ICE SUSTAINABLE FINANCE

Avoided Emissions ~Analysis of GPIF Portfolio~

July 2023

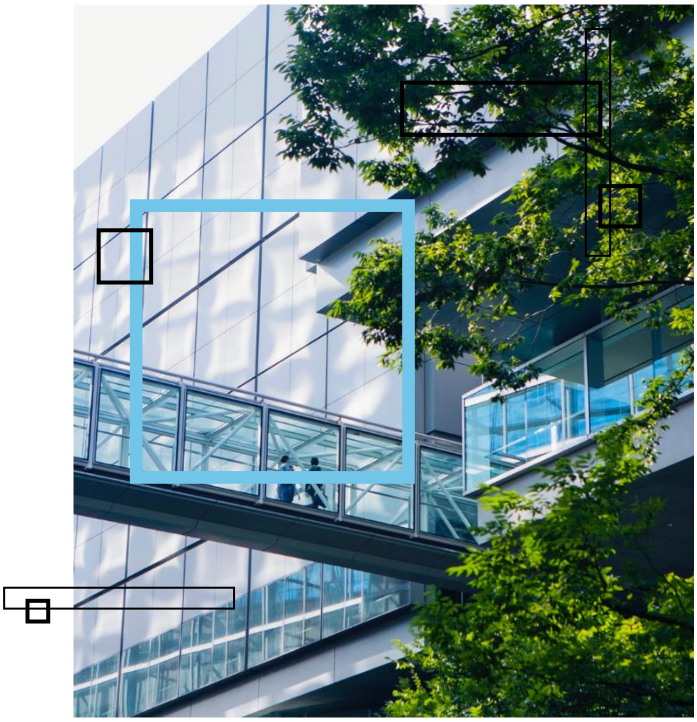


Table of Contents

1 Executive Summary

The ability to analyze Avoided Emissions can be a powerful tool for sustainable investing, helping to identify opportunities with a positive impact and quantify the real-world impacts such investments can generate.

Avoided Emissions can be incorporated in investment decision making. Indeed, Avoided Emissions can provide more insight to climate analysis, enabling the assessment of the positive impact contribution of individual companies to the transition towards a low-carbon economy.

Using Intercontinental Exchange's, Inc. (ICE) extensive carbon emissions database and avoided emissions methodology, ICE has constructed models in an attempt to estimate Avoided Emissions, building the analytical frameworks to try to better understand the broader climate impact of investments.

The ICE framework for Avoided Emissions analysis consists of three elements - data analysis, modelling, and comparative scenario analysis. This framework incorporates five key concepts that underpin ICE's approach to methodology construction: lifecycle assessment approach, materiality, apportionment, forward-looking capabilities, and geographical granularity.

Overall, this approach to Avoided Emissions helps to provide a more holistic view of the climate impact of individual companies and/or investment, also having the potential to channel capital towards solutions providing positive climate impact.

In this report ICE details the process used to identify, analyze and report the impact of the Avoided Emissions across the companies in three sectors within the GPIF portfolio. The sectors examined are Zero Emission Vehicles, Utilities and Mined Minerals.

2 Introduction

Globally, governments and regulators are implementing climate policy with an emphasis on companies setting their own Net Zero targets. This tends to encourage companies to reduce emissions across not only their own direct operations but also their value chains (Scope 3 emissions).

However, the need for companies to also develop innovative low or zero emissions solutions is becoming increasingly important for global decarbonization. There is also a need to measure the extent to which a company contributes to the broader global goal of Net Zero with decarbonizing solutions.

Avoided Emissions is one concept which aims to identify opportunities with a positive impact and quantify the real-world difference such investments can generate.

While the concept of Avoided Emissions is currently not as clearly defined as other climate metrics, the underlying intention is clear: to help stakeholders understand a company's role in the transition towards a low carbon economy.

An understanding of a company's or product's role in the transition allows the identification of low emission and carbon reducing solutions, helping to drive investment towards these opportunities.

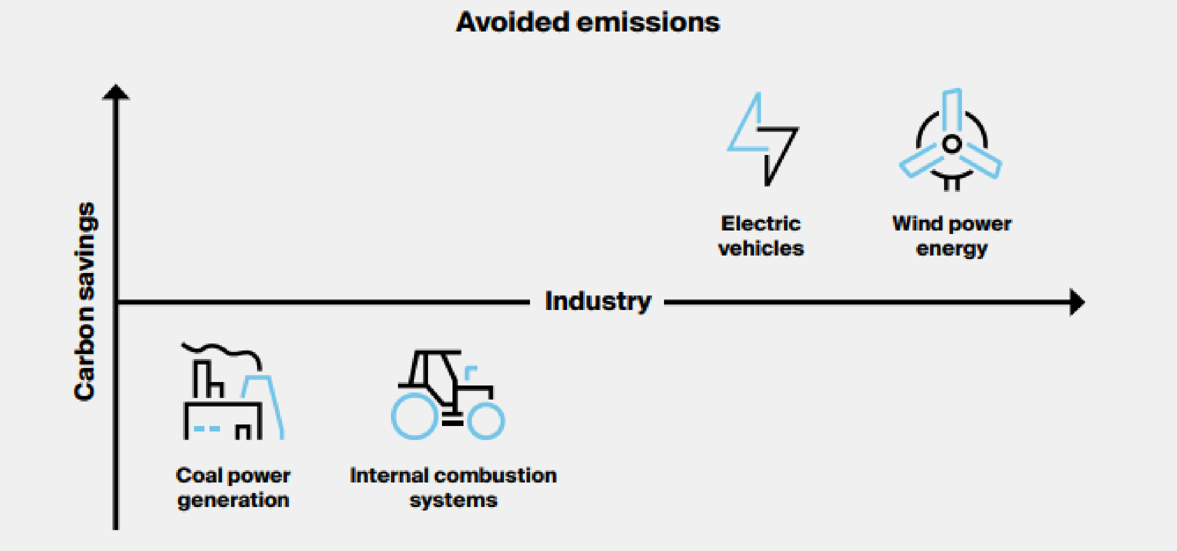
2.1 The Project Brief

ICE is supporting the Government Pension Investment Fund of Japan (GPIF) to improve the analysis and disclosure of the financial impact related to climate change-related opportunities. Specifically, this report summarizes ICE's identification, analysis, and quantification of GHG reduction contributions in the GPIF portfolio in the form of Avoided Emissions.

To achieve this, ICE has utilized its extensive, granular company-level emissions database and Avoided Emissions methodology to assess the potential Avoided Emissions in the GPIF portfolio across selected companies within the Zero Emission Vehicles, Utilities and Mined Minerals sectors.

Detailed analysis and results are presented to assist GPIF in the reporting of the broader climate impact of its investments, and specifically the investment in solutions which have the potential to contribute to the broader transition to a low-carbon economy.

Exhibit 1: Illustration of Potential Avoided Emissions at Industry Level



2.2 The Avoided Emissions Concept

2.2.1 What Are Avoided Emissions?

"Avoided emissions are emission reductions that occur outside of a product's life cycle or value chain, but as a result of the use of that product."[1]

2.2.2 Identifying Avoided Emissions

The concept of Avoided Emissions is applicable to many sectors providing climate solutions. Analysis across a broad range of sectors can identify sources of potential positive impact on the transition to a low carbon economy, even in the depths of complex supply chains.

Hence, the identification and quantification require significant research, knowledge and understanding of the subject and of the companies being assessed. Indeed, it is not uncommon for companies in sectors with large Avoided Emissions potential not to report this information.

2.3 Our Approach to Avoided Emissions

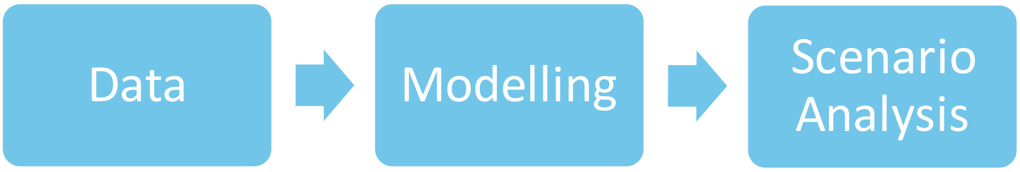
ICE has utilized its extensive carbon emissions database to construct a methodological framework to help identify and estimate potential Avoided Emissions in portfolios and develop a better understanding of investors' overall climate position.

For this report we have used this methodology and approach to Avoided Emissions to analyze selected companies within three sectors (Zero Emission Vehicles, Utilities and Mined Minerals) of the GPIF portfolio.
The structure of this approach to Avoided Emissions analysis consists of three main elements:

---

[1] Definition of Avoided Emissions provided in article by the World Resources Institute (Do We Need a Standard to Calculate "Avoided Emissions"?).

Exhibit 2: Three Stage Process to Avoided Emissions Analysis



The first element is the collection, assessment, and analysis of emissions data and information of individual companies to identify the various Avoided Emissions mechanisms, which each company may contribute to. Here we draw on ICE's comprehensive climate database, together with the expertise and experience of our climate analysts, to collect and analyze specific company information.

The second element is the modelling, where we explain the various methods, metrics and systems used as part of the overall process. Both bespoke company level bottom-up models and sector-specific inputs are used, including concepts such as Materiality Assessment and Life Cycle Assessment (LCA) modelling.

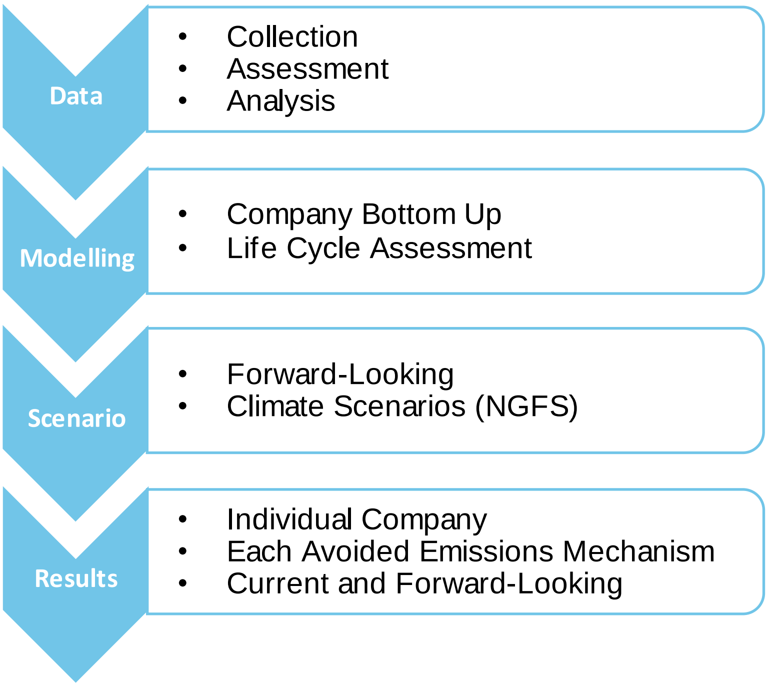
The third element of the approach is our comparative scenario analysis, including "what-if" scenarios and forward-looking analysis to help put the results of the process into context. Here, various climate scenarios (including NGFS - Network for Greening the Financial System) are used to better understand how the results depend on the various input variables under different scenarios.

The output from this process is a detailed set of results for each Avoided Emissions mechanism for individual companies, both current[2] and/or forward-looking, representing Avoided Emissions already achieved and potential future Avoided Emissions.

In the results, we outline different limitations of the models, calculations, underlying data points and comparative scenario analysis. The sophistication of the methodologies and understanding of the market are still evolving, hence our work is also constantly being updated considering the publication of new frameworks and research on how to best quantify Avoided Emissions.

[2] "Current" refers to the latest company level data available as of 31st March 2023. This is company reported data from 2020 to 2022, depending on their annual sustainability reports or peer-reviewed research.

Exhibit 3: Analysis Workflow



The analysis process follows the below steps:

- Research and identify avoided emissions mechanisms
- Data review
- Life Cycle Assessment Modelling
- Comparative scenarios
- Results

Avoided Emissions Identification and Data Review

This involves reviewing available public documents, including annual reports, analyst presentations, sustainability reports, websites, and other relevant documents. This process helps to identify the various avoided emissions mechanisms which each company may contribute to. This also involves understanding what company-specific preliminary data is available, including sales figures, reported avoided emissions, and other fundamental information. A review of literature and published Life Cycle Assessment data is also conducted, to understand what comparative studies are available to feed into the bespoke models.

Modelling approach

For the companies identified, the modelling is carried out both on a bespoke basis from the bottom up. We input company-specific parameters and ensure the methodology is fully aligned to the product or service. The models are developed to maximize the impact of any existing data and to ensure flexibility. The output is a base methodology which can serve as the foundation for future development through better quality data.

Comparative Scenarios

Where appropriate, NGFS scenarios are used to better understand how the outputs depend on input variables, particularly where the data input is estimated, and to provide a range of impact.

Results

For each avoided emissions mechanism, ICE generates results which are presented in annual tCO_2e avoided, for both current and forward-looking avoided emissions. Current figures relate to the achieved avoided emissions of the company, based on our models and data collected. Forward-looking figures are based on various projections of company variables, emissions factors, sales/revenue proportions, and other factors.

For transparency, the results are accompanied by an explanation of the limitations of the models and data, as well as the assumptions and comparative scenario used. This means the results are presented with the applicable context to provide an understanding of the appropriate use cases.

Please refer to the Appendix for the full list of sources used as part of this analysis.

3 The importance of Avoided Emissions

The identification of Avoided Emissions within individual companies, and more broadly within investment portfolios, is an important indicator of the decarbonization potential and ability to achieve climate (net zero) goals for both the individual companies and the investment strategy of the portfolio.

Avoided Emissions analysis allows for a positive narrative to be developed regarding a company's environmental impact, shifting the focus to Climate Opportunity.

3.1 A Focus on Positive Impacts

A focus on Avoided Emissions and their positive environmental impact by investors within their decision-making framework should encourage more companies to develop a robust Avoided Emissions methodology to quantify the climate impact from the use of their products and services.

Exhibit 4: Investor Focus on Positive Environmental Impact

An effective Avoided Emissions strategy at corporate level should be fully integrated into a company's overall processes from product design, manufacture and through to distribution. Being integral to a company's overall climate strategy, Avoided Emissions considerations can then be a guiding factor for companies in their business decision making.

Implementing such an approach to Avoided Emissions at the corporate level is not always easy. Companies can find themselves facing dilemmas, such as a rise in their own carbon footprint because of the development and growth of products and services designed to enhance broader Avoided Emissions.

Avoided Emissions strategies should not be considered a trade off against the reduction of an individual company's own carbon emissions (Scope 1,2 and 3). Companies acting as climate champions aim to reduce not only their own carbon footprint, but at the same time provide products and services to help their clients transition towards a lower carbon economy. These two goals should not be mutually exclusive.

3.1.1 Emphasis on the enabling aspect

Climate champions with a focus on products and services that have the potential to reduce emissions for the whole economy can have a significant role to play in leading sustainability practices and showing how individual companies can help the wider society decarbonize.

The role of climate champions also extends to attracting capital towards investment, products and services that can provide the opportunity to help decarbonize not just the value chain, but the wider economy.

In this regard, Avoided Emissions can provide useful tools to help investors identify opportunities with a wider climate impact. The development of Avoided Emissions metrics can enable investors to take a more comprehensive view of climate related opportunities within portfolios, allowing comparisons across industries and companies. In the transition to a lower carbon economy, companies that provide significant Avoided Emissions for the entire economy are potentially exposed to additional growth opportunities.

The addition of Avoided Emissions analysis to traditional climate risk analysis can provide investors with a greater understanding of the effects of climate change and impact at company and portfolio level.

3.2 Beyond the Carbon Footprint

In addition to the conventional carbon emissions metrics of Scope 1, 2 and 3, ICE believes there is now a need for more innovative and quantitative methodologies and tool kits to conduct a more thorough analysis across a broader range of perspectives to gain a holistic view of individual companies' wider climate impact.

The concept of Avoided Emissions has a significant role to play in such new perspective, especially when it comes to providing investors with a better understanding of the overall effects of decarbonization. So far there has been little research on Avoided Emissions, contributing to the concept being widely unrecognized, or even misunderstood.

3.2.1 Sustainable finance regulation and Avoided Emissions.

While global financial market regulators have been at the forefront with regards to implementing climate related guidelines and regulations, these have tended to focus on the risk side of the equation. Namely the identification and reporting of emissions at investment/portfolio level, climate alignment (net zero) analysis, and temperature target setting.

There is now an opportunity for policy makers and international organizations to also consider encouraging the development and use of metrics aimed at measuring and promoting positive climate impact, helping to direct capital to climate solutions and innovation rather than just discouraging investment in high-emitting industries. The disclosure of additional key climate information, such as Avoided Emissions, could go a long way in supporting these advancements in climate reporting.

3.3 Role of Avoided Emissions in Investment Decision Making

Understanding and identifying Avoided Emissions can be useful and even important for investment managers. It can inform the creation of a product or service that enables wider decarbonization and can create a business opportunity with potential for growth.
Companies identifying and reporting Avoided Emissions activities in their revenue and/or capex (future revenues), may assist investors in finding companies with meaningful secular growth opportunities in sustainability.

This is different to identifying companies with large carbon footprints and purely focusing on any opportunities from the reduction of those emissions. An example could be a refinery company that is introducing renewable natural gas or green hydrogen to their products. This could lead to Scope 1 and 2 reductions, which many investors view positively from a sustainability perspective.

4 Sector and Company Selection

ICE followed a multi-tiered approach trying to identify the sectors and companies within the GPIF portfolio that should be assessed for Avoided Emissions potential. The GPIF portfolio was screened for potential sources of Avoided Emissions at sector level taking various factors and variables into consideration, including potential size of Avoided Emissions at sector and company level and, significance of the investment holdings within the GPIF portfolio (both from an investment value and number of holdings perspective). Data quality and availability were also taken into consideration, especially with regards to data granularity and accuracy at the product/business segment level.

The key criteria used to select the sectors for Avoided Emissions Analysis included:

- Importance within GPIF universe (Investment Value, Number of Securities)
- How well methodologies are established for quantifying Avoided Emissions within the sector
- Data availability - company-specific variables, industry-level research, country-specific factors such as grid emission factors
- Data quality - reputable sources as well as granularity

4.1 Sector Selection

Based on these criteria the following three sectors were identified for Avoided Emissions analysis:

- Zero Emission Vehicles (ZEVs)
- Utilities
- Mined Minerals

These sectors were selected not only for their significant potential for Avoided Emissions, but also from a data quality and data availability perspective, taking into consideration data granularity and accuracy for the different products of companies.

The ZEV and Utilities (via renewable energy) sectors are commonly associated with Avoided Emissions potential and are also consistent with the other criteria including data quality and data availability as well as being important within the GPIF portfolio.

The Mined Minerals sector may at first glance seem a surprising choice, but it meets the criteria given the application of mined minerals in Electric Vehicle batteries. While minerals have applications in other segments of the energy transition with avoided emissions potentials, as highlighted in Exhibits 5 and 6, ICE has specifically focused on the application of minerals in EV batteries, as there are relatively good quality data inputs available including forward-looking data regarding how battery use could evolve. Additionally, EVs are projected to be the primary source of demand for minerals in 2030 as illustrated below (Exhibit 6).

Exhibit 5: Mined Minerals – Areas of Potential Avoided Emissions

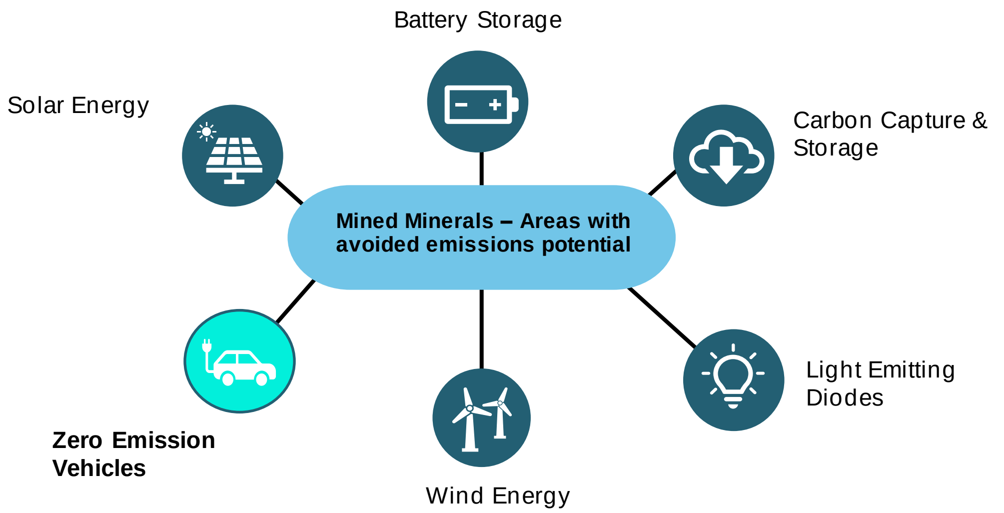


Exhibit 6: Mined Minerals – Total Mineral demand for select sectors with avoided emissions potential[3]

Exhibit 6A. **Total Mineral Demand for Sectors with Avoided Emissions Potential (2020)**

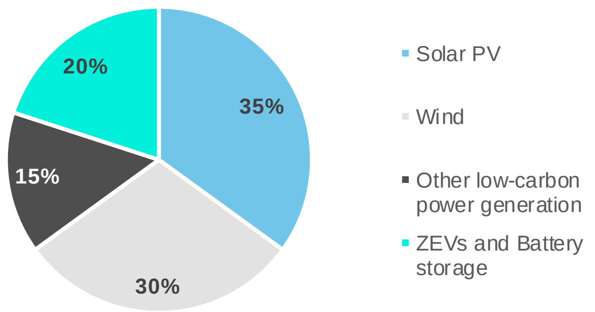
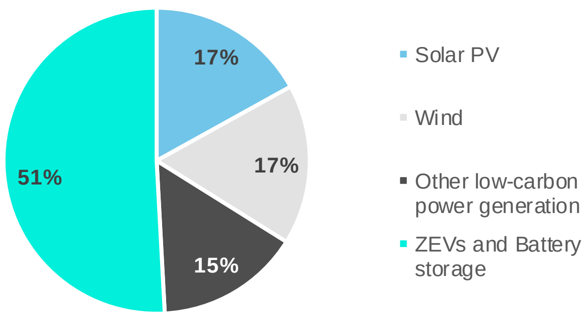


Exhibit 6B. **Total Mineral Demand for Sectors with Avoided Emissions Potential (2030 - Stated Policies Scenario)**



[3] Exhibit 6 includes minerals beyond the scope of this project as well, as mineral requirements for solar and wind are different from ZEV batteries. "ZEVs and Battery storage" includes electricity storage on grid or residential level, though the majority of new demand is expected to derive from Electric Vehicles. Steel and aluminum are not included in the data for the charts above, but aluminum has been considered in the project. The charts are based on data from IEA report – 'The Role of Critical Minerals in Clean Energy Transitions'. We have only included sectors deemed to have avoided emissions potential.

4.2 Company Selection

Several factors were considered for the company selection process in each of the sectors, these included:

- Leaders by way of revenue or market share
- GPIF portfolio representation
- Balance of regions
- Data availability

Using these criteria, the following number of companies were selected for Avoided Emissions analysis within the three chosen sectors.

- Zero Emission Vehicles - 16 Companies
- Utilities - 12 Companies
- Mined Minerals - 8 Companies

5 Sector Analysis

5.1 Overview

For the three sectors selected (ZEVs, Utilities, Mined Minerals) within the GPIF portfolio for Avoided Emissions analysis, an array of methodologies and approaches were used to take into account the specific characteristics of each of the sectors, including Attribution analysis, Scenario analysis and Life Cycle Assessment (LCA) analysis, where Avoided Emissions are calculated at each of the phases within the LCA, depending on company, region of operation and corresponding data availability.

For every avoided emissions calculation, the latest available company reported data has been defined as the “current” year. This ranges between 2020-2022 depending on the latest peer-reviewed research and company sustainability reports.

5.2 Zero Emission Vehicles

Based on the analysis and assumptions detailed below, the results of the Avoided Emissions analysis for ZEVs conducted on 16 companies from the Automotive Sector within the GPIF portfolio estimate that the total Avoided Emissions are equivalent to the carbon sequestered by circa 111 million acres (45 million hectares) (2022 Estimation) of forests in one year[4].

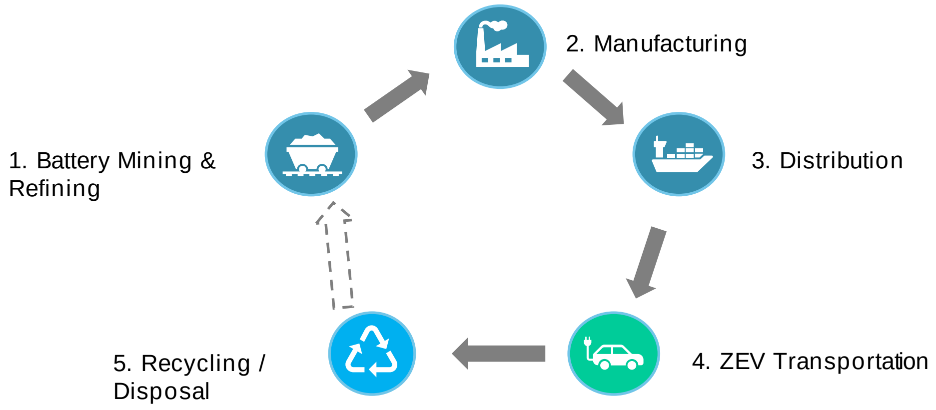
5.2.1 Approach and Methodology

The criteria used to select the companies for analysis were based on the ZEV related companies identified within the GPIF portfolio. These ZEV companies identified within the GPIF portfolio were then ranked by size according to their market capitalization. Then, an assessment of data availability was carried out to ensure the companies selected make the necessary data available to carry out the analysis. The location of the individual companies and, country of headquarters was then taken into consideration.

For the assessment of Avoided Emissions within the ZEV sector the Life Cycle Assessment (LCA) methodology was used. Using this approach, Avoided Emissions are calculated at each of the phases within the LCA, as per the corresponding data availability. Fuel-Cell Electric Vehicles (FCVs or FCEVs) are not included in our analysis due to the small number of vehicles produced and thus small number of emissions avoided, as well as a lack of data on expected production in 2030.

[4] 1 acre of afforestation is 0.85 of tCO_2e avoided, https://www.epa.gov/energy/greenhouse-gas-equivalencies-calculator

Exhibit 7: ZEV Life Cycle Assessment



The initial step in this approach is a calculation of the full life-cycle emissions of a ZEV sold in a particular region of a particular vehicle size.

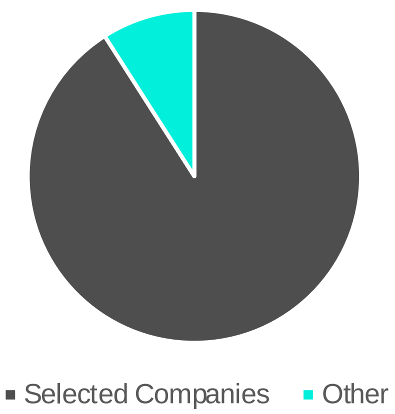
For an individual vehicle, the life-cycle assessment would cover the emissions from cradle-to-grave (Exhibit 7), encompassing all stages of the product life until disposal. Note that for both materiality and data availability purposes, we have excluded both the emissions from distribution of vehicles, and from their end-of-life (Recycling/Disposal) in both ZEVs and the baseline vehicles we assess. We then multiply the emissions of a given ZEV by the total number of EVs sold in that region to get the emissions for ZEVs.

Then the Baseline Emissions are calculated. The Baseline Emissions are composed of emissions from Internal Combustion Engine Vehicles (ICEV) and Plug-in Hybrid Electric Vehicles (PHEV)/Hybrid Electric Vehicles (HEV) in the same region. This is then multiplied by the number of ZEVs sold in that region by the company being analyzed. The difference between baseline emissions and ZEVs emissions represents the total avoided emissions from the ZEVs sold in the region.

This is followed by an aggregation of these values, either aggregated across the companies to get values for the country of sales or aggregated across regions and assigned to the country of the company's headquarters.

For estimating the 2030 sales in each region, we used credible company claims where available, but where it was not available we instead looked at the relative market share of the company currently against the total number of ZEVs sold according to the International Energy Agency (IEA). We assumed these regional market shares that a company has remain the same in the future (meaning the company remains as competitive as it currently is) and then scale by the regional projected number of ZEVs in 2030. The projections were calculated with a baseline assuming the IEA's "Stated Policies Scenario" or "STEPS".

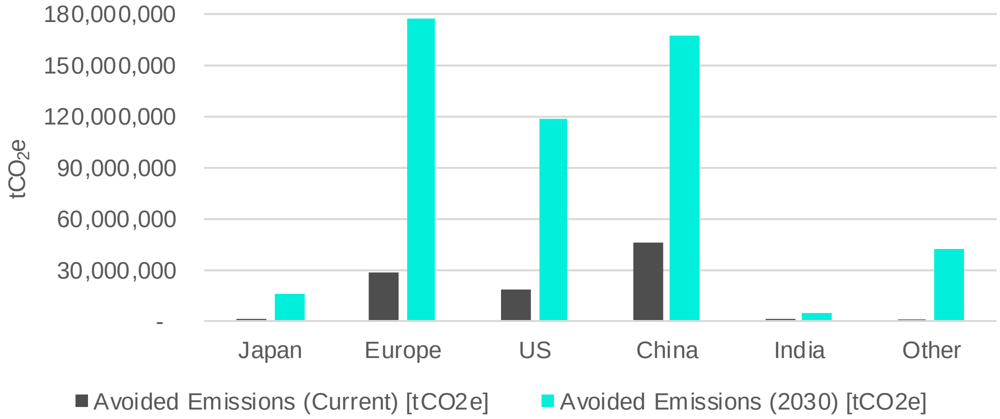
Exhibit 8: Selected Companies as % of GPIF Automotive Sector Exposure (Value)



The above chart shows the 16 companies selected for the ZEV Avoided Emissions analysis represent 91% of GPIFs total investment value in the Automotive Sector by value, based on the domestic and foreign equity portfolios.

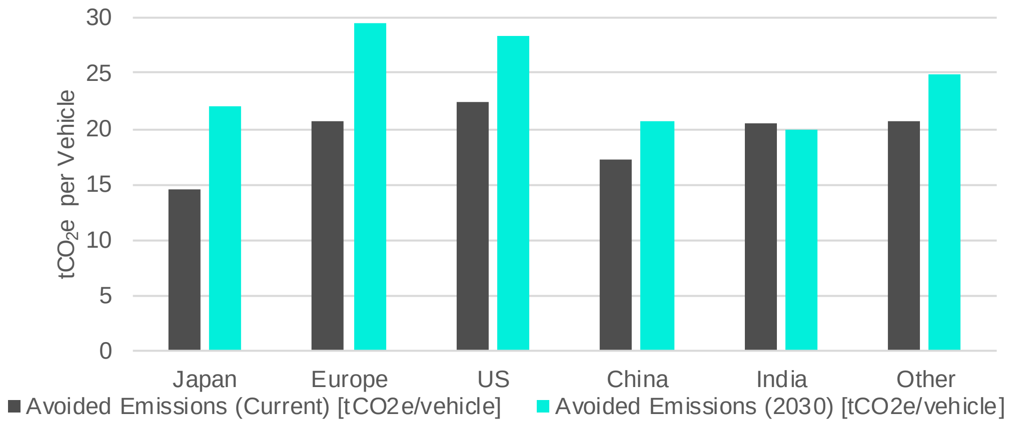
5.2.2 Avoided Emissions by Country of Sales

Exhibit 9: ZEV Avoided Emissions by County of Sales



The above chart shows the total Avoided Emissions (tCO2e) of the analyzed companies, attributed to the Country/Region of Sale (the country/region where the ZEV was sold by the analyzed companies). Both current and 2030 projected avoided emissions are depicted.

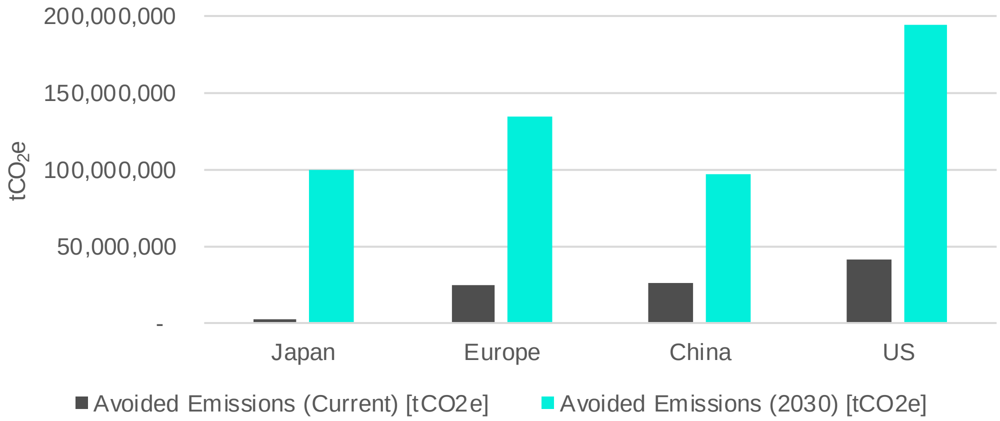
Exhibit 10: ZEV Avoided Emissions Per Vehicle by County of Sales



The Avoided Emissions per vehicle sold (tCO_2e/Vehicle), attributed to the Country/Region of Sales by the analyzed companies are shown in the above chart. Both current and 2030 projected Avoided Emissions intensities are depicted.

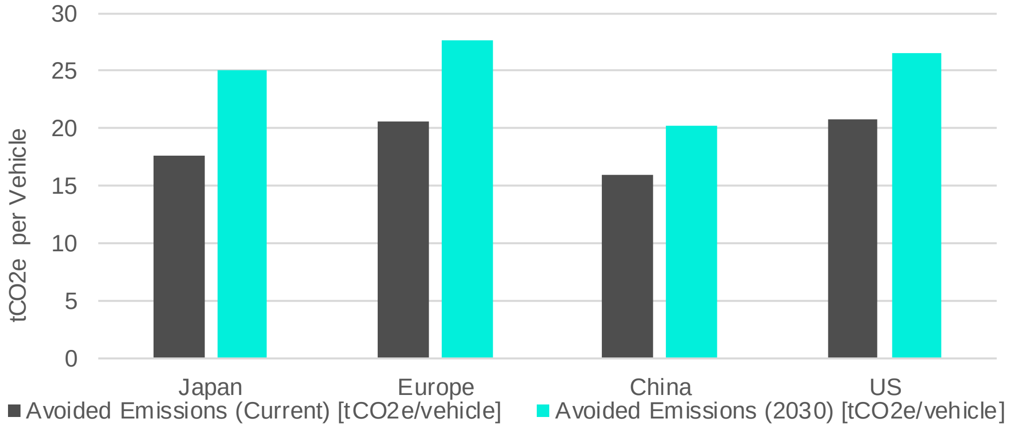
5.2.3 Avoided Emissions by Country (Company HQ)

Exhibit 11: ZEV Avoided Emissions by Company HQ



The total Avoided Emissions (tCO2e) of the analyzed companies, attributed to the Country/Region headquartered by the analyzed companies are shown in the chart above. Both current and 2030 projected Avoided Emissions are depicted.

Exhibit 12: ZEV Total Avoided Emissions per Vehicle by Company HQ



The Avoided Emissions per vehicle sold (tCO2e/Vehicle) of the analyzed companies, attributed to the Country/Region headquartered by the analyzed companies are shown in the above chart. Both current and 2030 projected Avoided Emissions intensities are depicted.

5.2.4 Zero Emission Vehicles - Key Themes and Results

Sixteen different automotive companies in four countries / regions were analyzed for Avoided Emissions. In terms of sales of vehicles, global sales were grouped into the following regions: Japan, China, India, US, Europe and Other.

In terms of global sales of vehicles in 2022, according to the IEA, China has the largest proportion (circa 52%) of ZEV sales, while Japan and India have the lowest share of ZEV sales (circa 1%). Europe (circa 24%) and US (circa 18%) follow China in terms of global ZEV sales.

Under the methodology used for this report, the absolute number of Avoided Emissions is driven by three key factors:

- The number of cars sold (this determines the number of traditional vehicles displaced by the ZEVs);
- LCA-based emissions for a ZEV;
- LCA-based emissions for an ICEV (the difference between the LCA emissions of traditional ICEVs and ZEVs defines the degree of Avoided Emissions per car sold).

Based on the location of the automotive manufacturers analyzed in this report, US manufacturers produce the largest numbers of ZEVs, while the ICEV LCA emissions of their vehicles is also higher (US manufacturers produce a higher proportion of larger vehicles, which tend to be less fuel efficient and have higher ICEV LCA) compared to other regions. Hence, US manufacturers tend to have the greatest total Avoided Emissions.

The same analysis based off the region of sales leads to the greatest Avoided Emissions being found in China. This is primarily driven by the fact that the highest volume of ZEV sales is in China (even for US and European automotive manufacturers, China is the biggest market outside of their home countries).

On a per-vehicle basis, however, it is European automotive manufacturers who have the greatest Avoided Emissions intensity, due primarily to selling in regions with the least carbon-intensive power grids, which is the predominant driver in changes across regions in a ZEV's effectiveness.

Examining the Avoided Emissions per vehicle projections for 2030, Europe and US are expected to lead due to a better power grid mix, leading to lower use-phase emissions from ZEV vehicles. Also counterintuitively, the LCA emissions from ICEV in China are expected to be lower than those from the US and Europe in 2030, driven by the targets set by Chinese manufacturers to improve fuel efficiency of their ICEV.

Overall, the global ZEV market is expected to grow from the current total of circa 8 million vehicles to 31 million vehicles by 2030. China is expected to remain the largest market by sales but is expected to experience a decline in global share from 52% to 40%; while the US and Japan are expected to increase their relative global shares.

Whilst the absolute sales of ZEVs by Chinese automobile manufacturers currently outstrip their Japanese counterparts, per-vehicle the Chinese car industry underperforms compared to Japan. This is because Chinese companies primarily sell domestically, and whilst the Chinese domestic ZEV market is the largest in the world, the more fossil-fuel dependent grid of China both current and in 2030 means the Japanese automotive industry is likely to lead Asia in Avoided Emissions per vehicle.

The Japanese companies assessed also benefit from more diversified global sales to regions with less carbon-intensive power grids, improving their per-vehicle assessment further.

5.2.5 Zero Emission Vehicles - Conclusions

While currently, Japanese automotive manufacturers may lag their global counterparts in terms of total absolute avoided emissions, given some of the commitments made by largest Japanese manufacturers to increase the production of ZEVs significantly by 2030, we estimate the overall total absolute avoided emissions of Japanese companies to be more than Chinese manufacturers and that they will get much closer to their US and European counterparts.

Using per-vehicle avoided emissions metrics, including avoided emissions intensity, Japanese automotive manufacturers are in a regional leadership position, with the potential to make further improvements to their global standing.

5.2.6 LCA Factors - Assumptions

We assumed the regional average vehicles for all life-cycle emissions, per vehicle size. We incorporated the grid of country of sales, separate from the regional manufacture emissions of the vehicle. This is true for both the ZEVs and the baseline vehicles (ICEVs, PHEVs, and HEVs) for both current year and 2030. Where possible we incorporated vehicle size into the life-cycle assessment.

We assumed a lifetime distance travelled by each vehicle of 150,000Km, that we utilized globally when estimating the vehicle LCAs. This was applied to all vehicles equally and is used to determine the use-phase emissions of the vehicles in their respective regions of sale.

Whilst discussions on projected improvements in battery end of life exist, there is currently no strong evidence for a quantitative estimate on how this will affect 2030 emissions factors for Evs. As such we have assumed the emissions associated with battery recycling in 2030 are as current. Qualitative assessments suggest the inclusion of mainstream battery recycling to further decrease the LCA emissions of a ZEV with respect to their ICEV counterparts. This would mean that the potential 2030 avoided emissions could be even greater than we have calculated here[5].

5.2.7 Company Sales - Assumptions

If a credible company projection exists for the number of ZEVs sold in 2030, this value was used. If it was not available, ICE instead estimated the regional ZEV sales of a company by assuming the market share a company has in a given region is constant between now and 2030, so company sales in a region grow at the same rate that ZEV sales in the region as a whole grow.

If possible, we attributed sales by vehicle size as well as region. However, if this was not possible, we assigned either car size C or car size D (mid-sized vehicle and large-sized vehicle/SUV respectively), based off an assessment of the vehicles discussed under company reporting.

Total EV sales are determined from IEA figures, whilst the regional breakdown is determined using the IEA STEPS scenario. To have EV sales by car size, we use the regional ratio of available cars by classification to apportion sales by region and vehicle size.

[5] According to the International Coalition on Clean Transportation (ICCT) - See Appendix

5.3 Utilities

Based on the analysis and assumptions detailed below, for 12 companies within the GPIF portfolio for the Utilities sector, the total avoided emissions from low-carbon energy generation are estimated to be equivalent to the carbon sequestered by circa 377 million acres (150 million hectares) (2022 Estimation) of forests in one year[6].

Definitions:

Renewables: Renewable energy comes from natural sources or processes that are constantly replenished and are thus not finite. This includes wind energy, photovoltaic (solar PV), geothermal, biomass, and hydropower.

Nuclear: The energy source that relies on nuclear fission to generate electricity. This uses Uranium as a fuel source, which is a finite resource. As such nuclear is non-renewable. It is however a low-carbon source of energy, and thus is included in assessments of "Low-Carbon" energy.

Low-Carbon: Any energy source that has very low or no use-phase emissions. This includes both the renewable energy sources listed above and nuclear energy.

5.3.1 Approach and Methodology

The initial step used for the Avoided Emissions analysis of the Utilities sector is the calculation of the full life-cycle emissions of the renewables or low-carbon generation per company and per source. This is then multiplied by the energy generated by each source.

The next step is to then aggregate up to the company level across sources. These results are then compared against the baseline emissions.

The baseline is calculated by using the LCA emissions by source and the power grid proportion of each country under the NGFS' "Current Policies" scenario and multiplying this by the total renewable energy generated by the company. The "Current Policies" scenario is the assumption that only those national policies and regulations that have been ratified and already implemented are carried on forward. This would globally lead to emissions leveling off circa. 2080, with >3°C warming by 2100.

The difference is the Avoided Emissions by the company (which is then aggregated based on the location of the company headquarters).

Forward-looking Avoided Emissions are also calculated by looking at the company-specific plans for renewable energy capacity in 2030 and 2050 and comparing this to the future LCA emissions of every energy source and also the country grid composition in 2030 and 2050, as per the NGFS "Current Policies" scenario.

[6] 1 acre of afforestation is 0.85 of tCO_2e avoided, https://www.epa.gov/energy/greenhouse-gas-equivalencies-calculator

Exhibit 13: Utilities Life Cycle Assessment

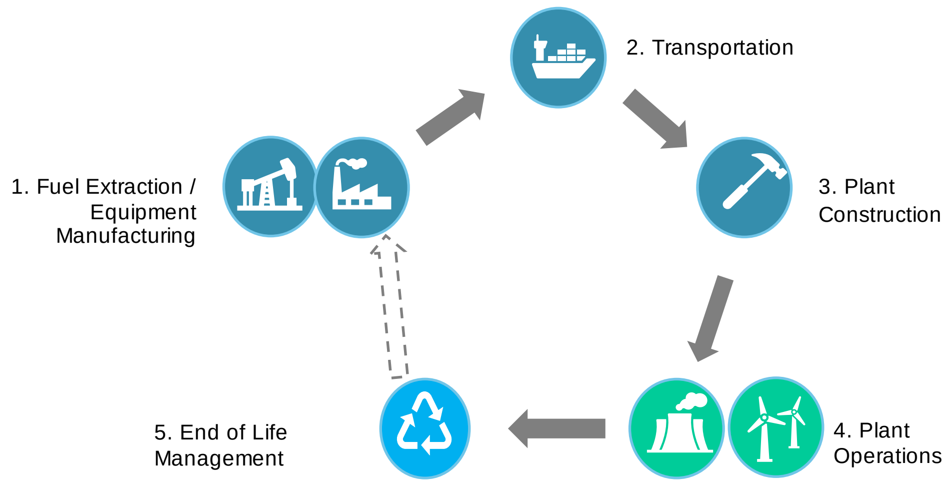
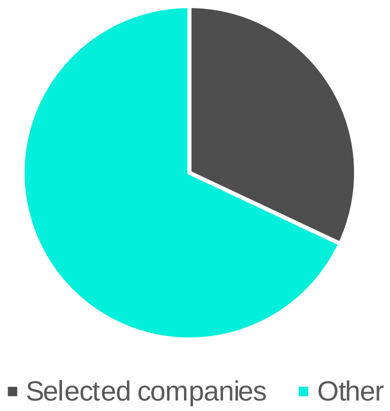
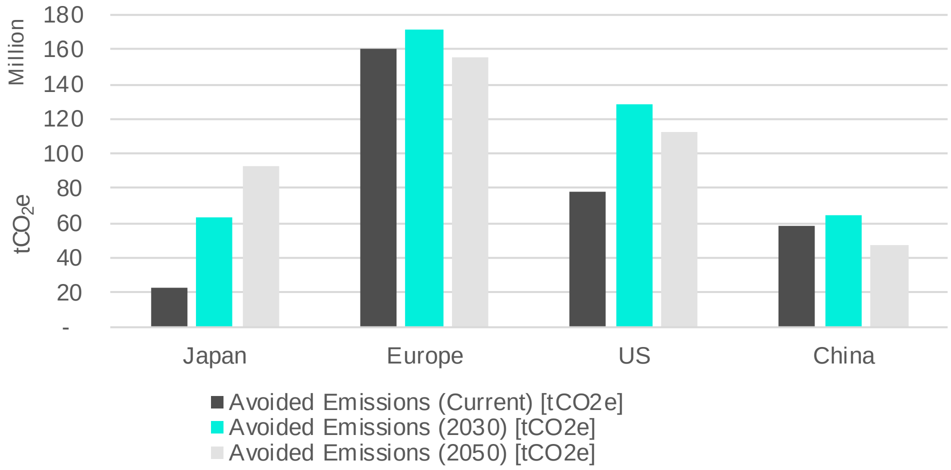


Exhibit 14: Selected Companies as % of GPIF Utilities Sector Exposure (Value)



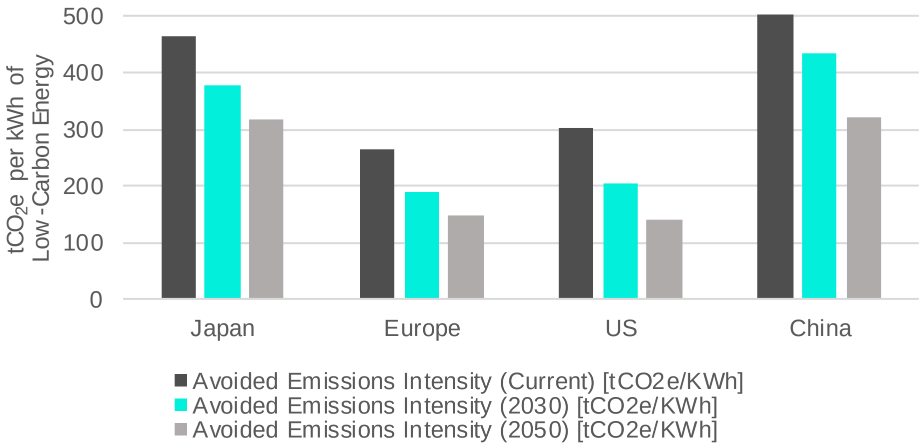
The above chart shows the 12 companies selected for the Utilities analysis represent 32% of GPIFs total investment value in the Utilities sector, based on their domestic and foreign equity portfolios.

Exhibit 15: LowCarbon Avoided Emissions by Country (Company HQ)



The above chart shows the total Avoided Emissions (tCO2e) from Low-Carbon energy generation per Country/Region, based on the headquarters of the analyzed companies. This includes any Avoided Emissions from the use of nuclear power.

Exhibit 16: Total Avoided Emissions Per Low-Carbon Energy by Country



The above chart shows the total Avoided Emissions per KWh of Low-Carbon energy generated (tCO2e per KWh) per Country. This is normalized as per the country power grid mix and the unit of low-carbon energy to enable a comparison of countries of different sizes. This includes any Avoided Emissions from the use of nuclear power.

Exhibit 17: Low Carbon Current Avoided Emissions by Country (Company HQ)

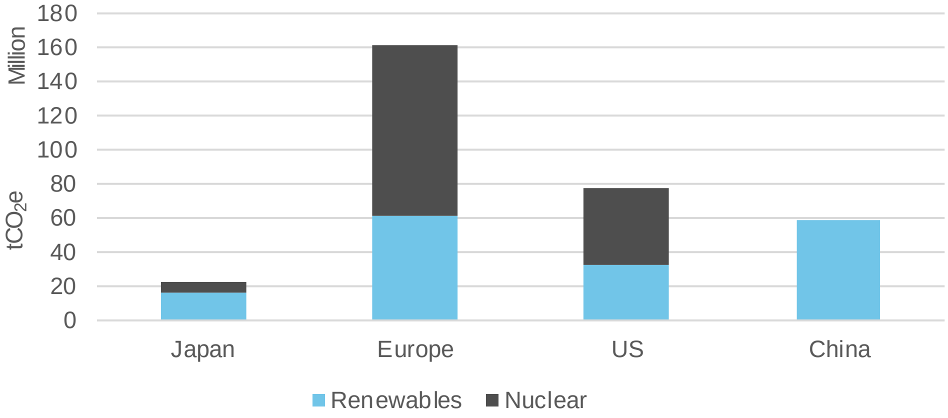


Exhibit 18: Low-Carbon 2030 Avoided Emissions by Country (Company HQ)

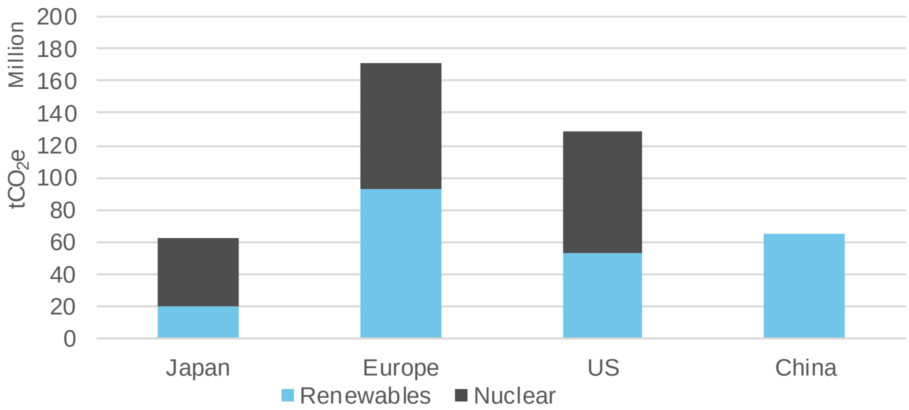
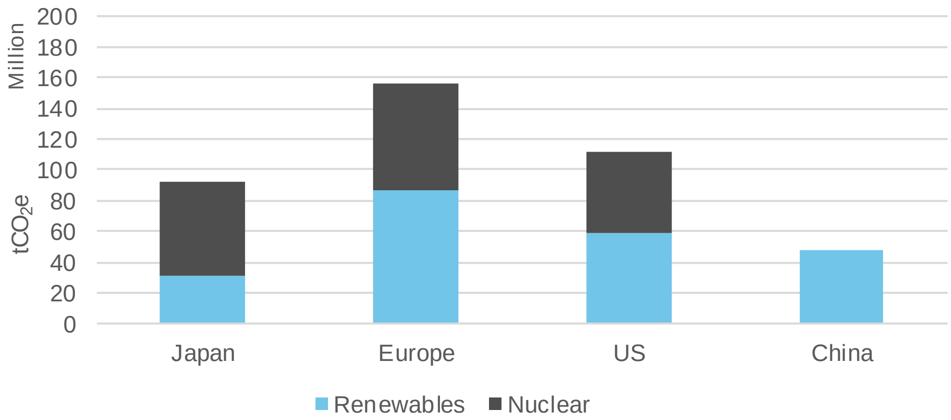
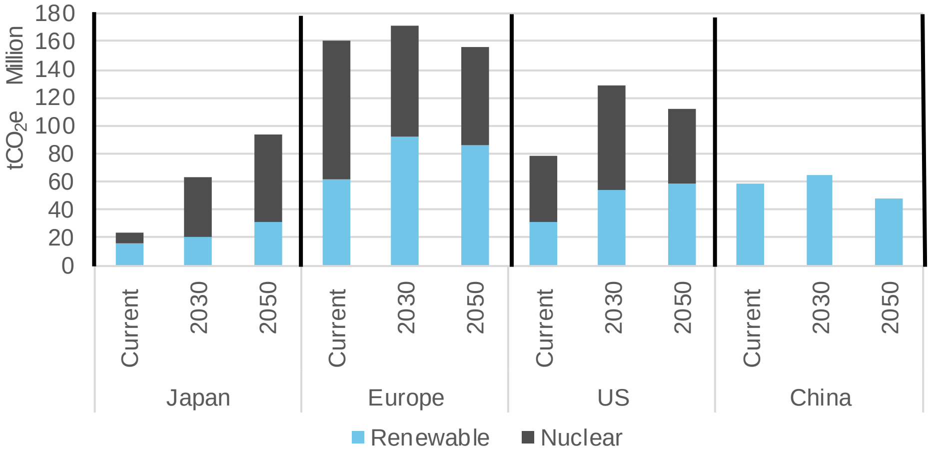


Exhibit 19: Low-Carbon 2050 Avoided Emissions (by Country (Company HQ)



The above charts show the total Avoided Emissions (tCO2e) from Low-Carbon energy generation per Country/Region, based on the headquarters of the analyzed companies for the current year, 2030 and 2050 (Exhibits 17-19, respectively). This includes any Avoided Emissions from the use of Nuclear Power.

Exhibit 20: Low-Carbon Avoided Emissions (Current, 2030, 2050) by Country (Company HQ)



The above chart shows the Avoided Emissions by Country (Company HQ). This is the total Avoided Emissions (tCO_2e) from Low-Carbon energy generation per Country/Region, based on the headquarters of the analyzed companies for current year, 2030 and 2050. It is a summary of the previous three charts.

Exhibit 21: Current Total Avoided Emissions per Low-Carbon Energy per Company

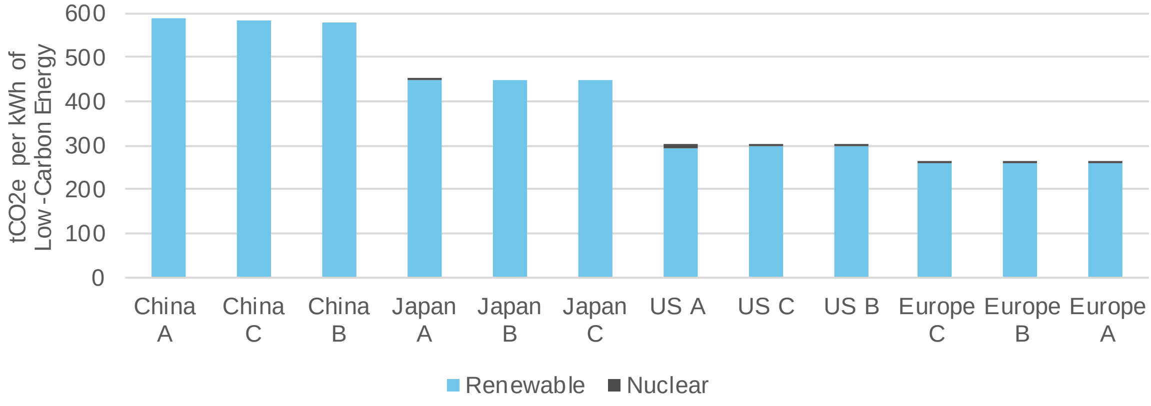


Exhibit 22: 2030 Total Avoided Emissions per Low-Carbon Energy per Company

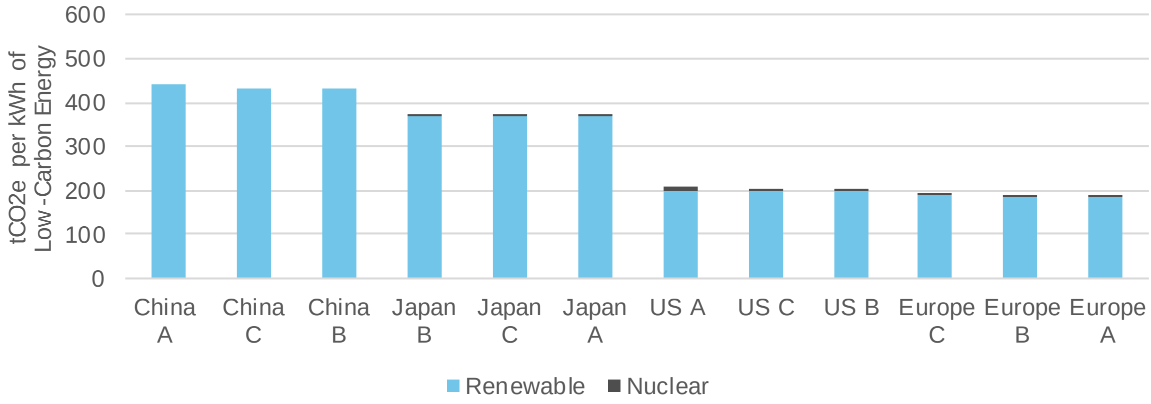
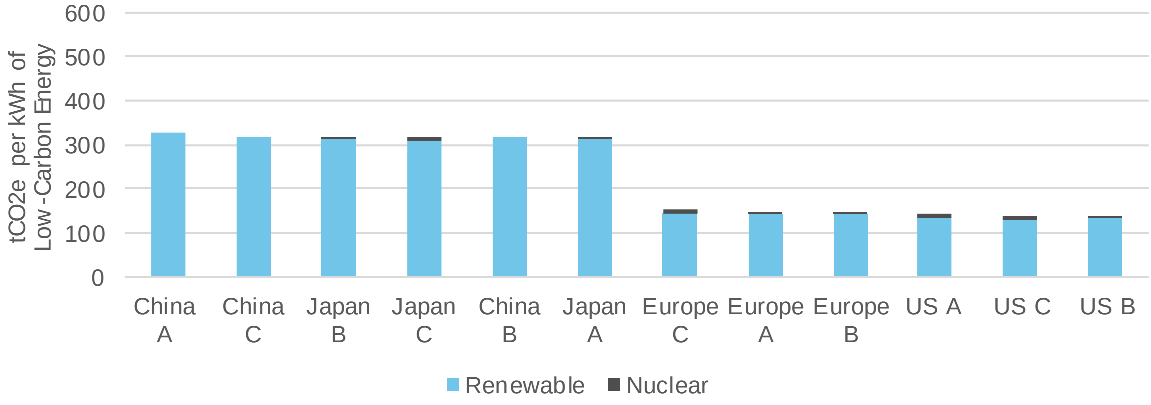


Exhibit 23: 2050 Total Avoided Emissions per Low-Carbon Energy per Company



The charts above show the total Avoided Emissions per KWh of Low-Carbon energy generated (tCO_2e per KWh) per Company for the current year, 2030 and 2050 (Exhibits 21-23, respectively). This is normalized as per the country grid mix and the unit of Low-Carbon energy to enable a comparison of countries of different sizes. This includes any avoided emissions from the use of nuclear power.

5.3.2 Utilities - Key Themes and Results

Twelve companies across 4 regions (Japan, China, USA, and Europe) were analyzed for the Avoided Emissions assessment of the Utilities sector.

Japan – Japan is a region with strong Avoided Emissions potential, as the addition of each KWh of low-carbon electricity avoids more emissions than in Europe and the US (Exhibit 16). This is driven by the more fossil-fuel heavy grid of Japan, where roughly 65% of the grid is powered by coal, oil, or natural gas. On an absolute scale, whilst the current low-carbon energy generated is small, there are ambitious plans to increase low-carbon output (Exhibit 17-20). This is proposed to be done primarily by the resumption and expansion of nuclear power generation. This region is the fastest growing of those assessed in Avoided Emissions.

Europe – Our analysis shows that the European companies assessed are leaders in absolute Avoided Emissions from low-carbon across the timeframes assessed (Exhibit 10-13). The growth of avoided emissions is relatively stagnant for this region, despite the significant addition of low-carbon energy capacity across the companies. This is due to the relatively ambitious decarbonization of the European grid, even under the Current Policies scenario. This decarbonization of the grid results in the rapidly diminishing returns of Avoided Emissions per KWh of low-carbon energy over time for Europe (Exhibit 16). This leads to a small dip in 2050 for the assessed companies' total Avoided Emissions.

USA – The US companies assessed have great ambition for their nearer-term targets, with a very rapid expansion of absolute Avoided Emissions (Exhibit 17-20) despite operating in an increasingly decarbonizing grid (Exhibit 16). This means that despite the sharp decarbonization of the US grid, the companies assessed have ambitions that overcome this and lead to increases in Avoided Emissions. In 2050 however, this increase is diminished. If we exclude nuclear the overall Avoided Emissions decline. This demonstrates that the longer-term ambitions of the US companies assessed rely on nuclear power to maintain decarbonization momentum.

China – Most of the Chinese companies assessed have published very ambitious near-term targets for additional renewable capacity within the next 5 years. This outpaces the expected performance of the Chinese grid under the Current Policies scenario, and that leads to significant Avoided Emissions for China as a whole. If we exclude nuclear the Chinese companies assessed currently have the second largest total Avoided Emissions (Exhibit 17). None of the Chinese companies assessed as part of this report are exposed to nuclear energy generation or have stated intentions to enter the nuclear energy business[7], so excluding nuclear is a fairer assessment to compare China against other regions. The Chinese companies assessed also have not published quantitative longer-term goals that would build upon the momentum developed up to 2025. This especially limits our assessment of 2050, where the Chinese grid decarbonization leads to a decrease in total Avoided Emissions. If the companies do successfully match the ambition that they have shown near-term, then their projected performance would improve significantly. Per KWh, China is the region with the highest Avoided Emissions potential, making it a key target market for increasing low-carbon electricity from a decarbonization potential perspective (Exhibit 16).

[7] Some of the state-owned parent companies of those companies assessed do have nuclear operations, however these are outside the scope of this report.

5.3.3 Utilities - Broader Social and Environmental Considerations

Whilst our analysis covers the avoided emissions potential of certain low-carbon technologies, it is worth noting that there are other social and environmental concerns with power generation that demand attention and diligence from Utilities companies and their stakeholders.

With regards to nuclear power, there are wider social and sustainability concerns such as management of long-term radioactive waste in relation to soil and groundwater preservation, as well as risks of accidental or mismanaged situations at power-plants which can lead to health and environmental accidents.

Hydroelectric power can also lead to some social and environmental concerns such as disruption of riverways, displacement of settlements to create reservoirs as well as large-scale flooding which can cause habitat decay and lead to significant methane emissions. The scale of these impacts are very unique to the project at hand and depend on the several factors such as the location and scale of the site. Thus, to minimize risks and mitigate potential negative impacts, strong implementation of effective Environmental Impact Assessments, adaptive management, transparency, and inclusion of affected stakeholder groups in project planning and the development of new technologies with potential to mitigate risks is vital.

5.3.4 Utilities - Conclusions

While our analysis shows Europe as the region with the greatest increase in Avoided Emissions through to 2030 and beyond in absolute terms, looking at the Avoided Emissions intensity analysis suggests that renewables generation in Europe will have diminishing returns, and the magnitude of Avoided Emissions will decrease between 2030 and 2050. This is a function of regional variations in existing grid intensities, with the European grid already relatively decarbonized, suggesting less Avoided Emissions potential from new sources of renewable energy.

For Japan, our analysis points to significant potential for Avoided Emissions improvement, from both the expansion and mix of low-carbon energy sources. Hydroelectric and nuclear power could make significant positive contributions to the Japanese Avoided Emissions intensity. Whilst both have many social and environmental concerns to overcome beyond their emissions, it is worth noting all the Japanese companies assessed have stated plans to utilize nuclear as a principal source of low-emissions energy, alongside their current hydropower resources.

China and Japan show Avoided Emissions potential for renewable energy in 2030 and beyond and are ideal target markets for longer-term renewable ambitions from a decarbonization perspective.

5.3.5 Electricity Source - Assumptions

If regional LCA emissions for power generation by a source were not available, we used global average values. This affects the life-cycle emissions of Biomass and Geothermal power we assess, alongside Oil for regions excluding Japan (where we used region-specific data).

For Solar PV, we have used the average for utilities scale solar, as opposed to selecting a particular material makeup. Similarly, the LCA values for Solar CSP in a region is the average of “trough” and “tower” technologies, and “Wind - Offshore” is the average between designs utilizing concrete foundations and steel foundations.

2030 LCAs are interpolated from the 2020 and 2050 data. This method is validated by testing with otherwise outdated literature and successfully replicating their 2030 estimates.

Where estimates for the LCA emissions of a source in 2050 are not given, we have conservatively assumed the life-cycle emissions for that source are static across time.

2050 estimates for LCA emissions assume no technological improvement for the power sources themselves, only changes in background grid mixes. This is a conservative approach. Testing using more aggressive estimates that factor in technological improvements does not materially affect results.

5.3.6 Grid Breakdown - Data Assumptions

The “Current Policies” scenario has been utilized to give the most realistic examination of avoided emissions. This scenario assumes that only the currently implemented national laws and policies are carried out. This leads to emissions growing until circa. 2080, and a >3°C warming by 2100. This is in contrast to other scenarios available within NGFS’ REMIND model, such as the “Nationally Determined Contributions” Scenario (the implementation of all stated intents or pledged policies, even if they have not been implemented or ratified into national laws) or “Net-Zero 2050” scenario.

An important assumption is that to define our baseline, we utilized the entire grid makeup of the country of importance, as opposed to the non-renewable contribution to the grid. This is done to assess the companies relative to their host nations’ decarbonization plans. This reduces the avoided emissions awarded to the companies, especially over time, as the amount of fossil-fuel generation being displaced diminishes over time.

To calculate the grid emissions intensity, the % breakdown by source is taken and multiplied by the LCA emissions factor for that source in that year and region. For Wind, the average in LCAs between onshore and offshore is used as the NGFS grid breakdown does not specify the type of wind energy.

5.3.7 Company Renewable Power Generation - Assumptions

Analysis is done both including and excluding Nuclear.

For estimating energy generation in 2030 by a source owned by a given company, the company-reported plans are examined to increase installed power capacity and estimate generation using the current year’s Power Generated to Capacity Installed ratio. In circumstances where this is not possible, we use either company targets for generation breakdown of certain sources, or physical estimates based off the installed capacity.
Where possible, we incorporate the same methodology for 2050, utilizing the net zero targets. If no additional capacity is discussed then if discussion is made on the generation makeup, the

displacement of existing fossil-fuel energy generation is assumed to estimate the additional capacity of renewables or low-carbon installed.

If no quantitative statements have been made for planned generation changes or capacity installations for either 2030 or 2050, it is assumed, conservatively, that generation has not increased since the prior assessment. This primarily affects the 2050 results of the Chinese companies assessed where no quantitative plans have been stated beyond the government mandated 14th 5-year plan (which ends in 2025).

For calculating the difference in emissions between the company’s renewables or low-carbon generation and the grid equivalent, the grid of the country of the company HQ is used.

5.4 Mined Minerals

Based on the analysis and assumptions detailed below, for 8 companies within the GPIF portfolio for the Mined Minerals sector, the current total avoided emissions estimated are equivalent to the carbon sequestered by circa 1 million acres (400 thousand hectares) (2022 Estimation) of forests in one year.[8]

The selected companies for Mined Minerals represent the 8 largest mining companies in terms of market share globally[9].

5.4.1 Approach and Methodology

For the calculation of Avoided emissions within the Mined Minerals sector an Attribution Methodology was used. The assessment of Avoided Emissions within the sector focused on the application of specific mined minerals used in batteries for ZEVs, depending on company-level mineral output data, global mineral output (based on IEA 2020 data from "The Role of Critical Minerals in Clean Energy Transitions")[10], mineral requirement breakdown per EV battery and global estimates of mineral output solely used for EV batteries (based on IEA 2020 data from "The Role of Critical Minerals in Clean Energy Transitions")[11]. This approach is also applied to forward-looking estimates. As before with ZEVs, we exclude the contribution to Fuel-Cell Electric Vehicles due to lack of data availability (a different range of mineral requirements) and the significantly smaller production volumes and thus avoided emissions potential.

The proportion of emissions for a ZEV that is attributed specifically to the 'Battery: Minerals' as a segment, is used as an estimation for the proportion of avoided emissions that can be attributed to the minerals, with the baseline of ICEVs (Global average estimates on ZEVs and ICEVs were utilized).

The weight of minerals required per EV battery is utilized to calculate the proportion of Avoided Emissions that can be attributed to each required mineral (the NMC 622 battery composition is considered here – the most commonly used battery type, globally across 2020).

Global and company-level data on overall mineral output along with estimations of mineral output used towards EV batteries is then utilized to calculate avoided emissions per company and mineral.

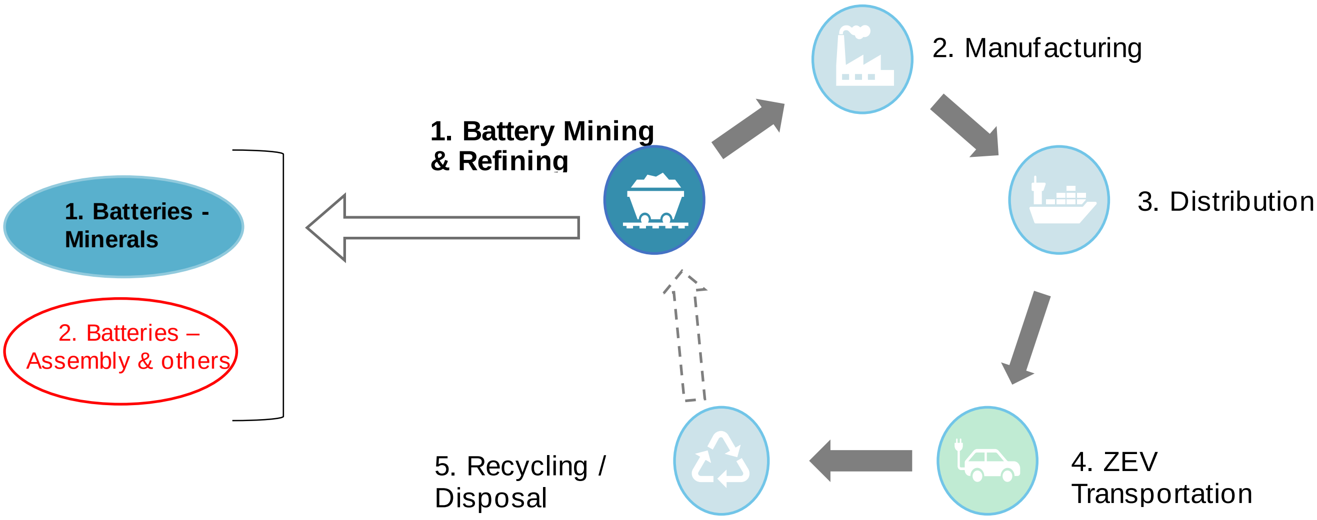
[8] 1 acre of afforestation is 0.85 of tCO_2e avoided, https://www.epa.gov/energy/greenhouse-gas-equivalencies-calculator

[9] These companies do not engage in mining Graphite, with the Graphite market being dominated by companies that specialize or predominantly focus on Graphite only.

[10] We acknowledge the release of the IEA Critical Minerals Data Tracker and Report 2023 - which provides updated 2022 data points. However, as the report was released publicly close to our report publication date on July 11, 2023, data and information from the study were not incorporated within this project.

[11] Same as above

Exhibit 24: Mined Minerals Life Cycle Assessment



The Mined Minerals methodology specifically looks at the application and use of minerals in ZEV batteries, focusing only on the Battery Mining and Refining stage of the LCA for EVs.

Assessing the emissions and Avoided Emissions for the 'Battery Mining & Refining' segment can be broken down to two further segments:

- Sourcing and refining the range of minerals required across the battery cathode, anode, cell and other components
- Assembly and manufacturing of the battery and related components.

The methodology used focuses on the sourcing and refining, specifically looking at the range of relevant minerals mined by the companies that are used in the ZEV battery components. The emissions associated with mining and refining the minerals are included in the "Batteries – Minerals" segment, whereas the 2nd segment focuses on emissions arising from manufacturing and assembling of the battery. As a result, we have focused on the "Batteries – Minerals" sub-segment for the calculation of avoided emissions.

Exhibit 25: Battery Composition by Mineral Weight

Mineral weight requirement (kgs) per EV for NMC 622 battery composition (Average estimates)	
Lithium	6
Cobalt	11
Nickel	32
Manganese	10
Graphite	50
Aluminum	33
Copper	19

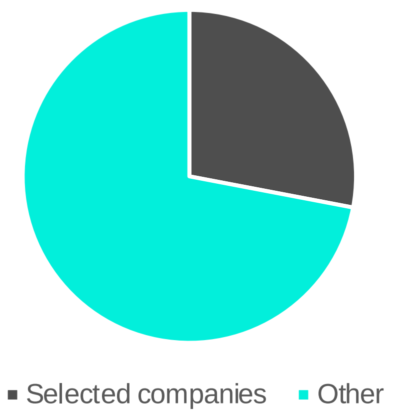
The above minerals and their respective weight proportions in NMC-622 cathode batteries are used as inputs for the calculation of avoided emissions.

NMC-622 batteries were the most commonly used composition across 2020.

Based on ICCT and Transport & Environment research estimates, it is projected that the NMC - 622 battery composition will continue to be a major battery chemistry in 2030. The methodology for forward-looking projections considers the same battery chemistry and mineral split but utilizes IEA projections of mineral use for ZEV batteries in 2030 as well as overall projected mineral output in 2030 (based on their 2020 report). Market share estimates for companies from the current model are then applied to 2030 projected global mineral output data to calculate the estimated mineral output for individual companies in 2030.

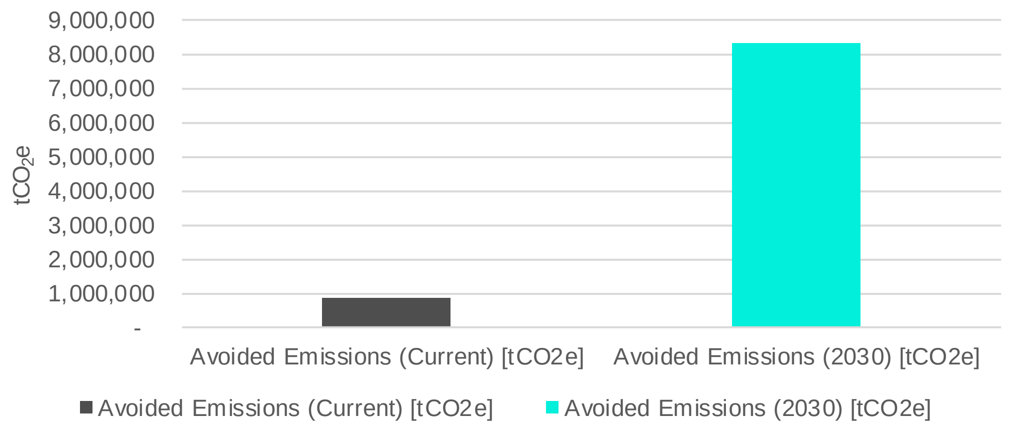
The same methodology used to calculate the current attribution of avoided emissions per mineral required in an EV battery is applied to calculate the potential avoided emissions for minerals in 2030. The share of avoided emissions attributable to "Batteries: Minerals" segment is projected to increase in 2030, based on the expected reduction in LCA footprints of both ZEVs and ICEVs in 2030.

Exhibit 26: Selected Companies as % of GPIF Mined Minerals Sector Exposure (Value)



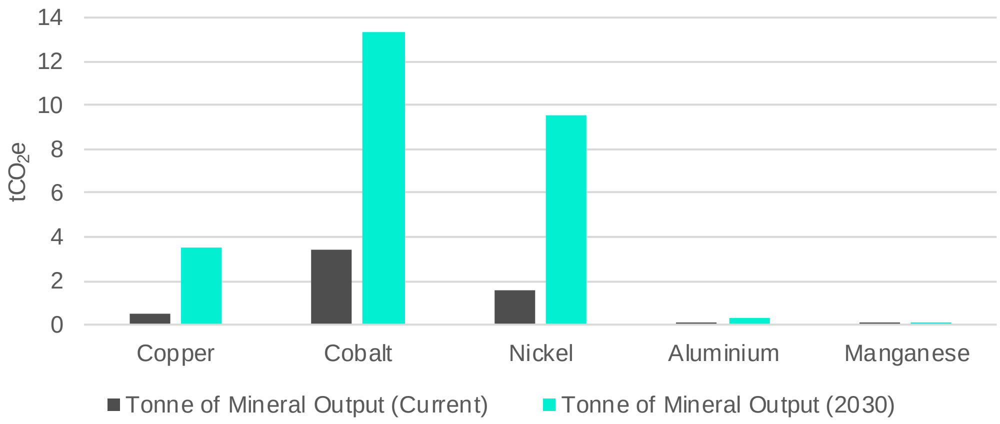
The above chart shows the 8 companies selected for the Mined Minerals analysis represent 28% of GPIF's total investment value in Mined Minerals, based on their domestic and foreign equity portfolios.

Exhibit 27: Mined Minerals Avoided Emissions (Global)



The above chart shows the total avoided emissions (tCO2e) for minerals used in the application of ZEV batteries, at a global level. Both current and projected avoided emissions are depicted.

Exhibit 28: Mined Minerals Avoided Emissions per Tonne of Overall Mineral Output (Global)



The above chart shows the avoided emissions per mined mineral per output (tCO2e per metric tonne) at a global level. Both current and projected Avoided Emissions are depicted. The chart displays the contribution of each mineral to Avoided Emissions.

5.4.2 Mined Minerals - Key Themes and Results

Eight Mined Minerals companies (globally) from within the GPIF portfolio were selected for Avoided Emissions analysis.

A significant increase in avoided emissions is expected from mined minerals by 2030, primarily driven by the substantial, projected increase in mineral output dedicated towards ZEVs by 2030 compared to 2021.

At the individual minerals level, Cobalt and Nickel in particular, are projected to generate more avoided emissions per metric tonne of overall output than the other minerals assessed, based on the selected companies in this analysis. This is driven by the relatively higher weight requirement of these minerals per ZEV battery/vehicle as well as a higher share of the overall mineral output used exclusively for ZEVs, compared to Aluminum.

Despite a considerable requirement of aluminum in ZEV batteries (33kg per battery), the percentage of global, overall output used for ZEV batteries is lower compared to the other minerals assessed in this analysis.

Graphite exclusion: As none of the selected companies are engaged in Graphite production, there are no modelled avoided emissions data for Graphite. However, as Graphite represents the largest share of an ZEV battery by weight and the projected increase in output by 2030, it is evident that Graphite will generate substantial avoided emissions per tonne of global output.

Currently the dominating battery chemistry is NMC 622 and this is expected to continue being one of the major battery types until 2030, with NMC 811 and NMC 955 expected to increase in prominence.

NMC 811 and NMC 955 require a larger share of Nickel than NMC 622, but require a relatively lower proportion of Cobalt and Manganese compared to NMC 622. As a result, the relative demand for Nickel from ZEV and battery manufacturers could increase at a higher rate in the future, depending on which battery chemistries dominate.

Solid-state batteries, which are an emerging battery technology have also been noted to solve potential ZEV battery charging and capacity issues. As this technology continues to develop and achieves commercial scalability, it may impact the ZEV battery landscape and have implications on the need for different minerals for battery development.

5.4.3 Broader Social and Environmental Considerations

In addition to GHG emissions arising from energy-intensive mining and processing activities, there are wider environmental considerations that can be associated with mining activities, including risk of biodiversity loss and social disruption due to land use change, water depletion and pollution, waste related contamination and air pollution. Social impacts including potential human rights issues have also been under scrutiny.

For companies involved particularly in the mining of minerals such as Lithium, Nickel, Rare Earths, Copper and Cobalt, there will need to be an increasing focus on sustainable water and waste management (including managing concerns around freshwater eutrophication, freshwater ecotoxicity levels and waste rock generation).

According to the IEA, conducting comprehensive Environmental and Social Impact Assessments (ESIA) is vital to ensure a more holistic assessment of a mining project's wider impact. At an international level, there are increasing frameworks by organizations such as OECD and World Bank to set standards for sustainable sourcing of minerals and supply chain practices. There are also organizations such as the Intergovernmental Forum on Mining, Minerals, Metals and Sustainable Development (IGF) which focus on advancing sustainable development initiatives and practices within the mining sector.

There are also initiatives by companies themselves - such as the International Council on Mining and Metals (ICCM) which brings together approximately one third of the global metals and mining sector, focusing on environmental resilience, social performance, governance & transparency, and sustainability.

5.4.4 Broader Applications of Mined Minerals

Within this report, we have focused on the potential, current and forward-looking Avoided Emissions arising from minerals, solely from their application in ZEV batteries. Minerals, are however fundamental to the clean energy transition - a key requirement for offshore and onshore wind and solar energy generation as well as energy storage. Offshore wind, in particular is significantly mineral-reliant, requiring, on average of more than twice the minerals (by weight) compared to solar energy (source: IEA, 2021).

From a weight-based perspective, while Graphite, Nickel and Copper are particularly crucial for ZEV batteries, Zinc and Copper are important for wind energy whereas Silicon and Copper are especially vital for solar energy. Rare earth minerals also play an important role for energy-efficient magnets in wind turbines as well as for solar panel modules (Source: IEA, 2021).

It is also important to note that with demand for minerals expected to exponentially increase in the coming decades, there are wider concerns around availability and reliability of the supply of these minerals. Developing viable alternatives and contingency measures is of equal importance given the scale and pace of the global energy transition.

5.4.5 Global Overall Mineral Production - Assumptions

Company-level Assumptions

The projected breakdown of mineral production/output in 2030 is not reported by the individual companies so 2021 market share estimates are applied to 2030 global mineral output to calculate the projected company-level mineral output for 2030.

The projected sales breakdown by end-use sector and region is not reported by the individual companies so the 2021 market share estimates of global use of mineral ZEV battery applications are applied for 2030.

For the projected mineral output for ZEV battery application in 2030 the IEA Stated Policies scenario is used as an approximate representative of BAU projection scenarios. For aluminum projection, BNEF estimates are utilized due to no IEA coverage of aluminum projection for ZEV application.

Global Assumptions

For the project global total mineral output in 2030 the IEA Stated Policies and Announced Pledges scenarios are used which are considered to be approximate representatives of BAU scenarios. For Manganese and Aluminum, industry association projections are utilized due to IEA not providing forward-looking projections.

For the Mineral requirements breakdown for ZEV (by weight) the mid-sized ZEV global average was used with a focus on the main minerals in ZEV batteries.

The intensities for an electric car are based on NMC (nickel manganese cobalt) 622 cathode and graphite-based anode, which represent the dominant battery composition in 2020/2021.

Values for the current model (2020) are also used for the projections due to lack of robust estimates on mineral requirement and projected battery composition in 2030.

The Avoided Emissions attributed to 'Battery: Minerals' segments in ZEVs are based on the IEA model. For the projected LCA ICEV emissions the ICEV global average for 2021 is used.

Projected emissions specifically attributed to ‘Battery: Minerals’ segment in ZEVs in 2030 is not available via IEA, hence the same LCA values for current (2020) ZEVs will be utilized. However, projected grid emissions for 2030 will be factored in due to good availability of data.

Double Counting

We would also like to acknowledge/recognize that by using the attribution-based methodology for calculating potential avoided emissions for mined minerals in ZEV batteries, there is the possibility of double counting as the total avoided emissions for ZEVs have been calculated for the entire vehicle using the LCA approach, where the companies selling the ZEVs are given the total share of avoided emissions.

5.4.6 Mined Minerals - Conclusion

Of the three sectors assessed for this report, our analysis suggests the mined minerals industry has the potential to increase avoided emissions at the greatest relative pace (% increase) through to 2030. This is driven by the demand for minerals in ZEV batteries. However, relative trends of avoided emissions within the sector and among various companies could well be impacted by the changing mix of minerals resulting from advancing battery technology. Nickel is one example which could see increased relative demand from ZEV battery manufactures as a result of changing battery chemistry.

Indeed, current ZEV lithium-ion batteries are based on liquid electrolytes, however solid-state batteries, which are an emerging battery technology have been noted to solve potential ZEV battery charging and capacity issues. One of the largest automobile manufacturing companies recently announced plans to leverage a breakthrough in solid-state battery technology, aimed at halving the size, cost and weight of batteries for its electric vehicles. Such developments and improvements in technologies may shift the ZEV battery landscape and subsequently have implications on the mineral requirements as well.

6 Conclusions

The importance of identifying and quantifying Avoided Emissions within portfolios is being increasingly recognized as a mechanism and metric for gaining a more holistic view of the broader climate impact of investments.

Using Avoided Emissions analysis alongside more traditional emissions analysis allows for the assessment of both Climate Risk and Climate Opportunity.

The analysis described in this report shows that Avoided Emissions can be located in various sectors and companies, even beyond the direct industries which have already established climate solutions on offer (ZEVs, renewable energy).

All the sectors examined in this analysis suggest growth of Avoided Emissions through to 2030. This growth in avoided emissions, is driven by the expected increase in demand for products, services and solutions that form the policy and transition plans for many countries where a climate target has been set.

The identification of companies and business that provide or are developing low carbon solutions have the potential to offer greater opportunities as these technologies are adopted. The analysis made in this report also suggests that these opportunities are not restricted to the finished products, but can be found upstream within the depths of the supply chains for these low-carbon solution providers.

7 Appendix

7.1 ZEV Sector Data Sources

7.1.1 ZEV Sector - LCA Factors

ICCT, “A Global Comparison Of The Life-cycle Greenhouse Gas Emissions Of Combustion Engine And Electric Passenger Cars”, (2021), Whitepaper, Available at: https://theicct.org/sites/default/files/publications/Global-LCA-passenger-cars-jul2021_0.pdf

IEA, “Comparative life-cycle greenhouse gas emissions of a mid-size ZEV and ICE vehicle”, IEA, Paris https://www.iea.org/data-and-statistics/charts/comparative-life-cycle-greenhouse-gas-emissions-of-a-mid-size-ZEV-and-ice-vehicle, IEA. Licence: CC BY 4.0

Ember Climate, "Global Electricity Review 2023 - Supplementary Material", (2023), Available at: https://ember-climate.org/insights/research/global-electricity-review-2023/#supporting-material

European Commission, “Passenger Car Classification - ACEA Classification”, (Online), Accessed 2023, available at: https://alternative-fuels-observatory.ec.europa.eu/general-information/vehicle-types

7.1.2 ZEV Sector - Company Sales

Company Reports

IEA (2023), “Global EV Outlook 2023”, IEA, Paris https://www.iea.org/reports/global-ev-outlook-2023, License: CC BY 4.0

IEA, “Electric vehicle stock by mode in the Stated Policies Scenario, 2022-2030”, IEA, Paris https://www.iea.org/data-and-statistics/charts/electric-vehicle-stock-by-mode-in-the-stated-policies-scenario-2022-2030, IEA. Licence: CC BY 4.0

IEA, “Electric vehicle sales by region, 2022-2030”, IEA, Paris https://www.iea.org/data-and-statistics/charts/electric-vehicle-sales-by-region-2022-2030, IEA. Licence: CC BY 4.0

IEA, "Breakdown of available cars by powertrain and segment, 2022", IEA, Paris https://www.iea.org/data-and-statistics/charts/breakdown-of-available-cars-by-powertrain-and-segment-2022

K. Wada & M. Inoue, "Japan and the Global Transition to Zero Emission Vehicles", (2022), Climate Group, Whitepaper, available at: https://www.theclimategroup.org/sites/default/files/2022-05/Japan%20and%20The%20Global%20Transition%20To%20Zero%20Emission%20Vehicles%20Report%20English%20language.pdf

IEA, "Electric vehicle share of vehicle sales by mode and scenario in Japan, 2030", IEA, Paris, Available at: https://www.iea.org/data-and-statistics/charts/electric-vehicle-share-of-vehicle-sales-by-mode-and-scenario-in-japan-2030

EEA, "New Registrations of Electric Vehicles in Europe", (2022), available at: https://www.eea.europa.eu/ims/new-registrations-of-electric-vehicles

7.2 Utilities Sector Data Sources

7.2.1 Utilities Sector - Electricity Source

T. Gibon, A.H. Menacho & M. Guiton. "Life cycle assessment of electricity generation options". (2021). Whitepaper. UN ECE.

E. Imamura, M. Iuchi, and S. Bando, "Comprehensive Assessment of Life Cycle CO2 Emissions from Power Generation Technologies in Japan", (2016), CRIEPI, Socio-economic Research Center Rep.No.Y06

International Resource Panel, "Green Energy Choices: The Benefits, Risks, and Trade-Offs of Low-Carbon Technologies for Electricity Production", (2016), Whitepaper, United Nations Environment Programme

NREL, "Life Cycle Greenhouse Gas Emissions from Electricity Generation: Update", (2021 - original document from 2013), US Department of Energy

7.2.2 Utilities Sector - Grid Breakdown

NGFS, "NGFS REMIND Model", (2021), Database, Year Accessed: 2023

7.2.3 Utilities Sector - Company Renewable Power Generation

Company Reports

7.3 Mined Minerals Sector Data Sources

7.3.1 Global Overall Mineral Production

USGS Mineral Commodities Summary Report - Mineral commodity summaries 2023 | U.S. Geological Survey (usgs.gov)

IEA – The role of critical minerals in clean energy transition: https://www.iea.org/reports/the-role-of-critical-minerals-in-clean-energy-transitions

IEA – Critical Minerals Policy Tracker: https://www.iea.org/reports/critical-minerals-policy-tracker

International Aluminium Institute – 2023 Report

7.3.2 Mineral requirements in ZEV batteries: Weight distribution

Transport & Environment (2021), From dirty oil to clean batteries: 2021_02_Battery_raw_materials_report_final.pdf (transportenvironment.org)

7.3.3 Global Mineral output for ZEV application projection (2030)

IEA – The role of critical minerals in clean energy transition: https://www.iea.org/reports/the-role-of-critical-minerals-in-clean-energy-transitions;

- Total mineral demand from new EV sales by scenario, 2020-2040 – Charts – Data & Statistics – IEA
- Comparative life-cycle greenhouse gas emissions of a mid-size ZEV and ICE vehicle – Charts – Data & Statistics - IEA

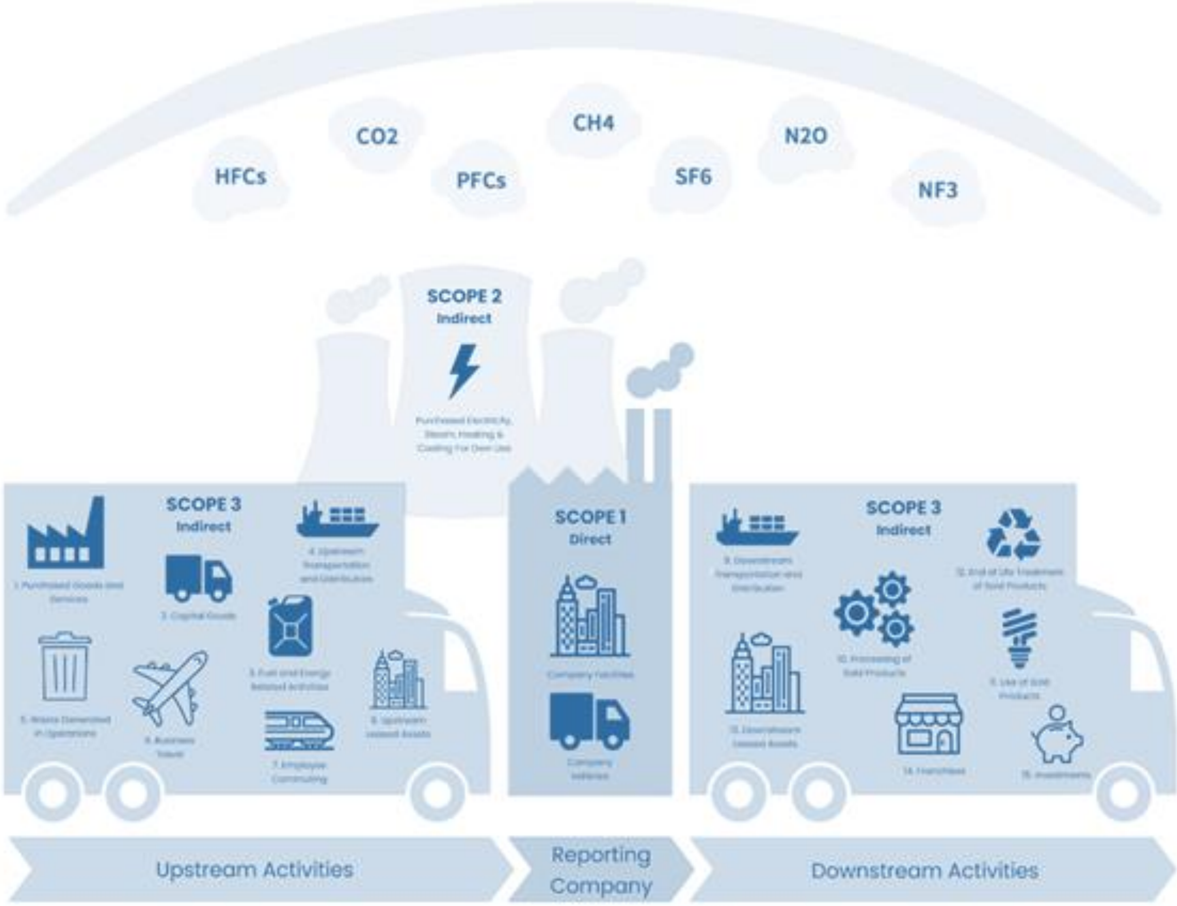
Aluminum EV Battery use projection - BNEF

Global ZEV and ICEV – LCA Emissions by segment (Used for Batteries: Minerals avoided emissions attribution)

7.4 GHG Emissions Scopes

The GHG Protocol Corporate Standard classifies a company's GHG emissions into three 'Scopes'.

- Scope 1 emissions are direct emissions from owned or controlled sources. Mobile emissions, process emissions and fugitive emissions are counted as Scope 1 if the company owns or controls the activities or equipment associated with the emissions.
- Scope 2 emissions are indirect emissions from the generation of purchased energy. The emissions resulting from the production of grid electricity are accounted for under Scope 2.
- Scope 3 emissions are all indirect emissions (not included in scope 2) that occur in the value chain of the reporting company, including both upstream and downstream emissions.



Source: ICE, Greenhouse Gas Protocol

LIMITATIONS:

The ICE Avoided Emissions ~Analysis of GPIF Portfolio~ Report (the "Report") was produced pursuant to an agreement between the ICE Group and the Government Pension Investment Fund who holds the copyrights to the Report. This Report contains information that is proprietary to Intercontinental Exchange, Inc. and/or its affiliates (the "ICE Group").

The information contained herein is subject to change without notice and does not constitute any form of warranty, representation, or undertaking and is provided for informational purposes only. Nothing herein should in any way be deemed to alter the legal rights and obligations contained in agreements between ICE Group and its respective clients relating to any of the products or services described herein.

This information is based on data which is either compiled from publicly reported information, provided to ICE Group by third parties or is estimated. ICE Group expressly disclaims any and all express or implied warranties or liability in relation to the data and the content of this report, and does not guarantee that it is accurate or complete.

There are many methodologies (including computer-based analytical modelling) available to calculate and determine information such as the information contained in this report; all future forecasts, estimates or values that are included in the report, including those that are reflections of data provided by other data providers as well as forecasts of expectations of change, are estimates based upon currently available information, are provided as is, and should be treated as estimates and forecasts with substantial potential deviations from underlying values.

Nothing herein is intended to constitute legal, tax, accounting or other professional advice or a representation that any investment or strategy is suitable or appropriate for any particular circumstances, or otherwise constitutes a recommendation to any person or entity, and is not to be used or considered as an offer or the solicitation of an offer to sell or to buy or subscribe for securities or other financial instruments.

ICE Group shall not have any liability for any errors or omissions in connection with any data or information contained in this report, or any liability for any direct, indirect, special, punitive, consequential or any other damages (including lost profits) arising from use of this report.

ICE Group is not registered as nationally registered statistical rating organizations, nor should this information be construed to constitute an assessment of the creditworthiness of any company or financial instrument.