STATISTICS

Trade in Low Carbon Technology Products

INTRODUCTION

There are more than 250 low-carbon technologies (LCTs) available today. These include mechanics like wind turbines, solar panels, biomass systems and carbon capture equipment. LCTs are less polluting than carbon-intensive technologies and therefore their adoption will be needed for mass decarbonization. Accelerating the development and transfer of LCTs has been at the core of international climate change negotiations since the 1992 UN Framework Convention on Climate Change (UNFCCC). International trade will play a central role in the transfer of LCTs between economies. For policymaking, data on trade in LCT products can be useful in the negotiation of agreements to lower tariff and non-tariff barriers as well as to identify key dependencies between economies for these goods.

This paper will explain the methodology for compiling the statistics on trade in low carbon technology (LCT) products, including the definition of LCT products. This will be followed by some of the key results and findings from the statistics. The paper closes with a discussion of the limitations and next steps.

DATA AND ESTIMATION METHODOLOGY

1. The data used for the estimation of trade in LCT products are from UN Comtrade,[1] a database of monthly trade flows by commodity and by partner economy reported by approximately 178 economies. Data are reported to Comtrade according to Harmonized Commodity Description and Coding Systems (HS) codes. The Harmonized System is "an international nomenclature for the classification of products," introduced in 1988, and used to classify goods for customs purposes.[2] It comprises approximately 5,300 article/product descriptions. At the international level, it is a six-digit code system. The data are based on HS 2017, the latest version.

2. Data for 6-digit commodity categories that meet the definition of LCT products are extracted from UN Comtrade and summed to estimate "LCT products" aggregates.

3. LCT products are defined as products that produce less pollution than their traditional energy counterparts, and will play a vital role in the transition to a low carbon economy. LCTs include mechanics like wind turbines, solar panels, biomass systems and carbon capture equipment.

[1] United Nations International Trade Statistics Database, Department of Economic and Social Affairs/Statistics Division.

[2] Information about the HS is summarized from UN Trade Statistics Trade Knowledgebase, available at https://unstats.un.org/unsd/tradekb/Knowledgebase/50018/Harmonized-Commodity-Description-and-Coding-Systems-HS. Additional information about the HS is also available from http://www.wcoomd.org/home_wco_topics_hsoverviewboxes.htm.

4. The LCT products designation is based on Pigato, Miria A., Simon J. Black, Damien Dussaux, Zhimin Mao, Miles McKenna, Ryan Rafaty, and Simon Touboul. 2020. "Technology Transfer and Innovation for Low-Carbon Development." International Development in Focus. Washington, DC: World Bank.

5. The procedures to estimate trade in LCT products are similar to those used to derive the trade in environmental goods indicators that are also included in the Climate Change Indicators Dashboard. LCT products are essentially a subset of environmental goods.[3] A comparison of the environmental goods listing with the LCT products listing is included in the Annex.[4]

6. With the LCT products aggregates calculated, eleven indicators are derived, shown in Table 1 and described more below.

7. Global trade aggregates from the IMF Direction of Trade Statistics (DOTS) database are also used to calculate some of the LCT products indicators. In the DOTS dataset, reported data are supplemented by estimates whenever such data are not available or current.[5] Therefore, the global aggregates from DOTS provide a better denominator to use in calculating shares of total trade.

Table 1: Trade in LCT products indicators

Indicator	Unit	Number of Countries	Frequency	Period
Exports of LCT products	US dollars	Around 140 countries (average) per year, plus World total	Annual	1994-2020
Imports of LCT products	US dollars	Around 140 countries (average) per year, plus World total	Annual	1994-2020
Exports of LCT products as share of total exports	Percent	Around 140 countries (average) per year, plus World total	Annual	1998-2020
Imports of LCT products as share of total imports	Percent	Around 140 countries (average) per year, plus World total	Annual	1998-2020
Exports of LCT products as percent of GDP	Percent	Around 140 economies (average) per year, plus World total	Annual	1994-2020
Imports of LCT products as percent of GDP	Percent	Around 140 economies (average) per year, plus World total	Annual	1994-2020
Trade balance in LCT products	US dollars	Around 140 countries (average) per year, plus World total	Annual	1994-2020
Trade balance in LCT products as percent of GDP	Percent	Around 140 economies (average) per year, plus World total	Annual	1994-2020
Total trade in LCT products	US dollars	Around 140 economies (average) per year, plus World total	Annual	1994-2020
Total trade in LCT products as percent of GDP	Percent	Around 140 economies (average) per year, plus World total	Annual	1994-2020
Comparative advantage in LCT products	Index	Around 140 countries (average) per year	Annual	1998-2020

8. **Exports of LCT Products**: Exports of LCT products comprise all LCT products leaving the national territory. It is simply the aggregation of all exports reported by each economy that meet the definition of "LCT

[3] With one major exception, which is that nuclear energy products are considered LCT products but are not considered environmental goods.

[4] Note that although there are around 250 LCTs, not all of these can be identified in trade statistics. Therefore, the list of HS codes used to estimate trade in LCT products comprises 124 codes.

[5] For more information, see https://data.imf.org/?sk=9d6028d4-f14a-464c-a2f2-59b2cd424b85

products." The series is estimated by economy, and then all economies are summed to get the "World" total. Data by trading partner are also available.[6] Exports of LCT products are expressed in US dollars.

9. **Imports of LCT Products:** Imports of LCT products comprise all LCT products entering the national territory. It is simply the aggregation of all imports reported by each economy that meet the definition of "LCT products." The series is estimated by economy, and then all economies are summed to get the "World" total. Data by trading partner are also available. Imports of LCT products are expressed in US dollars.

10. **Exports of LCT Products as Share of Total Exports:** The indicator is calculated as an economy's exports of LCT products divided by the economy's total goods exports, then multiplied by 100. The series is estimated by economy and for the "World" total. Total goods exports by economy are estimated by aggregating all commodities data (also from UN Comtrade). For "World," total goods exports come from DOTS. A relatively high share indicates that an economy produces and sells a significant share of LCT products to other economies.

11. **Imports of LCT Products as Share of Total Imports:** The indicator is calculated as an economy's imports of LCT products divided by the economy's total goods imports, then multiplied by 100. The series is estimated by economy and for the "World" total. Total goods imports by economy are estimated by aggregating all commodities data (also from UN Comtrade). For "World," total goods imports come from DOTS. A relatively high share indicates that an economy is consuming or investing in LCT products by importing from other economies.

12. **Exports of LCT Products as Percent of GDP:** The indicator is calculated as an economy's exports of LCT products divided by the economy's national-accounts-basis GDP at current prices (from World Economic Outlook), then multiplied by 100. The series is estimated by economy and for the "World" total. A relatively high percent indicates that an economy produces and sells a significant share of LCT products to other economies.

13. **Imports of LCT Products as Percent of GDP:** The indicator is calculated as an economy's imports of LCT products divided by the economy's national-accounts-basis GDP at current prices (from World Economic Outlook), then multiplied by 100. The series is estimated by economy and for the "World" total. A relatively high percent indicates that an economy purchases a significant share of LCT products from other economies.

14. **Trade Balance in LCT Products:** The trade balance in LCT products is calculated as exports of LCT products *minus* imports of LCT products. The series is calculated by economy and for the "World" total. Trade balance by trading partner is also available. The indicator is expressed in US dollars. A positive trade balance means an economy has a surplus in LCT products (exports are greater than imports), while a negative trade balance means an economy has a deficit in LCT products (imports are greater than exports). This series can be used to identify which economies are net exporters and which economies are net importers of LCT products.

15. **Trade Balance in LCT Products as Percent of GDP:** This indicator is calculated as an economy's trade balance in LCT products—the difference between its exports and imports of LCT products—divided by the economy's national-accounts-basis GDP at current prices (from World Economic Outlook), then multiplied by 100. The series is calculated by economy and for the "World" total.

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[6] See box "Bilateral Asymmetries in Trade Data" for information on how to interpret the bilateral trade data.

16. **Total Trade in LCT Products:** Total trade is the sum of exports and imports of LCT products. This measure provides an indication of an economy's involvement (openness) to trade in LCT products, which is important for understanding how these technologies can be transferred between economies. The series is calculated by economy and for the "World" total.

17. **Total trade in LCT Products as Percent of GDP:** This indicator is calculated as an economy's total trade in LCT products—the sum of exports and imports of LCT products—divided by the economy's national-accounts-basis GDP at current prices (from World Economic Outlook), then multiplied by 100. The series is calculated by economy and for the "World" total.

18. **Comparative Advantage in LCT Products:** Comparative advantage is a measure of the relative advantage or disadvantage a particular economy has in a certain class of goods (in this case, LCT products), and can be used to evaluate export potential in that class of goods. Comparative advantage is calculated as the proportion of an economy's exports that are LCT products to the proportion of global exports that are LCT products. The formula is shown in Figure 1. A value greater than one indicates a relative advantage in LCT products, while a value of less than one indicates a relative disadvantage.

Figure 1. Comparative advantage

$$\frac{\frac{LCTX_c}{TGX_c}}{\frac{LCTX}{TGX}}$$

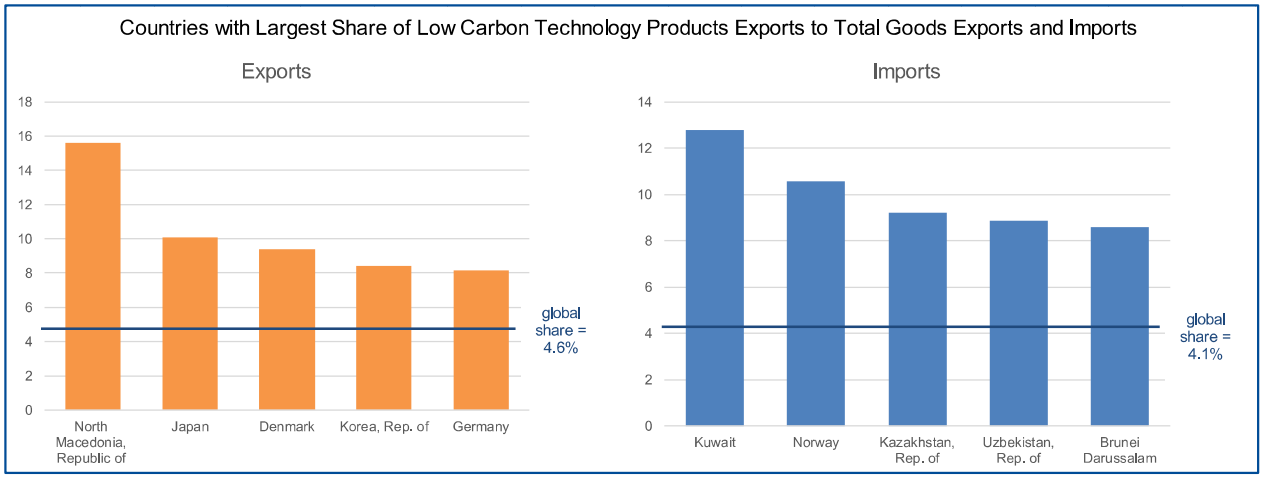
where:
$LCTX_c$ = LCT products exports of economy c, derived from UN Comtrade
$LCTX$ = LCT products exports of all economies (World total), derived from UN Comtrade
TGX_c = total goods exports of economy c, derived from UN Comtrade
TGX = total exports of all economies (World total), from DOTS

RESULTS

19. The resulting measures can provide valuable insights into which economies are exporting and importing LCT products, whether LCT products are becoming more important in merchandise trade over time, and which economies have a comparative advantage in these goods. Some illustrative results are provided below.

20. In 2019, the top 5 economies with the largest exports of LCT products were China, Germany, the United States, Japan and Korea, while the top 5 economies with the largest imports of LCT products were the United States, China, Germany, Mexico, and the United Kingdom. However, looking at the top 5 in terms of the share of LCT products to total goods presents a very different picture. Figure 2 shows the top 5 economies for exports and top 5 economies for imports in terms of the share of LCT products exports and imports to total goods exports and imports (for 2019). These economies all have shares of LCT products that exceed the global share, which is around 4 percent for both exports and imports.

Figure 2. LCT products as a share of total goods trade



21. Economies with the highest share of exports of LCT products to total goods exports have often specialized in certain technologies. For example, North Macedonia exports emission control catalysts that are used to filter diesel vehicle exhaust. These systems are mostly exported to other European countries to meet the Euro IV heavy duty diesel emission standards. Economies with high shares of imports of LCT products are consuming and investing in LCTs. For example, Kuwait imports parts for gas turbines and other equipment related to the use of natural gas in electrical power generation.[7]

22. The long time series that the trade data provide also allows us to see that LCT products are growing as a share of total goods trade. LCT products have grown as a share of total global exports from 3.2 percent in 1999 to 4.6 percent in 2019. Likewise, for imports, LCT products have grown from around 3.1 percent to 4.1 percent. Figures 3 and 4 show how the export shares have grown over time for selected economies—first for the economies with the largest increase in share over the period (Figure 3) and then for the largest exporters of LCT products (Figure 4). Figure 5 shows the shares for the largest importers of LCT products.

Figure 3. LCT products export share, countries with largest increase in share, 1999-2019

[7] These products are considered LCT products because electrical power generation using natural gas produces lower emissions than traditional fire power generation methods.

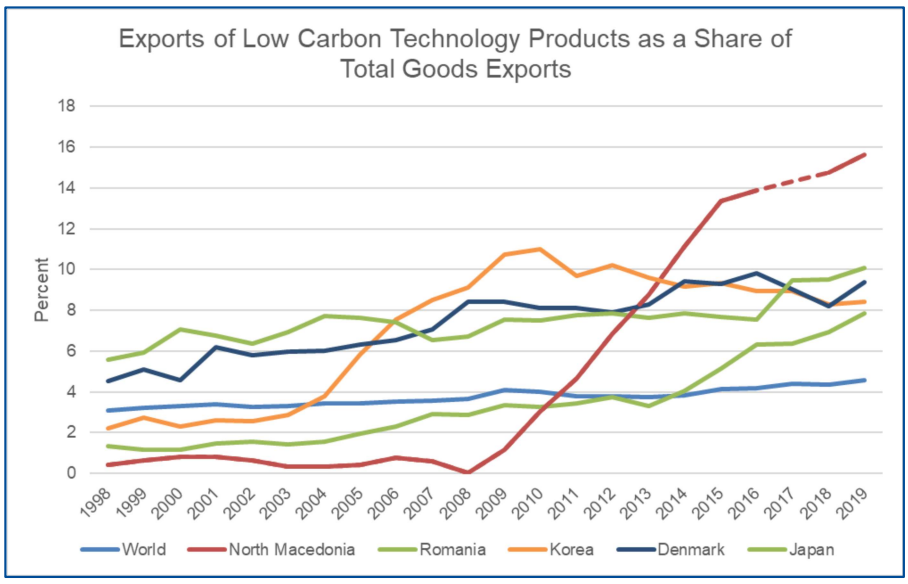


Figure 4. LCT products export share for largest exporters of LCT products

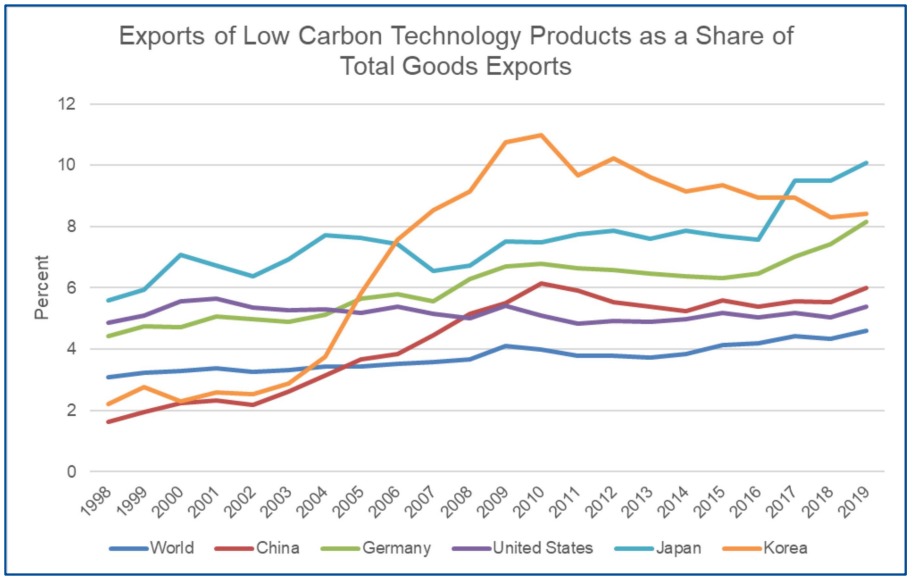


Figure 5. LCT products import share for largest importers of LCT products

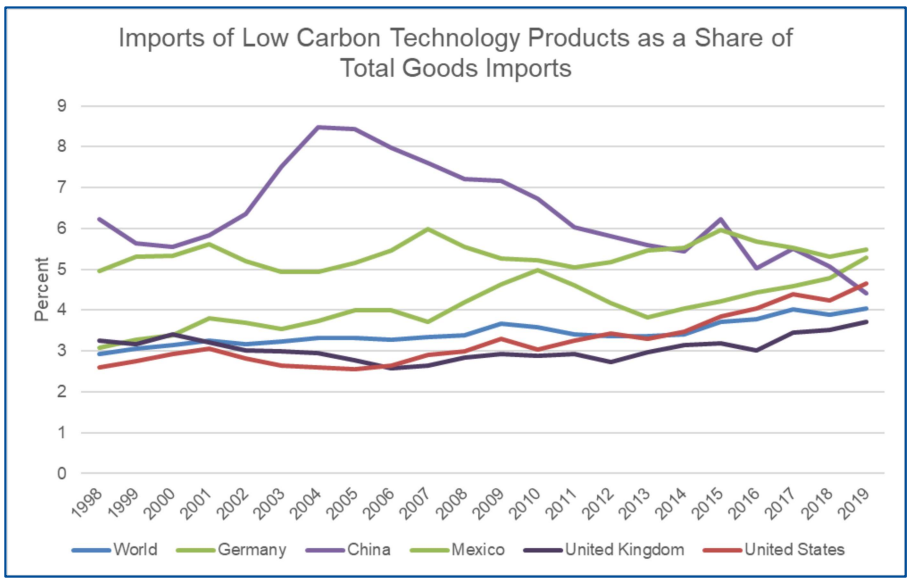
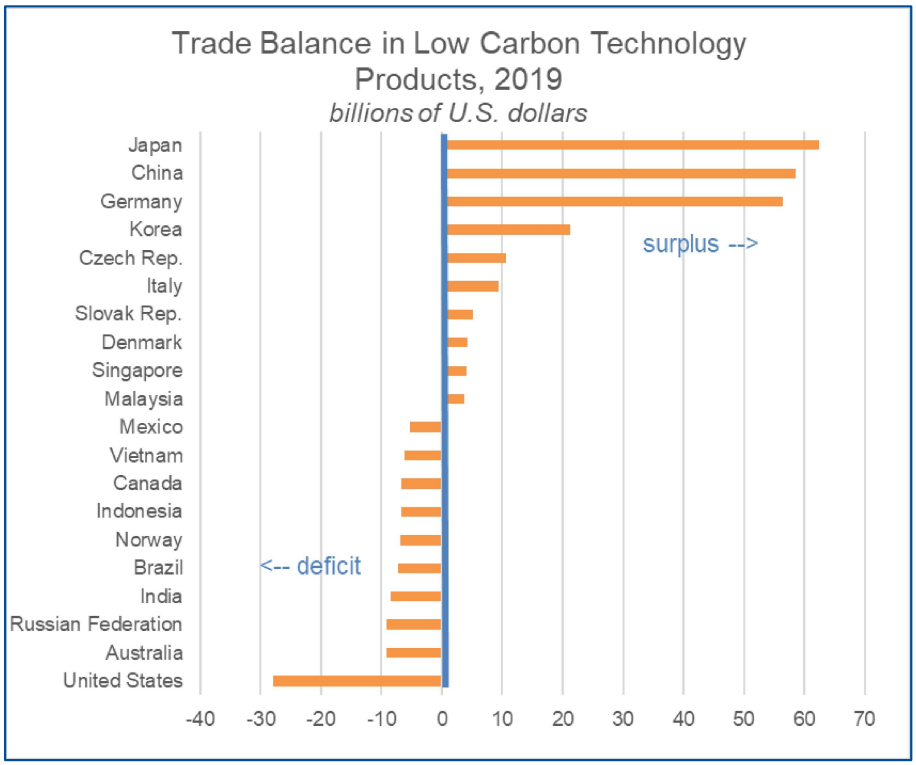


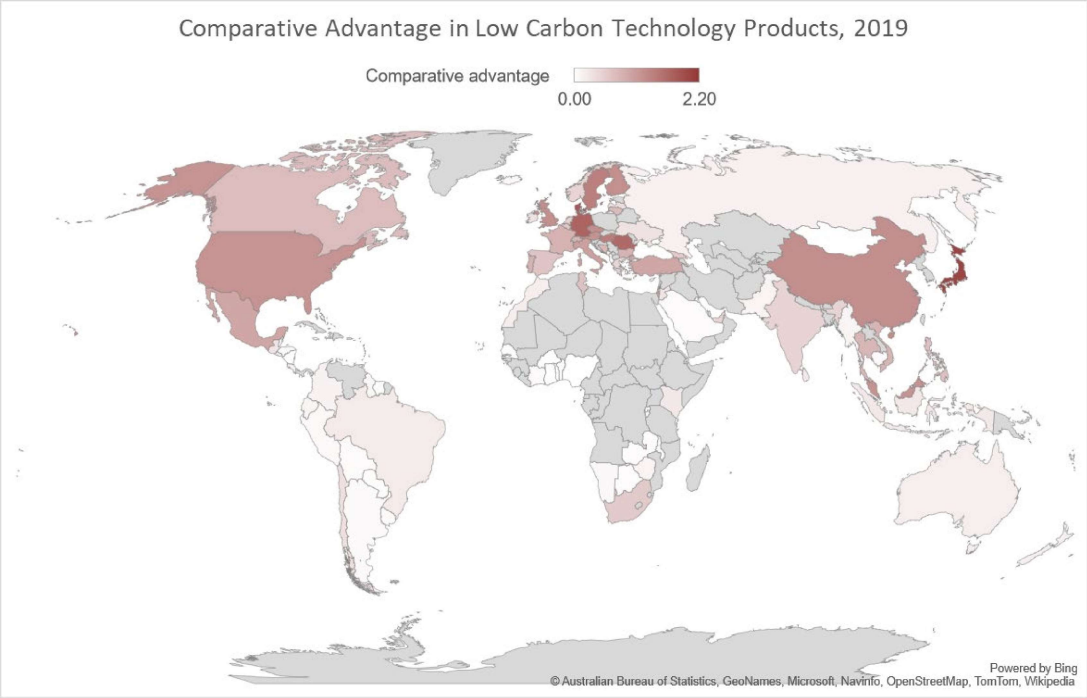
Figure 6. Net exporters and importers



24. The map in Figure 7 shows which economies have a relative advantage in LCT products (index greater than one, shown as a darker red) and which economies have a relative disadvantage in LCT products (index

less than one, lighter color).[8] North Macedonia (not shown) has the highest comparative advantage because of a few specialized products that account for a significant share of its exports, as mentioned earlier.[9] In total, twenty-three economies have a relative advantage in LCT products, including Japan, Denmark, Korea, Germany, China, the United Kingdom, and the United States.

Figure 7. Comparative advantage



LIMITATIONS AND NEXT STEPS

25. There are some limitations to the estimates of LCT products which are mostly related to the ability to define LCT products and measure it using trade data. The commodity codes used to report trade flows were developed for customs purposes, to impose duties, and not for statistical purposes. Therefore, there are challenges with applying them to the purpose of measuring LCT products. First, some LCT products have no equivalent commodity code. In other cases, the codes that have been included in the indicators may capture trade in commodities that are not LCT products. For example, the code used to capture wind turbines includes other engines that are not related to wind power. At the country or regional level, the commodity codes are more granular—with 8- or 10-digit codes, which allow for the identification of more detailed products within a 6-digit category. However, since these more detailed codes are not harmonized across all countries, they cannot be used to estimate LCT products for the broad set of countries included in the dashboard.

Bilateral Asymmetries in Trade Data

[8] Countries shown in gray are ones for which data are not available for 2019.

[9] It is excluded from the map in order to allow for more color variation across the other economies.

1. Bilateral trade flows, e.g. data by trading partner, are also available in the LCT products dataset. Bilateral trade flows can provide interesting insights into the destination of an economy's exports and the origin of an economy's imports. However, there are a number of known challenges in using bilateral trade data because there are asymmetries in the reporting by the two partners. So, for example, the amount Economy A reports that it exported to Economy B should equal the amount that Economy B reports that it imported from Economy A, but, in practice, this is never the case.

2. The primary reasons for trade asymmetries are a) the application of different criteria of partner economy attribution in import and export statistics, b) the use of different valuation bases for import and export statistics, and c) the application of different trade systems in data compilation.[10] The guidelines for measuring merchandise trade recommend that imports be recorded by "country of origin" while exports are to be recorded by "country of export," or "country of last known destination." This inevitably means that import data will not mirror export data.[11] Other sources of trade asymmetries include differences in classification and time of recording.

3. Given these challenges, the bilateral trade flows should be used with caution. For example, users may want to view bilateral detail reported by each partner economy to assess whether asymmetries are significant. Users may choose to use the flows reported from only one perspective, e.g. only the importer's reported goods imports, which are generally assumed to be better measured than goods exports. Another alternative would be to take an average of the two reported flows.

4. Bilateral trade asymmetries also have implications for global trade aggregates. Users of the LCT products indicators will note that at the World level the trade balance is not zero, as might be expected since all economies combined exports should, conceptually, equal all economies combined imports. This is because of bilateral asymmetries as well as non-reporting from some economies. These differences have been highlighted by international organizations for many years.[12]

[10] From "Bilateral Asymmetries" available at https://unstats.un.org/unsd/tradekb/Knowledgebase/50657/Bilateral-asymmetries.

[11] For more information, see Vladimir Markhonko, "Asymmetries in official international trade statistics and analysis of globalization: Discussion paper" Prepared for the International Conference on the Measurement of International Trade and Economic Globalization (2014); https://unstats.un.org/unsd/trade/events/2014/mexico/Asymmetries%20in%20official%20ITS%20and%20analysis%20of%20globalization%20-%20V%20Markhonko%20-%2018%20Sep%202014.pdf.

[12] See for example, "Revisiting Global Asymmetries—Think Globally, Act Bilaterally," Prepared by the IMF Statistics Department for the 28th Meeting of the IMF Committee on Balance of Payments Statistics (2015); https://www.imf.org/external/pubs/ft/bop/2015/pdf/15-08.pdf.

Annex 1. Environmental Goods Compared to Low Carbon Technology Products

	Environmental Goods as defined for the IMF Climate Change Indicators Dashboard	**Low Carbon Technology Products** as defined for the IMF Climate Change Indicators Dashboard
Definition	Environmental goods include both goods connected to environmental protection—such as goods related to pollution management and resource management—and adapted goods—which are goods that have been specifically modified to be more "environmentally friendly" or "cleaner."	Low carbon technology products produce less pollution than their traditional energy counterparts and will play a vital role in the transition to a low carbon economy.
Number of HS codes	222	124
Types of goods covered, according to Broad Economic Categories (BEC)	Food and beverages Industrial supplies, primary Industrial supplies, processed Fuels and lubricants Capital goods Transport equipment Consumer goods	Industrial supplies, processed Capital goods Transport equipment Consumer goods