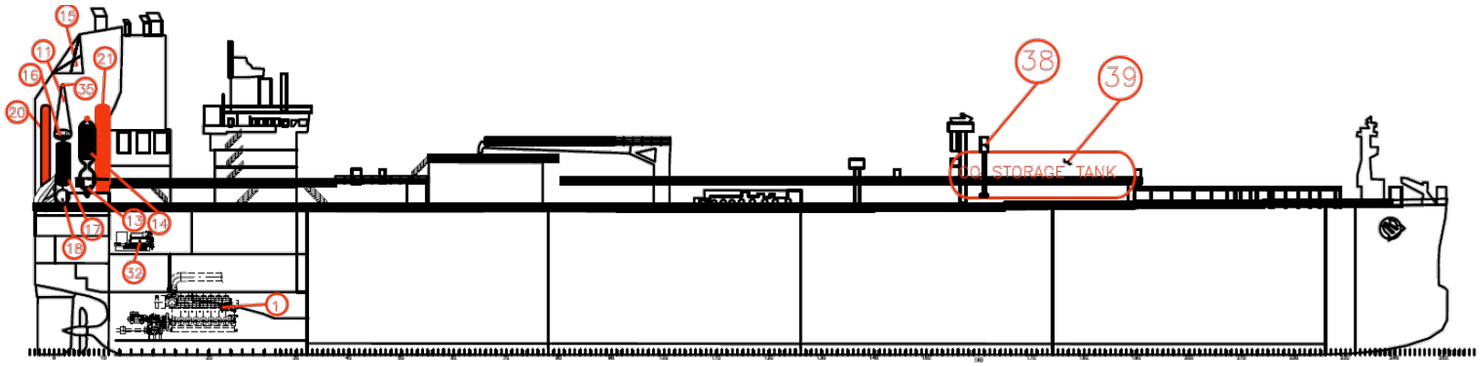
Faster build Karbon is simpler and uses off-the-shelf components, and can therefore be installed more rapidly than amine-based processes.

Other pollutants Karbon also eliminates SO_x, NO_x, particulate matter, CO, Hg and CH_4.

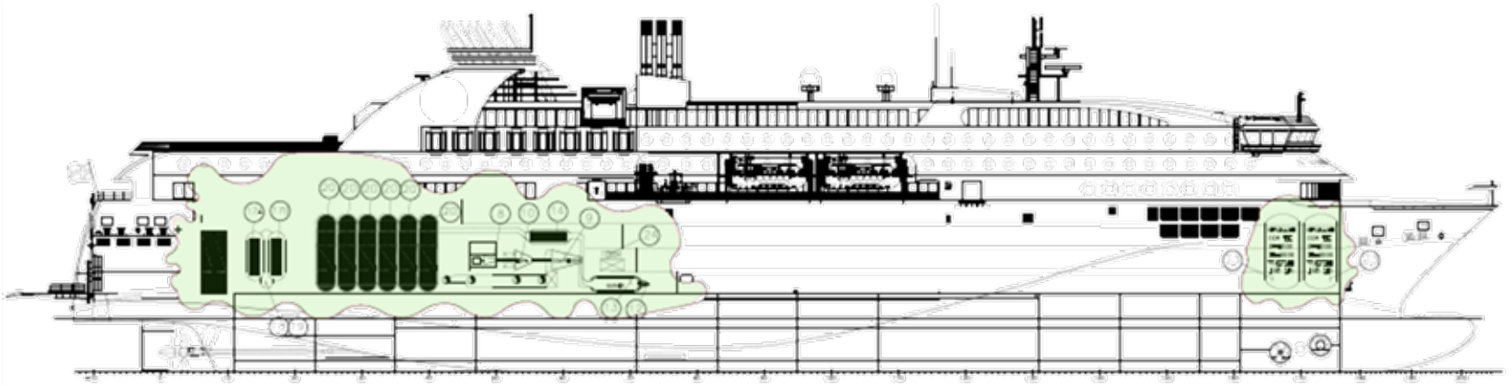
Karbon Technology Captures CO_2 from Ships as well

Capture plants will be installed during newbuilding or scheduled maintenance

General Arrangement onboard a VLGC capturing 120+ tpd of CO_2



General Arrangement of 100% decarbonisation of a car ferry



Up to 100,000 ships worldwide must soon eliminate their CO_2 emissions

Karbon Partners are Top-Tier

Exclusive partnership to use Siemens SGT5/6-2000E gas turbines for CO_2 capture.

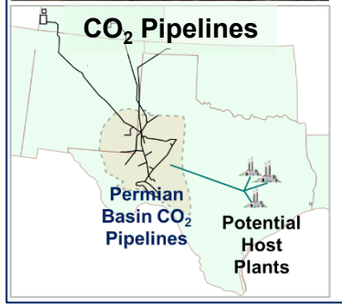
Karbon is discussing the use of GE turbines for the Karbon process.

Karbon is in discussions with a U.S. oil major for long-term purchase of CO_2.

BofA is advising Karbon and introducing potential counterparties.

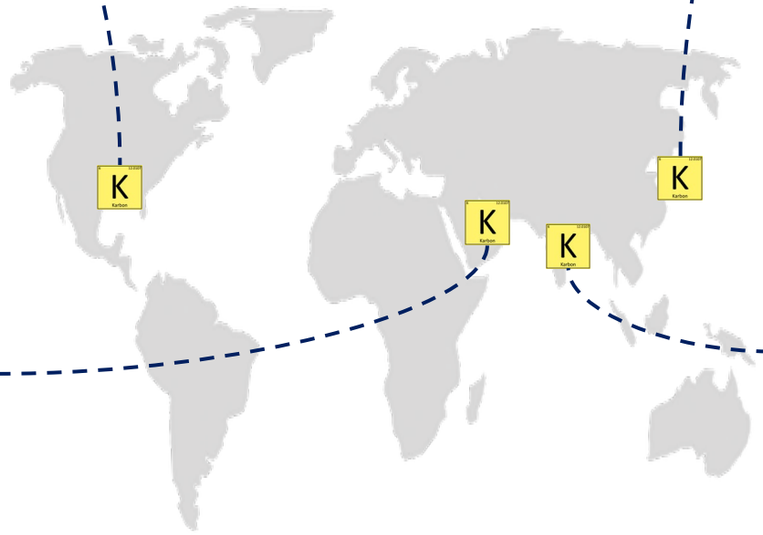
Karbon works closely with EPC firms for land-based capture plants and for marine and offshore solutions on existing or newbuilding ships.

3. Example Projects under Development



Sandy Creek, USA

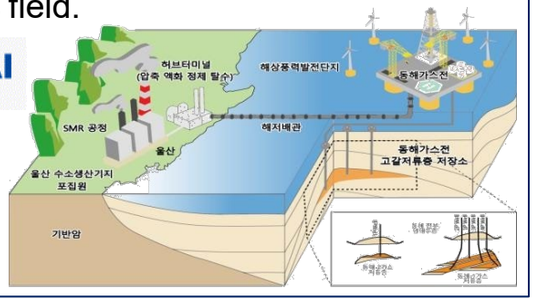
CO_2 capture plant at a coal-fired power plant in Texas, with a U.S. oil major as likely CO_2 offtaker.
Three further US coal- and gas-fired power plants at earlier stages.

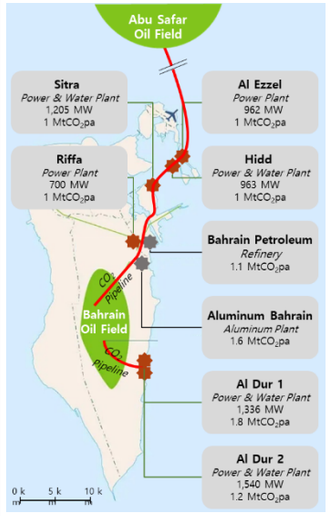


Busan, South Korea

Demo capture plant retrofitted to a KEPCO group 8×150 MW LNG plant near Busan, producing 400,000 tpa CO_2 for storage in the Donghae gas field.

HYUNDAI POWER SYSTEMS

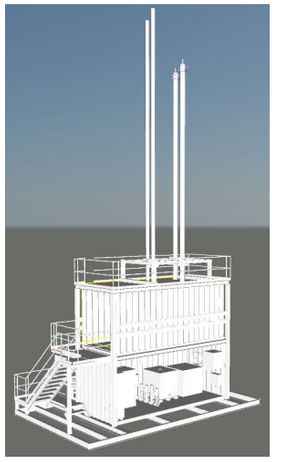




Kingdom of Bahrain

Advanced discussions with plants emitting 6 mtpa of CO_2, involving the Ministries of Finance and Oil.
New pipelines would carry CO_2 to oil fields in Bahrain and/or Saudi Arabia.

THDC, India

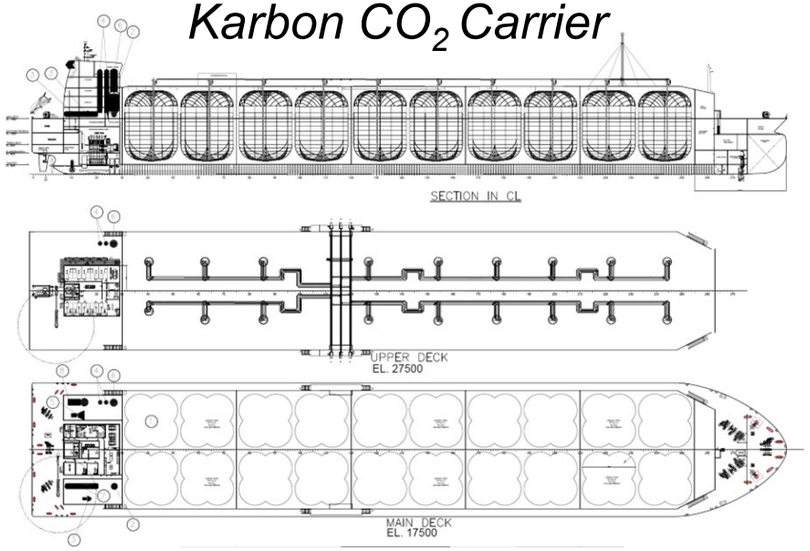


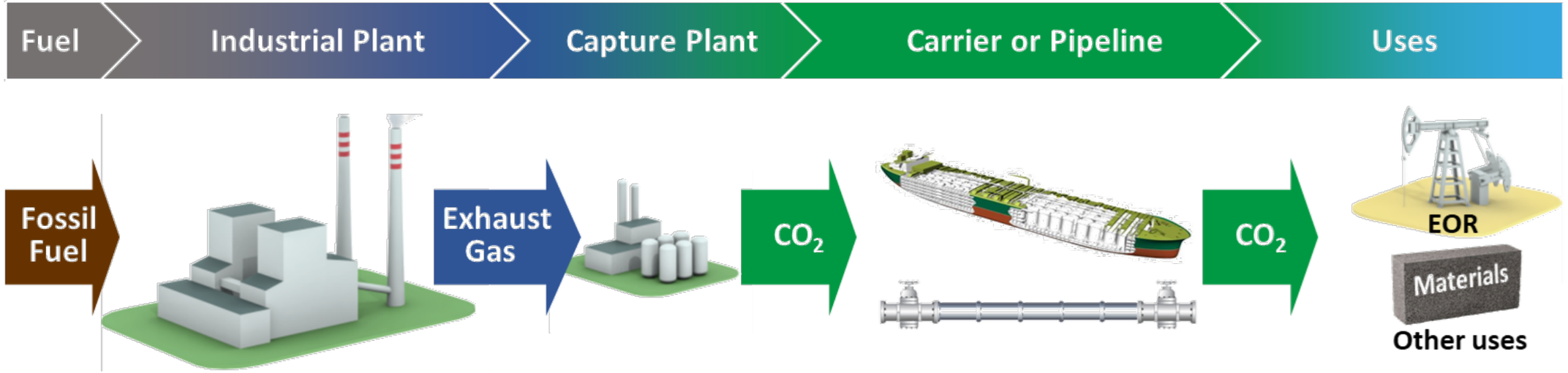
Demo capture plant at the new Khurja 1,320 MW coal-fired power plant.
May lead to a full-scale capture plant at Khurja and at other power plants in India.

CO_2 is Transported by Pipeline and Ship

- About 8,000 km of 20-60 cm CO_2 pipelines operate worldwide at 100-150 bara.
- Karbon is developing a dual LNG-CO_2 carrier e.g.:
  - Carry LNG from Persian Gulf to South Korea
  - Carry CO_2 on return to Saudi Aramco for EOR

Karbon CO_2 Carrier

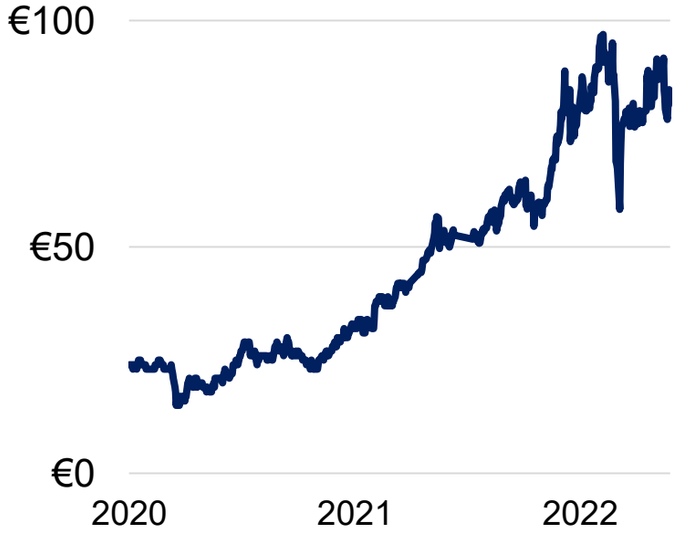




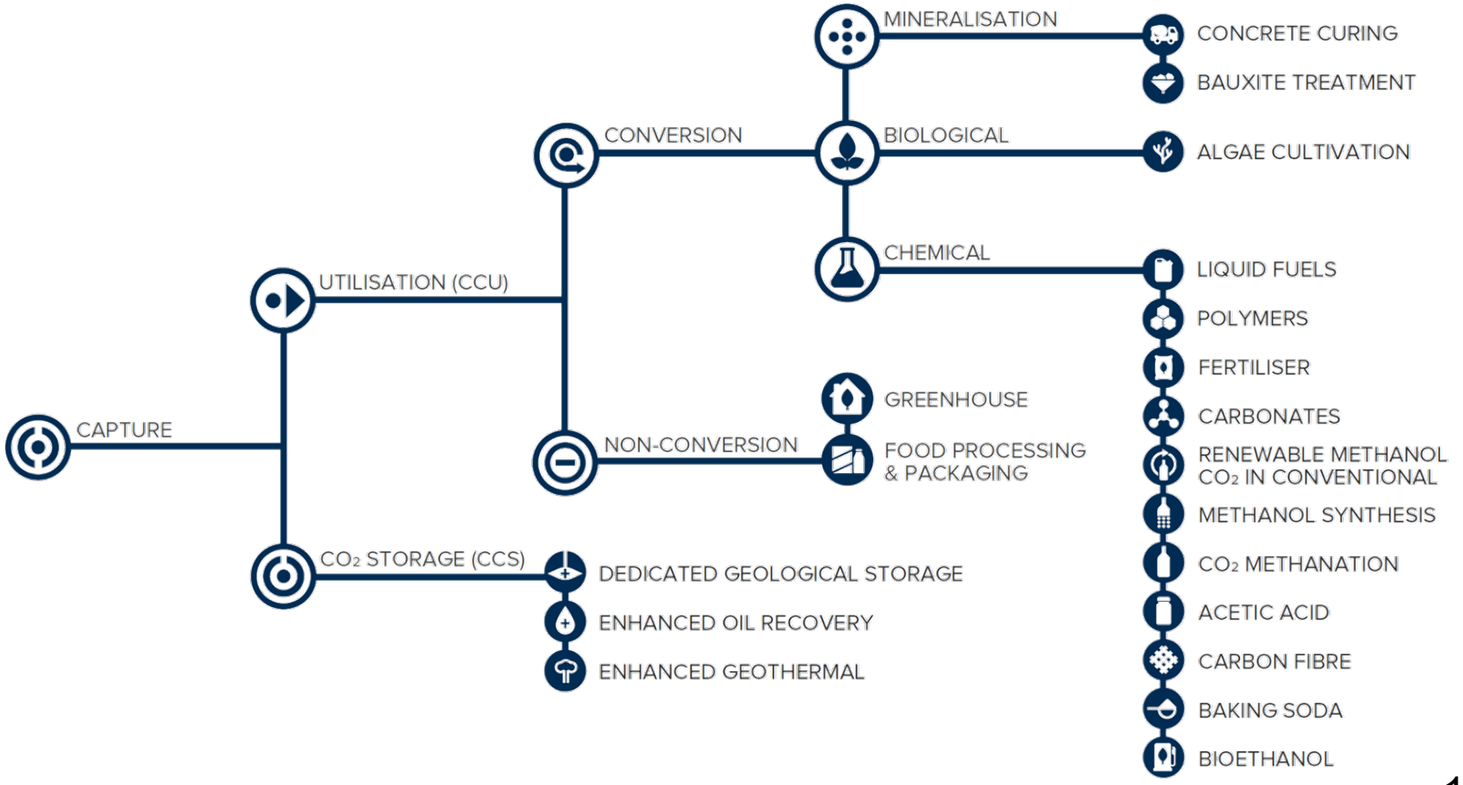
4. Demand for CO_2 is Large and Growing

Used for EOR and as feedstock for methanol, fertiliser, animal feed, and construction materials

CO_2 prices are surging in Europe



CO_2 has a broad range of uses



CO_2 is a Profitable Commodity

- One tonne of CO_2 captured with Karbon and used for EOR:

Cost of capturing 1 tCO_2	$30*
Additional oil production from 1 tCO_2	3 barrels
× Additional revenue = 3 bbl × $113/bbl	$339
- Marginal cost = 3 bbl × $13.29/bbl	($40)
= Profit per one tonne of CO_2	**$299**

- Once CO_2 is produced for $30 per tonne, it will be:
  - A mainstream commodity with multiple uses
  - Feedstock for fertilisers, foodstuffs and concrete.
  - Widely traded, e.g. by the Trafigura Carbon Trading desk.
- Food-grade CO_2 sells for $400 per tonne.

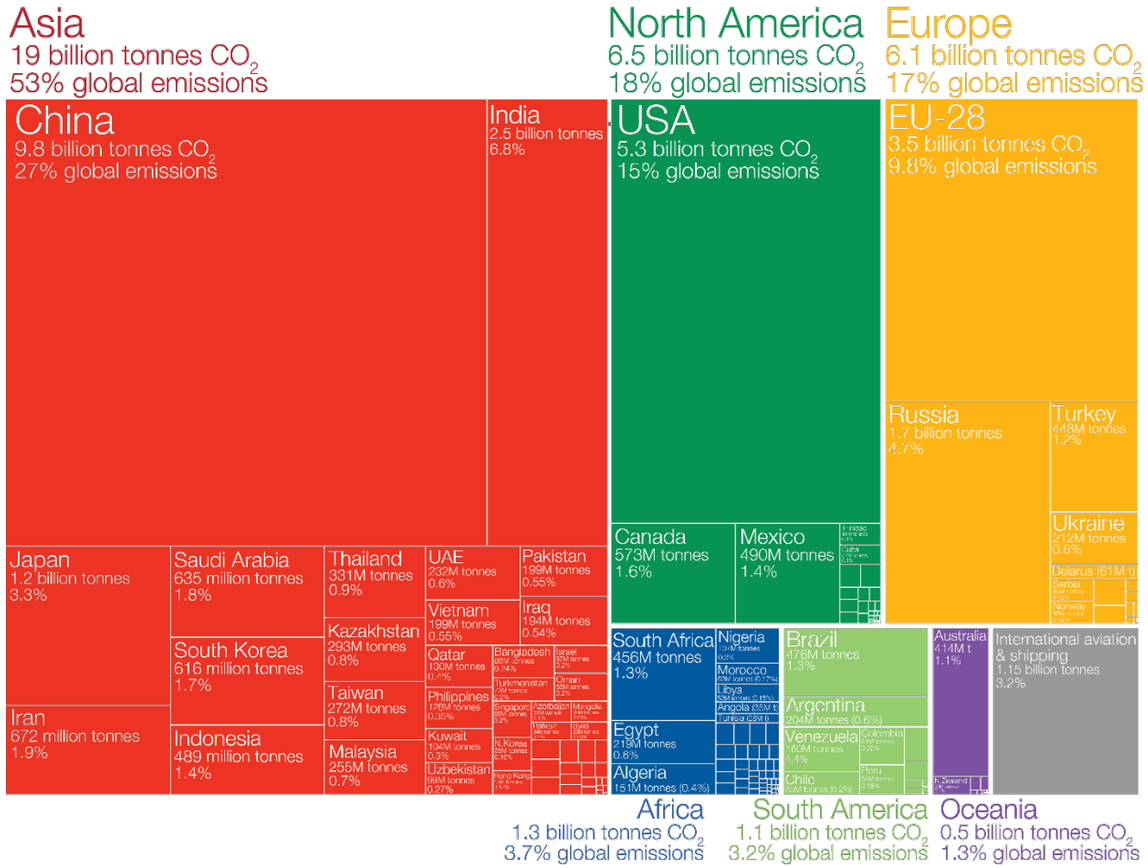
Volume of one tonne of CO_2

1,000 MW power plant emits:
7.0m tpy CO_2 (coal-fired)
3.5m tpy CO_2 (gas-fired)

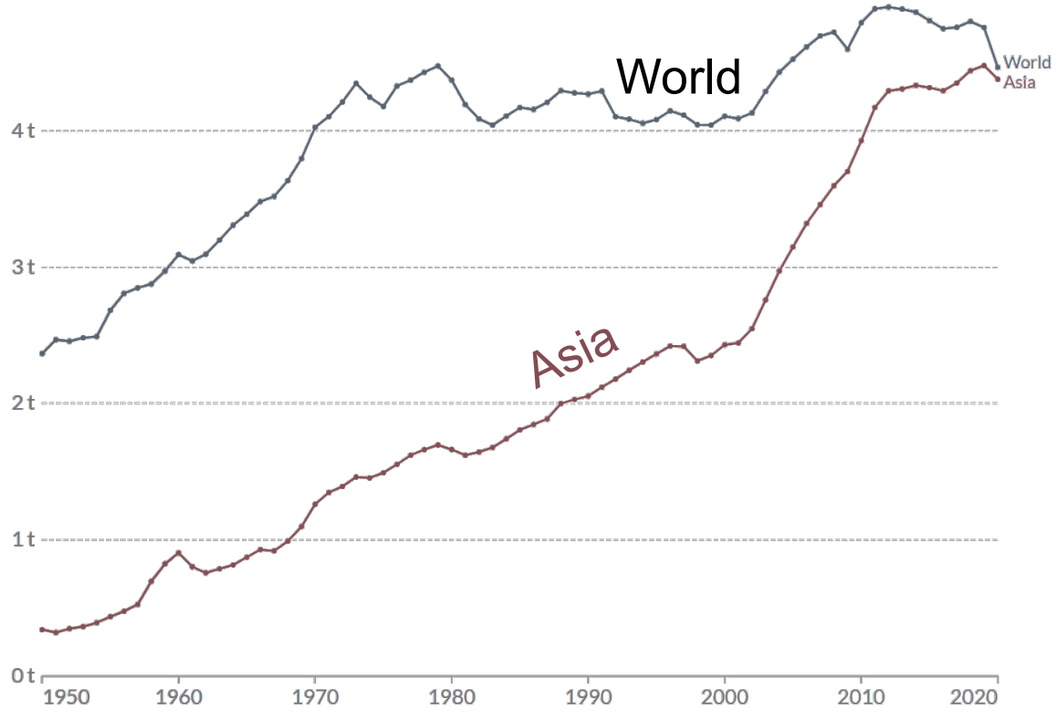
* From a coal-fired power plant in the USA

5. Asia Emits 53% of Global CO_2

China emits 28% of Global CO_2



Asia has caught up to the world in CO_2 emissions per capita



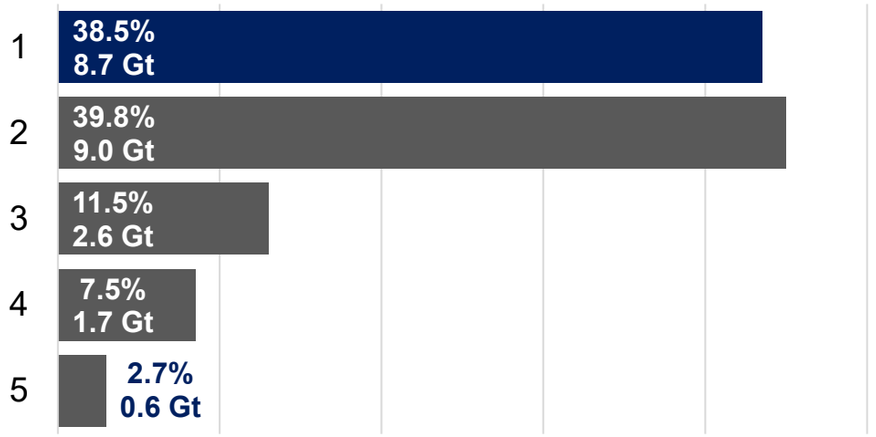
CCS is Critical for Reducing Emissions

- CCUS at coal-fired generation plants greatly reduces emissions from electricity generation.
- Hypothetical example of installing CCUS at coal-fired power plants in Asia:

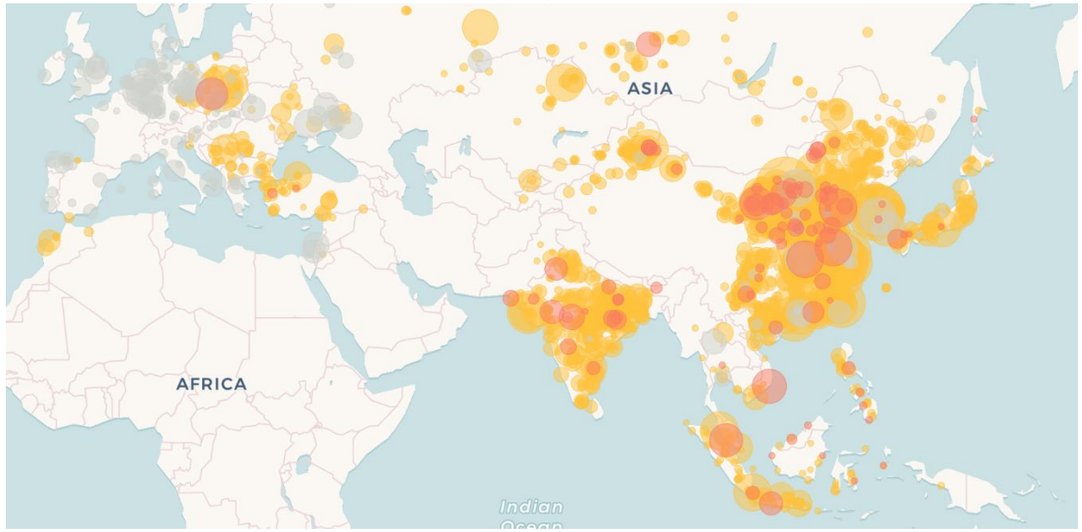
Assumed generation capacity	50,000 MW
CO_2 Captured	300 mtpy
Reduction in CO_2 from electricity	3.5%
Capital cost of CCUS	$35 billion

- Coal plants with CCUS are zero-carbon baseload, allowing more wind and solar onto the grid.
- CCUS saves the vast cost of decommissioning the coal-fired power plants.

CO_2 Emissions by ADB Members



Most coal-fired power is in Asia



6. Life of Industrial Assets can be Extended

- Asian institutions and corporations have extensive exposure to industrial assets emitting CO_2.
- They risk significant write-offs if such assets were decommissioned early to reduce emissions.
- With Karbon Technology capturing substantially all CO_2, such assets would be zero-carbon for their economic lives.
- Karbon cleans any flue gas, e.g. power plants, refineries, steel mills, cement plants and 100,000 ships.

Avoid write-offs and impairment from early decommissioning

7. Conclusions and Next Steps

1. Karbon technology uses proven components and is EPC-ready.

2. It captures 90-98% of CO_2 and other pollutants at the lowest cost,
   allowing industrial plants to serve out their operating lives without emissions.

3. Emissions goals for Asia can only be met if carbon capture is extensively deployed.

4. Asia can extend the life of its asset base by facilitating CCS technology.

Just capture it

Many thanks for inviting Karbon

ADB

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