



## Supplementary Materials

**Table S1.** Sectoral GHG emissions (kt CO<sub>2</sub> eq.) and direct emissions intensities (ton CO<sub>2</sub> eq. per million 2017 USD). The data are calculated by the authors for all sectoral GHG emissions (kt CO<sub>2</sub> eq.) and direct emissions intensities (ton CO<sub>2</sub> eq. per million 2017 USD).

No	Sectors	Emissions	Intensity
1	Rice	8,447.3	1,675.2
2	Wheat, Barley, and other Grains	57.3	253.5
3	Beans	81.7	152.3
4	Potatoes	200.1	210.8
5	Vegetables	2,521.7	242.2
6	Fruits	955.7	227.8
7	Flower Crops	265.9	513.3
8	Medicinal Crops	204.9	111.5
9	Leaf Tobacco	15.4	218.2
10	Natural Rubber	-	-
11	Seeds	58.3	113.5
12	Other Edible Crops	60.7	106.3
13	Other Non-Edible Crops	3.3	78.1
14	Dairy Farming	4,713.0	2,199.8
15	Domestic Cow	1,741.3	415.3
16	Pig	1,769.0	291.2
17	Poultry	759.5	152.3
18	Other Livestock	215.7	340.5
19	Forest Management	132.0	98.9
20	Hardwood	29.2	64.6
21	Edible Forestry Products	51.6	52.9
22	Other Forest Products	57.1	316.8
23	Fishery	3,674.5	788.1
24	Marine Aquaculture	307.6	103.5
25	Agriculture, forestry, and fishing-related services	214.1	232.5
26	Anthracite Coal	205.1	809.5
27	Bituminous Coal	-	-
28	Crude Oil	0.2	20.2
29	Natural Gas (LNG)	2.7	20.9
30	Iron Ore	2.1	68.6
31	Other Nonferrous Metal Ore	3.8	139.1
32	Aggregate and Stone	234.2	98.5
33	Limestone	4,285.3	3,815.6
34	Other Nonmetallic Minerals	32.0	131.6
35	Slaughter Meat	10.4	0.9
36	Poultry Meat	33.9	8.3
37	Processed Meat	64.4	18.5
38	Dairy Products	155.4	22.5
39	Processed Marine Products	108.4	22.3
40	Marine Animal Storage	45.9	9.5
41	Milled Grains	16.0	2.6
42	Milling	9.6	5.0
43	Raw Sugar	-	-
44	Refined Sugar	8.9	10.7
45	Starch and Sugar	40.2	32.4

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46	Rice Cake, Bread, and Snacks	197.5	27.6
47	Noodles	88.8	32.7
48	Seasoning and other Foods	106.1	17.2
49	Milk Fat	115.1	44.2
50	Processed Fruit and Vegetable Products	104.3	22.6
51	Coffee and Tea	80.3	31.8
52	Ginseng and Health Supplements Groceries	61.1	18.9
53	Other Groceries	287.2	38.3
54	Livestock feeds	200.1	22.0
55	Alcoholic Beverage	58.2	149.5
56	Soju	37.0	12.0
57	Beer	102.8	27.0
58	Other Alcoholic Beverage	21.3	23.7
59	Non-alcoholic beverages and ices	253.6	41.9
60	Tobacco products	72.0	7.8
61	Natural and Chemical Fiber Yarn	60.7	31.5
62	Other Fiber Yarn	14.5	14.0
63	Natural and Chemical Fiber Fabrics	169.7	32.6
64	Other Fiber Fabrics	43.9	45.8
65	Weaving Fabrics	49.2	32.6
66	Manufacturing services of fiber bleaching and dyeing	173.0	72.6
67	Fabric Products	83.0	15.9
68	Nonwoven Felt Fabrics	65.6	41.4
69	Other Fabric Products	44.7	14.0
70	Sewing Clothing	260.5	9.9
71	Braided Clothing	40.7	11.7
72	Leather Clothing	5.0	16.1
73	Fur Clothing and Fur Products	2.8	8.7
74	Clothing Accessories	29.8	17.3
75	Leather	14.7	14.1
76	Fur	0.7	39.0
77	Bags and Handbags	34.3	11.7
78	Shoes	32.6	9.9
79	Other Leather Products	2.5	13.5
80	Lumber	15.7	8.0
81	Plywood	21.7	23.2
82	Reinforced and Recycled Wood	31.5	31.8
83	Wooden Products for Construction	13.0	8.1
84	Timber Container and Deck board	14.2	8.2
85	Other Wood Products	3.9	8.9
86	Pulp	11.0	81.7
87	Printing Paper	100.9	24.2
88	Other Original Paper and Cardboard	188.1	36.7
89	Corrugated Cardboard and Cardboard Products	134.1	23.5
90	Paper Containers	45.1	17.2
91	Stationery and Office Paper	19.0	21.6
92	Sanitary Paper	68.3	23.4
93	Other Paper Products	76.2	43.4
94	Printing and reproduction of recorded media	155.2	17.2
95	Coke and Coal-Related Products	835.0	3,105.4
96	Briquette	1,863.2	15,302.0
97	Naphtha	634.3	54.3
98	Gasoline	845.1	41.1
99	Jet Oil	1,028.7	82.2
100	Kerosene	250.0	101.4
101	Diesel	1,815.3	46.4

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102	Heavy Crude Oil	494.3	77.9
103	Liquefied Petroleum Gas	308.6	83.8
104	Crude Oil for The Refining Mix	593.9	127.3
105	Lubricating Oil and Grease	2,430.8	1,004.1
106	Other Petroleum Refineries	965.1	264.4
107	Aliphatic Basic Oil	8,670.3	884.9
108	Aromatic Base Oil	12,274.9	668.0
109	Petrochemical Intermediate Products	2,531.7	181.9
110	Other Basic Organic Compounds	1,003.6	109.2
111	Industrial Gas	426.5	99.7
112	Basic Inorganic Compounds	1,495.0	215.9
113	Dyes, Pigments, and Softeners	131.9	64.0
114	Synthetic Resin	5,918.2	166.0
115	Synthetic Rubber	913.6	235.1
116	Chemical fibers	94.9	28.3
117	Medicaments	961.2	52.8
118	Fertilizer and Nitrogen Compounds	680.7	262.9
119	Pesticides	78.4	53.0
120	Paint	377.3	76.4
121	Ink	34.8	42.8
122	Soap, Detergent, and Toothpaste	167.0	47.1
123	Cosmetics	277.1	26.4
124	Adhesive and Gelatin	102.7	45.8
125	Chemicals and Photosensitive Materials for Photographic Use	36.5	51.7
126	Other Chemical Products	1,048.7	82.3
127	Primary plastic products	618.6	43.6
128	Plastic Products for Construction	258.5	43.6
129	Plastic Products for Packaging	435.7	49.1
130	Transport Equipment and Plastic Products for Assembly	843.0	49.3
131	Other Plastic Products	627.4	50.6
132	Tires and tubes	390.1	64.2
133	Rubber Products for Industrial Use	693.7	121.3
134	Other Rubber Products	84.1	100.7
135	Plate Glass and Primary Glass Products	165.7	304.0
136	Glass Products for Electronic Devices	493.0	136.7
137	Glass Products for Industrial Use (exclude. Electronic Devices)	535.9	145.5
138	Other Glass Products	230.6	263.2
139	Household Ceramic Products	129.6	290.0
140	Industrial Ceramics Products	55.7	91.5
141	Fireproof Ceramic Products	293.3	261.5
142	Non-Fireproof Ceramic Products for Construction	175.6	304.6
143	Cement	37,895.7	9,366.5
144	Ready-mix Concrete	667.8	58.6
145	Concrete Products	354.4	71.1
146	Lime and Plaster Products	2,620.6	2,197.3
147	Stone Products	44.3	39.2
148	Abrasive Material	24.0	39.6
149	Ascon and Asphalt Products	276.0	128.9
150	Other Nonmetallic Mineral Products	627.0	348.3
151	Pig Iron	1,143.8	2,677.0
152	Alloy Iron	1,837.9	1,051.8
153	Crude Steel	2,927.6	1,479.7
154	Rebar and Bar Steel	3,405.1	350.1
155	Shaped Steel	516.9	161.7
156	Wire and Rail	7,399.6	2,267.2
157	Heavy Plates (>3mm Thick)	15,227.3	2,766.4

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158	Hot Rolled Steel Plate	34,505.9	3,291.4
159	Steel Wire	1,130.8	309.8
160	Steel Pipe	701.3	63.9
161	Cold rolled steel plates and sheets	28,060.0	2,391.5
162	Surface Treated Steel	17,104.0	1,198.5
163	Other Primary Steel Products	306.3	39.6
164	Copper Smelting, Refining, and Alloying Products	49.3	9.6
165	Aluminum Smelting, Refining, and Alloying Products	122.5	36.0
166	Lead and Zinc Smelting, Refining, and Alloying Products	568.7	103.2
167	Gold and Silver Ingots	120.0	29.5
168	Other Non-Ferrous Metal Smelting, Refining, and Alloying Products	199.0	498.2
169	Primary Copper Products	91.8	13.3
170	Primary Aluminum Products	288.2	40.8
171	Other Primary Non-Ferrous Metal Products	1,392.1	544.3
172	Metal foundries	375.5	66.6
173	Construction Metal Products	647.0	45.7
174	Structural Metal Products	203.3	18.7
175	Metal Tank and Pressure Vessel	55.3	21.9
176	Industrial Boilers and Steam Generator	191.2	76.2
177	Metal Forging and Metallurgy Products	469.8	140.7
178	Pressed metal products	179.6	24.4
179	Metal Treatment	1,017.4	103.4
180	Metal Treatment Processed Products	1,152.5	85.6
181	Household Metal Products	45.9	23.4
182	Metal Products for Attachment	66.8	19.6
183	Tools	64.9	22.6
184	Screw and Wire Products	265.3	35.9
185	Metal Packaging Containers	164.6	53.8
186	Other Metal Products	211.3	26.6
187	Semiconductor (Single Discrete)	574.2	67.7
188	Semiconductor (Integrated Circuit)	6,424.1	68.5
189	LCD Flat Display	312.2	6.1
190	Other Electronic Display Device	216.6	15.8
191	Printed circuit boards	219.0	18.5
192	Capacitor, Resistor, Magnet Coil and Transformer	50.2	12.3
193	Other Electronic Components	43.5	8.0
194	Computers	12.7	7.5
195	Computer Storage Devices	39.6	6.7
196	Computer Peripheral Devices	19.4	8.0
197	Cable Communication Equipment	19.4	6.7
198	Mobile Phones	136.2	4.0
199	Other Wireless Communication Equipment and Broadcasting Equipment	74.0	6.7
200	TV	58.4	13.1
201	Video Equipment	25.0	12.3
202	Audio and Acoustic-Apparatus	29.5	10.6
203	Medical Devices	63.1	8.1
204	Measurement and Analysis Devices	127.5	11.1
205	Self-Adjustment and Control Devices	51.2	12.3
206	Cameras and Projectors	26.3	12.1
207	Other Optical Instruments	31.8	7.3
208	Clocks	1.0	8.6
209	Motors and generators	202.6	24.8
210	Electric Transformers	35.0	14.8
211	Electrical Conversion Equipment	53.6	16.3
212	Electrical Network Switching and Connection Equipment	156.0	15.5
213	Switchboard and Electrical Automatism Control Panel	113.0	14.6

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214	Batteries	239.7	22.0
215	Electric wires and cables	309.6	28.7
216	Household Refrigerators and Freezers	46.0	14.7
217	Household Electrical Equipment (Kitchen and Heating)	50.4	18.3
218	Other Household Electrical Equipment	157.7	24.5
219	Bulbs and Lamps	96.9	66.1
220	Illumination Systems	458.6	60.3
221	Other Electrical Equipment	224.9	17.3
222	Engines and turbines	89.6	20.2
223	Pumps and compressors	220.2	27.0
224	Valves	155.2	33.3
225	Bearing, Gear, and Power Train Systems	128.1	27.8
226	Lifting and handling equipment	177.4	18.8
227	Air Conditioning and Refrigeration Equipment	248.2	20.9
228	Air and Liquid Filters	65.0	9.7
229	Office Equipment	7.5	5.4
230	Other General-Purpose Machines	111.6	12.7
231	Agricultural Machines	31.7	10.7
232	Construction and Mineral Processing Machines	77.3	8.5
233	Metalworking machinery	137.8	20.6
234	Metal molds and industrial patterns	130.5	11.5
235	Semiconductor Manufacturing Machines	168.7	10.6
236	Display Manufacturing Machines	106.6	12.1
237	Food and Beverage Processing Machines	24.7	27.5
238	Fiber and Clothes Processing Machines	23.1	25.5
239	Industrial Robots	38.8	14.2
240	Paper and Printing Machines	9.1	12.3
241	Rubber and Plastic Molding Machine	22.6	15.6
242	Other Special Purpose Machines	118.7	17.8
243	Passenger Cars	822.6	11.4
244	Buses	56.6	17.4
245	Trucks	115.6	22.0
246	Special Use Vehicles	75.5	26.0
247	Trailers and Containers	5.7	17.0
248	Motor vehicle engine	316.1	17.6
249	Motor vehicle parts	638.0	9.6
250	Steel Ships	195.8	10.0
251	Other Ships	118.3	12.0
252	Ship Repair and Components	123.5	56.0
253	Railroad vehicles and parts	13.5	7.6
254	Aircraft and parts	64.0	14.1
255	Motorcycles	7.8	74.2
256	Other Transportation Equipment	6.4	5.4
257	Wood Furniture	70.5	9.5
258	Metal Furniture	30.3	14.0
259	Other Furniture	24.8	13.9
260	Toy and Entertainment Products	8.7	12.6
261	Exercise and Sporting Products	23.7	20.2
262	Musical Instrument	3.3	15.7
263	Stationery Products	9.7	14.1
264	Precious metals and jewelry	20.8	15.7
265	Assembly Models and Decorative Items	144.4	43.9
266	Other Manufacturing Products	143.9	75.8
267	Manufacturing Equipment Repair services	1,259.2	28.2
268	Industrial Machinery and Equipment Repair	56.7	5.5
269	Hydro power	142.8	185.0

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270	Thermal Power	258,848.1	6,573.4
271	Nuclear Power	1,639.0	164.0
272	Private Power Station	521.6	251.3
273	Renewable Energy	526.6	200.1
274	Gas and distributions of gaseous fuel through mains	1,756.8	81.6
275	Steam, chilled or hot water, and air conditioning supply	602.2	117.0
276	Water supply	136.2	35.9
277	Sewage and wastewater treatment services (Public)	1,435.4	635.4
278	Sewage and wastewater treatment services (Industry)	767.3	611.1
279	Waste collection and disposal (Public)	6.8	2,464.6
280	Waste collection and disposal (Industry)	16,115.4	2,283.6
281	Materials recycling services	41.4	7.5
282	Constructions of residential buildings	1,362.8	15.7
283	Constructions of non-residential buildings	1,340.3	16.2
284	Repairs of buildings	178.3	15.3
285	Road Facilities	1,019.1	76.4
286	Railway Facilities	205.1	37.7
287	Port Facilities	123.2	88.1
288	River Erosion Control	149.8	86.8
289	Water and Sewerage Facilities	116.7	33.6
290	Agriculture, Forestry and Fisheries Civil Engineering	127.5	99.6
291	Urban Civil Engineering	718.2	81.1
292	Environmental Cleanup Facilities	12.7	6.7
293	Communication Facilities	79.1	36.7
294	Power Facilities	131.8	14.0
295	Industrial Facilities	38.1	4.1
296	Other constructions	178.4	55.3
297	Wholesale and retail trade and commodity brokerage services	9,450.5	39.1
298	Railway transport services	681.5	109.9
299	Road Passenger Transportation	17,749.8	1,063.9
300	Road Haulage Transportation	13,616.3	501.9
301	Coastal and Inland Water Transportation	2,109.5	1,037.6
302	Marine Transportation	9,359.6	603.9
303	Air transport services	14,815.1	841.4
304	Land Supporting services for transportation	186.4	22.2
305	Water Supporting services for transportation	66.5	74.5
306	Air Supporting services for transportation	77.0	37.2
307	Cargo handling services	260.6	71.1
308	Warehousing and storage services	251.1	22.4
309	Other services incidental to transportation	136.1	16.4
310	Public postal services	130.4	51.1
311	Transport services for parcels	1,506.5	320.6
312	General Restaurants	2,560.4	30.2
313	Other Restaurants	523.1	24.2
314	Bars	112.2	10.0
315	Non-Alcoholic Beverage Shop	49.5	5.9
316	Accommodation	229.2	21.9
317	Cable Communication Service	43.5	4.1
318	Wireless and Satellite Communication Service	148.0	6.2
319	Telecommunication Resale and Brokerage Service	32.7	16.3
320	Other Telecommunication Service	71.3	21.0
321	Ground Wave Broadcasting Service	12.9	4.3
322	Cable, Satellite, and other Broadcasting Service	22.0	3.1
323	Information services	91.5	9.1
324	Game Software Publishing	37.3	4.0
325	Computer software development and distribution	118.2	3.5

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326	Other IT services	35.1	2.6
327	Newspaper and publishing	56.1	8.0
328	Video and audio production and distribution	90.9	16.4
329	Movie Screening	80.6	42.7
330	The central bank and depository institutions	213.5	4.2
331	Financial Investment Institutions	29.5	5.7
332	Other Financial Intermediaries	152.1	5.7
333	Life Insurance services	129.7	6.0
334	Pension Fund services	1.1	1.6
335	Non-Life Insurance services	91.5	4.4
336	Services auxiliary to financial and insurance services	78.8	3.1
337	Rental or leasing services of residential property	220.3	2.2
338	Rental or leasing services of non-residential property	797.2	22.2
339	real estate development and Supply	135.0	16.2
340	Real estate-related services	655.6	13.6
341	Research and development services (Public)	138.1	17.0
342	Research and development services (Nonprofit)	63.8	11.2
343	Research and development services (Industry)	18.1	24.5
344	In-house Research and development services	378.3	6.8
345	Judicial Affairs and Accounting Service	111.8	8.5
346	Marketing Research and Management Support Service	4,365.5	91.8
347	Advertising	34.1	2.9
348	Architectural-related services	269.9	17.0
349	Engineering Related Service	94.3	11.3
350	Science and Technology Service	118.0	15.4
351	Other Professional Services	287.8	41.9
352	Leasing or rental services concerning equipment, goods, and intellectual property rights	314.6	13.6
353	Landscaping, maintenance services for business facilities	149.2	11.8
354	Human resource provision and employment placement agencies	101.4	5.7
355	Other business support services	261.1	11.4
356	Public administration and defense (Central Government)	5,680.0	82.9
357	Public administration and Defense (Local Government)	992.0	18.3
358	Social security insurance services	135.4	35.5
359	Educational Service (Public)	458.4	8.2
360	Educational Service (Nonprofit)	942.4	36.7
361	Educational Service (Industry)	2,224.8	87.1
362	Medical and Health Care Services (Public)	45.8	24.6
363	Medical and Health Care Services (Nonprofit)	1,094.2	29.3
364	Medical and Health Care Services (Industry)	1,569.5	25.1
365	Social care services (Public)	52.0	17.5
366	Social care services (Nonprofit)	2,194.1	116.2
367	Cultural Service (Public)	134.6	44.2
368	Play, Music, and Other Arts	55.4	21.1
369	Other Cultural Services	26.4	16.5
370	Travel Agency and Travel Assistance Service	72.1	14.2
371	Sports Service	565.5	43.9
372	Entertainment Service	376.6	26.4
373	Industry and Professional Organization	54.7	15.9
374	Other Social Organizations	223.0	23.9
375	Car Repair Service	233.3	15.1
376	Electronic Communication Device and Home Appliance Repair Service	75.0	13.7
377	Beauty Related Service	160.4	19.0
378	Landry	39.4	23.4
379	Housekeeping Service	-	-
380	Other Personal Services	220.3	45.8
381	Others	77.6	20.4
382	Residential	53097.0	-