Carbon Performance Assessment of automobile manufacturers:

Note on methodology

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Transition Pathway Initiative

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1. INTRODUCTION

The purpose of this note is to provide an overview of the methodology followed by the Transition Pathway Initiative (TPI) in its assessment of the carbon performance of automobile manufacturers.

TPI is a global initiative led by asset owners and supported by asset managers. Established in January 2017, TPI investors now collectively represent more than 50 supporters with over US$15.5 trillion of assets under management.[1]

On an annual basis, TPI assesses how companies are preparing for the transition to a low-carbon economy in terms of their:

- *Management Quality* – all companies are assessed on the quality of their governance/management of greenhouse gas emissions and of risks and opportunities related to the low-carbon transition.
- *Carbon Performance* – in selected sectors, TPI quantitatively benchmarks companies' carbon emissions against the international targets and national pledges made as part of the 2015 UN Paris Agreement.

TPI publishes the results of its analysis through an open access online tool hosted by the Grantham Research Institute on Climate Change and the Environment at the London School of Economics (LSE): http://www.transitionpathwayinitiative.org.

Investors are encouraged to use the data, indicators and online tool to inform their investment research, decision making, engagement with companies, proxy voting and dialogue with fund managers and policy makers, bearing in mind the Disclaimer that can be found in Section 6. Further details of how investors can use TPI assessments can be found on our website at http://www.lse.ac.uk/GranthamInstitute/tpi/about/how-investors-can-use-tpi/.

[1] As of 7th October 2019.

2. THE BASIS FOR TPI'S CARBON PERFORMANCE ASSESSMENT: THE SECTORAL DECARBONIZATION APPROACH

TPI's carbon performance assessment is based on the Sectoral Decarbonization Approach (SDA).[1] The SDA translates greenhouse gas emissions targets made at the international level (e.g. under the Paris Agreement to the UN Framework Convention on Climate Change) into appropriate benchmarks, against which the performance of individual companies can be compared.[2]

The SDA is built on the principle that different sectors of the economy (e.g. oil and gas production, electricity generation and automobile manufacturing) face different challenges arising from the low-carbon transition, including where emissions are concentrated in the value chain, and how costly they are to reduce. Other approaches to translating international emissions targets into company benchmarks have applied the same decarbonization pathway to all sectors, regardless of these differences.[2]

Therefore the SDA takes a sector-by-sector approach, comparing companies within each sector both against each other and against sector-specific benchmarks. These benchmarks establish the performance of an average company that is aligned with international emissions targets.

Applying the SDA can be broken down into the following steps:

- A global carbon budget is established, which is consistent with international emissions targets, for example keeping global warming below 2°C. To do this rigorously, input from climate models is required.
- The global carbon budget is allocated across time and to different regions and industrial sectors. This typically requires an integrated economy-energy model, and these models usually allocate emissions reductions by region and by sector according to where it is cheapest to reduce emissions and when (i.e. the allocation is cost-effective). Cost-effectiveness is, however, subject to some constraints, such as political and public preferences, and the availability of capital. This step is therefore driven primarily by economic and engineering considerations, but with some awareness of political and social factors.
- In order to compare companies of different sizes, sectoral emissions are normalised by a relevant measure of sectoral activity (e.g. physical production, economic activity). This results in a benchmark path for emissions intensity in each sector:

  $$\text{Emissions intensity} = \frac{\text{Emissions}}{\text{Activity}}$$

  Assumptions about sectoral activity need to be consistent with the emissions modelled and therefore should be taken from the same economy-energy modelling, where possible.
- Companies' recent and current emissions intensity is calculated and their future emissions intensity can be estimated based on emissions targets they have set (i.e.

[2] Another initiative that is also using the SDA is the Science Based Targets Initiative (http://sciencebasedtargets.org/).

this assumes companies exactly meet their targets).[3] Together these establish emissions intensity paths for companies.

- Companies' emissions intensity paths are compared with each other and with the relevant sectoral benchmark pathway.

[3] Alternatively, future emissions intensity could be calculated based on other data provided by companies on their business strategy and capital expenditure plans.

3. HOW TPI IS APPLYING THE SDA

3.1. Deriving the benchmark paths

TPI evaluates companies against benchmark paths, which quantify the implications of the 2015 UN Paris Agreement on climate change at the sectoral level. These benchmarks include:

1. A **2 Degrees scenario**, which is consistent with the overall aim of the Paris Agreement to hold "the increase in the global average temperature to well below 2°C above pre-industrial levels and to pursue efforts to limit the temperature increase to 1.5°C above pre-industrial levels", albeit at the low end of the range of ambition.[3]
2. A **Paris Pledges scenario**. The Paris Agreement also incorporates emissions reduction pledges by individual countries, called Nationally Determined Contributions (NDCs). There is variation in the ambition of countries' NDCs.[4] On aggregate, they are forecast to reduce global emissions well below business as usual (assuming they are fully implemented), but they are currently insufficient to put the world on a path to limit warming to 2°C.[5]–[7]

In other sectors, we have also benchmarked companies against a Below 2 Degrees scenario, consistent with a more ambitious interpretation of the Paris Agreement's overall aim, stated above.

However, in the automobile sector there is a more important source of uncertainty about how fast automobile manufacturers will have to transition in a low-carbon scenario: the extent to which emissions reductions need to be achieved via the performance of new vehicles, versus changes in demand for travel and use of different modes of transportation.

Therefore in the automobile sector, rather than including a Below 2 Degrees scenario, we benchmark companies against two different 2 Degrees scenarios:

- The **2 Degrees (Avoid-Shift-Improve)** scenario assumes that emissions reductions associated with road transportation are delivered through a mixture of measures that place relatively more emphasis on avoiding the need for travel altogether (Avoid) and shifting to more energy-efficient modes of travel (Shift), compared with improving vehicle carbon efficiency (Improve).
- The **2 Degrees (High Efficiency)** scenario, by contrast, assumes that emissions reductions are achieved mainly by improving the carbon efficiency of new vehicles, resulting in a global average emissions intensity of new vehicles that is particularly low (and lower than a Below 2 Degrees, Avoid-Shift-Improve scenario), but technically feasible and consistent with policy commitments in some regions, such as the EU and India.[8]

For each benchmark path, the key inputs are:

- A time path of carbon emissions;
- A breakdown of this economy-wide emissions path into emissions from key sectors (the numerator of sectoral emissions intensity), including the sector in focus;
- Consistent estimates of the time path of physical production from, or economic activity in, these key sectors (the denominator of sectoral emissions intensity).

A central feature of automobile manufacturing is that the majority of the sector's lifecycle emissions, of the order of three quarters,[4] originate downstream from fuel combustion as the vehicles that have been manufactured and sold are driven (these emissions are categorised as "use of sold products", a subset of Scope 3 emissions).

Therefore it is more appropriate to measure companies according to the performance of their vehicles than it is according to the operational emissions involved in manufacturing (i.e. companies' Scope 1 and 2 emissions). This is in contrast to other sectors TPI has assessed, such as cement, electricity and steel, where most lifecycle emissions belong to Scopes 1 and 2. New vehicles are also the most appropriate focus, as existing stock usage is not normally within the scope of influence of manufacturers' sustainability policies.

It has thus been suggested that a suitable measure of carbon performance in the automobile manufacturing sector is the **average emissions intensity of a company's fleet of new vehicles.**[9] This is the approach being followed by TPI.

TPI's benchmark paths for fleet emissions are based on research by the International Council on Clean Transportation (ICCT), in particular the outputs from its Roadmap model of global transportation.[10] Roadmap provides detailed, integrated modelling of emissions and activity for different modes of transportation.

For each scenario, Roadmap provides a pathway for lifecycle (known as Well-to-Wheel) emissions from Light Duty Vehicles (LDVs), including passenger cars specifically, as well as the level of use of these vehicle classes in terms of distance travelled. **The scope of TPI's analysis is limited to passenger cars**, due to the greater availability of manufacturer data on this subset of LDVs. Roadmap also incorporates a model of the stock of vehicles in use at any point in time, which can be used to assess the emissions intensity of new vehicles specifically, which is what is required for carbon performance assessment.[5]

In order to ensure the benchmarks are comparable with data on fleet emissions intensity commonly reported by manufacturers, the precise measure of fleet emissions intensity that TPI uses is **Tank-to-Wheel CO_2 emissions per kilometre**. In order to obtain this measure using output from the Roadmap model, the following conversions are necessary:

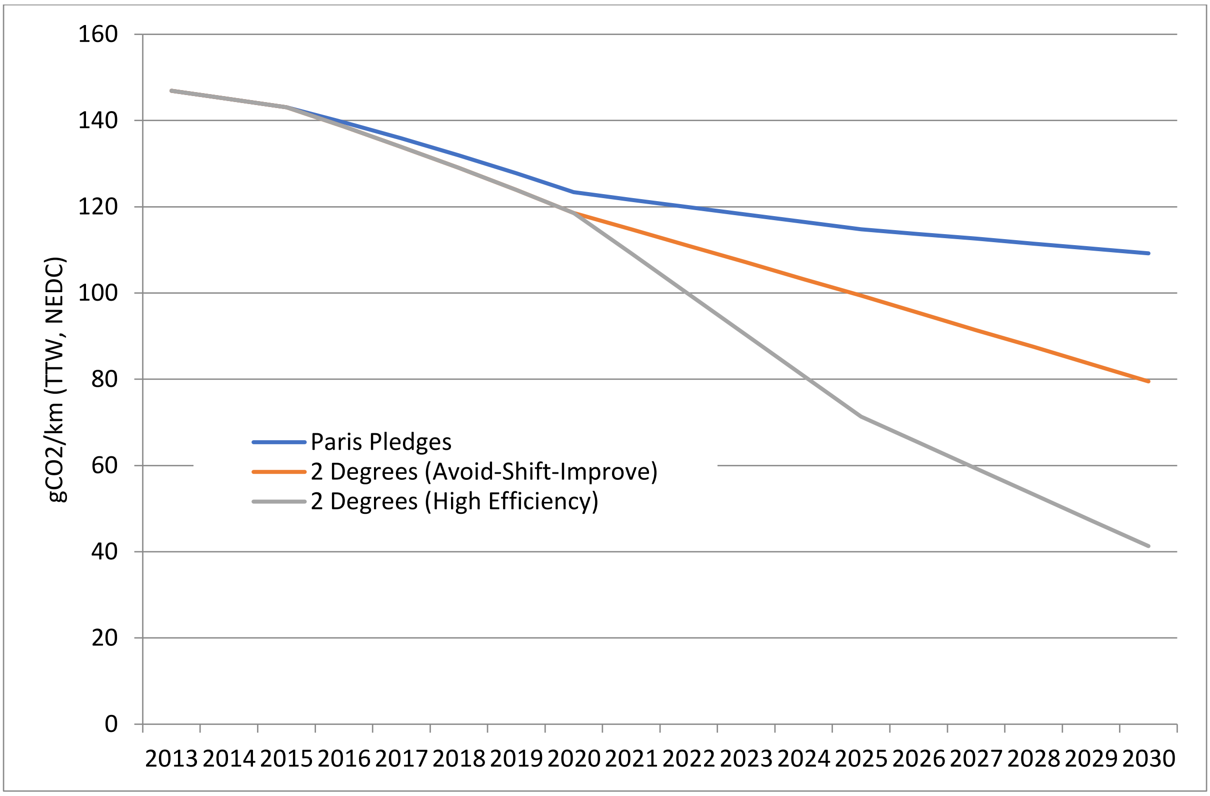
- Well-to-Wheel emissions are converted to Tank-to-Wheel emissions using ICCT data.
- Tank-to-Wheel emissions based on real-world driving conditions are converted into equivalent emissions in test-cycle conditions, using detailed analysis from ICCT showing that nowadays real-world emissions exceed test-cycle emissions by a significant margin, which varies depending on the precise test cycle.[11] TPI uses the New European Driving Cycle (NEDC) as the common basis for comparison.

[4] Source: ICCT.

[5] We verified that emissions from passenger cars and LDVs in the Roadmap model scenarios are consistent, in terms of cumulative emissions from 2015 to 2050, with the scenarios provided by the International Energy Agency (IEA),[14] which TPI has used to derive benchmark pathways in other sectors. Doing so ensures the economy-wide carbon budget is not exceeded once automobile manufacturing is included.

Figure 1 shows the benchmark emissions intensity paths for automobile manufacturers.

Figure 1 Benchmark global carbon intensity paths for automobile manufacturers' fleets of new passenger cars (grams of CO_2 per kilometre) consistent with limiting warming to 2°C and with the sum of the Paris Pledges



3.2. Data sources and validation

In automobile manufacturing, the primary sources of company data are companies' own disclosures, as well as publicly available information held by regulators. Sales data mostly come from company disclosures, whereas emissions data mostly come from regulators. Once a company's preliminary performance assessment has been made, it is subject to the following quality assurance:

- *Internal findings review*: the preliminary assessment is reviewed by analysts who were not originally involved in making it.
- *Company review*: once the initial findings review is complete, TPI writes to companies with their assessment and requests companies to review it and confirm the accuracy of the company disclosures being used. The company review includes all companies, i.e. it also includes those who provide unsuitable or insufficiently detailed disclosures.
- *Final assessment*: company assessments are reviewed and, if it is considered appropriate, revised.

3.3. Responding to companies

Allowing companies the opportunity to review and, if necessary, correct their assessments is an integral part of TPI's quality assurance process. We send each company its draft TPI assessment and the data that underpin the assessment, offering them the opportunity to review and comment on the data and assessment. We also allow companies to contact us at any point to discuss their assessment.

If a company seeks to challenge its result/representation, our process is as follows:

- TPI reviews the information provided by the company. At this point, additional information may be requested.
- If it is concluded that the company's challenge has merit, the assessment is updated and the company is informed.
- If it is concluded that there are insufficient grounds to change the assessment, this decision is explained to the company.
- If a company chooses to further contest the assessment and reverts to legal means to do so, the company's assessment is withheld from the TPI website and the company is identified as having challenged its assessment.

3.4. Presentation of assessment on TPI website

The results of the carbon performance assessment are posted on the TPI website (http://www.lse.ac.uk/GranthamInstitute/tpi/the-toolkit/). On each company page, its emissions intensity path is plotted on the same chart as the benchmark paths for the relevant sector. Different companies can also be compared on the main page of the online tool, with the user free to choose which companies to include in the comparison.

4. SPECIFIC CONSIDERATIONS IN THE ASSESSMENT OF AUTOMOBILE MANUFACTURERS

4.1. Measure of emissions intensity

TPI measures emissions intensity in the automobile sector according to the **average Tank-to-Wheel CO_2 emissions per kilometre of newly registered passenger cars globally, measured in terms of the New European Driving Cycle (NEDC)**. For individual manufacturers, the average is calculated at the fleet level. For the sectoral benchmarks, the average is taken across all manufacturers' fleets.

Vehicle manufacturers are subject to different regulatory regimes covering vehicle performance in different jurisdictions.[6] In each one, a designated driving cycle is used to test vehicle emissions. TPI uses the test standard applied by the European Union, the NEDC, as it directly measures CO_2 emissions per kilometre.[7] Other major regions use test cycles that report fuel efficiency instead (e.g. the Corporate Average Fuel Economy or CAFE standard that is used in the US and China, and the JC08 cycle that is used in Japan).

As well as for passenger cars, data are sometimes published for LDVs, a classification that includes smaller commercial vehicles, such as pick-ups, vans and minibuses. As mentioned in the previous section, TPI focuses on passenger cars, since data are available for a wider range of countries than is the case for LDVs.[8] However, there are slight variations in vehicle classifications between different regulatory regimes. In the EU, the passenger car classification (category M1) covers vehicles "designed…for the carriage of passengers and not exceeding eight seats".[9] By contrast, under the CAFE standards in the US and China, classification is primarily made by weight, meaning that sports utility vehicles (SUVs) are classified as light trucks.[10] These variations are accepted, because data are not available to adjust for the small discrepancies that result.

4.2. Estimating manufacturers' current fleet emissions intensity

4.2.1. Overview

To estimate the global-average emissions intensity of manufacturers' fleets of new passenger cars today, TPI combines regulatory data on test results for new cars in different jurisdictions with individual companies' regional sales figures.

Emissions or fuel economy data for new car registrations are published by regulators in the EU, US and China.[11] These data are often published by companies too, in their annual reports, sustainability reports, or CDP disclosures, in some cases complemented by coverage of other jurisdictions. Sales data are published by companies in annual reports, sales reports, or CDP disclosures.

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[6] Source: ICCT (http://www.theicct.org/chart-library-passenger-vehicle-fuel-economy).

[7] Since 1st September 2017, vehicle testing and type approval of vehicles in the EU has applied the World Harmonised Light Vehicle Test Procedure (WHTP). However, legislated emissions limits will continue to apply the NEDC until 2020.

[8] In some cases, LDV results are used as a basis to calculate a representative figure for passenger cars.

[9] European Union Regulation (EC) No 443/2009 of the European Parliament and of the Council of 23rd April 2009 (http://eur-lex.europa.eu/legal-content/EN/TXT/?uri=CELEX:32009R0443), Article 2 (Scope)

[10] https://www.epa.gov/emission-standards-reference-guide/epa-emission-standards-light-duty-vehicles-and-trucks

[11] For the EU, this is the EU Environment Agency. In China, data are published by the Ministry of Industry and Information Technology (MIIT) and reproduced in English language reports by the Innovation Center for Energy and Transportation (iCET). For the US, data are published by the National Highway Traffic Safety Administration (NHTSA).

4.2.2. Test cycle standardisation

As previously explained, regulators in the US and China regulate and report on fuel efficiency rather than emissions intensity, and US regulators do so according to a different test cycle to the NEDC. US and Chinese data must therefore be converted to gCO_2 / km as measured by the NEDC test cycle; this is done using a methodology published by the ICCT, which involves regression analysis of data on test cycle results.[12] The methodology also allows for the calibration of fuel efficiency conversions according to the proportion of sales that are diesel versus petrol (diesel vehicles emit more CO_2 per unit volume than petrol vehicles).

For US fuel efficiency results, which are published in miles per gallon (mpg) according to the CAFE test cycle, we apply the following formula:

$$Y = \textit{Fuel type coefficient}/(X/(A * LnX + B)).$$

Where:

- Fuel type coefficients are 5,497 for petrol and 6,315 for diesel
- Y = emissions per kilometre figure (gCO_2/km, NEDC)
- X = fuel efficiency figure (mpg, CAFE)
- A = -0.1033
- B = 1.473

For Chinese fuel efficiency results, which are published in litres per 100 km (l / 100 km) according to the NEDC test cycle, the following modification is made:

$$Y = \textit{Fuel type coefficient}/(235/X)$$

In a limited number of cases, Japanese fuel efficiency results are published by automobile companies and must also undergo conversion. Japanese regulation covers fuel efficiency in kilometres per litre (km/l) according to the JC08 test cycle. The following formula is applied:

$$Y = \textit{Fuel type coefficient}/\big(X * (-0.0841 * LnX + 1.3464)\big).$$

In the calculation of fuel type coefficients, diesel sales shares are estimated as 1% for all companies in China and the US, and 4% for all companies in Japan.[13]

4.2.3. Using regional data to calculate a global average for companies

The availability of EU, US and Chinese emissions data is a good starting point for calculating manufacturers' global-average fleet emissions intensity, as these three markets make up about two thirds of the global market for new cars.[14] However, most companies sell cars outside these three markets, where emissions data are generally unavailable.[15]

Most companies typically disclose sales data that cover a number of countries/regions, usually reflecting where their business is focused. For almost all companies, verified sales data are available for some markets outside the EU, US and China. In these other markets, TPI

[12] The methodology is published online at the following website address: https://theicct.org/sites/default/files/publications/ICCT_LDV-test-cycle-conversion-factors_sept2014.pdf
[13] Source: ICCT.
[14] Based on CY2016 data (EFTA sales included with EU) (OICA, http://bit.ly/1Ljltdh).
[15] The exceptions are Brilliance, whose sales are focused in China, and Renault and BMW, for whom global emissions data are available.

estimates fleet emissions intensity using regional data on industry-wide emissions intensity over the period 2013-20.[16] In particular, these data allow us to calculate how emissions intensity in other regions relates to US and EU data (Table 1).[17]

Table 1. Regional passenger car average CO_2/km relative to the EU and US

		Africa	*Australia*	*Latin America*	*Canada*	*China*	*EU-28*	*India*	*Japan*	*Mexico*	*Middle East*	*Other Europe*	*Eurasia*	*South Korea*	*Other Asia Pacific*	*U.S.*
Relative to EU-28	**2013**	1.149	1.302	1.239	1.209	1.198	1.000	0.777	1.014	1.250	1.405	1.046	1.369	1.074	1.149	1.368
	2014	1.167	1.304	1.258	1.209	1.190	1.000	0.778	1.026	1.241	1.427	1.062	1.390	1.074	1.167	1.351
	2015	1.185	1.306	1.278	1.208	1.181	1.000	0.778	1.037	1.231	1.449	1.079	1.412	1.074	1.185	1.333
	2016	1.234	1.360	1.299	1.223	1.162	1.000	0.789	1.042	1.271	1.466	1.092	1.429	1.051	1.200	1.344
	2017	1.288	1.419	1.322	1.238	1.142	1.000	0.801	1.048	1.314	1.484	1.106	1.448	1.026	1.215	1.356
	2018	1.346	1.483	1.347	1.256	1.120	1.000	0.814	1.055	1.361	1.504	1.121	1.468	0.999	1.232	1.369
	2019	1.410	1.553	1.374	1.274	1.096	1.000	0.828	1.062	1.412	1.525	1.138	1.490	0.969	1.251	1.383
	2020	1.480	1.630	1.405	1.295	1.069	1.000	0.844	1.069	1.468	1.549	1.156	1.514	0.936	1.272	1.399
Relative to US	**2013**	0.840	0.951	0.906	0.884	0.876	0.731	0.568	0.741	0.913	1.027	0.764	1.001	0.785	0.840	1.000
	2014	0.864	0.965	0.931	0.895	0.881	0.740	0.576	0.759	0.918	1.056	0.786	1.029	0.795	0.864	1.000
	2015	0.889	0.979	0.958	0.906	0.885	0.750	0.583	0.778	0.924	1.087	0.809	1.059	0.806	0.889	1.000
	2016	0.918	1.011	0.966	0.910	0.864	0.744	0.587	0.775	0.945	1.090	0.812	1.063	0.782	0.892	1.000
	2017	0.950	1.046	0.975	0.913	0.842	0.737	0.591	0.773	0.969	1.094	0.815	1.068	0.757	0.896	1.000
	2018	0.983	1.083	0.984	0.917	0.818	0.730	0.594	0.770	0.994	1.098	0.819	1.072	0.730	0.900	1.000
	2019	1.019	1.123	0.994	0.921	0.792	0.723	0.599	0.768	1.021	1.103	0.822	1.077	0.701	0.904	1.000
	2020	1.058	1.165	1.004	0.926	0.764	0.715	0.603	0.764	1.050	1.107	0.826	1.083	0.669	0.909	1.000

Very few companies provide a comprehensive breakdown of sales, meaning that some portion of sales remains unallocated to any particular market. When this is the case, we assume that the average emissions intensity that we are able to calculate for countries/regions where sales data are available is representative of global sales. This is unlikely to be problematic, as companies usually report the location of more than 85% of their sales.

4.3. Estimating manufacturers' future fleet emissions intensity

TPI can estimate companies' future fleet emissions intensity when they have published targets to reduce new vehicle emissions or improve new vehicle fuel efficiency. However, there are variations in the way in which companies specify targets, which poses certain challenges for target estimation.

While most companies specify a global target, some companies target different reductions in different markets. When this is the case, TPI calculates targets based on a forecast sales weighting for the target year. This sales forecast is based on the ICCT Roadmap model and broadly assumes that vehicle sales increase at a greater rate in emerging economies, particularly in China. Appendix 1 provides further details.

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[16] Source: ICCT data on annual Well-to-Wheel CO_2/km for 2013-2020.

[17] Where sales data are available for countries that have very similar fleet emissions intensity to the EU, US or China, these data are apportioned to the EU, US or China respectively. In particular, any sales in NAFTA countries are apportioned to the US. When no distinction was made between sales in China and in 'other Asia', sales were assumed to refer to China only; hence, Chinese emissions were assumed to apply. All countries that might be reported as being within Europe are apportioned to the EU, apart from Russia, whose average emissions intensity is closer to the US.

Some companies have set targets relative to a base year before 2013. In these cases, we estimate base-year emissions by back-casting from our 2013 company figure using the recorded change in the company's vehicles' emissions for that period in either the EU or the US, whichever is the larger market for the company.

Some companies publish targets for classes of vehicles that are broader than just passenger cars. In these cases, TPI assumes that targets apply equally to all vehicle sub-classes.

4.4. Worked example[18]

4.4.1. Historical emissions intensity

Company X publishes historical gCO_2 / km tailpipe new vehicle emissions (NEDC) for 2013 to 2015 for the EU and Japan. Figures are also available for the US and China through regulators. These data can be used alongside a sales breakdown to calculate company X's new vehicle average gCO_2 / km (NEDC) emissions between 2013 and 2015.

The emissions data available for company X are:

		2013	2014	2015
EU	gCO2/km, NEDC	117	113	108
Japan	gCO2/km, NEDC	111	104	104
US	Mpg, CAFE	40.3	40.5	39.7
China	l/100km, CAFE	8.1	7.4	6.8

American and Chinese fuel efficiencies are then converted to emissions intensities according to the NEDC test cycle. Diesel sales shares in the US and China are estimated as 1% for all companies. Thus fuel type coefficients for both countries are:

$$Fuel\ type\ coefficient = (diesel\ sales\ share \times diesel\ coefficient) + (petrol\ sales\ share \times petrol\ coefficient)$$

$$Fuel\ type\ coefficient = (1\% \times 6315) + (99\% \times 5497) = 5505$$

Therefore, Chinese and US fuel efficiencies are converted as follows (with fuel efficiency values equal to X):

$$US\ emissions\ intensity\ (\frac{gCO2}{km}, NEDC) = 5505/(\,X/(\,-0.1033 \times\ LnX + 1.473))$$

$$Chinese\ emissions\ intensity\ (\frac{gCO2}{km}, NEDC) = 5505/(235/X)$$

[18] In the following examples various numbers are rounded for ease of presentation.

This results in the following regional emissions data:

		2013	2014	2015
EU	gCO2/km, NEDC	117	113	108
Japan	gCO2/km, NEDC	111	104	104
US	gCO2/km, NEDC	149	148	152
China	gCO2/km, NEDC	190	173	159

These emissions can then be weighted by the company's sales data to provide global averages. The company's sales data are:

	2013	2014	2015
Japan	2.4	2.2	2.1
NAFTA	2.5	2.7	2.8
China	1.6	1.5	1.3
Other Asia	0.3	0.3	0.3
Europe	0.8	0.9	0.8
South Korea	1.0	1.1	1.2
Total	9.1	9.0	9.2
Volume covered by sales breakdown	8.6	8.7	8.5
% of total sales covered by breakdown	95%	97%	92%

We have published emissions data for all markets in the sales breakdown bar South Korea, as the 'Other Asia' sales category is assumed to have the same average emissions as China. It is assumed that NAFTA and European emissions are the same as the US and EU respectively.

South Korean emissions can be calculated from ICCT's Well-to-Wheel historical country new vehicle average gCO_2 / km emissions (Table 1). The coefficient used is relative to the US emissions intensity, as this is the biggest sales market for Company X. This coefficient is 0.8. Therefore South Korean emissions are estimated as:

		2013	2014	2015
South Korea	gCO2/km, NEDC	119	119	121

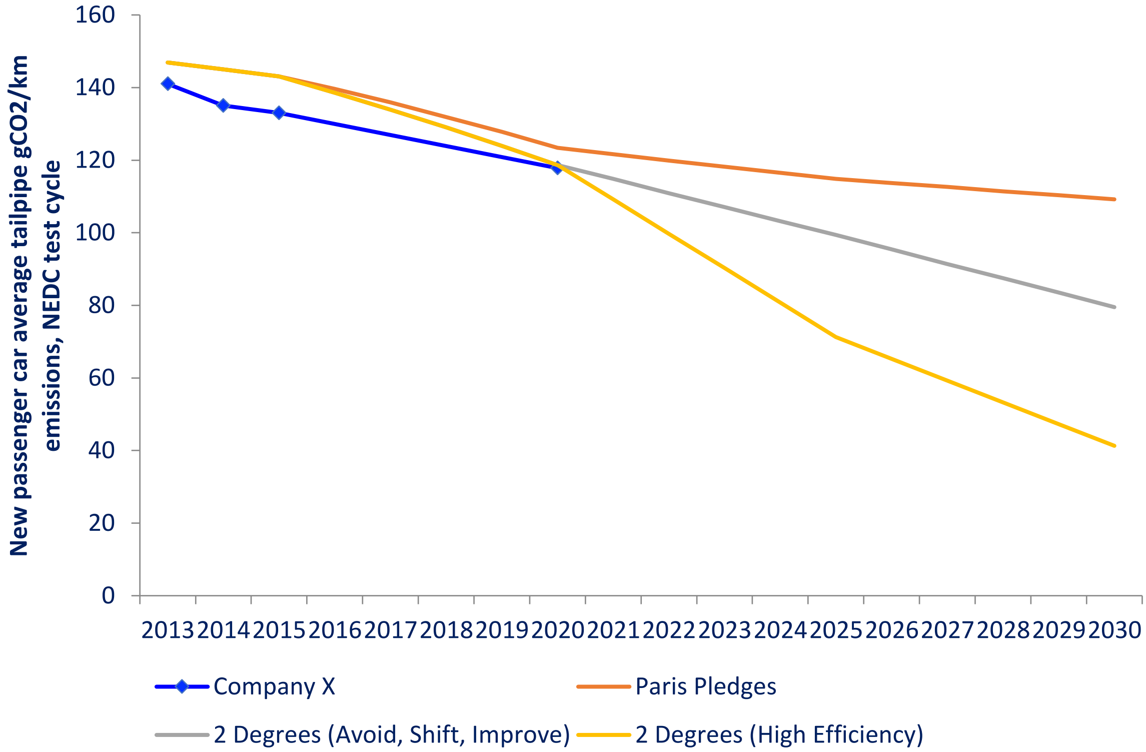
EU, US, Chinese and estimated South Korean emissions figures are then given a weighting determined by the company's sales breakdown: this is determined by each region's share of sales in each year covered by the breakdown. For example, Chinese emissions for company X in 2013 are weighted by a factor of 1.9/8.6. This yields company X's historical emissions figures:

		2013	2014	2015
Company X new vehicle registrations	Average gCO2/km, NEDC	141	135	133

4.4.2. Future emissions intensity

Company X has disclosed that its target is to reduce CO_2 emissions of newly registered cars in 2020 by 22% from a 2010 base year. The company also separately reports that its 2010 new vehicle CO_2 emissions were 13.6% higher than they were in 2015. Therefore Company X's 2020 new vehicle emissions target can be calculated as:

$$2020\ target = 133 \times 1.136 \times 0.78 = 117.8$$



5. DISCUSSION

This note has described the methodology followed by TPI in carrying out carbon performance assessment of companies, with a particular focus on automobile manufacturers.

TPI's carbon performance assessment is designed to be easy to understand and use, while robust. There are inevitably many nuances surrounding each company's individual performance, how it relates to the benchmarks and why. Investors may wish to dig deeper to understand these.

5.1. General issues

The assessment follows the Sectoral Decarbonization Approach (SDA), which involves comparing companies' emissions intensity with sector-specific benchmark emissions intensities that are consistent with international targets (i.e. limiting global warming to no more than 2°C, and the sum of the Paris Pledges).

For the automobile manufacturing sector, TPI uses the modelling of the International Council on Clean Transportation (ICCT) to calculate the benchmark paths. The ICCT modelling has a number of advantages, but it is also subject to limitations, like all other economy-energy modelling. In particular, model projections often turn out to be wrong. The comparison between companies and the benchmark paths might then be inaccurate. However, there is no way to escape the need to make a projection of the future in forward-looking exercises like this.

TPI uses companies' self-reported data to derive emissions intensity paths, as well as data held by regulators. Companies' paths are only as accurate as the underlying data.

Estimating the recent, current and especially the future emissions intensity of companies involves a number of assumptions. Therefore it is important to bear in mind that, except in a very few cases, the emissions path drawn for each company is an estimate made by TPI, based on information disclosed by companies and available from regulatory bodies, rather than the companies' own estimate or target. In a very few cases, the information disclosed by companies is sufficient on its own to completely characterise the emissions intensity path.

5.2. Issues specific to automobile manufacturers

Within the context of the SDA, automobile manufacturing has required a distinctive approach to carbon performance assessment, compared with other sectors that TPI has covered so far, i.e. cement, electricity and steel. In particular, the assessment focuses on the emissions performance of automobile manufacturers' new vehicles, rather than the emissions intensity of the manufacturing process itself. This is justified on the grounds that it is downstream of manufacturing where automobile makers' lifecycle carbon footprint is concentrated.

Benchmarking the performance of automobile manufacturers' fleets can be achieved using integrated modelling of the transportation sector (in TPI's case by the ICCT Roadmap model). A significant source of variation between the 2°C-compliant scenarios of different transportation modelling groups is the share of the burden that is placed on avoiding travel, shifting modes of transportation and improving the efficiency of transportation.[12] In view of this uncertainty, TPI has proposed two different 2 Degrees scenarios, capturing the range of assumptions on this issue.

In order to derive company paths for new vehicle emissions, we have combined regulatory data on emissions performance or fuel efficiency with company data on sales. The main challenges encountered here include converting regulatory data to a common basis, which involves some uncertainties but does rest on good empirical data, and imputing emissions performance data for countries and regions outside of the EU, US and China, which is achieved by assuming variations at the company level mirror variations at the sector level.

As in other sectors, TPI's analysis is highly dependent on company disclosure. In the automobile sector, this poses three particular challenges. First, passenger cars are defined differently by the different regional regulatory bodies, to whom companies report their emissions intensities, as well as by the companies themselves. For example, Chinese and American industry bodies classify some SUVs, mini-vans and pickups as light trucks rather than regular passenger cars. On the other hand, companies may classify these cars as passenger cars in their disclosed sales volumes. Consequently, for certain regions there can be a discrepancy between a company's car sample used to calculate the company's average emissions intensity (excluding light trucks), and the sample of cars used for the regional sales weighting (including some light trucks). This can result in an underestimate of a company's overall intensity, especially for automobile manufacturers that sell a larger number of big passenger cars such as SUVs and pickups in the US. Second, there have been controversies around automakers efforts to minimize their intensities in official emissions tests. Research by the ICCT [13] has shown that there is an increasing divergence between real-world performance and official emissions test intensities, leading to an underestimation. Some, but not all, of this divergence is being addressed by the World Harmonized Light Vehicles Test Procedure (WLPT) which started being phased in for new type approvals in 2017. Third, currently electric vehicles (EVs) are treated as having zero emissions. This is consistent with how regulators around the world have decided to treat EVs and how it is accounted for in the benchmark scenarios. However, as long as countries' electricity grids are not delivering electricity with zero emissions, charging EVs cannot be carbon-free. These three limitations are currently accepted as they cannot be solved with more accurate and comprehensive data. For these reasons we conclude that our estimates should be considered as a lower-bound estimate for most companies.

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APPENDIX 1 FORECASTING REGIONAL SHARES OF GLOBAL CAR SALES

Regional shares of global car sales forecast by the ICCT Roadmap model are shown in Table 2. First, we use these to calculate the change in each market's share of global sales between 2015 and 2020 (right-hand column).

Table 2 Forecast shares of new passenger car sales in 2015 and 2020

	Roadmap model forecast		% change in share, 2015-2020
	2015	2020	
China	12.5%	22.5%	80.1%
Other Asia	9.8%	10%	1.8%
Japan	5%	3.8%	-22.8%
EU	19%	16.3%	-14.2%
US	20.5%	17.9%	-12.5%
Other	33.3%	29.5%	-11.4%
Total	100%	100%	0%

We then apply these calculated changes in shares to companies' 2015 sales breakdowns in the following way:

- The estimated 2020 sales share (Column D of Table 3) is calculated by scaling reported company sales shares (Column B) by forecast proportional changes in regional sales shares, as presented in Table 2.
- The estimated 2020 company sales share is then re-normalised to 100% (Column E) and used in calculating the global 2020 target weighting.

Table 3 Forecasting passenger car sales shares for an example company

A. Region	B. Company reported 2015 sales share (from company Annual/Sales Report)	C. Reported 2015 sales share re-normalised to 100%	D. Estimated 2020 sales share	E. Estimated 2020 sales share re-normalised to 100%	F. Percentage change in company's regional sales
Japan	3%	3.9%	3%	2.8%	-28 %
EU-28	39%	43%	33%	34.4%	-21%
US	21%	23%	18%	18.7%	-19%
China	20%	23%	36%	37.4%	67%
Other Asia	6%	7%	6%	6.7%	-6%
	89%	100%	96%	100%	

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