PATENT LANDSCAPING ANALYSIS IN CO_2 CAPTURE TECHNOLOGIES

Presentation
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PATENT ANALYSIS

- **Database –** All data for patent analysis is taken from **ORBIT PATENT DATABASE**

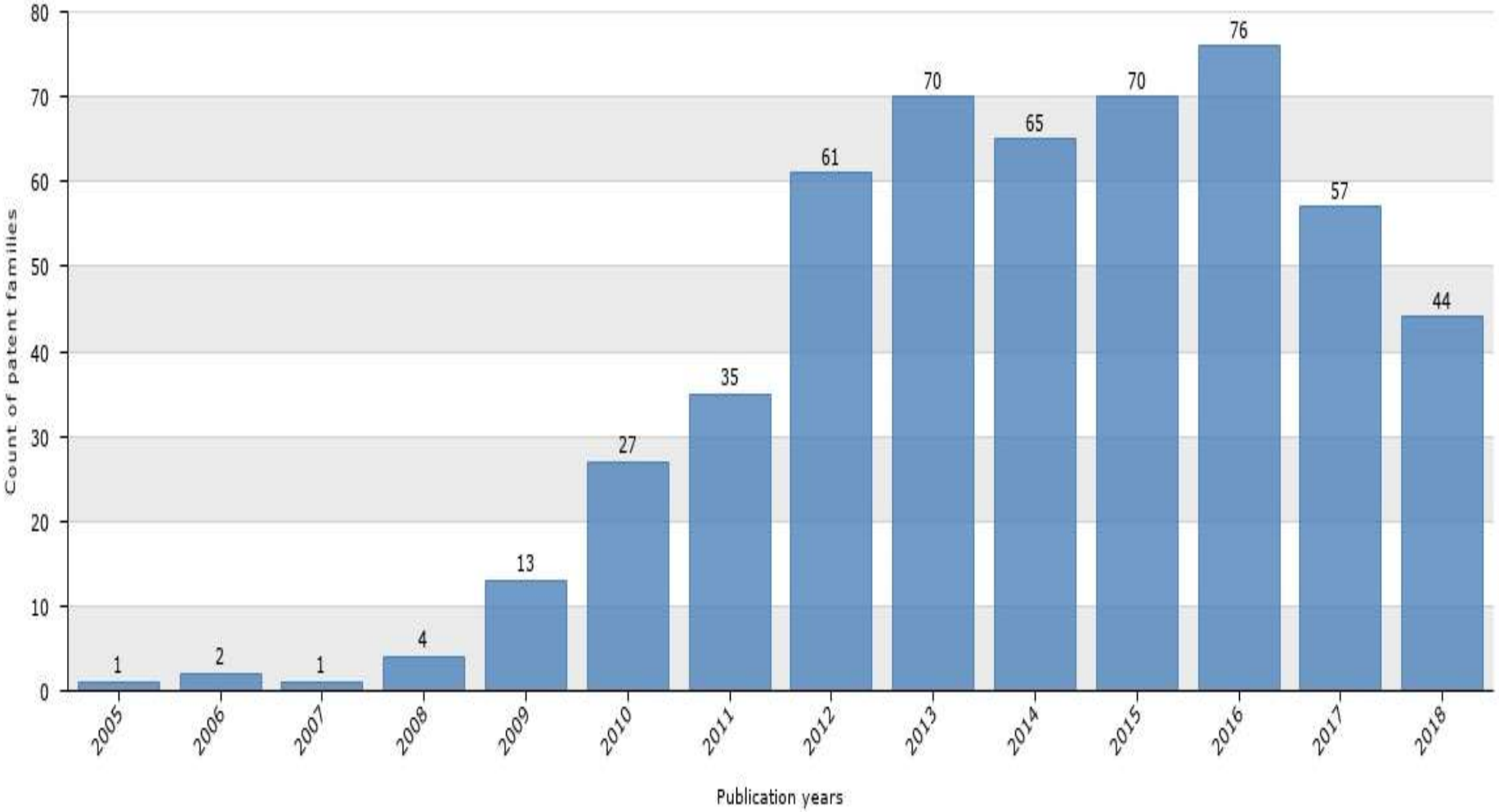
- **Period of Analysis –** January,2003 to August ,2018 (15 years)

- **Strategy –**Carbon Capture Technologies

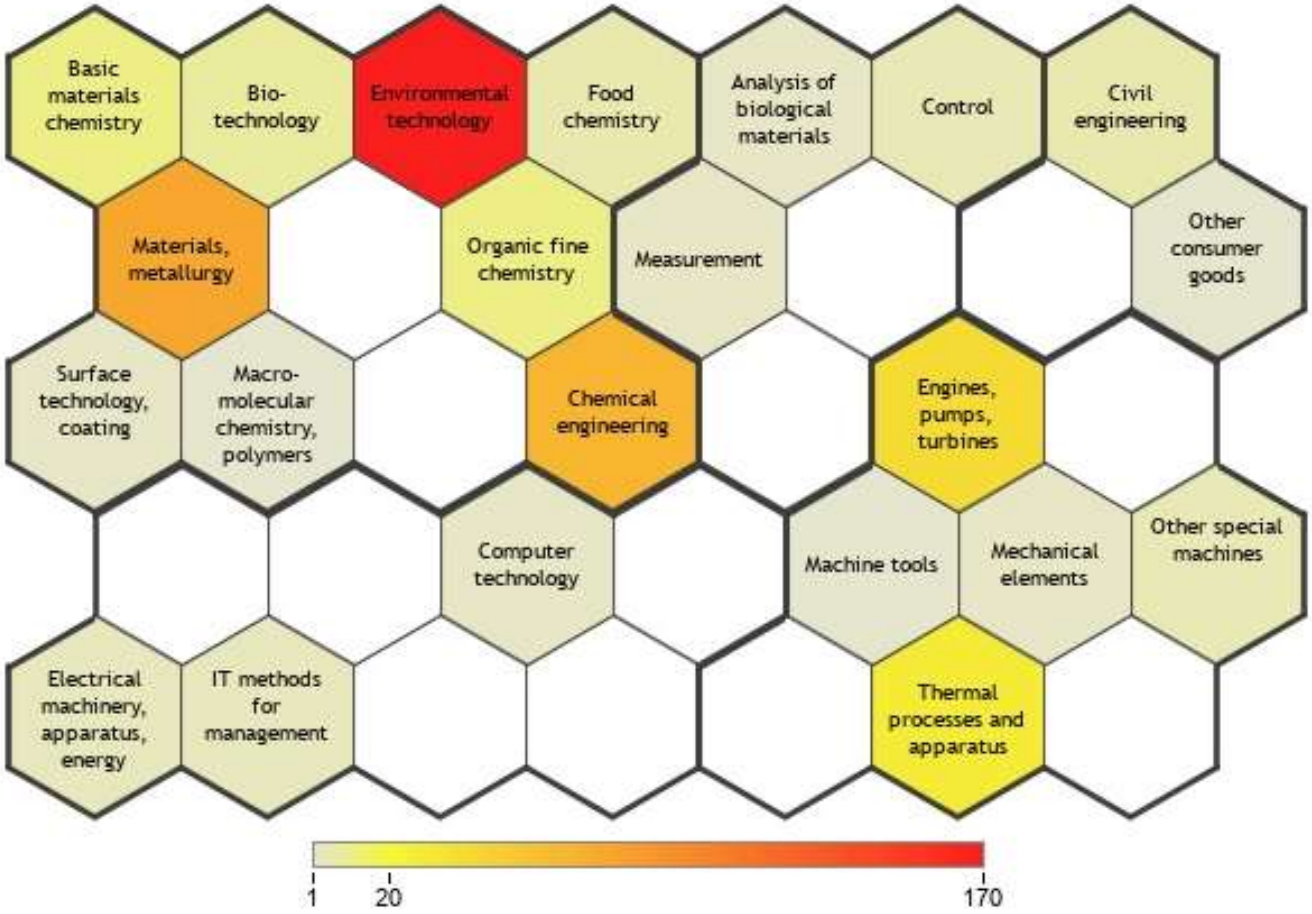
  - Keywords- “carbon capture Technologies” , “capturing carbon ” , “CO_2 Capturing ” , “carbon dioxide capturing”
  - Along with IPC codes

- **Number of Patents**-8080 in total

GROWTH IN PATENTS



PATENTS BY TECHNOLOGY DOMAIN



Environmental Technology
-170 Patent Families

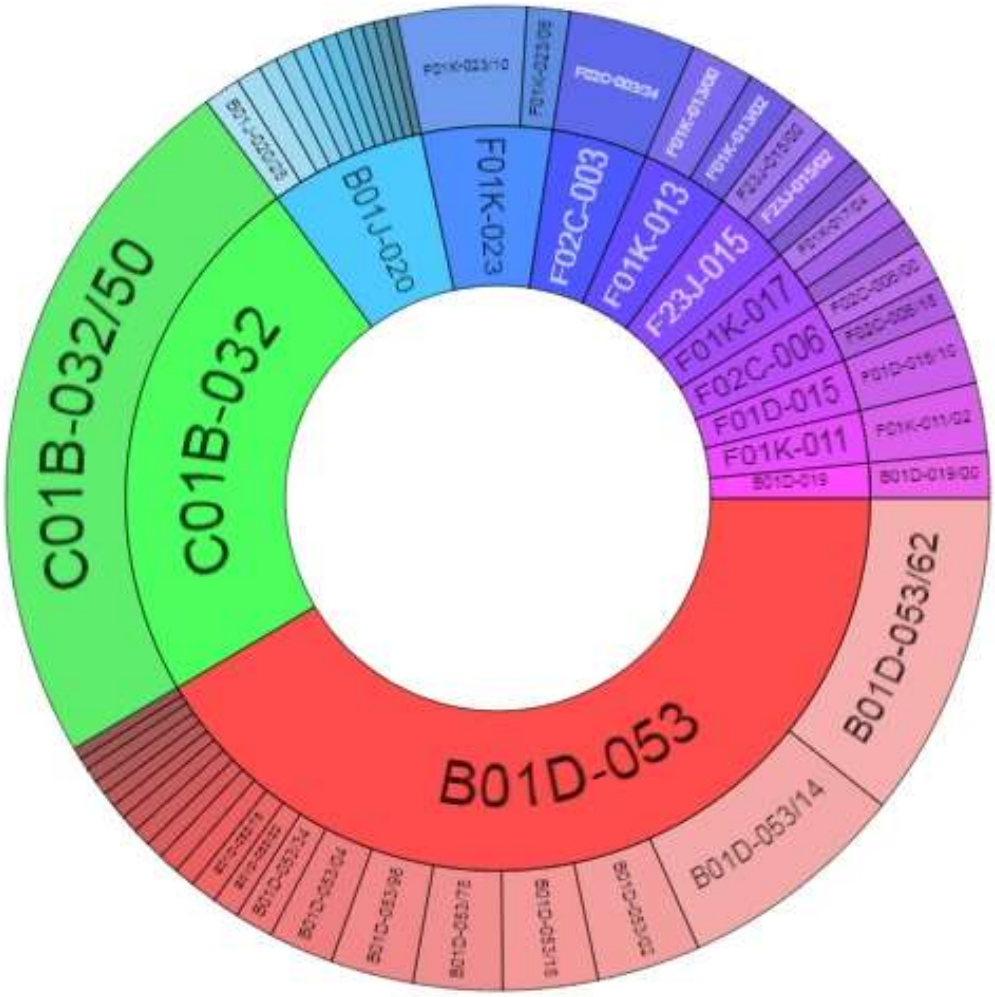
Materials ,metallurgy
-75 Patent Families

Chemical Engineering
- 65 Patent Families

Engines ,pumps ,turbines
-39 Patent Families

Thermal processes and apparatus
-27 Patent Families

PATENTS BY IPC CODES



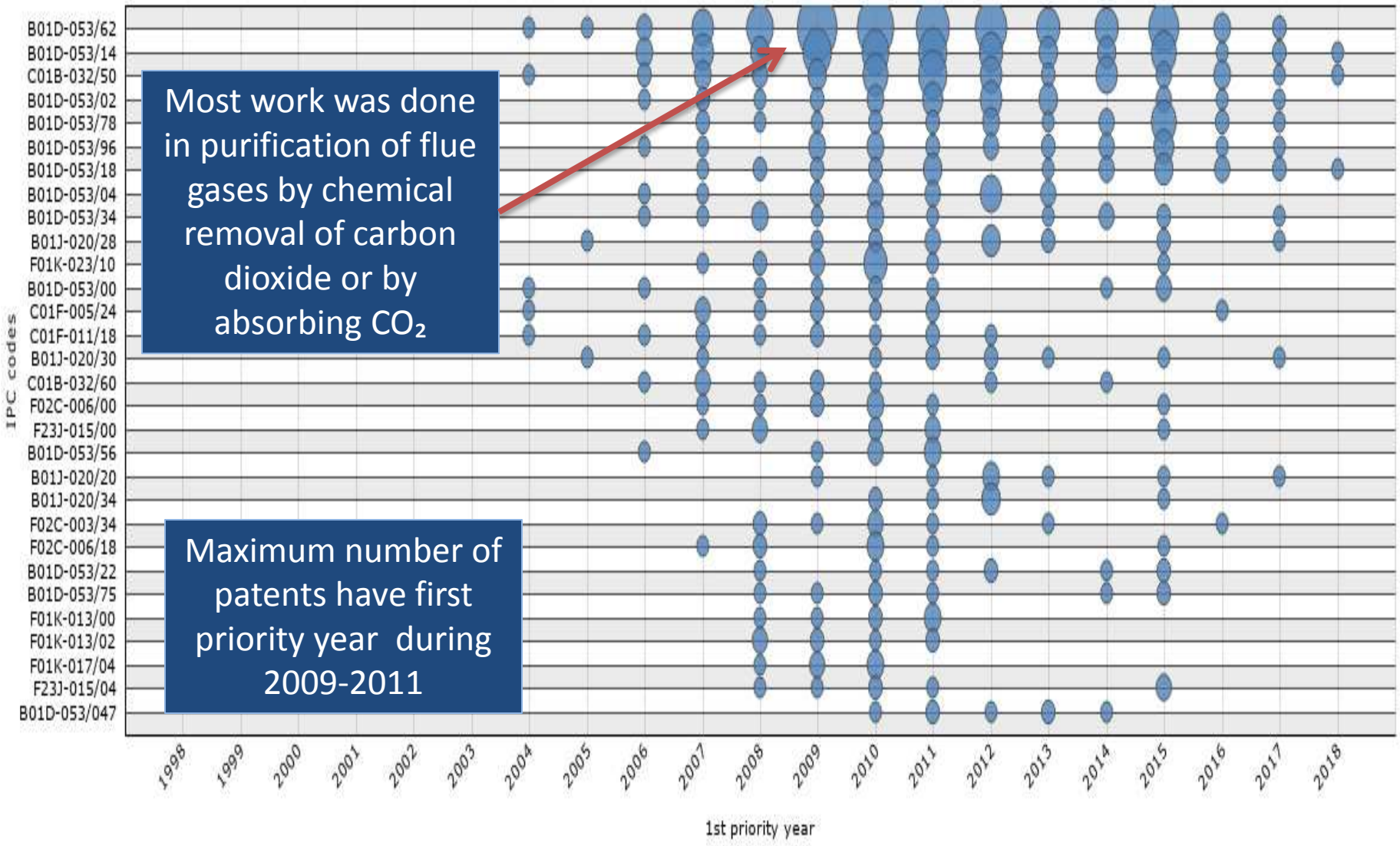
B01D-053 :- PERFORMING OPERATIONS; TRANSPORTING, PHYSICAL OR CHEMICAL PROCESSES OR APPARATUS IN GENERAL, Separation of gases or vapours; Recovering vapours of volatile solvents from gases; Chemical or biological purification of waste gases, e.g. engine exhaust gases, smoke, fumes, flue gases or aerosols.

B01D-053/62 :- by Chemical or biological purification of waste gases done by removing components of Carbon oxides .

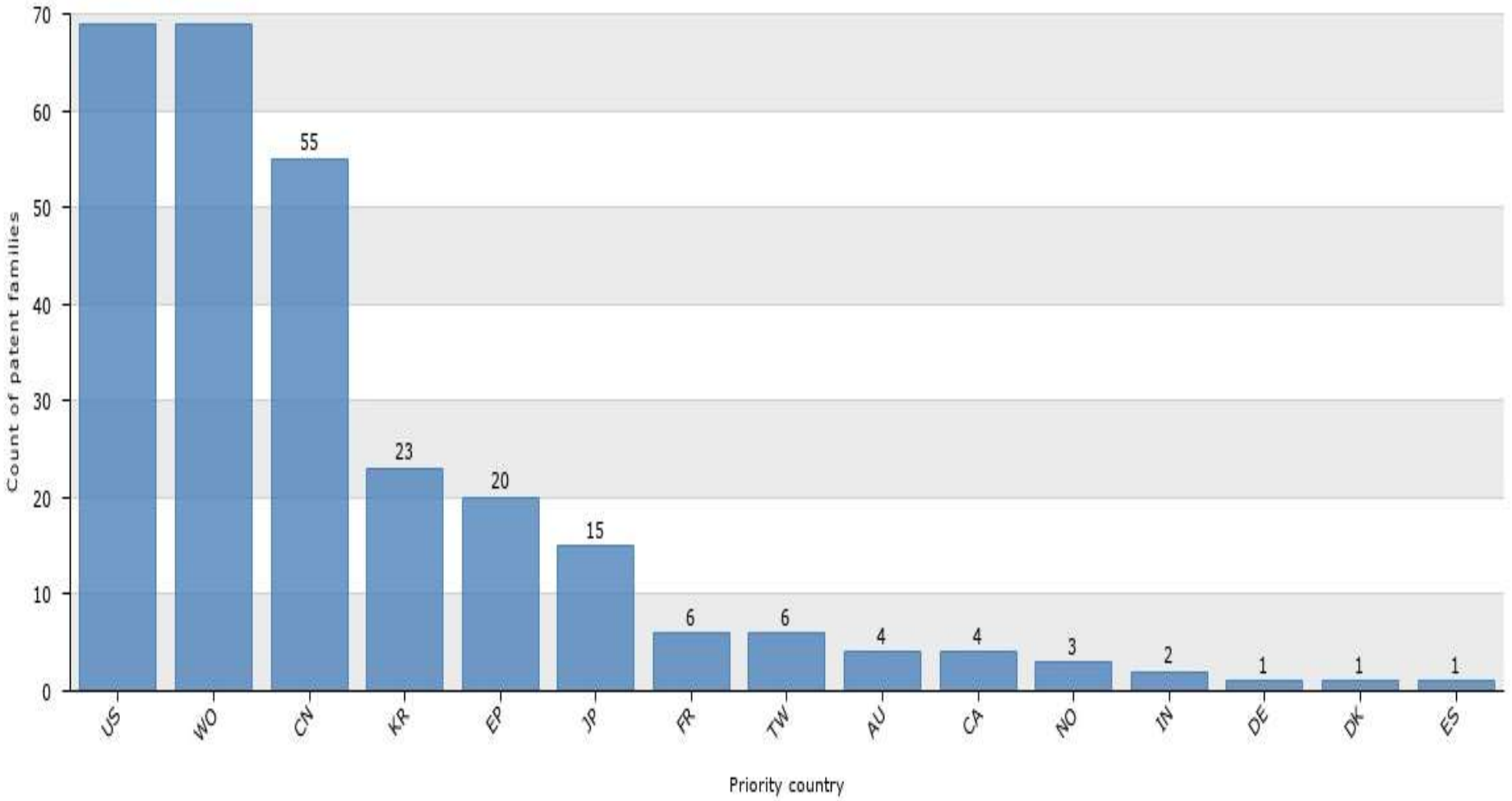
B01D-053/14 - by absorption .

C01B-032/50 - CHEMISTRY; METALLURGY,CHEMISTRY,INORGANIC CHEMISTRY, NON-METALLIC ELEMENTS; COMPOUNDS THEREOF , Carbon; Compounds thereof, Carbon dioxide

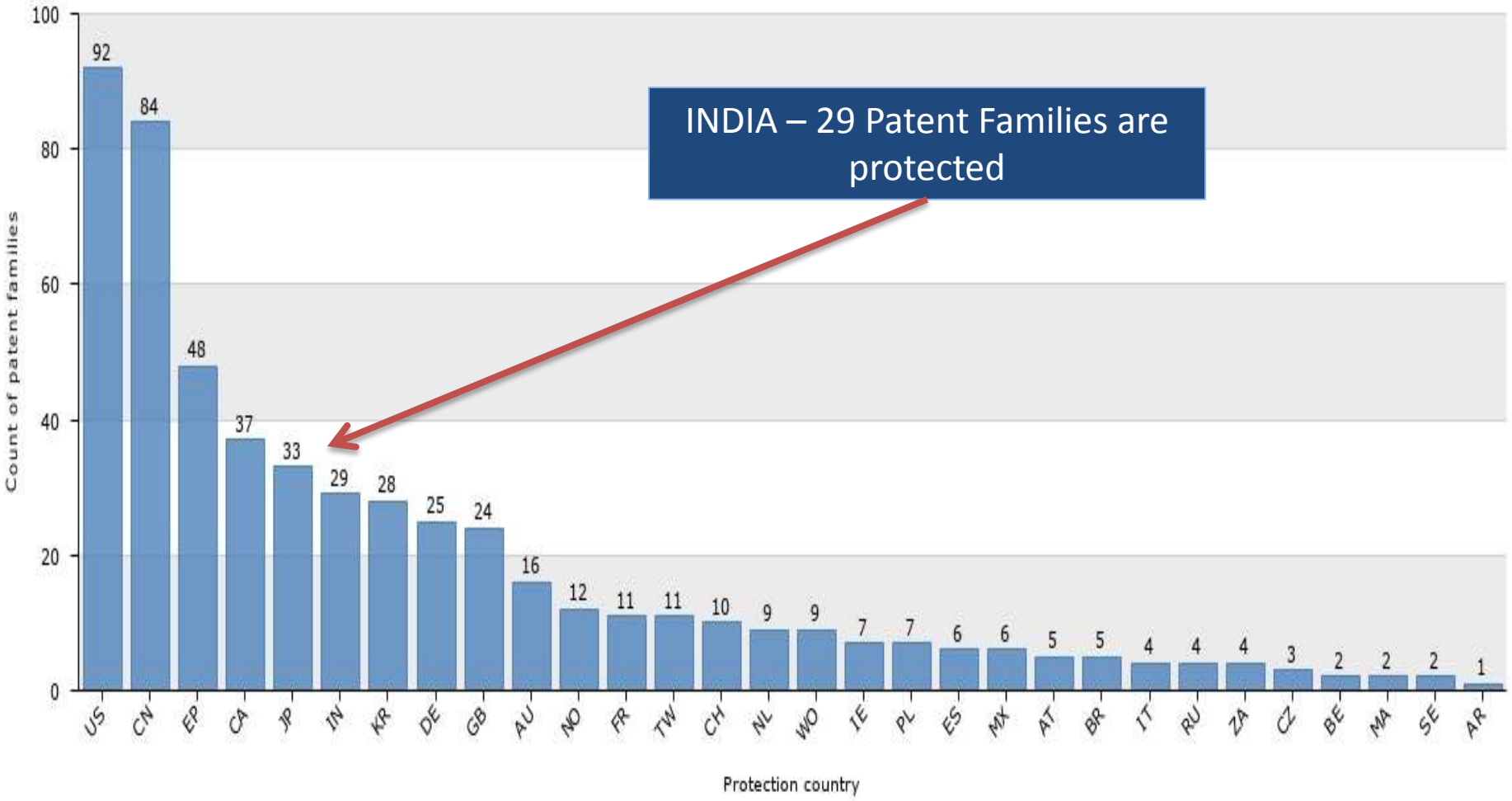
PATENT FAMILIES BY 1ST PRIORITY YEAR / IPC CODES



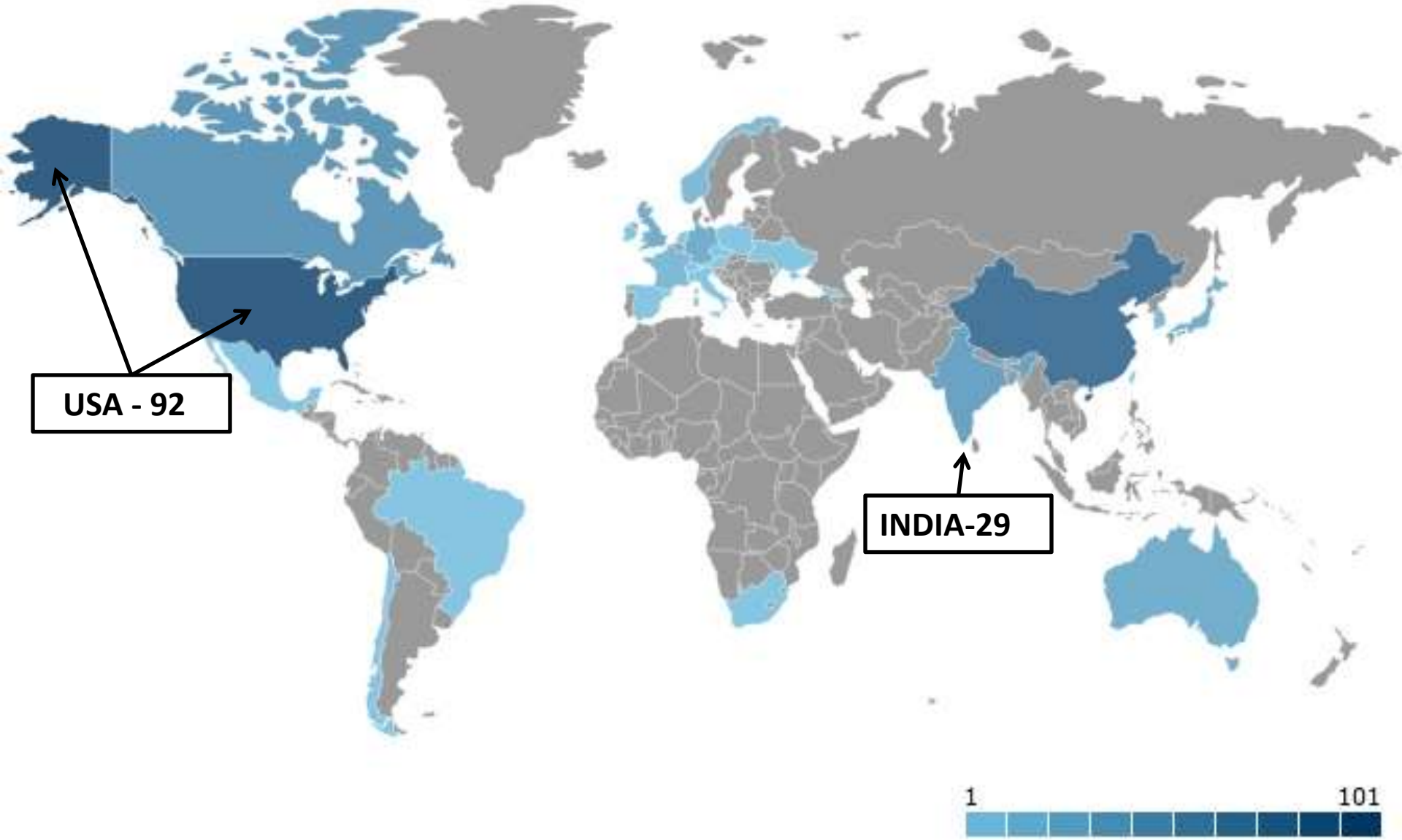
PATENT FAMILIES BY PRIORITY COUNTRY



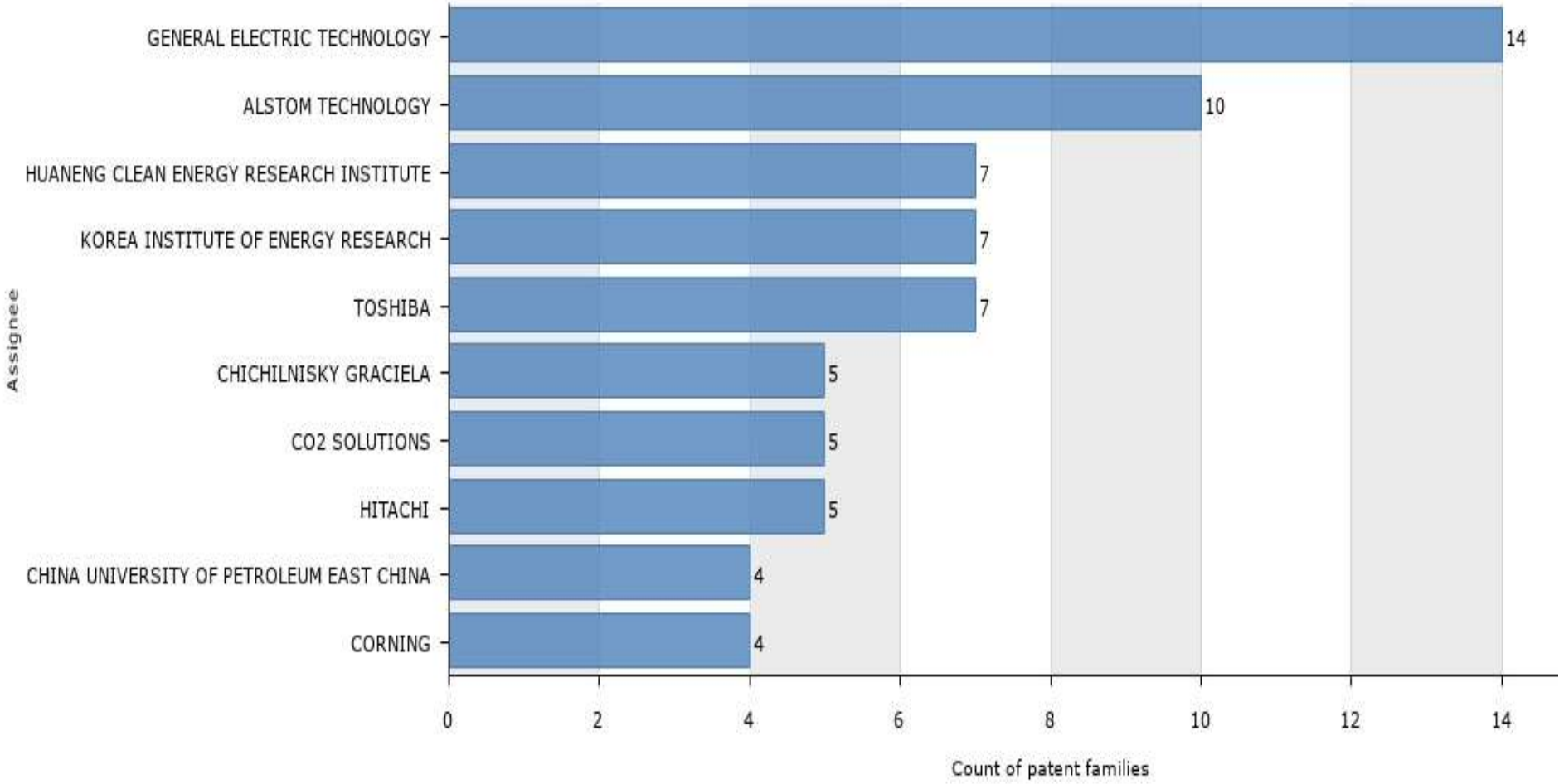
PATENT FAMILIES BY PROTECTION COUNTRY



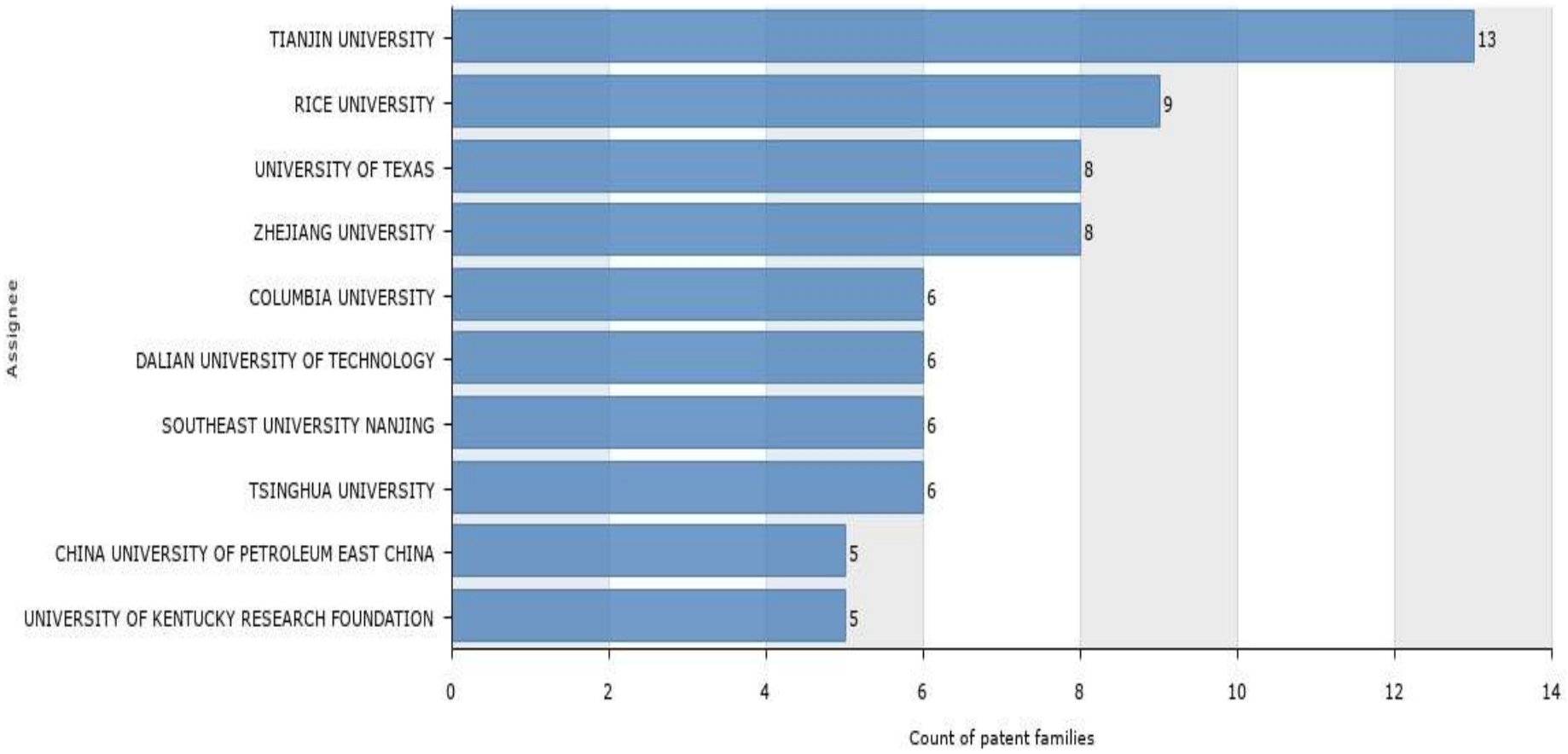
PATENT FAMILIES BY PROTECTION COUNTRY



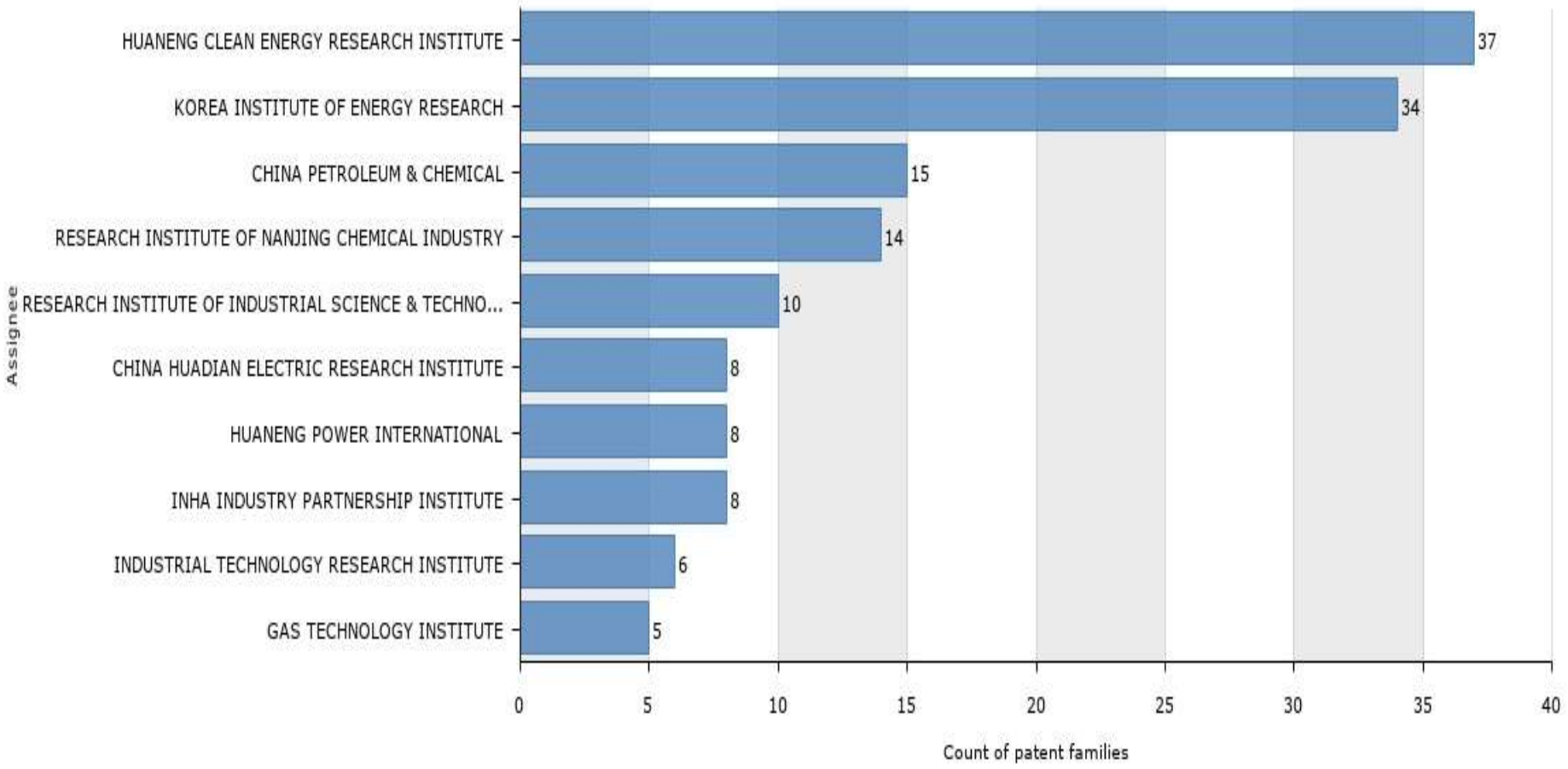
PATENT FAMILIES BY ASSIGNEE – TOP 10



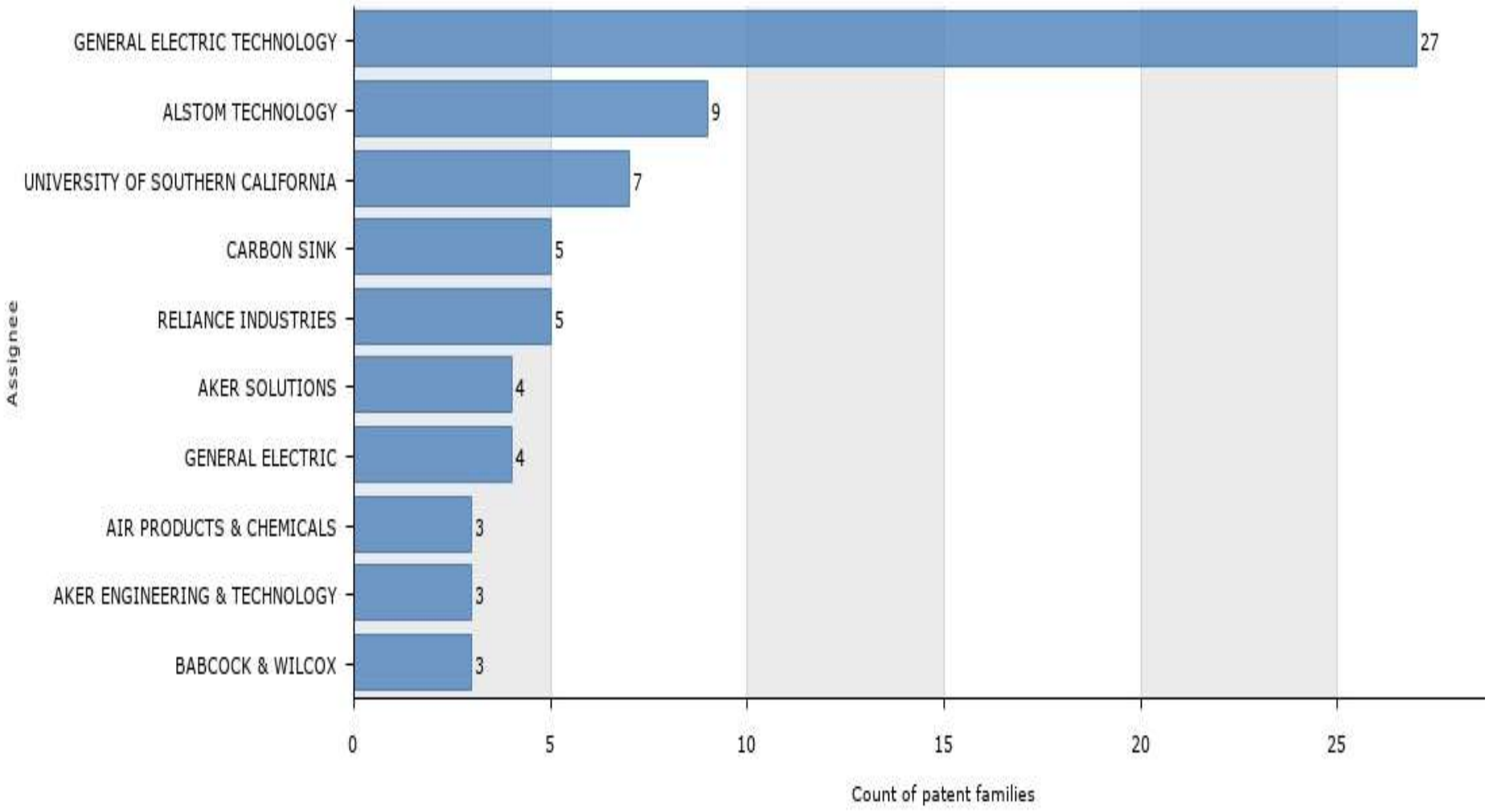
UNIVERSITY PATENT HOLDERS - WORLD



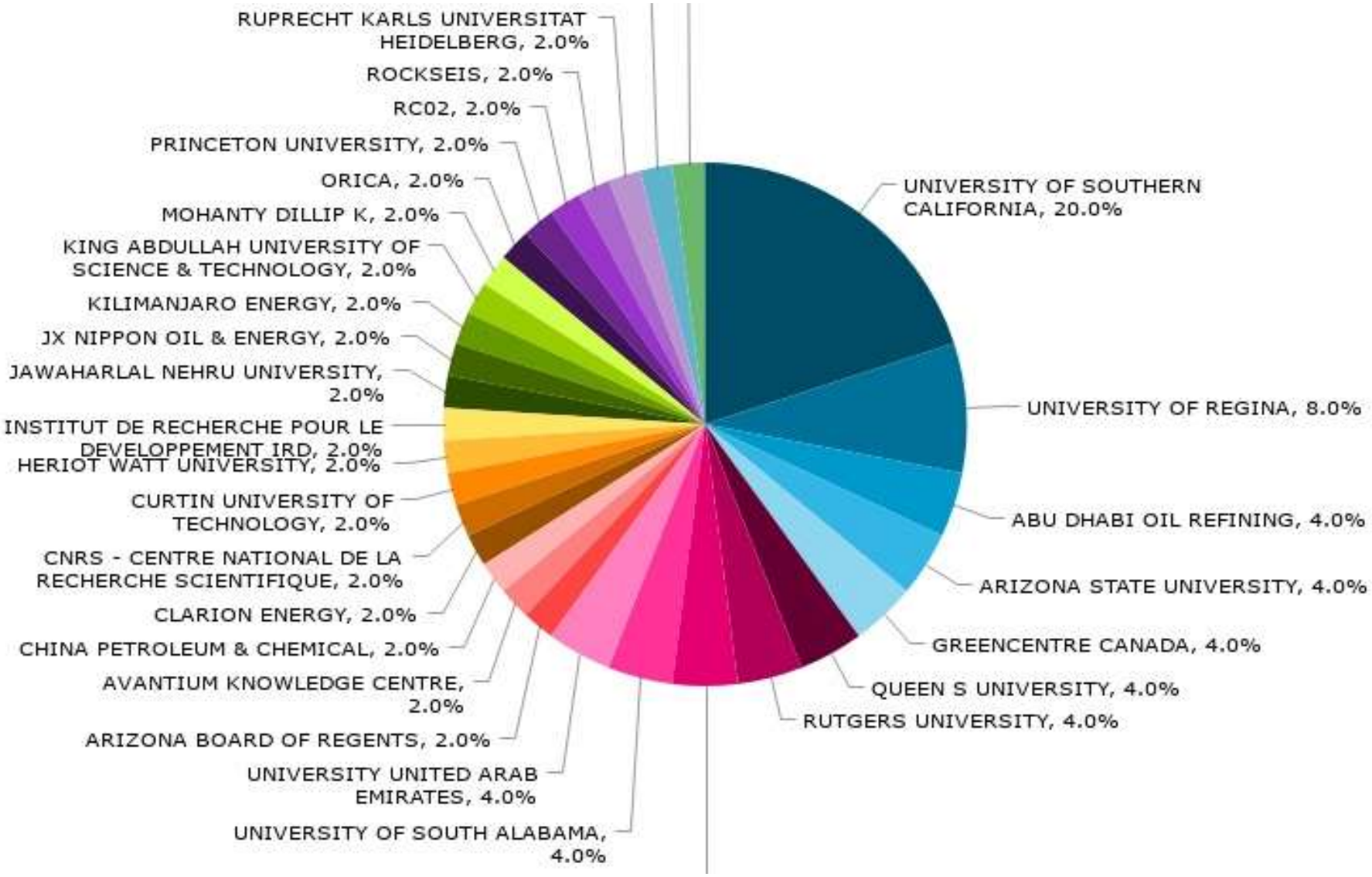
INSTITUTE PATENT HOLDERS - WORLD



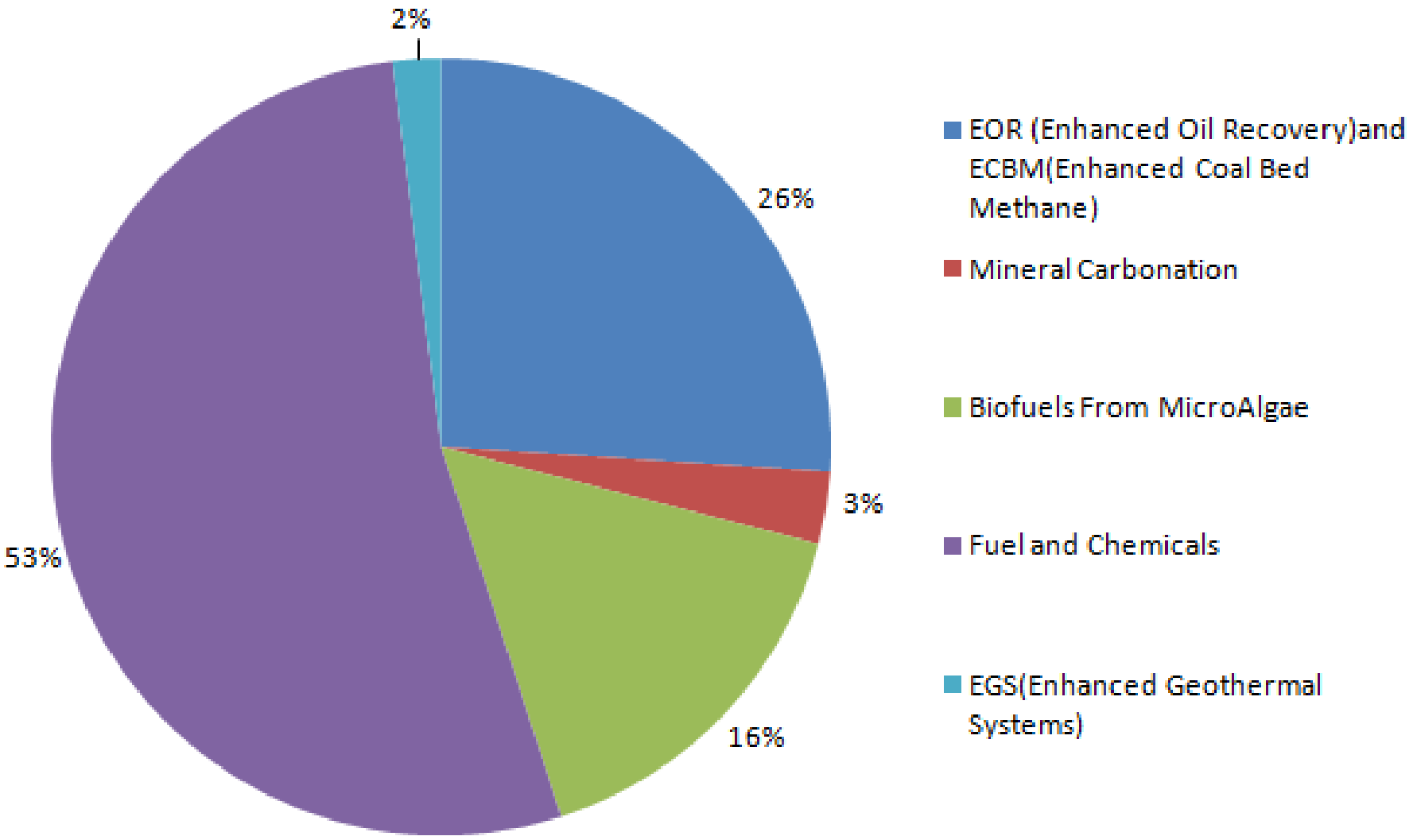
PATENT HOLDERS IN INDIA – TOP 10



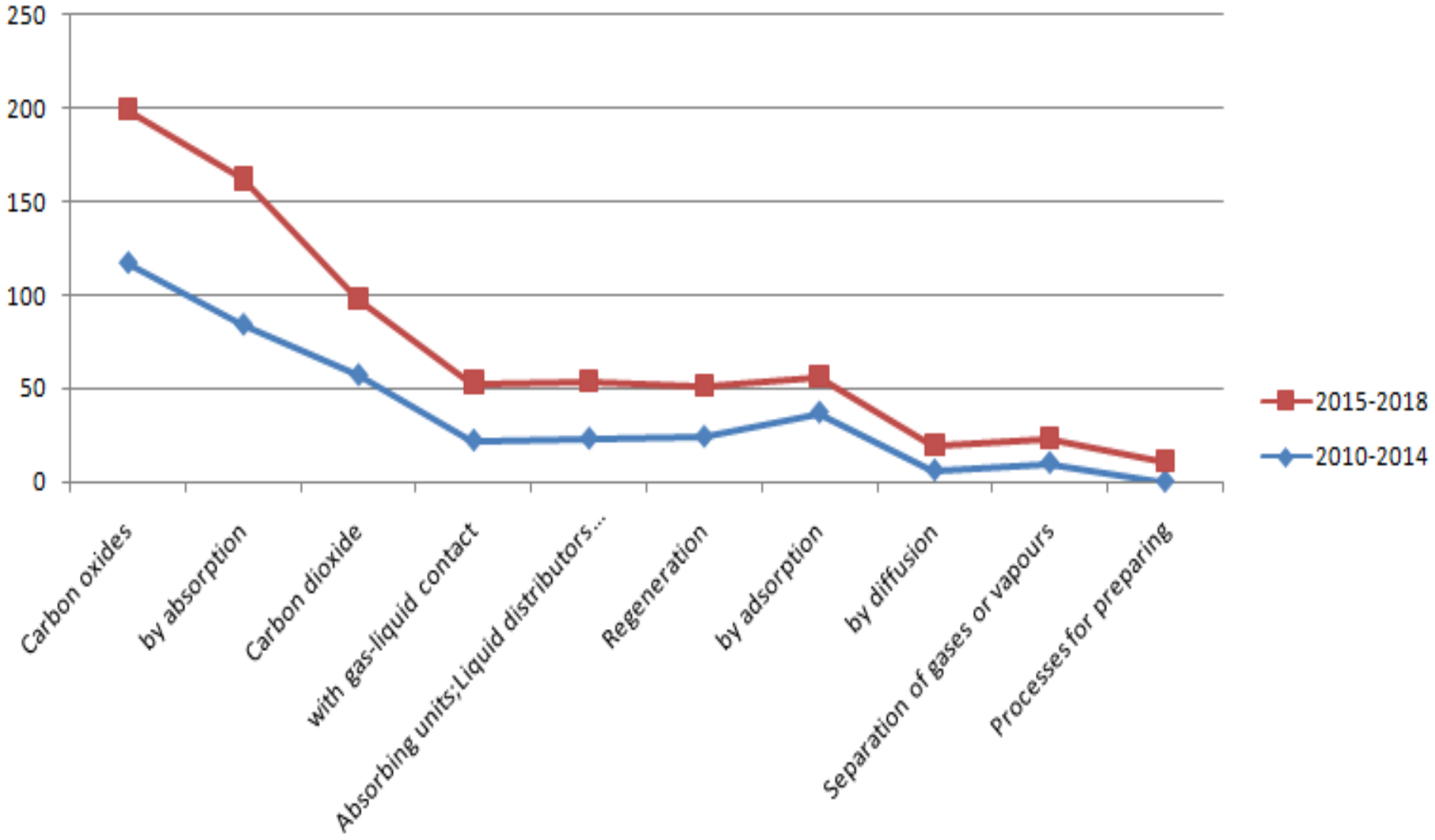
INSTITUTE PATENT HOLDERS - INDIA



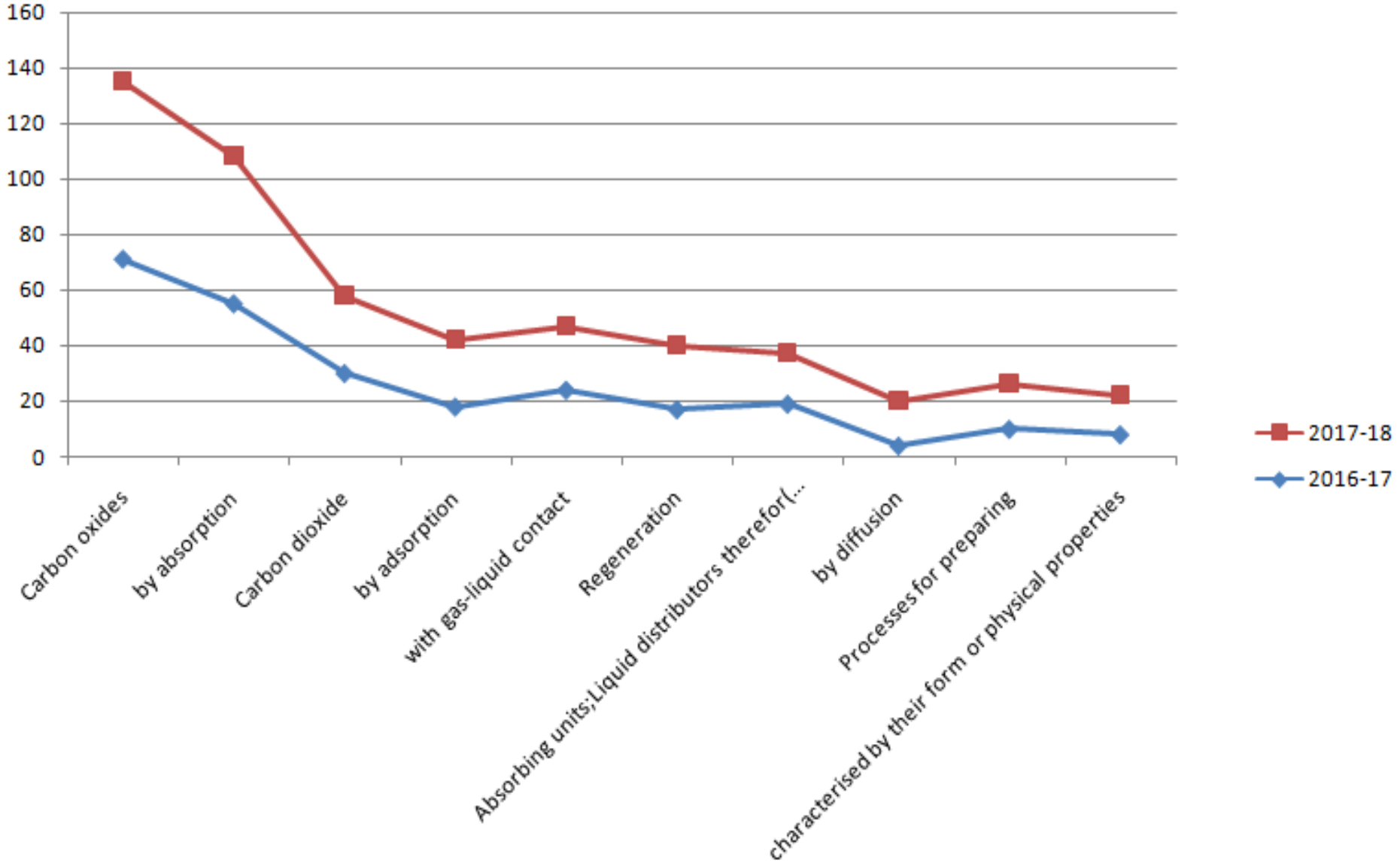
TYPES OF CO_2 UTILIZATION PATENTS



Technology Trend -I



Technology Trend -II



LARGE SCALE CCS INTEGRATED FACILITIES

•Large-scale integrated CCS facilities are defined as facilities involving the capture, transport, and storage of CO2 at a scale of:

- at least 800,000 tonnes of CO2 annually for a coal–based power plant, or
- at least 400,000 tonnes of CO2 annually for other emissions–intensive industrial facilities (including natural gas–based power generation).

• At present among total 38 facilities

- Operating – 18
- In Construction – 5
- Advanced Development – 4
- Early Development – 11

OPERATING FACILITIES - 18

- Industry Type –
  - Ethanol Production (1),Fertilizer Production (2), Hydrogen Production (2), Iron and Steel Production (1),Natural Gas Processing (9), Power Generation (2), Synthetic Natural Gas(1).
- Countries -
  - United States (9), Canada (3),Norway (2), China (1), Brazil(1), UAE(1), Saudi Arabia (1) .
- On the basis of capture type
  - 16 facilities use industrial separation and 2 use post combustion method.
- On the basis of Storage
  - 14 facilities use EOR(Enhanced Oil Recovery)
  - 2 facilities use Dedicated geological storage - offshore deep saline formations
  - 2 facilities use Dedicated geological storage - onshore deep saline formations

PROJECTS-OPERATING

Name	Location	Operation date	Industry	Capture type	Capture capacity (Mtpa)	Primary storage type
Terrell Natural Gas Processing Plant (formerly Val Verde Natural Gas Plants)	United States	1972	Natural Gas Processing	Industrial Separation	0.4 - 0.5	Enhanced oil recovery
Enid Fertilizer	United States	1982	Fertiliser Production	Industrial Separation	0.7	Enhanced oil recovery
Shute Creek Gas Processing Plant	United States	1986	Natural Gas Processing	Industrial Separation	7.0	Enhanced oil recovery
Sleipner CO2 Storage	Norway	1996	Natural Gas Processing	Industrial Separation	1.0	Dedicated Geological Storage
Great Plains Synfuels Plant and Weyburn-Midale	Canada	2000	Synthetic Natural Gas	Industrial Separation	3.0	Enhanced oil recovery
Snøhvit CO2 Storage	Norway	2008	Natural Gas Processing	Industrial Separation	0.7	Dedicated Geological Storage
Century Plant	United States	2010	Natural Gas Processing	Industrial Separation	8.4	Enhanced oil recovery
Air Products Steam Methane Reformer	United States	2013	Hydrogen Production	Industrial Separation	1.0	Enhanced oil recovery
Coffeyville Gasification Plant	United States	2013	Fertiliser Production	Industrial Separation	1.0	Enhanced oil recovery

PROJECTS- OPERATING

Lost Cabin Gas Plant	United States	2013	Natural Gas Processing	Industrial Separation	0.9	Enhanced oil recovery
Petrobras Santos Basin Pre-Salt Oil Field CCS	Brazil	2013	Natural Gas Processing	Industrial Separation	1.0	Enhanced oil recovery
Boundary Dam Carbon Capture and Storage	Canada	2014	Power Generation	Post-combustion capture	1.0	Enhanced oil recovery
Quest	Canada	2015	Hydrogen Production	Industrial Separation	1.0	Dedicated Geological Storage
Uthmaniyah CO2-EOR Demonstration	Saudi Arabia	2015	Natural Gas Processing	Industrial Separation	0.8	Enhanced oil recovery
Abu Dhabi CCS (Phase 1 being Emirates Steel Industries)	United Arab Emirates	2016	Iron and Steel Production	Industrial Separation	0.8	Enhanced oil recovery
Illinois Industrial Carbon Capture and Storage	United States	2017	Ethanol Production	Industrial Separation	1.0	Dedicated Geological Storage
Petra Nova Carbon Capture	United States	2017	Power Generation	Post-combustion capture	1.4	Enhanced oil recovery
CNPC Jilin Oil Field CO2 EOR	China	2018	Natural Gas Processing	Industrial Separation	0.6	Enhanced oil recovery

ADVANCED DEVELOPMENT

Name	Location	Operation date	Industry	Capture type	Capture capacity (Mtpa)	Primary storage type
CarbonNet	Australia	2020s	Under evaluation	Under evaluation	1.0 - 5.0	Dedicated Geological Storage
Lake Charles Methanol	United States	2022 (Institute estimate)	Chemical Production	Industrial Separation	4.2	Enhanced oil recovery
Texas Clean Energy Project	United States	2022 (Institute estimate)	Chemical Production	Industrial Separation	1.5 - 2.0	Enhanced oil recovery
Norway Full Chain CCS	Norway	2023 - 2024	Cement Production and Waste-to-Energy	Various	0.8	Dedicated Geological Storage

EARLY DEVELOPMENT

Name	Location	Operation date	Industry	Capture type	Capture capacity (Mtpa)	Primary storage type
China Resources Power (Haifeng) Integrated Carbon Capture and Sequestration Demonstration	China	2020's	Power Generation	Post-combustion capture	1.0	Dedicated Geological Storage
Huaneng GreenGen IGCC Large-scale System (Phase 3)	China	2020's	Power Generation	Pre-combustion capture (gasification)	2.0	Enhanced oil recovery
Korea-CCS 1	South Korea	2020's	Power Generation	Post-combustion capture	1.0	Dedicated Geological Storage
Korea-CCS 2	South Korea	2020's	Power Generation	Under evaluation	1.0	Dedicated Geological Storage
Shanxi International Energy Group CCUS	China	2020's	Power Generation	Oxy-fuel combustion capture	2.0	Not specified
Shenhua Ningxia CTL	China	2020's	Coal-to-liquids (CTL)	Industrial Separation	2.0	Not specified
Sinopec Shengli Power Plant CCS	China	2020's	Power Generation	Post-combustion capture	1.0	Enhanced oil recovery
Teesside Collective	United Kingdom	2020's	Various	Various	0.8	Dedicated Geological Storage
Sinopec Eastern China CCS	China	2020-2021	Fertiliser Production	Industrial Separation	0.5	Enhanced oil recovery
Caledonia Clean Energy	United Kingdom	2024	Power Generation	Post-combustion capture	3.0	Dedicated Geological Storage
South West Hub	Australia	2025	Fertiliser Production and Power Generation	Industrial Separation	2.5	Dedicated Geological Storage

CCS IN INDIA

- Presently about 75% of the total primary energy demand in India is met by the fossil fuels. And as for electricity, coal is the largest source of electricity in India and will continue to be the major component in energy mix even by 2050. India ratified the Paris agreement on climate change on 2nd October 2016, marking the occasion of Gandhi Jayanti, which is also the International Day of Non-Violence.

- India, which is the world's fourth-largest carbon emitter accounting for 4.1% of the total global emission, is the 62nd nation to ratify the agreement. As part of the "Intended Nationally Determined Contribution (INDC)", India has committed to reduce the emission intensity by 33-35% by 2030.The major focus of the mitigation strategy is on improving the energy efficiency and use of renewable sources of energy. . The aim is to produce 40% of the total electricity from sources other than fossil fuels.

FUTURE- CCU

- Carbon Clean Solutions founded by Aniruddha Sharma and Prateek Bumb in 2009.

- Carbon Clean Solutions built a plant in Tuticorin in southern India (in partnership with Tuticorin Alkali Chemicals and Fertilisers) that captures carbon dioxide from its coal-fired boiler and converts it into soda ash.

- Carbon Clean Solutions has filed six patents

    - 5 - US patents
    - 1-International patent (in US and Europe).

FUTURE- CCU

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- Mr.Aniruddha quotes “It’s a world’s first, the commercial-scale plant set to capture 60,000 tons of CO_2 annually does it so cheaply that it did not need any government subsidies.”
- According to Sharma and Bumb, they launched the company while they were still students at the Indian Institute of Technology (IIT), Kharagpur. As they couldn’t find investors for their company in India. So they turned to the UK government, which was willing to provide grants and special entrepreneur visas.

SUMMARY

- Based on analysis most of the patents are filed by **US, China , Korea, Europe and Japan.**

- Most explored technologies are technologies for removing **carbon by absorption or adsorption**. There was sharp increase in research in this field during 2009-2012 ,which has stabilized in recent years.

- Research Work is being done on some emerging technologies also like **capturing carbon dioxides by diffusion or study characterization by new form or physical properties**

- Expected Areas for CCU are technologies which are not location dependent (like EOR) and cost effective for developing countries. So more research is directed towards carbon utilization like mineral carbonation(need of building materials in developing countries) .

THANK YOU

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