UK CENTRE FOR GREENING FINANCE & INVESTMENT

UK Research and Innovation

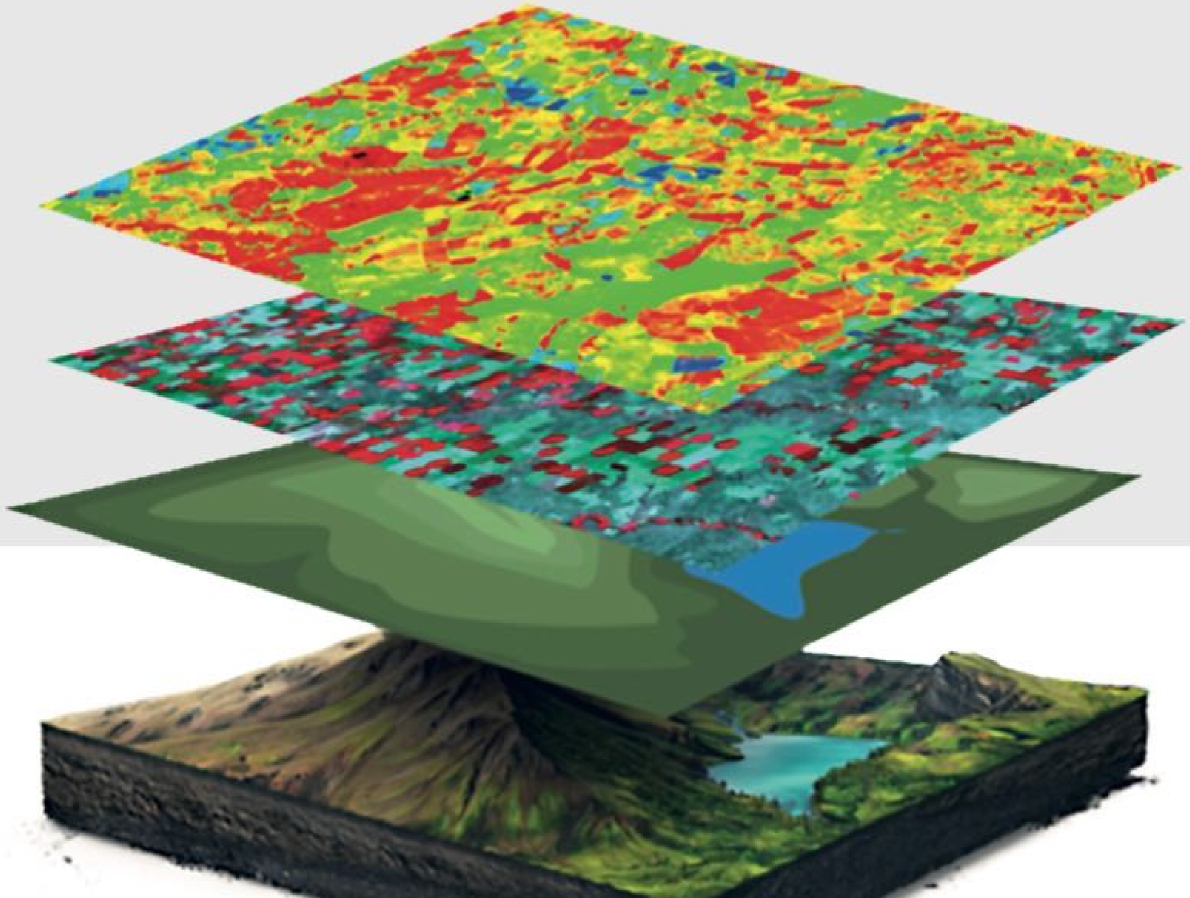
CGFI

The UK Centre for Greening Finance and Investment (CGFI) is a national centre established to accelerate the adoption and use of climate and environmental data and analytics by financial institutions internationally. It will unlock opportunities for the UK to lead in greening finance and financing green.

ULTIMATE VISION

Financial institiutions able to access and use climate and environmental data and analytics for:

- Any point on earth
- Past, present, and future
- Every major sector
- Material climate and environmental factors



SUCCESS WILL MEAN

- Enhanced solvency of financial institutions
- Reallocation of capital towards green
- Resilient global financial system

SPATIAL FINANCE INITIATIVE

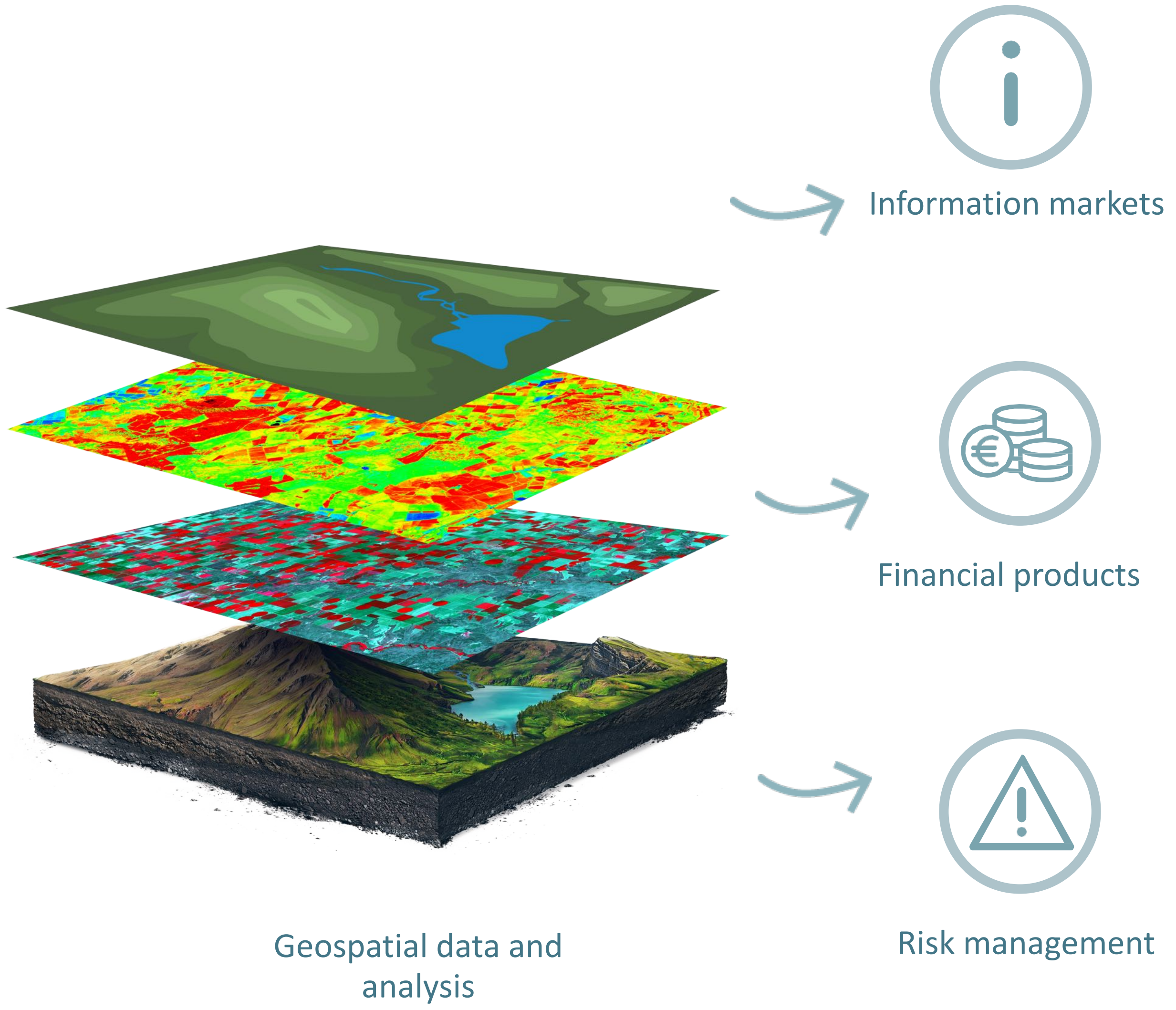
Space technology and data science to transform decision-making in finance

Spatial Finance

‘Spatial finance’ is the integration of geospatial data and analysis into financial theory and practice.

Increasing availability and quality of spatial information will profoundly change how climate and environmental **risks, opportunities, and impacts** are measured and managed by financial institutions.

In tandem: reliable, consistent **asset-level datasets** tying physical & natural assets to ownership structures can deliver a step change in **accountability and transparency**



Commodification of space is generating huge amount of Earth Observation (EO) data

Key enablers include:

- Satellite hardware miniaturization, cost reduction and technical improvement
- Reusable rocket launchers

Where we are now:

- **Free** medium resolution (>10m) data available globally
- **Commercial** very high resolution (~0.3m) of targeted sites available on a daily basis
- Multispectral sensors For insights beyond the visible spectrum (e.g. infrared – methane leaks from gas infrastructure)

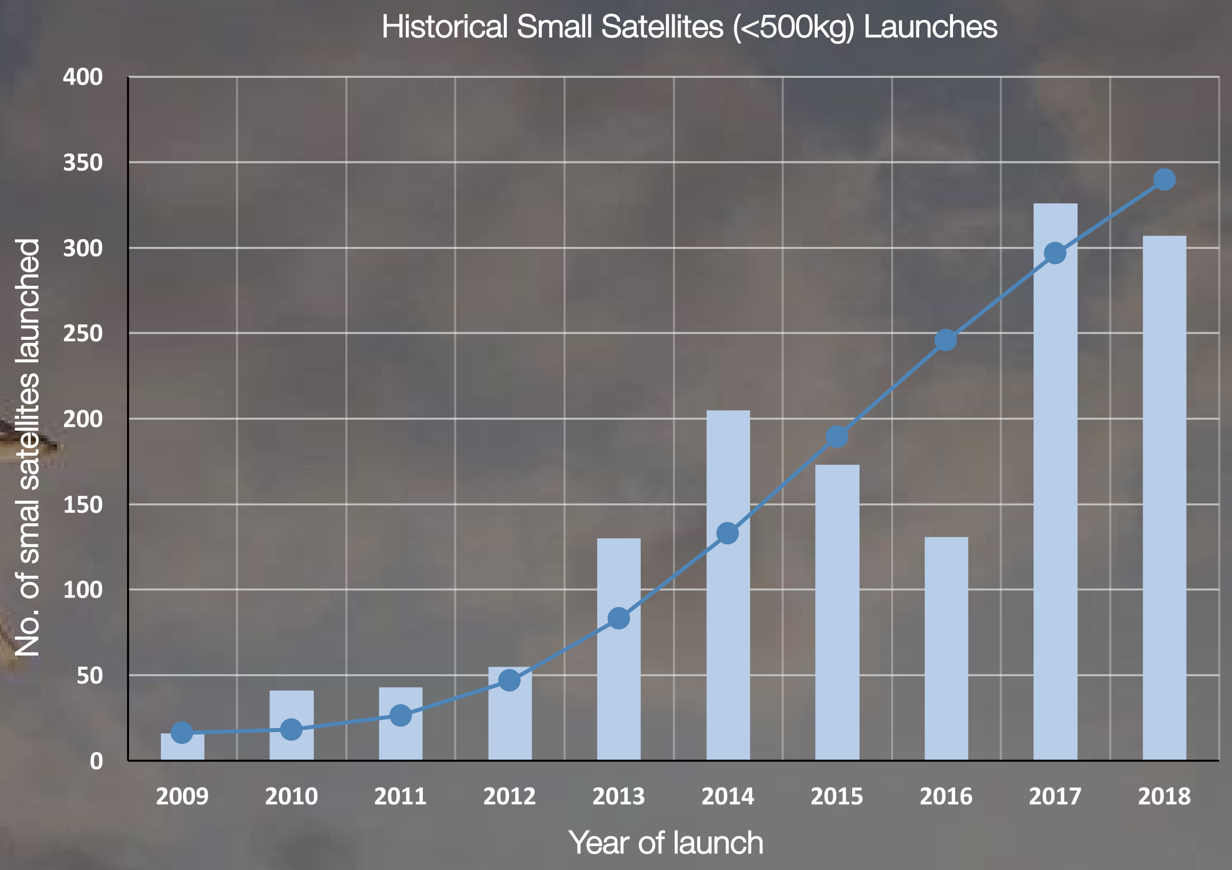
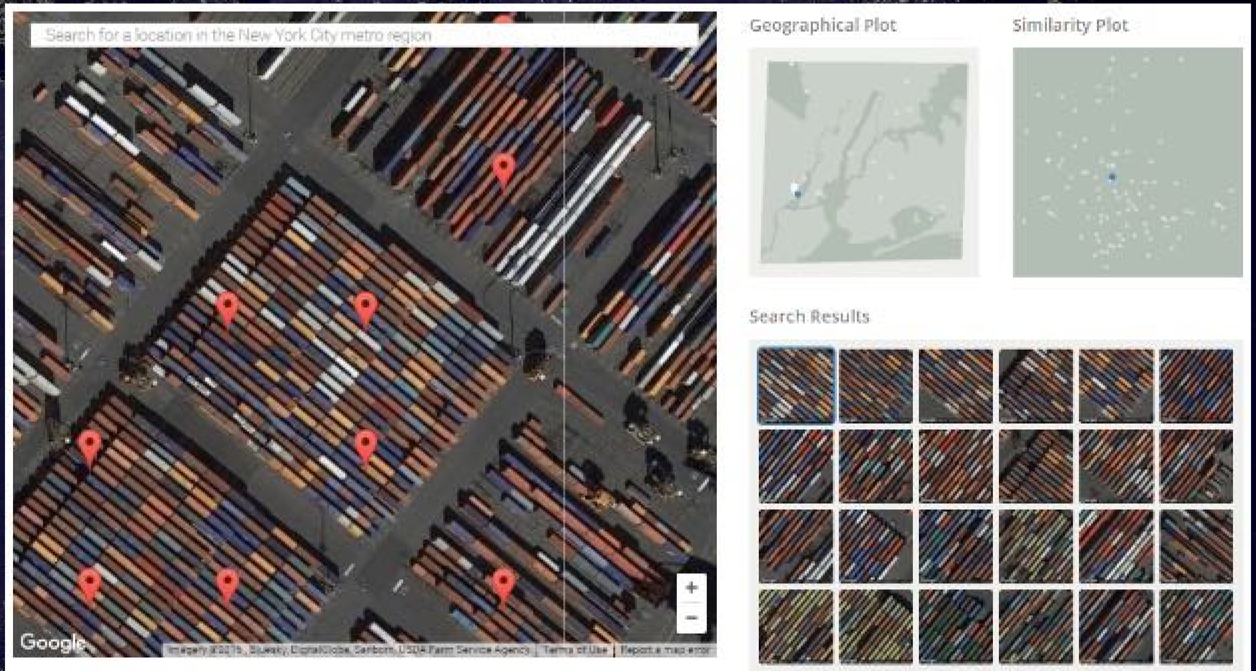


Image credits: SPACE EXPLORATION TECHNOLOGIES CORP

Artificial intelligence is helping to process and interpret this data at the asset level

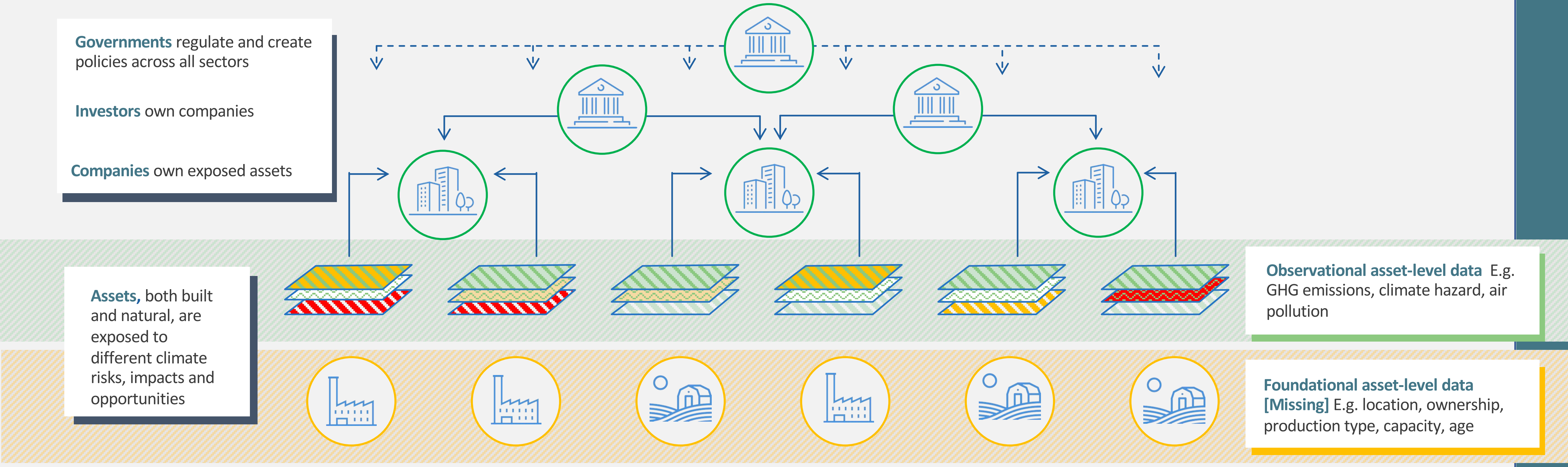
Advances in AI and machine learning allow for automated analysis of large, complex EO datasets and matching with other data sources:

- Assets identified by algorithmic collection of features (e.g. edges, shapes, colours)
- Convolutional Neural Networks learn sophisticated features of the input image to identify similar objects and features
- Applying computer vision techniques to global remote sensing datasets enables localisation of assets & asset types



Asset-level data: an essential enabler for climate action in finance

Bottom-up, asset-level analysis is essential to accurately assess physical and transition climate risks, opportunities and impacts across all sectors of the economy.



Barriers to asset-level data creation and adoption

A **lack of foundational asset-level data** remains the primary barrier to.

Availability, Completeness and Cost

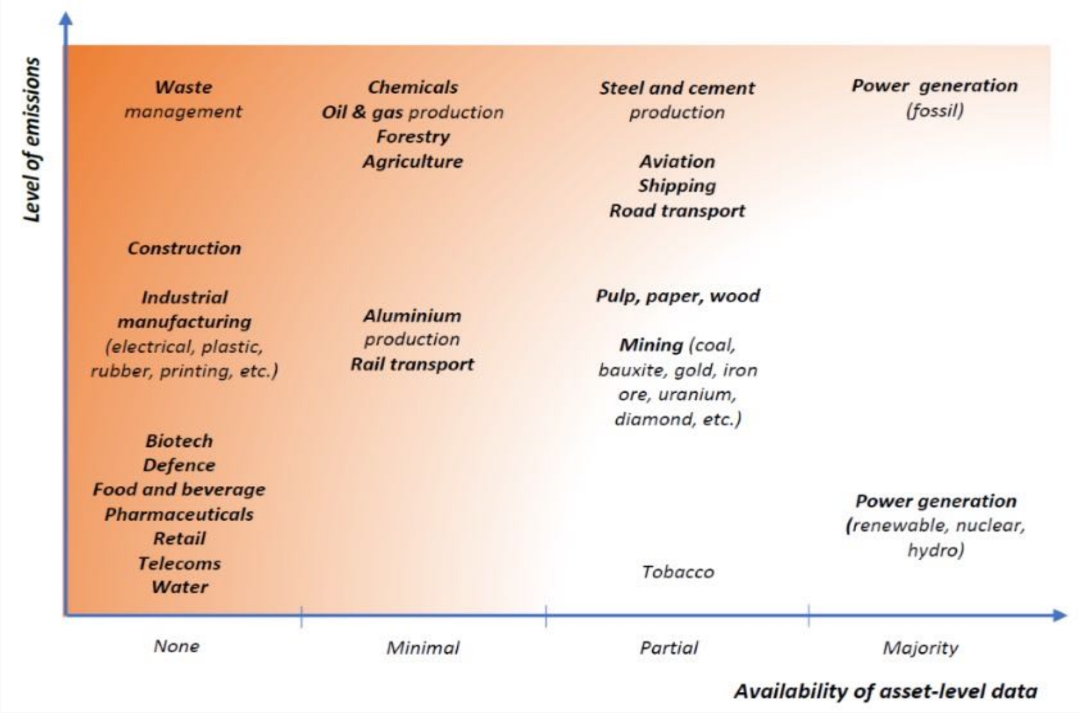
Most global asset-level datasets for emissions-intensive industries are incomplete, inaccurate, and/or prohibitively expensive

Transaction Costs

Current data access approaches, using disclosures and bilateral engagement, multiplies both the costs of accessing data, and the costs of providing it

Market Failure

Financial sector climate data efforts and strategies are dispersed and rely on company disclosure, which is too slow a process to drive effective action now



OPEN FOUNDATIONAL ASSET-LEVEL DATASETS AS FUNDAMENTAL ENABLER

Foundational asset-level data tied to ownership

Measures of current and future risks, opportunities and impacts

Accurate climate risk and impact assessments and forward looking scenarios

Foundational asset-level data for both built and natural assets provides information on asset location, type, and ownership, and is a critical enabler for a wide range of climate-related analyses.

Observational asset-level data on climate-related risks (e.g. heat stress, exposure to natural disasters, sea level rise) and impacts (e.g. air pollution, greenhouse gas emissions) can be combined with foundational data to create truly actionable insights.

Open global asset-level datasets will drive an **increasing usage of existing public data initiatives**

- Public satellite data programmes
  (E.g. Copernicus, LandSat)
- Public climate data and models
  (E.g. UNFCC, MetOffice, ESA CCI)
- Public environmental data
  (E.g. Defra, Environment Agency, UK Centre for Ecology & Hydrology)

The GeoAsset Project

Enabling the financial sector to respond to climate change requires robust foundational datasets of physical assets– but these do not yet exist across most carbon-emitting sectors.

GeoAsset is a collaborative endeavour to provide **accurate**, **comprehensive**, **comparable** foundational data on physical assets across all major sectors, **tied to financial ownership information**, at low cost and as in as open a format as possible.

Part of the new UK Centre for Greening Finance & Investment. Core partners are Oxford Sustainable Finance Programme, The Alan Turing Institute, and the Satellite Applications Catapult.

CEMENT AND IRON & STEEL

- Cement production and iron & steel production are two of the most emissions intensive industries, accounting for around 5.7% and 7.2% of global CO_2 emissions respectively
- Current asset-level datasets for iron & steel production and cement production are insufficient for undertaking full global sectoral risk and impact assessment
- These datasets often do not provide exact locations for assets, which is required for physical risk assessments and frequently do not include important data fields, such as capacity
- Current asset-level datasets are infrequently updated, typically only amended every 1 to 2 years

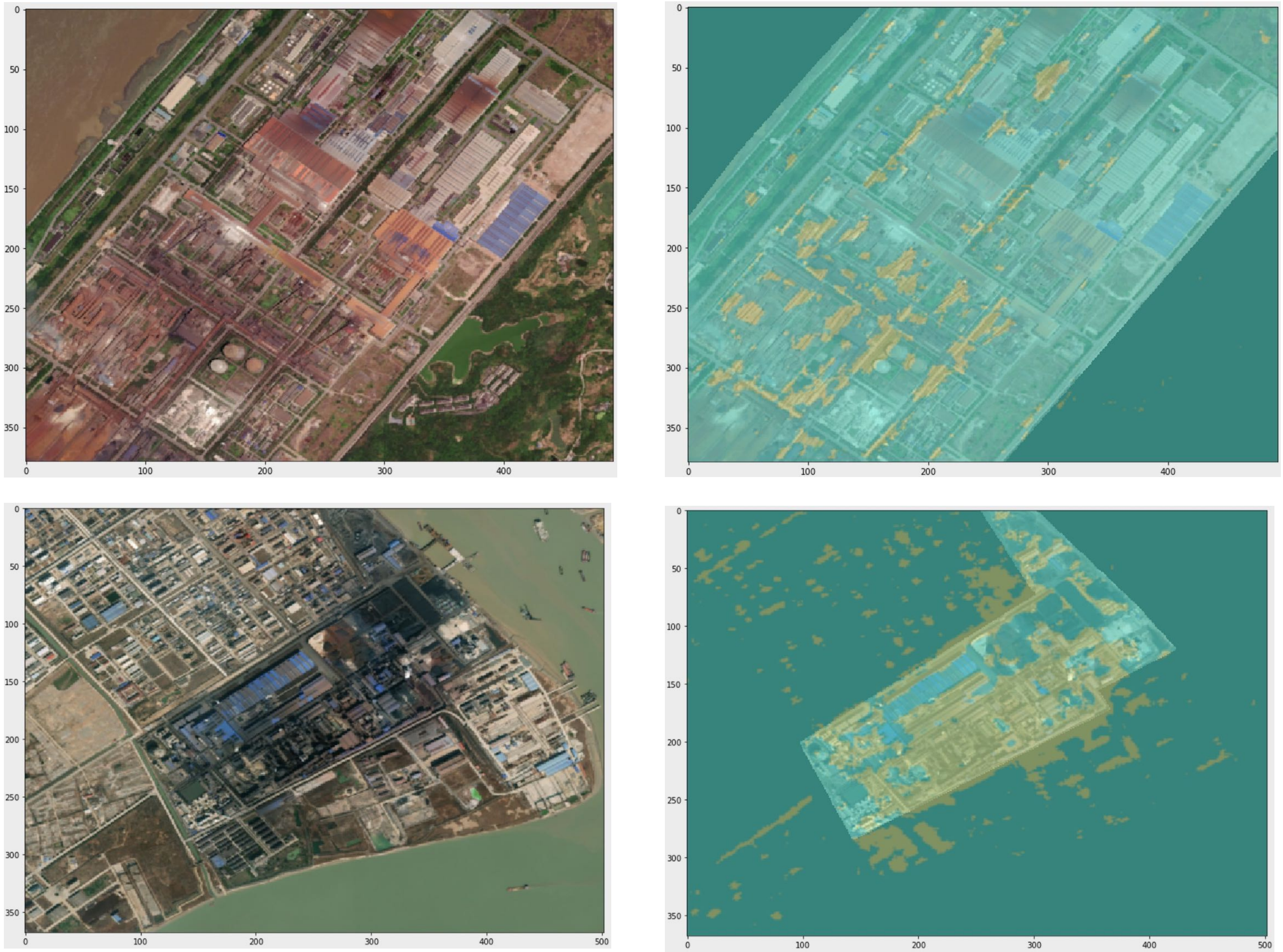
CEMENT AND IRON & STEEL

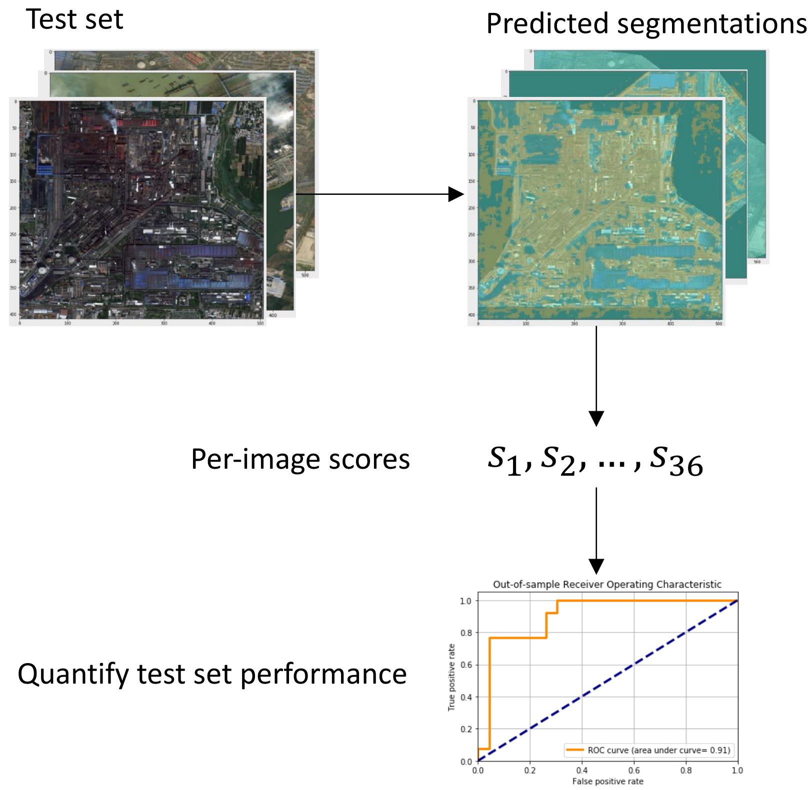
- Create an improved asset-level dataset that will be available open source

- Characteristics
  - Exact location (coordinates)
  - Ownership details (direct and ultimate owner – unique identifiers and links to ticker/exchange for publicly traded companies)
  - Production type
  - Capacity
  - Age (kiln/furnace)
  - Utilisation

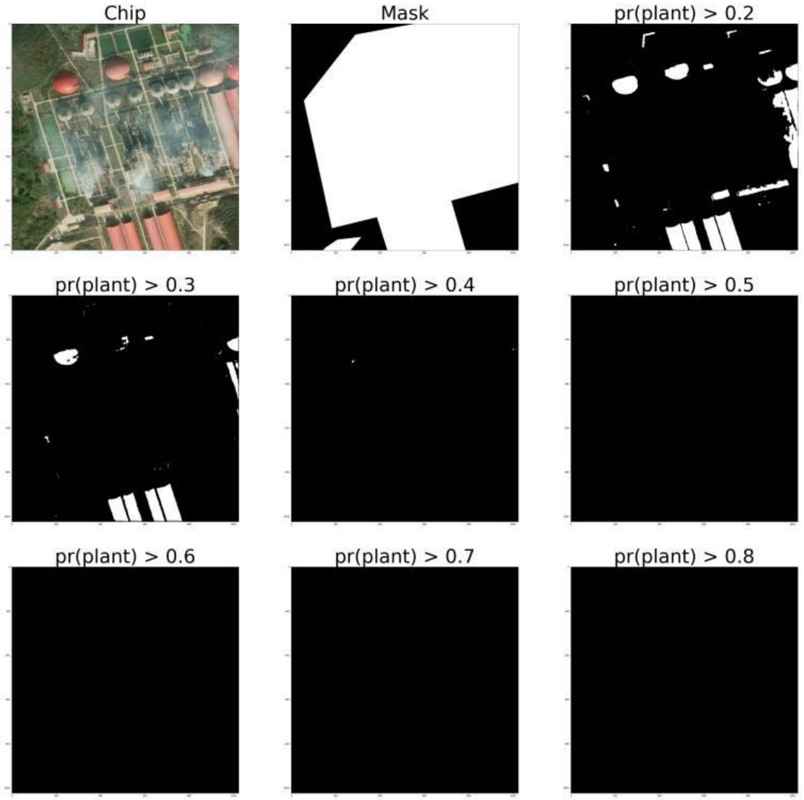
- Methods
  - Machine learning (satellite imagery)
  - Web scraping
  - Crowd sourcing
  - Manual

ASSET IDENTIFICATION





ASSET IDENTIFICATION



ASSET IDENTIFICATION

OWNERSHIP IDENTIFICATION

Jindal Steel Bolivia, Midrex to construct world's largest capacity single Direct Reduction (DR) module

Jindal Steel Bolivia, a subsidiary of Jindal Steel & Power Ltd. (JSPL) of India, will build a2.52 MMTPA natural-gas-based MIDREX® Direct Reduction Plant at EL-Mutun, Puerto Suarez, Bolivia, South America. The new MIDREX® Plant will be the largest single module till date of any commercial direct reduction technology in the world. The contract for this new MIDREX® Plant was signed on March 30, 2011.

The project will be known as the Naveen Ultra Mega Mod DRI and will feature the latest MIDREX® Shaft Furnace innovations and will have the flexibility to produce both quality Hot DRI and Hot Briquetted Iron for use in a new proposed greenfield meltshop. Iron Ore and Iron Pellets will be supplied from Jindal Steel's El Mutun Iron Ore Reserves in Bolivia, where Jindal Bolivia is also installing a Pellet Plant and a Steel Making facility.

Based on the stellar performance of MIDREX® DRI Plants, this new facility at Jindal Steel Bolivia will be capable of producing more than the rated capacity -- making it truly the world's largest single module DR plant. The Naveen Ultra Mega Mod plant can produce up to 2.70 million metric ton per year of DRI depending upon the quality of inputs, operating parameters and skill of the workforce.

This is the third time that JSPL is making use of the MIDREX® Direct Reduction Process technology for its commercial DR production. In 2009, JSPL contracted with Midrex Technologies, Inc. for a 1.8 million ton per year coal gasification-based MXCOL® Direct Reduction Plant in Angul, Orissa, India. The MXCOL plant commercially pairs a 7.15 meter MIDREX® Shaft Furnace with available gasification technology from Lurgi GmbH of Germany, to produce DRI for use in meltshop applications. In 2010, JSPL acquired the former Shadeed MIDREX® HOTLINK® plant in Sohar, Oman. Renamed as Jindal Shadeed Iron & Steel, the plant was commissioned successfully and has been producing HBI since December, 2010.

Facility

Entity Relation

Production capacity

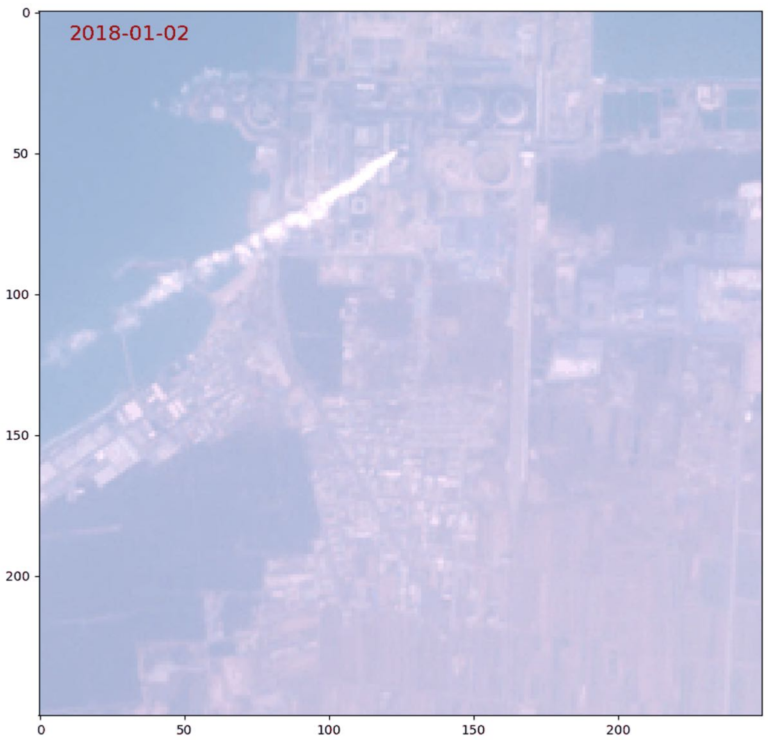
Innovation/Technology

Location

IDENTIFYING CHARACTERISTICS

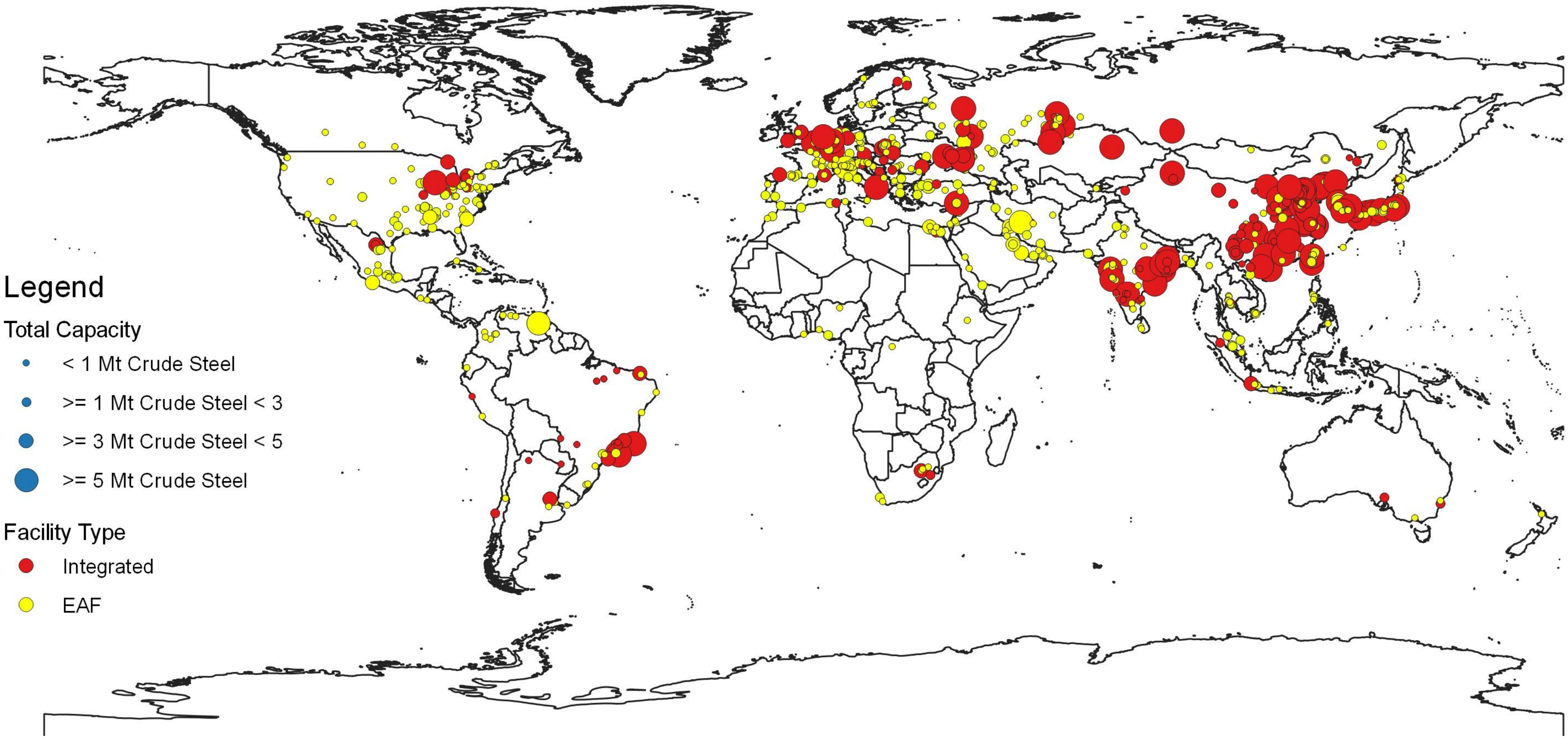
TEMPORAL CHANGES

EMISSIONS MEASUREMENT



Mission	Launch	Orbit	T. Cov.	Spatial Scale	PS Det.	GSD	Measure Technique	Fitting window [nm]	Data Products	DT	RP
GOSAT	2009	ss	3	regional/continental	no	10	passive SWIR	1650, 2060	XCO_2, XCH_4	7.1	1 - 2
GOSAT-2	2018	ss	6	regional/continental	no	10	passive SWIR	1650, 2060, 2300	XCO_2, XCH_4, XCO	4.0	0.4
TROPOMI	2017	ss	1	global	partly	7	passive SWIR	2300	XCH_4, XCO	4.2	< 1
Sentinel-5/UVNS	2021	ss	29	global	no	7.5	passive UV/VNIR/SWIR	290, 400, 1633, 2345	i. a. XO_3, XSO_2, XCO, XCH_4	n.o.	n.o.
OCO-2	2014	ss	16	global	partly	1.29 x 2.25	passive SWIR	1610, 2060	XCO_2	n.o.	< 0.3
TanSat	2016	ss	16	national/global	no	1 x 2	passive SWIR	1610, 2060	XCO_2	n.o.	< 1
GHGSat	2016	ss	14	local	yes	0.05	passive SWIR	1650	XCH_4, XCO	0.24	1
Bluefield	2019 - 21	ss	1	global	yes	0.02	passive SWIR	2300	XCH_4	0.015	0.8
CarbonSat	2020	ss	5 - 10	global	yes	2	passive SWIR	1650	XCH_4, XCO_2	0.8	0.4
MERLIN	2021/22	ss	28	global	yes	0.15	active Lidar	1650	XCH_4	n.o.	1 - 2
GEO-CAPE	2022	gs	< 1	continental	yes	0.375	passive UV/VNIR/SWIR	340, 1100, 1245, 1640, 2135	i.a. XSO_2, XHCHO, XCH_4, XNH_3	4.0	n.o.
GeoFTS	proposed	gs	< 1	continental	no	2.7	passive NIR/SWIR	760, 1600, 2300	XCO_2, XCH_4, XCO, XH_2O	0.61	0.2 - 2
geoCARB	2020 - 23	gs	< 1	continental	no	5 - 10	passive NIR/SWIR	763, 1611, 2065, 2323	XCO_2, XCH_4, XCO	4.0	0.7 - 10
G3E	proposed	gs	< 1	continental	yes	2 x 3	passive NIR/SWIR	760, 1600, 2300	XCO_2, XCH_4, XCO	1.3	0.5 - 10
Sentinel-4/UVN	2019	gs	< 1	national	no	8	passive UV/VNIR	305, 500, 760	XO_3, XNO_2, XSO_2 and XHCHO	n.o.	n.o.
AIRS	2002	ss	0.5	global	no	45	passive TIR	6200, 8200	XO_3, XSO_2, XCO, XCH_4, XCO_2	n.o.	1.5
IASI	2007	ss	0.5	regional/global	no	12	passive TIR	7100, 8300	XO_3, XCH_4, XCO_2, XH_2O	n.o.	1.2
IASI-NG	2021	ss	0.5	regional/global	no	12	passive TIR	7100, 8300	XO_3, XCH_4, XCO_2, XH_2O	n.o.	n.o.
CrIS	2011	ss	0.5	global	no	14	passive TIR	7300, 8000	XCH_4	n.o.	1.5

GLOBAL – CRUDE STEEL PRODUCTION



GLOBAL – CRUDE STEEL PRODUCTION

	No. of Facilities		Crude Steel Production Capacity (Mt)			Estimated CO2 Emissions from Crude Steel Production (Mt)	Emissions/ Capacity
Company Name	Integrated	EAF	Blast Furnace	EAF	Total		
Africa	4	30	10.0	25.1	35.1	25.0	0.7
Asia	30	177	160.0	142.5	302.5	253.0	0.8
China	105	37	480.6	54.0	534.6	865.6	1.6
Eurasia	11	14	33.7	10.9	44.6	65.2	1.5
Europe	34	162	120.2	122.4	242.6	194.6	0.8
India	40	31	64.1	31.2	95.3	232.9	2.4
North America	14	116	48.9	97.1	146.0	92.3	0.6
Oceania	2	3	5.1	1.7	6.7	6.7	1.0
Russia	14	31	51.7	35.6	87.3	98.8	1.1
South America	29	36	44.3	26.5	70.7	100.0	1.4
Global Total	**283**	**637**	**1018.5**	**547.0**	**1565.5**	**1934.1**	

Note: Based on dataset still in development

MOST EMITTING COUNTRIES

Company Name	No. of Facilities			Crude Steel Production Capacity (Mt)			Estimated CO2 Emissions from Crude Steel Production (Mt)
	Integrated	EAF	Other	Blast Furnace	EAF	Total	
China	105	37	155	480.6	54.0	534.6	865.6
India	40	31	71	64.1	31.2	95.3	232.9
Japan	13	46	28	89.0	27.6	116.6	121.6
Russian Federation	14	31	29	51.7	35.6	87.3	98.7
Brazil	23	17	15	38.4	12.2	50.7	83.2
United States	10	84	123	38.8	69.0	107.7	65.9
Ukraine	10	5	16	28.4	4.5	32.9	56.1
Korea, Republic of	3	17	20	45.7	22.5	68.2	53.2
Germany	7	24	51	22.4	19.4	41.9	42.3
Taiwan	2	16	17	16.3	11.2	27.5	23.8
Turkey	3	21	19	12.1	25.1	37.1	21.6
Italy	2	31	32	11.5	25.5	37.0	21.4
France	3	18	23	11.9	7.6	19.4	16.3
Mexico	2	17	18	4.2	19.6	23.8	15.1
Iran	2	11	5	3.2	16.7	19.9	14.6
Other Countries	44	231	346	100.3	165.2	265.5	201.8
Total	**283**	**637**	**968**	**1018.5**	**547.0**	**1565.5**	**1934.1**

Note: Based on dataset still in development

MOST EMITTING STEEL PRODUCERS

Company Name	No. of Facilities			Crude Steel Production Capacity (Mt)			Estimated CO2 Emissions from Crude Steel Production (Mt)
	Integrated	EAF	Other	Blast Furnace	EAF	Total	
China Baowu Steel Group Corp Ltd	11	2	3	88.63	6.94	95.57	166.68
Arcelormittal SA	23	19	49	97.51	30.70	128.21	143.45
Ansteel Group Corp Ltd	7	2	3	35.68	2.32	38.00	72.38
Nippon Steel Corp	8	8	17	52.22	3.29	55.51	64.61
Steel Authority of India Ltd	6	2	0	19.69	0.41	20.10	61.33
Shandong Iron & Steel Group Co Ltd	3	0	0	26.88	0.00	26.88	54.55
Shougang Group Co Ltd	5	1	2	32.74	1.10	33.84	53.98
HBIS Group Co Ltd	6	1	1	28.90	1.80	30.70	53.48
Tata Steel Ltd	6	2	12	25.10	1.48	26.58	49.47
JSW Steel Ltd	4	2	4	10.46	6.83	17.29	42.81
POSCO	3	2	13	36.65	3.25	39.90	41.79
JFE Steel Corp	3	3	6	28.14	3.06	31.20	36.42
Jiangsu Shagang Group Co., Ltd	4	3	0	22.45	12.08	34.53	35.86
Techint Holdings SARL	4	8	9	18.00	7.32	25.32	35.41
Liaoning Provincial Government	2	0	0	16.63	0.00	16.63	31.90
Other Producers	188	582	849	478.83	466.37	945.20	989.95
Total	**283**	**637**	**968**	**1018.50**	**546.95**	**1565.45**	**1934.07**

Note: Based on dataset still in development

COMMITTED EMISSIONS

- Committed emissions are the cumulative carbon emissions an infrastructure asset would emit over its remaining lifetime under normal economic conditions.

- The long lifetimes of infrastructure assets mean that any investments made today will have a considerable effect on the ability to achieve required emission reductions in the future.

- Committed emissions analysis allows us to determine the extent to which current or planned infrastructure assets are compatible with different carbon budgets.

- Committed emissions are a function of the lifetime of the asset, utilisation rates, and carbon intensity.

- Committed emissions analysis also allows us to optimize infrastructure portfolios at country, sector, company and investor levels given various constraints in addition to carbon budgets, such as the marginal cost, capital cost, and the age of assets.

Note: Based on dataset still in development

COMMITTED EMISSIONS

- **Committed Emissions calculation:**
  - $CommittedEmissions_i = EmissionsFactor_i \times ActivityFactor_i \times LifetimeFactor_i$
  - *where:*
    - $EmissionsFactor_i$ = *CO2/ton steel|iron*
    - $ActivityFactor_i$ = *ton steel|iron /year*
    - $LifetimeFactor_i$ = *25 years*
- **Emission Factor**: Emissions factors by process type are taken from a combination of:
  - IEA Tracking Clean Energy Progress 2015 (energy and electricity intensities by process)
  - IPCC GHG Methodologies—average CO2 emissions factors
  - IEA CO2 emissions from Fossil Fuels (CO2 factors for electricity by country)
  - US EPA Technical Support Document for GHG Reporting; process-related CO2 emissions from reduction.
- **Activity Factor**: (utilisation rate) taken from WorldSteel estimates by region

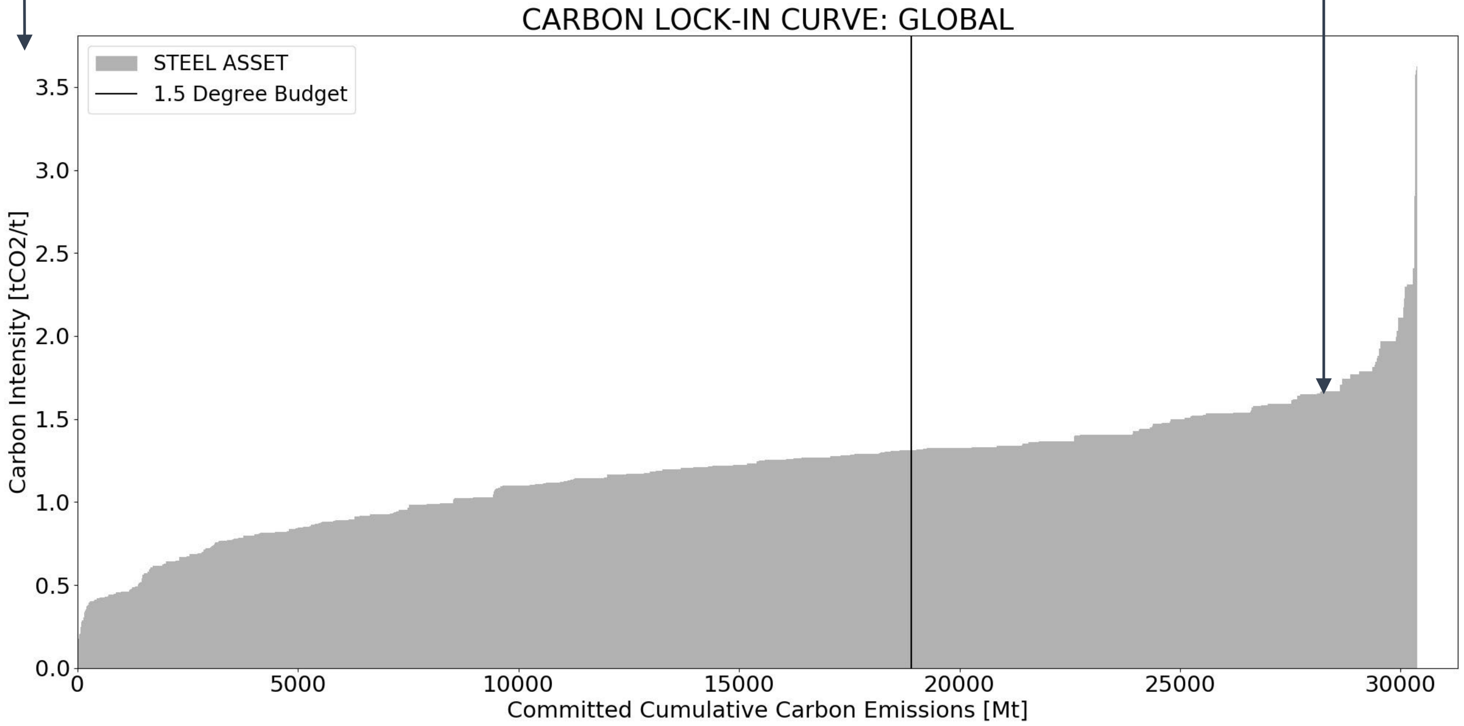
Note: Based on dataset still in development

CARBON LOCK-IN CURVES

- Steel plants on the x-axis are ordered by an ordering metric on the y axis.
- This graph is ordered by carbon intensity which is emissions produced per tonne of steel produced.

- The black vertical line is the carbon budget.
- A carbon budget is the cumulative amount of CO_2 emissions permitted over a period to keep within a certain temperature threshold.
- Steel plants to the right of the black line are incompatible with that carbon budget

- The x-axis shows an estimate of what the cumulative emissions of all steel plants globally are likely to produce over their remaining life.
- Each bar represents a crude steel production asset.
- The width of each line represents the amount of carbon emission associated with each steel production asset.

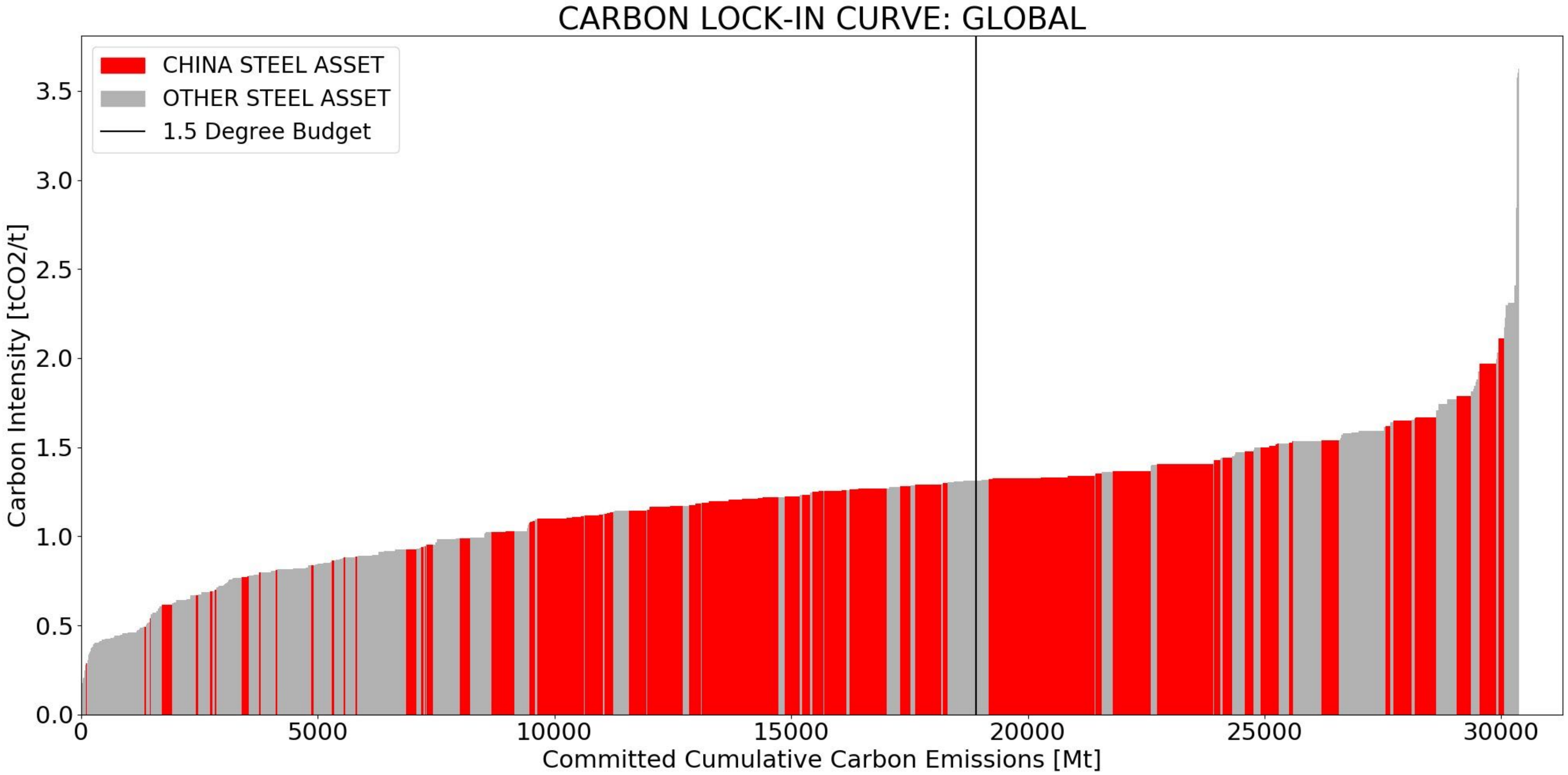


24.8% of GLOBAL crude steel producing assets incompatible SR 1.5ºC
18.6% of GLOBAL crude steel capacity incompatible SR 1.5ºC

- SR 1.5°C is the IPCC's latest estimate of a carbon budget that corresponds to 1.5°C with a 66% probability.

Note: Based on dataset still in development

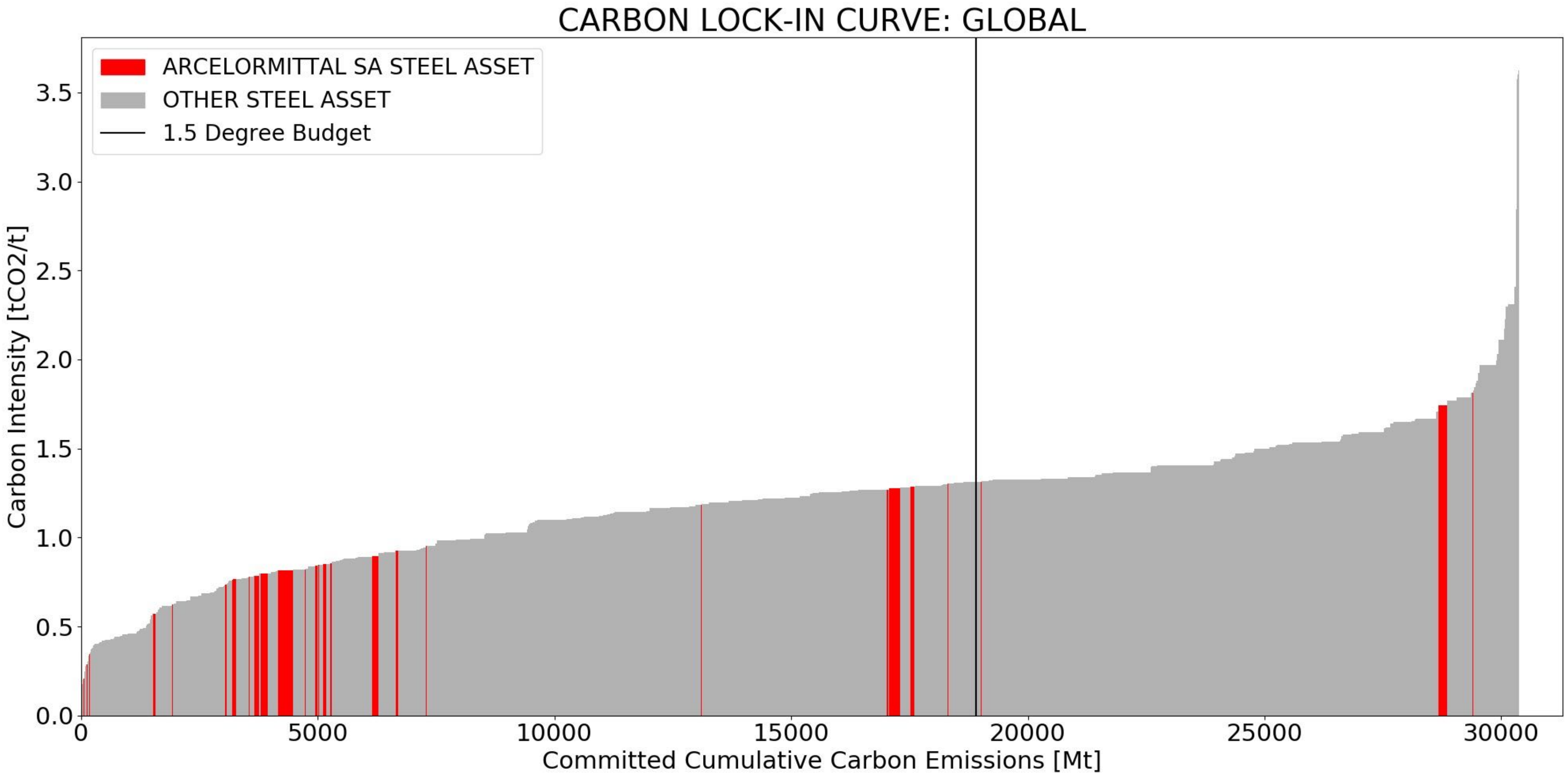
CARBON LOCK-IN CURVES



34.6% of CHINA crude steel producing assets incompatible SR 1.5°C
29.7% of CHINA crude steel capacity incompatible SR 1.5°C

Note: Based on dataset still in development

CARBON LOCK-IN CURVES



22.2% of GLOBAL crude steel producing assets incompatible SR 1.5°C
8.7% of GLOBAL crude steel capacity incompatible SR 1.5°C

Note: Based on dataset still in development

LEAST ALIGNED COUNTRIES

Country	No. of Facilities			Capacity			Total CO2 Emissions (Mt/yr)	Total Committed Emissions (Mt)
	>1.5 Budget	Total		>1.5 Budget	Total			
India	70	102	68.6%	81.12	97.80	82.9%	232.92	3515.63
South Africa	8	13	61.5%	8.02	11.97	67.1%	11.05	109.53
Iran	7	13	53.8%	13.20	19.88	66.4%	14.56	166.45
Indonesia	5	17	29.4%	6.43	11.57	55.6%	10.90	187.08
Taiwan	1	18	5.6%	10.30	27.53	37.4%	23.83	420.35
China	63	182	34.6%	159.04	534.64	29.7%	865.65	17075.03
Egypt	3	15	20.0%	2.15	13.03	16.5%	7.98	122.73
Brazil	14	45	31.1%	3.39	50.67	6.7%	83.16	1002.74
Japan	4	62	6.5%	0.30	116.62	0.3%	121.65	1227.56
Other Countries	97	629	15.4%	10.30	697.39	1.5%	562.38	7458.69

Note: Based on dataset still in development

LEAST ALIGNED STEEL PRODUCERS

Company Name	No. of Facilities >1.5 Budget	No. of Facilities Total		Capacity >1.5 Budget	Capacity Total		Total CO2 Emissions (Mt/yr)	Total Committed Emissions (Mt)
Steel Authority of India Ltd	6	8	75.0%	22.29	22.60	98.7%	61.33	432.15
JSW Steel Ltd	4	6	66.7%	15.88	17.29	91.9%	42.81	895.56
Ansteel Group Corp Ltd	4	9	44.4%	26.49	38.00	69.7%	72.38	1371.39
Liaoning Provincial Government	1	2	50.0%	9.70	16.63	58.3%	31.90	865.70
Tata Steel Ltd	4	9	44.4%	13.40	26.58	50.4%	49.47	961.50
Jindal Steel And Power Ltd	3	4	75.0%	5.96	11.96	49.8%	19.00	318.12
HBIS Group Co Ltd	2	7	28.6%	12.50	30.70	40.7%	53.48	1114.93
China Baowu Steel Group Corp Ltd	5	14	35.7%	37.63	95.57	39.4%	166.68	2926.06
Shougang Group Co Ltd	2	6	33.3%	12.84	33.84	37.9%	53.98	879.07
Jiangsu Shagang Group Co., Ltd	1	7	14.3%	13.00	34.53	37.6%	35.86	522.27
Shandong Iron & Steel Group Co Ltd	2	3	66.7%	8.80	26.88	32.7%	54.55	1000.55
Shanxi Provincial Government	1	3	33.3%	3.75	12.35	30.4%	25.49	391.87
Jianlong Group	1	7	14.3%	1.20	12.83	9.4%	16.58	252.53
Arcelormittal SA	12	54	22.2%	11.39	130.21	8.7%	143.45	1826.35
Other Producers	224	957	23.4%	99.42	1071.13	9.3%	1107.12	17527.72

Note: Based on dataset still in development

Use cases in finance and policy: mutual benefits from geospatial analysis

Asset managers

- Differentiate between companies and projects based on risk and impact
- Support active ownership, risk management and high-res stress testing

Asset owners

- Assess asset manger portfolios against investment beliefs

Corporates

- Verify internal data collection
- Peer benchmarking

Regulators

- Assess and manage systemic risks
- Verify and enhance regulation on corporate disclosures

Policymakers

- Track and manage Paris and SDG implementation

Civil society

- Verify company disclosures and track asset financing