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Corporate Reporting of CO_2 Emission Disclosures in Electric Vehicle Manufacturing: an Overview of Tesla Inc.

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Electric vehicles have been gaining ground over the past decade, with sales reaching 3 M units worldwide by 2020. From an environmental point of view, this type of propulsion has advantages in terms of lower emissions, which contributes to the growth in demand. In the present research, using content analysis of corporate reports, we have examined the CO_2 emissions data of Tesla Inc., which has recently experienced heavy growth in the electric vehicle market. The research question is particularly relevant due to the increasing emphasis in the international regulatory environment on the obligation to disclose corporate sustainability information in a relevant and clear manner. Tesla's position, given its geographically extensive manufacturing network, is questionable in the application of public standards, guidelines, and measurement methods. Based on findings, Tesla's disclosures do not fully comply with the proposed requirements of International Sustainability Standards. Among research results, the emissions-focused disclosures connected to vehicle production and sales volume were examined. Model 3 production between 2017-2021 has significantly increased from 2,7 k to 906 k vehicles globally, which puts a measurable impact on well-to-wheel CO_2 emissions, influenced by the location of use and type of charging system. The disclosure gaps were addressed by examining the actual emissions performance from the open data source available to stakeholders as a contribution to the development of a future assessment system for digital reporting and accountability.

1. Introduction

Environmental pollution and one of its main consequences, global warming, is a pressing problem for our world. In global data, broken down by industry, electricity is the largest emitter of carbon dioxide (941 $MtCO_2/y$), while transport (501 $MtCO_2/y$) is also a major polluter (Global Energy Review, 2021). It is no coincidence that sustainable operation has been and will continue to be a priority objective. A possible way to reduce CO_2 from a transportation perspective and based on vehicle operation, for example, is the production of electric and hybrid vehicles. However, the environmental friendliness of production such processes and their public representation for stakeholders is a controversial issue (Tóth et al., 2021). In our research, we examine one of the most important participants in the global market for electric vehicles. In 2021 Tesla had a market share of 13.8 % for the production of plug-in electric vehicles, and this number keeps on growing which confirms its dominance (Carlier, 2022). We aim to use the financial and emission disclosures given by the company and the available sustainability standards to make findings to support or refute its environment-friendly operation.
Tesla Motors has overcome several obstacles to become a leader in the field of electric vehicles. Tesla is aiming to develop and scale up, starting with partnerships and a minimum viable product (Stringham et al., 2015). Tesla became the world's most valuable automobile manufacturer in 2020 as a result of its business strategy, which also included independent research and development of crucial technologies (f.e.: motors, batteries). Tesla's product range is very broad and its differentiation strategy meets the needs of several customer segments with different priorities. The Roadster features a superior appearance, exceptional performance, and expensive cost, Model S and Model X are mid-to-high-end models aimed at the middle and upper classes, while the Model Y and Model 3 are primarily cost-effective and reasonably priced (Shao et al., 2021). Tesla's strategy was unusually opposite of the approach taken by new OEMs from Henry Ford onwards, namely, introducing low-cost entry-level products to establish enough volume for economies of scale and to build brand recognition and

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a dealer network, before adding higher-end (and eventually luxury) vehicles to the line-up (MacDuffe et al., 2018). In this research, we aim to examine the sustainable operation of Tesla, behind its business success. Based on our results, which were calculated using publicly available, official emissions data of the company, it can be stated that Tesla does not produce without emissions–as mentioned in its impact reports–and for their products, both in terms of production and consumption, emissions are concentrated in the Chinese region, where its business activity is the most significant.

2. Literature Review

During the literature review, several relevant academic sources in the area of interest were accessed and reviewed. In the first part of the chapter Tesla's corporate strategy, the reasons for its profitability, and its main business partners were described. Subsequently, the relationship between electric vehicle manufacturing and sustainability was discussed, as a preliminary source of information for the analysis presented in the following chapters.

2.1 Innovative elements of Tesla’s corporate strategy

Tesla developed values, standards, and governance structures for the development and commercialization of alternative energy vehicles from the ground up. In other words, the company gained a competitive advantage over original equipment manufacturers (OEMs) by focusing its corporate culture on the design, manufacture, and marketing of electric vehicles, including production competence and market relationships (Thomas et al., 2019). Tesla’s product focus is concentrated solely on electric vehicles, its supply chain has a high degree of vertical integration, including the production of its batteries and components, and it also operates its charging stations (Bilbeisi et al., 2017). Strategic partners can be distinguished according to their type of cooperation. In the form of joint ventures, Toyota and Daimler are important collaborators, while in the field of research and development, the most prominent business partner is Panasonic, which plays a key role in connection with battery cells (Lang et al., 2021). Panasonic and LG Chem are the largest cell suppliers for the U.S. market. Panasonic supplies battery cells for several vehicle models, including top-selling models such as Tesla Model S, Model X, Model Y, and Model 3 (Zhou et al., 2021). Market data shows there is pent-up consumer demand for high-performance and efficient vehicles, that serves as a positive role model for other car manufacturers (Cheong et al., 2016). Tesla relies on technology from throughout the world to ensure the quality of its goods. Its business model specifies that the entire production process in Tesla's manufacturing would be completed in its factories, to improve product quality. And it is also an advantage that Tesla does not have any third-party shops in the market enabling direct contact with customers and improving customer relations (Wang et al., 2021). Tesla can lower battery production costs by leveraging economies of scale–not only for itself but also for any market participants who adopt its battery standard (Flaig et al., 2021).

2.2 Electric vehicle production and sustainability

As the format and chemistry of batteries become more standardized, innovations like battery swapping will become more feasible, potentially reducing the need for frequent quick-charging, which places a strain on battery management (Costa et al., 2022). As this article deals with the sustainability and environmental aspects of corporate reporting–CO_2 emission disclosures–it is also important to bear in mind the following findings.
The dynamic increase in motorization and demand for transportation has necessitated the creation of sustainable transportation systems. The transportation sector's GHG emissions are increasing at a greater rate than other sectors. In terms of performance, cost, and emission efficiency, several measurements and assessments have been offered for a better transportation system (Fan et al., 2018). Our current mobility paradigm is based on car ownership, individual mobility, and the use of fossil fuels as the primary energy source. As previously stated, such mobility patterns have reached their limits and exacerbated negative external impacts, particularly in cities (Nemoto et al., 2021). Energy is a critical component of societal growth, with a primary indication of environmental problems (Sari et al., 2021). For these reasons, the concentration of certain industrial sectors towards sustainability is particularly important. In our case, Tesla, as a major player in the electric vehicle market, can serve as an example of whether or not its technology and operational processes are truly environmentally friendly.

3. Methodology

The sustainability of various car companies, especially Tesla, has been discussed heavily. Our contribution is in combining existing analysis based on the latest climate-related disclosure of the International Sustainability Standard Board (ISSB, 2022), based on the SASB reporting standards, with specific vehicle production and sales data extracted from Tesla's corporate reports.

As presented in Table 1, data were collected from four main sources, the official Tesla website and the US Securities and Exchange Commission, which provided annual and quarterly financial and sustainability data. Additionally, the required ISSB standards were used in their most current form (31/03/2022).

Table 1: Presentation of the data source used for analysis

Number	Type of document	Period	Reference
1.	Tesla, Inc.'s quarterly reports	2016-2021	Tesla (2022.a)
2.	Tesla, Inc.'s annual reports	2016-2021	U.S Securities and Exchange Commission (2022.a)
3.	Tesla, Inc. Impact report	2018-2020	Tesla (2022.b)
4.	Climate-related disclosures	31/03/2022	ISSB (2022)

During data collection, the following changes were observed for each of the financial and sustainability reports. On Tesla's official website, while the quarterly data is available in a standard format, the annual reports have been made available in video format, which has made it difficult to extract the data. Accordingly, it was necessary to rely on different data sources as well. The necessary and missing data were found in the US Securities and Exchange Commission database. Besides, only three years of sustainability reporting data are available as the company has made such reports available only for 2018, 2019, and 2020.
The purpose of financial disclosures about sustainability is to ensure information about the relevant sustainability risks and opportunities to which the reporting company is exposed and that is practical because it can help both the CEO and the members of the director board, and the potential investors, stakeholders, and shareholders to overlook the way the company operates.

4. Results

In the following section, we present our results calculated from sales and production data published by the company and regional distribution data from external sources. It is important to highlight that Tesla does not specify in its reports which production processes carbon emission data refers to, but based on the disclosed information we can assume the relation to well-to-wheel cycles (Woo et al., 2017). Figure 1 shows the production data for both Model S/X and Model 3/Y on a quarterly basis. Although the Model S/X is a previously launched product for Tesla, the graph indicates how the Model 3 is outgrowing it dynamically. Data movements show a close correlation between sales and production data, with the most intense growth trend in 2020 and 2021, despite minor ups and downs. In 2020, Model 3 production figures almost doubled, with 87.3 k vehicles produced in the first quarter and 163.7 k in the fourth quarter. In 2021, the upward trend was maintained, but with less intensity, with 180.3 k vehicles produced in the first quarter and 292.7 k in the fourth one.

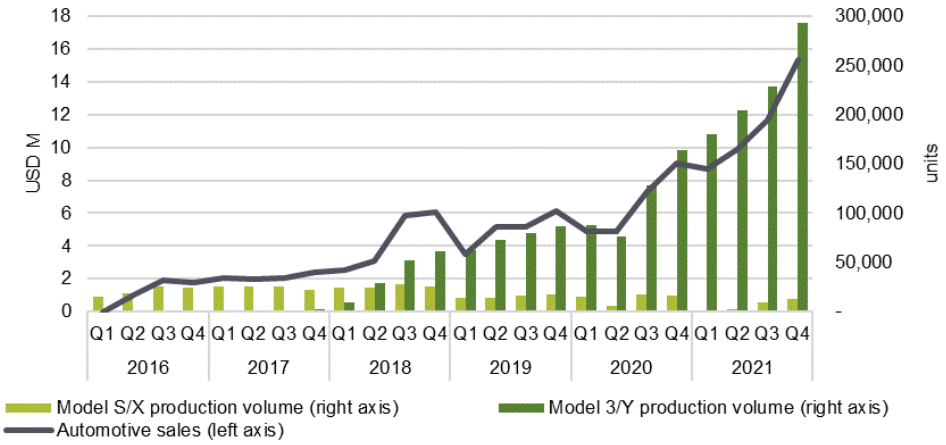

Figure 1: Model S/X and Model 3/Y production volume with total automotive sales, 2016 – 2021

A comparison of the production volume and sales data for the period under review suggests that the backlog does not differ significantly, with an average quarterly value of only 230 vehicles between 2017 and 2021 (lowest: -8.6 k; highest: 14.2 k vehicles). This means that–considering a company either produces for stock or

sale–sales timing does not differ significantly from production timing. Figure 2 presents the estimated Model 3 Personal Use Average Lifecycle Emissions solar and grid charged (related to home solar systems and solar charging stations) data for China, America, and Europe, provided by Tesla (2022.b, p. 87).

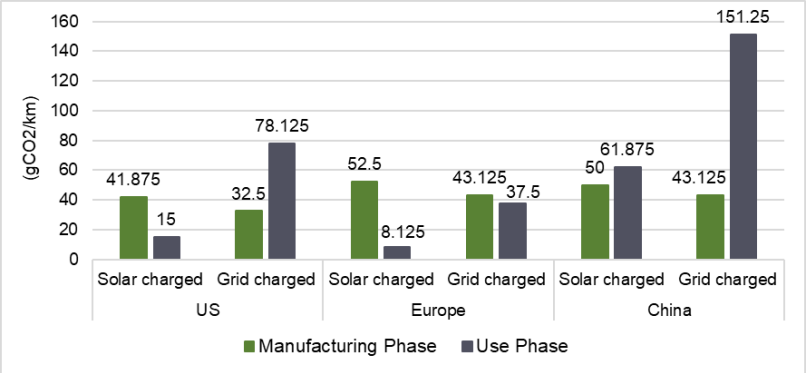

Figure 2: Emission data published by Tesla for personal use, by region and charging system

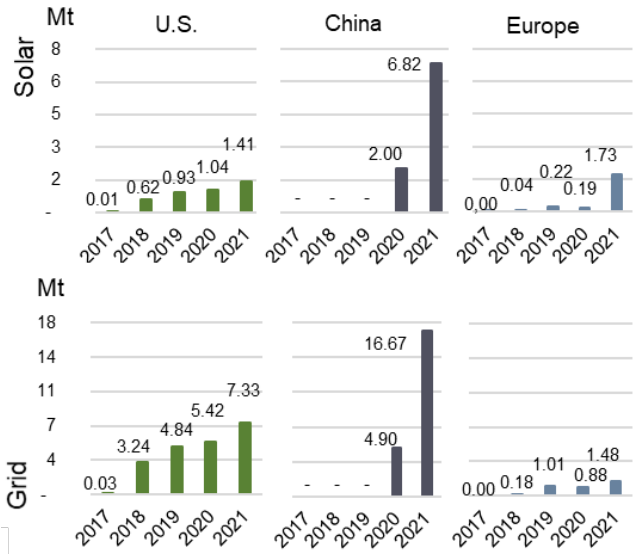

Figure 3: Model 3 Use-Phase Average Lifecycle Emissions by region, and charging system, 2016-2021 (Mt of CO_2 equivalents)
Note: Missing values indicate n/a

Figure 3 shows the lifecycle emissions data for Model 3 vehicles broken down by region. We converted the unit of measurement used by Tesla–gCO_2e/mi–to g/km to represent the emissions during the use phase as in Figure 2. We then multiplied our results by the company's calculated battery capacity, which is available in the company's report. For Europe and China, a 241 k km lifetime is calculated, and for the U.S., 322 k km. The results were then converted to tonnes, giving the final results shown in Figure 3 in Mt format. Unfortunately, neither the company nor any other relevant source has published production or output data for regional distribution, however, the available data suggest that high output is expected in addition to the high production volume as shown in Figures 1 and 3. Manufacturing output published in Tesla's 2020 Impact Report also suggests the dominance of the Chinese region (China Electricity Council, 2020), as shown in the calculated personal consumption. The large presence of emissions in Chinese markets is not surprising, as currently there is rarely a systematic review of Chinese carbon trading policies (Huang et al., 2022), while plants in European countries may face the need to comply with standards that are being developed. We did a plausibility review and concluded that Chinese manufacturers emit significantly more tonnes of CO_2 than their US and European counterparts in general (Liu et al., 2020). It may be that Chinese manufacturing is more efficient than its US and European counterparts, but the variance of CO_2 emissions could be explained by various reasons. Firstly, the regionally varying energy mixes result in different CO_2 emissions in the manufacturing/use phase of vehicles

(CNBC, 2021). Secondly, the use phase emissions are higher due to more vehicles being sold in China/Asia. As previously stated, the sustainability indicators and standards used help the company's many external and internal stakeholders gain an overview of the company's operations. Unfortunately, the international, uniform application and display of SASB standards are not mandatory, and thus could not be observed. This fact has restricted both data collection and transparency of operational data on sustainability, including the CO_2 impact methodology used by the company. However, the International Sustainability Standards Board is continuously developing these standards to create a composite set of standards on which companies can base their reporting and which provide transparency across the international, industry-wide sustainability operations.

5. Conclusion

From the results, we could conclude the following important areas concerning Tesla. Before all else, Tesla's purpose is to build redesigned factories for more sustainable operations to reduce unnecessary distances within the factory and achieve the most appropriate structure for manufacturing above all these local production processes are also in the focus (Europe, China, U.S.)The development of industrial centers reduces shipping and logistical expenses, as well as emissions, and increases the number of energy sources available. To capitalize on this, the corporation is contemplating production modifications.

Tesla is also transitioning to its own 4680 battery cells, which, according to them, will lower the energy usage of the entire cell production process by at least 70%. Tesla has also claimed that it will consume energy from renewable sources in both its factory and its service and delivery locations. With all this in mind, it is also worth pointing out that while the primary goal is to operate sustainably, Tesla has published its carbon emissions figures without stating a zero-emission workflow. It is considered a limitation of results that the theoretical grounding of the used method is not presented in the sustainability reports, while energy consumption in the use phase of the vehicles is a subject of many factors (Pusztai et al., 2021).

In the current study financial and sustainability data published by Tesla for the period 2016-2021 were used. Production and sales volume for the Model 3/Y and Model S/X were retrieved to determine the backlog where it was determined that sales and production timing did not differ significantly. Using the company's sales figures by regional distribution (US, China, European markets) the CO_2 emissions in the use phase were observed to be the highest in the Chinese region. As mentioned earlier, unfortunately, neither Tesla nor any other reliable source has published data on manufacturing volume and related emissions by regional distribution, so the detail and calculation of this problem will be part of a further extension of the research. Results also indicate the possibility of mathematical modelling of an optimal distribution of grid- and solar-powered electric mobility to minimize excess emissions with the Scope 1 and 2 (manufacturing and use phase) lifecycle emission rates of electric cars taken into consideration.

Important conclusions can be drawn from the available data sources in several directions. Data on emissions and the corresponding energy production can be found in the Tesla report. This fact could have important implications for investors - a relevant issue given Tesla's business model - as the company says that it does have emissions and discloses the methodology for calculating them in its reports. What is more, it is important to highlight that the implementation of disclosure will allow emissions data to be compared and analysed on a real methodological basis. And this kind of honesty makes Tesla particularly unique compared to its competitors, as this level of disclosure is not achieved by other companies. In future research, it is important to establish a comprehensive system for measuring company performance based on sustainability standards, which will allow companies to track and measure their emissions and, last but not least, make them comparable on the basis of these indicators.

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