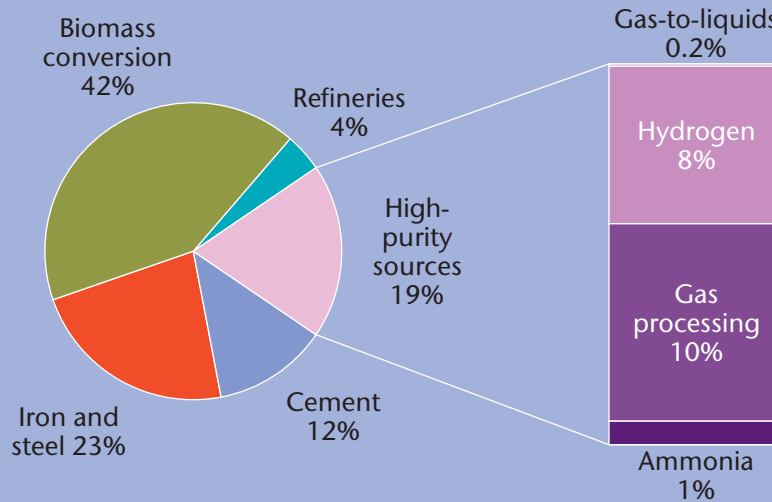


Key findings

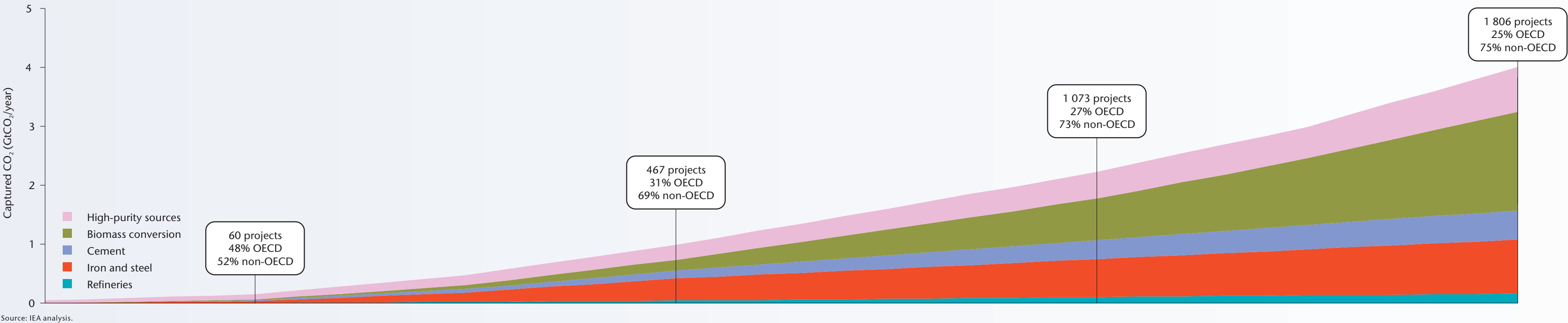
- Carbon capture and storage (CCS) is a key long-term cost-effective option for reducing CO<sub>2</sub> emissions from industrial applications, and the only way some industries will be able to achieve deep reductions.
- Globally, CCS in industrial applications can reduce CO<sub>2</sub> emissions by up to 4.0 Gt annually by 2050, accounting for about 9% of the global reductions needed to halve energy-related CO<sub>2</sub> emissions in 2050. Achieving this will require 20% to 40% of all industrial and fuel transformation plants to be equipped with CCS by 2050.
- CCS in the high-purity sources sector<sup>1</sup> presents early opportunities for CO<sub>2</sub> storage demonstration, as only compression, transport and storage are needed for CCS. If these opportunities can be linked to storage through enhanced oil recovery (EOR), overall costs of CCS could be lower than USD 10/tCO<sub>2</sub> or even negative.
- CCS technologies for some industry sectors, such as cement, require additional research and development (R&D), pilot plant testing and demonstration projects before a commercial-scale application can be implemented. Incentives and government support are required for the development of suitable carbon capture technologies for some industries.
- This roadmap envisages that additional investments of about USD 172 billion for CCS in industrial applications will be required in developing countries from 2010 to 2030. The high cost of CCS is one of the key barriers to implementation in both developed and developing countries.
- The most suitable mechanisms for supporting CCS may vary as the technology matures. In addition, financing and incentive mechanisms for industry may need to differ from those for the power sector; if CCS is pursued in industry through pricing mechanisms or technology-specific mandating, production could shift to countries or regions with less stringent emission reduction policies – so-called carbon leakage – because of greater international competition in industrial sectors than in power.

1. The high-purity source sector includes natural gas processing (onshore/offshore); hydrogen production from natural gas, coal or biomass; ethylene oxide production; coal-to-liquids (CTL); ammonia production.

CO<sub>2</sub> captured in 2050 by sector



Global deployment of CCS in industrial applications, 2015-2050 by sector

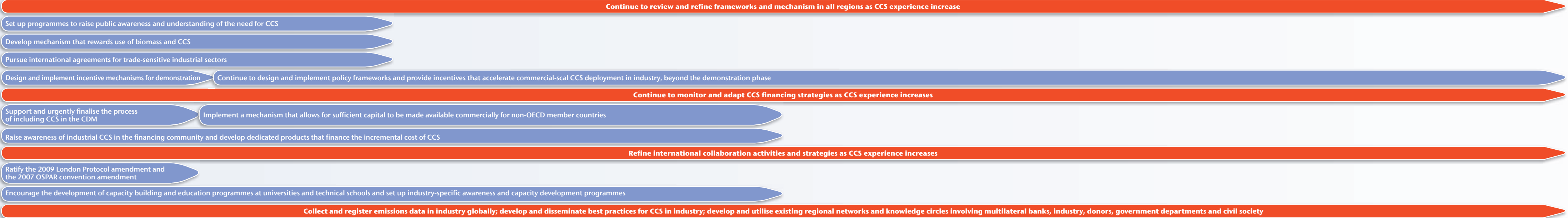


Roadmap milestones

Technology



Policy, finance and international collaboration

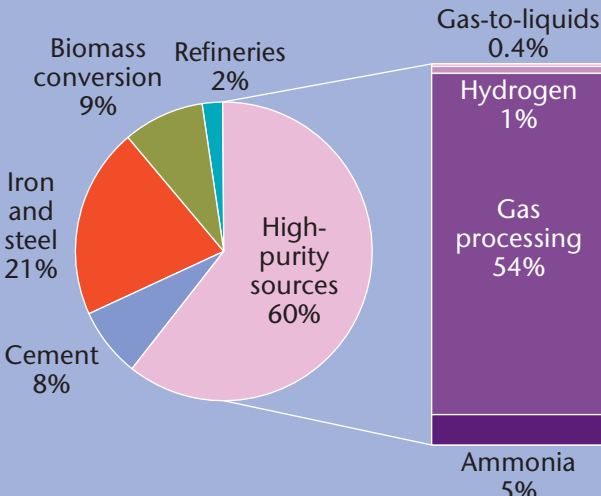


Key actions over

the next ten years:

- Governments need to ensure that CCS demonstration programmes include projects using high-purity sources, and in the biomass conversion, refineries, iron and steel, and cement sectors. USD 27 billion will be needed by 2020 to fund about 60 demonstration projects.
- Funding and collaboration mechanisms will be needed to support demonstration and then deployment of CCS in developing countries, where some of the largest opportunities exist for industrial CO<sub>2</sub> capture.
- To enable a deeper understanding of the potential for CCS in industry, data on current emissions and technologies, as well as cost data and projections, need to be improved.
- More global assessments of CO<sub>2</sub> sources and potential reservoirs are needed, including storage opportunities in EOR operations. The identification of geological structures with high levels of injectivity and strong, deep cap rocks is critical to the successful deployment of CCS.

CO<sub>2</sub> captured in 2020 by sector



Number of projects and additional investment needs for CCS in industrial applications

Central South America	Cumulative number of projects				Additional investments* (USD billion)			
	2020	2030	2040	2050	2010-20	2021-30	2031-40	2041-50
High-purity sources	0	1	4	11	0	1	1	1
Biomass conversion	1	12	53	93	1	4	11	12
Cement	1	9	23	37	1	5	9	9
Iron and Steel	0	4	7	9	0	3	2	1
Refineries	0	2	4	6	0	1	1	1

Former Soviet Union	Cumulative number of projects				Additional investments* (USD billion)			
	2020	2030	2040	2050	2010-20	2021-30	2031-40	2041-50
High-purity sources	0	4	9	23	0	1	1	2
Biomass conversion	1	8	23	46	1	5	8	10
Cement	1	4	11	18	1	2	4	4
Iron and Steel	1	16	24	30	1	10	6	4
Refineries	0	0	2	4	0	0	1	1

Middle East	Cumulative number of projects				Additional investments* (USD billion)			
	2020	2030	2040	2050	2010-20	2021-30	2031-40	2041-50
High-purity sources	4	12	20	26	1	2	2	0
Biomass conversion	0	0	5	19	0	0	1	3
Cement	0	5	13	21	0	3	5	5
Iron and Steel	1	9	12	16	1	6	2	3
Refineries	0	2	8	14	0	1	4	4

Africa	Cumulative number of projects				Additional investments* (USD billion)			
	2020	2030	2040	2050	2010-20	2021-30	2031-40	2041-50
High-purity sources	1	4	5	8	1	1	1	1
Biomass conversion	0	3	18	43	0	2	7	12
Cement	1	14	44	75	1	9	20	21
Iron and Steel	1	4	9	15	1	2	4	4
Refineries	0	0	2	4	0	0	1	1

India	Cumulative number of projects				Additional investments* (USD billion)			
	2020	2030	2040	2050	2010-20	2021-30	2031-40	2041-50
High-purity sources	1	4	8	18	1	1	1	1
Biomass conversion	0	4	22	61	0	2	7	13
Cement	2	27	61	95	1	13	19	16
Iron and Steel	2	26	52	78	1	14	16	14
Refineries	0	2	6	10	0	1	3	3

Note: \* Additional investments excluding transport and storage investments.  
Source: IEA analysis.

CO<sub>2</sub> captured in 2050 under the BLUE Map Scenario (%)



China	Cumulative number of projects				Additional investments* (USD billion)			
	2020	2030	2040	2050	2010-20	2021-30	2031-40	2041-50
High-purity sources	3	22	35	60	1	3	3	3
Biomass conversion	1	9	42	95	1	5	13	20
Cement	1	18	44	71	1	9	14	13
Iron and Steel	4	53	111	169	2	28	36	31
Refineries	0	2	8	14	0	1	3	3

Other developing Asia	Cumulative number of projects				Additional investments* (USD billion)			
	2020	2030	2040	2050	2010-20	2021-30	2031-40	2041-50
High-purity sources	1	7	13	18	1	2	2	1
Biomass conversion	0	4	18	48	0	3	6	12
Cement	2	27	56	86	1	17	19	20
Iron and Steel	1	2	4	6	1	1	1	1
Refineries	0	2	6	10	0	1	3	3

OECD North America	Cumulative number of projects				Additional investments* (USD billion)			
	2020	2030	2040	2050	2010-20	2021-30	2031-40	2041-50
High-purity sources	12	18	30	50	3	2	3	3
Biomass conversion	2	9	53	91	1	4	16	14
Cement	1	11	22	35	1	5	7	7
Iron and Steel	1	11	18	25	1	6	4	4
Refineries	1	7	11	15	1	4	3	3

OECD Europe	Cumulative number of projects				Additional investments* (USD billion)			
	2020	2030	2040	2050	2010-20	2021-30	2031-40	2041-50
High-purity sources	3	5	10	25	1	1	1	2
Biomass conversion	0	3	17	33	0	2	4	5
Cement	1	12	25	38	1	7	8	8
Iron and Steel	2	22	27	32	1	13	3	3
Refineries	1	5	7	9	1	3	1	1

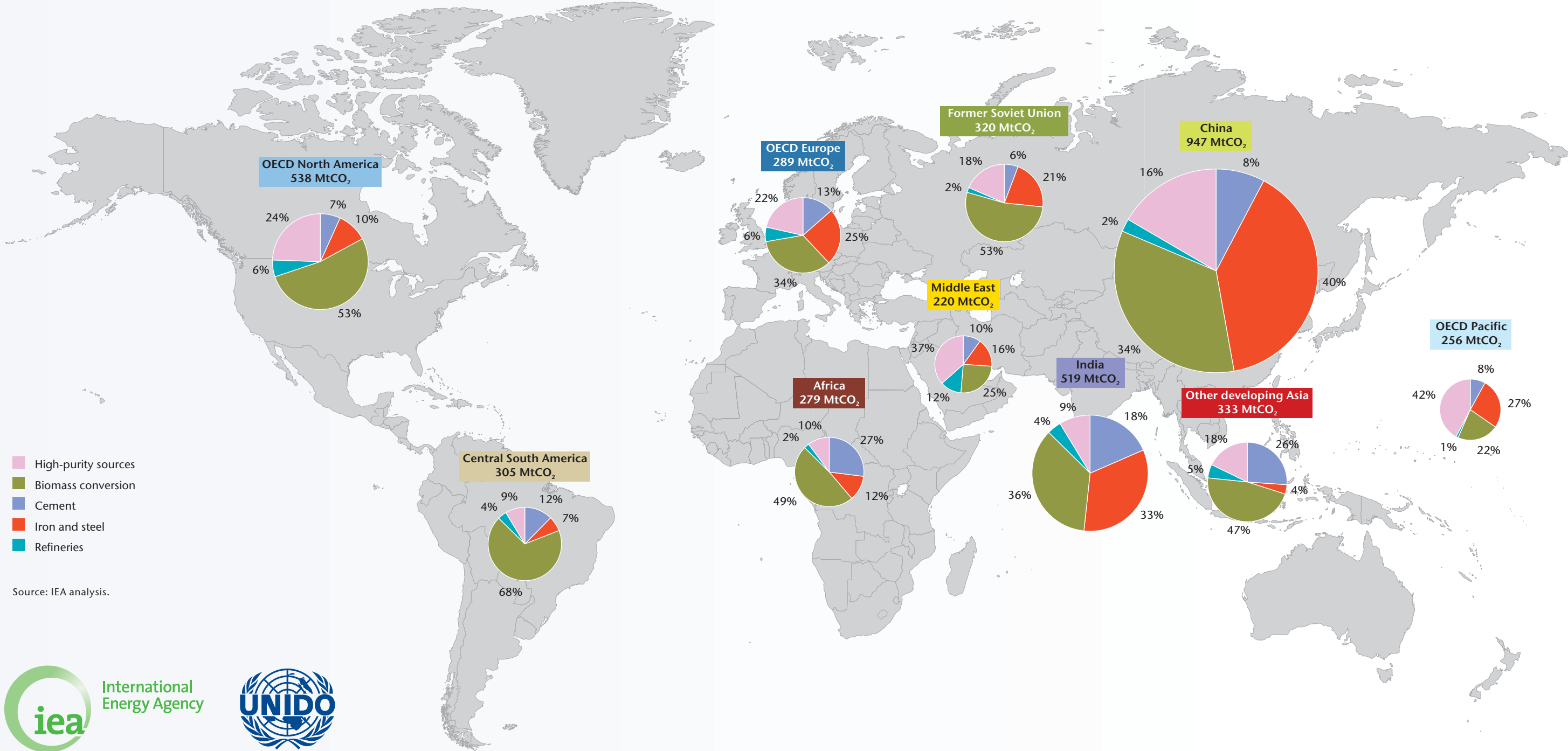
OECD Pacific	Cumulative number of projects				Additional investments* (USD billion)			
	2020	2030	2040	2050	2010-20	2021-30	2031-40	2041-50
High-purity sources	4	10	20	29	1	2	3	2
Biomass conversion	0	1	8	15	0	1	3	3
Cement	0	7	14	19	0	5	5	4
Iron and Steel	1	22	27	31	1	16	4	4
Refineries	0	2	2	2	0	1	1	1

Note: \* Additional investments excluding transport and storage investments.  
Source: IEA analysis.



Carbon Capture and Storage in Industrial Applications

Regional CO<sub>2</sub> captured in 2050 by sector



This map is for illustrative purposes and is without prejudice to the status of or sovereignty over any territory covered by this map.