Journal of Global Economic Analysis, Volume 8 (2023), No. 2, pp. 100-133.

GTAP-Power Data Base: Version 11

BY MAKSYM CHEPELIEV[a]

This paper provides an overview of the version 11 of the Global Trade Analysis Project (GTAP) Power Data Base, which covers 141 individual countries, 19 composite regions and 76 sectors, reporting data for five reference years – 2004, 2007, 2011, 2014 and 2017. The newly constructed database builds on the previous efforts, introducing several new features and updates. First, by extending the coverage across reference years, GTAP-Power 11 Data Base uses updated levelized costs of electricity generation estimates. Second, the database updates the shares of transmission and distribution costs across countries. Finally, the newly constructed database includes complementary accounts of greenhouse gases and air pollutants. In an application of the database, changes in greenhouse gas emissions from electricity generation in each country are decomposed into changes in (1) the amount of electricity generated, (2) the mix of technologies, and (3) the emissions intensity of each technology.

JEL codes: C61, D57, D58, L94, Q40.

Keywords: GTAP; GTAP-Power; Computable general equilibrium; Disaggregation.

1. Introduction

Over the past decade, the number of climate policy initiatives implemented by countries around the world has increased dramatically (Nascimento et al., 2022; World Bank, 2023). While in 2012 there were 24 carbon pricing initiatives across various geographical jurisdictions, by 2023 this number has more than tripled reaching 73 cases (World Bank, 2023). In addition, over 100 countries around the world are discussing, have announced or already adopted net zero mitigation targets, substantially increasing the level of their climate mitigation ambitions (Höhne et al., 2021; Hale et al., 2022). Achievement of such stringent climate goals requires a complex quantitative assessment of the alternative mitigation pathways using comprehensive modeling tools, such as integrated assessment and computable general equilibrium models. Such modeling tools, however, are usually data-intensive, especially when energy technology details need to be incorporated into the assessment framework.

[a] Center for Global Trade Analysis, Department of Agricultural Economics, Purdue University, West Lafayette, IN, 47906 (e-mail: mchepeli@purdue.edu).

To facilitate the decision-support process within the global economic modeling community, starting from version 9 a special version of the Global Trade Analysis Project (GTAP) Data Base, which disaggregates the electricity sector, has been constructed (Peters, 2016a; Chepeliev, 2020a). The corresponding database, labeled GTAP-Power, disaggregates the single electricity and heat generation sector present in the standard GTAP Data Base into 11 generation technologies as well as a transmission and distribution activity. This paper builds on the previous versions of the GTAP-Power Data Base and introduces several refinements and updates while enriching the standard GTAP 11 Data Base (Aguiar et al., 2023).

First, the GTAP-Power 11 Data Base introduces updates to the levelized cost of electricity generation (LCOE) for the reported set of countries and regions. The GTAP-Power 9 Data Base relied on the IEA/NEA (2010) for LCOE estimates and used the same generation costs across all reference years (adjusted to inflation) (Peters, 2016a). The GTAP-Power 10 Data Base further added the IEA/NEA (2015) data source for the LCOE estimates and introduced the multi-year cost allocation (Chepeliev, 2020a). In GTAP-Power 11, the most recent IEA/NEA (2020) LCOE estimates are used to capture changes in generation costs over time.

Second, in version 9 of the GTAP-Power Data Base the share of transmission and distribution costs in total electricity costs was assumed to be 21% in all countries and regions, based on the data for the United States (Peters, 2016a). The GTAP-Power 10 Data Base introduced country-specific estimates of the transmission and distribution shares for 80 countries primarily in Europe and Africa (Chepeliev, 2020a). In the GTAP-Power 11 Data Base, we further update the transmission and distribution shares for 36 countries as well as add estimates for six countries (Singapore, New Zealand, Philippines, Japan, Australia and Colombia).

Finally, both the GTAP-Power 9 and GTAP-Power 10 Data Bases reported CO_2 emissions from fossil fuels combustion only. In the GTAP-Power 11 Data Base, we extend the emission coverage by adding non-CO_2 greenhouse gases, such as methane, nitrous oxide and fluorinated gases, as well as CO_2 emissions from industrial processes (e.g. production of cement and fertilizers). In addition, using estimates by Chepeliev (2021), of the GTAP-Power 11 Data Base includes emissions of nine air pollutants.

The rest of the paper is organized as follows. Section 2 provides an overview of the GTAP-Power 11 Data Base. Section 3 discusses updates introduced to the GTAP-Power 11 Data Base. Section 4 uses the developed GTAP-Power 11 Data Base decomposes the drivers behind changing CO_2 emissions from the electricity and heat generation activities over time. Finally, Section 5 concludes.

2. An overview of the GTAP-Power 11 Data Base

Following sectoral classification introduced in the GTAP-Power 9 Data Base (Peters, 2016a), the GTAP-Power 11 Data Base splits a single electricity and heat generation sector of the standard GTAP Data Base (Aguiar et al., 2023) into 11 generation technologies, as well as transmission and distribution (Table 1). Corresponding generation technologies include both base and peak load activities, capturing differences in the production costs depending on the load type. Emission accounts in the GTAP-Power 11 Data Base covers CO_2 emissions from fossil fuel combustion and industrial process, methane, nitrous oxide and 25 types of fluorinated gases (Table 1). In addition, the constructed database reports emissions across nine types of air pollutants (Table 1).

Table 1. Key features of the GTAP-Power 11 Data Base

Feature	Description
Geographical coverage	141 individual countries and 19 composite regions, following standard GTAP 11 Data Base
Temporal coverage	2004, 2007, 2011, 2014 and 2017 reference years
Reference years used to benchmark the LCOE estimates	2010, 2015 and 2020
Country-specific estimates of transmission and distribution shares	The database includes 86 cases with the country-specific estimates of transmission and distribution shares
Representation of the electricity and heat generation activities	Transmission and distribution sector, as well as 11 generation activities: nuclear base load (“NuclearBL”), coal base load (“CoalBL”), gas base load (“GasBL”), gas peak (“GasP”), oil base load (“OilBL”), oil peak (“OilP”), hydro base load (“HydroBL”), hydro peak (“HydroP”), wind base load (“WindBL”), solar peak (“SolarP”), other base load (“OtherBL”)
Emission substances reported in the database	CO_2 emissions from fossil fuel combustion and industrial processes, N_2O, CH_4, F-gases (25 types), nine types of air pollutants – SO_2, NO_x, $PM_{2.5}$, PM_{10}, NMVOC, BC, CO, OC, NH_3.

To disaggregate the electricity and heat sector of the standard GTAP Data Base, the GTAP-Power 11 Data Base relies on the estimates of cost components across four categories – investments/capital, fuel, operation and maintenance costs, and taxes. For each generation technology, data on the cost components is included using the balancing routines discussed in Peters (2016a). Figure 1 provides an overview of the global-average cost shares across power activities represented in the GTAP-Power 11 Data Base. In the case of fossil-fuel generation technologies, fuel represents the largest expenditure category: the corresponding cost shares vary from 42% for the case of coal base load generation to 84% for the case of oil base load generation (Figure 1). In the case of renewable generation activities, the most substantial expenditure category is capital as it represents between 33%-34% (nuclear base load and other base load) and 71% (hydro peak load) of total generation costs. When combined with labor costs, the value-added shares vary from around 9% (for the caser of oil base load) to over 70% (for the cases of hydro base and peak load, wind base load and solar peak).

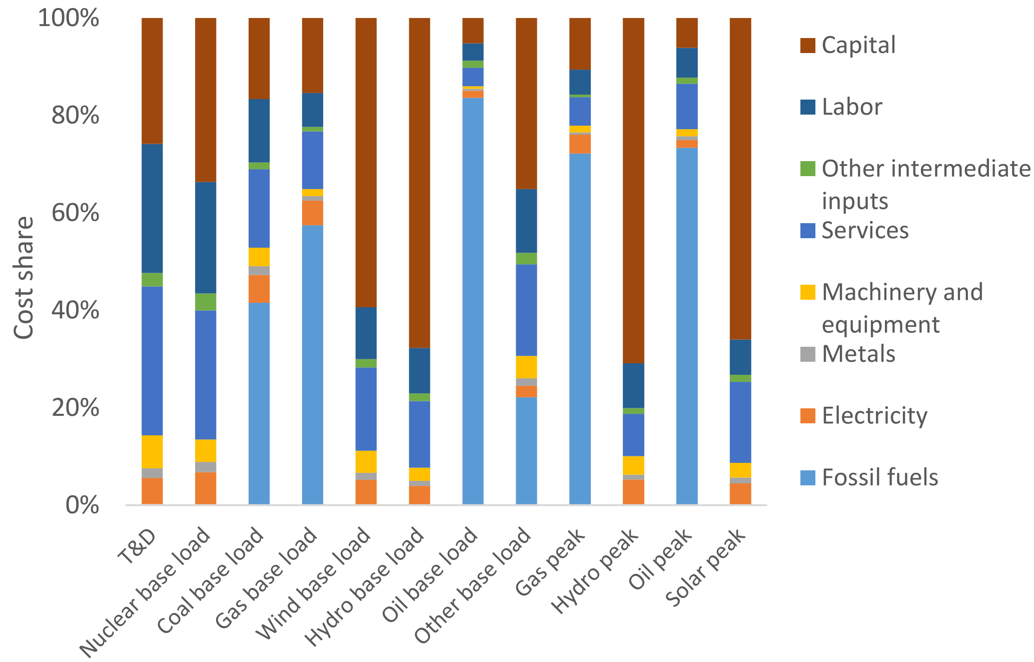

Figure 1. Aggregate global weighted-average cost structures for the transmission and distribution and generation activities in the GTAP-Power 11 Data Base (2017 reference year).

Notes: "Fossil fuels" correspond to fossil fuels commodities in the GTAP-Power Data Base; "Electricity" is an aggregation of 11 generation technologies and transmission and distribution activity; "Metals" category corresponds to the iron and steel, non-ferrous metals and metal products; "Machinery and equipment" category covers "ele", "eeq", "ome", "mvh", "otn" and "omf" sectors of the GTAP-Power Data Base; "Other intermediate inputs" represent all other intermediate commodity inputs excluding categories listed above; "Services" category is an aggregate of all service sectors (excluding electricity) in the GTAP-Power Data Base "Labor" corresponds to an aggregate of five labor types represented in the GTAP-Power Data Base; "Capital" corresponds to the capital in the value-added category of the GTAP-Power Data Base.

The construction process for the GTAP-Power Data Base assures that the this database is nested within the standard GTAP Data Base, so that aggregating the electricity generation and transmission activities within the GTAP-Power Data Base into a single electricity and heat sector will reproduce the standard GTAP Data Base.

3. Revision of the data inputs

3.1. Transmission and distribution costs

The GTAP-Power 9 Data Base assumed that costs shares for electricity transmission and distribution in the total non-tax value of the electricity and heat generation were uniform across all countries and regions represented in the database (Peters, 2016a). The GTAP-Power 10 Data Base introduced country-specific electricity transmission and distribution cost shares to the database covering 80 individual countries (Chepeliev, 2020a). In the current update, we further refine the corresponding shares by expanding the country-specific data coverage and providing more up-to-date shares for selected countries with available data.

In the case of the European Union, to update the electricity transmission and distribution shares for the 2017 reference year, we follow an approach outlined in Chepeliev (2020a) relying on the data from Eurostat (2023). Since Eurostat reports transmission and distribution shares across different consumption bands, for the case of households we assume that a representative band is the group with annual electricity consumption between 2500 KWh and 4999 KWh, while for non-household consumers, we define a band with the 500-1999 MWh annual electricity consumption band is used to represent non-household consumers. As discussed in Chepeliev (2020a), these two bands are the most representative for the respective category of consumers in the European Union. Unlike in the case of the GTAP-Power 10 Data Base, where the second half of each year’s statistics was used to estimate the transmission and distribution shares (due to limited data availability in the Eurostat database), we now rely on the annual average statistics for the 2017 reference year in GTAP-Power 11. This provides a more comprehensive representation of the transmission and distribution costs in the 34 European countries (Appendix A).

Transmission and distribution shares for the case of Ukraine are updated using data for residential consumers from NERC (2018) and for non-residential users from Infocenter (2017). In the case of the United States, the updated electricity transmission and distribution shares are sourced from EIA (2022). In addition, country-specific transmission and distribution shares for six countries are introduced to the GTAP-Power 11 Data Base. For Singapore, New Zealand and the Philippines, corresponding shares represent the 2020 tariff structure and are sourced from Ravago (2023). Shares for Australia are derived from Evans (2021).

In the case of Colombia, the transmission and distribution costs correspond to the residential tariff structure for May 2017 and are sourced from ENEL (2017). Transmission and distribution shares are assumed to be uniform across GTAP-Power 11 reference years for the five aforementioned countries due to the lack of year-specific data. In the case of Japan, multi-year allocation is implemented using the data from REI (2017). Data for the 2011 tariff structure in this country is mapped to 2004, 2007 and 2011 reference years of the GTAP-Power Data Base, 2014 data is allocated to the 2014 reference year, while the 2016 tariff structure from REI (2017) is used to represent the GTAP's 2017 reference year.

Appendix A provides estimates of transmission and distribution shares in the total non-tax value of electricity output for the countries with updated or newly introduced shares. For other countries and regions, not covered in Appendix A but with available country-specific estimates, the same shares as in the GTAP-Power 10 Data Base are used. In the case of multi-year data availability, estimates from the 2014 reference year in the GTAP-Power 10 Data Base are mapped to the 2017 reference year in the GTAP-Power 11 Data Base. Finally, for the countries without available data, global average year-specific shares are estimated using GTAP electricity and heat generation volumes as weights.

3.2. Levelized cost of electricity

Relying on the IEA/NEA (2020) report, the GTAP-Power 11 Data Base includes updates for the LCOE for each cost type (i.e. investment, operation and maintenance (O&M), fuel, own-use, and effective tax), disaggregated sector (e.g., nuclear base load, hydro base load, coal base load, etc.) and country/region. Extending an earlier implementation in the GTAP-Power 10 Data Base, GTAP-Power 11 Data Base uses IEA/NEA (2010) report to estimate LCOE for 2004, 2007 and 2011 reference years, IEA/NEA (2015) is used to derive the LCOE for the 2014 reference year, while IEA/NEA (2020) data is used to represent the LCOE for the 2017 reference year. For the case of IEA/NEA (2020) report, we extract data for a total of 226 plants across 24 distinct countries. Appendix B provides a mapping between the corresponding plant types and GTAP-Power 11 sectors together with the estimates of the LCOE for each case.

A comparison of the LCOE for different technologies aggregated across plants and countries provides several broad insights. Despite substantial reductions in the costs of renewable energy in recent years (Luderer, et al., 2022), non-renewable energy is still the cheapest source of electricity generation, with nuclear power having the lowest LCOE (Figure 2). Across renewable generation technologies, bio-based energy is associated with the highest global average LCOE, followed by solar, geothermal, hydro and wind. At the same time, there is a substantial variation in LCOE across different power plants within each group of energy sources (indicated by the error bars in Figure 1). When considered across all power plant types and locations, wind power plants have the lowest LCOE across all options – 25.3 USD/MWh, followed by nuclear (27.3 USD/MWh), hydropower (28.5 USD/MWh), gas power plants (28.7 USD/MWh) and solar power (28.9 USD/MWh). As a result, while on average fossil-based generation has lower LCOE than renewable energy, in the most favorable locations, renewable energy sources are comparable to or even cheaper than non-renewable energy.

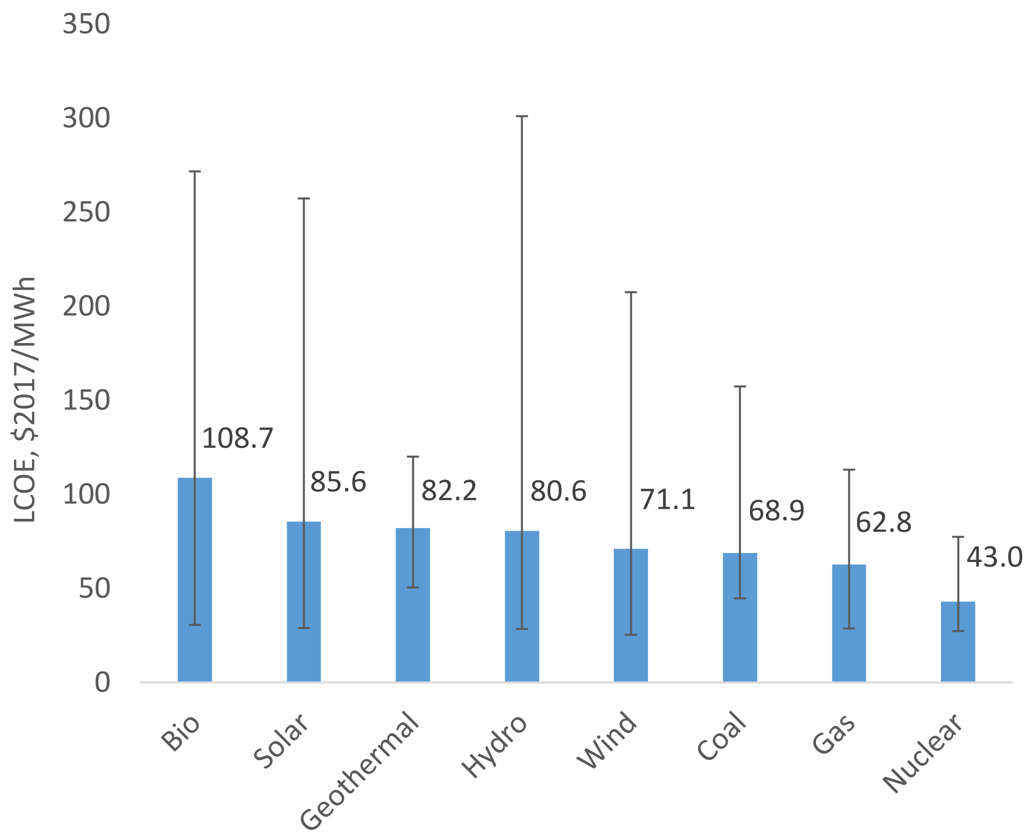

Figure 2. Global-average levelized costs of electricity generation across technologies, $2017/MWh.

Notes: Blue bars represent simple-average estimates of the LCOE across various plants and countries reported in the IEA/NEA (2020). Error bars represent the range of reported LCOE estimates within each group of generation technologies identifying the upper and lower bounds of the provided estimates. For the case of wind power generation, a small power plant with a capacity of 0.014 MW and reported LCOE of 844.7 USD/MWh was excluded from the reporting as it was considered non-representative.

3.3. Complementary emission accounts

While both the GTAP-Power 9 and GTAP-Power 10 Data Bases reported CO_2 emissions from fossil fuels combustion only, the GTAP-Power 11 Data Base extends the emission coverage by including process CO_2 emissions, non-CO_2

greenhouse gases, and air pollutants. For CO_2 emissions from industrial processes and non-CO_2 greenhouse gases, we rely on the complementary emissions accounting developed in Chepeliev (2020b). The latter is primarily based on emissions reported by the Food and Agricultural Organization (FAO) and the Emissions Database for Global Atmospheric Research (EDGAR) databases (FAO, 2023; Crippa et al., 2022). For air pollutants, we build on a recently developed GTAP air pollution Data Base developed by Chepeliev (2021), which largely relies on the original data reported in the EDGAR database (EC-JRC/PBL, 2022). For both GHG and air pollutant emissions, the original databases provide emission estimates consistent with the geometry of the standard GTAP Data Base, i.e. the electricity generation is represented by a single activity. To align these data with the GTAP-Power sectoral classification, we further disaggregate the emissions across generation technologies. When considered across emission drivers, in the cases of both greenhouse gases and air pollutants, emissions in the electricity and heat generation sector are associated with either output or intermediate use flows (Chepeliev, 2021; Chepeliev, 2020b). We redistribute these emissions across generation technologies proportionally to the value flows (in basic prices) of output or intermediate use respectively.

In the case of air pollutants, for six out of nine substances, coal power generation accounts for at least 40% of all emissions of the aggregate electricity sector at the global level (Figure 2a). Corresponding substances include BC (with a share of coal power-based emissions of 43.8%), NOx (54.3%), PM10 (64.4%), OC (69.7%), PM2.5 (77.1%) and SO_2 (82.5%). For CO, NH_3 and NMVOC emissions, the distribution of air pollutants across generation activities is more heterogeneous. In terms of the shares of the aggregate electricity-related emissions in the global totals (excluding land use), SO_2 is associated with the largest share (around 42.7%), followed by NO_x (24.9%) and PM10 (10.3%). In the case of all other substances, electricity generation and supply contribute less than 8% of global emissions (Figure 3a).

CH_4 and N_2O emissions are also associated primarily with coal power generation activities (Figure 3b). At the same time, the relative contribution of electricity generation to global emissions of the corresponding substances is rather low – 2.8% for N_2O and only 0.1% for CH_4 (Figure 2b). The volume of non-combustion CO_2 emissions associated with electricity generation is even lower – around 1.3 Mt of CO_2 eq. globally, which represents less than 0.004% of the global CO_2 emissions.

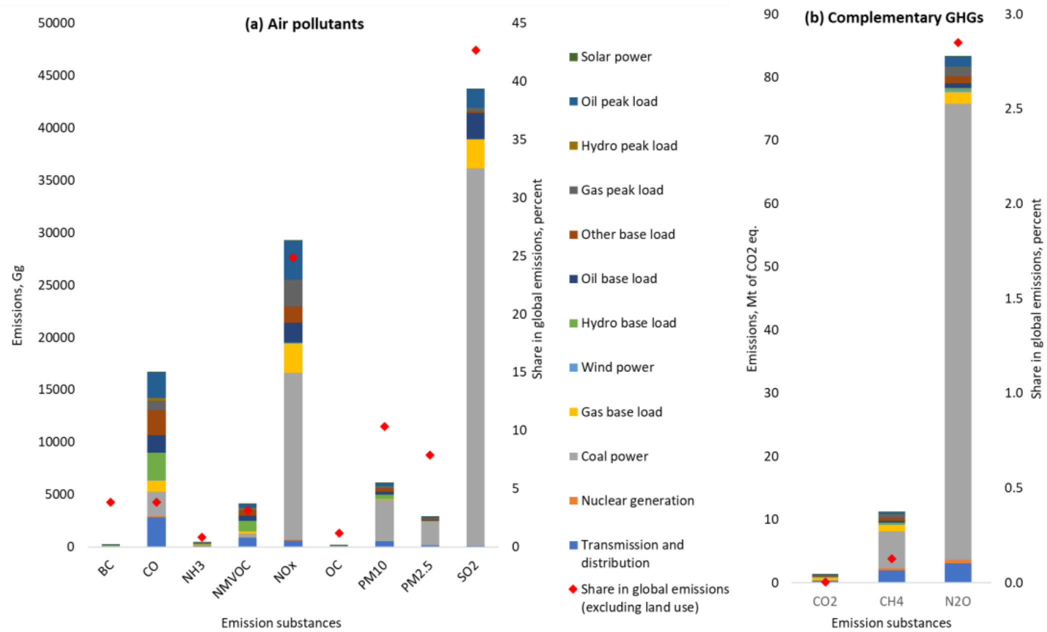

Figure 3. Distribution of air pollutants (panel "a") and complementary greenhouse gas emissions (panel "b") across electricity and heat activities in the GTAP-Power Data Base for the 2017 reference year.

Notes: CO2 emissions reported on panel "b" include non-combustion CO2 emissions only. The share of the CO2 emissions is estimated using both combustion and non-combustion CO2 totals.

4. LMDI decomposition of changes in CO_2 emissions from electricity generation

Between 2004 and 2017, the volume of global fossil fuel combustion CO_2 emissions from electricity and heat generation activities has increased substantially – by over 2.8 billion tonnes of CO_2 equivalent (CO_2e) or by 27% (Figure 4). In absolute terms, a substantial portion of this increase is associated with a group of upper-middle income countries, which includes China, where emissions have grown by over 2.6 billion tonnes of CO_2e or by 63.5%. In relative terms though even more rapid growth has been observed for a group of low- and lower-middle income countries – an increase of 84.4% between 2004 and 2017. The only group which managed to achieve an absolute reduction in CO_2 emissions from electricity and heat generation are high income countries, where emissions have declined by 12.4% or 664 million tonnes of CO_2e. To provide a decomposition of historical drivers of changing fossil fuel combustion CO_2 emissions from the electricity and heat generation sector across aggregate regions, we decompose changes in CO_2 emissions from these activities between the 2004 and 2017 reference years into activity (the amount of electricity generated), structure (the mix of electricity generation technologies), and intensity (emissions per unit of electricity) effects. We do this using the logarithmic mean Divisia index (LMDI) I additive decomposition method (Ang, 2015).

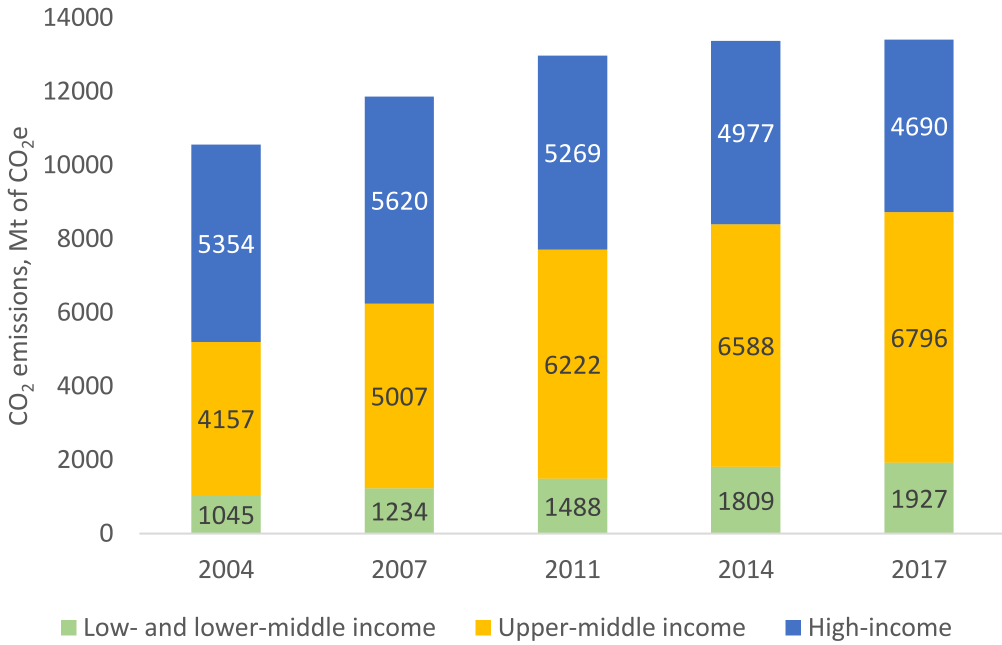

Figure 4. CO2 emissions from electricity and heat generation activities across years and regions in the GTAP-Power 11 Data Base, Mt of CO2e.

Notes: Country groupings reported on the figure are based on the World Bank classifications of countries by income level (GDP per capita) for the 2017-2018 period (World Bank, 2017).

The decomposition is implemented for all 160 countries and regions in the GTAP-Power 11 Data Base and the results are aggregated to three composite regions reported in Figure 4. The implementation begins from the following identity (for each considered country/region):

$$ELYEMI = \sum_i ELYEMI_i = \sum_i ELY \frac{ELY_i}{ELY}\frac{ELYEMI_i}{ELY_i} = \sum_i ELY\, S_i\, INT_i, \quad (1)$$

where $ELYEMI$ is the total amount of emissions from electricity and heat generation in the specific country/region; $ELYEMI_i$ is the amount of emissions generated by sector i (set i covers all electricity and heat generation activities); $ELY = \sum_i ELY_i$ is the amount of total electricity generation in the country; $S_i = \frac{ELY_i}{ELY}$ represents the share of specific generation technology in the overall electricity supply; $INT_i = \frac{ELYEMI_i}{ELY_i}$ corresponds to the emission intensity of each electricity generation sector i.

For the additive decomposition analysis, we can further represent a change in ELYEMI between 2004 and 2017 years in the following way:

$$\Delta ELYEMI_{tot} = ELYEMI^{2017} - ELYEMI^{2004}$$
$$= \Delta ELYEMI_{act} + \Delta ELYEMI_{str} + \Delta ELYEMI_{int},$$

where subscripts *act*, *str*, and *int* denote the effects associated with the overall activity level, activity structure, and sectoral emission intensity, respectively.

The following formulas are further used to calculate the effects in the LDMI-I additive model:

$$Activity:\ \Delta ELYEMI_{act} = \sum_i L\left(ELYEMI_i^{2017}, ELYEMI_i^{2004}\right) \ln\left(\frac{ELY^{2017}}{ELY^{2004}}\right), \quad (2)$$

$$Structure:\ \Delta ELYEMI_{str} = \sum_i L\left(ELYEMI_i^{2017}, ELYEMI_i^{2004}\right) \ln\left(\frac{S_i^{2017}}{S_i^{2004}}\right), \quad (3)$$

$$Intensity:\ \Delta ELYEMI_{int} = \sum_i L\left(ELYEMI_i^{2017}, ELYEMI_i^{2004}\right) \ln\left(\frac{INT_i^{2017}}{INT_i^{2004}}\right), \quad (4)$$

where

$$L\left(ELYEMI_i^{2017}, FLW_i^{2004}\right) = \frac{ELYEMI_i^{2017} - ELYEMI_i^{2004}}{\ln(ELYEMI_i^{2017}) - \ln(ELYEMI_i^{2004})}.$$

The decomposition results suggest that for all three groups of countries, a key driver of the increase in the CO_2 emissions from electricity and heat generation was the activity effect (Figure 5). In the case of low- and middle-income countries, this factor had a more substantial contribution to the overall change in emissions due to rapidly rising population and incomes, when compared to the high-income economies. The structure effect was largest for high-income countries. In these countries, an increasing share of renewable energy generation led to the reduction in CO_2 emissions by around 957 Mt of CO_2e – more than outweighing an increase in emissions due to the activity effect in this group of countries (Figure 5). Changes in the electricity generation mix also contributed to the reduction in emissions across upper-middle income countries but its magnitude was substantially lower than in the case of high-income countries and not sufficient to compensate the contribution of the activity effect. In the case of low- and middle-income economies, the structure effect led to a moderate increase in CO_2e emissions between 2004 and 2017. Finally, the intensity channel contributed to a reduction in

CO_2 emissions from electricity and heat generation across all three country groups. In the case of high-income economies, this channel alone was sufficient to outweigh an increase in emissions due to the activity effect. For both low- and middle-income economies, the emission intensity reduction channel offset approximately one fifth of the emissions increase from the activity factor.

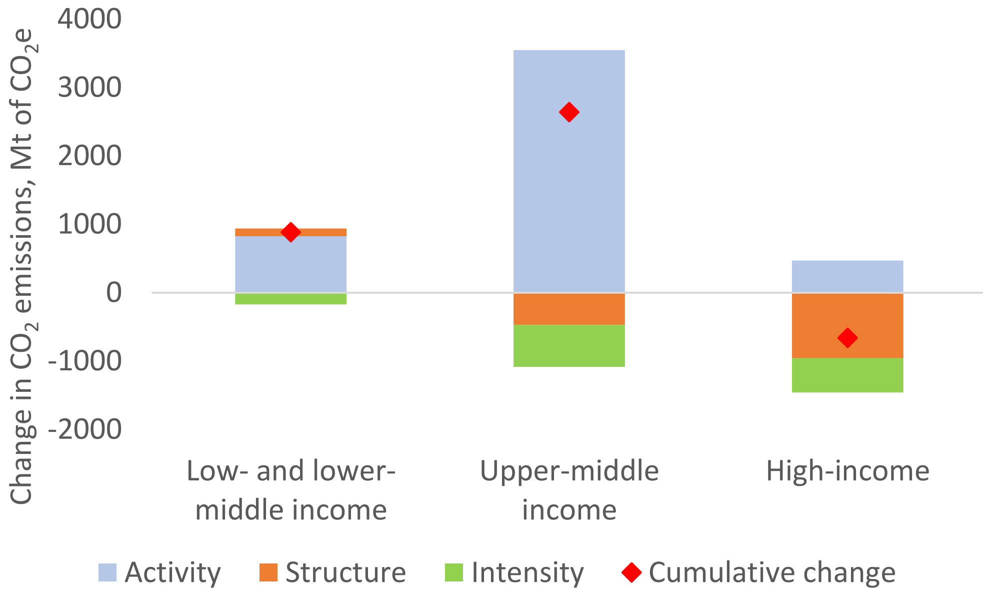

Figure 5. LMDI-I additive decomposition of changes in CO2 emissions from electricity and heat generation between 2004 and 2017 across groups of countries, Mt of CO2e

Notes: Country groupings reported on the figure are based on the World Bank classifications of countries by income level (GDP per capita) for the 2017-2018 period (World Bank, 2017).

5. Summary and discussion

With the increasing need for the quantitative assessment of alternative mitigation and adaptation policies to support decision-making processes in countries around the world, there is increased demand for global databases for quantitative modeling analysis. To advance the assessment of energy and climate policies within the global modeling community, this paper develops an updated version of the widely-used GTAP-Power Data Base. In this process, we introduce several refinements and modifications compared to earlier versions of this database.

First, we provide updates to the levelized costs of electricity generation relying on the three consecutive releases of the IEA/NEA reports covering 2010, 2015 and 2020 technology updates, allowing us to capture changes in the generation costs over time. Second, we further refine the country-specific estimates of the transmission and distribution costs by providing updated estimates for 36 countries, primarily in the European Union, and adding estimates for six additional countries – Singapore, New Zealand, Philippines, Japan, Australia and Colombia. Finally, we expand a set of the reported emission accounts by adding a reporting of process CO_2 emissions, non-CO_2 greenhouse gases, and air pollutants. All these updates are used to develop the GTAP-Power 11 Data Base covering 76 sectors of the economy, five reference years (2004, 2007, 2011, 2014 and 2017), 141 individual countries and 19 composite regions.

The new database is used to decompose the drivers behind changes in emissions from electricity and heat generation between 2004 and 2017 years across three broad groups of countries – low- and lower-middle income, upper-middle income and high-income. To develop such a decomposition, we use the logarithmic mean Divisia index I additive technique. The results suggest that in both low- and middle-income countries, a substantial increase in fossil fuel combustion CO_2 emissions from electricity and heat generation has been observed. The latter has been primarily driven by increased electricity generation due to rapidly rising population and incomes. While a reduction in emission intensity (both groups of countries) and an increasing share of renewable generation (upper-middle income economies) have partly offset the rising emissions from the activity channel, this was not sufficient to lead to an overall emissions' decline. This is not the case for the high-income countries, where structure and intensity effects combined more than compensated for increased emissions from a rise in electricity generation, and led to an overall reduction in CO_2 emissions by around 12.4% over the 2004-2017 timeframe.

When linked to the computable general equilibrium or integrated assessment models, the developed database could form a comprehensive assessment framework to support the decision-making process for energy and environmental policies. However, it should be noted that in order to fully utilize the economic and technological details included in the GTAP-Power Data Base and provide a more realistic representation of the future evolution of the energy system, specific model developments and refinements might be needed within the baseline and/or policy scenarios. While the database captures variations in the LCOE and generation mix across various technologies and it is possible to explicitly calibrate energy prices as observed in the reference (e.g. van der Mensbrugghe, 2019), a future evolution of the energy system in most computable general equilibrium models that utilize (additive) constant elasticities of substitution production functions (e.g. Peters, 2016b; Faehn et al., 2020) is largely driven by the initial (reference year) shares. In order to represent a more realistic dynamics of the generation mix and electricity demand over time, additional assumptions regarding the evolution of the generation costs, changes in energy efficiency rates across technologies and fuels, adjustments in consumers' preferences, changes in the electrification rates, etc. should be introduced to the modeling framework (e.g. Faehn et al., 2020; Chepeliev and van der Mensbrugghe, 2020). Such assumptions and refinements could be implemented based on the information available in the literature (e.g. Chepeliev and van der Mensbrugghe, 2020; Chepeliev et al., 2021) or using inputs from other models, such as power system or energy system models (e.g. Delzeit et al., 2020).

There are several data and model extensions related to the GTAP-Power Data Base that can further enhance the current framework. First, while relying on publicly available data, the construction process of the GTAP-Power Data Base can be enriched by additional country-specific data inputs, such as production cost structures across generation technologies or shares of transmission and distribution for selected countries. Second, the GTAP-E-Power model (Peters, 2016b), which only tracks CO_2 emissions from fossil fuel combustion could be extended to include other GHG emissions and air pollutants, which are now included in the GTAP-Power Data Base. Third, incorporating marginal abatement cost curves for GHG emissions would facilitate the assessment of mitigation opportunities across broad set of abatement options within a comprehensive modeling framework (Wietzel et al., 2019; Eory et al., 2018). Finally, future database developments efforts would benefit from combining electricity generation technologies represented in the GTAP-Power Data Base with other energy- and environmental-focused GTAP databases, such as GTAP-BIO (Golub and Hertel, 2012).

Acknowledgements

I am grateful for the valuable comments provided by Niven Winchester and one anonymous reviewer.

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Appendix A. Share of the transmission and distribution costs in the total non-tax value of electricity sector output in 2017 for countries with updated or newly introduced data, %

No.	Country code	Country name	2017 transmission and distribution share
1	bel	Belgium	0.3676
2	bgr	Bulgaria	0.1846
3	cze	Czech Republic	0.3643
4	dnk	Denmark	0.4237
5	deu	Germany	0.486
6	est	Estonia	0.3475
7	irl	Ireland	0.3709
8	grc	Greece	0.2407
9	esp	Spain	0.2009
10	fra	France	0.3492
11	hrv	Croatia	0.3941
12	ita	Italy	0.213
13	cyp	Cyprus	0.203
14	lva	Latvia	0.4824
15	ltu	Lithuania	0.3325
16	lux	Luxembourg	0.4197
17	hun	Hungary	0.3688
18	mlt	Malta	0.1912
19	nld	Netherlands	0.2839
20	aut	Austria	0.3968
21	pol	Poland	0.3807
22	prt	Portugal	0.3642
23	rou	Romania	0.3834
24	svn	Slovenia	0.3253
25	svk	Slovakia	0.4945
26	fin	Finland	0.3376
27	swe	Sweden	0.364
28	gbr	United Kingdom	0.3218
29	isl	Iceland	0.1196

No.	Country code	Country name	2017 transmission and distribution share
30	lie	Liechtenstein	0.3512
31	nor	Norway	0.4774
32	mne	Montenegro	0.4079
33	srb	Serbia and Montenegro	0.249
34	tur	Turkey	0.1434
35	usa	United States of America	0.1797
36	ukr	Ukraine	0.1112
37	sgp	Singapore	0.25
38	nzl	New Zealand	0.6219
39	phl	Philippines	0.3659
40	jpn	Japan	0.2686
41	aus	Australia	0.5
42	col	Colombia	0.5

Notes: For almost all country-cases, the data year used to estimate 2017 transmission and distribution shares is 2017. Exceptions include the following countries: Ukraine (2017 data year is used for residential users, while 2015 data year for industrial users); Singapore (uses data from the 2020 year); New Zealand (2020); Philippines (2020); Japan (2016); Australia (based on the report from August 2021); Colombia (based on the data for May 2017).

Source: Developed by authors based on Eurostat (2023), NERC (2018), Infocenter (2017), EIA (2022), Ravago (2023), Evans (2021), ENEL (2017) and REI (2017).

APPENDIX B. Levelized costs of electricity across IEA generation technologies mapped to the GTAP-Power 11 sectors for 2017 reference year

No.	Plant type	GTAP-Power 11 sector code	Country of the plant reporting	Country code	LCOE, $2017/MWh
1	Ultra-supercritical (pithead) (400 MW)	CoalBL	India	ind	44.7
2	Supercritical pulverised (709 MW)	CoalBL	Australia	aus	48.3
3	Ultra-supercritical (954 MW)	CoalBL	Korea, Republic of	kor	48.9
4	Ultra-supercritical (347 MW)	CoalBL	China	chn	49.8
5	Pulverised (650 MW)	CoalBL	United States of America	usa	56.3
6	Supercritical pulverised (650 MW)	CoalBL	United States of America	usa	56.6
7	Coal (900 MW)	CoalBL	Brazil	bra	58.9
8	Supercritical pulverised (722 MW)	CoalBL	Australia	aus	59.0
9	Ultra-supercritical (749 MW)	CoalBL	Japan	jpn	68.6
10	Pulverised (140 MW)	CoalBL	United States of America	usa	71.9
11	Ultra-supercritical (load centered) (400 MW)	CoalBL	India	ind	74.5
12	Coal (641 MW)	CoalBL	United States of America	usa	81.9
13	Pulverised (138 MW)	CoalBL	United States of America	usa	87.8

No.	Plant type	GTAP-Power 11 sector code	Country of the plant reporting	Country code	LCOE, $2017/MWh
14	Pulverised, lignite (CHP) (2900 MW)	CoalBL	Romania	rou	157.4
15	Gas (CCGT) (835 MW)	GasBL	Mexico	mex	28.7
16	Gas (CCGT) (785 MW)	GasBL	Mexico	mex	30.2
17	Gas (CCGT) (727 MW)	GasBL	United States of America	usa	32.5
18	Gas (CCGT) (503 MW)	GasBL	Mexico	mex	33.1
19	Gas (CCGT) (471 MW)	GasBL	Canada	can	36.0
20	Gas (CCGT) (980 MW)	GasBL	Brazil	bra	38.9
21	Gas (CCGT, CHP) (5.8 MW)	GasBL	Slovakia	svk	39.7
22	Gas (CCGT) (500 MW)	GasBL	Belgium	bel	56.8
23	Gas (CCGT) (790 MW)	GasBL	Italy	ita	58.0
24	Gas (CCGT, CHP) (500 MW)	GasBL	Denmark	dnk	58.8
25	Gas (CCGT) (500 MW)	GasBL	Belgium	bel	56.8
26	Gas (CCGT) (500 MW)	GasBL	Belgium	bel	56.8
27	Gas (CCGT) (506 MW)	GasBL	Australia	aus	71.5
28	Gas (CCGT) (475 MW)	GasBL	China	chn	72.2
29	Gas (CCGT) (982 MW)	GasBL	Korea, Republic of	kor	74.4
30	Gas (CCGT) (1372 MW)	GasBL	Japan	jpn	79.0
31	Gas (CCGT) (491 MW)	GasBL	Korea, Republic of	kor	82.5

No.	Plant type	GTAP-Power 11 sector code	Country of the plant reporting	Country code	LCOE, $2017/MWh
32	Gas (CCGT) (750 MW)	GasBL	Romania	rou	95.8
33	Gas (OCGT/int. comb., CHP) (195 MW)	GasP	Romania	rou	44.3
34	Gas (OCGT/int. comb., CHP) (35.9 MW)	GasP	Slovakia	svk	46.1
35	Gas (OCGT/int. comb., CHP) (125 MW)	GasP	Denmark	dnk	51.9
36	Gas (OCGT/int. comb.) (243 MW)	GasP	Canada	can	59.1
37	Gas (OCGT/int. comb.) (980 MW)	GasP	Brazil	bra	60.5
38	Gas (OCGT/int. comb.) (100 MW)	GasP	Canada	can	64.4
39	Gas (OCGT/int. comb.) (350 MW)	GasP	Belgium	bel	89.4
40	Gas (OCGT/int. comb.) (130 MW)	GasP	Italy	ita	93.4
41	Gas (OCGT/int. comb.) (500 MW)	GasP	Belgium	bel	93.6
42	Gas (OCGT/int. comb.) (500 MW)	GasP	Belgium	bel	93.6
43	Gas (OCGT/int. comb.) (537 MW)	GasP	Australia	aus	113.1
44	Run of river (>= 5 MW) (248 MW)	HydroBL	Brazil	bra	33.1
45	Run of river (< 5 MW) (3.0 MW)	HydroBL	Norway	nor	35.5
46	Run of river (< 5 MW) (2.2 MW)	HydroBL	Austria	aut	41.5
47	Run of river (>= 5 MW) (24.5 MW)	HydroBL	Germany	deu	44.1
48	Run of river (< 5 MW) (0.50 MW)	HydroBL	Italy	ita	46.8

No.	Plant type	GTAP-Power 11 sector code	Country of the plant reporting	Country code	LCOE, $2017/MWh
49	Run of river (< 5 MW) (2.1 MW)	HydroBL	Italy	ita	49.6
50	Run of river (< 5 MW) (1.0 MW)	HydroBL	Italy	ita	51.1
51	Run of river (>= 5 MW) (median case) (44.7 MW)	HydroBL	United States of America	usa	51.8
52	Run of river (>= 5 MW) (median case) (94.0 MW)	HydroBL	United States of America	usa	62.5
53	Run of river (< 5 MW) (0.69 MW)	HydroBL	Italy	ita	63.7
54	Run of river (>= 5 MW) (82.2 MW)	HydroBL	United States of America	usa	64.7
55	Run of river (< 5 MW) (4.2 MW)	HydroBL	United States of America	usa	70.5
56	Run of river (>= 5 MW) (44.1 MW)	HydroBL	United States of America	usa	72.6
57	Run of river (< 5 MW) (0.10 MW)	HydroBL	Italy	ita	73.8
58	Run of river (< 5 MW) (0.25 MW)	HydroBL	Italy	ita	74.8
59	Run of river (>= 5 MW) (5.0 MW)	HydroBL	Italy	ita	80.8
60	Run of river (< 5 MW) (0.50 MW)	HydroBL	Italy	ita	46.8
61	Run of river (< 5 MW) (0.19 MW)	HydroBL	Italy	ita	85.4
62	Run of river (< 5 MW) (4.8 MW)	HydroBL	United States of America	usa	88.9
63	Run of river (< 5 MW) (3.7 MW)	HydroBL	United States of America	usa	96.9
64	Run of river (< 5 MW) (0.015 MW)	HydroBL	Italy	ita	100.3
65	Run of river (< 5 MW) (0.50 MW)	HydroBL	Italy	ita	46.8

No.	Plant type	GTAP-Power 11 sector code	Country of the plant reporting	Country code	LCOE, $2017/MWh
66	Run of river (< 5 MW) (0.25 MW)	HydroBL	Italy	ita	74.8
67	Run of river (< 5 MW) (0.25 MW)	HydroBL	Italy	ita	74.8
68	Hydro reservoir (>= 5 MW) (30.0 MW)	HydroP	Norway	nor	28.5
69	Hydro reservoir (>= 5 MW) (175 MW)	HydroP	India	ind	38.0
70	Hydro reservoir (< 5 MW) (0.32 MW)	HydroP	Italy	ita	55.9
71	Hydro reservoir (>= 5 MW) (15.0 MW)	HydroP	Italy	ita	71.3
72	Hydro reservoir (>= 5 MW) (12.0 MW)	HydroP	Japan	jpn	106.3
73	LTO (20 years) (1000 MW)	NuclearBL	Sweden	swe	27.3
74	LTO (20 years) (1000 MW)	NuclearBL	Switzerland	che	28.5
75	LTO (20 years) (1000 MW)	NuclearBL	France	fra	29.4
76	LTO (10 years) (1000 MW)	NuclearBL	Sweden	swe	30.6
77	LTO (20 years) (1000 MW)	NuclearBL	United States of America	usa	32.5
78	LTO (10 years) (1000 MW)	NuclearBL	Switzerland	che	32.6
79	Gen III projects (1122 MW)	NuclearBL	Russian Federation	rus	34.0
80	LTO (10 years) (1000 MW)	NuclearBL	France	fra	34.1
81	LTO (10 years) (1000 MW)	NuclearBL	United States of America	usa	35.4

No.	Plant type	GTAP-Power 11 sector code	Country of the plant reporting	Country code	LCOE, $2017/MWh
82	LWR (950 MW)	NuclearBL	India	ind	37.8
83	ALWR (1377 MW)	NuclearBL	Korea, Republic of	kor	45.6
84	LWR (1100 MW)	NuclearBL	United States of America	usa	56.2
85	Gen III projects (1650 MW)	NuclearBL	France	fra	56.8
86	Nuclear (950 MW)	NuclearBL	China	chn	57.1
87	ALWR (1152 MW)	NuclearBL	Japan	jpn	72.6
88	Nuclear (1004 MW)	NuclearBL	Slovakia	svk	77.4
89	Ultra-supercritical (CHP) (700 MW)	OtherBL	Denmark	dnk	30.6
90	Biomass (25.0 MW)	OtherBL	Brazil	bra	45.1
91	Geothermal (30.0 MW)	OtherBL	United States of America	usa	50.5
92	Geothermal (39.6 MW)	OtherBL	Italy	ita	55.5
93	Biomass (0.45 MW)	OtherBL	Italy	ita	64.0
94	Geothermal (25.0 MW)	OtherBL	United States of America	usa	76.4
95	Geothermal (15.0 MW)	OtherBL	Italy	ita	82.9
96	Biomass (CHP) (258 MW)	OtherBL	Denmark	dnk	83.3
97	Biomass (CHP) (358 MW)	OtherBL	Denmark	dnk	102.4
98	Biomass (CHP) (177 MW)	OtherBL	Denmark	dnk	104.9
99	Geothermal (10.0 MW)	OtherBL	Italy	ita	107.7

No.	Plant type	GTAP-Power 11 sector code	Country of the plant reporting	Country code	LCOE, $2017/MWh
100	Biomass (30.0 MW)	OtherBL	India	ind	115.6
101	Biomass (CHP) (261 MW)	OtherBL	Denmark	dnk	117.3
102	Geothermal (5.0 MW)	OtherBL	Italy	ita	120.1
103	Biomass (CHP) (0.42 MW)	OtherBL	Italy	ita	152.5
104	Biomass (0.42 MW)	OtherBL	Italy	ita	271.7
105	Solar PV (utility scale) (25.0 MW)	SolarP	France	fra	28.9
106	Solar PV (utility scale) (100 MW)	SolarP	United States of America	usa	29.6
107	Solar PV (utility scale) (35.0 MW)	SolarP	India	ind	30.4
108	Solar PV (utility scale) (100 MW)	SolarP	United States of America	usa	29.6
109	Solar PV (utility scale) (100 MW)	SolarP	Australia	aus	33.2
110	Solar PV (utility scale) (8.0 MW)	SolarP	Denmark	dnk	35.5
111	Solar PV (utility scale) (8.0 MW)	SolarP	Denmark	dnk	35.5
112	Solar PV (utility scale) (median case) (100 MW)	SolarP	United States of America	usa	37.9
113	Solar PV (utility scale) (25.0 MW)	SolarP	Brazil	bra	39.5
114	Solar PV (utility scale) (100 MW)	SolarP	United States of America	usa	29.6
115	Solar PV (utility scale) (20.0 MW)	SolarP	China	chn	43.7
116	Solar PV (utility scale) (100 MW)	SolarP	United States of America	usa	29.6
117	Solar PV (utility scale) (0.83 MW)	SolarP	Italy	ita	51.0

No.	**Plant type**	**GTAP-Power 11 sector code**	**Country of the plant reporting**	**Country code**	**LCOE, $2017/MWh**
118	Solar PV (utility scale) (20.0 MW)	SolarP	Canada	can	53.3
119	Solar PV (utility scale) (0.83 MW)	SolarP	Italy	ita	51.0
120	Solar PV (commercial) (0.21 MW)	SolarP	Italy	ita	62.1
121	Solar PV (commercial) (0.30 MW)	SolarP	United States of America	usa	63.2
122	Solar PV (commercial) (0.50 MW)	SolarP	France	fra	65.9
123	Solar PV (commercial) (0.10 MW)	SolarP	Denmark	dnk	66.8
124	Solar PV (commercial) (0.30 MW)	SolarP	United States of America	usa	63.2
125	Solar PV (utility scale) (8.0 MW)	SolarP	Netherlands	nld	70.4
126	Solar PV (utility scale) (20.0 MW)	SolarP	Hungary	hun	74.0
127	Solar PV (floating) (8.0 MW)	SolarP	Netherlands	nld	76.2
128	Solar PV (utility scale) (20.0 MW)	SolarP	Canada	can	53.3
129	Solar PV (utility scale) (1.0 MW)	SolarP	Belgium	bel	77.5
130	Solar PV (commercial) (0.20 MW)	SolarP	Netherlands	nld	79.2
131	Solar PV (commercial) (median case) (0.30 MW)	SolarP	United States of America	usa	79.9

No.	Plant type	GTAP-Power 11 sector code	Country of the plant reporting	Country code	LCOE, $2017/MWh
132	Solar PV (commercial) (0.42 MW)	SolarP	Italy	ita	81.5
133	Solar PV (utility scale) (3.0 MW)	SolarP	Korea, Republic of	kor	82.7
134	Solar PV (commercial) (0.099 MW)	SolarP	Korea, Republic of	kor	84.1
135	Solar PV (commercial) (0.30 MW)	SolarP	United States of America	usa	63.2
136	Solar PV (commercial) (0.083 MW)	SolarP	Italy	ita	88.5
137	Solar PV (residential) (0.010 MW)	SolarP	Belgium	bel	89.1
138	Solar PV (commercial) (0.050 MW)	SolarP	Hungary	hun	89.5
139	Solar PV (commercial) (0.50 MW)	SolarP	Hungary	hun	90.9
140	Solar thermal (CSP) (median case) (100 MW)	SolarP	United States of America	usa	95.4
141	Solar PV (residential) (0.020 MW)	SolarP	Austria	aut	97.6
142	Solar PV (residential) (0.006 MW)	SolarP	Denmark	dnk	97.8
143	Solar PV (commercial) (0.30 MW)	SolarP	United States of America	usa	63.2
144	Solar thermal (CSP) (100 MW)	SolarP	United States of America	usa	99.5

No.	**Plant type**	**GTAP-Power 11 sector code**	**Country of the plant reporting**	**Country code**	**LCOE, $2017/MWh**
145	Solar PV (residential) (0.010 MW)	SolarP	France	fra	107.4
146	Solar PV (residential) (median case) (0.005 MW)	SolarP	United States of America	usa	107.4
147	Solar PV (residential) (0.010 MW)	SolarP	Belgium	bel	89.1
148	Solar thermal (CSP) (150 MW)	SolarP	Australia	aus	111.0
149	Solar PV (residential) (0.005 MW)	SolarP	United States of America	usa	114.9
150	Solar PV (residential) (0.005 MW)	SolarP	United States of America	usa	114.9
151	Solar PV (residential) (0.004 MW)	SolarP	Hungary	hun	120.6
152	Solar thermal (CSP) (100 MW)	SolarP	United States of America	usa	99.5
153	Solar PV (commercial) (0.30 MW)	SolarP	Norway	nor	124.3
154	Solar PV (residential) (0.005 MW)	SolarP	Italy	ita	126.4
155	Solar PV (residential) (0.005 MW)	SolarP	United States of America	usa	114.9
156	Solar PV (residential) (0.005 MW)	SolarP	United States of America	usa	114.9

No.	Plant type	GTAP-Power 11 sector code	Country of the plant reporting	Country code	LCOE, $2017/MWh
157	Solar PV (residential) (0.010 MW)	SolarP	Belgium	bel	89.1
158	Solar PV (utility scale) (2.0 MW)	SolarP	Japan	jpn	147.8
159	Solar PV (residential) (0.004 MW)	SolarP	Japan	jpn	190.3
160	Solar PV (residential) (0.004 MW)	SolarP	Italy	ita	257.3
161	Wind onshore (>= 1 MW) (4.5 MW)	WindBL	Denmark	dnk	25.3
162	Wind onshore (>= 1 MW) (130 MW)	WindBL	Norway	nor	27.2
163	Wind onshore (>= 1 MW) (30.0 MW)	WindBL	Brazil	bra	28.9
164	Wind onshore (>= 1 MW) (65.0 MW)	WindBL	India	ind	30.5
165	Wind onshore (>= 1 MW) (100 MW)	WindBL	United States of America	usa	30.7
166	Wind onshore (>= 1 MW) (100 MW)	WindBL	United States of America	usa	30.7
167	Wind onshore (>= 1 MW) (100 MW)	WindBL	United States of America	usa	30.7
168	Wind onshore (>= 1 MW) (median case) (100 MW)	WindBL	United States of America	usa	34.2
169	Wind onshore (>= 1 MW) (100 MW)	WindBL	United States of America	usa	30.7
170	Wind onshore (>= 1 MW) (50.0 MW)	WindBL	Netherlands	nld	36.9
171	Wind onshore (>= 1 MW) (100 MW)	WindBL	Australia	aus	37.3
172	Wind onshore (>= 1 MW) (30.0 MW)	WindBL	Finland	fin	38.5

No.	Plant type	GTAP-Power 11 sector code	Country of the plant reporting	Country code	LCOE, $2017/MWh
173	Wind offshore (11.5 MW)	WindBL	Denmark	dnk	39.6
174	Wind onshore (>= 1 MW) (200 MW)	WindBL	Canada	can	41.2
175	Wind onshore (>= 1 MW) (100 MW)	WindBL	United States of America	usa	30.7
176	Wind offshore (11.3 MW)	WindBL	Denmark	dnk	45.5
177	Wind onshore (>= 1 MW) (10.0 MW)	WindBL	Italy	ita	46.5
178	Wind onshore (>= 1 MW) (100 MW)	WindBL	United States of America	usa	30.7
179	Wind onshore (>= 1 MW) (50.0 MW)	WindBL	France	fra	49.6
180	Wind onshore (>= 1 MW) (30.0 MW)	WindBL	Belgium	bel	49.9
181	Wind onshore (>= 1 MW) (50.0 MW)	WindBL	China	chn	50.8
182	Wind onshore (>= 1 MW) (20.0 MW)	WindBL	Italy	ita	51.2
183	Wind offshore (600 MW)	WindBL	United States of America	usa	51.7
184	Wind offshore (600 MW)	WindBL	United States of America	usa	51.7
185	Wind offshore (600 MW)	WindBL	United States of America	usa	51.7
186	Wind onshore (>= 1 MW) (30.0 MW)	WindBL	Belgium	bel	49.9
187	Wind offshore (600 MW)	WindBL	United States of America	usa	51.7
188	Wind offshore (600 MW)	WindBL	United States of America	usa	51.7
189	Wind offshore (median case) (600 MW)	WindBL	United States of America	usa	58.2

No.	Plant type	GTAP-Power 11 sector code	Country of the plant reporting	Country code	LCOE, $2017/MWh
190	Wind onshore (>= 1 MW) (280 MW)	WindBL	Russian Federation	rus	58.3
191	Wind offshore (600 MW)	WindBL	United States of America	usa	51.7
192	Wind offshore (600 MW)	WindBL	United States of America	usa	51.7
193	Wind onshore (>= 1 MW) (5.0 MW)	WindBL	Belgium	bel	60.4
194	Wind onshore (< 1 MW) (0.90 MW)	WindBL	Italy	ita	61.9
195	Wind onshore (>= 1 MW) (60.0 MW)	WindBL	Russian Federation	rus	62.4
196	Wind offshore (600 MW)	WindBL	United States of America	usa	51.7
197	Wind onshore (>= 1 MW) (100 MW)	WindBL	United States of America	usa	30.7
198	Wind offshore (600 MW)	WindBL	United States of America	usa	51.7
199	Wind onshore (< 1 MW) (0.80 MW)	WindBL	Italy	ita	65.9
200	Wind onshore (>= 1 MW) (3.0 MW)	WindBL	Austria	aut	67.5
201	Wind onshore (>= 1 MW) (4.5 MW)	WindBL	Belgium	bel	68.1
202	Wind onshore (< 1 MW) (0.90 MW)	WindBL	Italy	ita	61.9
203	Wind offshore (50.0 MW)	WindBL	China	chn	71.2
204	Wind offshore (600 MW)	WindBL	United States of America	usa	51.7
205	Wind offshore (100 MW)	WindBL	Australia	aus	74.0
206	Wind onshore (< 1 MW) (0.83 MW)	WindBL	Italy	ita	76.0
207	Wind offshore (50.0 MW)	WindBL	Belgium	bel	77.3

No.	Plant type	GTAP-Power 11 sector code	Country of the plant reporting	Country code	LCOE, $2017/MWh
208	Wind offshore (500 MW)	WindBL	France	fra	78.5
209	Wind onshore (>= 1 MW) (1.0 MW)	WindBL	Italy	ita	78.5
210	Wind onshore (>= 1 MW) (100 MW)	WindBL	United States of America	usa	30.7
211	Wind offshore (600 MW)	WindBL	United States of America	usa	51.7
212	Wind offshore (12.0 MW)	WindBL	Belgium	bel	85.1
213	Wind onshore (< 1 MW) (0.50 MW)	WindBL	Italy	ita	85.7
214	Wind offshore (600 MW)	WindBL	United States of America	usa	51.7
215	Wind onshore (>= 1 MW) (14.9 MW)	WindBL	Korea, Republic of	kor	99.0
216	Wind offshore (600 MW)	WindBL	United States of America	usa	51.7
217	Wind onshore (< 1 MW) (0.10 MW)	WindBL	Italy	ita	117.9
218	Wind onshore (>= 1 MW) (20.0 MW)	WindBL	Japan	jpn	121.2
219	Wind onshore (>= 1 MW) (100 MW)	WindBL	United States of America	usa	30.7
220	Wind offshore (99.0 MW)	WindBL	Korea, Republic of	kor	141.4
221	Wind onshore (< 1 MW) (0.060 MW)	WindBL	Italy	ita	152.7
222	Wind onshore (< 1 MW) (0.19 MW)	WindBL	Italy	ita	158.5
223	Wind offshore (100 MW)	WindBL	Japan	jpn	177.7
224	Wind onshore (< 1 MW) (0.020 MW)	WindBL	Italy	ita	183.4

No.	**Plant type**	**GTAP-Power 11 sector code**	**Country of the plant reporting**	**Country code**	**LCOE, $2017/MWh**
225	Wind onshore (< 1 MW) (0.059 MW)	WindBL	Italy	ita	207.5
226	Wind onshore (< 1 MW) (0.014 MW)	WindBL	Italy	ita	844.7

Source: Developed by authors based on IEA/NEA (2020).