Substantial decline in Commercial Industry sector energy consumption and background statistical accuracy issue

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Summary

Final energy consumption in FY2022 decreased by 3.3% from the previous year, the first decline in two years. The Transportation sector was the only energy consumption gainer, posting a 4.0% increase thanks to the easing of behavioural restrictions. The industry sector (Manufacturing and Agriculture, Fishery, Mining and Construction) reduced energy consumption by a steep 6.4% due to sluggish manufacturing production. The Residential sector registered a 2.3% decrease due to fewer opportunities to stay at home and a drop in space/water heating demand under warm winter weather, cutting energy consumption for the second straight year. The Commercial Industry sector recorded a 5.3% decline, the second fastest fall after the industry sector decrease.

Why did the Commercial Industry sector reduce energy consumption so remarkably despite the normalisation of the services industry after the COVID-19 disaster? The reason may be found in the statistical system and accuracy rather than in energy efficiency improvement or warm winter weather. A major factor behind the sharp Commercial Industry sector energy consumption decline was a drop in gasoline and other energy consumption that was caused by Unable to Classify subsector contained in the Commercial Industry sector. The Commercial Industry sector reportedly covers energy consumption by public sector vehicles. Given a mismatch between energy supply and demand, however, we can suspect that an energy consumption decline in the *pure* commercial sector may have been more moderate.

For most of the last 10 years, diesel oil in Unable to Classify was more than any other energy source, accounting for 10% of diesel oil supply. Due to the wide range of applications of diesel oil, it is not easy to determine the cause of this situation. Therefore, we evaluated the correlation between diesel oil demand in each user category and supply excluding the influence on each category from demand in other categories. As a result, we found that some improvements could be made in Agriculture, Fishery, Mining and Construction, the specified industries of the Commercial Industry sector, and Truck and Lorry, known for the largest diesel oil demand.

Figure 1 | Commercial Industry sector energy consumption (year-on-year changes)

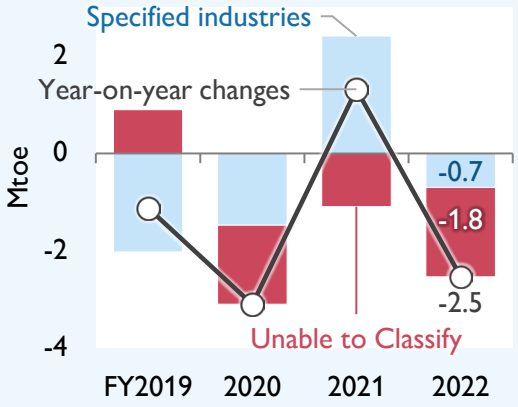
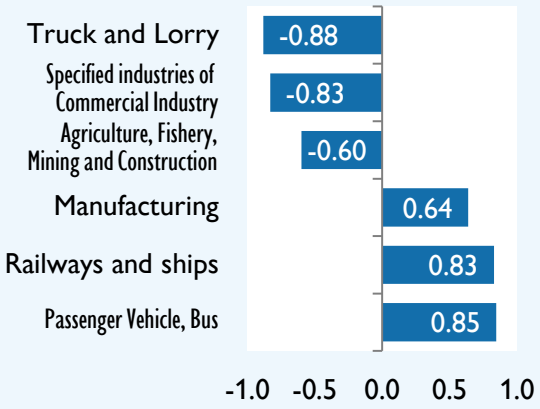


Figure 1 | Partial correlation coefficient between diesel oil demand in each user category and supply



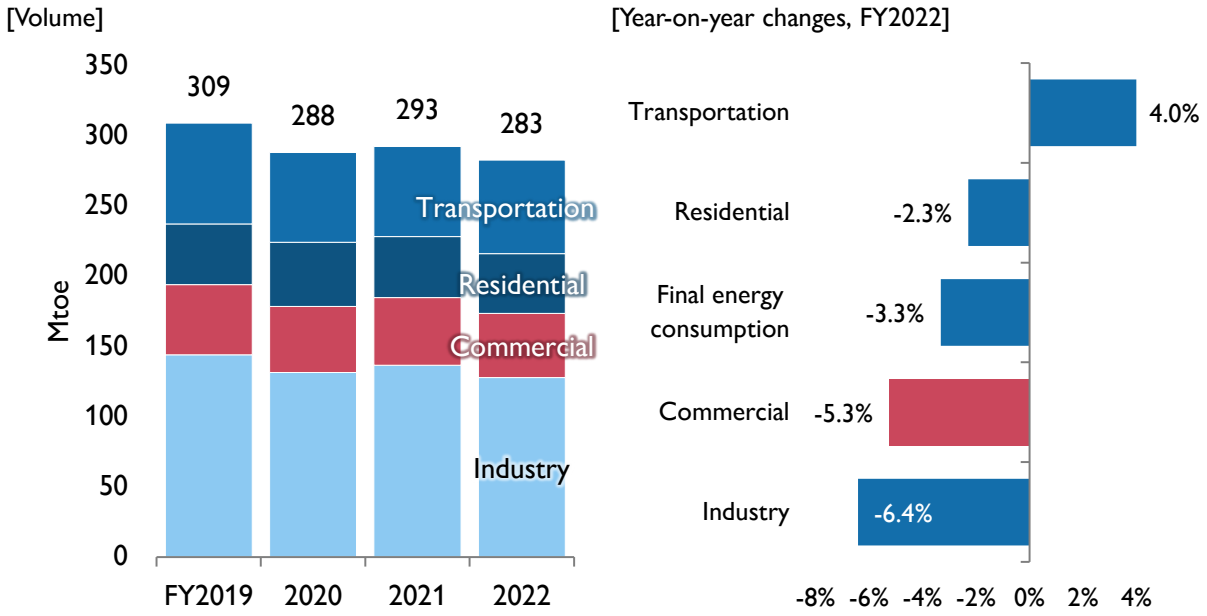
Keywords: diesel oil, Commercial Industry sector, Unable to Classify, trucks, fuel efficiency, General Energy Statistics

In FY2022, the diesel oil supply-demand gap widened as a fuel efficiency improvement for trucks more than offset an increase in truck mileage in a manner to reduce the demand. It, however, is unclear whether this rapid improvement in fuel efficiency accurately reflects reality. It is implied that the accuracy of the Energy Consumption Statistics and, above all, of the Survey on Motor Vehicle Fuel Consumption should be improved to resolve the "missing barrels" of diesel oil. Specific improvement measures may include the creation of various verification opportunities and the improvement of a commercial vehicle survey that is limited to seven days a month.

Energy consumption declined for the first time in two years, slipping below the level seen in the first year of the COVID-19 pandemic

According to the General Energy Statistics[1] released recently by the Agency for Natural Resources and Energy, Japan's final energy consumption in FY2022 decreased by 3.3% from the previous year for the first decline in two years (Figure 3). As economic and social activities were on the way out of the COVID-19 disaster, real gross domestic product (GDP) increased by 1.5% in the year. This GDP growth, however, was driven by the services industry (with the Tertiary Industry Activity Index rising by 2.2%), which benefited from the easing of behavioural restrictions to prevent COVID-19 infections, and by the machinery industry (with the Industrial Production Index increasing by 2.0%), including automakers, which expanded production after a decline attributable to semiconductor and other component shortages. Both are non-energy-intensive industries. On the other hand, production was sluggish in manufacturing industries other than the machinery industry, leading the overall mining and manufacturing production index to drop by 0.3% for the first decline in two years. Temperatures, which have a significant impact on energy demand, tended to be higher than in the previous year. Higher temperatures contributed to an increase in demand for space cooling in summer and a decrease in demand for space/water heating in winter. Russia's invasion into Ukraine accelerated energy price hikes, exerting downside pressure on energy demand.

Figure 2 | Final energy consumption



Source: Agency for Natural Resources and Energy "General Energy Statistics", https://www.enecho.meti.go.jp/statistics/total_energy/

Transportation (sector code in the General Energy Statistics: #800000) was the only sector to increase energy consumption, posting a 4.0% rise. This was because consumption by Passenger Transportation (#810000) soared as car use recovered from low levels in FY2020 and FY2021 due to the easing of behavioural restrictions. On the other hand, manufacturing production was sluggish, including production in energy-intensive petrochemical and steelmaking industries. As a result, the industry sector[2] recorded a 6.4% decline in energy consumption, the third ever sharpest fall after plunges in FY2020 or the first year of the COVID-19 disaster and FY2008 amid the global financial crisis. This

[1] https://www.enecho.meti.go.jp/statistics/total_energy/ (Accessed on 12 April 2024)

[2] Manufacturing (#620000) and Agriculture, Fishery, Mining and Construction (#610000). Energy consumption in the industry sector is dominated by Manufacturing.

was the fastest decline among sectors in FY2022. In the Residential sector (#700000), fewer opportunities to stay at home amid the easing of behavioural restrictions affected energy consumption. A decline in space/water heating demand under warm winter weather more than offset an increase in space cooling demand under summer heat waves. Although the Residential sector in FY2020 and FY2021 had been the only sector to increase energy consumption from the pre-COVID-19 level, its consumption in FY2022 decreased by 2.3% from the previous year, slipping below the FY2019 level. The Commercial Industry sector (#650000) posted a 5.3% energy consumption decline in FY2022, the second fastest after the industry sector decrease.

Why was the Commercial Industry sector decline so remarkable?

Here is a question. Why was the decline in the Commercial Industry sector so remarkable? Services, including personal services, were being normalised after the devastation caused by the COVID-19 disaster. For example, the Nationwide Travel Support that started in October 2022 stimulated tourism demand, leading the accommodation industry to regain its vitality to the extent where labour shortages were seen. For the answer to the question, some people may look to temperatures. Certainly, it is suspected that warm winter weather worked to reduce energy consumption through a decrease in space/water heating demand. The Commercial Industry sector, however, features less space/water heating demand and more space cooling demand, which increased in FY2022, than the residential sector. Nevertheless, the energy consumption decline in the Commercial Industry sector was more than two times faster than in the Residential sector. Temperature data rather deepen the question.

Perhaps the answer to the question should be sought in the statistical system. There are three types of tables in the General Energy Statistics, with different sectors and energy intensities. Two tables other than the summary table provide a breakdown of the Commercial Industry sector (Table 1). The breakdown covers not only specified industries[3] ranging from Electricity, Gas, Heat Supply and Water (#651000) to Government (#680000) but also Unable to Classify (#690000) that should be revisited here. The Commentary of General Energy Statistics by the Agency for Natural Resources and Energy[4] explains:

> *Energy consumption of aircraft, ships and vehicles used by the public sector for policing, firefighting, maritime security, defence and other purposes is covered in this sector as they do not transport passengers or cargo.*

The Unable to Classify made a great contribution to the decrease in the Commercial Industry sector in FY2022. It, while accounting for less than 10% of the Commercial Industry sector's energy consumption, posted a greater energy consumption decrease than the specified industries (Figure 4). Of the sector's energy consumption decline at 2.5 million tonnes of oil equivalent (Mtoe) or 5.3%, it captured 1.8 Mtoe with -3.8% of contribution.

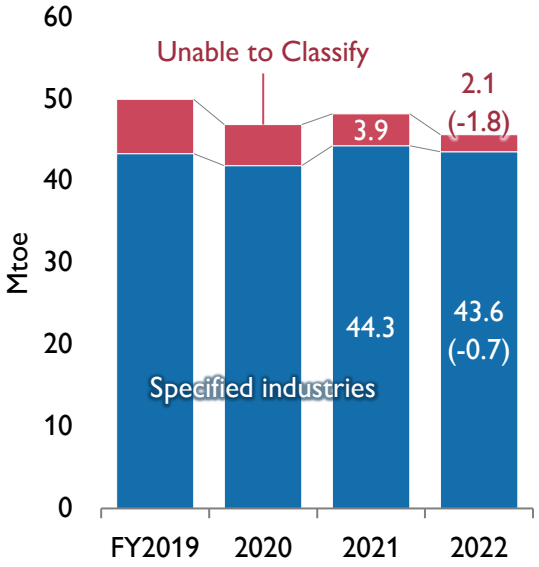
[3] "Specified industries" represent a term used for this paper, failing to appear in the General Energy Statistics.

[4] https://www.enecho.meti.go.jp/appli/public_offer/2023/data/0216_02_04.pdf (Accessed on 16 February 2024)

Table 1 | Breakdown of Commercial Industry sector

Commercial Industry (#650000)
Specified industries
◆ Electricity, Gas, Heat Supply and Water (#651000)
◆ Information and Communications (#652000)
◆ Transport and Postal Activities (#653000)
◆ Wholesale and Retail Trade (#654000)
◆ Finance and Insurance (#655000)
◆ Real Estate and Goods Rental and Leasing (#656000)
◆ Scientific Research, Professional and Technical Services (#657000)
◆ Accommodations, Eating and Drinking Services (#658000)
◆ Living-related and Personal Services and Amusement Services (#659000)
◆ Education, Learning Support (#660000)
◆ Medical, Health Care and Welfare (#661000)
◆ Compound Services (#662000)
◆ Miscellaneous Services (#663000)
◆ Government (#680000)
Unable to Classify (#690000)

Figure 4 | Commercial Industry sector

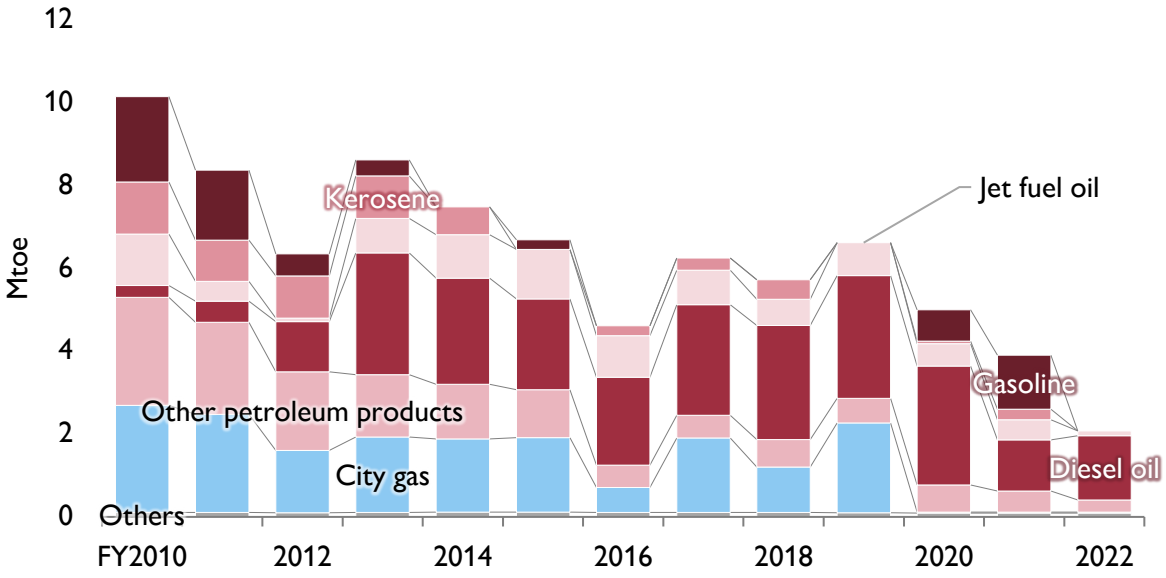


Note: In parentheses are changes from the previous year
Source: Agency for Natural Resources and Energy "General Energy Statistics", https://www.enecho.meti.go.jp/statistics/total_energy/

What are energy sources that contributed to the energy consumption decrease covered by Unable to Classify?

If so, what are energy sources that contributed to the energy consumption decrease of 1.8 Mtoe covered by Unable to Classify in FY2022? First, gasoline accounted for 1.3 Mtoe of the decline, followed by jet fuel oil for 0.4 Mtoe (Figure 5).

Figure 5 | Unable to Classify



Source: Agency for Natural Resources and Energy "General Energy Statistics", https://www.enecho.meti.go.jp/statistics/total_energy/

It, however, is difficult to believe that the disappearance of gasoline consumption for policing and firefighting services and a 75% plunge in jet fuel oil consumption by the Japan Coast Guard and the Self-Defense Forces from FY2021 to FY2022 reflect reality. Rather, it may be more natural to interpret it as statistical errors as defined by the Commentary of General Energy Statistics by the Agency for Natural Resources and Energy as follows:

> *Energy consumption that is logically estimated consumed domestically but cannot be classified into any final consumption sector is treated as Unable to Classify (#690000).*

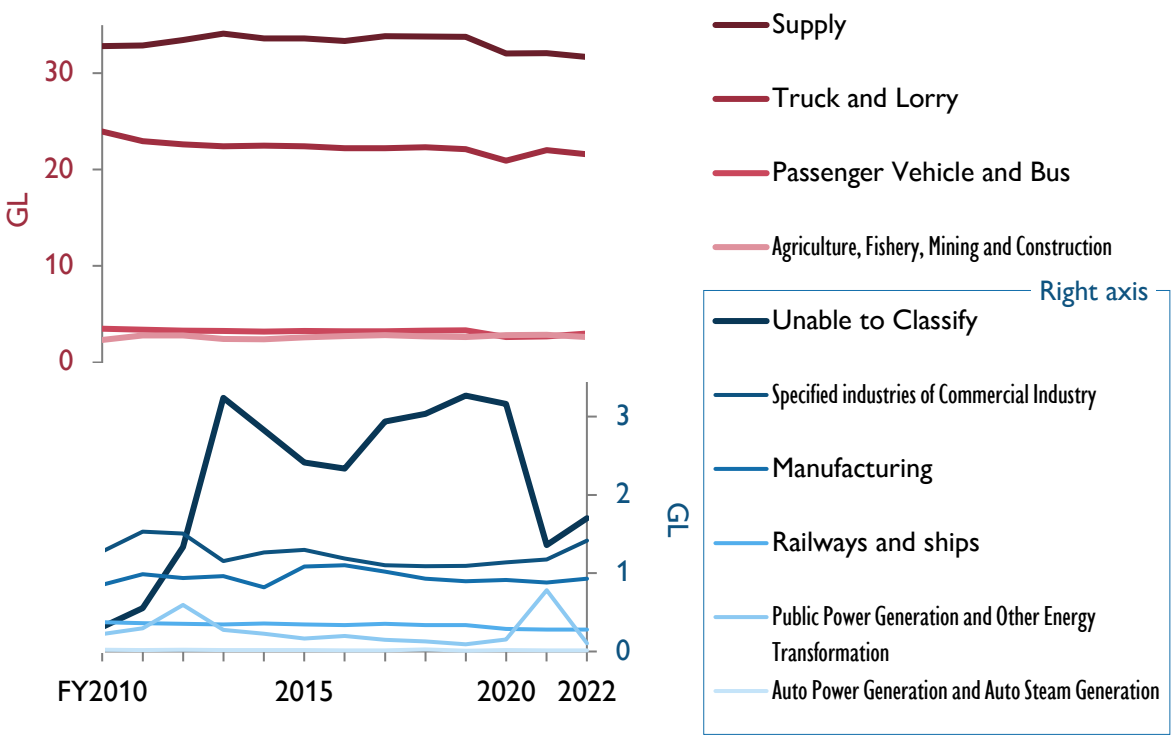
It thus represents a gap between supply and demand excluding Unable to Classify. According to the interpretation, an energy consumption decline in the *pure* commercial sector in FY2022 can be presumed as more moderate. A decline that is similar to or more moderate than the Residential sector fall may be persuasive.

However, it is ideal for numbers in statistics to be picked up with no consideration given to the need for such speculation. In this sense, amount of Unable to Classify (or its year-on-year changes) must be reduced close to zero. As gasoline is mostly consumed by vehicles, the Survey on Motor Vehicle Fuel Consumption by the Ministry of Land, Infrastructure, Transport and Tourism, which covers demand, must be made consistent with the Mineral Resources and Petroleum Products Statistics by the Agency for Natural Resources and Energy, which cover the supply side. If the consistency between them is further enhanced, the impact of Unable to Classify that may disrupt the Commercial Industry may be mitigated. The Mineral Resources and Petroleum Products Statistics known as a complete enumeration look accurate. In 2023, however, domestic sales of liquefied petroleum gas were revised by nearly 10% due to erroneous reports by some business establishments. As well as the Survey on Motor Vehicle Fuel Consumption, which is a sample survey, the supply side statistics should be improved further.

How about diesel oil which dominates Unable to Classify?

Gasoline and jet fuel oil statistics are easy to find measures to improve because their consumption areas are limited. In contrast, diesel oil, for which Unable to Classify increased by 344 ML in FY2022, has a wide range of uses, indicating that multiple primary surveys are required to depict the entire picture of its supply and demand. This is no exception regarding the tabulation of diesel oil data in the General Energy Statistics. Because of this, diesel oil posted more Unable to Classify than any other energy source in most of the latest decade. The errors for diesel oil, though declining in the latest two years, accounted for 10% of diesel oil supply in the 10 years (Figure 6). It is desirable to determine which primary surveys are responsible for this situation. It, however, cannot be easily elucidated since Unable to Classify are like statistical errors.

Figure 6 | Supply and demand of diesel oil



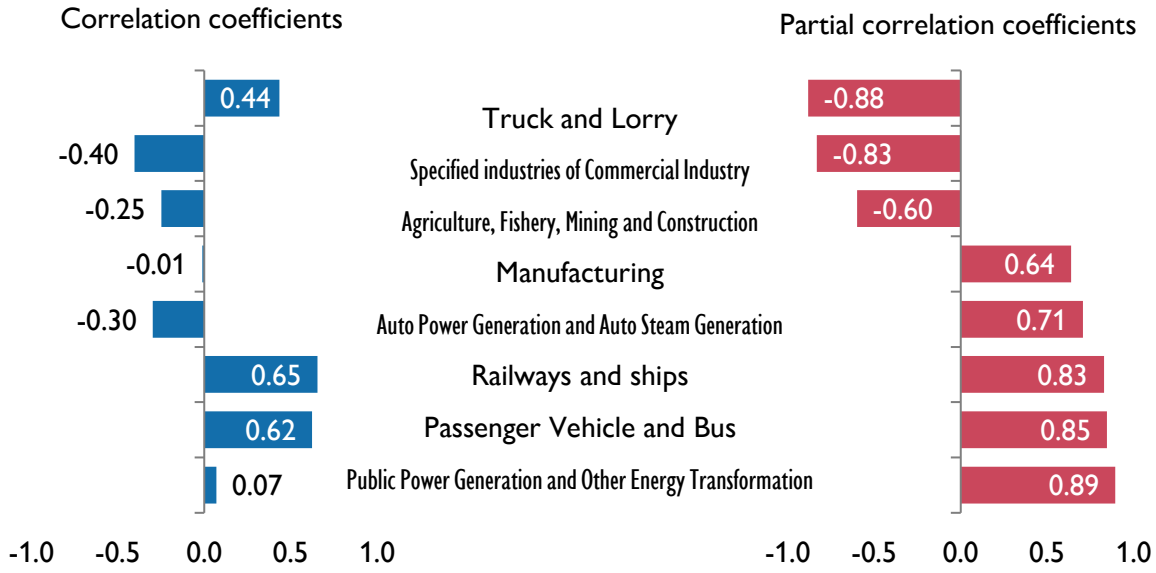
Source: Agency for Natural Resources and Energy "General Energy Statistics", https://www.enecho.meti.go.jp/statistics/total_energy/

Therefore, we tried to change our thinking and seek clues in General Energy Statistics data. We compared year-on-year changes in diesel oil demand for each user category and supply. Specifically, we checked how demand changes in each category are linearly correlated with supply changes. Correlation coefficients obtained in this way were 0.6 or more for railways (#813000 and #852000) and ships (#814000 and #853000), and for Passenger Vehicle (#811000) and Bus (#811500), indicating that the demand-supply correlation is fairly good for these categories (see the left part of Figure 7). A correlation coefficient for Truck and Lorry (#851000), the largest consumer of diesel oil, and in the same Transportation sector with the abovementioned modes, was 0.44, showing a smaller supply-demand correlation than for the other categories in the Transportation sector. For other user categories, however, supply-demand correlations were poor. In particular, supply-demand correlations were negative for the specified industries of the Commercial Industry, Auto Power Generation (#260000) and Auto Steam Generation (#250000), and Agriculture, Fishery, Mining and Construction (#610000) for which the Energy Consumption Statistics by the Agency for Natural Resources and Energy are used for calculation for the General Energy Statistics, meaning that supply declines when demand in these categories increases. We had no choice but to have doubts about such correlations.

Is the key to diesel oil in the Survey on Motor Vehicle Fuel Consumption and the Energy Consumption Statistics?

However, diesel oil supply and demand in each user category are not independent. For example, suppose that there were many years when diesel oil demand increased in the largest user category of Truck and Lorry while decreasing incidentally in Agriculture, Fishery, Mining and Construction. In this case, demand in Agriculture, Fishery, Mining and Construction is negatively correlated with supply, with supply looking inconsistent with demand. Taking such situation into account, we calculated a partial correlation coefficient to measure how demand in each user category is correlated with supply, after eliminating the influence of demand in other categories. As was the case with correlation coefficients, partial correlation coefficients were relatively high for railways and ships, and for Passenger Vehicle and Bus (seen the right part of Figure 7).

Figure 7 | Correlation coefficients and partial correlation coefficients between diesel oil demand in each user category and supply



Notes: Supply covers Domestic Primary Energy Supply (#190000), Oil Product Blending (#221000), Oil Refinery (#222000) and Other Energy Transformation (#280000) in the General Energy Statistics. The correlation coefficient and partial correlation coefficient are for between annual changes in demand in each user category and those of supply for the FY2011-2022 period.
Source: Calculated from the Agency for Natural Resources and Energy "General Energy Statistics", https://www.enecho.meti.go.jp/statistics/total_energy/

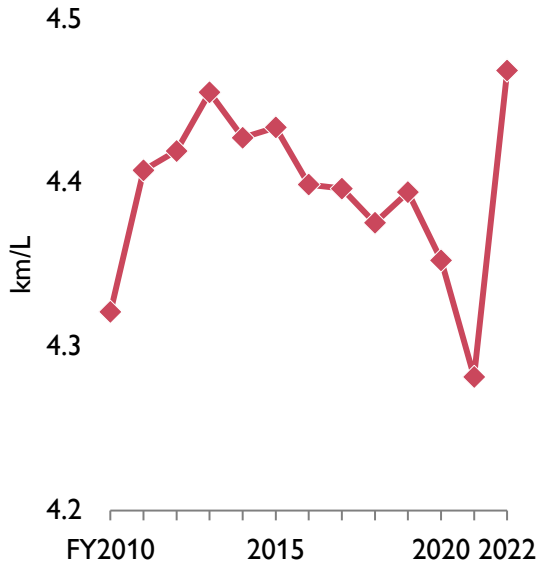
On the other hand, the user categories of Manufacturing (#620000), Auto Power Generation and Auto Steam Generation showed good partial correlation coefficients whilst posting negative correlation coefficients. When the General Energy Statistics are tabulated, not only the Energy Consumption Statistics but also the relatively accurate Current Survey of Energy Consumption by the Ministry of Economy, Trade and Industry are used for these user categories. This might have produced the better results. This is because the relationship between demand and supply as indicated by partial correlation coefficients is doubtful for the specified industries of Commercial Industry and Agriculture, Fishery, Mining and Construction for which the Current Survey of Energy Consumption are not used.

It should be noted here that the user category of Truck and Lorry recorded the largest negative partial correlation coefficient, implying that the reasonably good relationship between diesel oil demand for Truck and Lorry and supply as indicated by the correlation coefficient is only superficial and that whether diesel oil supply is consistent with demand for Truck and Lorry is uncertain. The diesel oil demand situation for Truck and Lorry, which account for 70% of diesel oil supply, is extremely significant for improving the supply-demand discrepancy.

Truck fuel efficiency in FY2022 behind expanded Unable to Classify for diesel oil

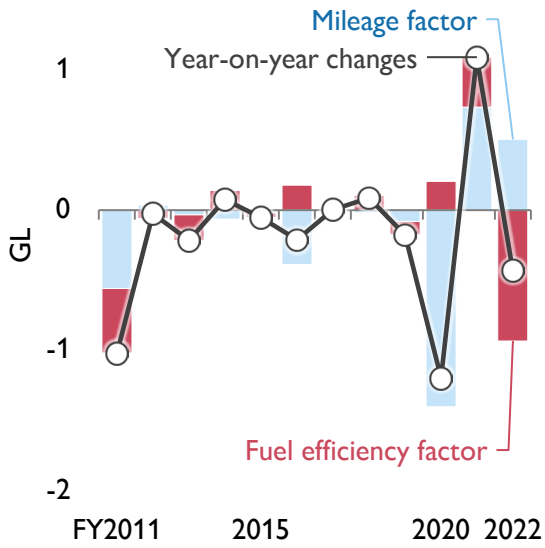
In FY2022, the rapid improvement in truck fuel efficiency more than offset the impact of an increase in truck mileage, exerting great downside pressure on diesel oil demand (Figures 8 and 9). Furthermore, supply failed to decline to reflect demand's reactionary fall after an increase in FY2021 for Public Power Generation (#240000) and Other Energy Transformation (#301000 and #350000). As a result, the supply-demand gap widened.

Figure 8 | Fuel efficiency for diesel-powered trucks



Source: Calculated from Ministry of Land, Infrastructure, Transport and Tourism "Survey on Motor Vehicle Fuel Consumption"

Figure 9 | Diesel oil demand for trucks (year-on-year changes)



Source: Calculated from Ministry of Land, Infrastructure, Transport and Tourism "Survey on Motor Vehicle Fuel Consumption"

Truck fuel efficiency had been relatively stable since FY2011, following the launch of the Survey on Motor Vehicle Fuel Consumption. However, a change in the efficiency in FY2022 was the largest ever, nearly seven times the previous 10-year average[5]. Whether or not this rapid improvement in fuel efficiency accurately reflects the actual situation cannot be verified due to the lack of detailed data or other statistics that can be compared. Anyway, the rapid improvement in truck fuel efficiency was one of the factors that statistically pushed up demand for diesel oil for the Commercial Industry through the expansion of a gap between supply and demand.

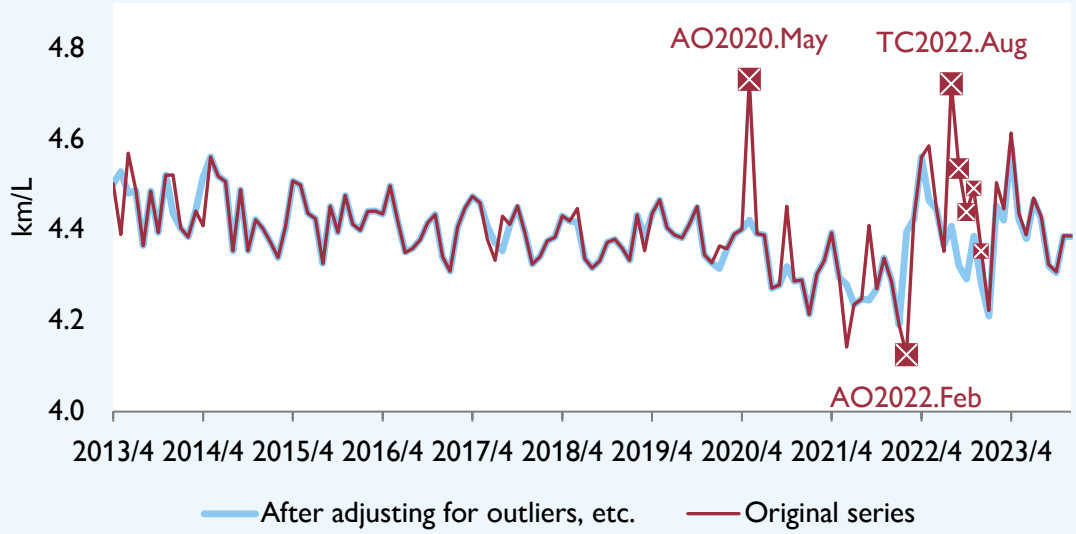
Box 1 | Destabilisation of fuel efficiency of diesel-powered trucks

Since FY2011, diesel-powered trucks' fuel efficiency calculated from the Survey on Motor Vehicle Fuel Consumption had remained in a range around 4.4 km/L. Since around FY2022, however, the changes seem to have become somewhat larger. Therefore, we used monthly data to delve into the trend. Specifically, we used the X-13ARIMA-SEATS seasonal adjustment method of the U.S. Census Bureau to verify the presence or absence of values that deviate from the trend. For the period from April 2013 to December 2023, for which monthly data were published, additive outliers in May 2020 and February 2022 (AO2020.May and AO2022.Feb) and a temporary change from August 2022 (TC2022. Aug) were detected (Figure 10).

May 2020 is considered to be an extremely special period, as a state of emergency was first declared due to the COVID-19 infection. In the period for upward deviation from August 2022, there was neither state of emergency declaration nor quasi-state of emergency declaration to prevent the COVID-19 spread, making it difficult to attribute the temporary change to any COVID-19 countermeasures.

[5] Some may believe that diesel oil price hikes led to the improvement in fuel efficiency. However, the year-on-year increase in diesel oil prices in FY2022 was limited to ¥7.6/L, the sixth largest increase in the 12 years from FY2011, due to the effects of the fuel oil price change mitigation subsidy that came into effect in January 2022 (Agency for Natural Resources and Energy "Petroleum Product Price Survey", gas station retail price). In FY2021, in contrast, fuel efficiency posted the greatest deterioration in the past 12 years despite the rapid price hike of ¥26.6/L.

Figure 10 | Fuel efficiency for diesel-powered trucks



Source: Ministry of Land, Infrastructure, Transport and Tourism "Survey on Motor Vehicle Fuel Consumption" [original series]

If the impact of this temporary change from August 2022 is eliminated, fuel efficiency in FY2022 may decrease by 1.9% from the actual value of 4.47 km/L to 4.38 km/L, indicating its deterioration. If the mileage is in line with the statistics, demand for diesel oil for trucks may be 422 ML more, reaching the level for the previous year. As a result, the year-on-year increase of 344 ML in Unable to Classify for diesel oil may be completely cancelled out.

Situation regarding statistics development is difficult despite its growing need

It is essential to improve the accuracy of the Energy Consumption Statistics and, above all, of the Survey on Motor Vehicle Fuel Consumption, given the scale of the demand, to resolve the "missing barrels" of diesel oil. Specific improvement measures may include the publication of more detailed statistical data for encouraging various quarters' verification and the reform of the survey method for commercial vehicles, which now limits the survey to seven days a month.

There is a growing need for more accurate, detailed, and fast statistics and data. However, there is a serious shortage of human resources for statistical development. Although there are many challenges and various constraints, we hope that the current situation will be improved from the perspective of appropriate policy implementation. OKUMA Shigenobu[6] stated:

> *"If the current state of the country fails to be clarified in more detail, the government will lose the reason for implementing policies. If the government fails to refer to the results of past policies, it will be unable to know whether the past policies were good or not."*

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[6] 1838-1922. A Japanese statesperson, the eighth and the 17th prime minister, the founder and the first president of the Statistics Bureau.