SCIENCE BASED TARGETS

DRIVING AMBITIOUS CORPORATE CLIMATE ACTION

Methodology for setting corporate emission reduction targets in line with climate science:

THE SECTORAL DECARBONIZATION APPROACH (SDA)

Draft for Public Consultation

SEPTEMBER 2014

Driving Ambitious Corporate Climate Action

MIND THE SCIENCE, MIND THE GAP INITIATIVE BY:

CDP DRIVING SUSTAINABLE ECONOMIES

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ACKNOWLEDGMENTS

CDP, World Resources Institute (WRI), and WWF are grateful for the advice and inputs received from various experts during the development of the methodology.

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Participants in two stakeholder workshops held in London and Washington and one online workshop for Asia provided additional useful insight and feedback.

We benefited as well from advice and support from a number of WWF colleagues including: Aaron Sobel, Andrea Dreifke-Pieper, Erika Bellmann, Mandy J. Woods, Matthias Kopp, Matt Banks, Milan Kooijman, and Priscilla Presser-Velder, among others.

Several other experts were consulted for specific issues.

Our partner in outreach and engagement is the United Nations Global Compact.

CDP, WRI and WWF are grateful for the financial support from We Mean Business to complete the first phase of this project.

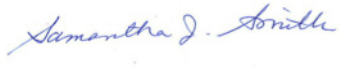
FOREWORD

After the urgent warning from the scientific community to keep global warming below a 2˚C temperature rise at the risk of irreversible environmental, social and economic damage, it has never been so evident that the business sector must contribute its fair share of emissions reductions to make sense of this 2˚C target. Science has set the benchmark under which climate action can truly become meaningful. Efforts lacking the ambition suggested by science will be insufficient to mitigate the worst impacts of climate change. The business community should be using this scientific benchmark when planning future business activities and considering their related climate impacts.

In pursuit of guidance on target setting to reduce GHG emissions, corporations from across different sectors have looked to CDP, World Resources Institute (WRI) and WWF for support, often individually and with differing levels of commitment. In 2014, these organizations decided to join forces and provide more comprehensive guidance to equip companies with a methodology that acknowledges the challenges posed by current climate science and the differences of each sector of the economy to achieve reductions. This quest for corporate guidance has motivated this work, which seeks to offer business the possibility not only to act for climate but to act in concert.

The first step of this joint effort is the presentation of the target setting methodology included in this report to help companies set targets aligned with what the best of science is telling us now. This method takes as point of departure the premise that a global carbon budget must be distributed among sectors, since each sector bears a different responsibility and a reduction burden that must be met to add up to the 2˚C mitigation pathway.

Our hope is for companies to adopt this method and commit to a shared long-term vision towards a low-carbon, thriving economy. We propose this method as a robust scientific alternative but also with the aim to resonate in harmony with the existing approaches that already exist in the scientific literature. As it is, the methodology leaves the door open for further improvements and adaptation to the constant change of circumstances in the economy since it operates under the assumption that companies should be able to set targets without sacrificing economic growth.



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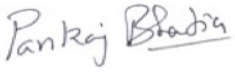

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EXECUTIVE SUMMARY

The present work describes the Sectoral Decarbonization Approach (SDA), a sector-based target-setting methodology for companies to reduce greenhouse gas emissions in line with the latest scientific scenario that would limit global temperature rise to 2˚C above pre-industrial levels.

The methodology presented in this report is part of a larger initiative on Science-based Target Setting, led by CDP (formerly the Carbon Disclosure Project), the World Resources Institute (WRI) and WWF. The objective is to provide a scientifically-informed methodology for companies seeking to raise the level of ambition on corporate target-setting. Ultimately, the leading organizations plan to engage with the business sector in the adoption of this methodology, and other approaches to science-based target setting, to ensure that the greatest number of companies commit to reduce their carbon footprint, recognizing the urgency of climate science.

Sectoral Decarbonization Approach (SDA) overview

Corporate target setting and the 'fair share' contribution to the 2˚C goal

Business plays a critical role in the transition towards a low-carbon economy. Not only is business a key contributor to the 49 gigatonnes of greenhouse gas (GHG) emissions that are released into the atmosphere every year, but it is also as a key driver of innovation and technological change. Today, over 80 percent of the Global 500 companies have adopted emission reduction targets of some kind. The majority of these targets are rather conservative and respond either to existing or expected regulations or to projects that are already in the short-term time horizon, normally leading to incremental improvements in the carbon footprint of companies. However, a few forward-looking companies have already aligned their targets to emission reductions that the scientific community deems necessary to limit global warming to less than 2˚C above pre-industrial levels.

Currently, companies can use available methods to set GHG reduction targets according to the level of decarbonization needed to stay below a 2˚C increase. However, current methods do not allow for comparisons of GHG intensity. In one existing approach, GHG targets are set based on their relative contribution to the economy, measured as 'Gross Value Added' or 'Gross Profit.' This gives companies the flexibility to grow and change business models. Though this approach is simple and broadly applicable, absolute emissions may still increase. Setting GHG targets using a sectoral decarbonization approach (SDA) – the focus of this work - provides a new approach to science based target setting which allocates a 2˚C carbon budget

by sector. The SDA methodology provides a more resolute and accurate GHG budget per sector, taking into account inherent differences between sectors such as mitigation potential and activity growth relative to economic and population growth. Within each sector, companies can derive their science-based emission reduction targets based on their relative contribution to total sector activity and their company's intensity relative to the sector's for the base year.

SDA: Methodological overview

The Sectoral Decarbonization Approach (SDA) is a freely available, methodology that allows companies to set GHG reduction targets necessary to stay within a 2˚C temperature rise above pre-industrial levels. This section provides an overview of its main features and how companies can use it in their target setting.

Development Process

The SDA methodology was developed by CDP (formerly the Carbon Disclosure Project), the World Resources Institute (WRI), and WWF with consulting support from Ecofys. To assure a robust and practical result, a Technical Advisory Committee of more than 20 experts provided input throughout the development process. Public stakeholder workshops were also held in Washington D.C. and London, as well as a webinar for companies in Asia, to solicit broader input. A public comment period and additional stakeholder workshops are being scheduled to get a final round of feedback before the methodology is finalized and published.

Tool

Accompanying the methodology is a tool that companies can use to enter their information to determine sector-based trajectories and targets. Companies can enter their sector, activities in their base year, estimated annual activity growth rate, electricity use in their base year, and scope-level emissions to determine their emissions targets for each scope. The user-friendly analytical tool can be found at: www.sciencebasedtargets.org.

Sector & emissions coverage

The activities and sectors covered in this methodology represent over 60% of global GHG emissions. Using the detailed-sector scenarios from the International Energy Agency's 2˚C Scenario (IEA 2DS) model, it is possible to estimate the 2˚C-compatible CO2 intensity for any sector by dividing the total direct CO2 emissions of the sector in any given year by the total activity of the sector in the same year (IEA, 2012). For each sector, a specific activity indicator is proposed based on the common practice of the sector (Table 1).[1 &2]

Table 1. Activity indicator per sector used in SDA

Sector	Activity Indicator
Power Generation	Kilowatt-hour[1]
Iron & Steel	Tonne steel
Cement	Tonne cement[2]
Aluminium	Tonne aluminium
Pulp & Paper	Tonne paper & cardboard
Chemicals & Petrochemicals	$ value-added
Other Processing & Manufacturing Industries	$ value-added
Passenger Transport - Air	Passenger kilometer
Passenger Transport – Light Road	Passenger kilometre
Passenger Transport – Heavy Road	Passenger kilometer
Passenger Transport - Rail	Passenger kilometer
Other Transport	$ value-added
Service buildings	Square meter

1 For the Power generation sector, a common used indicator for activity is the amount of kWh generated. This is a well-documented indicator and also calculated for most scenarios, including 2DS (IEA, 2012, 2014; Royal Dutch Shell, 2013; UNEP, 2011).

2 Cement is a shorthand for "cementitious products" as defined by the CSI: Cementitious products consist of all clinker produced by the reporting company for cement

Treatment of Scope 1, 2, and 3 emissions

Scope 1 emissions are those for which a company is directly responsible. In the SDA-methodology the sectoral decarbonization pathway are translated into scope 1 carbon intensity pathways of the sector towards 2050. Based on these sectoral pathways the scope 1 emissions of a company[2] are calculated based on their relative share to the total sector activity, resulting in a scope 1 CO2 budget for a company. A company should express its science-based targets for Scope 1 emissions in absolute terms.

Scope 2 emissions are indirect GHG emissions from consuming purchased electricity, heat or steam. The vast majority of Scope 2 emissions come from consuming electricity and 2˚C decarbonization models are available for the power sector but not for the heat or steam sectors. Therefore, for the purpose of this methodology, the indirect CO2 emissions from consumption of purchased electricity is used as a proxy for Scope 2 emissions. The 2˚C compatible emissions budget for Scope 2 emissions for any sector is estimated through the power-intensity (or power consumption) of the sector in any given year and the (2˚C compatible) CO2 intensity for the generation of power in the same year. It is possible to estimate the 2˚C carbon budget of the company by multiplying the Scope 2 carbon intensity times the activity of the company in any given year.

Scope 3 emissions are indirect emissions in the value chain not covered in Scope 2. They have more limited availability of information. Activity data and emission factors used can be less specific. However, many scope 3 emissions are caused by suppliers or other value chain partners that are part of sectors currently covered by the methodology. The 2 degrees scenarios for those sectors can be translated to category-specific scope 3 targets.

Double Counting

As long as consistent consolidation approaches are used, scope 1 and/or 2 emissions of companies (excluding the scope 1 emissions of utilities) can be aggregated to determine the total emissions of a sector, set of companies, etc. without double counting. On the other hand, scope 3 by definition contains emissions occurring in the companies' value chain, which are scope 1 and 2 emissions of other companies and value chain players (like consumers). Therefore, double counting can occur with scope 3 emissions and they should not be aggregated.

Cross-sector dependencies can hamper proper accounting of emission reductions. This shouldn't be a problem, since:

- The objective of the methodology is to set targets for individual companies, not to set up a validated accounting system at global level. Double counting is only an issue when you aggregate individual results;
- The fact that two companies pull at the same target will only create a stronger impetus to achieve this target, and even make a better business model;
- The objective is to reduce the emissions of the sector. By achieving this target, both companies contribute to achieving the global 2˚C decarbonization pathway.

Periodic revision of methodology and target-adjustment

The SDA-methodology uses both sectoral GHG emissions pathways as sectoral activity growth prediction. Both can deviate over time due to lower decarbonization rates or lower demand rates. This fact requires that the methodology should be periodically revised to check the validity of the projections used and that companies should also revise and check "compliance" to their targets, by checking if activity matched their previous projections and if intensities are below their specified pathway. Furthermore, as time progresses, the global budget can change due to changes in economic activity or population growth, new scientific evidence on climate change, or a new climate consensus that demands higher probabilities of staying below 2˚C or a different threshold for temperature increase (e.g. 1.5˚C). Regularly updating the global budget figure will constitute an important condition of the robustness and integrity of the methodology as a tool to help companies setting emission reduction targets.

Rationale behind SDA

In this section, an overview of the methodological context, choices and scientific basis that underlie the methodology are provided.

Global CO2 budget

To prevent the most severe impacts of climate change, parties to the UN Framework Convention on Climate Change (UNFCCC) agreed in 2010 to commit to a maximum temperature rise of 2˚C above pre-industrial levels (UNFCCC, 2011). To achieve this, significant reductions in global GHG emissions are needed.

A global CO2 budget is a practical and powerful concept that is easy to work with and communicate. Net zero emissions to the atmosphere will need to occur in order to not exceed the budgeted CO2 amounts that lead to warming higher than 2˚C. Limiting the global warming caused by man-made CO2 emissions alone, with a probability of >66% to less than 2˚C since pre-industrial levels, will require cumulative CO2 emissions -- i.e. a "CO2 budget" -- from all man-made sources to stay below 3,670 Gt CO2 from pre-industrial levels. When taking non-CO2 gases into account, this CO2 budget reduces to about 2,900 GtCO2 (IPCC, 2014a).

Since 1,890 Gt CO2 was already emitted by 2011, the remaining CO2 budget from 2011 onward is 1,010 GtCO2 (IPCC, 2014a).[3] This is the global CO2 budget that is at the core of this methodology.

From the different emission scenarios assessed under the IPCC Fifth Assessment Report, the best chances of limiting global warming to less than 2˚C is Representative Concentration Pathway (RCP) 2.6. This pathway would stabilize concentrations of GHG emissions in the atmosphere at about 450 parts per million (ppm) by 2100. The RCP2.6 scenario gives the highest likelihood (probability of 66-100%) to reach 450 ppm CO2e and thus to keep average global temperature rise below 2˚C in 2100. This scenario constitutes the basis for the 2˚C decarbonization pathway for the SDA methodology and is compatible with the global budget above. In total, the RCP2.6 estimates emissions of 990 Gt CO2 up to 2050, with a relevant and important component of carbon capture and storage being deployed beyond 2050.

Sector CO2 budgets

Linked to this 2˚C decarbonization pathway, IPCC AR5 Working Group III recently published its report on Mitigation of Climate Change (IPCC, 2014b). In this report 2˚C mitigation scenarios for the sectors energy supply, transport, buildings, industry and agriculture, forestry and other land use (AFOLU) are assessed. However, for industry most mitigation scenarios are not detailed enough. Therefore, following the IPCC AR5 Working Group III, the detailed CO2 scenarios that the International Energy Agency (IEA) has created in their 2014 Energy Technology Perspectives (ETP) report are used for all sectors.

The 2˚C scenario (2DS) in this ETP report is consistent with the RCP2.6 scenario and has a breakdown in several industrial sectors, making it a very useful source for developing the sector based methodology. This scenario estimates an overall budget of up to 2050 of 1055 Gt CO2,[4] with carbon capture and storage playing an important role after 2050.

SDA takes the data from IEA ETP 2DS to breakdown the CO2 budget in the period 2011-2050 into the sectors that it currently covers, resulting in sectoral 2°C decarbonization pathways for 2011-2050. These are based on the cumulative CO2 emissions from 2011-2050, according to the IEA 2DS.

The pathway proposed under the ETP 2DS scenario basically results in a deep decarbonization of the power sector. Some considerations used in calculating this trajectory are: phasing out of coal plants due to increasing use of renewable energy technologies with support of natural gas, increasing carbon capture and sequestration at gas facilities, and evolving economic activity and production for each of the sectors.

A sector intensity pathway is created by dividing the emissions pathway by the activity growth. The sector intensity pathways form the basis to define the targets for companies based on their current carbon intensity and convergence of their carbon

3 This budget is expressed in CO2 and not in CO2eq. This means that the budget accounts for CO2 from fossil fuel combustion and industrial processes, already taking the forcing of non-CO2 gases into account in the remaining budget.

4 The IEA provides emission values for the years 2011 and then 2020 to 2050 every five years. This value of 1055 GtCO2 was calculated by linear interpolation of the values for the years where no emission value is defined.

intensity to the sector intensity in 2050. The cumulative sum of these CO2 emissions result in 1055 GtCO2.

For homogenous sectors, physical indicators are used as the allocation method, i.e. share of global production. For heterogeneous sectors a monetary indicator ($ value added as contribution to GDP[5]) is used to translate sectoral CO2 emissions budgets to intensity targets (see Table 1 for the used activity indicators). It is important to note that the companies' intensity pathways – given by the methodology – multiplied by their projected activity give a company's carbon budget for the target period. In principle, the sum of these budgets should be contained within the sector projected budget given by the IEA 2DS.

Assumptions made in SDA methodology

For transparency purposes in this section a rationale and explanation of relevant assumptions made in the SDA is presented. These include:

- The carbon intensity of each company in a homogeneous sector will converge with the sectoral carbon intensity in 2050.
- The SDA methodology intrinsically accounts for regional differences regarding level of activity and carbon intensity but not explicitly in relation to historical responsibility
- Economic growth is decoupled from demand for energy and materials.
- Added value of individual heterogeneous sectors is assumed to grow proportional to GDP growth.
- Added value is defined as gross profit, which equals revenue minus cost of sold goods and services.
- Emissions from heat, steam, and cooling are negligible compared with those of electricity; this also holds for the longer term.
- Road vehicles are assumed to have a lifetime of 15 years; the carbon efficiency of new vehicles is calculated based on this assumption.

Next Steps

The methodology may be extended in scope and depth if relevant data become available. Since there are current limitations in data availability and restricted feasibility in applying all data available, the model may be further developed to include:

- Structural parameters within sectors to more accurately account for deviations from a sector's average structure
- Additional scope 3 emissions categories
- Additional sectors that have science-based 2°C decarbonization pathways

Conclusion

This methodology provides a sector-based approach for companies to set the GHG reduction targets necessary for our planet to stay within a 2˚C temperature rise. Companies can align their strategies with climate science to play a constructive role in decarbonizing the economy. Raising the ambition on corporate target setting levels will drive bolder business solutions and promote innovation in driving targets. Moreover, it will demonstrate to policy-makers the scale of ambition in industry to reduce emissions and act as a positive influence on international climate policy.

5 Added value is defined as gross profits (= revenue minus cost of bought in goods and services) in the SDA methodology

INTRODUCTION

Climate change has moved far beyond scientific and environmental circles to transforming the way businesses operate.

A decade ago, only a handful of forward-looking companies were measuring and disclosing their greenhouse gas emissions. Now it is common practice for businesses not only to report their annual emissions but also to make efforts to reduce their carbon footprint.

These companies have been spurred by increasing energy costs, technological developments, growing awareness, and rising scrutiny from stakeholders and investors. However, despite undeniable progress in the corporate sector, climate science shows that current efforts are setting us on a path to a 4˚C to 6˚C rise in global temperatures (rather than the internationally targeted 2˚C increase) by the end of the century with well-known consequences for ecosystems, vulnerable communities, infrastructure, and economies.

The myriad of actions undertaken by governments, businesses, and civil society so far are not enough to change this alarming trajectory. As emissions grow, the level of effort required to avoid exceeding 2˚C of global warming has also grown, but not enough. In 2013, CDP reported that over 80 percent of the Global 500 companies had targets to reduce their emissions (CDP, 2013). However, emissions of the 50 largest emitters, responsible for over 70 percent of the Global 500 emissions, increased in the past five years, according to data reported to CDP. A similar trend was observed for the five largest emitters in every sector analyzed by CDP.

In response to the disparity between the business sector's current trajectory of emissions and the trajectory required to meet the international 2˚C target, CDP, the World Resources Institute (WRI) and the WWF formed a collective effort to increase the level of ambition of emission reduction targets in the corporate sector.

As part of this effort, the organizations commissioned Ecofys, a leading consultancy that specializes in sustainable energy solutions and climate change issues, to develop a methodology.

Our proposed methodology, called the Sectoral Decarbonization Approach (SDA), builds on existing approaches that allocate a carbon budget to companies based on their contribution to the economy or value-added. However, unlike existing approaches, this methodology looks at sector-specific decarbonization pathways that are compatible with the 2˚C threshold rather than applying a generic decarbonization pathway for all companies regardless of the nature of their operations.

The sector modeling for the SDA methodology is built on the 2 Degree Scenario (2DS) developed by the International Energy Agency (IEA) as part of its Energy Technology Perspectives (ETP) outlook. IEA's 2DS provides a cost-competitive mitigation pathway[1] to achieve the 2˚C target while acknowledging differences in activity growth, mitigation potentials, and technological options for each sector. For relatively homogenous sectors, the methodology uses physical indicators (e.g. tonnes of product) to express activity. For more heterogeneous sectors, economic indicators are used as a proxy for activity (e.g. value-added). In both cases, the 2˚C carbon budget is allocated to companies based on their specific intensity pathway as calculated by the method and their relative contribution to the total output in the respective sector (or sectors) in which they operate.

This document describes the conceptual approach applied in the methodology, provides detail about the underlying modeling, assumptions, and data, and explores the strengths and limitations of the methodology. Two case studies illustrate the applicability of this methodology (section 3) and an elaborate scientific justification of the methodological choices and principles is presented (section 4).

The methodology is intended to be a living document. We anticipate upgrades to the SDA methodology and the underlying modeling as more accurate data and better models become available. We invite businesses to test the methodology, to challenge the underlying assumptions, to push the limits of this approach, and to make recommendations for improvement.

We hope that the results of this and similar methodologies will help companies understand the level of transformation required in their business and production models to meet the 2˚C goal. We have confidence that, in applying this goal-setting methodology, companies will find new sources of innovation and opportunities to become more competitive in a carbon-constrained economy. Many businesses have already taken steps to measure and reduce their carbon emissions. However, the growing impacts of climate change and the alarming scientific projections suggest that the bar needs to be set much higher.

Any target is no longer a good target. Responsible companies need to step up their levels of ambition and set credible, science-based greenhouse gas emission reduction targets and strategies that will allow us to meet the 2˚C goal and avert the most harmful effects of climate change.

1 Based on the cost-minimization criteria.

1. SCIENCE-BASED TARGET SETTING: OVERVIEW

1.1 The two-degree threshold and the imperative for rapid decarbonization

At the 1992 Earth Summit in Rio de Janeiro, more than 170 governments agreed to the United Nations Framework Convention on Climate Change (UNFCCC) with the purpose of "stabilizing greenhouse gas concentrations in the atmosphere at a level that would prevent dangerous anthropogenic interference with the climate system" (United Nations, 1992).

Although the definition of "dangerous" has been subject to interpretation, for almost a decade and with substantial advancements in climate modeling and climate science, an increase in the global mean surface temperature of 2˚C over pre-industrial levels has been accepted as an upper limit beyond which climate change becomes catastrophic and irreversible. Yet, many—including several small islands, least-developed countries, and environmental organizations—consider a 2˚C threshold dangerous for the most fragile ecosystems and vulnerable communities and propose an alternative threshold of 1.5°C. The international community agreed in 2010 at the 16th Conference of the Parties to the UNFCCC to "review progress made towards [the] two-degree objective, and a review by 2015 on whether the objective needs to be strengthened in future, including the consideration of a 1.5° C goal, on the basis of the best scientific knowledge available" (UNFCCC).

Staying below either 2°C or 1.5°C requires rapid decarbonization of our economy. According to the 5th Assessment Report (AR5) of the Intergovernmental Panel on Climate Change (IPCC), emissions in 2050 need to be 41–72 percent below 2010 emissions to keep temperature change below 2°C (IPCC, 2014a). Assuming a linear trajectory, this would require an emissions reduction of 10–18 percent every decade from the base year of 2010.

Unfortunately, the current trend is in the opposite direction. According to IPCC, in the last decade greenhouse gas (GHG) emissions grew by 2.2 percent every year. Even more concerning, the rate at which emissions are growing is also increasing. Under the current trajectory, we will exceed 450 parts per million (ppm) of GHG, the concentration identified by climate scientists as the threshold to keep temperatures below 2°C, by 2030. The business-as-usual trajectory is expected to generate 3.7 to 4.8˚C of global warming by the end of the century.

1.2 CORPORATE TARGET SETTING AND "FAIR SHARE" CONTRIBUTION TO THE 2°C GOAL

The critical role of business in the transition to a low-carbon economy is unquestionable. Business is not only a key contributor to the 49 gigatonnes of emissions released to the atmosphere every year, but is also a key driver of innovation and technological change. Over 80 percent of the Global 500 companies have adopted emission reduction targets (CDP, 2013). However, most of these targets are conservative and in response to existing or expected regulations, or they are short-term projects, leading to incremental improvements in the companies' carbon footprints.

A few forward-looking companies have aligned their emissions targets to the emission reductions that the scientific community deems necessary to limit global warming to less than 2°C.

Section 1 provides an overview of the most common approaches available for companies to set emission reduction targets consistent with the 2°C threshold.

1.2.1 ABSOLUTE EMISSION REDUCTION TARGETS

The first and simplest approach for reducing emissions in line with the 2°C threshold, is to reduce the overall carbon footprint of a company according to the level of decarbonization required to keep temperature increase below 2°C. According to the IPCC's 5th Assessment Report, this would require emission reductions of 41–72 percent by 2050 compared with 2010 emissions (IPCC, 2014a). Under a linear trajectory, the overall carbon footprint of a company would be reduced 10–18 percent every decade, taking 2010 as a base year (Figure 1).

While this method is simple, robust, and intuitive, it has some shortcomings. For instance, it does not recognize emission reduction actions implemented before 2010, and it does not easily accommodate changes in a business's circumstances, such as organic growth or mergers and acquisitions.

1.2.2 VALUE-ADDED APPROACH

A method that has gained popularity in recent years among pioneering companies setting emission reduction targets in line with climate science is the value-added approach (Figure 2). Under this approach, a global (or regional) 2°C carbon budget

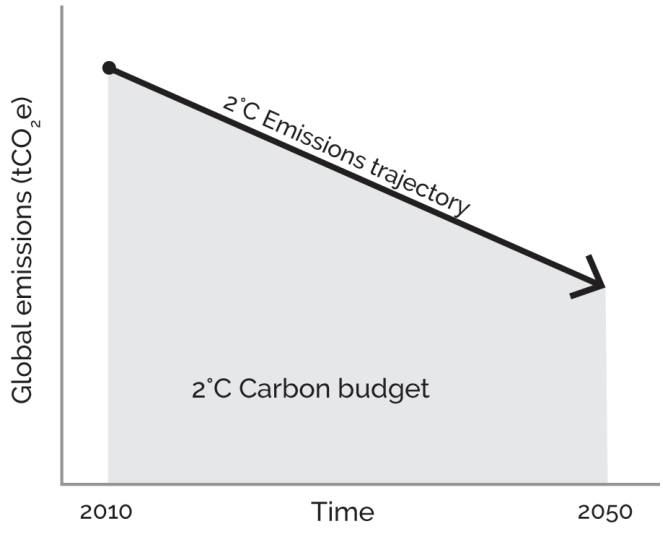


Figure 1 Absolute emission reduction targets

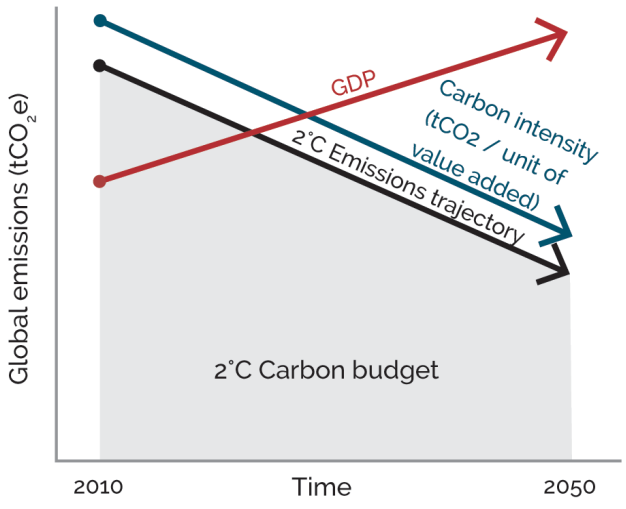


Figure 2 Value-added approach

is allocated to companies based on their relative contribution to the economy. In most cases, this contribution is measured as "gross value added" of "gross profit." See Box 1 and 2.

This method, built on the premise of carbon-intensity compression, has been well received within the corporate sector because of its simplicity and intuitive allocation of emission allowances. This method also gives corporations room to grow, organically or inorganically, and allows for flexibility to transform business models as an approach to achieve climate targets. The main shortcoming of this method is the underlying assumption that all companies, regardless of the nature of their operations, will be able to sustain the same level of decarbonization per unit of value-added.

Box 1: THE CENTER FOR SUSTAINABLE ORGANIZATION'S CONTEXT-BASED CARBON METRIC

The Center for Sustainable Organization's (CSO) context-based carbon metric, developed in 2006 with the support and involvement of ice cream maker Ben & Jerry's, was the first science-based metric for assessing the sustainability of greenhouse gas (GHG) emissions by organizations. It has been in continual use ever since with improvements added as needed. Although CSO's metric was designed for use by organizations, a variant was developed in 2011 for communities and municipalities in a project by CSO, the Donella Meadows Institute, and Pontifex Consulting. Sector-specific applications of the metric are supported, as are country-based and/or geographical analyses. CSO's metric supports the inclusion of Scopes 1, 2 and 3 emissions at the user's discretion.

CSO's carbon metric compares the GHG emissions of organizations to specific targets taken from science-based climate change mitigation/stabilization scenarios. The choice of a scenario is not imposed. The metric also takes organization-specific circumstances into account (e.g., changes in size over time) and thereby makes it possible to set targets that are both science- and (more broadly) context-based. The method also features an internal mass balance function that helps ensure that the logic used to define emissions targets for individual organizations, if generalized to the wider population as a whole, will not result in emissions that collectively exceed globally allowable science-based thresholds. Emissions targets for individual organizations are thereby continually recalculated in a way that is (a) sensitive to changes in an organization's size, (b) sensitive to changes in the broader population of emitters, and (c) mindful of the need to strictly abide by steadily declining (and science-based) emissions budgets at the global level. Performance is then reported annually and cumulatively in three ways: intensity, absolute, and context-based.

CSO's Context-Based Carbon Metric is freely downloadable by organizations under restricted license. The download link and more information (FAQs) about CSO's Context-Based Carbon Metric can be found at http://sustainableorganizations.org/, or by contacting CSO's Executive Director, Mark W. McElroy, by email: mmcelroy@vermontel.net.

Box 2: GREENHOUSE GAS EMISSIONS PER UNIT OF VALUE ADDED (GEVA)

The Greenhouse gas emissions per unit of value-added (GEVA) methodology proposes a method to target corporate greenhouse gas reductions based on their percentage of value-added.

If all nations reduce their "GHG emissions per unit of GDP" by 5 percent per year, global GHG emissions will be 50 percent lower in 2050 than in 2010 as long as the global economy continues to grow at its historical rate of 3.5 percent per year. The suggested 5 percent per year decline can be translated into a corporate resolution to reduce corporate "GHG emissions per unit of value added" (GEVA) by 5 percent per year.

If all corporations cut their GEVA by 5 percent per year, the same global result will be achieved. The suggested 5 percent per year decline can be used as a guideline for responsible action on a voluntary basis. The guideline is unlikely to be made mandatory soon, but compulsory publication of the necessary emissions and productivity data by nations and corporations could help civil society highlight top performers.

For further information see J. Randers, Greenhouse gas emissions per unit of value added ("GEVA")

1.2.3 THE SECTORAL DECARBONIZATION APPROACH (SDA)

While a single indicator of activity for the entire economy (e.g., GDP) is a simple way to determine CO2 intensity, different sectors grow at different paces because of a number of factors including population, economic structure, and dynamics. This is especially true for many energy-intensive sectors that represent a large share of industrial GHG emissions. For example, demand for certain materials (like cement and steel) increases with income levels and then stabilizes at a level of saturation, whereas demand for other materials, like paper and aluminum, continues to increase along with economic and population growth according to a Global Energy Assessment study (GEA, 2012).

Different sectors also have different mitigation potentials and mitigation costs because of their different levels of technical and commercial maturity, and different availabilities of low-carbon technologies. Considering the expected growth in different sectors, and their respective mitigation potentials (along with many other factors), a number of integrated assessment models provide optimal transformation pathways – and associated carbon budgets – for different sectors. (See Box 3)

Taking these cost-mitigating transformation pathways as a basis, it is possible to derive science-based emission reduction targets by allocating a sector's optimized 2˚C carbon budget to a specific company based on (1) the compression (for a heterogenous sector) or convergence (for a homogenous sector) of the CO2 intensity of the company to the 2°C CO2 intensity of the sector and (2) the contribution of the company to the total sector activity.

For homogeneous sectors it is possible to use physical indicators as a proxy for activity (e.g. tonne of product). For more heterogeneous sectors, economic indicators (e.g. value-added) are more appropriate.

Shortcomings of this method include lack of data with sector-specific resolution for heterogeneous sectors and the complexity in interpreting and disaggregating data from integrated assessment models. This method is explained in more detailed in section 2.

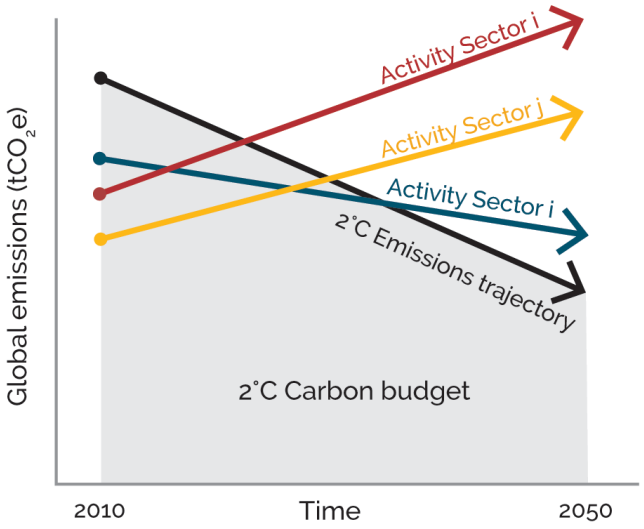


Figure 3 Sectoral decarbonization approach

Box 3: THE 3% SOLUTION: A SECTOR-SPECIFIC APPROACH

The 3% Solution identifies how U.S. corporations can set GHG-reduction targets that lead to a collective cost savings of US$780 billion between 2010 and 2020, while aligning targets with a 2˚C pathway. Developed by World Wildlife Fund for Nature, with CDP, McKinsey & Company, and Point380, these savings are achieved by boosting energy-efficiency measures and transitioning to low-carbon energy sources. The U.S. corporate sector would cut carbon emissions by 3 percent annually on average, though the methodology customizes targets to each company using a simple tool called the Carbon Target and Profit Calculator.

The Carbon Target and Profit Calculator helps companies set a 2020 carbon reduction target and determine potential cost savings if those reductions are achieved. The calculator translates the U.S. economy-wide savings presented in "The 3% Solution" report down to an individual company level, taking into account sector-specific opportunities. This tool is not intended to replace customized savings assessments for each company, but can serve as an indicator of approximate potential financial savings and

carbon reductions that a company could achieve by following the guidance outlined in the report. The 3% Solution report, the carbon productivity portfolio, and a free carbon profit calculator can be found at www.the3percentsolution.org

2. SECTORAL DECARBONIZATION APPROACH (SDA): METHODOLOGICAL OVERVIEW

The Sectoral Decacrbonisation Approach (SDA) is a freely available open-source methodology that allows companies to set emission reduction targets in line with a 2°C decarbonization scenario. It is based on the 2°C scenario (2DS) developed by the International Energy Agency (IEA) as part of its publication, Energy Technology Perspectives 2014 (IEA, 2014).

This section provides an overview of the main features of the methodology and includes a step-by-step description on how companies can use it to set greenhouse gas (GHG) emissions reduction targets. More detail on underlying assumptions, scenarios, and models can be found in section 4. A user-friendly tool for companies to set science-based targets applying this approach can be downloaded from www.sciencebasedtargets.org

2.1 A snapshot into the methodology development

The elements and phases for the development of SDA's science-based target-setting methodology are illustrated in Figure 2.

In developing this methodology, the following elements were considered: carbon budget and emission scenarios, sector and emissions coverage, sector classification and activity indicators, treatment of Scope 1, Scope 2, and Scope 3 emissions, and double counting. Each element is described below.

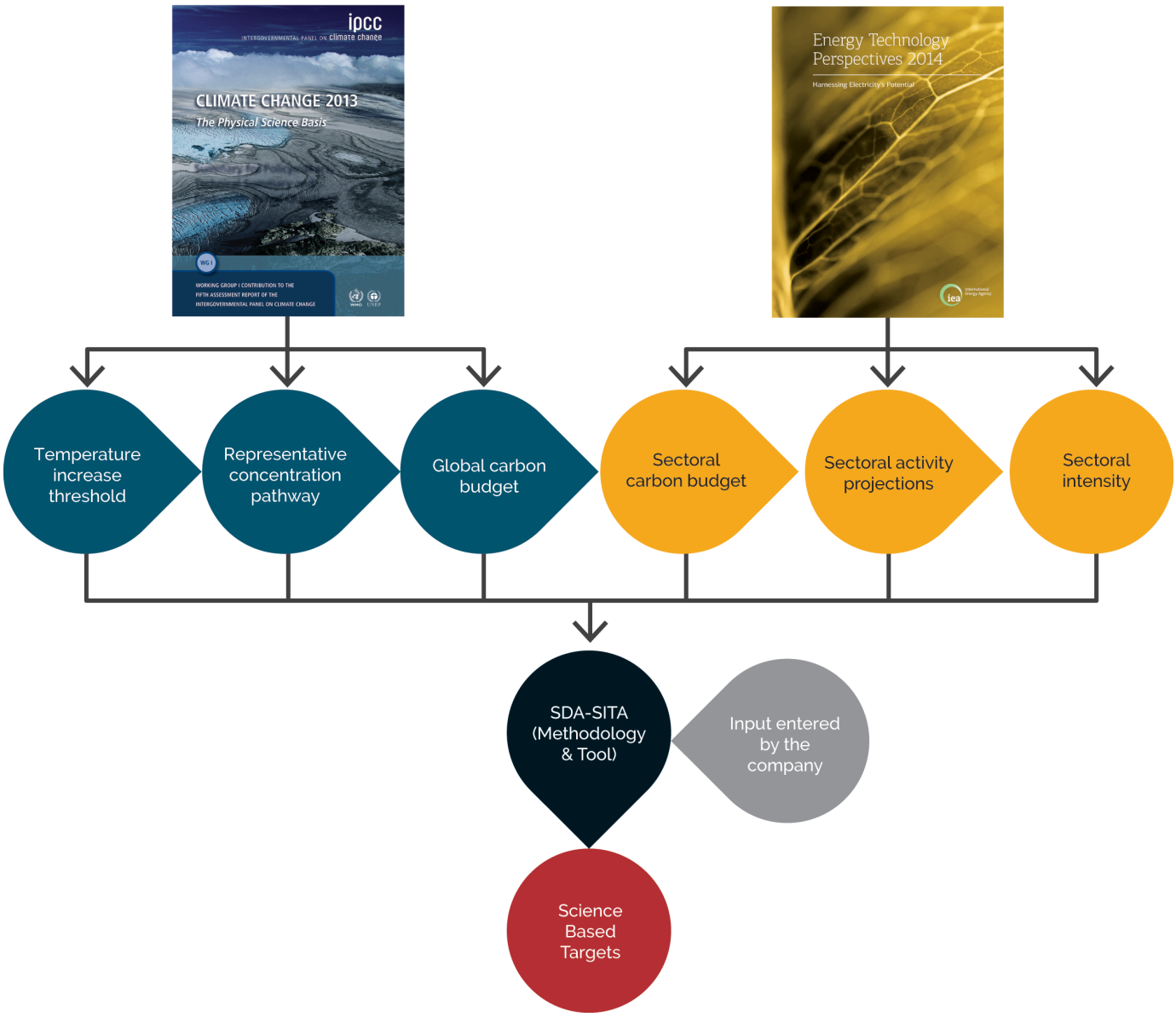


Figure 4. Development of the SDA methodology

2.1.1 Carbon budget and emission scenarios

The first step in defining science-based emission reduction targets is to understand the maximum increase in global average temperature that would prevent "dangerous anthropogenic interference with the climate system." As discussed in the previous section, the threshold generally accepted in scientific literature and the policy community is a ceiling of 2°C increase in global average surface temperatures compared with pre-industrial levels. While a cap of 1.5°C holds better chances of averting "dangerous climate change," there is considerably more modelling and publically available data with sufficient resolution at the sector level for a 2°C threshold. Therefore, the 2°C limit is applied in this methodology.

According to the IPCC 5th Assessment Report: Working Group I, limiting anthropogenic global warming to less than 2°C with a probability of more than 66 percent, requires keeping cumulative CO_2 emissions from all anthropogenic sources below about 1,000 gigatonnes (Gt) of CO_2 considering carbon and noncarbon forcings (IPCC, 2013). This figure constitutes the carbon budget for all anthropogenic carbon emissions necessary to limit global warming to less than 2˚C.

From the four different emission scenarios assessed by the IPCC 5th Assessment Report: Working Group III, the one that holds the best chances of limiting global warming to less than 2°C is the "Representative Concentration Pathway (RCP 2.6)" (IPCC, 2014b)[1]. This concentration

1 IPCC developed a total of four scenarios: RCP2.6, RCP4.5, RCP6, and RCP8.5. They are named after a possible range of

pathway, developed by the IMAGE modelling team of the PBL Netherlands Environmental Assessment Agency, represents a peak-and-decline model that reaches a maximum level of radiative forcings of 3.1 watts per cubic meter (W/m$^{2)}$ by midcentury and then declines to about 2.6 W/m^2 by the end of the century. This scenario would stabilize concentrations of GHG emissions in the atmosphere at about 450 parts per million (ppm) by 2100.

While the RCP 2.6 emissions scenario provides a useful framework to understand the emissions trajectory at the macro level, it does not provide sufficient resolution at the sectoral level to understand the type of transformations required in different industries to achieve this level of decarbonization. Thus, IEA's 2°C scenario (2DS) was used for this purpose (IEA, 2014). The 2DS scenario describes an energy and industrial system consistent with an emissions trajectory that, according to climate science, has a good chance of limiting global warming to less than 2°C. The correspondence between the RCP 2.6 and 2DS scenarios has been assessed and validated (Schaeffer & Van Vuuren, 2012).

2.1.2 Sector and emissions coverage

This methodology described in this report allows companies to set emission reduction targets that are in line with IEA's 2DS scenario based on sector-specific decarbonization pathways. The activities and sectors covered under this version 1.0 of the methodology are shown in Figure 5. This coverage represents over 60 percent of global GHG emissions.

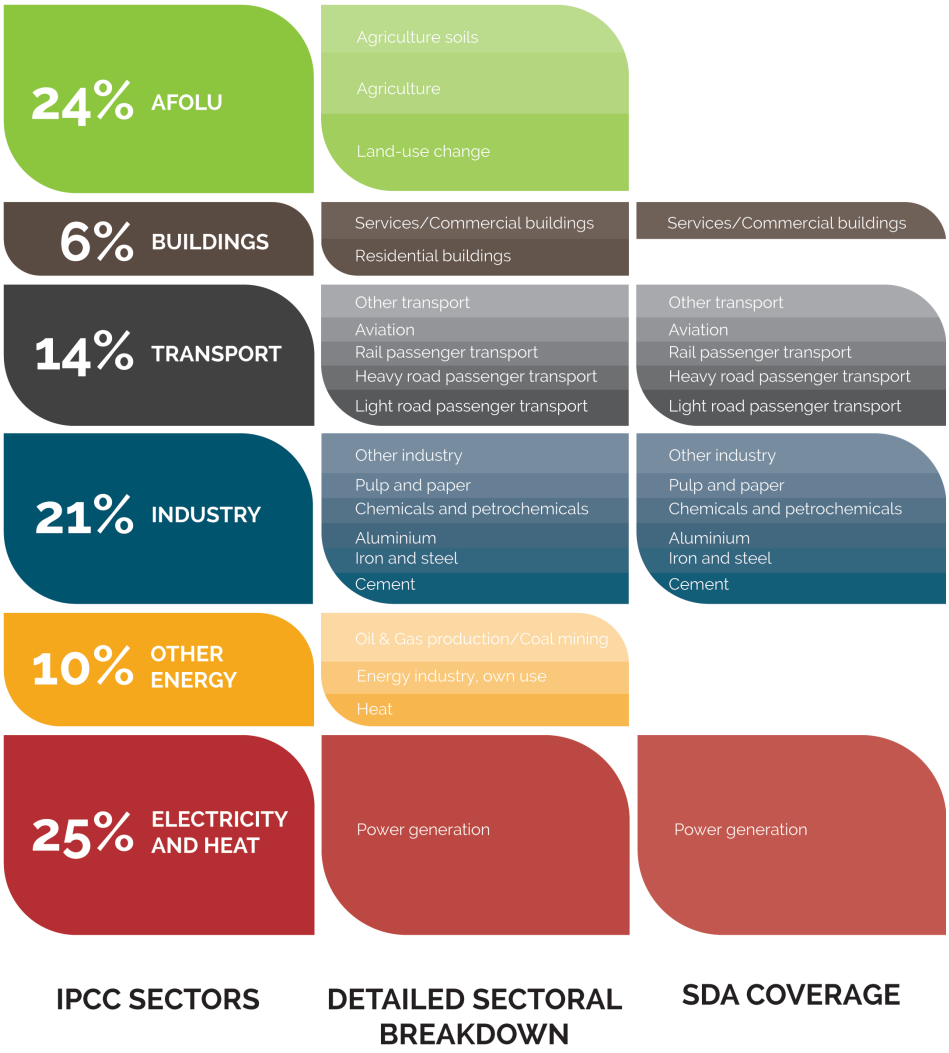


Figure 5. Sectoral coverage under the SDA methodology Sources: IPCC, 2014a; IEA, 2014

radiative forcing values in the year 2100 relative to pre-industrial values (+2.6, +4.5, +6.0, and +8.5 W/m^2, respectively).

2.1.3 Sector classification and activity indicators

For the purpose of the SDA methodology, the following four broad sector classifications were considered. For each sector, a specific activity indicator is proposed based on the common practice in the sector. Please refer to Appendix VI for a detailed sectoral breakdown of the final 13 sectors for which decarbonization pathways were developed.

Table 1. Sector classification and activity indicators

Sector	High-level sector description	Subsector	Activity Indicator
1.Power Generation	Power is primary business activity.	N/A	Kilowatt-hour[a]
2.Industry[b]	The industry sector is heterogeneous and very complex. Generally speaking, the industry sector covers the manufacture of finished goods and products, mining and quarrying of raw materials, and construction. Power and heat generation, refineries, and the distribution of electricity, gas and water are excluded. The International Energy Agency (IEA) energy balance follows this definition (IEA, 2014). International Standard Industrial Classification codes usually included in Industry sector by the IEA are matched with this sector [c]	Iron & Steel	Tonne steel
		Cement	Tonne cement[d]
		Aluminum	Tonne aluminum
		Pulp & paper	Tonne paper and cardboard
		Chemicals & petrochemicals	$ value-added
		Other processing & manufacturing industries	$ value-added
3. Transport Services[e]	The transport sector includes the movement of people and goods by the transport modes of road, rail, water and air. Energy consumption in the transport sector is driven by a wide range of factors, which are different for the passenger segment and the freight segment. As a result, the passenger and freight energy and efficiency trends are calculated separately (IEA, 2014).	Passenger transport - Air	Passenger kilometer
		Passenger transport – Light road	Passenger kilometre
		Passenger transport – Heavy road	Passenger kilometer
		Passenger transport - Rail	Passenger kilometer
		Other transport	$ value-added
4. Services / Commercial Buildings[f]	The services sector, also referred to as the commercial and public service sectors or the tertiary sector, includes all activities related to trade, finance, real estate, public administration, health, food and lodging, education and commercial services, as classified ISIC. It covers energy consumed for space heating, cooling and ventilation; water heating; and lighting; and in a number of other miscellaneous energy-using equipment such as commercial appliances and cooking devices, x-ray machines, office equipment, and generators. Energy consumption for transportation, or for commercial transport fleets, and energy consumption for electricity and heat generation are excluded from the services sector. (IEA, 2014).	Trade / Retail	Square meter
		Finance	
		Real estate	
		Public administration	
		Health	
		Food and lodging	
		Education	
		Other commercial services	

2.1.4 The Greenhouse Gas Protocol

The Greenhouse Gas Protocol (GHG Protocol) is the most widely used international accounting tool for government and business leaders to understand, quantify, and manage greenhouse gas emissions. The GHG Protocol, a decade-long partnership between the World Resources Institute and the World Business Council for Sustainable Development, works with businesses, governments, and environmental groups around the world to build a new generation of credible and effective programs for tackling climate change.

It provides an accounting framework for nearly every GHG standard and program in the world - from the International Standards Organization to The Climate Registry - as well as hundreds of GHG inventories prepared by individual companies.

The GHG Protocol defines direct and indirect emissions as follows:

- Direct GHG emissions are emissions from sources that are owned or controlled by the reporting entity.
- Indirect GHG emissions are emissions that are a consequence of the activities of the reporting entity, but occur at sources owned or controlled by another entity.
- The GHG Protocol further categorizes these direct and indirect emissions into three broad scopes:
- Scope 1: All direct GHG emissions.
- Scope 2: Indirect GHG emissions from consumption of purchased electricity, heat or steam.
- Scope 3: Other indirect emissions, such as the extraction and production of purchased materials and fuels, transport-related activities in vehicles not owned or controlled by the reporting entity, electricity-related activities not covered in Scope 2, outsourced activities, waste disposal, etc.[3]

2.1.5 Treatment of Scope 1 emissions

Scope 1 emissions are direct emissions from sources owned or controlled by the reporting company. They are the most straightforward to estimate and track.

a For the power generation sector, a commonly used indicator for activity is the kWh generated. This is a well-documented indicator that has been calculated for most scenarios, including 2DS (IEA, 2012a, 2014; Royal Dutch Shell, 2013; UNEP, 2011).

b The cement, iron and steel, aluminium, and pulp and paper sectors are relatively homogeneous (Farla, 2000; Phylipsen et al., 1998). Therefore, it is possible to use the physical output as activity indicator. These are tonnes of cement, crude steel, aluminium, and paper and cardboard respectively. The activity in the iron and steel sector is based on steel production, but in reality, many different iron and steel products and intermediate products can be distinguished (Farla, 2000). This also holds for the cement, pulp and paper, and aluminium sectors to some degree (Phylipsen et al., 1998). Both the emissions and activity data for these sectors is given for five-year intervals in IEA ETP 2DS.

c http://www.iea.org/statistics/resources/balancedefinitions/#industry.

d Cement is a shorthand for “cementitious products” as defined by the Cement Sustainability Initiative (CSI): Cementitious products consist of all clinker produced by the reporting company for cement making or direct clinker sale, plus gypsum, limestone, Cement Kiln Dust (CKD) and all clinker substitutes consumed for blending, plus all cement substitutes.

e In the light and heavy rail and aviation transport sector, the indicator used in IEA ETP 2DS is total passenger kilometers (pkm).

f For service buildings, the indicator for activity is square meter, since this data is available for five-year intervals in IEA ETP 2DS and this indicator is also often used in climate science (Girod & De Haan, 2010; Girod, van Vuuren, & Hertwich,2014).

3 The GHG Protocol website, “Frequently Asked Questions,” http://www.ghgprotocol.org/calculation-tools/faq#directindirect.

2.1.5.2 Homogenous sectors

From the detailed sector data in the 2DS scenario, it is possible to estimate the 2°C-compatible CO2 intensity for specific sectors by dividing the total direct CO_2 emissions of the sector in any given year (between 2011 and 2050) by the total activity of the sector in the same year. The RCP 2.6 and the 2DS scenarios represent "peak-and-decline" emissions trajectories thus the decarbonization pathways and the CO2 intensity trajectories for the different sectors are not linear. The 2°C trajectory (emissions, activity and CO2 intensity) for the iron and steel sector based on the 2DS scenario produced by the IEA is shown in Figure 6.

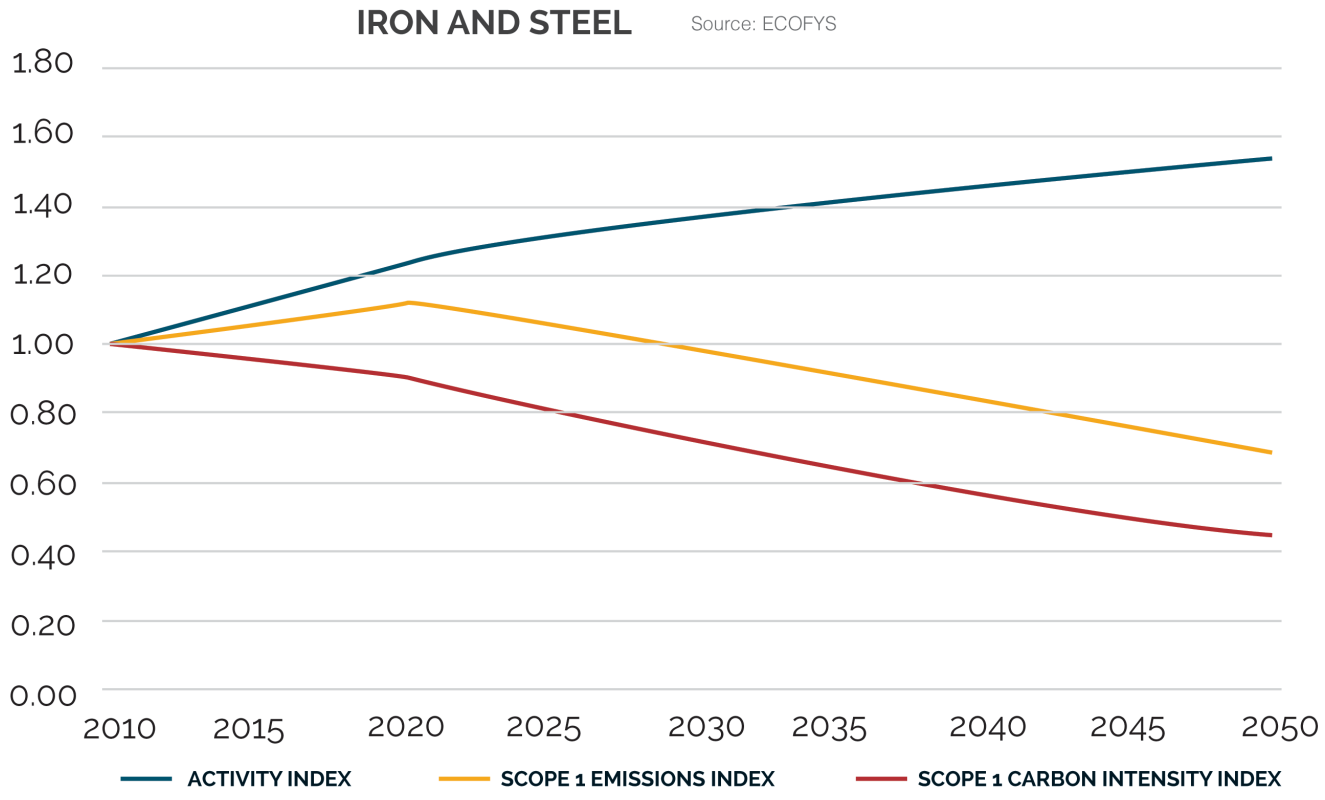


Figure 6. 2ºC pathway for the iron and steel sector Source: Based on IEA 2DS scenario (IEA, 2014).

The SDA methodology assumes that the CO2 intensity for the companies in all homogeneous sectors tends to converge in 2050 (see section 4.2.1). The rate of convergence depends on the differential between the CO2 intensity of the company and the 2°C CO2 intensity of the sector. This differential declines linearly until 2050, when the CO2 intensity of all companies is the same as the 2°C CO2 intensity for the sector. The convergence of the carbon intensities of different companies within a homogeneous sector is illustrated in Figure 7

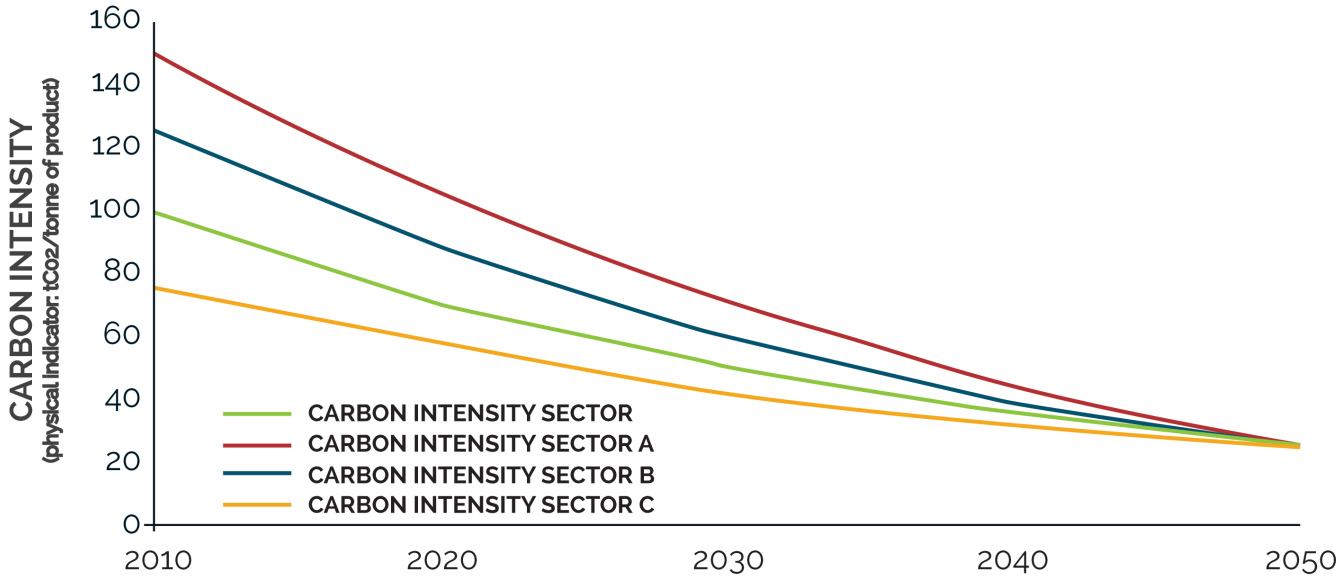


Figure 7. Convergence of carbon intensities within a sector

Assuming that the CO2 intensity of a company and the 2°C CO2 intensity for the homogeneous sector tend to converge in 2050, the 2°C CO2 intensity for a company can be estimated according equation 1:

$$CI_{i,y} = \left(\frac{CI_{i,BL} - SI_{2050}}{SI_{BL} - SI_{2050}} \right) \times \left(SI_y - SI_{2050} \right) + SI_{2050}$$

Equation 1

Where:

$CI_{i,y}$	CO2 intensity for the company i in target year y (tCO_2e / activity)
$CI_{i,BL}$	CO2 intensity for the company i in the base year (tCO_2e / activity)
SI_{2050}	CO2 intensity for the sector in 2050 (tCO_2e / activity)
SI_{BL}	CO2 intensity for the sector in the base year (tCO_2e / activity)
SI_y	CO2 intensity for the sector in the target year y (tCO_2e / activity)

A detailed forecast of activity and 2°C-compatible emissions for the sectors covered in the methodology is provided in Appendix I.

2.1.5.2 Heterogenous sectors

For heterogeneous sectors – that is, sectors that can't be described using a single physical indicator – the methodology uses value-added as an indicator of activity. As with the value-added approaches described in section 1.2.2, "gross profit" is used as a proxy for value-added. For these sectors, it is not accurate to assume that the CO2 intensity of different companies will converge at any point in time, considering the differences across industries and among companies. For instance, a TV manufacturer, a manufacturer of home appliances, and a manufacturer of industrial packaging machines will always generate different volumes of emissions per unit of value-added, despite the fact that they could all fall into a broad category of "manufacturers of electrical equipment." In the absence of more sector-specific decarbonization pathways, a reasonable alternative is to depict how the carbon-intensities of different companies would compress to be within a broad 2°C carbon budget (see Figure 8).

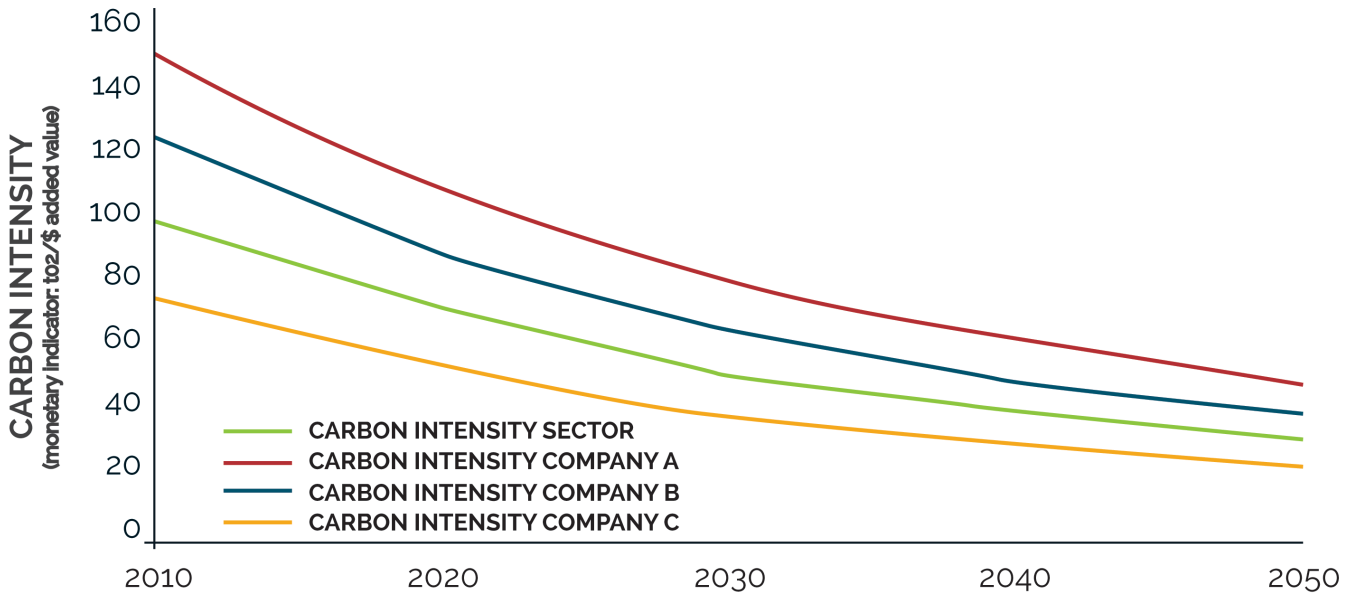


Figure 8. Carbon-intensity compression for heterogenous sectors

With this as a basis, the target CO2 intensity of a company is determined using equation 2:

$$CI_{i,y} = (SI_y / SI_{BL}) * CI_{BL}$$

Equation 2

Where:

$CI_{i,y}$	CO2 intensity for the company i in target year y (tCO_2e / activity)
$CI_{i,BL}$	CO2 intensity for the company i in the base year (tCO_2e / activity)
SI_{BL}	CO2 intensity for the sector in the base year (tCO_2e / activity)
SI_y	CO2 intensity for the sector in the target year y (tCO_2e / activity)

Since in heterogeneous sectors the total sectoral value-added is unknown, it is assumed that the value-added grows proportionally to GDP. The ratio (SI_y/SI_{BL}) is calculated by dividing the emissions in the base year by the GDP index in the base year (=100 percent) and dividing the emissions in the target year in the 2°C-compatible sector pathway by the GDP index in the target year (=growth percent of GDP compared to base year). The resulting sector intensities SI_{BL} and SI_y are indices as well. See equation 3.

$$SI_y = (SE_y / GDPI_y)$$

Equation 3

Where:

SE_y	Carbon emissions of the sector in target year y (tCO_2e)
$GDPI_y$	GDP index in target year (growth % of GDP compared to base year)

A company can express its science-based targets for Scope 1 emissions in relative or absolute terms. To express the targets in intensity terms, equation 1 is used. To express the targets in absolute terms, the 2°C carbon budget is estimated by multiplying the 2°C-compatible CO2 intensity of the company times the activity forecast for any given year, according to equation 4:

$$CB_{i,y} = CI_{i,y} \times A_{i,y}$$

Equation 4

Where:

$CB_{i,y}$	Carbon budget for the company i in target year y (tCO_2e)
$CI_{i,y}$	CO2 intensity for the company i in target year y (tCO_2e / activity)
$A_{i,y}$	Activity for the company i in target year y (activity indicator)

2.1.6 Treatment of Scope 2 emissions

Scope 2 emissions as the indirect GHG emissions from consumption of purchased electricity, heat or steam. Indirect emissions are a consequence of the activities of the reporting entity, but occur at sources owned or controlled by another entity (WBCSD, WRI, 2004).

Given that the consumption of electricity represents the vast majority of Scope 2 emissions and that there is a lack of 2°C decarbonization models for the heat and steam sectors, this methodology uses the indirect GHG emissions from consumption of purchased electricity as a proxy for Scope 2 emissions.

Taking the total electricity consumption at the sector level, the 2°C budget for the generation of this electricity (i.e. using the 2°C CO2 intensity indicator for the power sector), and the total sectoral activity, it is possible to estimate the Scope 2 CO2 intensity for a sector as in equation 5:

$$SI_{S2,y} = \frac{PS_y \times SI_{Power,y}}{A_y}$$

Equation 5

Where:

$SI_{S2,y}$	Scope-2 CO2 intensity for the sector in year y (tCO_2e / activity)
PS_y	Power consumption for the sector in year y (MWh)
$SI_{Power,y}$	2°C CO2 intensity for the power sector in year y (tCO2 / MWh)
A_y	Activity for the sector in year y (activity indicator)

Under the same assumption that the Scope-2 CO2 intensity of a company and the 2°C CO2 intensity for the homogenous sector tend to converge toward 2050, it is possible to estimate the Scope-2 CO2 intensity for an individual company by using equation 1. Having this CO2 intensity, it is then possible to estimate the 2°C carbon budget of the company by multiplying the Scope-2 CO2 intensity times the activity of the company in any given year.

For heterogeneous sectors, equation 5 is indexed with the GDP index in year y as activity for the sector. The resulting Scope-2 CO2 intensity of the sector is used to calculate the company's CO2 intensity in year y by using equation 2.

A detailed forecast of CO2 intensity for the power sector and expected power consumption for different sectors is provided in Appendix I.

2.1.7 Treatment of Scope 3 emissions

Scope 3 emissions are other indirect emissions, such as the extraction and production of purchased materials and fuels, transport-related activities in vehicles not owned or controlled by the reporting entity, electricity-related activities not covered in Scope 2, outsourced activities, waste disposal, etc.

The methodology can assist companies in managing their Scope 3 emissions by identifying science-based emission reduction trajectories for carbon "hot spots" in their value chains. The GHG Protocol Corporate Value Chain (Scope 3) Accounting and Reporting Standard defines 15 subcategories for Scope 3, highlighted in Figure 9

Scope 3 emission for light vehicle manufacturing have been included in the tool, which is the most carbon-intensive Scope 3 category for the automotive sector. The methodology can also be used to indirectly assess Scope 3 emissions for

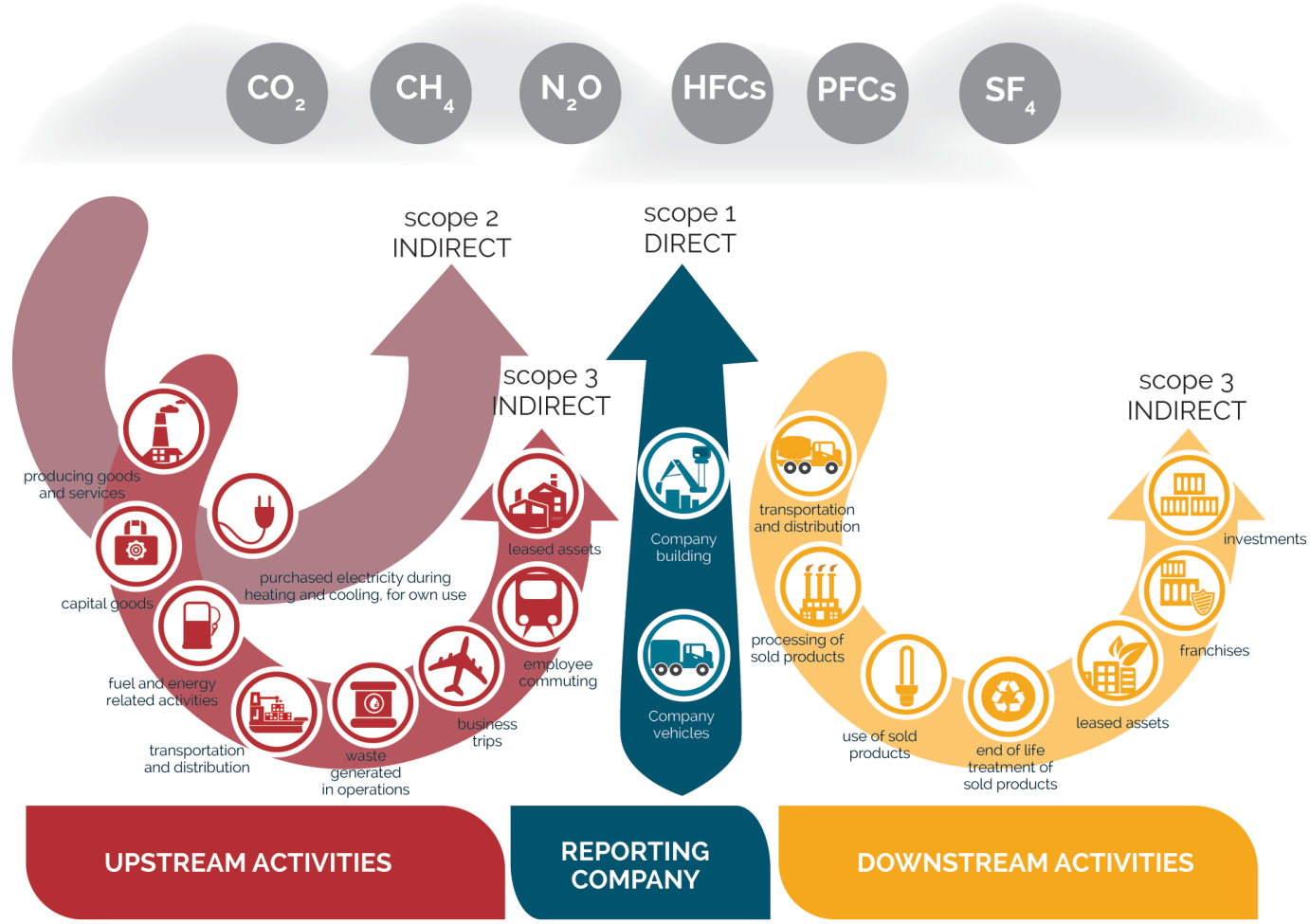


Figure 9. The three scopes in the GHG Protocol: Scope 1, direct emissions; Scope 2, indirect emissions; and Scope 3, other indirect emissions in the value chain
Source: GHG Protocol, 2011.

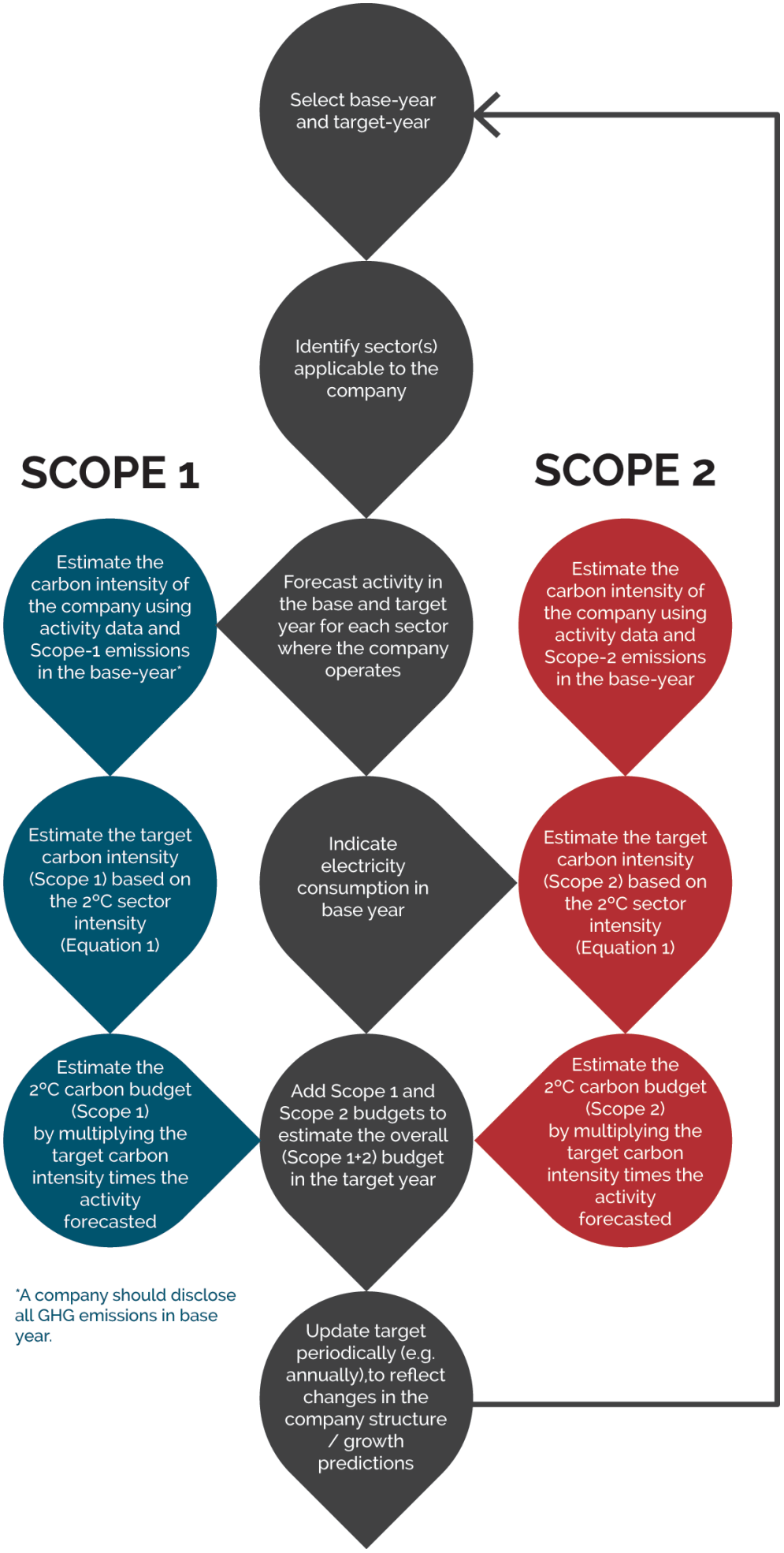


Figure 10. Flow-chart: Scope 1 and 2 target setting using the SDA methodology

other categories. Please refer to Appendix III for more details.

2.1.8 Double counting

Cross-sector dependencies can hamper proper accounting of emission reductions. For example, a truck manufacturer can achieve a Scope 3 target by making more efficient trucks. A transportation company can achieve a Scope 1 target by using these more efficient trucks. When both companies claim these emission reductions, it results in double counting. This shouldn't be a problem, since:

- The objective of the methodology is to set targets for individual companies, not to set up a validated accounting system at the global level. Double counting is only an issue when you aggregate individual results.
- The fact that two companies reduce emissions in the same activity will only create a stronger impetus to achieve this target, and support a better business model, like in the example of the truck manufacturer.
- The objective, in this example, is to reduce the emissions of the transportation sector. By achieving this target, both companies contribute to achieving the global 2˚C decarbonization pathway.

2.2 Step-by-step protocol for using this methodology

The step-by-step protocol for calculating Scope 1 and Scope 2 emission-reduction targets in line with a 2˚C scenario using the SDA is illustrated in Figure 10.

2.3 Periodic revision of methodology and target adjustment

The SDA methodology works with data projections and forecasts for different sectors to achieve a least-cost decarbonization pathway in line with a 2°C scenario. Although these projections set the necessary pathway for sectors, some uncertainty (and inaccuracy) is involved as with any future projection.

This inherent uncertainty and the evolution of scientific knowledge in the climate field require a periodic revision of the method as well as regular updates in the emissions reduction targets by companies to reflect realistic forecasts.

The target-setting SDA methodology is constructed around the sectoral emission pathways and is based on data from IPCC and IEA ETP 2DS. The emission pathways are used to determine company targets. The IPCC has released new assessment reports on a regular basis (every five to six years). The IEA plans to release regular updates of the underlying data of the 2DS every two years. The authors plan to update this methodology in line with the IPCC updates of the assessment report approximately every five years. An earlier revision will be considered if a significant change occurs in the IEA ETP 2DS data. A regular update to the methodology every five years fits with common practices in the business sector to adjust GHG emissions reduction targets in a similar timeframe.

The SDA methodology is built on the assumption that each company will do its fair share to close the 2°C emissions gap. However, it is reasonable to assume that not all companies will follow an ambitious decarbonization pathway. Thus, future pathways required to meet a 2°C target might become steeper leading to tighter emission-reduction targets. Companies are encouraged to set emission-reduction targets in line with climate science and to involve their sector peers in adopting similar practices.

2.4 Limitations of the SDA methodology

An overview of the main characteristics of the SDA methodology is given in . Some of the limitations, as well as future areas for development, are described in more detail in section 4.

Table 2. Main characteristics of the SDA methodology

Characteristic	Benefit	Limitation
The CO2 intensity pathway is used to calculate the absolute GHG emission reduction targets.	- By using a CO2 intensity indicator, the company can still grow, as long as the company's emissions per unit of activity decline to the target level. - Using a CO2 intensity target does not penalize early movers, since their CO2 intensity will already be lower than the sector and they will need to reduce less to reach their target.	Data on both emissions and the activity of the company (e.g. tonnes of steel produced) are needed for the base year in addition to the 2˚C pathway for the sector or the company. Not all sectors are covered with a 2˚C pathway because data from the IEA is limited. However, pathways for additional sectors can be created at a later stage.
A single activity indicator per sector is used, without taking into account structural differences between companies in a sector.	The method stays practical and easy to use.	There are limitations to the applicability within sectors, such as product mix and other structural parameters that are not taken into account.
It is assumed that the physical CO2 intensity of companies converges to a sector average in 2050.	All homogenous companies within a sector, no matter where they operate, can have the same 2050 target. It is assumed that regional carbon intensities will converge toward 2050.	Convergence is an assumption in the IEA scenarios. One could dispute whether it meets the equity principle formulated in the UN Climate Convention.
The number of sectors is limited.	The methodology currently covers a limited number of sectors. The categories "other industry" and "other transport" have been introduced for use by companies with activities that are not currently covered by specific subsectors.	Not all subsectors are covered by detailed science-based 2˚C scenarios. The targets for the companies with activities not covered by 2˚C scenarios (i.e. "other industry" and "other transport") are less specific.
Scopes 1, 2, and 3.	Companies can set targets for mainly Scopes 1 and 2 and use the methodology to set targets for Scope 3 GHG emissions if the specific Scope 3 category is covered by the methodology.	Not all Scope 3 emission categories are included in the methodology due to limited data availability. Companies with very large value chains and evenly spread Scope 3 emissions might find the method impractical to set their Scope 3 reduction targets.
Companies with activities in more than one sector.	Companies with activities in more than one sector can allocate emissions to more sectors. These companies can set GHG emission targets per sector and aggregate these targets to a company target (per scope).	The methodology is accompanied by a tool to set science-based targets and to make it practical for corporate GHG emissions to be allocated to a maximum of three sectors.

3. CASE STUDIES

Two cases studies were developed to test and refine the SDA methodology as well as illustrate implementation of the approach. Two sectors were chosen: the steel sector with high Scope 1 emissions, and the automotive sector with high Scope 3 emissions.

3.1 Case study of Company A: Steel

Company A is a multinational steel company. In 2012, Company A produced 70.6 megatonnes (Mt) of steel. In that same year it used 32,005,276 megawatt hours (MWh) of electricity and steam (of which electricity was 31,493,191 MWh, or 98.4 percent). The priority indicators for the iron and steel sector are Scope 1 and Scope 2 emissions. Scope 1 emissions for 2012 were 126,400,000 tonnes of CO_2 equivalent (tCO_2e) and Scope 2 emissions were 13,600,000 tCO_2e. The expected annual activity growth is 1.6 percent.

3.1.1 Aim of the case study

Company A was selected as a case study to check the basic principles of the methodology (such as using a physical CO2 intensity indicator).

Company A wants to use the methodology to calibrate its emissions target for 2020 and to set a 2°C GHG emissions reduction target for 2050. The methodology can also be used to set emission targets for other years and currently allows for the selection of four base years: 2010, 2011, 2012, or 2013.

3.1.2 Input data

Input data can be retrieved from various sources including the CDP database, for companies reporting to CDP, and from annual reports.

Table 3. Company A input information

Company	**Company A**
Sector:	**Iron and steel**
Base year:	**2012**
Target year:	**2020**
Activities company base year:	**70,560,000 tonnes crude steel**
Annual activity growth rate:	**1.6% per year**
Scope 1 emissions company base year:	**126,400,000 tCO_{2e}**
Scope 2 emissions company base year (market method):	**13,600,000 tCO_{2e}**
Electricity consumption base year:	**31,493,191,200 kWh**
Scope 1 emission intensity base year:	**1.8 tCO_2/tonne crude steel**
Scope 2 emission intensity base year:	**0.2 tCO_2/tonne crude steel**

3.1.3 2°C GHG emissions reduction pathway for the iron and steel sector

The iron and steel sector produced 1,482 Mt of steel in 2010 and emitted 2.955 $GtCO_2$ (Scope 1) (IEA, 2014). This implies a CO2 intensity of 1.99 tCO_2/tonne of steel. Significant activity growth is expected because of the growing demand for steel in emerging economies. Steel production is expected to increase by roughly 25 percent in 2020, and is expected to increase by 50 percent by 2050 compared with 2010, reaching a production of 2,295 Mt (IEA, 2014).

The 2°C GHG emissions reduction pathway for iron and steel shows that the total Scope 1 emissions of the sector will increase until 2020, despite a decreasing CO2 intensity compared with 2010 (-10 percent) (IEA, 2014). In 2050, the total Scope 1 emissions will decrease by 31 percent and the intensity will decrease by 55 percent compared with 2010 (IEA, 2014).

3.1.4 Methodological approach and outcome for Company A

Based on the principle of convergence,[1] the Scope 1 CO2 intensity targets for Company A in 2050 is set equal to the sectoral CO2 intensity in 2050. The difference between Company A's Scope 1 CO2 intensity in the base year and the sectoral 2°C GHG emissions reduction pathway declines toward zero in 2050, see Figure 11. Sector (blue) and Company A (green) Scope 1 intensity targets

The targets for Company A in 2020 and 2050 are shown by the green company line in Figure 11. Sector (blue) and Company A (green) Scope 1 intensity targets. The targets are lower than the development of the sector CO2 intensity because Company A already has a lower CO2 intensity in 2012.

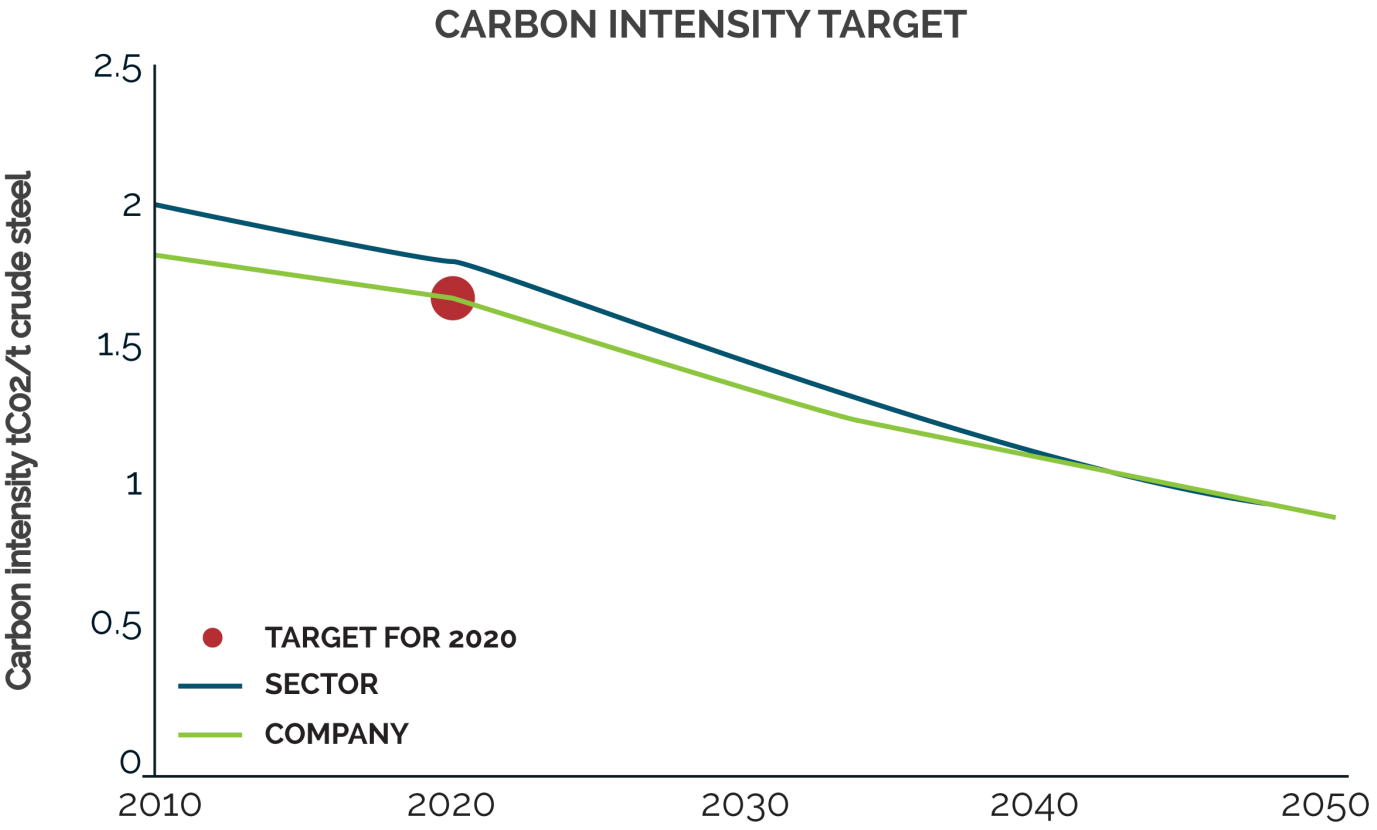


Figure 11. Sector (blue) and Company A (green) Scope 1 intensity targets Note: Shown in tonnes of CO_2 per tonne of crude steel

1 The intensity of Company A in 2050 should be equal to the intensity of the sector in 2050. The difference between Company A's CO2 intensity and the sector's average CO2 intensity at the base year will linearly decrease over the period 2010 to 2050, converging to the same point in 2050. This is referred to as the principle of convergence.

Similarly, the principle of convergence is used to create the Scope 2 CO2 intensity targets for Company A. For 2050, its CO2 intensity targets are set equal to the sector's CO2 intensity in 2050. The difference between Company A's Scope 2 CO2 intensity in the base year and the sectoral 2oC GHG emissions reduction pathway declines linearly toward zero in 2050, see Figure 12. Sector (blue) and Company A (green) Scope 2 intensity targets.

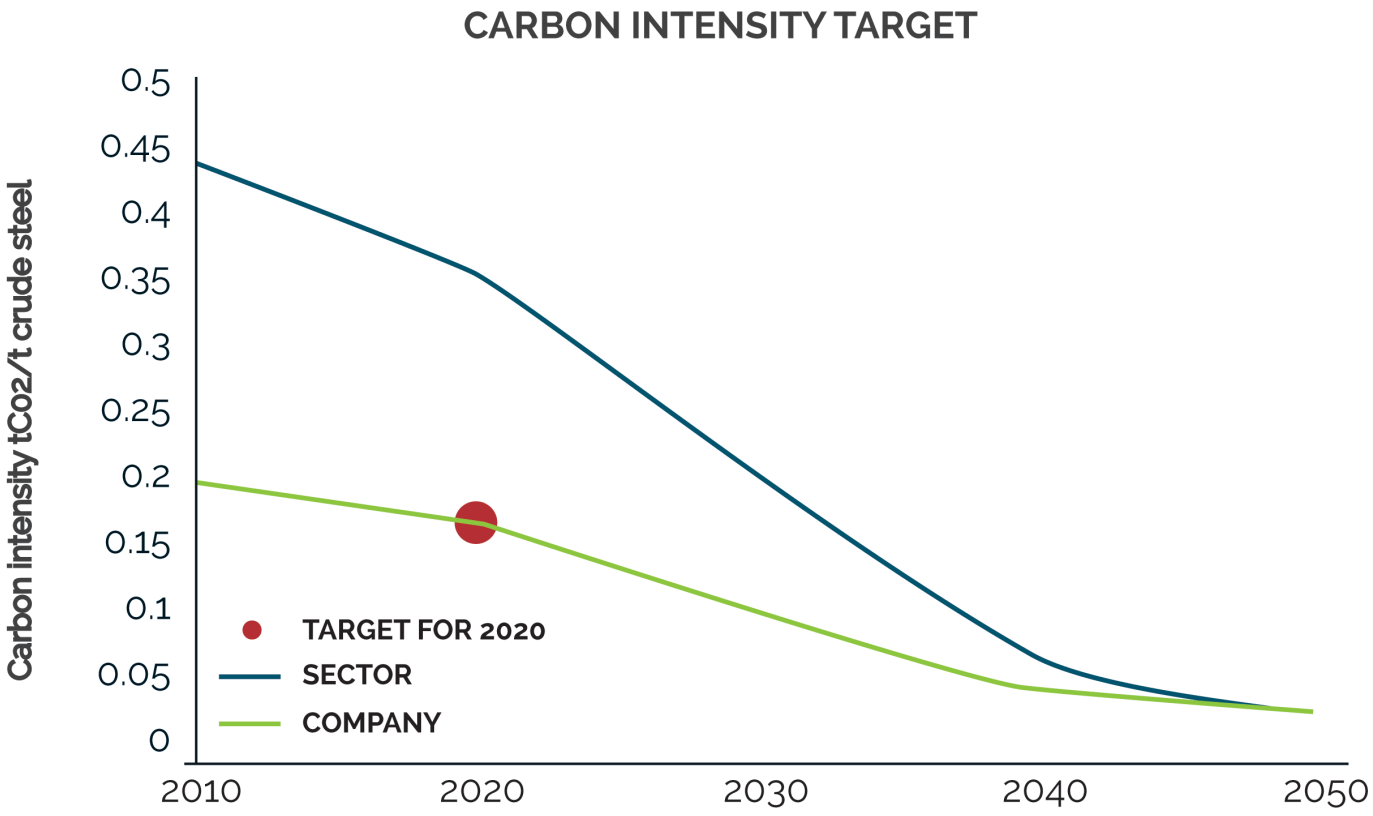


Figure 12. Sector (blue) and Company A (green) Scope 2 intensity targets Note: Shown in tonnes of CO_2 per tonne of crude steel

As with the targets for Scope 1, Company A's Scope 2 target for 2020 is significantly lower compared with the sector, since Company A's CO2 intensity at the base year is already much lower than that of the sector.

The methodological approach intensity and absolute targets for Company A in 2020 and 2050 are shown in Table 4.

Table 4. CO2 intensity and absolute emissions targets for Company A

Iron and steel		Unit of measure	2012	2020	Percent change
Scope 1	CO2 intensity target	tCO_2/t crude steel	1.8	1.7	-7
	Absolute emissions target	tCO_2	126,400,000	133,519,485	6
Scope 2	CO2 intensity target	tCO_2/t crude steel	0.2	0.2	-14
	Absolute emissions target	tCO_2	13,600,000	13,222,495	-3
Scopes 1 and 2	CO2 intensity target	tCO_2/t crude steel	2.0	1.8	-8
	Absolute emissions target	tCO_2	140,000,000	146,741,979	5

3.2 Case study of Company B: Automotive

Company B is a multinational automaker. Its total turnover in 2010 was over US$100 billion. In 2013, Company B produced millions of vehicles. In 2010, Company B emitted 1,312,000 tCO2e as Scope 1 emissions and 2,872,000 tCO2e Scope 2 emissions, and it consumed 4,708,981,600 kWh of purchased electricity and steam. Since steam was only a small fraction of this amount, it will be treated as electricity. Company B anticipates an annual growth of about 2 percent.

3.2.1 Aim of the case study

Company B was chosen for a case study to check the adaptability of the methodology for Scope 3 emissions (use of sold products, in this case the fuel combustion of vehicles) and to check the flexibility of the methodology to future changes, such as a transition to electric vehicles. Furthermore, this case study shows how the methodology works when using different activity indicators for Scopes 1, 2, and 3. Targets for Scopes 1 and 2 for the automotive sector are calculated based on the "other industry" sector, which is based on value added. Targets for the Scope 3 emissions of the automotive sector (which have a much higher impact than the Scope 1 and Scope 2 emissions) are calculated based on a physical indicator (grams of CO2 equivalent per passenger kilometer [gCO2e/pkm]).

3.2.2 Input data

The Scope 3 emissions for a new vehicle from Company B is 128 gCO2e per pkm in 2010. A conversion factor needs to be defined for the input data because the activity indicator used in the methodology is passenger kilometer. Automotive companies are expected to have estimations regarding the average number of passengers per vehicle. For this case study, the factor 1.65 was used, which represents the average number of passengers per vehicle in Europe (Adra, Michaux and André, 2004).

In reality, however, the value for passengers per kilometer is different for different locations. The same holds for the emissions per vehicle kilometer, which differs per region and per vehicle type. Applying location-specific values for passengers per vehicle and using a weighted average for the emissions per vehicle kilometer would provide a better approximation of the new vehicles produced by Company B and would lead to more accurate results.

Table 5. Company input information

Company	Company B
Sector	Light road vehicles manufacture
Base year:	2010
Target year:	2020
Activities company base year:	103,200,000,000 $ value added[1]
Annual activity growth rate:	2% per year
Scope 1 emissions company base year:	1,312,000 tCO_2e
Scope 2 emissions company base year:	2,872,000 tCO_2e
Scope 3 intensity (g CO_2/pkm):	62.08 gCO_2e / pkm
Electricity consumption base year:	4,708,981,600 kWh

3.2.3 2°C GHG emissions reduction pathway for the automotive sector

The automotive sector produced about 70 million light duty vehicles and was responsible for about 421 Mt of CO2 emissions (Scopes 1 and 2) in 2010 (Carbon Trust, 2011). However, the most important emissions are emitted during the use of the product, that is, driving the car (Scope 3). For this reason, Scope 3 will be the priority carbon indicator for this company.

Scopes 1 and 2 targets will be analyzed in line with the "other industry" sector, by applying a percentage reduction of a monetary indicator (gCO2/$ value added). This percentage reduction is based on an index created by dividing the emissions of the "other industry" sector (IEA, 2014) by an index for global GDP growth that is set at 1 for 2011. This led to an index for the intensity of the "other industry" sector that gradually decreases from 1 to 0.13 from 2011 to 2050.

Scope 3 targets will be in line with the sector emission targets based on a physical indicator (gCO2/pkm). The Scope 3 pathway for light road vehicles manufacture was constructed for new vehicles based on the pathway for light road passenger transport from the IEA (IEA, 2014). Because this pathway uses passenger kilometers as an indicator, this indicator is also used for the Scope 3 pathway for light road vehicles manufacture, but can be converted to vehicle kilometers by using the number of passengers per vehicle as explained in the first paragraph of section , Input data.

For the automotive sector, much growth in activity is expected, which goes hand in hand with the expected GDP growth in developing countries. This growth results in a larger market for automobiles (IEA, 2012a). However, toward 2050, the growth rate is expected to decrease because of a modal shift (IPCC, 2014a).

The sector's Scope 3 emissions will reach its peak in the coming decades before efficiency improvements and the decarbonization of electricity will gradually lead to lower emissions. "With oil accounting for more than 90% of its primary energy, transport remains the end-use sector most dependent on fossil fuels. The electrification of transport offers great opportunities to foster fuel diversification, carbon dioxide (CO2) mitigation, and increased energy efficiency while contributing to other sustainable transport goals," (IEA, 2014).

By 2050, total Scope 3 emissions will have decreased by 40 percent and the emission intensity by 83 percent compared with 2010 (IEA, 2012a and IEA, 2014)[2].

In line with the "other industries" sector, the Scope 1 CO2 intensity should be reduced by 87 percent in 2050 compared with 2010. For Scope 2, the CO2 intensity should be reduced by 98 percent in 2050 compared with 2010.

1 In this case study, revenue has been as a proxy for value added, a more accurate approximation of value added will lead to more accurate results.

2 Data for the tank-to-wheel emissions for various transport categories and on the activities of different transport options has been obtained from the IEA, but from different sources. The categories, however, did not match one-on-one. The emissions were given for "Light Duty Vehicles" and the activities for "Light road." It could be that there is a discrepancy between these two categories, which would reduce the accuracies of the results.

3.2.4 Methodological approach and outcome for Company B

As mentioned earlier, the Scope 1 and 2 targets have been based on the "other industries" sector. See Figures 13 and 14 for Company B's targets for Scope 1 and Scope 2. These figures contain only the company's targets because these they are based on a percentage reduction determined by an index and not by a sector intensity pathway. This makes it impossible to include the sector intensity pathway in the graph. Since the reductions are based on an index, if the Y-axis were applied to both the company and sector, the lines would completely overlap and the sector pathway would not be visible.

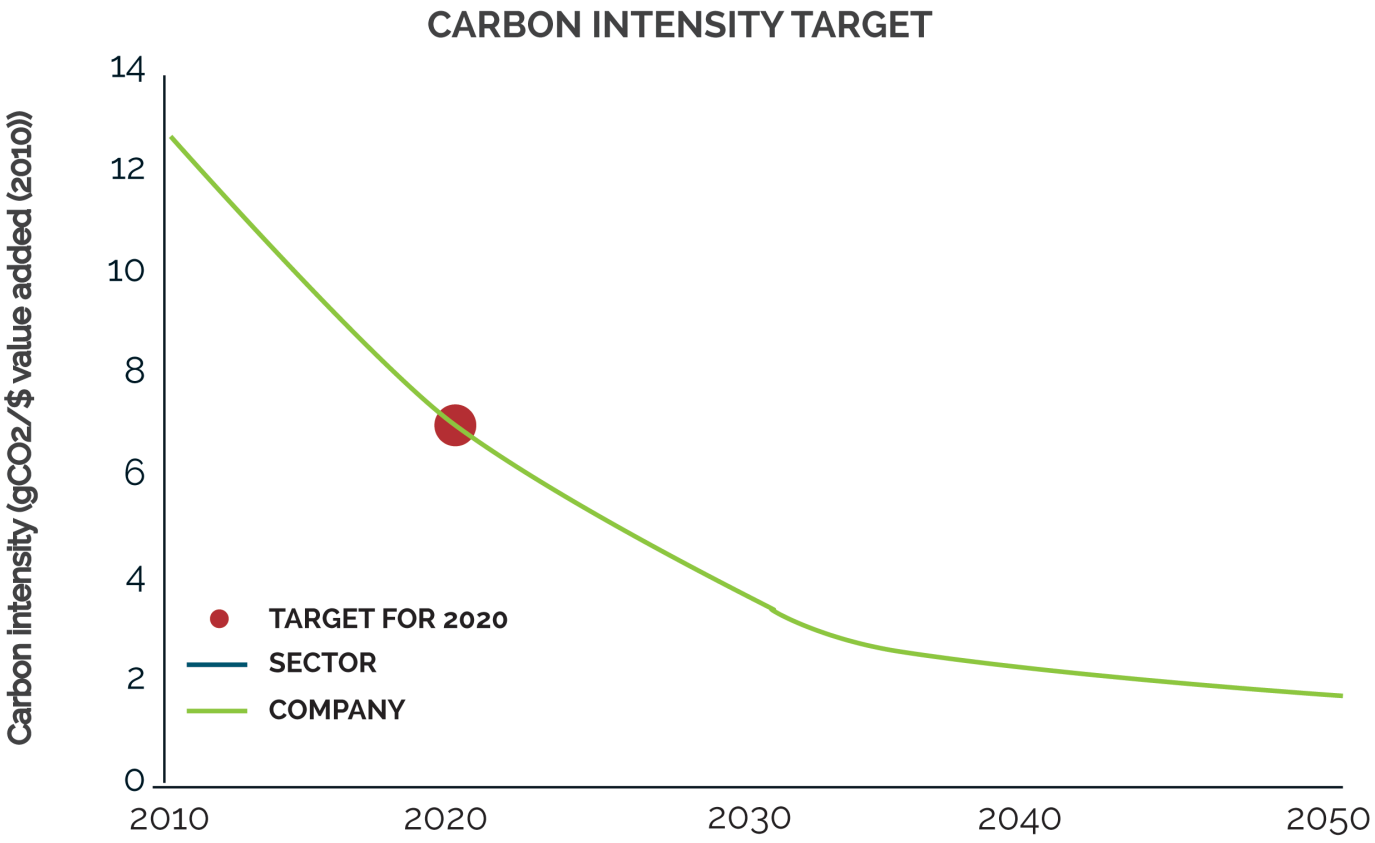


Figure 13: Company B Scope 1 intensity target
Notes: Shown in gCO_2 per $ value added. The target for 2020 is shown by a red dot. No sector intensity target is shown, because the light road vehicles manufacture sector uses a monetary activity indicator for Scope 1, which works with an index.

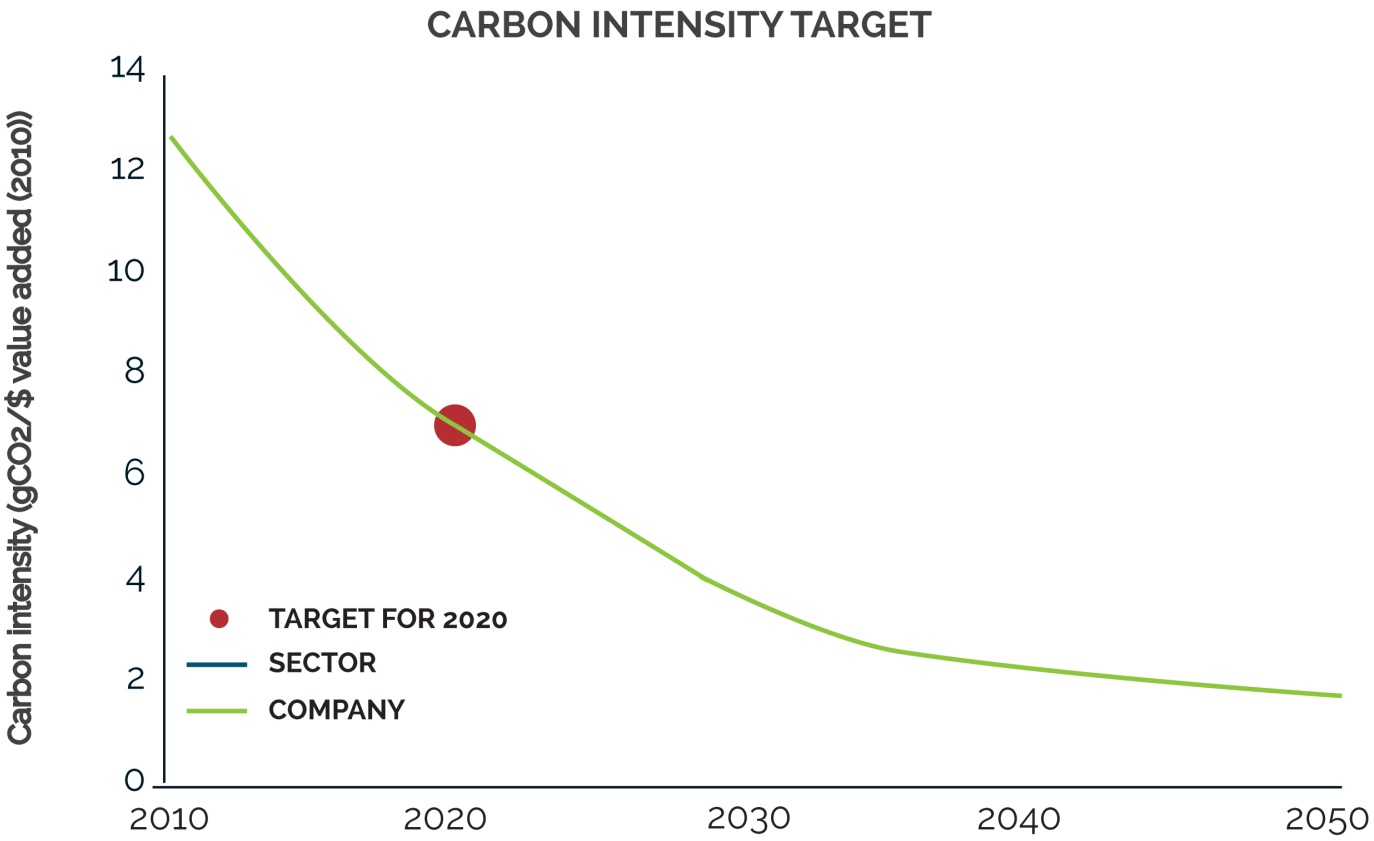


Figure 14. Company B Scope 2 intensity target
Notes: Shown in gCO_2 per $ value added. The target for 2020 is shown by a red dot. No sector intensity target is shown, because the light road vehicles manufacture sector uses a monetary activity indicator for Scope 2, which works with an index.

As mentioned earlier, the targets for Scope 3 were taken from the 2DS scenario of IEA (total emissions decreased by 40 percent and CO2 intensity by 83 percent in 2050). However, to end up at a Scope 3 CO2 intensity target for newly produced cars, the IEA Scope 3 targets for existing stock were corrected based on a stock model, assuming an average lifetime of 15 years for a passenger vehicle (IPCC, 2014b)

Based on the principle of convergence,[3] the Scope 3 CO2 intensity for Company B in 2050 is set equal to the sectoral CO2 intensity in 2050 (reduction of CO2 intensity of 87 percent in 2050). See Figure 15 for the company targets for 2020 and 2050 and the sector intensity pathway.

3 The intensity of Company B in 2050 should be equal to the intensity of the sector in 2050. The difference between Company B's CO2 intensity and the sector's average CO2 intensity at the base year will linearly decrease over the period 2010 to 2050, converging to the same point in 2050. This is referred to as the principle of convergence.

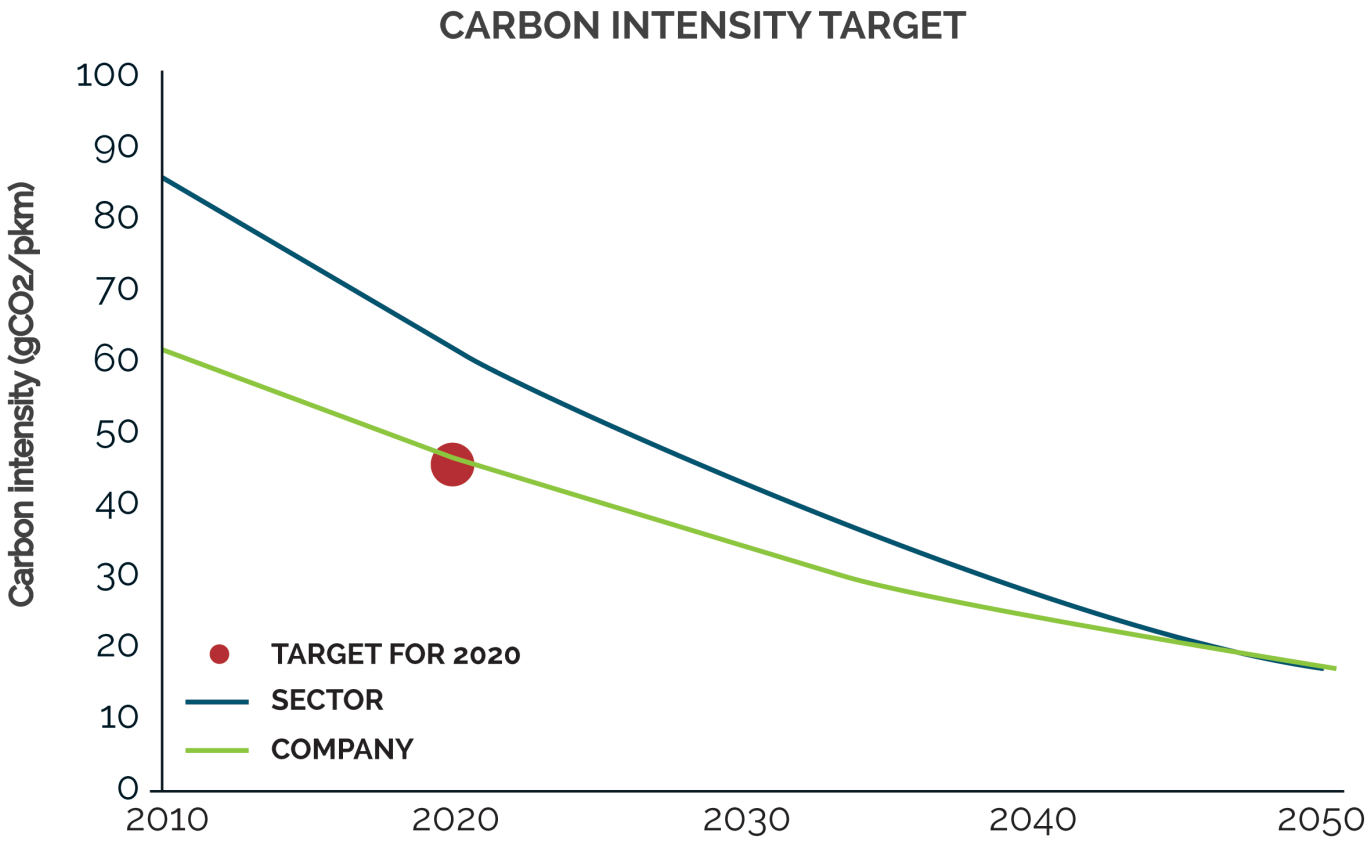


Figure 15. Sector (blue) and Company B (green) Scope 3 intensity target
Note: Shown in gCO_2 per pkm. The target for 2020 is shown by a red dot.

Table 6 shows the CO2 intensity and absolute emissions targets for Scopes 1, 2, and 3 for 2020 and 2050. Absolute emissions targets for Scope 3 are not shown because no information is available on the actual vehicle kilometers driven by Company B vehicles in 2010 and 2050.

Table 6. CO2 intensity and absolute emissions targets for base year 2010

Light road vehicles manufacture		Unit of measure	2010	2020	Percent change
Scope 1	CO2 intensity target	gCO_2/$ value added	12.7	7.1	-44
	Absolute emissions target	tCO_2	1,312,000	891,514	-32
Scope 2	CO2 intensity target	gCO_2/$ value added	27.8	18.1	-35
	Absolute emissions target	tCO_2	2,872,000	2,280,828	-21
Scopes 1 and 2	CO2 intensity target	gCO_2/$ value added	40.5	25.2	-38
	Absolute emissions target	tCO_2	4,184,000	3,172,342	-24
Scope 3	CO2 intensity target	gCO_2/pkm	62	46	-26

4 RATIONALE FOR SECTOR-BASED METHODOLOGY

This section gives an overview of the methodological context and the choices and scientific basis that underlie the methodology.

The first part treats the pertinence of the 2°C benchmark and gives background on the methodology's underlying carbon budget and emission scenarios, including an explanation on how the political context is related to climate science. It also explains how non-CO_2 greenhouse gases are considered in the overall budget. The second part specifies the assumptions made in the methodology, such as the long-term development of CO_2 intensity and intensity convergence, and regional differences.

4.1 Pertinence of the 2°C benchmark

4.1.1 Carbon budget and emission scenarios

Despite a growing number of climate mitigation efforts, global GHG emissions increased from 27 to 49 GtCO2e between 1970 and 2010 (see Figure 16). In the period 1970–2000 the growth was 1.3 percent per year. In the period 2000–10 growth was even highter at 2.2 percent per year, and annual anthropogenic GHG emissions increased by 10 GtCO2e, (IPCC, 2014b).

CO2 emissions from fossil fuel combustion and industrial processes contributed about 78 percent of the total GHG emission increase from 1970 to 2010 (IPCC, 2014b).

IPCC concluded that without additional efforts to reduce GHG emissions, emissions will grow further. The main drivers are growth in global population and economic activities.

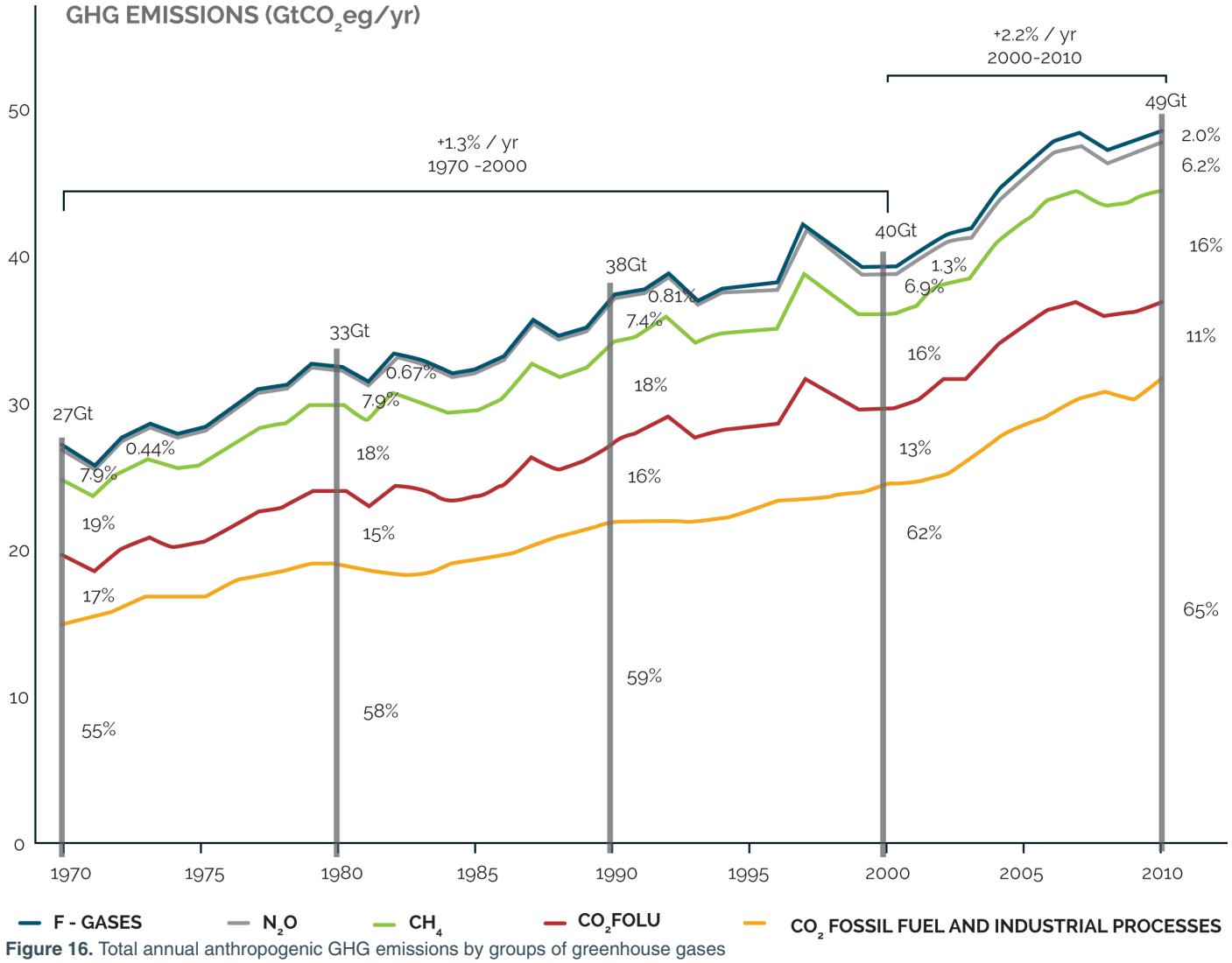


Figure 16. Total annual anthropogenic GHG emissions by groups of greenhouse gases
Source: IPCC, 2014.

Of the 49 GtCO2e of global GHG emissions in 2010, 35 percent (17 GtCO2e) was released in the energy sector; 24 percent (12 GtCO2e) in agriculture, forestry and other land use (AFOLU); 21 percent (10 GtCO2e) in industry; 14 percent (7 GtCO2e) in transport; and 6 percent (3.2 GtCO2e) in commercial buildings. When emissions from electricity and heat production are attributed to the sectors that use the final energy (i.e. indirect emissions), the shares of the industry and buildings sectors are increased to 32 percent and 19 percent respectively, see Figure 17.

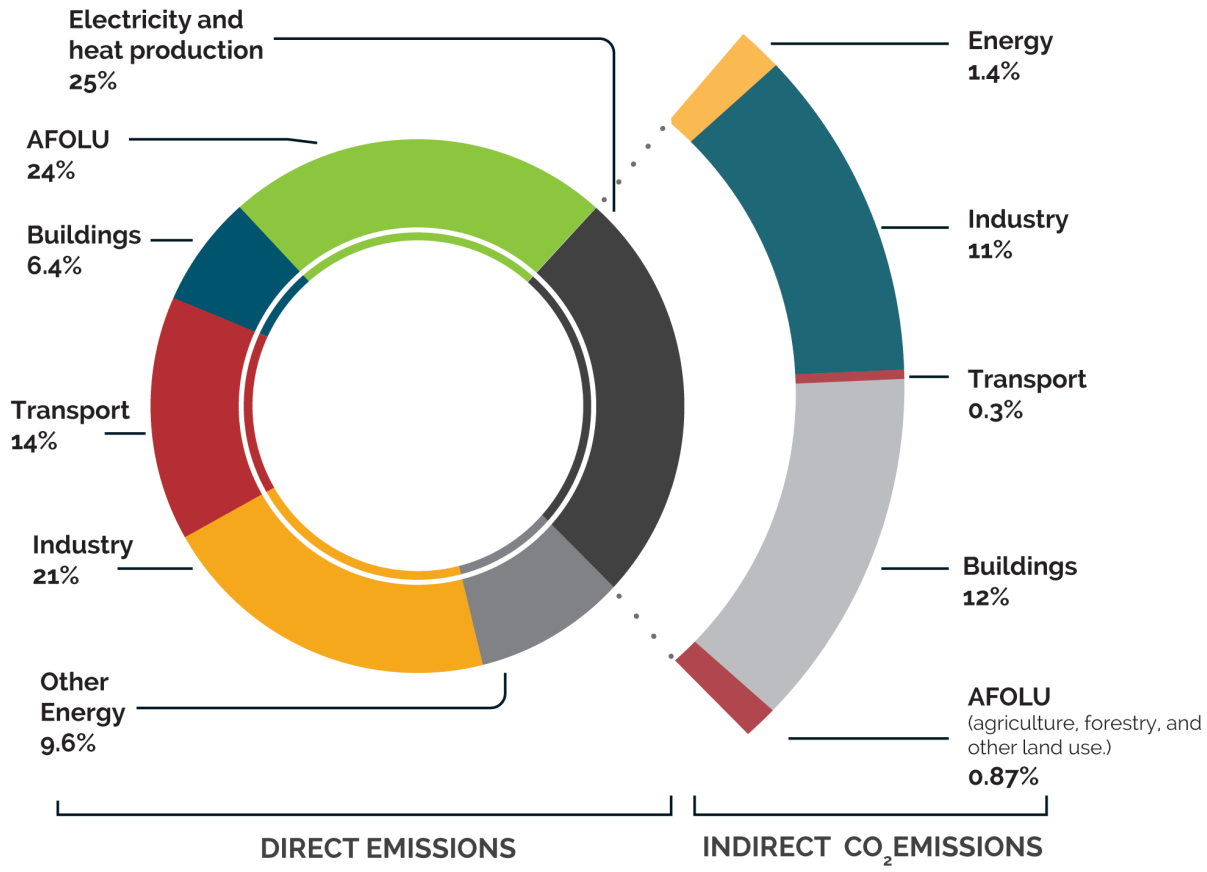


Figure 17. Share of direct and indirect GHG emissions in 2010 by economic sector
Source: IPCC, 2014.

Without additional efforts, anthropogenic GHG emissions will increase to over 100 GtCO2e by 2100, resulting in an increase of global temperatures of 3.7°C to 4.8˚C (IPCC, 2014a).

To prevent the most severe impacts of climate change, parties to the UN Framework Convention on Climate Change (UNFCCC) agreed in 2010 to commit to a maximum temperature rise of 2˚C above pre-industrial levels (UNFCCC, 2011).

Most recently, the concept of a cumulative carbon emission budget has entered the public domain. "The principal driver of long-term warming is the total cumulative emission of CO2 over time.[1] To limit warming caused by CO2 emissions to a given temperature target, cumulative CO2 emissions from all anthropogenic sources therefore need to be limited to a certain budget. Higher emissions in earlier decades simply imply lower emissions by the same amount later on (IPCC, 2014a)."

1 The validity of this approach is presented in Meinshausen et al. (2009) who show the approximate linearity between temperature and CO2 emissions. Its use is also discussed in IPCC (IPCC, 2014a).

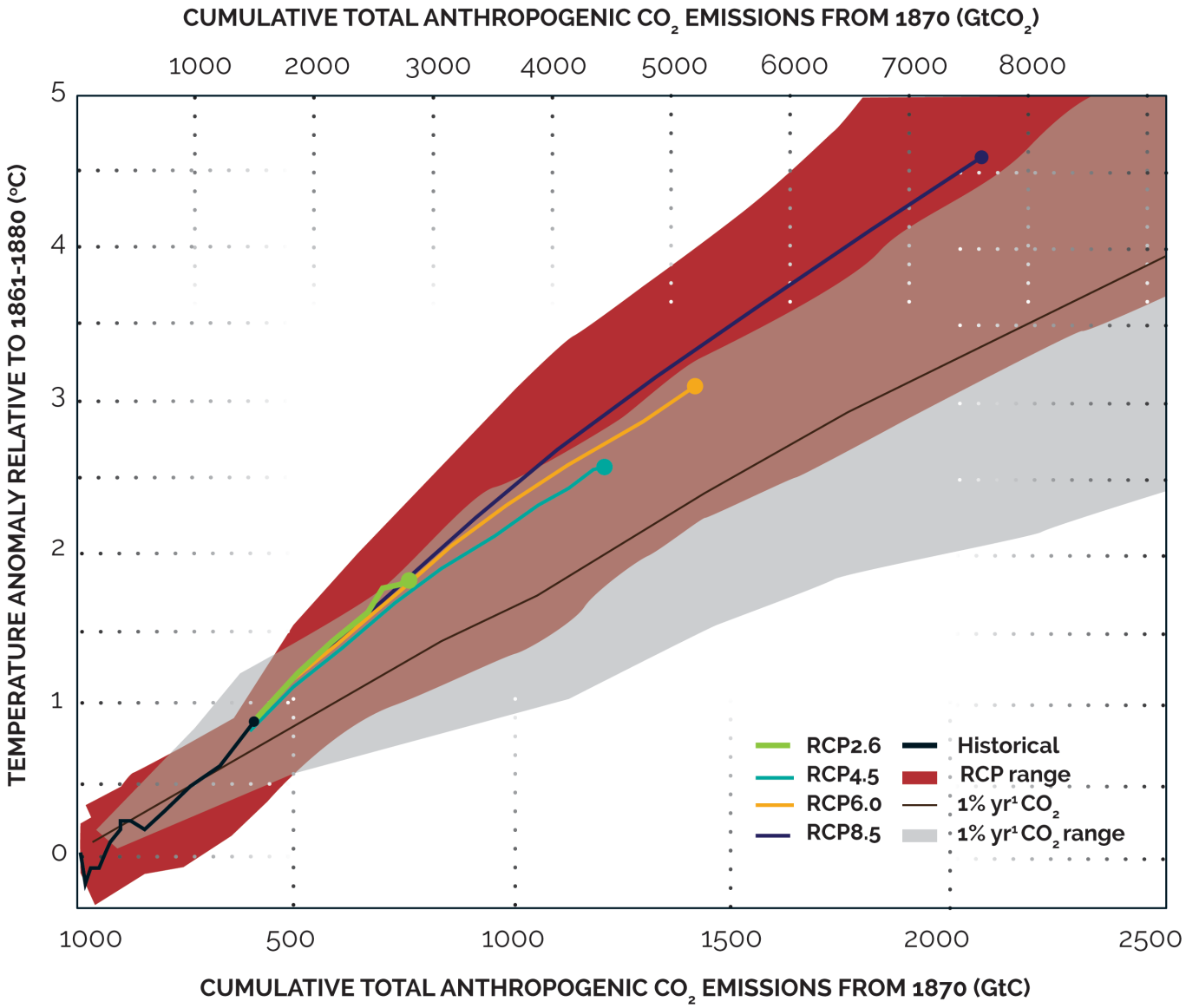


Figure 18. Cumulative total anthropogenic CO_2 emissions from 1870 illustrate the concept of a carbon budget for a given increase of global average temperature
Source: IPCC, 2014.

A global carbon budget is a practical and powerful concept that is easy to work with and communicate. In practice, even if in certain 2˚C scenarios some sectors do not fully decarbonize, in the long term (beyond 2050), net zero emissions to the atmosphere must occur to avoid exceeding the budgeted CO2 amount that would lead to warming higher than 2˚C.

Limiting the global warming caused by anthropogenic CO2 emissions, with a probability of greater than 66 percent, to less than 2˚C since pre-industrial levels will require cumulative CO2 emissions (the CO2 budget) to stay below 3,670 GtCO2 since the pre-industrial period. When taking non-CO2 gases into account, this remaining budget reduces to about 2,900 GtCO2 (IPCC, 2014a). Since 1,890 GtCO2 was emitted by 2011, the remaining CO2 budget from 2011 onward is 1,010 GtCO2 (IPCC, 2014a)[22] This is the global budget at the core of the methodology. Over time the global budget will change: it will decrease as economic activity continues to emit CO2 into the atmosphere; new scientific evidence might lead to increases or decreases in emissions; or a new political and social consensus might arise to limit emissions. The authors acknowledge that regularly updating the global budget will be important for the robustness and integrity of the sector-based methodology as a tool to help companies setting emission reduction targets.

22 This budget is expressed in CO2 and not in CO2e. This means that the budget accounts for CO2 from fossil fuel combustion and industrial processes, already taking the forcing of non-CO2 gases into account in the remaining budget.

The Representative Concentration Pathways (RCP's) are the latest generation of IPCC scenarios that provide input for climate models (see Appendix IV for more information). They are based on newly developed, more detailed knowledge and are better integrated with other disciplines (e.g. economics) than previous scenarios (Vuuren, D.v., 2011). The four RCP scenarios are peer-reviewed and represent the most recent scientific literature. IPCC's RCP 2.6 scenario gives the highest likelihood (probability of 66-100 percent) of staying below 450 ppm CO2e and thus keeping the average global temperature rise below 2 ˚C in 2100. The RCP 2.6 scenario is the basis for the 2˚C decarbonization pathway for the sector-based methodology and is compatible with the global carbon budget. RCP 2.6 estimates emissions of 990 tCO2 up to 2050[23], with a relevant and important component of carbon capture and storage being deployed beyond 2050.

Linked to this 2˚C decarbonization pathway, IPCC AR5 Working Group III recently published its report "Mitigation of Climate Change" (IPCC, 2014b), in which 2˚C mitigation scenarios for the sectors "energy systems," "transport," "buildings," "industry and agriculture," and "forestry and other land use (AFOLU)" are assessed.

However, for industry most mitigation scenarios are not detailed enough. Therefore, following the IPCC AR5 Working Group III report, the detailed CO2 scenarios that the International Energy Agency (IEA) has created in its 2014 Energy Technology Perspectives (ETP) report are used for all sectors. IEA's 2˚C scenario (2DS) is consistent with the RCP 2.6 scenario (see Figure 20) and has breakdowns of several industrial sectors, which makes it useful for developing the sector-based methodology. This scenario estimates an overall budget up to 2050 of 1,055 GtCO2,[24] with carbon capture and storage playing an important role after 2050, and representing up to 93 GtCO2 up to that year.

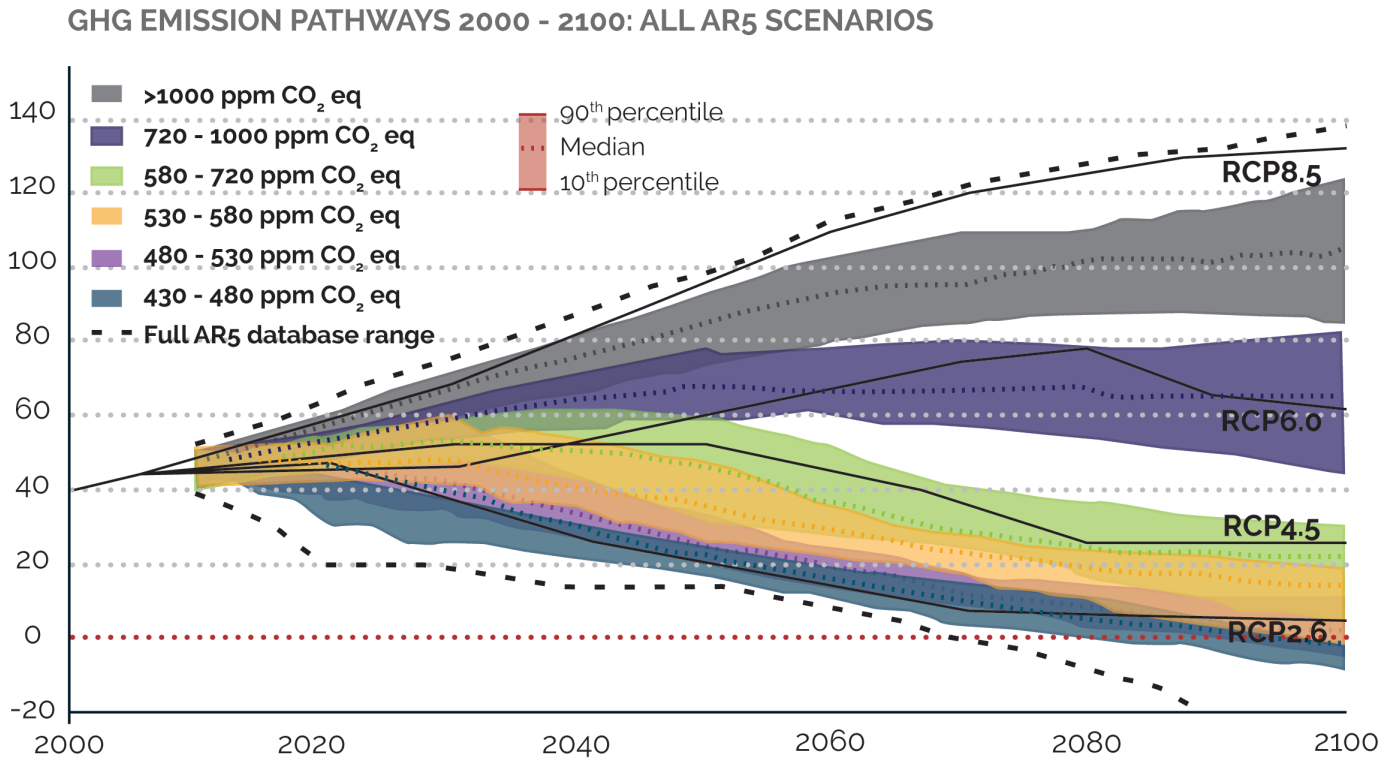


Figure 19. Pathways of global GHG emissions, 2000–2100
Source: IPCC, 2014, Note: $GtCO_2e/yr$= gigatonnes of carbon dioxide equivalent per year.

IEA ETP has been reviewed by scientists and compared with RCP 2.6 in a peer reviewed paper by Schaeffer & van Vuuren (2012). Furthermore the IEA ETP-TIMES model (see Appendix V) is used by more than 250 groups in 70 countries and is revised and updated regularly by a large network

23 This budget is for the period 2012-50 and is a mean value for a range that varies between 510 to 1505 (IPCC, 2014a).

24 The IEA provides emission values for the years 2011 and then 2020 to 2050 every five years. This value was calculated by linear interpolation of the values for the years where no emission value is defined.

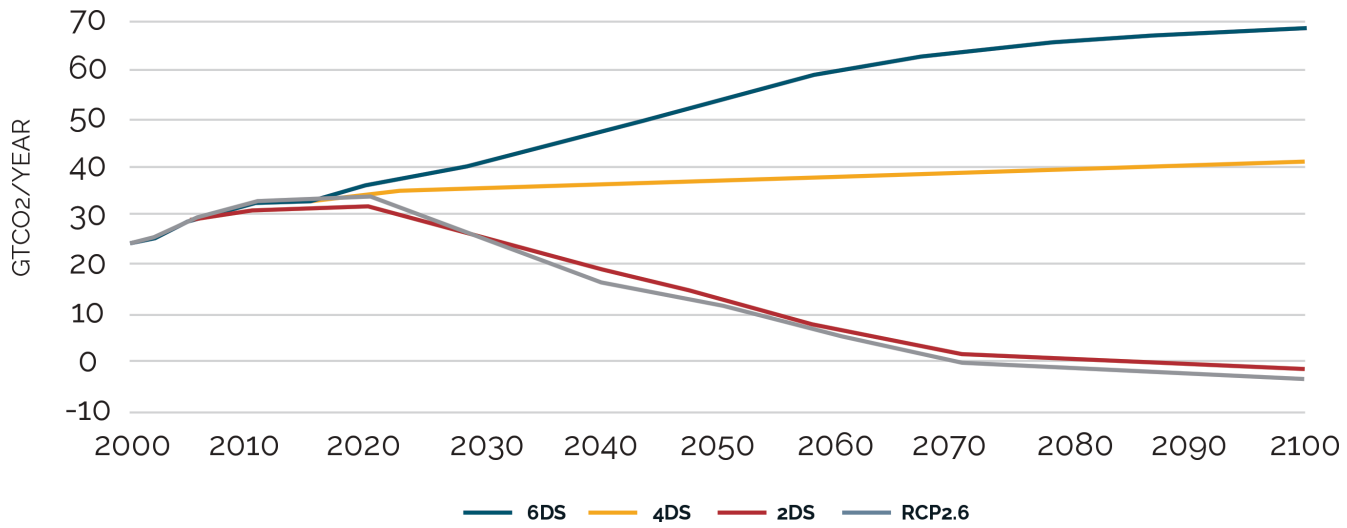


Figure 20. Energy-related CO_2 emissions derived from ETP scenarios
Note: RCP 2.6 = the IPPC scenario used for the basis of this methodology, 2DS = 2 degree, 4DS = 4 degree 6DS = 6 degree, meaning the number of degrees in temperature rise allowed by the carbon budget of each scenario.

of collaborators in which the IEA plays a central role.

The methodology uses data from IEA ETP 2DS to break down the CO2 budget in the period 2011-2050 into the sectors that it currently covers. In this way, CO2 budgets per sector are compatible with the global carbon budget defined in RCP 2.6. Figure 21 shows the Scope 1 sectoral 2oC decarbonization pathways and Table 7 shows the CO2 budget per sector 2011–50, which is the cumulative CO2 emissions between 2011 and 2050, according to the IEA 2DS.

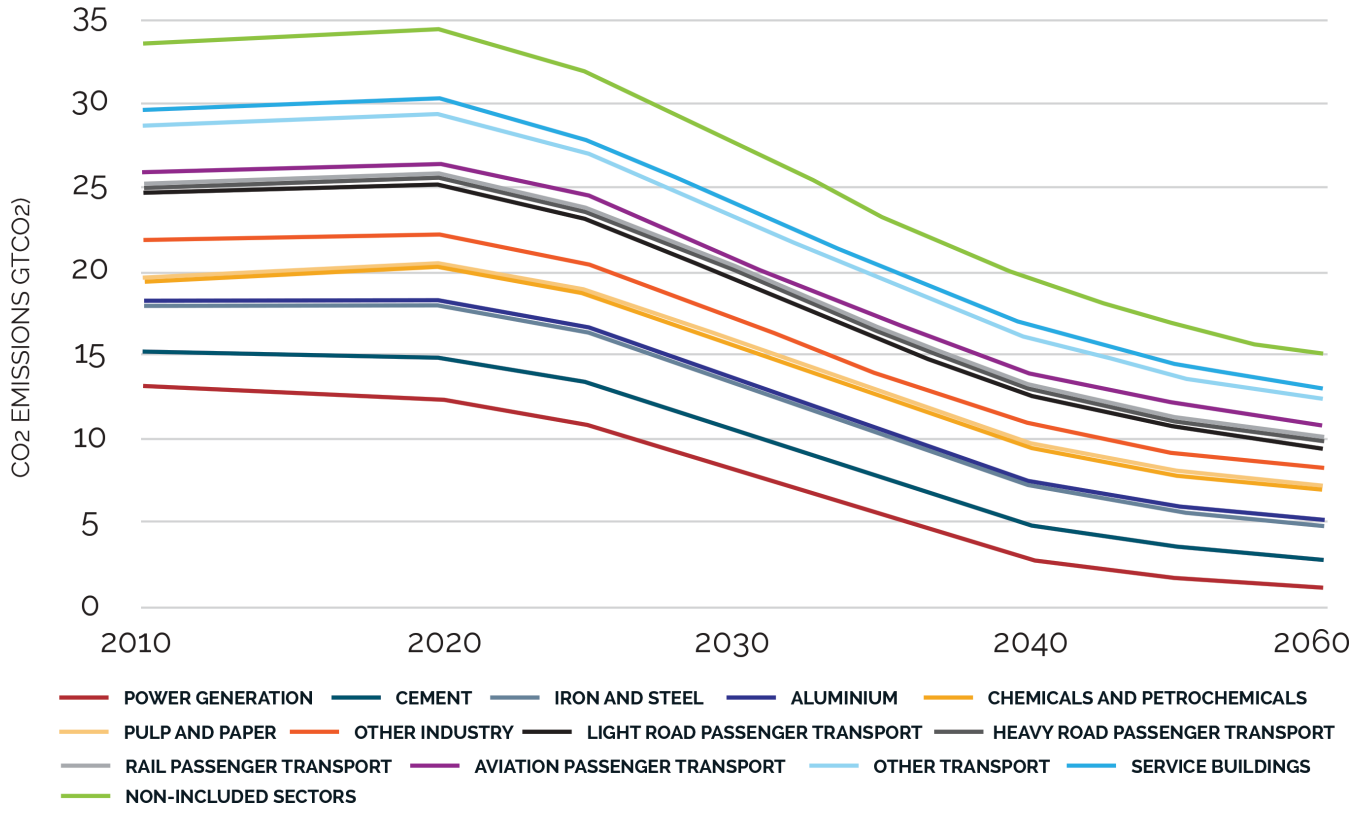


Figure 21. Sectoral breakdown of CO_2 emissions budget 2011–50 Source: IEA ETP 2DS 2014.

As can be seen in Figure 21, the pathway proposed under the ETP 2DS scenario results in a deep decarbonization of the power sector, which initially reduces emissions modestly between 2011 and 2025, and then decarbonizes faster in the period 2025–50. This results from the phasing out of coal power with natural gas playing an important role until 2040 by supporting renewable energy by providing either base or peak load. Gas should maintain its capacity up to 2040, at which point it should include CCS at its facilities[25]. Renewable energy should steadily increases its generation share until 2025–30 with a more pronounced uptake after that date (IEA, 2014). Also, decarbonizing the electricity sector can deliver a spillover effect of reducing emissions from end-use sectors, without further investments (IEA, 2014). This scenario results from a set of assumptions relative to a carbon pricing which, in this scenario, is expected to start at US$30-$50 per tonne of CO2 in 2020 and go up to US$140–$170 per tonne in 2050.

The IEA scenarios estimate levels of economic activity and production for each sector, with an increase in material output between 2010 and 2050 as low as 26 percent for the cement sector to a high of 169 percent for aluminium. Although other sectors are not expected to reduce their carbon emissions as steeply as the power sector, it will be a considerable challenge to contain emissions with continuously growing economic activity and increased physical output. Reductions of carbon intensities can be more than 50 percent as in the cases of the steel and pulp and paper sectors. More information about the data for each sector under the 2DS scenario, as well as an explanation of how the model forecast these reductions can be found in Appendix I.

Table 7 shows an overview of the emissions budget for each sector.

Table 7. Sectoral CO_2 budget 2011–50

Sector	**Subsector**	**Cumulative CO_2 emissions 2011–50 ($GtCO_2$)**
Power Generation	N/A	300
Industry[26]	Iron & steel	112
	Cement	89
	Aluminum	11
	Pulp & paper	8
	Chemicals & petrochemicals	78
	Other processing & manufacturing industries	51
Transport Services[27]	Passenger transport - Air	36
	Passenger transport – Light road	93
	Passenger transport – Heavy road	15
	Passenger transport - Rail	1
	Other transport	91
Services / Commercial Buildings[28]	Trade / Retail	32
	Finance	
	Real estate	
	Public administration	
	Health	
	Food and lodging	
	Education	
	Other commercial services	
Nonincluded sectors		138
Total cumulative emissions		**1,055**

25 "Regionally, whether the primary decarbonization benefit of gas-fired generation is to displace coal or to support renewables depends on a number of factors. These include a country's existing electricity mix, its relative prices of coal and natural gas, its penetration of VRE, its regulation of CO2 emissions, and the availability of competing technologies for low-carbon dispatchable electricity. Because these factors vary between regions, the evolution of gas-fired generation and other sources of electricity follow different patterns in the 2DS." (IEA, 2014)

26 The cement, iron & steel, aluminium and pulp & paper sectors are relatively homogeneous sectors (Farla, 2000; Phylipsen et al., 1998). Therefore, for these sectors it is possible to use the physical output as activity indicators. These are tonne of cement, crude steel, aluminium and paper and cardboard respectively. The activity in the iron and steel sector is based on steel production, but in reality, a lot of different iron and steel products and intermediate products can be distinguished (Farla, 2000). This also holds for the cement, pulp and paper, and aluminium sectors to some degree (Phylipsen et al., 1998). Both the emissions and activity data for these sectors is given for 5-year intervals in IEA ETP 2DS.

27 In the light/heavy, rail and aviation transport sector, the indicator that is used in IEA ETP 2DS is the total passenger kilometer (pkm).

28 For service buildings, the indicator for activity is square meter, since this data is available for 5-year intervals in IEA ETP 2DS and this indicator is also often used in climate science (Girod & De Haan (2010) and Girod, van Vuuren, & Hertwich (2014).

The metric used for translating sector budgets into company targets can be double checked by performing a validation. In this validation equations 6 and 7 are assessed:

$$\int_j \int_y \left(A_{j,y} \times SI_{j,y} + Other_y \right) \leq Budget_{2°C,2050} \quad \text{Equation 6}$$

$$\int_j \left(A_{j,y} \times SI_{j,y} \right) + Other_y \leq Emissions_{2°C,y} \quad \text{Equation 7}$$

Where:

$A_{j,y}$	Activity of sector *j* in year *y*
$SI_{j,y}$	Carbon intensity of sector *i* in year *y*
$Other_y$	Other GHG emissions (not accounted for in the methodology) in year *y*
$Budget_{2°C,2050}$	Cumulative carbon budget 2011-2050 compatible with a below 2ºC scenario
$Emissions_{2°C,y}$	Emissions in year y compatible with a below 2ºC scenario

These equations were checked only for Scope 1 direct emissions and their emissions pathways. In Appendix II all data is provided on Scope 1 emissions and activity of the sectors included in the methodology. Based on the Scope 1 emissions and the activity of each sector the CO2 intensity in each year per sector was calculated. Multiplying the CO2 intensity by the activity leads back to the emission pathway per sector as shown in Figure 18. The cumulative sum of these CO2 emissions is 1,055 GtCO2, as in Table 7. This is consistent with RCP 2.6, where in the last decades of this century negative CO2 emissions due to carbon capture and storage occur that compensate for this overshoot, see Figure 20.

Companies' intensity pathways – given by the method - multiplied by their projected activity give a company's carbon budget for the target period. In principle, the sum of these budgets should be contained contained within the sector's projected budget given by the IEA 2DS. However, it can be shown that even if the sum of all activity data by companies in the sector match the activity data of IEA 2DS, it cannot be guaranteed that the sector budget will be met. This fact requires that the methodology should be periodically revised to check the validity of the projections used and that companies should also revise and check "compliance" to their targets, by checking whether activity matched their projections and if intensities were below the specified pathway.

4.1.2 Sufficiency of the 2˚C target and global carbon budget

In 1996, the European Union, with support with some environmentalists and scientists, proposed to limit global warming to 2˚C relative to pre-industrial times based on evidence that many ecosystems are at risk with greater climate change.[29] This was echoed in the "Copenhagen Accord" (2009, 15th Conference of the Parties of the UNFCCC) where parties "agree that deep cuts in global emissions are required according to science, as documented in the IPCC 4th Assessment Report with a view to reduce global emissions so as to hold the increase in global temperature below 2 degrees Celsius…". Again, at the 2010 UNFCCC conference in Cancun, parties reiterated this consensus and agreed to commit to a maximum temperature rise of 2˚C above pre-industrial levels (UNFCCC, 2011). Thus, through the negotiation process a political consensus was formed to limit global warming to 2˚C.

Nevertheless, this consensus has its critics ranging from scientific experts, who think it is insufficient to avoid dangerous climate change,

29 For further discussion on the limitations and benefits of the 2°C target, see Randalls, S. (2010) History of the 2°C climate target. WIREs Clim. Change 1, 598–605.

to economists, who argue that the target is an infeasible, expensive, and an inappropriate way of framing climate policy (Hansen et al., 2013).

Recognizing that the political consensus does not necessarily reflect scientific agreement, the consensus that has been built around this target and the challenges implied in achieving it justify that it should be the starting point for this methodology. It is assumed that the political commitment to limit the temperature rise of 2˚C above pre-industrial levels is the starting point of the methodological approach in setting a global carbon budget that is sufficient to avoid dangerous climate change.

Scenarios build around the 2˚C emission pathway have uncertainties, which are commonly expressed as probabilities to achieve the 2˚C target. The methodology heavily relies on IEA's 2˚C Scenario, which, according to IEA describes "an energy system consistent with an emissions trajectory that recent climate science research indicates would give at least a 50% chance of limiting average global temperature increase to 2˚C" (IEA, 2014a). The 2DS is modelled for 2011–50, an appropriate time frame because both the cumulative emissions up to 2050 and the 2050 emissions level are robust indicators of the probability of meeting the 2˚C target (Meinshausen et al., 2009; O'Neill et al., 2010).

Using alternative scenarios proposing different probabilities of achieving a 2˚C target is theoretically possible, but such scenarios are not currently available at the level of sector discrimination available in the IEA 2DSa.

4.1.3 Consideration of non-CO2 GHGs in the budget

The global budget considered for the methodology— totalling 1,010 GtCO2— is expressed in gigatonnes of CO2 rather than in CO2 equivalent, which includes other greenhouse gases. This value originates from AR5 (IPCC, 2014a) which mentioned that the figure is achieved when accounting for non-CO2 forcings as in RCP 2.6. This means that the budget accounts for CO2 emissions only, but considers that other gases that cause forcing are also emitted. This aspect is important because the relationship between CO2 and the increase in the average global temperature (TCRE or ratio of global temperature change to total cumulative anthropogenic CO2 emissions) "only characterizes the warming due to CO2 emissions, and contributions from non-CO2 gases need to be considered separately when estimating likelihoods to stay below a temperature limit" (IPCC, 2014a). Warming as a function of cumulative CO2 emissions in the presence of non-CO2 forcing is larger since non-CO2 forcings contribute warming in these scenarios (Hajima et al., 2012).

Considering that the budget of 1,010 GtCO2 and RCP 2.6 take in account the effect of non-CO2 forcing and that "by far the most important contribution to increased radiative forcing compared to pre-industrial levels comes from CO2, both in the baseline and the mitigation case" (IPCC, 2014a), the authors decided to use CO2 emissions as the measure in the carbon budget for the method (Van Vuuren et al., 2011).

Non-CO2 emissions are usually negligible for a majority of corporations and in the most significant emissions processes (e.g. in most combustion processes they are represent less than 2 percent of emissions). There are, however, GHG sources where non-CO2 gases might not be negligible. For example, some agriculture activities are significant sources of nitrous oxide (N2O) and methane (CH4) and the production and exploration for oil, gas, and coal, can produce significant methane. Unfortunately, these sectors are currently not covered in the methodology. In special cases of sectors covered by the methodology where there might be nonnegligible sources of non-CO2 gases, the recommendation is to set the target based on the full CO2e corporate footprint. This way, the effect of non-CO2 gases would be counted twice and the method would be conservative, by decreasing the budget more than it would otherwise be.

Finally, the RCP 2.6 does contain mitigation scenarios for non-CO2 gases, namely CH4, N2O, and perfluorocarbons (PFC), sulfur hexafluoride (SF6) and hydrofluorocarbons (HFC). However, these gases are not discriminated by sectors, so their use under the current methodology was not possible. However, this can be an area for further improvement of the method, particularly when considering the inclusion of the sectors that are currently excluded, as mentioned earlier.

4.2 Assumptions in the methodology

Methods and models usually rely on a set of key assumptions. For transparency, a rationale and explanation of relevant assumptions in the methodology is presented. Assumptions include:

- **The CO2 intensity of each company in a homogeneous sector will converge with the sectoral CO2 intensity in 2050.**
- **Regional differences are not taken into account.**
- **Economic growth is decoupled from demand for energy and materials.**
- **Added value of individual heterogeneous sectors is assumed to grow proportional to GDP growth.**
- **Added value is defined as gross profit, which equals revenue minus cost of sold goods and services.**
- **Emissions from heat, steam, and cooling are negligible compared with those of electricity; this also holds for the longer term.**
- **Road vehicles are assumed to have a lifetime of 15 years; the carbon efficiency of new vehicles is calculated based on this assumption,**

The method also inherits the assumptions and modelling parameters used in the IEA Energy Technology Perspectives 2DS scenario that is the basis of the intensity pathways adopted. Table 8 provides an overview of assumptions in the models behind IEA ETP 2DS.

Table 8. Main assumptions in the models behind IEA ETP 2DS[29]

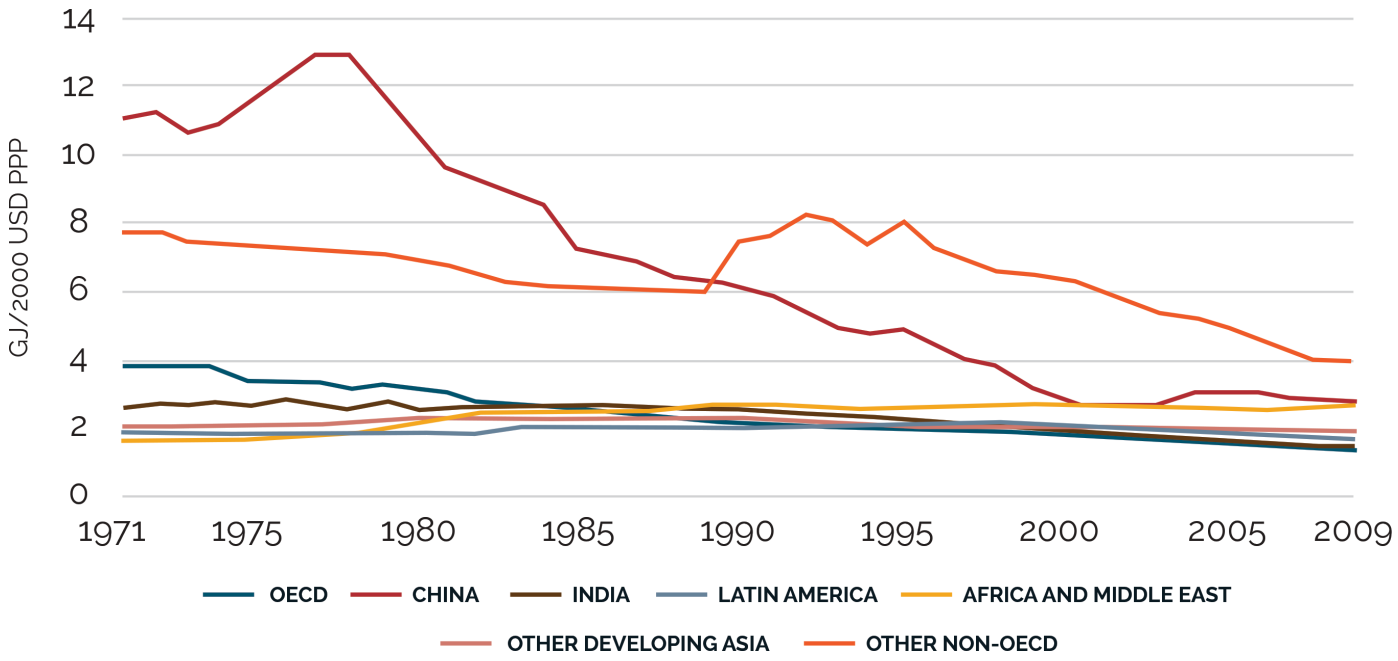
GDP growth	**2011-20**	**2020-30**	**2030-50**	**2011-50**	
Compound annual growth rate (CAGR) in %	4.0	3.4	2.7	3.2	
Marginal abatement cost[4]	**2020**	**2030**	**2040**	**2050**	
US$/$tCO_2$	30-50	80-100	120-140	140-170	
Population projections	**2011**	**2020**	**2030**	**2040**	**2050**
Global population (millions)	6,986	7,701	8,406	9,016	9,524

29 "These values represent the costs associated with the abatement measures to mitigate the last tonne of CO2 emissions to reach the annual emissions target in a specific year. The global marginal abatement costs can be regarded as a benchmark CO2 price allowing the comparison of the cost-effectiveness of mitigating options across technologies, sectors and regions.", IEA, 2014, page 351. Furthermore, these costs are comparable with the ones achieved in RCP2.6 of 7 USD/tCO2 in 2010; 60 USD/tCO2 by 2020; 80 USD/tCO2 by 2030, and around 160 USD/tCO2 by 2050 (Van Vuuren, 2011b).

4.2.1 Long-term development of the CO2 intensity and intensity convergence

In designing this methodology, it was anticipated that, in the long run, large companies will have equal opportunities to abate the greenhouse gas emissions of their activities. If the focus lies on carbon emissions, three elements are important: the energy efficiency of most production processes, the CO2 intensity of the energy used, and the emissions related to the process and its design.

Although there are still differences in energy efficiency among world regions, these differences will tend to disappear in the long term because of the convergence of the energy efficiency of technologies – as shown by the historical trend and as projected by the 2DS scenario. In Figure 22, the development of industrial energy efficiency from 1971 to 2010 by region, illustrates that energy efficiencies are already converging.



Notes: GJ = gigajoules, PPP = purchasing power parity

Figure 22. The convergence of energy intensities: Evolution of aggregate industrial energy intensity by region.
Source: IEA, 2012a.

As for the CO2 intensity of the primary energy supply, the historical world trend since the 1970's shows only a slight decrease, see Figure 23. This index, will vary regionally, but it is thoroughly understood that to meet a 2DS scenario the global profile needs to change radically. This transition depends on the decarbonization of the power sector itself – almost 40 percent of global primary energy is used to generate electricity - which worldwide, under a 2DS scenario, will have to decarbonize steeply up to 2050, see Figure 23.

Currently, strong regional variations exist, but under a 2DS scenario the convergence of the intensities of several regional power systems is forecast, as can be seen in Figure 24.

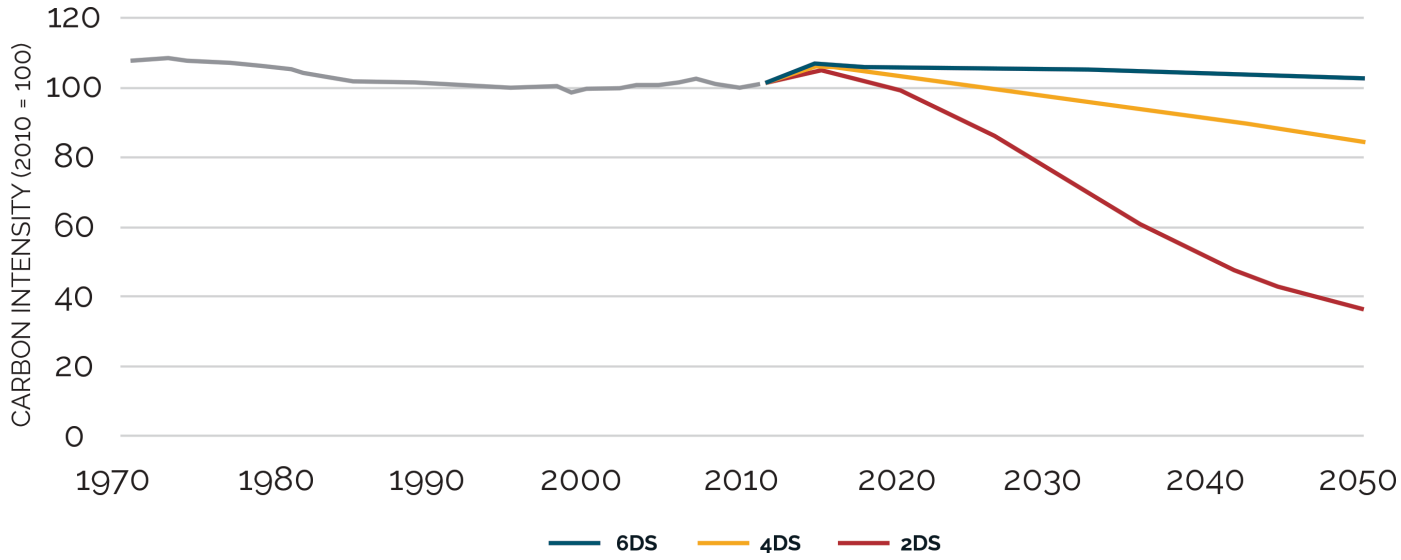


Figure 24. Convergence of regional electricity intensity under a 2DS scenario
Source: Calculated from Data from IEA, 2014.

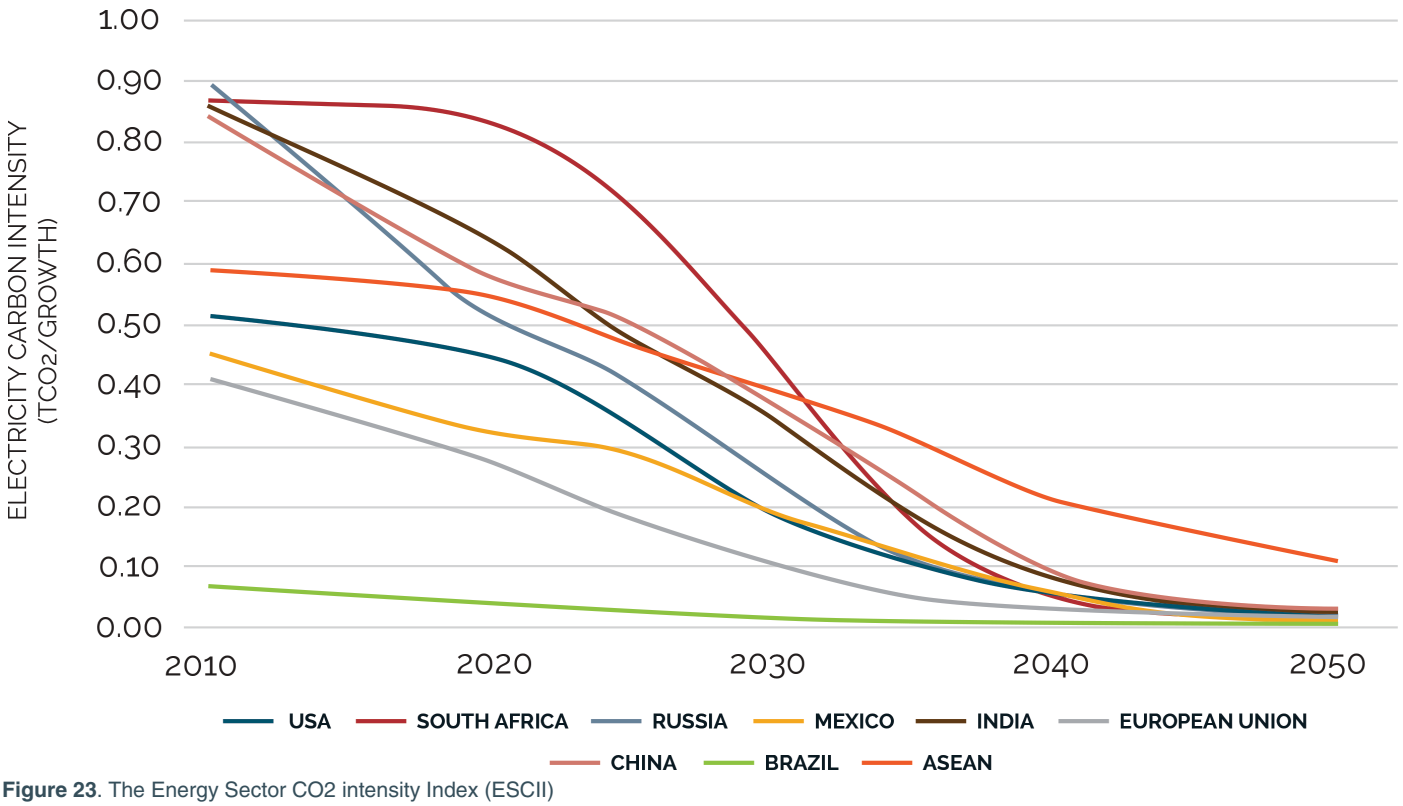


Figure 23. The Energy Sector CO2 intensity Index (ESCII)
Source: IEA, 2014.

Finally, technological convergence assumes that processes all over the world will evolve in the long term to the same level of energy efficiency, close to the minimum value. The energy-efficiency of most production process has a minimum value: a certain amount of energy is always required to drive the processes e.g., the energy required to produce iron from iron ore in a blast furnace.

The methodology uses the potential development of the CO2 intensity as the basis for setting targets. In line with the conclusions of IEA, we assume that the carbon intensities of world regions converge. Thus, all companies from the same sector, no matter where they operate, can have the same target: there is no need to account for regional differences as the carbon intensities of world

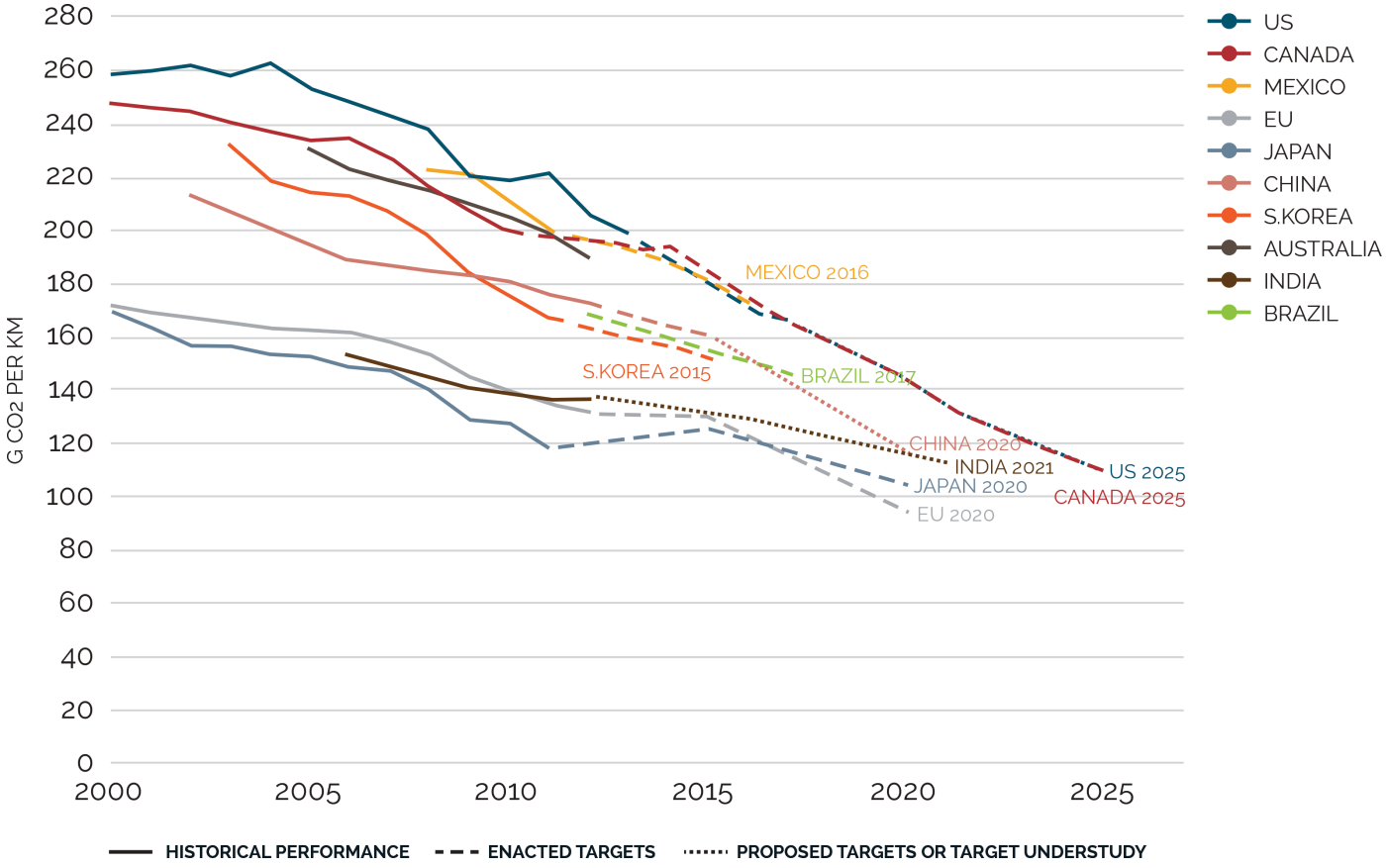


Figure 25. Historic and future (projected and mandated) GHG emissions of light-duty vehicles
Source: IPCC, 2014.

Since companies in developed countries have put more effort into improving the energy-efficiency of their processes, they are closer to this minimum value than companies in developing countries.Thus, their potential for improving energy efficiency is smaller than in developing countries. Growth of activity is an excellent opportunity to improve energy efficiency because growth requires new investments and because new plants are inherently more efficient than existing plants. Countries with high growth rates can therefore improve their energy efficiency at a steeper rate than countries with low growth rates. Note that growth might result in an increase in absolute emissions while the growth rate exceeds the rate of efficiency improvement.
Figure 25, illustrates another example of intensity convergence of the world regions, in this case for the emissions of the light duty vehicles.

regions and sectors will converge toward 2050. World regions and sectors with a higher CO2 intensity will have a steeper reduction pathway than other regions, but will also have a larger potential for improvement.

4.2.2 Regional differences are not taken into account

The first basic principle of the UN Climate Convention requires that climate protection should take place on the basis of equity and in accordance with the parties' common but differentiated responsibilities and respective capabilities, with the developed world taking the lead. There has been debate about the differentiation of the climate change commitments over regions. Several proposals account for this burden sharing, see for instance (Groenenberg, Phylipsen, & Blok, 2001) and (Kartha, Athanasiou, & Baer, 2012).

Countries differ in their capacity to abate greenhouse gas emissions. This is not just a matter of costs, but also of potential to reduce the emissions, access to technology, and the ability to implement adequate policies. There are also differences in the growth of economic activities and in energy efficiency among world regions. Currently a steeper activity growth is seen in Asian and BRICS (Brazil, Russia, India, China, and South Africa) countries than in European countries or the United States. Industrial emissions grew fastest in the Asian region over the past 10 years.

Although the relevance of the equity discussion is acknowledged, this discussion is less relevant when dealing with large companies. Many of these companies are multinationals, with activities spread over world regions. Of course, some large companies notably in the power sector, operate locally. That, particularly for the power sector, is a shortcoming of the method. Nevertheless, for global businesses, differences in local environmental parameters that might influence their direct or indirect emissions, will tend to average out. Accommodating local variations within the method would be like accommodating different types of products and processes for a specific sector – it would undermine the overall comparability and applicability of the method. Overall, the decarbonization trend is strong and durable enough to make these variations negligible.

Other local or regional variations such as costs of abatement measures will be an issue for companies, but can fundamentally be treated like other investment decisions. Access to technology can be restricted by patents, but accepted approaches, like operations under a license, can mitigate this problem. Currently, differences in climate policy schemes around the world result in different incentives and opportunities for companies. However, to achieve the steep reduction in greenhouse gas emissions required, countries and regions need to align their climate abatement strategies, for example by agreeing on a common international treaty on mitigation of GHG emissions under the UNFCCC.

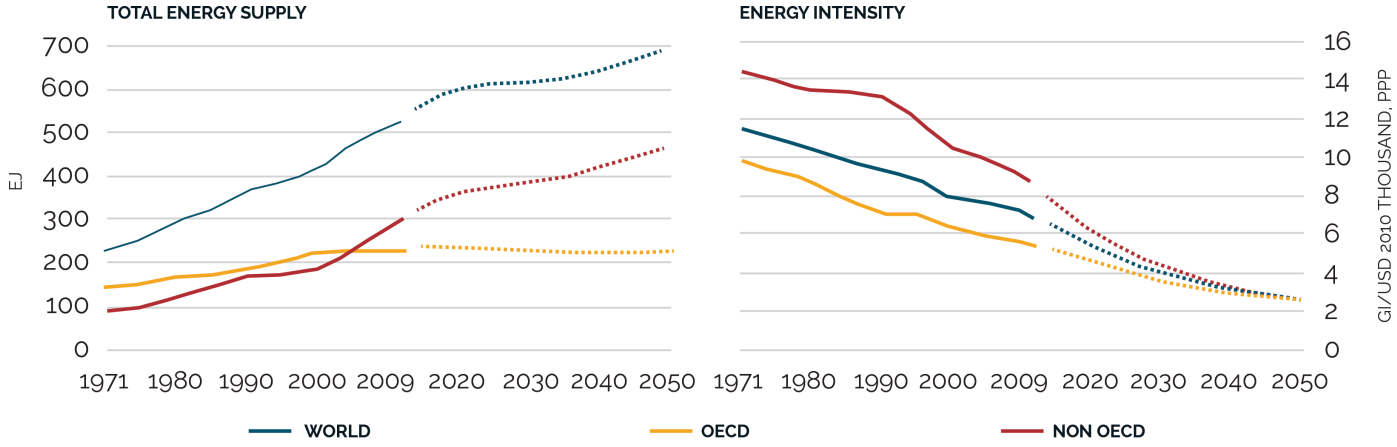
Nevertheless, in the short term, strong regional differences will be observed, considering both policy issues and intensities performance. For particular sectors, like the power generation sector, which function in regional markets, the assumption of a single global average sector is a rough approximation. Given the important emission reductions and transformation that the power markets will need to go through up to 2050 – they will deliver the bulk of the emission reductions needed – in the future it will be important to differentiate among regional markets. This is also particularly relevant, when using power sector emissions to establish a company's Scope 2 emissions. Thus, an important methodological development will be the consideration of the potential regional variations in terms of mitigation for the sectors, where relevant.

4.2.3 Economic growth is decoupled from demand for energy and materials

As noted above, the IEA 2DS assumes continuous population and economic growth. These projections are equal under all the IEA scenarios. In the 6DS, the scenario that leads to a 6°C increase, the extension of recent trends to 2050 imply a global energy demand growth of 70 percent and emissions growth of more than 60 percent against 2011 levels. However, in 2DS, under the same growth projections, radical action dramatically improves energy efficiency to limit increases in demand by just over 25 percent while emissions are cut by more than 50 percent. While in the 6DS, oil remains the most important primary energy carrier with demand increasing by 45 percent, under 2DS the policy and technology choices made deliver a 30 percent reduction in oil demand (IEA, 2014).

Figure 26 gives the development of the energy intensity and energy demand by world region from 1971 to 2010. It also shows a projection to

2050 under the assumptions of the 2DS scenario. It shows that energy intensities of economies will continue to decrease and converge in this scenario.



Note GDP = gross domestic product

Figure 26. IEA 2DS scenario for world energy supply and energy intensity, 1970 to 2010, with projections to 2050
Source: IEA, 2012a.

The policy and technology scenarios in IEA models imply that decoupling economic growth from demand for energy and materials is possible, which is a conclusion of the scenario and assumption of the methodology. Most important IEA notes that "achieving the ETP 2014 2˚C scenario (2DS) does not depend on the appearance of breakthrough technologies. All technology options introduced in ETP 2014 are already commercially available or at a stage of development that makes commercial-scale deployment possible within the scenario period. Costs for any of these technologies are expected to fall over time, making a low-carbon future economically feasible," (IEA, 2014).

4.2.4 Activity of nonhomogeneous sectors grows proportionally to GDP growth

For nonhomogeneous sectors a physical metric relating to CO_2 emissions has not been established. The intensity pathways of these sectors are built using value added, but the IEA scenarios that project the sectors emissions do not detail the specific value-added growth for the sector. For that reason, sector growth in value added is equal to the overall economy (GDP) growth considered in the IEA 2DS scenario (see Table 8). This growth is indexed to the year 2011.

4.2.5 Added value equals gross profit

For heterogeneous sectors, physical output cannot be used as a measure of activity. In these cases the method reverts to a monetary measure of activity that tries to capture the company's contribution to overall economic growth. Economic growth is universally expressed as GDP, which is an established metric for global and local economies as well as sectors. Thus the method aims to establish a measure that captures the contribution of a single company to the sector GDP used to build the intensity pathways.[30] However, this link is not straightforward.[31] For the purpose of GDP and national accounts, gross value added (GVA) usually accounts for more than 90 percent of GDP[32] and is calculated as:

GVA = output at producer prices - intermediate consumption at purchaser prices

The equivalent measure of gross value added in an organization can be calculated as:

GVA = Employee costs + Taxes net of subsidies (excluding those applied to products) + Gross operating surplus (see Figure 27).

30 That, as per previous point, is established proportional to its contribution to global GDP in 2011 and projected in the future assuming equal economic growth rates as the ones used in IEA 2DS for the entire economy.

31 See http://www.icaew.com/en/technical/sustainability/what-is-economic-success-going-beyond-gdp-and-profit/current-measures-of-economic-success, consulted on 25 August 2014.

32 http://epp.eurostat.ec.europa.eu/statistics_explained/index.php/Glossary:Value_added, consulted on 25 August 2014.

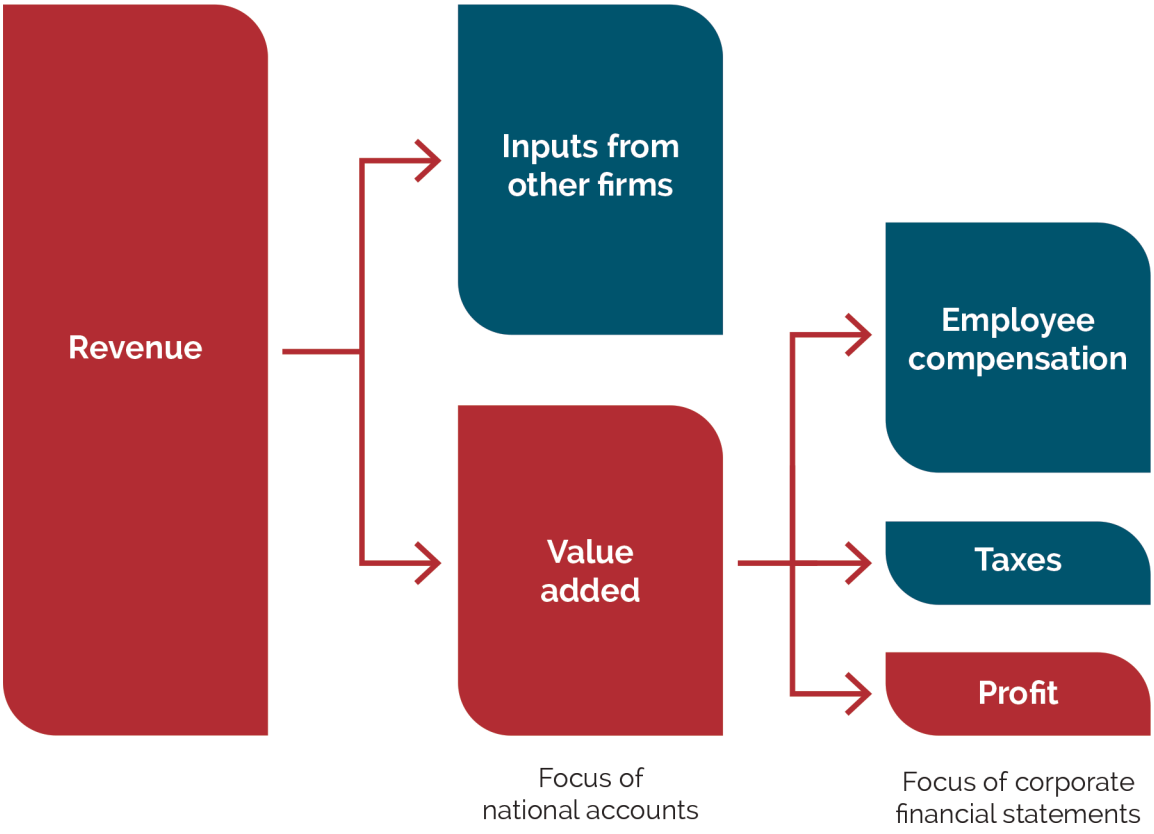


Figure 27 Analogy between the concept of value added in national accounts and corporate financial statements
Source: ICAEW

According to the Institute of Chartered Accountants in England and Wales (ICAEW) it can also be thought of as "revenue less costs of sales, so is less than its revenue but more than its profits." Thus, accordingly, gross value added can also be defined as:

GVA[33] = Revenue - cost of goods and services

For reference, in its application of the "Climate Stabilisation Intensity Targets," BT considered two methods to define value added by companies (Tuppen, 2009):

Value Added = EBITDA + employee costs

Value Added = turnover (=revenue) – cost of purchases in goods and services

As another example, Deloitte UK calculated its contribution to GDP by calculating its gross value added in the following manner (Figure 28):

Gross Value Added (GVA) measures the economic output produced in a given sector or organisation and is analogous to Gross Domestic Product (GDP). It includes all value added at that stage of production, namely: remuneration of labour, operating profit and attributable taxes. It excludes all intermediate inputs to production – at that stage of production – to measure economic value rather than turnover (gross output). Deloitte's economic footprint is estimated using a combination of internal financial, management and HR information.

This 'direct' data is then used in conjunction with a model (based on ONS data) of the UK economy that approximates the supply chain (indirect) and consumer spending (induced) effects of Deloitte's direct impact across other sectors of the economy and in aggregate. The methodology employed in estimating Deloitte's economic contribution is the same process that has been employed for Deloitte's private and public sector clients across a range of organisations, sectors, events and policies, including the likes of Facebook Inc, VisitBritain and the Ministry of Defence (Deloitte, 2012).

33 Also called Gross Profit in USA.

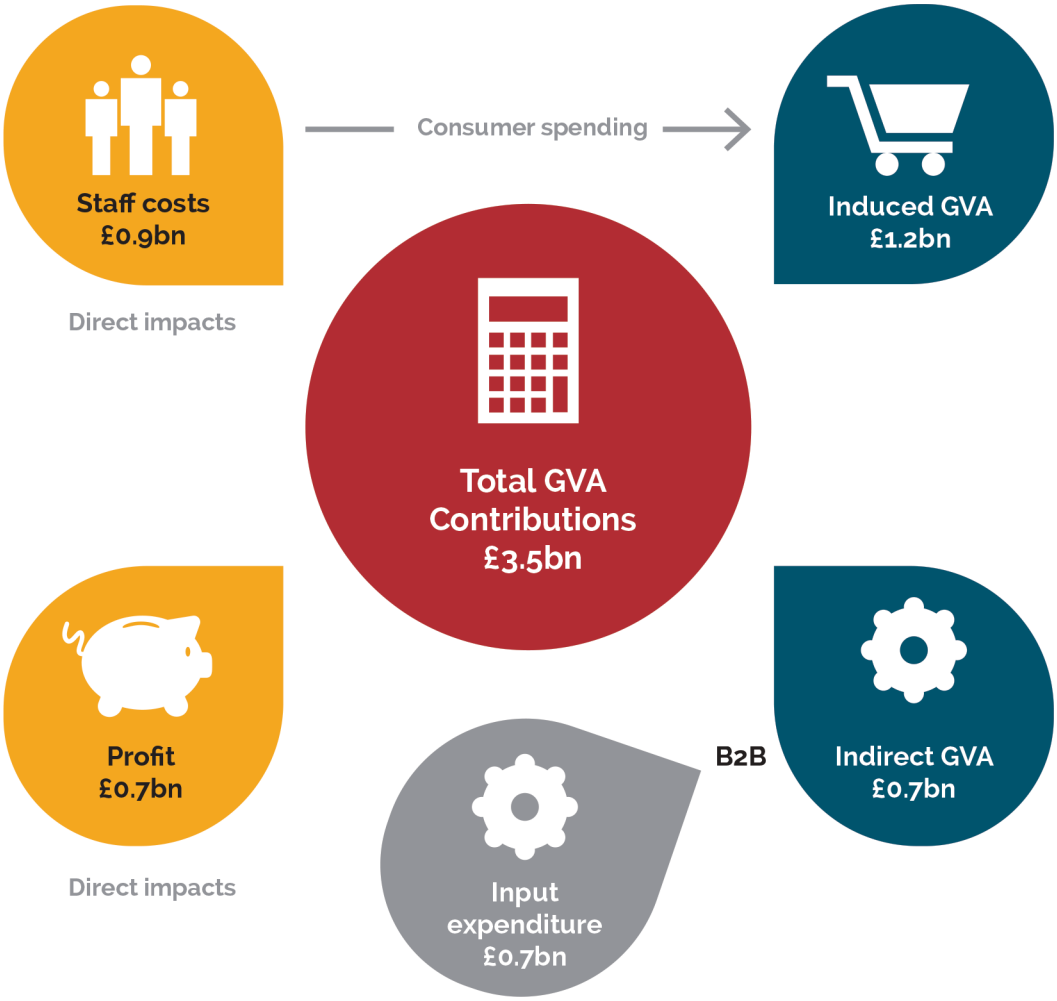


Figure 28. Deloitte's contribution to UK GDP Source: Deloitte.

In conclusion, the concept is not totally free of interpretation - on the basis that accounting concepts and GDP are different systems of recognition and measurement at different levels - and, as such, the approach highlighted above should be seen as a generic recommendation. If a company has a method to determine its contribution to GDP that is slightly different, it can be used under this method.

4.2.6 Emissions from heat, steam, and cooling are negligible compared with electricity

IEA information about heat and power is typically presented in aggregated form, which does not allow for the differentiation of heat from power production. Corporates will account, as part of their Scope 2 emissions, purchased power, heat, steam, and cooling. An absence of publicly available data on heat, steam, and cooling presents a challenge in the application of this methodology. Despite this lack of data, a sense of the relevance of each of these sources of Scope 2 emissions can be hinted at by looking at the energy balances produced by the IEA on global power and heat generation flows (Figure 29).

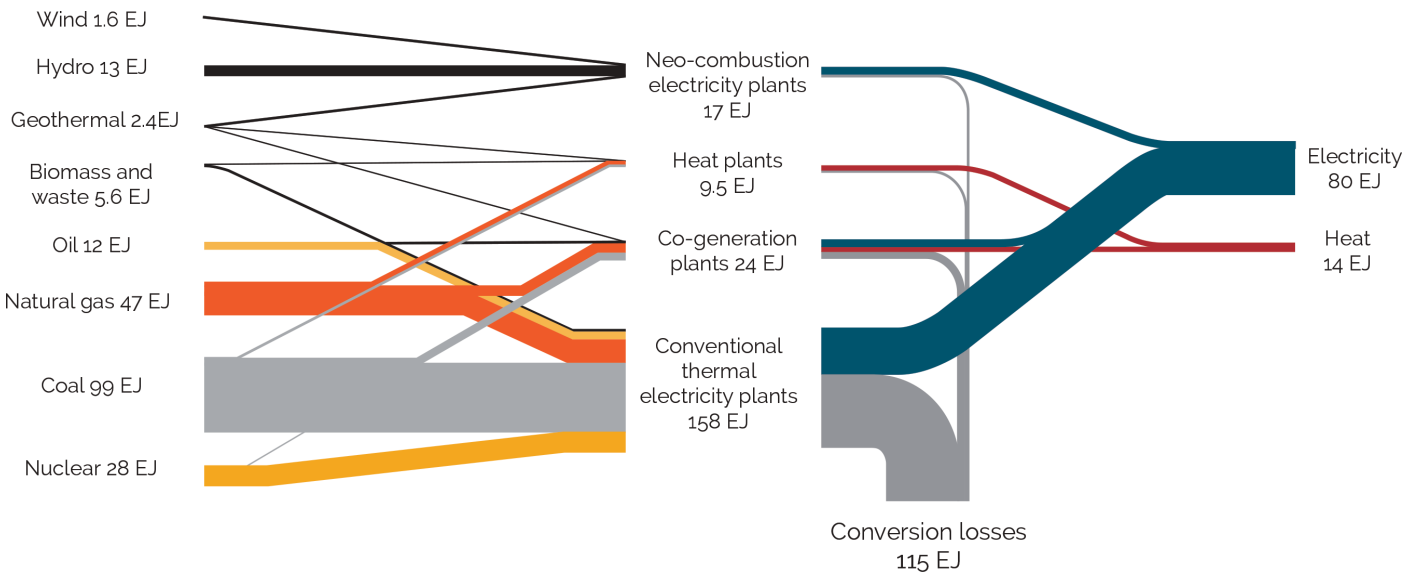


Figure 29. Global power and heat generation flows, 2011 Source: IEA, 2014.

The primary input of energy into conventional thermal power production is 16 times higher than that destined to heat production (Combined Heat and Power is not considered for this calculation), with coal and gas providing the main fuels for heat and power production. Heat consumes less than 6 percent of the primary energy provided by fossil fuels for the heat and power system.

Assuming that this is also a good proxy for GHG emissions, the sector-based method assumes that the totality of Scope 2 emissions are derived from the consumption of electricity only. For many corporations, which consume negligible amounts of heat, cooling, and steam, this will be accurate. However, for some industrial sectors, there might be significant exchanges of heat and steam among neighboring facilities that could complicate Scope 2 calculations. However, we believe the company can isolate its electricity-only Scope 2 footprint and use only that portion to apply the sector methodology.

4.2.7 Passenger vehicles have a lifetime of 15 years

This is a frequent assumption in modelling the lifetime of road vehicles. It is used in IEA modelling on transport, energy, and CO2 (IEA, 2009).

5. NEXT STEPS

In constructing this guidance, existing methodologies and the most applicable available data were used to provide the most accurate and resolute methodology possible. Since there are current limitations in data availability, the model may be further developed. This section discusses how the methodology may be extended in scope and depth if relevant data become available.

5.1 Refine sector approaches by including structural parameters

The SDA methodology uses a high-level approach in describing the development of the CO2 intensity of the sectors, based on scenario assumptions about each sector's average structure. For instance, in the pulp and paper sector a scenario assumption for a structural parameter is the shift from wood pulp to recycled paper. Another example is the regional and local differentiation of grid mixes for power generation. The structure of a given company will almost certainly differ from the global average sector structure. Sector-specific benchmarks take these structural parameters into account. For almost all energy-intensive sectors such benchmark approaches have been developed. Unfortunately, this approach and many others are based on proprietary data that are not publicly available. Using (elements of) sector-specific benchmarks where possible would improve the applicability of the methodology. The idea is that companies would be able to select some structural parameters that would be taken into account in target setting. These structural parameters could be used in the future to differentiate among regional differences as well.

5.2 Expand to include more Scope 3 emissions

Some Scope 3 categories are covered by the methodology; however, extending to all Scope 3 categories could make the method more appealing to companies that have potential to reduce upstream or downstream emissions. For example, companies may be able to change the qualifications of their products. This is a challenge, since first setting these targets along a 2°C decarbonization pathway is not straightforward. Second, the reporting of Scope 3 emissions by companies is still under development as more and more value chain data become available.

In a next step, it is proposed to analyze which Scope 3 emissions can be included for each sector, assuming that a target can be set and that reporting is possible. This approach could

be gradually expanded when the methodology is taken to the next level.

5.3 Extend to more sectors

The number of sectors is restricted because of limited data availability or a missing science-based 2oC decarbonization pathway. The most carbon-intensive sectors are included. However, some key sectors are not included, such as the agriculture, forestry and other land use (AFOLU) sector and the oil and gas sector. As more information becomes available and 2oC decarbonization pathways are constructed for these (sub)sectors, the list can be extended to increase the coverage of large companies. Note that for each sector specific issues would need to be addressed.

5.4 Extend to non-CO2 gases

Non-CO2 gases are not included in the current version of the methodology (see section 4.1.3). Using IPCC mitigation scenarios for non-CO2 gases and distinguishing these at the (sub)sector level could be an approach for further improvement. Particularly when considering the incorporation of sectors like agriculture, forestry, and other land-use (AFOLU) and oil and gas.

6. PUBLIC CONSULTATION

The public will have the opportunity to provide valued feedback on the science-based methodology.

The engagement process will solicit general suggestions for improvement or clarification as well as target certain areas that may benefit from additional stakeholder review. Sufficient time will be provided for stakeholders to thoroughly review the document, then offer responses online. Comments will be carefully considered and, if deemed appropriate, incorporated in the final methodology or future versions.

7. CONCLUSION

This methodology provides a sector-based approach for companies to set GHG reduction targets necessary to meet a global 2°C temperature rise.

Companies can align their strategies with climate science to play a key role in decarbonizing the economy. Raising the ambition on corporate target setting levels will drive bolder business solutions and promote innovative approaches to corporate GHG goal setting. In addition, it will demonstrate to policymakers the scale of ambition in industry to reduce their emissions and act as a positive influence on international climate policy.

GLOSSARY

2DS - Two Degrees Scenario, the focus of the ETP 2014, describing an energy system consistent with an emissions trajectory that would give a 50% chance of limiting average global temperature increase to 2˚C.

Absolute emission target - The level of absolute emissions that has to be achieved in a certain year.

Absolute emission reduction target - the magnitude of change of the absolute emissions in a certain year compared to a base year, expressed in percentages.

Activity – Main economic activity of a company for which the activity indicator is used.

AR - Assessment Report, published materials by the IPCC composed of the full scientific and technical assessment of climate change, generally one for each Working Group.

BAU - Business As Usual, the unchanged development of the situation without any interference, for example through policy.

CO2 intensity reduction target - the magnitude of change of the CO2 intensity in a certain year compared to a base year, expressed in percentages.

CO2 intensity target - the level of CO2 intensity that has to be achieved in a certain year.

CCS - carbon capture and storage, the process of capturing CO2 (usually from large point sources), transporting it to a storage site and depositing it, usually in a geological formation, so it does not enter the atmosphere.

CH4 – Methane

CO2- Carbon dioxide

CO2e - CO2 equivalent, is a unit used to express the global warming potential of (a mix of) greenhouse gasses as a single figure, namely the equivalent amount or concentration of carbon dioxide.

ETP - Energy Technology Perspectives, published by the IEA, the ETP provides scenarios that set out pathways to a sustainable energy future in which optimal technology choices are driven by costs, energy security and environmental factors.

GDP - Gross Domestic Product

GEVA - Greenhouse gas emissions per value added

GHG – Greenhouse gas, a gas that absorbs and emits radiation in the atmosphere, contributing to the greenhouse effect. GHG include (among others) water vapour, carbon dioxide, methane, nitrous oxide, ozone and CFCs.

Global Warming Potential – Global warming potential, or GWP, is a relative measure of how much heat a greenhouse gas traps in the atmosphere. It relates this heat to the amount of heat trapped by a similar mass of carbon dioxide.

IEA - International Energy Agency

IPCC - Intergovernmental Panel on Climate Change

KPI - Key Performance Indicator

kWh – kilowatt hour

NGO - nongovernmental organization

pkm - passenger kilometer, a kilometer travelled by one passenger.

ppm - parts per million

ppmv - parts per million by volume

RCP - Representative Concentration Pathway, one of the four GHG concentration trajectories used in the IPCC 5th Assessment Report (AR5), which are used for climate modeling and research.

Sector – A subdivision of businesses and activities in the global economy used in this report to give companies GHG emission targets.

SRES - Special Report on Emissions Scenarios, a report published by the IPCC in 2000 containing greenhouse gas emissions scenarios that have been used to make projections of possible future climate change.

TES - The Energy Scenario, published by Ecofys and WWF, describes a possible transition to a global, sustainable energy system.

UNEP - United Nations Environment Programme

UNFCCC - United Nations Framework Convention on Climate Change

WEO - World Energy Outlook, published by the IEA, is a comprehensive and authoritative analysis of medium- and longer-term energy trends with energy projections until 2040, providing insights into their meaning for energy security, the economy and the environment.

WRI - World Resources Institute

WWF - World Wide Fund for Nature

APPENDIX I: INSIGHTS INTO SECTORAL 2°C DECARBONIZATION PATHWAYS

For 13 sectors, we juxtapose the activity level from 2010 projected to 2050 against the actual and projected indexes for Scope 1 CO2 emissions and CO2 intensity that show the pathways for each sector to meet their share of reductions to keep global warming to 2°C.

These sectoral activity-level projections and 2˚C decarbonization pathways are based on the IEA ETP 2014 2DS scenario. The 2DS scenario corresponds to an emission pathway to limit global warming to 2˚C with a probability of at least 50 percent and is consistent with the IPCC's RCP 2.6 pathway. If sources other than the IEA ETP 2014 2DS are used, they will be noted.

Per sector, the expected activity and emissions targets are combined to create sectoral CO2 intensity pathways. Figures for each sector show 2010-50 activity levels, and indexes for emissions and CO2 intensity. The text explains the underlying assumptions and where there is potential for reducing emissions in that sector. The emissions and pathways cover only Scope 1 emissions for most sectors, but where relevant Scope 2 emissions are covered by IEA ETP 2014 2DS and will be described qualitatively.

1. Power generation

The power generation sector is responsible for the generation of electricity. This encompasses generation using fossil fuels (i.e. oil, natural gas, and coal), renewable energy sources (such as solar, wind), and nuclear. Because about two-thirds of electricity is generated by the combustion of fossil fuels, this sector emits large quantities of greenhouse gases (GHGs).

1.1 Activity level

The activity indicator for the power generation sector is the number of terawatt hours (TWh) generated. In 2010, this was globally about 21,500 TWh and is expected to increase to roughly 40,000 TWh in 2050, an increase of about 87 percent. The growth is driven by rising demand from non-OECD countries and increased electrification of transport and buildings. This results in an increasing share of electricity in the overall global energy mix.

1.2 Emission reduction potential

In 2010, the power generation sector emitted about 13 gigatonnes (Gt) of CO2. In 2050, the target for CO2 emissions is roughly 1 Gt, a decrease of almost 91 percent compared with 2010 levels that can be achieved only through global effort.

A wide variety of mitigation options are available in electricity generation, and therefore most mitigation scenarios assign a major GHG reduction to this sector (IPCC, 2014a). As electricity generation shifts from centralized to decentralized and from fossil fuels to renewables, the CO2 intensity from power generation is expected to reduce significantly. To a lesser extent, the gradually increasing role of nuclear power (in the 2DS scenario, from 12 percent in 2010 to 17 percent in 2050) also contributes to reduction in CO2 intensity. Scenarios with similar activity levels, albeit a different technology mix, show that it is technologically possible to reduce the carbon emissions from power generation to zero by using only zero-emission technologies for power generation (WWF & Ecofys, 2011). Similarly, in the IPCC AR5 Working Group III report on the mitigation of climate change, emissions from the power generation sector are expected to decrease, approaching 0 between 2040 and 2050 (IPCC, 2014b). However, this assumes that new technologies (e.g., carbon capture and storage or smart grids) are technically feasible. Studies show that a low-carbon power sector is technologically viable at an acceptable cost (IEA, 2013c; McKinsey & Company, n.d.).

1.3 CO2 intensity pathway

While the amount of electricity generated almost doubles from 2010 to 2050, CO_2 emissions must gradually until 2050, with an increased decline after 2020. This leads to a steady decline in the CO2 intensity of electricity with the amount of GHG per kWh reduced by more than 95 percent compared with 2010 levels in 2050 as shown in Figure I.1 .

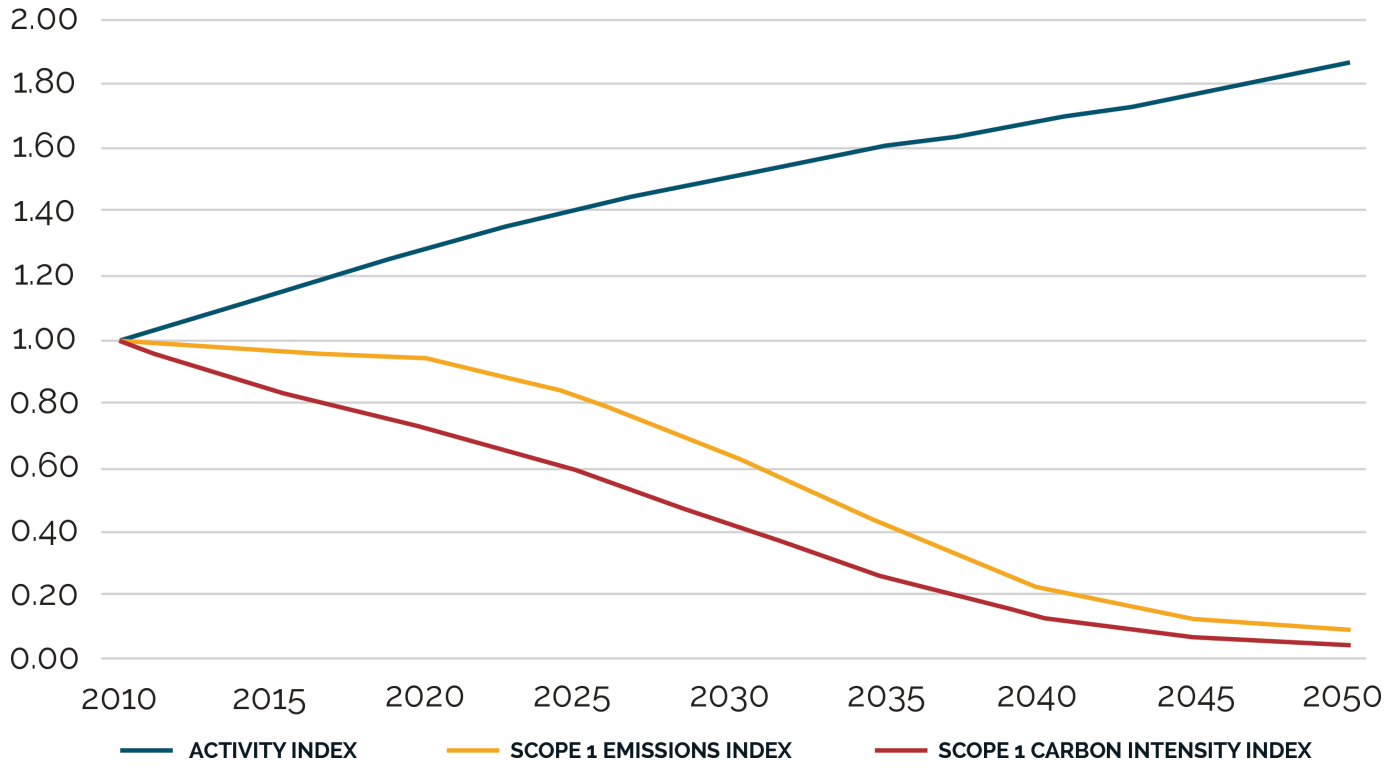


Figure I.1 The CO2 intensity of electricity must decline steadily as the GHG per kilowatt hour is reduced by 95 percent over 2010 levels in 2050
Source: based on IEA, 2014.

2 Cement

The cement sector produces cement out of clinkers and a mix of other minerals. The production process is energy intensive because it involves the heating of ingredients to 1,450 °C. Mostly fossil fuels are used to provide this heat, which produces large quantities of GHG emissions. Also, the calcination reaction which takes place in cement production produces CO2. Therefore, part of the emissions from this sector cannot be avoided (IPCC, 2014a) if the sector sticks to the conventional production processes.

2.1 Activity level

In 2010, the cement industry produced 3,551 Mt of cement. In 2050, this is expected to increase to 4,475 Mt, an increase of almost 26 percent. Because cement is the main ingredient for various building materials, the economic growth in developing countries (IEA, 2012a) accompanied with an increase in buildings is expected to increase demand for cement. This will only hold if no new building technologies or fabrications are found with equivalent properties as a building material (e.g., steel, glass, wood).

2.2 Emission reduction potential

The cement sector directly emitted 2.1 Gt of CO2 in 2010. By 2050, it would need to decrease emissions to 1.7 Gt, a reduction of about 20 percent. Fuel-related emissions can be brought down through fuel switching and using biofuels instead of fossil fuels, assuming sufficient access to biofuels for the cement sector. Emissions can be brought down even further by implementing best available technologies including energy efficiency measures.

Energy efficiency improvement options have only limited potential, because about 50 percent of the 2010 emissions were process emissions from the calcination reaction, which are difficult to reduce cost-effectively given current technology (IPCC, 2014a). These emissions can be partially reduced by reducing the share of clinkers or using clinker substitutes in the mix of input minerals. However, the largest reductions in CO2 emissions from the calcination reaction can be made by capturing and storing these emissions. By combining these measures, the emissions per tonne of cement can be brought down by around 50 percent without carbon capture and storage (CCS) and around 80 percent with the use of CCS (IPCC, 2014a).

According to the IEA fuel switching and the use of clinker substitutes can contribute 29 percent to emission reductions in the cement sector in 2050 (+/- 265 Mt CO2), whereas CCS could be responsible for 63 percent of the emission reductions (+/- 575 Mt CO2). The largest emission reduction potential is found in India and China (IEA, 2012a).

2.3 CO2 intensity pathway

Figure I.2 shows the projected activity and emissions, and the resulting intensity pathway. Emissions peak in 2020, because of the growing activity, and then a decline toward 2050 due the effect of mitigation measures. In 2050, emission levels have reduced by 20 percent compared with 2010. The CO2 intensity of cement production in 2050 has decreased by 37 percent compared with 2010.

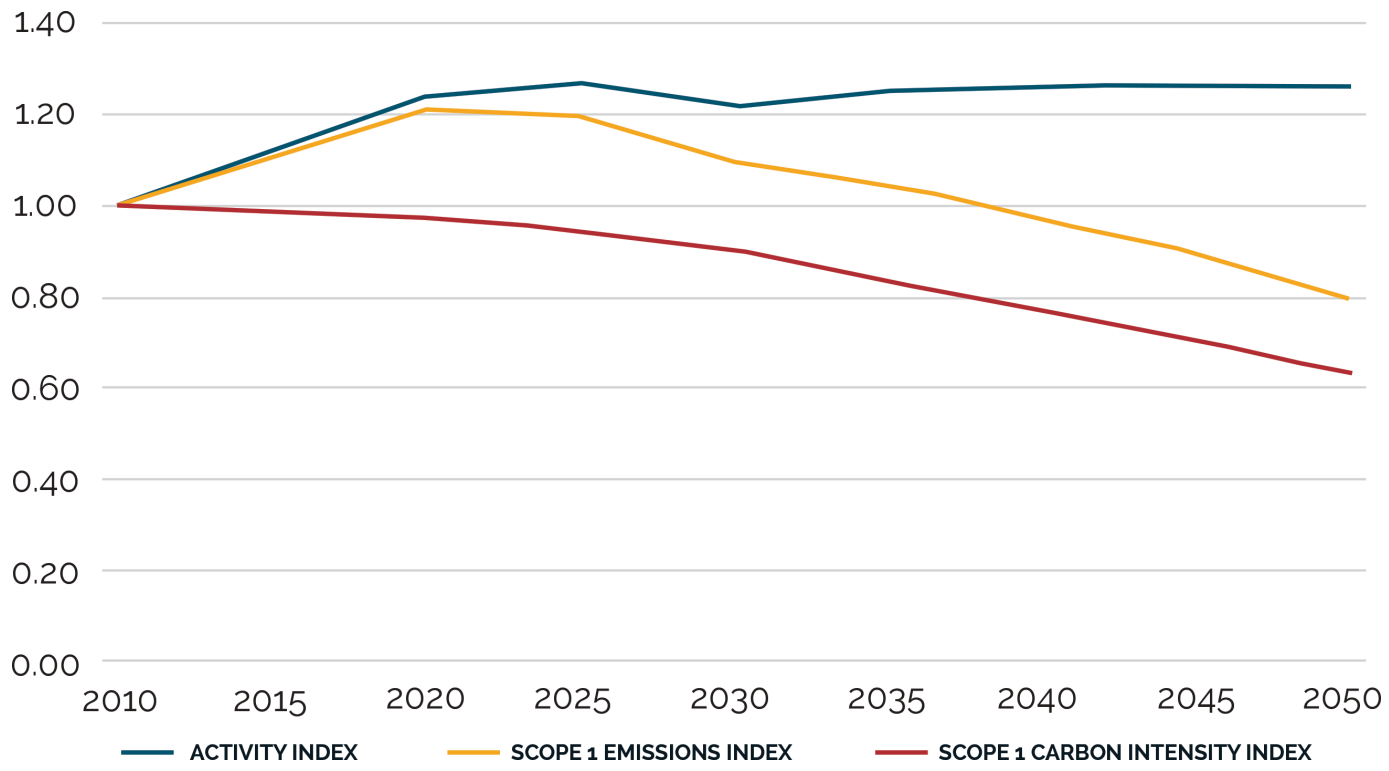


Figure I.2 Cement manufacture GHG emissions peak in 2020, because of activity growth, then decline toward 2050 because of mitigation measures to meet their target
Source: based on IEA, 2014

3. Iron and steel

In primary steelmaking, the iron and steel sector uses iron ore as an input to make iron, then uses the iron to make steel. The main process of primary steelmaking involves smelting iron ore, which requires high heat. In conventional iron and steel making, emission-intensive coking coal is used for fuel. Steel can also be made from scrap (secondary steelmaking), which is generally very electricity intensive.

3.1 Activity level

In 2010, the sector produced 1,482 Mt of crude steel. In 2050, global steel production is expected to increase to 2,295 Mt, an increase of almost 55 percent. This growth will be driven mainly by an increased demand for steel in emerging economies. Demand is expected to increase partly because of its use as a building material for a growing population.

3.2 Emission reduction potential

The iron and steel sector directly emitted 2,955 Gt of CO2 in 2010. In 2050, emissions would need to decrease to 2,044 Gt, a reduction of almost 31 percent. Possible technologies to reduce the amount of CO2 emitted per tonne of steel are to use natural gas, hydrogen, or oil instead of coal. Also, efficiency measures can be implemented. Nearly half of the CO2 reductions in the iron and steel sector is expected to be from energy efficiency improvements. The greatest potential for efficiency increases comes from "phasing out open-hearth furnaces in countries such as Ukraine and Russia, and from blast furnace improvements in India, China, and Ukraine." In addition, CCS can be used to further reduce CO2 emissions. The IEA expects CCS to capture 812 Mt of CO2 in 2050 for the iron and steel sector. Emissions can be further reduced through increased secondary steelmaking, which has primarily Scope 2 emissions (and is limited by scrap availability), in combination with decarbonization of electricity.

3.3 CO2 intensity pathway

Because of this activity growth, the sector's emissions will increase slightly until 2020, even when the CO2 intensity decreases by 10 percent compared with 2010. By 2050, the total emissions will need to decrease by 31 percent and the intensity by 55 percent compared with 2010 as shown in Figure I.3.

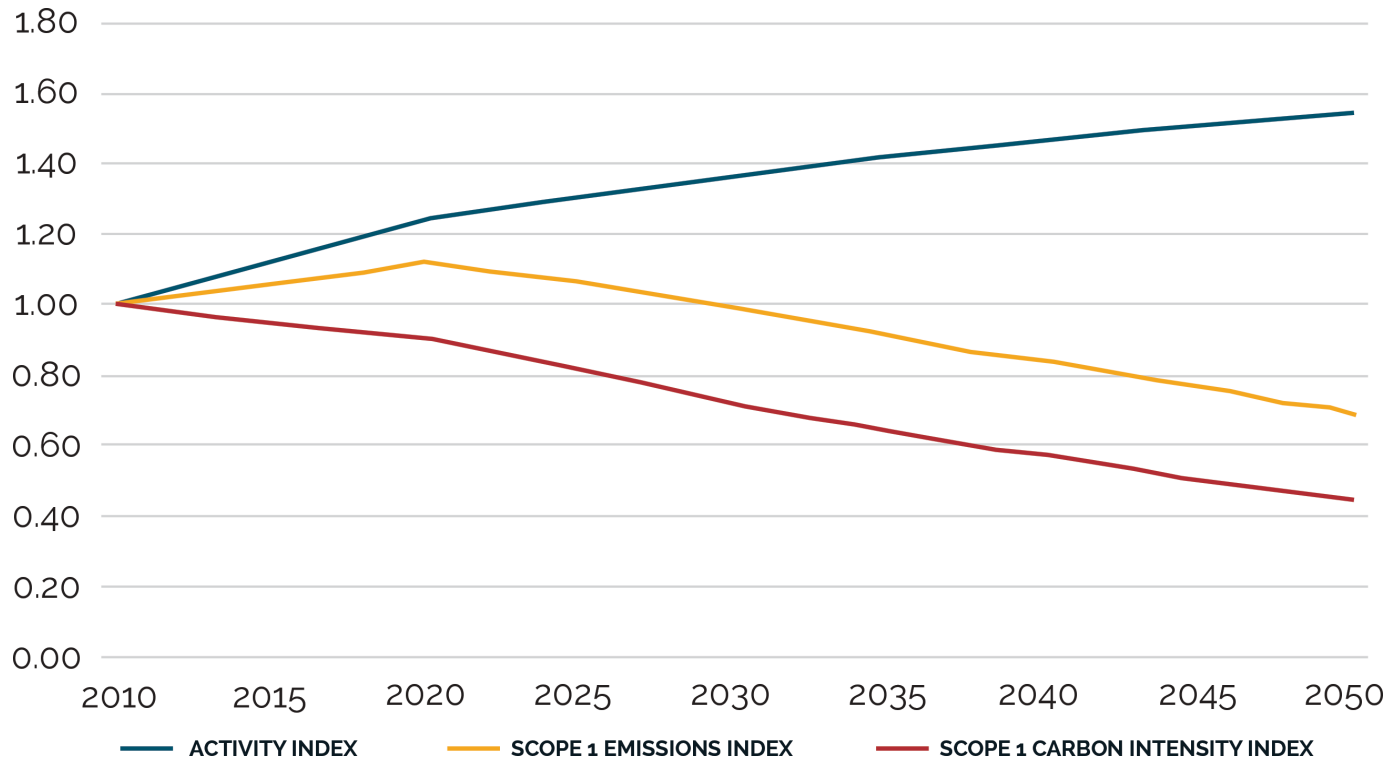


Figure I.3 Iron and steel sector emissions will increase slightly because of this activity growth, but the total emissions need to decrease by 31 percent and intensity by 55 percent by 2050
Source: based on IEA, 2014

4. Aluminum

The aluminum sector makes aluminum out of raw materials (like bauxite; primary aluminum) or out of recycled aluminum (secondary aluminum). Most of the recycling takes place in the industry itself (IPCC, 2014a). In primary aluminum making, an electrolysis reaction is necessary, requiring a large amount of electricity (IPCC, 2014a).

4.1 Activity level

In 2010, aluminum production amounted to 87 Mt (neglecting industry internal recycling to avoid double counting). In 2050, this is expected to increase to 234 Mt (IEA, 2014), an increase of almost 169 percent. The demand for aluminum is expected to grow significantly because of its increased application in transport, construction, and engineering, in particular in developing countries because of expected economic growth.

4.2 Emission reduction potential

In 2010, the Scope 1 CO2 emissions from the aluminum sector were 141 Mt. By 2050, emissions are expected to increase to 333 Mt (IEA, 2014), up 136 percent, because of the large increase in production.

Even though the emissions from aluminum are only a small share of global emissions, the expected increase in activity and the current energy intensity allow for a high reduction potential, with Asia holding more than half of the global reduction potential (IEA, 2012a). The quality of the ore used is an important factor in the emission intensity, but there is also potential for technical abatement measures (IEA, 2012a). The implementation of best available technologies can reduce energy use for aluminum production by about 10 percent (IPCC, 2014a). Recycling more aluminum can also reduce emissions significantly.

4.3 CO2 intensity pathway

Figure I.4 shows the sector's intensity pathway. The activity steadily increases to more than 2.5 times 2010 activity in 2050. Emissions are allowed to increase, but at a declining pace. The result is that the CO2 intensity needs to be reduced to 88 percent of the 2010 intensity.

For indirect emissions (Scope 2), decarbonization of electricity can reduce the CO2 intensity even further (IEA, 2012a). With the increasing decarbonization of the power sector, Scope 2 emissions are expected to drop significantly from 2011 to 2050 (from 4.47 tonmes of CO2 to 0.16 tonnes of CO2 per tonne of aluminum).

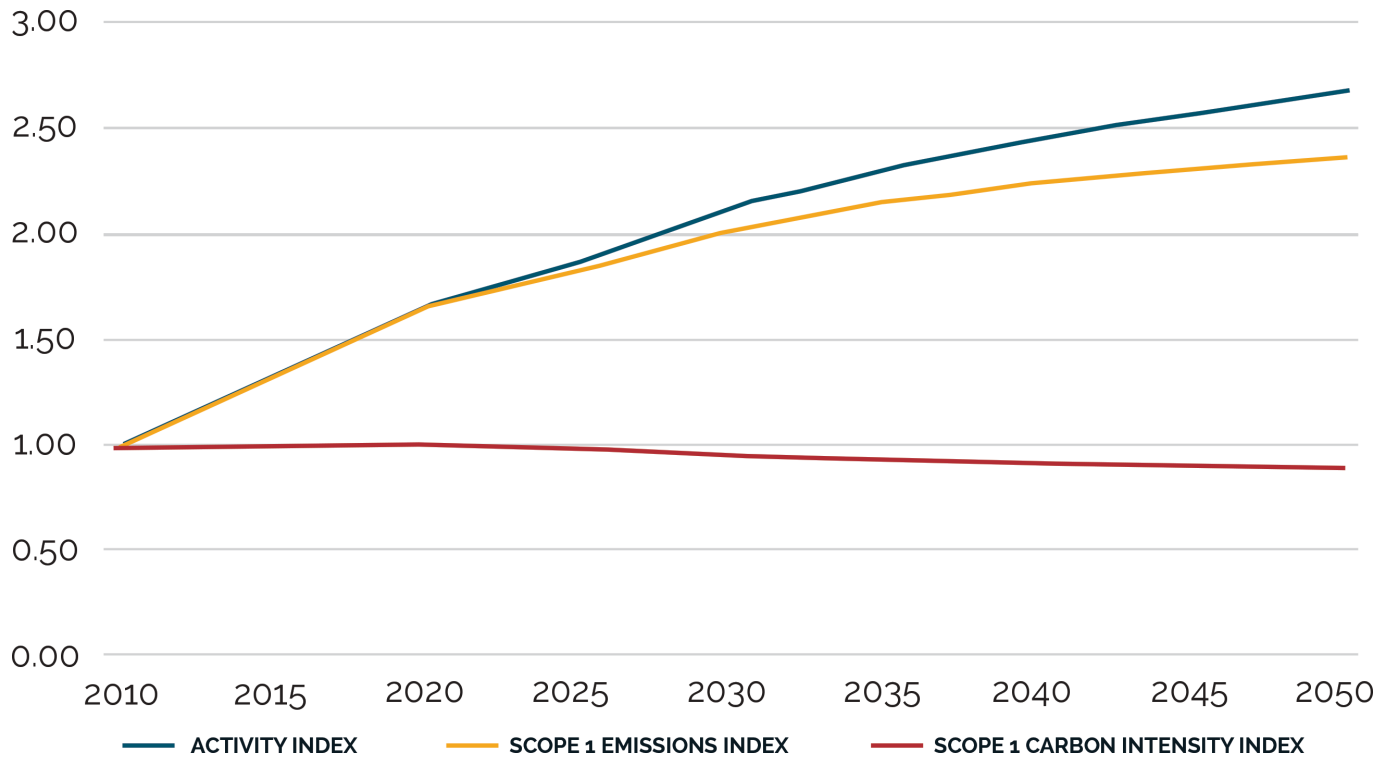


Figure I.4 Aluminum manufacturing activity steadily increases to more than 2.5 times the 2010 activity by 2050, but CO2 intensity needs to reduce by 88 percent
Source: based on IEA, 2014

5. Chemicals and petrochemicals

The chemicals and petrochemicals sector produces plastics, fertilizers, and other chemicals. GHG emissions of the chemicals and petrochemicals sector come mainly from two sources: the combustion of fossil fuels for heat demand, and emissions from chemical processes.

5.1 Activity level

Because this sector produces a wide range of different intermediate and end products, a monetary rather than a physical indicator is used to model activity. However, the predicted activity in contribution to GDP is not given for this sector. Instead, the predicted global economic growth rate of the IEA ETP 2014 2DS pathway—roughly 3.3 percent per year—is used because chemicals and petrochemicals permeate all levels of industry.

5.2 Emission reduction potential

In 2010, global CO2 emissions from the chemical and petrochemical sector were 1.2 Gt. Global CO2 emissions would increase to 2 Gt by 2050, an increase of almost 68 percent. China, Africa and the Middle East account for more than half the emission reduction potential (IEA, 2012a).

More efficient or less emission-intensive alternatives are available for many processes required to make products in the chemical and petrochemical sector (IPCC, 2014a). Improvements in efficiency can be achieved by increased process integration, waste heat recovery and utilization, the use of efficient electrical equipment, and the implementation of captive co-generation units. Substantial opportunities exist (up to 50 percent emissions reduction) in using less material (IPCC, 2014a). Low-carbon technologies, including the deployment of bio-based chemical facilities, and improved performance of catalysts and related process technologies can also reduce the emissions. In addition, CCS can be used to meet the sector's targets. The IEA states that CCS could be responsible for 551 Mt of CO2 captured in 2050.

5.3 CO2 intensity pathway

While the required emissions pathway for the chemical and petrochemical industry is given in the 2DS scenario, the relative growth in the emission scenario is divided by the economic growth over the same period. The final CO2 intensity pathway shows a small increase in CO2 intensity because of the higher uptake of carbon-intensive special chemicals until 2020, and then a decline in CO2 intensity of 52 percent by 2050 (Figure I.5).

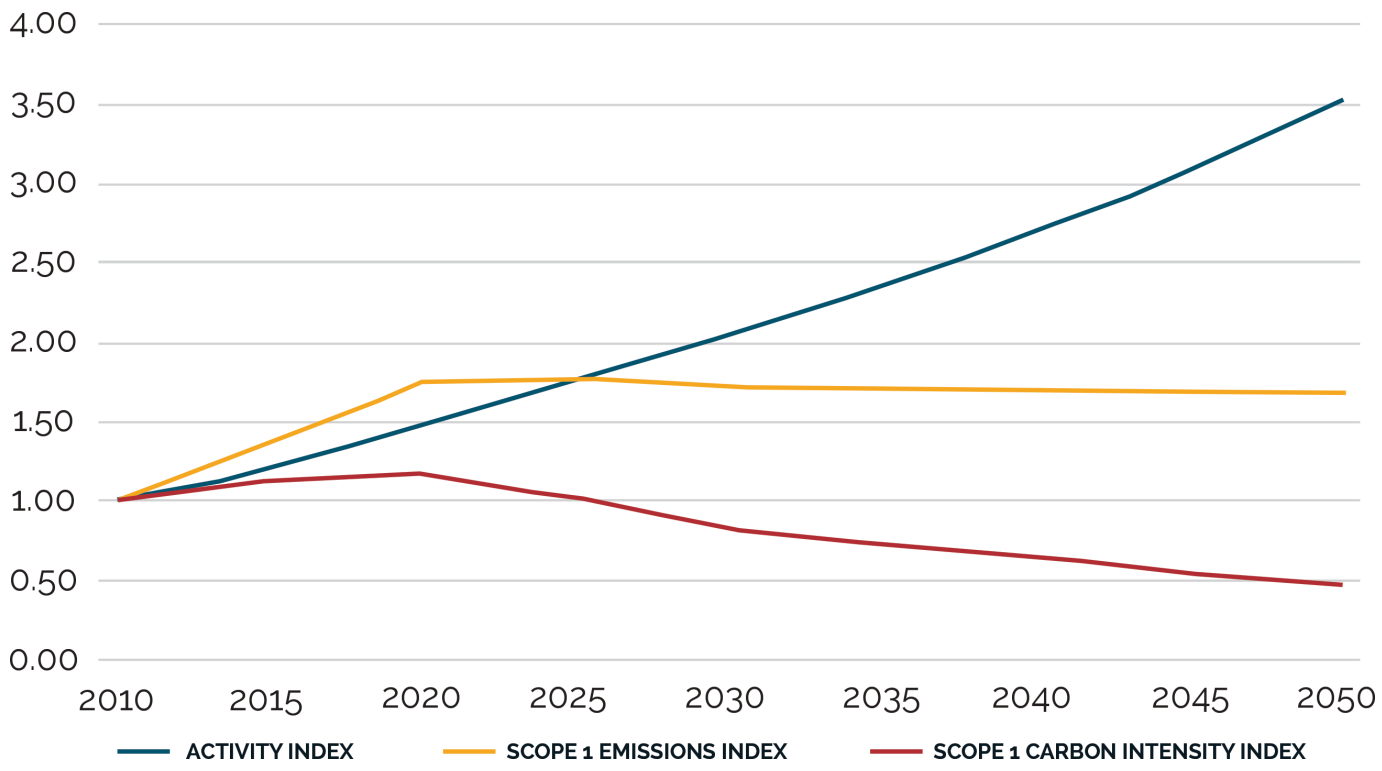


Figure I.5. Although activity will grow in the chemical and petrochemical sector, CO2 intensity would peak in 2020, then decline by 52 percent by 2050
Source: based on IEA, 2014

6. Pulp and paper

The pulp and paper sector produces all types of paper and cardboard. Fuel and energy use are the main sources of GHG emissions during forestry, pulping, and manufacturing of paper (IPCC, 2014b).

6.1 Activity level

During recent decades, global pulp and paper production has increased steadily, mostly because of increased demand from developing countries. This trend is expected to continue and total production is expected to increase from 392 Mt in 2010 to 755 Mt in 2050, an increase of 93 percent.

6.2 Emission reduction potential

The global direct CO2 emissions from pulp and paper production would decrease from 238 Mt to 164 Mt by 2050, roughly 31 percent. These emission reductions would predominantly originate from the OECD region, closely followed by China, the second largest contributor. A wide range of energy efficiency technologies are available for this sector, including more efficient heat use for drying paper, increasing the energy efficiency of the pulp and paper mills and waste-to-energy technologies.

Higher material efficiency, for example through printing on demand or paper reuse can also reduce emissions (IPCC, 2014b). According to the IEA, energy efficiency measures would be responsible for 47 percent of the emission reductions and fuel switching would be responsible for 38 percent of the emission reductions. The latter includes the increased use of biomass and shifting to less-intensive conventional fuels.

6.3 CO2 intensity pathway

The sectoral Scope 1 CO2 intensity pathway decreases from 0.61 tonne of CO2 per tonne paper in 2010 to 0.22 tonne of CO2 per tonne paper in 2050. This is a decrease of almost 64 percent as shown in Figure I.6.

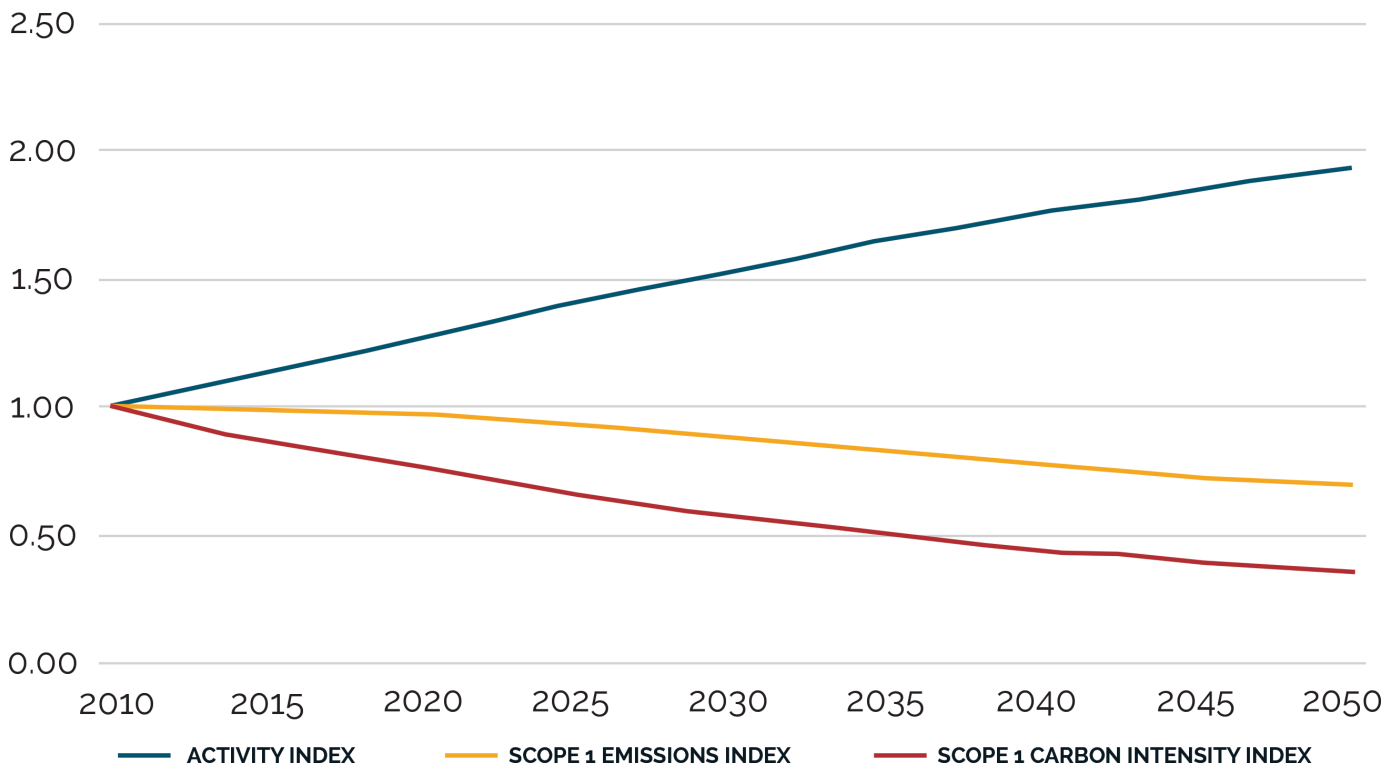


Figure I. 6 As pulp and paper manufacturing activity grows, its CO2 intensity wold need to decline by 64 percent by 2050.
Source: based on IEA, 2014

7. Other industry

The "other industry" sector includes all industries that cannot be allocated in one of the six industry sectors above. It includes industries like food, beverage and tobacco processing; manufacturing of other nonferrous metals (e.g., copper, lead, nickel, tin, titanium, zinc, gold, silver, platinum) and other nonmetals (e.g., glass, ceramics); manufacturing of textiles, wearing apparel, leather, and related products; manufacturing of computers, electronics, optical products, and electrical equipment; manufacturing of machinery and equipment; and the construction industry.

7.1 Activity level

For the other industry sector no specific information was found on sector or subsector level in IPCC and IEA ETP 2DS on their activities in 2010 or toward 2050. For that reason, the value-added indicator is used. The relative activity growth of the sector was modelled by using the predicted global economic growth rate from the IEA ETP 2014 2DS pathway, roughly 3.3 percent per year.

7.2 Emission reduction potential

Because no data are available for these industries, the emission budget of this sector was determined by the total industry IEA ETP 2014 2DS emission pathway minus the emission budgets of the five energy-intensive industry sectors described above. In that way, the emissions pathway of the other industry sector can be determined for 2010 to 2050. CO2 emissions in 2010 were 2,140 Mt, targeted to decrease to 903 Mt in 2050, a decrease of 58 percent.

A steep decline of the emission intensity is needed in this sector with its many and diverse small and medium size enterprises (SMEs). Because SMEs typically have larger reduction potential than the large energy-intensive companies (Saygin, Patel, & Gielen, 2010), this potential can be used by implementing generic efficiency improvements. There is also potential to reduce Scope 2 emissions, such as more efficient motor systems and decarbonizing electricity.

7.3 CO2 intensity pathway

With increasing activities and decreasing emissions from 2010 to 2050, the CO2 intensity of the sector declines steeply. The CO2 intensity index of the sector goes from 1 in 2010 to 0.14 in 2050, a decrease of around 87 percent.

The CO2 intensity of a company in this sector is calculated by dividing the emissions of the company by the added value of the company. The same reduction (in percent) as the decline of the CO2 intensity of this sector was applied to the base-year CO2 intensity of the company in this sector to determine the targets. This means that companies in this sector will have an intensity target that should decline about 87 percent by 2050.

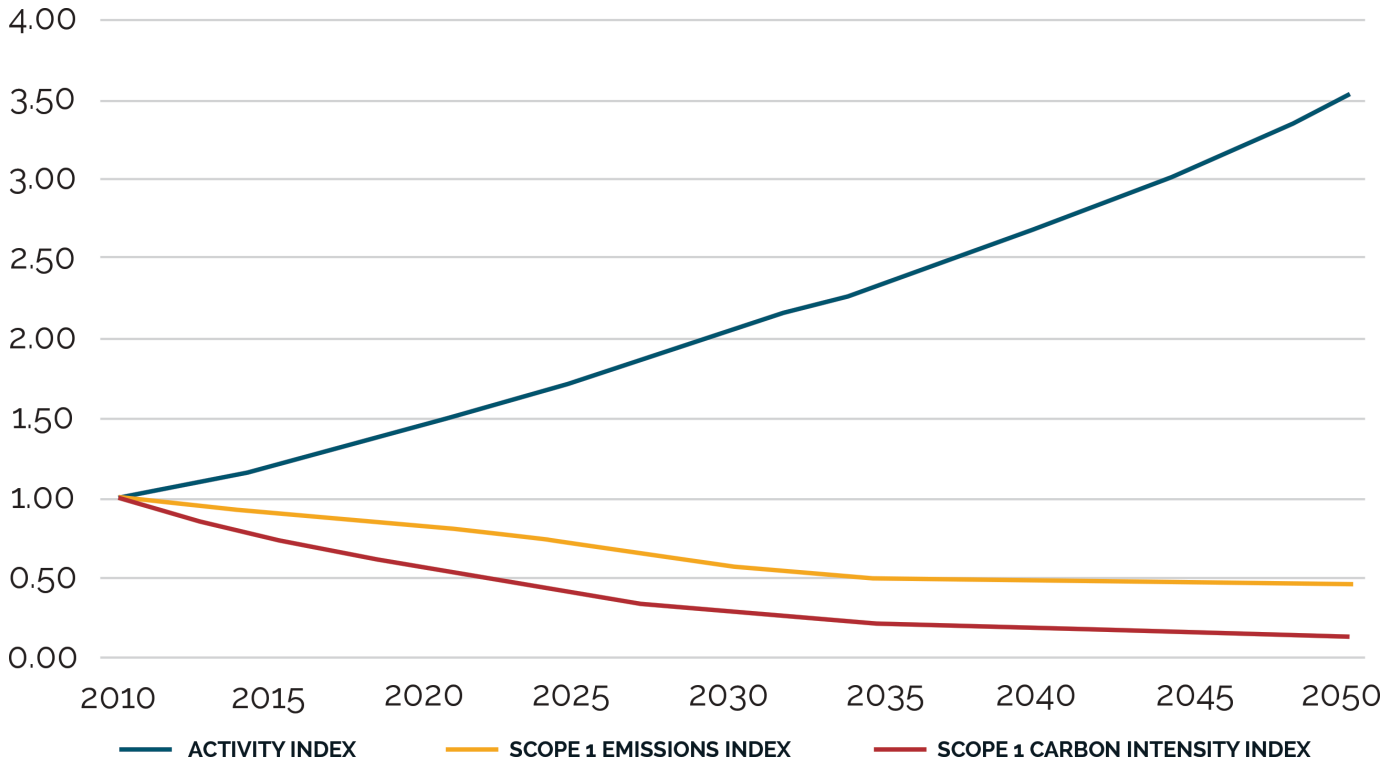


Figure I.7 Other industries will grow, but have a target of reducing CO2 intensity by 87 percent by 2050
Source: based on IEA, 2014

8. Light road Passenger transport

This category includes passenger vehicles up to nine persons per vehicle and 3.5 tonnes of gross vehicle weight (IEA, 2012a). Most of the GHG emissions in this sector are caused by combustion of fossil fuels either directly in an internal combustion engine, or indirectly through the generation of electricity in electric vehicles.

8.1 Activity level

The transport sector will grow significantly by 2050 in terms of passenger kilometers, especially in non-OECD regions, where increasing wealth is driving motorization. In 2010, the passenger kilometers of light road passenger vehicles were almost 28 trillion. In 2050, it is expected to increase to 50 trillion passenger kilometres, an increase of roughly 79 percent.

8.2 Emission reduction potential

The CO2 emissions from the use of light duty vehicles were just below 2.9 Gt in 2010 and are targeted to decrease to 1.2 Gt in 2050, a decrease of roughly 58 percent. This decrease is in line with the 60 percent reduction potential decrease from 2010 to 2050 estimated by the IPCC (IPCC, 2014a). A wide range of reduction technologies are available (e.g. hybrid drive trains, increased aerodynamics, weight reduction, fuel cell vehicles, biofuels, eco-driving, full electric battery vehicles) (IPCC, 2014a). To help to unlock this potential, the IEA describes three reduction strategies in the IEA ETP 2014 2DS scenario: Avoid, Shift, and Improve. Avoid slows individual travel growth via city planning and demand management. Shift enables people and business to shift to more efficient modes, such as rail. Improve encourages the adoption of new technologies and fuels.

8.3 CO2 intensity pathway

Figure I.8 shows the absolute emissions from light duty vehicle use first having a small increase of 4 percent up to 2015 due to increased activity. In 2050, the emissions are modelled to decline to 42 percent of 2010 levels. This means that the intensity in 2050 needs to be 76 percent lower than in 2010 to remain in line with this sector's 2°C decarbonization pathway.

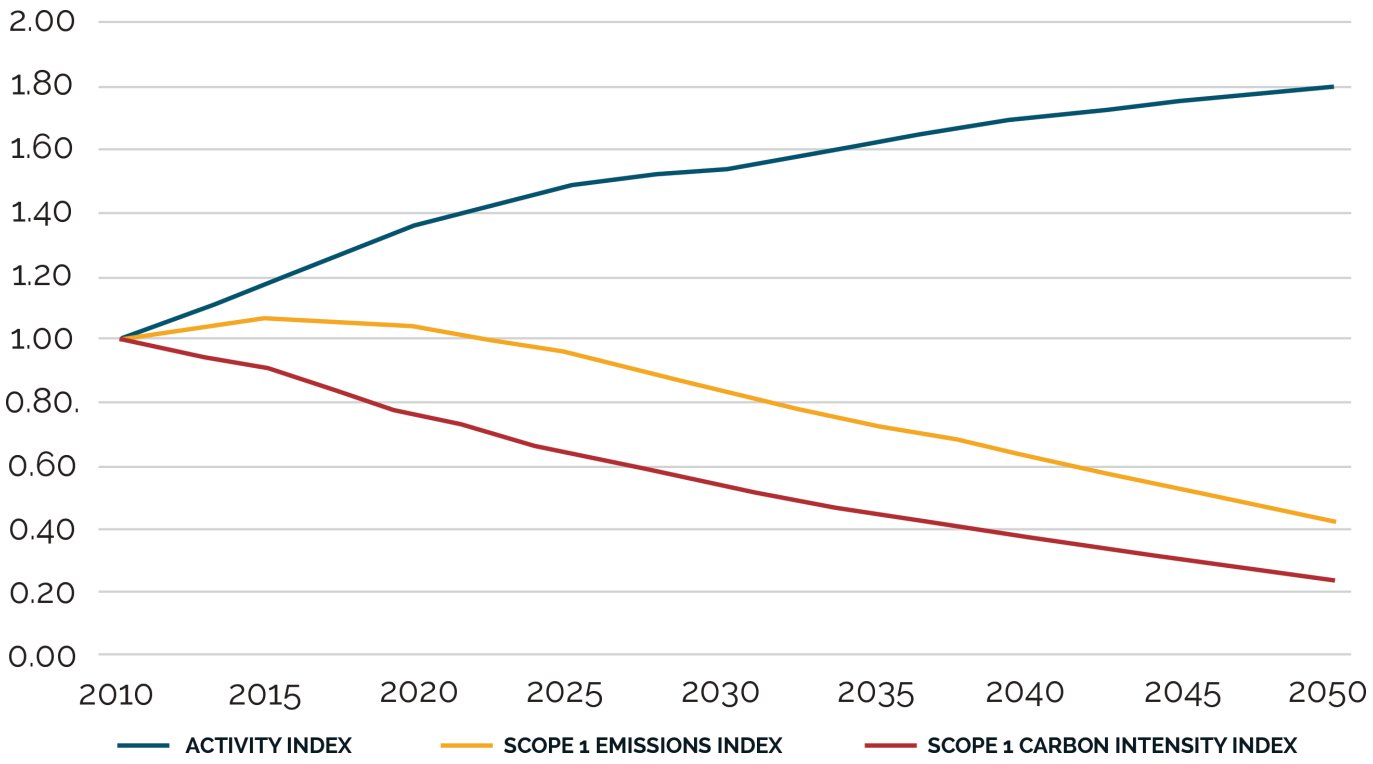


Figure I.8 Cars and light trucks will continue growth in activity, but need to reduce CO2 intensity by 76 percent by 2050
Source: based on IEA, 2014

9. Heavy road passenger transport

Heavy road transport includes motorized passenger vehicles with more than nine seats like buses and minibuses. It does not include freight transport.

9.1 Activity level

In 2010, the global activity of the heavy road passenger transport sector amounts to 7.2 trillion passenger kilometers. This is expected to rise to more than 18 trillion passenger kilometers by 2050, an increase of 157 percent. The increase is driven by a rise in world population and the drive to avoid slow individual travel.

9.2 Emission reduction potential

In 2010, the heavy road passenger transport emitted 356 Mt of CO2. In 2050, this is expected to decrease to 315 Mt, a decrease of 12 percent. With an activity increase of 157 percent, this means a large reduction in emission intensity is needed realize these emission reductions. The potential to bring down the emission intensity of heavy-duty passenger vehicles is large. It can be done by technological innovation incentivized by policies like fuel-economy standards for heavy-duty vehicles as well as technological development (e. g. hybrid drive-trains, increased aerodynamics, weight reduction, fuel cell vehicles, biofuels, eco-driving, full electric battery vehicles, etc.), as well as improved consumer information schemes, fuel taxation, or implementing of bus rapid transit (BRT) systems, or other mass transit schemes.

9.3 CO2 intensity pathway

As is shown Figure I.9, the number of 2050 passenger kilometers is expected to be more than 2.5 times the 2010 passenger kilometers. Despite this growth in activity, the reduction potential could bring down the 2050 CO2 intensity by 65 percent compared with 2010.

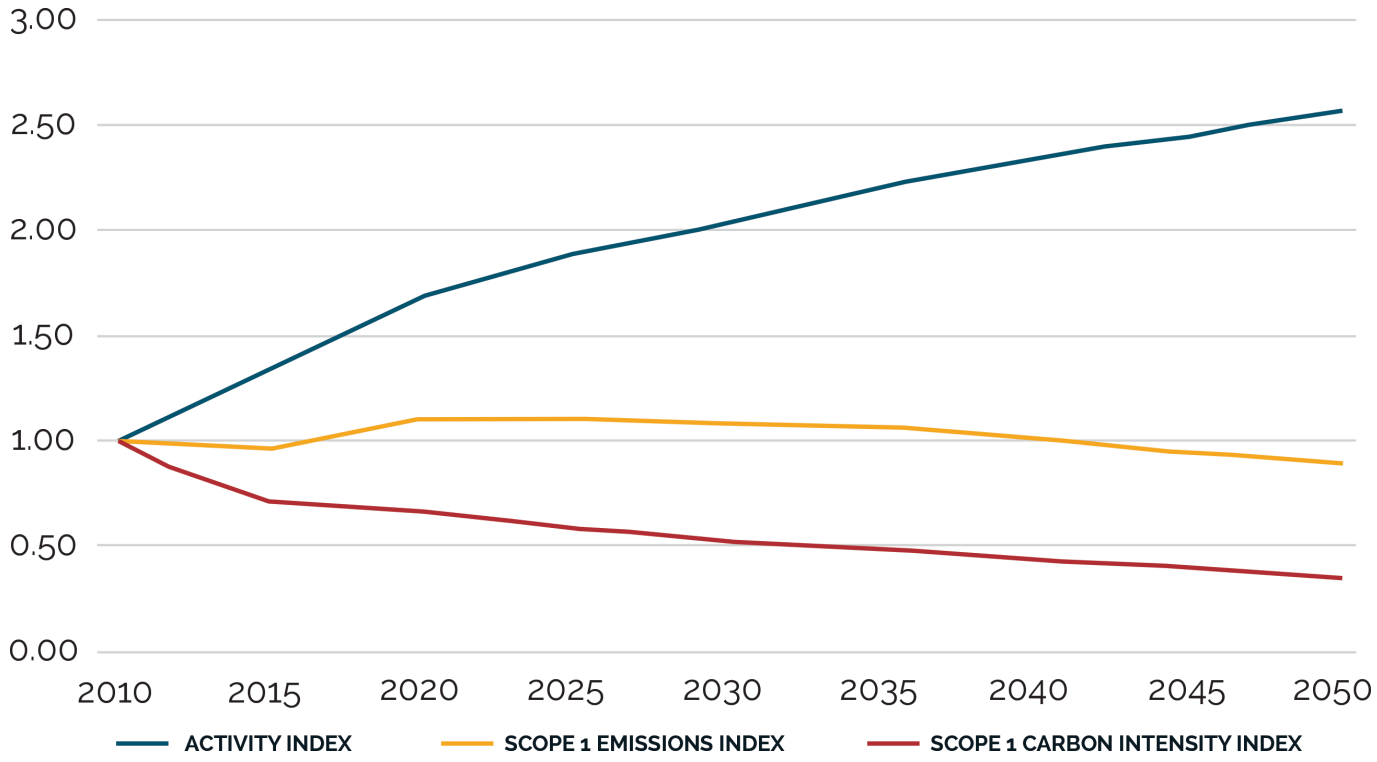


Figure I.9 While passenger kilometres travelled in heavy road vehicles will more than double, CO2 intensity is targeted to decline by 65 percent.
Source: based on IEA, 2014

10. Rail passenger transport

This sector includes passenger trains, but not freight transport. Rail passenger transport has one of the lowest emission intensities per passenger kilometer. With an increasing amount of electric trains and an increasing amount of renewable energy share in the power generation sector, this mode of transport will continue to be an important option to reduce emissions from the transport sector.

10.1 Activity level

In 2010, 2.6 trillion passenger kilometers were travelled by rail. This number is expected to increase to 9.2 trillion passenger kilometers in 2050, an increase of 254 percent. The increase in world population and shift of travel and transport to more efficient modes drive the growth in rail passenger kilometers.

10.2 Emission reduction potential

CO2 emissions from rail passenger transport are expected to increase from 19 Mt in 2010 to 23 Mt in 2050, an increase of about 21 percent. Despite the increase in emissions, the direct emissions remain around 1 percent of the total transport sector.

10.3 CO2 intensity pathway

Due to the large increase in activity compared to the increase in emissions, the CO2 intensity of Scope 1 emissions is expected to decrease 65 percent by 2050 compared with 2010.

The CO2 intensity pathway in Figure I.10 only covers Scope 1 emissions. However, since rail transport almost exclusively uses electricity, the rail passenger transport sector also has a high reduction potential in Scope 2 emissions as the share of renewable energy in electricity generation increases. Taking the 2°C decarbonization pathway of the power sector into account, the CO2 intensity of Scope 1 and 2 combined is expected to decrease from 21.27 gCO_2/passenger km to 3.07 gCO_2/passenger km, a decrease of around 86 percent.

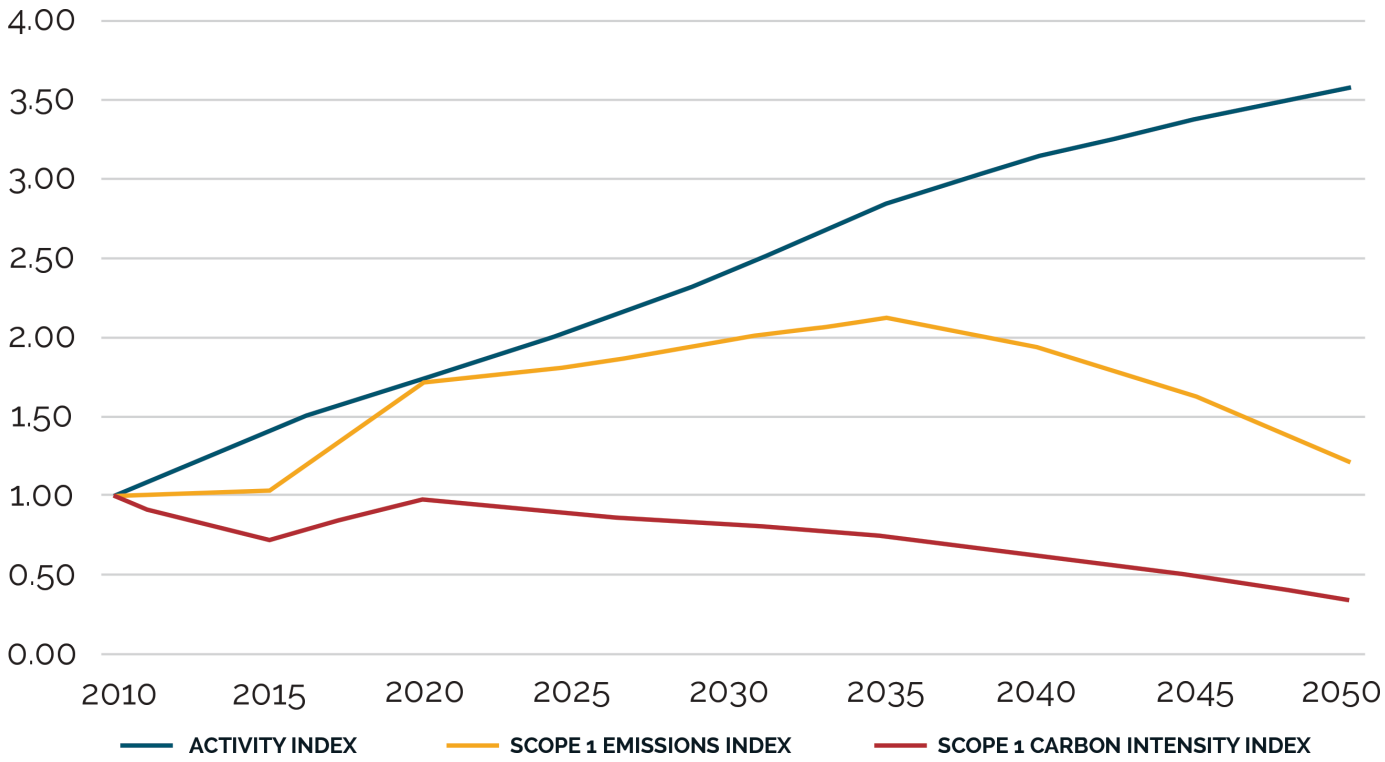


Figure I.10 Rail passenger transport activity will grow, but CO2 intensity is expected to decline by 65 percent
Source: based on IEA, 2014

11. Aviation passenger transport

This sector encompasses the transportation (both domestic and international) of passengers only. Cargo by plane is included in the sector other transport. The main source of GHGs for this sector is the combustion of fossil fuels in airplane engines.

11.1 Activity level

The activities of the aviation passenger sector were about 4.3 trillion passenger kilometers in 2010. Significant growth is expected because of rising wealth in emerging economies and an increase in aviation tourism transport (IPCC, 2014a; IEA, 2012a). Activities in the passenger aviation sector are expected to increase to 7.8 trillion passenger kilometers by 2050, up 82 percent.

11.2 Emission reduction potential

In 2010, the aviation sector emitted about 755 Mt of CO2 (tank to wheel). In 2050 this is expected to increase to 1,020 Mt, an increase of 35 percent. For large aircraft, no serious alternative to jet engines have been identified. Therefore, biofuels are expected to play an important part in reducing the CO2 intensity of aviation (IPCC, 2014a). However, since airplanes emit greenhouse gases at high altitudes, the impact of biofuels on global warming cannot be considered zero. Taken this into account and due to limitations of reduction options, the aviation sector is expected to have an increased share in global GHG emissions in the future (IEA, 2012a).

11.3 CO2 intensity pathway

As can be seen in Figure I.13, the number of passenger kilometers in aviation is expected to almost double between 2011 and 2050. Total emissions increase as well, though at a lower rate, resulting in a CO2 intensity pathway of 26 percent in 2050 compared to 2010.

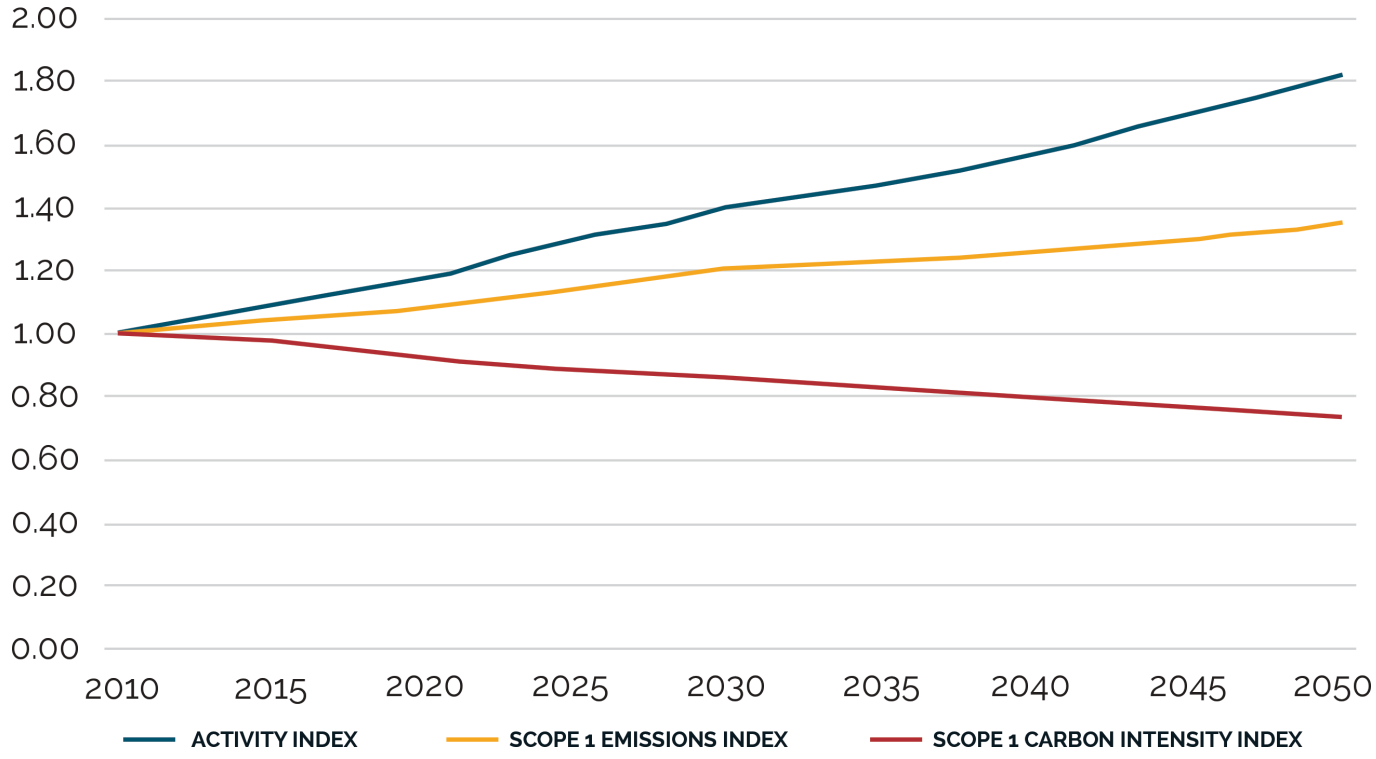


Figure I.11 Air passenger transport will increase by 82 percent in kilometres travelled, but with a CO2 intensity pathway of 26 percent
Source: based on IEA, 2014

12. Other transport

The other transport sector includes all freight transport.

12.1 Activity level

For the other transport sector, no activity information was found in IPCC and IEA 2DS on activities and emissions in 2010 and toward 2050. Therefore, a monetary CO2 intensity indicator was used. The relative activity growth of the sector is modelled by using the predicted global economic growth rate from the IEA for the ETP 2DS pathway, which equals roughly 3.3 percent per year.

12.2 Emission reduction potential

The reduction potential was determined by the overall reduction potential of whole transport sector of the ETP 2014 2DS pathway. The pathway of the specified transport sectors above were subtracted from the pathway of the whole transport sector. What is left, was used as the emission pathway for the other transport sector for 2010 to 2050. CO2 emissions in 2010 were 2,788 Mt and need to decrease to 1,445 Mt by 2050, a decrease of 48 percent.

Reduction measures include fuel economy policies, fuel replacement options, load optimisation and efficiency strategies, and vehicle technology improvements.

12.3 CO2 intensity pathway

The activity level in terms of monetary value continues to increase while emissions show a decreasing trend, resulting in an expected decline in CO2 intensity of 85 percent by 2050. Value added as proxy for contribution to GDP was used for company targets. The same reduction (in percent) as the decline of the CO2 intensity of this sector is applied to the base-year CO2 intensity of the company to determine the targets.

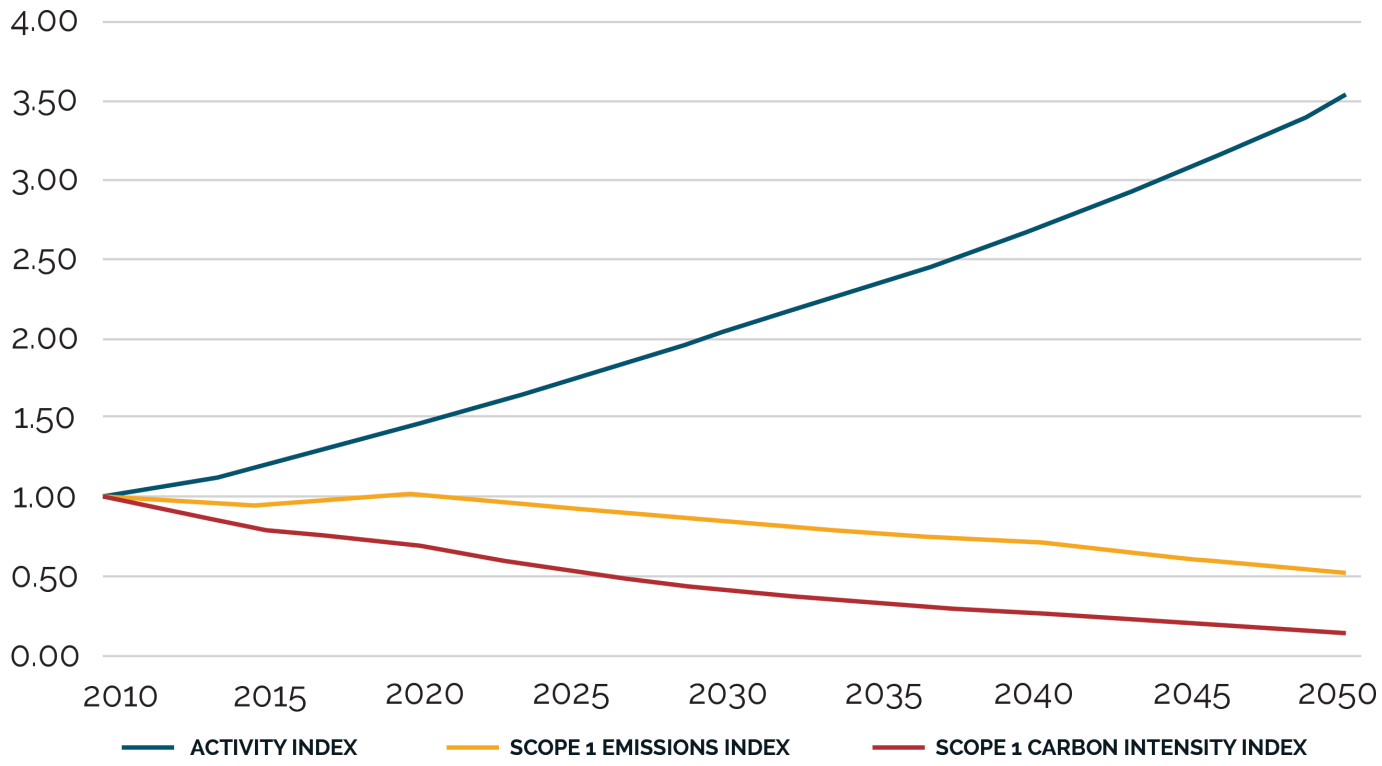


Figure I.12 Freight (other) transit will grow, but both emissions and CO2 intensity can decline with new fuels
Source: based on IEA, 2014

13. Service buildings

All companies of which most of their CO2 emissions arise from buildings, are included in this sector. Examples are trade, finance, real estate, public administration, health, food, lodging, education and commercial services. Energy use in this sector includes space heating and cooling, water heating, lighting, appliances (HVAC is the technical term), and miscellaneous equipment (such as office equipment and other small plug loads in the service sectors). Heating and cooling has the largest contribution to GHG emissions (Girod et al., 2014).

13.1 Activity level

Since heating and cooling are the source of GHG emissions in the service building sector the square meter was used as the activity parameter. In 2010, this sector entailed about 38 billion square meters, and is expected to grow by 66 percent by 2050, reaching 63 billion square meters.

13.2 Emission reduction potential

CO2 emissions are expected to decrease from 870 Mt in 2010 to 645 Mt in 2050, a reduction of 26 percent.There is a large potential to reduce emissions in this sector, without changing the comfort level of the buildings or requiring businesses to reduce the number of appliances and electronic equipment. Most reductions will be due to increased insulation, electrification of the offices, more energy efficient appliances, and an increase in the use of renewable energy. Tapping into this potential will be different for developed and developing countries (IEA, 2012a). In developed countries retrofitting existing building stock can significantly reduce CO2 emissions. In developing countries many new buildings are being built, which offers opportunities to reduce emissions through improved efficiency standards.

13.3 CO2 intensity pathway

The emission pathway shows a small increase up to 2020, but a reduction by a quarter over 2010 to 2050. Over the same period the square meters of service buildings increases by two-thirds. This results in a CO2 intensity decrease of 55 percent by 2050 compared with 2010.

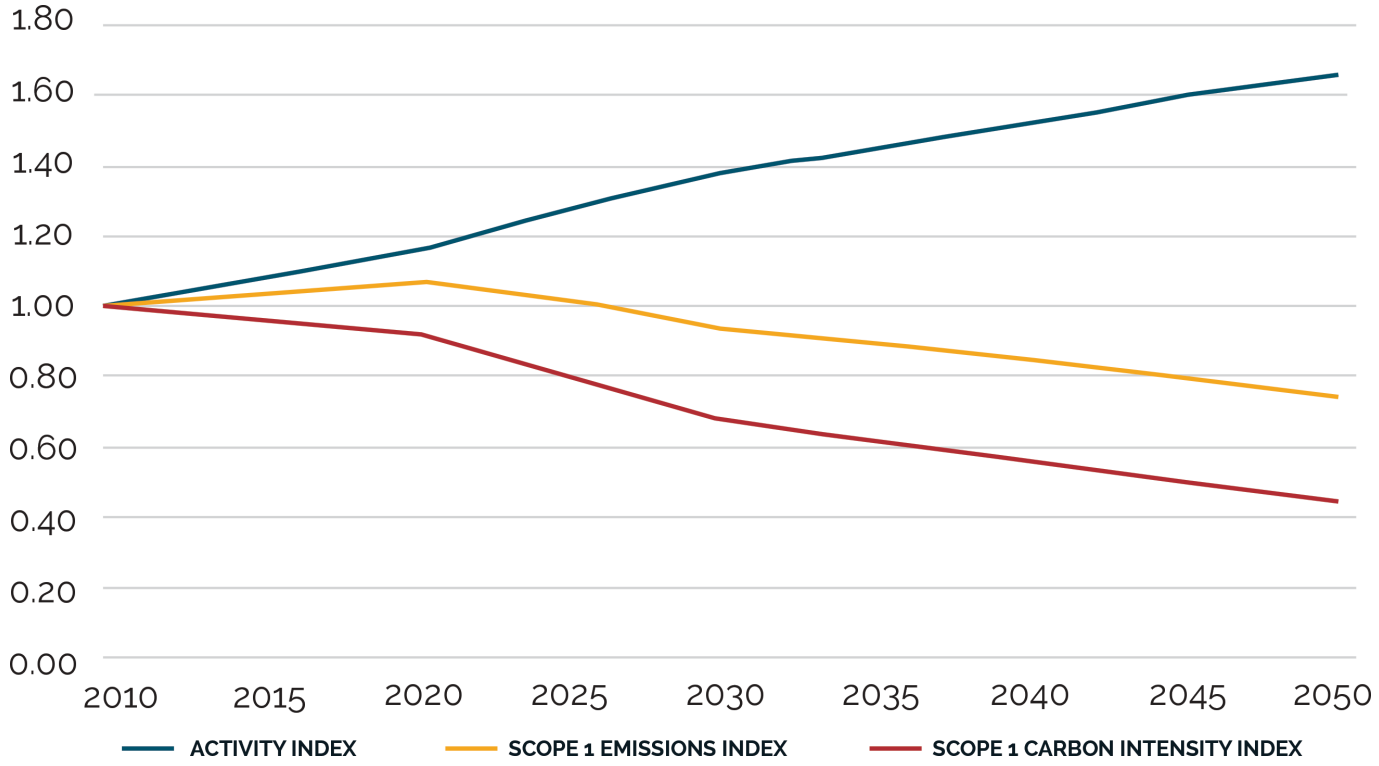


Figure I.13 The space in service and office buildings will increase by two thirds, but the CO2 intensity is modelled to decline by 55 percent because of more efficient fuels for heating, cooling, and electricity
Source: based on IEA, 2014

APPENDIX II: SECTOR DATA

Tables II.1, II.2 and II.3 show the data retrieved from ETP 2014.[1] The (linearly) interpolated values are printed in italics.

1 DISCLAIMER © OECD/IEA 2014, ETP 2014 data, IEA Publishing. Licence: http://www.iea.org/t&c/termsandconditions/. Authorisation to use and distribute data in this report is being cleared with the IEA. Full data will be provided upon clearance from IEA.

Table II.1: CO_2 emissions per sector in the International Energy Agency's 2 Degree Scenario

No.	Sector	Unit	2010	2011	2015	2020	2025	2030	2035	2040	2045	2050
1	Power generation	$MtCO_2$	13,152									1,151
2	Cement	$MtCO_2$	2,119									1,692
3	Iron and steel	$MtCO_2$	2,955									2,044
4	Pulp and paper	$MtCO_2$	239									164
5	Aluminum	$MtCO_2$	141									333
6	Chemicals and petrochemicals	$MtCO_2$	1,185									1,987
7	Other industry	$MtCO_2$	1,909									903
8	Aviation passenger transport	$MtCO_2$	755									1,020
9	Light road passenger transport	$MtCO_2$	2,895									1,230
10	Heavy road passenger transport	$MtCO_2$	356									315
11	Rail passenger transport	$MtCO_2$	19									23
12	Other transport	$MtCO_2$	2,788									1,445
13	Service buildings	$MtCO_2$	870									645

Source: IEA, 2014.

Table II.2: Activity per sector in the International Energy Agency's 2 Degree Scenario

No.	Sector	Activity indicator	2010	2011	2015	2020	2025	2030	2035	2040	2045	2050
1	Power generation	TWh										
2	Cement	Mt cement										
3	Iron and steel	Mt crude steel										
4	Pulp and paper	Mt paper and cardboard										
5	Aluminum	Mt aluminum										
6	Chemicals and petrochemicals	GDP%										
7	Other industry	GDP%										
8	Aviation passenger transport	Billion pkm										
9	Light road passenger transport	Billion pkm										
10	Heavy road passenger transport	Billion pkm										
11	Rail passenger transport	Billion pkm										
12	Other transport	GDP%										
13	Service buildings	million m^2 floor area										

FULL DATA WILL BE PROVIDED UPON CLEARANCE FROM IEA

Source: IEA, 2014.

Table II.3: Electricity use per sector in the International Energy Agency's 2 Degree Scenario

No.	Sector	Unit	2010	2011	2015	2020	2025	2030	2035	2040	2045	2050
1	Power generation	TWh										
2	Cement	TWh										
3	Iron and steel	TWh										
4	Pulp and paper	TWh										
5	Aluminum	TWh										
6	Chemicals and petrochemicals	TWh										
7	Other industry	TWh										
8	Aviation passenger transport	TWh										
9	Light road passenger transport	TWh										
10	Heavy road passenger transport	TWh										
11	Rail passenger transport	TWh										
12	Other transport	TWh										
13	Service buildings	TWh										

Source: IEA, 2014.

Sectoral targets

Table II.4 shows the intensity pathways for the base year 2011 and for 5-year intervals from 2015 to 2050. The pathways are calculated from the data shown in section 4.5 as described in section 4.4.

Table II.4 Sectoral CO2 intensity pathways distilled from the 2 Degree Scenario

No.	Sector	Unit	Scope	2010	2011	2015	2020	2025	2030	2035	2040	2045	2050
1	Power generation	gCO_2/kWh	1										
2	Cement	tCO_2/t cement	1										
			2										
3	Iron and steel	tCO_2/t crude steel	1										
			2										
4	Pulp and paper	tCO_2/t paper and cardboard	1										
			2										
5	Aluminum	tCO_2/t aluminum	1										
			2										
6	Chemicals and petrochemicals	2011%	1										
			2										
7	Other industry	2011%	1										
			2										
8	Aviation passenger transport	gCO_2/pkm	1										
			2										
9	Light road passenger transport	gCO_2/pkm	1										
			2										
10	Heavy road passenger transport	gCO_2/pkm	1										
			2										

11	Rail passenger transport	gCO2/ pkm	1	7.22									2.45
			2	15.21									0.62
12	Other transport	gCO2/$ value added	1	1.05									0.15
			2	1.05									0.08
13	Service buildings	kgCO2/ m2/year	1	23.12									10.32
			2	67.16									2.88

FULL DATA WILL BE PROVIDED UPON CLEARANCE FROM IEA

Source: IEA, 2014

APPENDIX III: SCOPE 3

This section provides background on Scope 3 and an explanation on how Scope 3 emissions should be treated under this version 1.0 of the SDA methodology. Further details and improvements regarding Scope 3 are expected to be developed for the next version of the methodology.

The GHG Protocol scopes were designed to prevent double counting of emissions among different companies within Scope 1 and 2 (as long as consistent consolidation approaches are used). Therefore, Scope 1 and/or 2 emissions of companies – excluding the (Scope 1) emissions of utilities – can be aggregated to determine a total of a given region, set of companies, etc. Conversely, Scope 3 by definition contains emissions occurring in the companies' value chain, which are Scope 1 and 2 emissions of other companies and value chain players (like consumers). Therefore, double counting can occur and emissions should not be aggregated over companies (see also section 2.1.8 Double counting).

In contrast to Scopes 1 and 2, target setting on Scope 3 is more complex, because less information on (the most relevant) corporate Scope 3 emissions is available. A recent CDP report on the GHG reports of the 500 largest public companies states that, "Most companies (97%) disclose Scope 1 and 2 emissions from their operations. However, while companies are able to identify the most carbon intensive activities from their value chains, the emissions of nearly half (47%) of these activities are yet to be quantified." The report concludes that "companies often focus on relatively insignificant opportunities for carbon reductions," (CDP, 2013).

Figure III.1 highlights this conclusion by showing that while "use of sold products" is reported by 25 percent of companies, it accounts for 76 percent of reported Scope 3 emissions. Meanwhile, 72 percent of companies report emissions from business travel, which accounts for only 0.2 percent of total reported Scope 3 emissions.

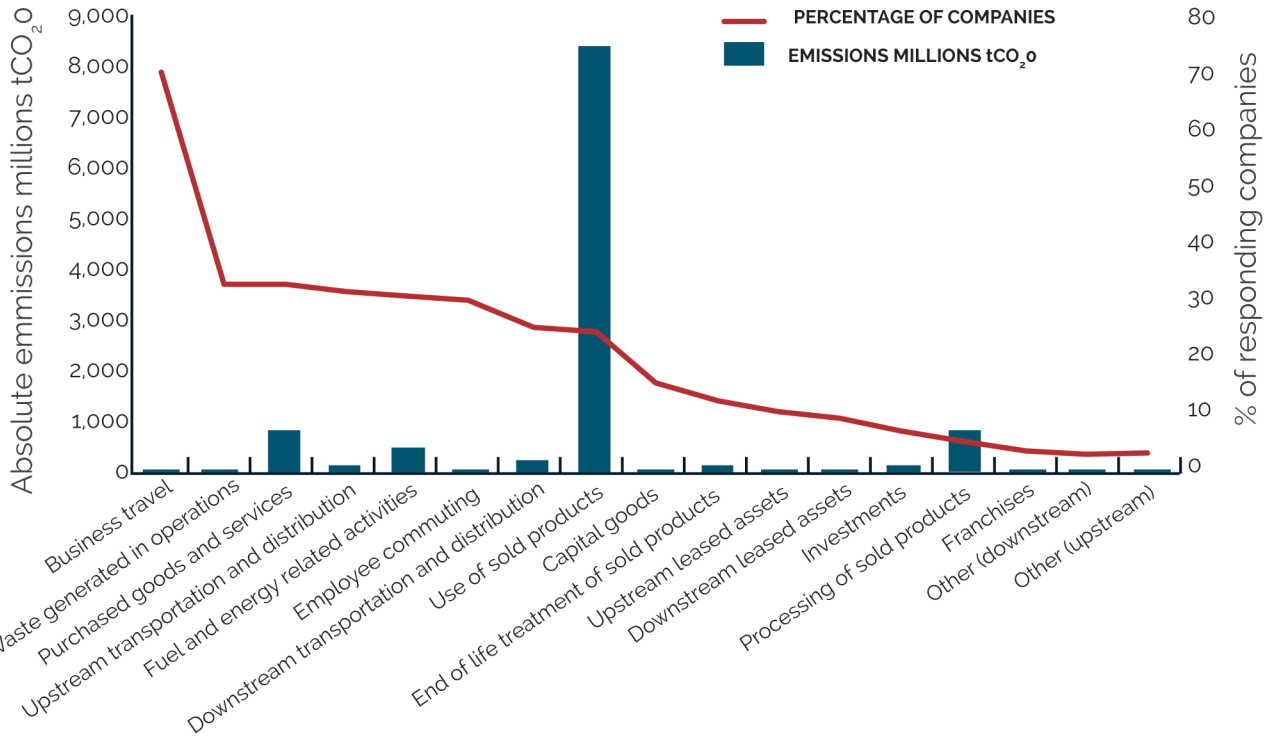


Figure III.1 Scope 3 reporting of Global 500 companies to CDP Source: CDP, 2013.

In addition, Scope 3 emission calculations often show higher uncertainty levels, as the activity data and emission factors used may be less specific. For example, while the emission factors for combustion of fuels (Scope 1) are fixed and fuel use is often measured in detail, the exact carbon footprint of purchased materials can be less straightforward. This footprint can depend largely on the supplier and production process used, thus generic and average emission factors are often used. The same often occurs with transport-related emissions where an average emission factor per tonne kilometer are used because fuel use is not separately tracked per customer (yet) by large logistical companies.

For many companies insight into their value chain, or Scope 3 emissions is relevant. Many companies have or want to set Scope 3 targets. For companies in energy-intensive industries (like material production) Scopes 1 and 2 emissions are often most significant. But, for example, companies selling energy-using products (e.g., equipment, cars) or purchasing materials from energy-intensive sectors, Scope 3 emissions are more relevant. The GHG Protocol Scope 3 standard states: "Scope 3 emissions can represent the largest source of emissions for companies and can present the most significant opportunities to influence GHG reductions and achieve a variety of GHG-related business objectives. Developing a full corporate GHG emissions inventory enables companies to understand their full emissions impact across the value chain and focus efforts where they can have the greatest impact," (GHG Protocol, 2011).

The current methodology contains information to assist setting Scope 3 targets in line with a 2˚C pathway. In fact, many Scope 3 emissions are caused by suppliers or other value chain partners from sectors currently covered by the methodology. The target setting for those sectors could be translated to specific company Scope 3 targets.

An overview of the way the current methodology can cover some of the Scope 3 categories is shown in Table III.1.

Table III.1. Use of the methodology to set Scope 3 targets

Scope 3 category	Direction to set targets in line with a 2˚C pathway
Category 1: Purchased goods and services	Set target based on the 2 ˚C pathway of the applicable supplier sector (e.g. the chemical sector for companies purchasing chemical compounds).
Category 2: Capital goods	Set target based on the 2˚C pathway of the applicable supplier sector.
Category 3: Fuel- and energy-related activities	Not covered in current methodology.
Category 4: Upstream transportation and distribution	Set target based on 2˚C pathway of light passenger transport sector.
Category 5: Waste generated in operations	Parts of the waste disposal process, like transport and waste management services, can be covered by the methodology. Incineration or landfill emissions are not covered by the current methodology.
Category 6: Business travel	Set target based on the 2˚C pathway of the light passenger transport and aviation sector.
Category 7: Employee commuting	Set target based on the 2˚C pathway of the light passenger transport sector.
Category 8: Upstream leased assets	Set target based on the 2˚C pathway of the service buildings sector.
Category 9: Downstream transportation and distribution	Set target based on the 2˚C pathway of the light passenger transport and aviation sector.
Category 10: Processing of sold products	Not covered in current methodology.
Category 11: Use of sold products	Besides the use of light duty vehicles, Scope 3 emissions of other sold products are not covered in current methodology, and target setting is not yet possible. However some aspects related to the emissions of sold products are included in the background of the methodology: - General energy efficiency improvements will reduce the impact per sold product and are included in the scenario's for final energy demand per year; - Increased renewable energy production will in time reduce the emissions per sold product.
Category 12: End-of-life treatment of sold products	Not covered in current methodology.
Category 13: Downstream leased assets	Set target based on the 2˚C pathway of applicable sector of the franchisee (like for instance service/commercial buildings).
Category 14: Franchises	Set target based on the 2˚C pathway of applicable sector of the franchisee (like for instance service/commercial buildings).
Category 15: Investments	This category is specifically targeted toward financial institutions where the majority of emissions are related to their investing and lending activities. Targets can be set based on the 2˚C pathway of applicable sector of the investee.

APPENDIX IV: REPRESENTATIVE CONCENTRATION PATHWAY 2.6 (RCP 2.6) SCENARIO

The Representative Concentration Pathway 2.6 scenario (RCP 2.6) was developed by a scientific team at the PBL Netherlands Environmental Assessment Agency, headed by scientist Detlef van Vuuren.

The scenario was created using the IMAGE model (Bouwman, Kram, & Goldewijk, 2006), an assessment framework consisting of a set of linked and integrated submodels. The framework describes important elements in the long-term dynamics of global environmental change such as air pollution, climate change, and land-use change.

Three major steps can be distinguished in the IMAGE methodology (Figure IV.14):

1. The baseline emission scenario was constructed based on the energy and land use submodels of IMAGE. Other outputs are information on the abatement potential and costs of GHG emissions from the energy and land-use systems.

2. Pathways were developed toward long-term stabilization of the atmospheric greenhouse gas concentration. This was done by the FAIR-SiMCaP model. As part of this step, the FAIR model determined the abatement cost and global emission reduction from the baseline scenario, assuming a cost-optimal implementation of available reduction options over the different regions.

3. The full IMAGE model framework implemented the changes in emission levels resulting from the abatement actions and the carbon price to develop the final mitigation scenario.

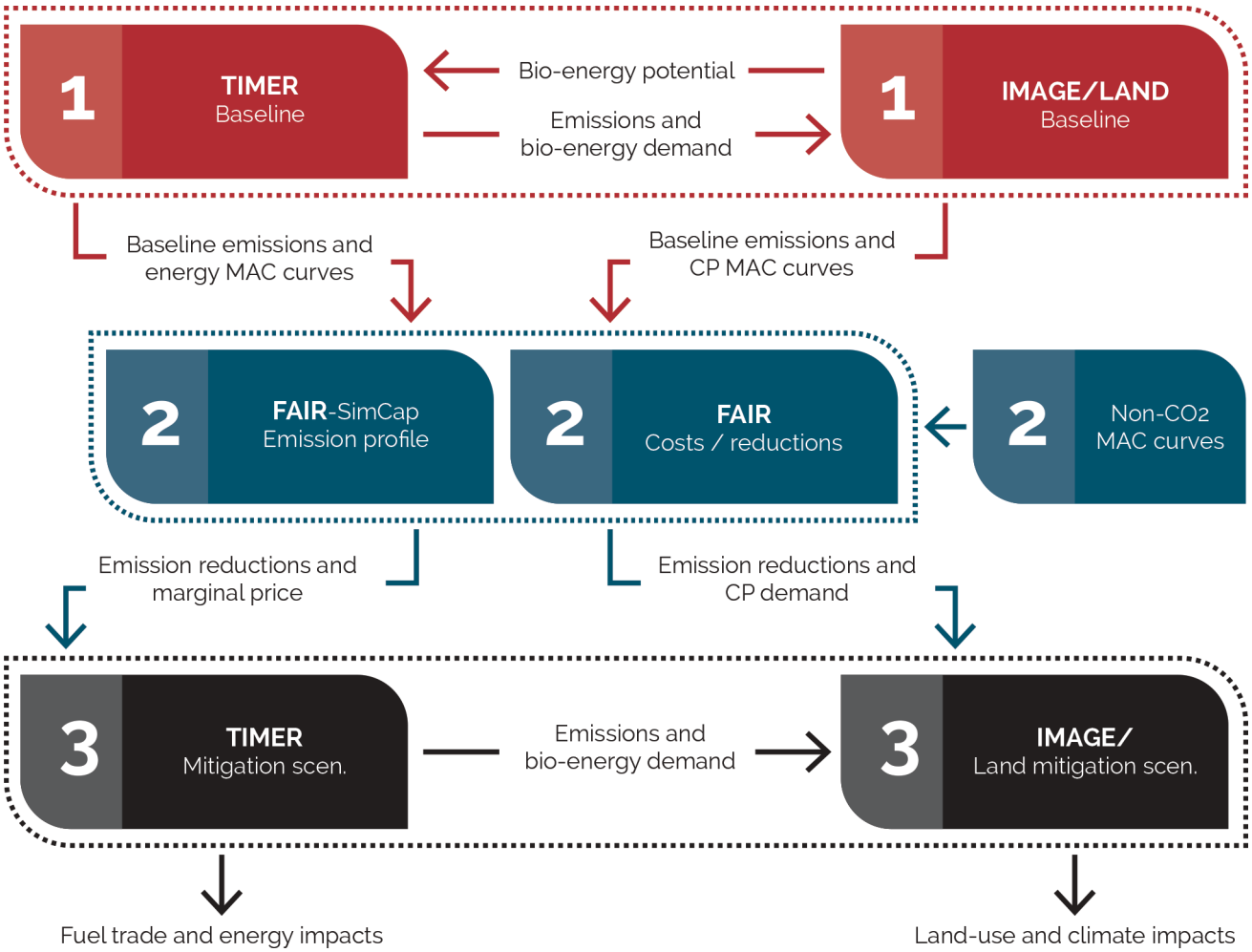


Figure IV.1 Overall methodology for creating RCP2.6.

Main characteristics and assumptions:

- It is representative of the literature on mitigation scenarios aiming to limit the increase of global mean temperature to 2°C.
- It is the Representative Concentration Pathway scenario with the highest likelihood to reach this goal.
- It is technically feasible based on the IMAGE integrated assessment modelling framework from a medium emission baseline scenario, assuming broad participation of countries and sectors.
- It uses marginal abatement costs to ensure least-cost optimization. These are direct costs and do not capture any macroeconomic feedback.
- A cost-optimal implementation of available reduction options over the different regions is assumed.
- The model framework includes both the energy system and land-use change.
- Bioenergy and carbon capture and storage are assumed to be viable technological solutions in the future. It includes abatement through climate policy frameworks.
- It models CO2 emissions and other greenhouse gases.
- The energy demand is modelled using the TIMER submodel, which makes a distinction among five sectors: industry, transport, residential, services, and other.

The scenario gives annual outcomes until 2100 and uses the year 2000 as its base year.

APPENDIX V: ENERGY TECHNOLOGY PERSPECTIVES (ETP) - 2 DEGREE SCENARIO (2DS)

The International Energy Agency (IEA) developed a similar low carbon scenario in its Energy Technology Perspectives (ETP) report (IEA, 2014). This extensive scenario shows a pathway consistent with the Representative Concentration Pathway 2.6 (RCP 2.6) scenario (Schaeffer & van Vuuren, 2012). ETP's 2DS scenario includes roadmaps for specific sectors and energy-intensive industries to reach the goals in the scenario and translates the findings of the ETP into policies and technology focus areas (IEA, 2012b, 2013a, 2013b, 2013c, 2013d).

The scenario was created using the ETP-TIMES model (IEA, 2014) and used to determine the least-cost technology mix needed to meet the final demand for three sectors: industry, transport, and buildings. Figure V.1 shows the structure of the ETP-model.

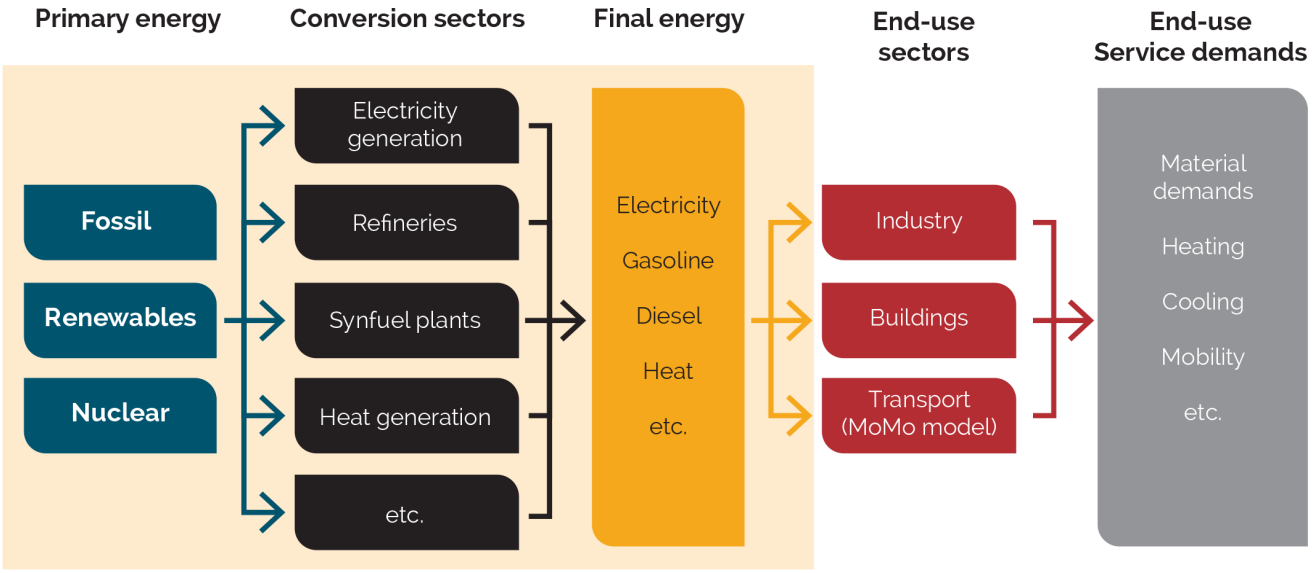


Figure V.1. Structure of the ETP model.
Notes: The scheme with the pale yellow background shows the ETP-TIMES model (The Integrated MARKAL-EFOM System). This TIMES model provides information for the specific end-use sectors.

ETP-TIMES is the state-of-the-art in modelling energy technologies, used by more than 250 groups in 70 countries. Both TIMES and its predecessor MARKAL were developed through the IEA's Energy Technology Systems Programme (ETSAP) set up more than 30 years ago. The ETP-TIMES model starts from primary energy supply and conversion to final energy demand up to 2075 (Figure 16). It models the current situation in the conversion sectors (e.g. existing capacity stock, operating costs, and conversion efficiencies) and then integrates the technical and economic characteristics of existing technologies that can be added to the energy system. In this way it can then determine the least-cost technology mix needed to meet the final demand. This final demand is determined by the submodels of the specific end-use sectors.

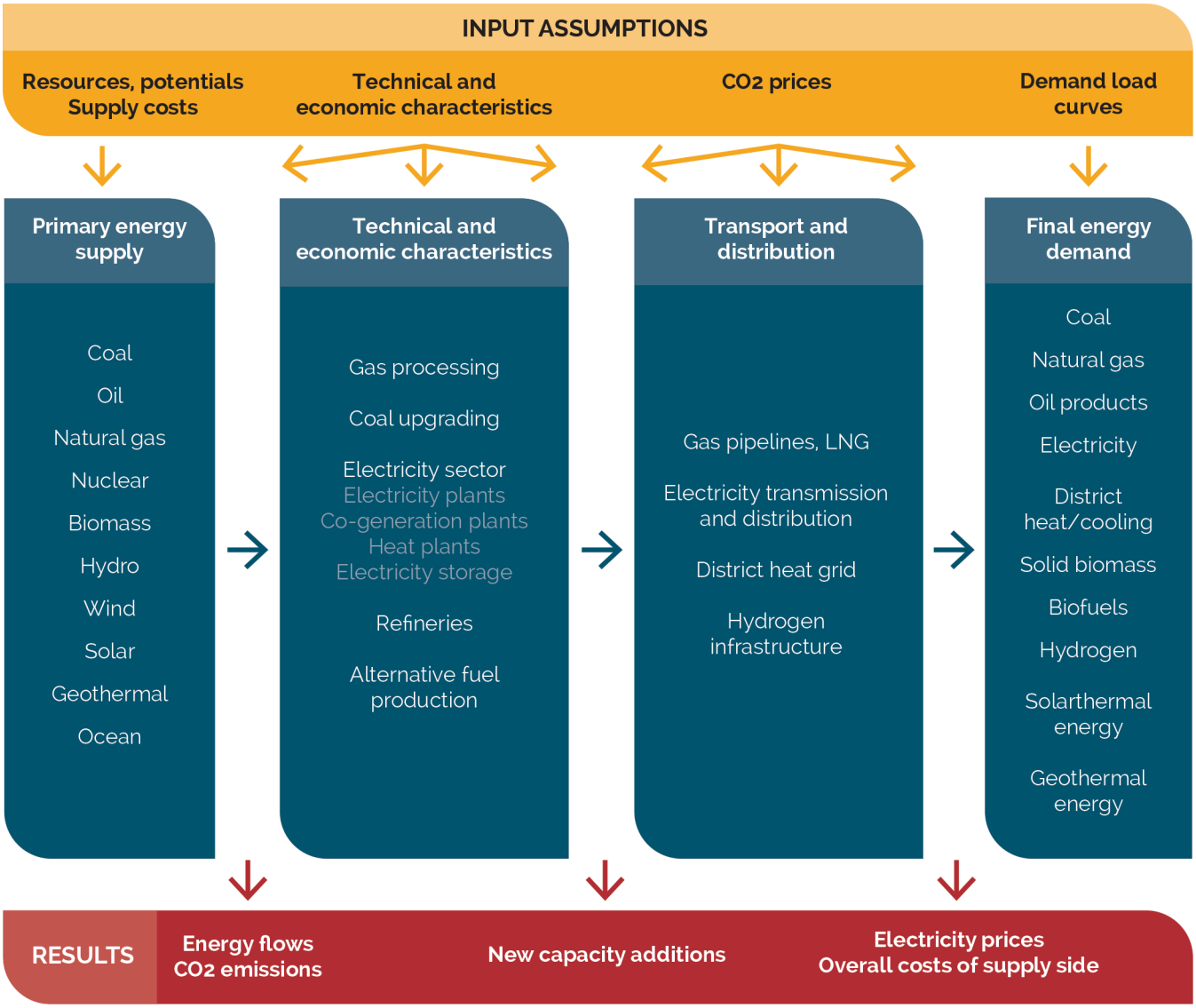


Figure V.2 The model ETP-TIMES.
Note: This model is designed to determine the least-cost strategy in terms of supply-side technologies and fuels to cover the final demand vector from the end-use sector models
Source: IEA, 2014.

Main characteristics and assumptions:

- The ETP2014 pathway and the RCP 2.6 scenario provide a similar CO2 budget over time.
- IEA ETP 2DS scenario was created using the ETP-TIMES model, which is state-of-the-art in modelling energy technologies, used by more than 250 groups in 70 countries and is revised and updated regularly by a large network of collaborators
- The ETP model enables a technology-rich, bottom-up analysis of the global energy system and covers 28 regions.
- The model is designed for a cost-effective transition to a sustainable energy system using marginal abatement costs.
- All technology options introduced in the ETP 2014 pathway are commercially available or at a stage of development that makes commercial-scale deployment possible within the scenario period.
- The sectors "industry," "buildings," and "transport" are modelled in more detail to determine the final demand (bottom-up). Industry is modelled in five energy-intensive subsectors (cement, steel, paper, chemicals, and aluminum) using stock accounting spreadsheets. This method is also used for modelling the buildings sector. The transport sector is modelled with the Mobility Model (MoMo). These sector models determine the end-use service demands (e.g. material demands, heating, cooling)
- Subtleties are not and cannot be captured in the cost optimization framework: like political preferences, feasible ramp-up rates, capital constraints, and public acceptance. To increase the robustness of the model, a portfolio

of technologies are analyzed within a framework of cost minimization.

- The 2DS scenario was built on the assumption that economic growth is decoupled from demand for energy and materials. This is possible through technological developments and behavioral change (e.g. consumption of services substituting for consumption of physical goods) (IEA, 2012a, 2014).
- The model works in five-year time steps and uses 2011 as its base year.

Draft for Public Consultation | September 2014

APPENDIX VI: SECTOR DEFINITIONS

IEA Sector	SDA Sector	Subsector	Description	Global Industry Classification Standard subindustry		Global Industry Classification Standard descriptions
Power Generation			Includes power and heat generation when primary business activity and their own energy use and losses.	55101010	Electric Utilities	Companies that produce or distribute electricity. Includes both nuclear and nonnuclear facilities.
				55103010	Multi-Utilities	Utility companies with significantly diversified activities in addition to core electric utility, gas utility and/or water utility operations.
				55105010	Independent Power Producers & Energy Traders	Companies that operate as Independent Power Producers (IPPs), gas and power marketing and trading specialists and/or integrated energy merchants. Excludes producers of electricity using renewable sources, such as solar power, hydropower, and wind power. Also excludes electric transmission companies and utility distribution companies classified in the electric utilities sub-industry.
				55105020	Renewable Electricity	Companies that engage in the generation and distribution of electricity using renewable sources, including, but not limited to, companies that produce electricity using biomass, geothermal energy, solar energy, hydropower, and wind power. Excludes companies manufacturing capital equipment used to generate electricity using renewable sources, such as manufacturers of solar power systems, installers of photovoltaic cells, and companies involved in the provision of technology, components, and services mainly to this market.

IEA Sector	SDA Sector	Subsector	Description	Global Industry Classification Standard subindustry		Global Industry Classification Standard descriptions
Industry	Iron & Steel Industry		Includes basic transformation of iron ore to iron as well as foundry processes such as iron casting and molding. ISIC codes 241, Manufacture of basic iron and steel and 2431, Casting of iron and steel apply to this category.	15104050	Steel	Producers of iron and steel and related products, including metallurgical (coking) coal mining used for steel production.
	Cement		Includes activities related with the production of clinker, cement and cementitious materials by the mixture of ground clincker with specific additives. ISIC code 2394, Manufacture of cement, lime and plaster, apply with exclusion of dedicated/ exclusive production of lime and plaster.	15102010	Construction Materials	Manufacturers of construction materials including sand, clay, gypsum, lime, aggregates, cement, concrete, and bricks. Other finished or semifinished building materials are classified in the building products sub-industry.
	Chemical and Petrochemical Industry		Includes all major industrial chemical production, with the exception of oil and gas refineries for energy purposes. ISIC Division 20, Manufacture of chemicals and chemical products apply. Certain activities of ISIC Division 21, Manufacture of pharmaceuticals, medicinal chemical and botanical products can also apply (agricultural chemicals).	15101010	Commodity Chemicals	Companies that primarily produce industrial chemicals and basic chemicals. Including but not limited to plastics, synthetic fibers, films, commodity-based paints and pigments, explosives and petrochemicals. Excludes chemical companies classified in the diversified chemicals, fertilizers and agricultural chemicals, industrial gases, or specialty chemicals sub-industries.
				15101020	Diversified Chemicals	Manufacturers of a diversified range of chemical products not classified in the industrial gases, commodity chemicals, specialty chemicals or fertilizers and agricultural chemicals sub-industries.
				15101030	Fertilizers and Agricultural Chemicals	Producers of fertilizers, pesticides, potash or other agriculture-related chemicals not classified elsewhere.
				15101040	Industrial Gases	Manufacturers of industrial gases.

IEA Sector	SDA Sector	Subsector	Description	Global Industry Classification Standard subindustry		Global Industry Classification Standard descriptions
Industry				15101050	Specialty Chemicals	Producers of iron and steel and related products, Companies that primarily produce high value-added chemicals used in the manufacture of a wide variety of products, including but not limited to fine chemicals, additives, advanced polymers, adhesives, sealants and specialty paints, pigments and coatings.(coking) coal mining used for steel production.
	Aluminum		Includes both production of aluminum from alumina (primary aluminum) and secondary aluminum production and of aluminum alloys. ISIC Code 2420, Manufacture of basic precious and other non-ferrous metals applies, where aluminum related activities are concerned. Bauxite mining activities and aluminum casting/profile production activities are not included.	15104010	Aluminum	Producers of aluminum and related products, including companies that mine or process bauxite and companies that recycle aluminum to produce finished or semifinished products. Excludes companies that primarily produce aluminum building materials classified in the Building Products Sub-Industry.
	Pulp & Paper		Includes the production of bleached, semibleached or unbleached paper pulp by mechanical, chemical or semichemical processes, as well as, production of paper and paperboard intended for further industrial processing. ISIC code 1701, manufacture of pulp, paper and paperboard applies.	15105020	Paper Products	Manufacturers of all grades of paper. Excludes companies specializing in paper packaging classified in the paper packaging sub-industry.

IEA Sector	SDA Sector	Subsector	Description	Global Industry Classification Standard subindustry		Global Industry Classification Standard descriptions
Industry	Other Industry	Non-ferrous metals basic industries	Includes production of precious metals and their alloys, production od lead, zinc and tin and their alloys, production of copper and its alloys, as well all other non-iron metals and their alloys. ISIC code 2420, Manufacture of basic precious and other non-ferrous metals applies with exception of aluminum activities and code 2432, Casting of non-ferrous metals.	15104020	Diversified Metals and Mining	Companies engaged in the diversified production or extraction of metals and minerals not classified elsewhere. Including, but not limited to, nonferrous metal mining (except bauxite), salt and borate mining, phosphate rock mining, and diversified mining operations. Excludes iron ore mining, classified in the steel sub-industry, bauxite mining, classified in the aluminum sub-industry, and coal mining, classified in either the steel or coal and consumable fuels sub-industries.
				15104030	Gold	Producers of gold and related products, including companies that mine or process gold and the South African finance houses that primarily invest in, but do not operate, gold mines.
				15104040	Precious Metals and Minerals	Companies mining precious metals and minerals not classified in the gold sub-industry. Includes companies primarily mining platinum.
				15104045	Silver	Companies primarily mining silver. Excludes companies classified in the gold or precious metals and minerals sub-industries.
		Manufacture of other non-metallic mineral products	Includes glass, ceramics and others non-metallic mineral products, including dedicated lime and gypsum production. ISIC Division 23, Manufacture of other non-metallic mineral products will aply with exception of cement production.	15102010	Construction Materials	Manufacturers of construction materials including sand, clay, gypsum, lime, aggregates, cement, concrete and bricks. Other finished or semi-finished building materials are classified in the Building Products Sub-Industry.
				15103010	Metal and Glass Containers	Manufacturers of metal, glass or plastic containers. Includes corks and caps.
				25201050	Housewares and Specialties	Manufacturers of durable household products, including cutlery, cookware, glassware, crystal, silverware, utensils, kitchenware and consumer specialties not classified elsewhere.

IEA Sector	SDA Sector	Subsector	Description	Global Industry Classification Standard subindustry		Global Industry Classification Standard descriptions
Industry	Other Industry	Manufacture of motor vehicles, trailers, semi-trailers and other transport equipment	General manufacture of transport equipment including manufacture of motor vehicles for transporting passengers or freight, the manufacture of various parts and accessories, as well as the manufacture of trailers and semi-trailers, transportation equipment such as ship building and boat manufacturing, the manufacture of railroad rolling stock and locomotives, air and spacecraft and the manufacture of parts thereof, as well as . ISIC Division 29, Manufacture of motor vehicles, trailers and semi-trailers and 30, Manufacture of other transport equipment applies.	20106010	Construction Machinery and Heavy Trucks	Manufacturers of heavy duty trucks, rolling machinery, earth-moving and construction equipment, and manufacturers of related parts. Includes non-military shipbuilding.
				20106015	Agricultural and Farm Machinery	Companies manufacturing agricultural machinery, farm machinery, and their related parts. Includes machinery used for the production of crops and agricultural livestock, agricultural tractors, planting and fertilizing machinery, fertilizer and chemical application equipment, and grain dryers and blowers.
				25101010	Auto Parts and Equipment	Manufacturers of parts and accessories for automobiles and motorcycles. Excludes companies classified in the Tires & Rubber Sub-Industry.
				25102010	Automobile Manufacturers	Companies that produce mainly passenger automobiles and light trucks. Excludes companies producing mainly motorcycles and three-wheelers classified in the motorcycle manufacturers sub-industry and heavy duty trucks classified in the construction machinery and heavy trucks sub-industry.
				25102020	Motorcycle Manufacturers	Companies that produce motorcycles, scooters or three-wheelers. Excludes bicycles classified in the leisure products sub-industry.
		Manufacture of fabricated metal products	Includes ISIC Division 25, Manufacture of fabricated metal products, except machinery and equipment which includes the manufacture of "pure" metal products (such as parts, containers and structures), usually with a static, immovable function, as opposed to divisions 26-30, which cover the manufacture of combinations or assemblies of such metal products (sometimes with other materials) into more complex units that, unless they are purely electrical, electronic or optical, work with moving parts.	15103010	Metal and Glass Containers	Manufacturers of metal, glass or plastic containers. Includes corks and caps.
				20101010	Aerospace and Defense	Manufacturers of civil or military aerospace and defense equipment, parts or products. Includes defense electronics and space equipment.
				20102010	Building Products	Manufacturers of building components and home improvement products and equipment. Excludes lumber and plywood classified under forest products and cement and other materials classified in the construction materials sub-industry.

IEA Sector	SDA Sector	Subsector	Description	Global Industry Classification Standard subindustry		Global Industry Classification Standard descriptions
Industry	Other Industry	Manufacture of computer, electronic and optical products	Includes the manufacture of computers, computer peripherals, communications equipment, and similar electronic products, as well as the manufacture of components for such products. Also contains the manufacture of consumer electronics, measuring, testing, navigating, and control equipment, irradiation, electromedical and electrotherapeutic equipment, optical instruments and equipment, and the manufacture of magnetic and optical media. Corresponds to ISIC Division 26, Manufacture of computer, electronic and optical products.	25201010	Consumer Electronics	Manufacturers of consumer electronics products including TVs, home audio equipment, game consoles, digital cameras, and related products. Excludes personal home computer manufacturers classified in the technology hardware, storage, and peripherals sub-industry, and electric household appliances classified in the household appliances sub-industry.
				25201040	Household Appliances	Manufacturers of electric household appliances and related products. Includes manufacturers of power and hand tools, including garden improvement tools. Excludes TVs and other audio and video products classified in the consumer electronics sub-industry and personal computers classified in the technology hardware, storage, and peripherals sub-industry.
				45201020	Commu-nications Equipment	Manufacturers of communication equipment and products, including LANs, WANs, routers, telephones, switchboards and exchanges. Excludes cellular phone manufacturers classified in the technology hardware, storage and peripherals sub-industry.
				45202030	Technology Hardware, Storage, and Peripherals	Manufacturers of cellular phones, personal computers, servers, electronic computer components and peripherals. Includes data storage components, motherboards, audio and video cards, monitors, keyboards, printers, and other peripherals. Excludes semiconductors classified in the semiconductors sub-industry.
				45203010	Electronic Equipment, and Instruments	Manufacturers of electronic equipment and instruments including analytical, electronic test and measurement instruments, scanner/barcode products, lasers, display screens, point-of-sales machines, and security system equipment.
				45203015	Electronic Components	Manufacturers of electronic components. Includes electronic components, connection devices, electron tubes, electronic capacitors and resistors, electronic coil, printed circuit board, transformer and other inductors, signal processing technology/components.
				45203020	Electronic Manufactur-ing Services	Producers of electronic equipment mainly for the OEM (Original Equipment Manufacturers) markets.

IEA Sector	SDA Sector	Subsector	Description	Global Industry Classification Standard subindustry		Global Industry Classification Standard descriptions
Industry	Other Industry			45301010	Semiconductor Equipment	Manufacturers of semiconductor equipment, including manufacturers of the raw material and equipment used in the solar power industry.
				45301020	Semiconductors	Manufacturers of semiconductors and related products, including manufacturers of solar modules and cells.
		Manufacture of electrical equipment	Includes the manufacture of products that generate, distribute and use electrical power, as well as manufacture of electrical lighting, signaling equipment and electric household appliances. Corresponds to ISIC Division 26, Manufacture of electrical equipment.	20104010	Electrical Components & Equipment	Companies that produce electric cables and wires, electrical components or equipment not classified in the Heavy Electrical Equipment Sub-Industry.
				20104020	Heavy Electrical Equipment	Manufacturers of power-generating equipment and other heavy electrical equipment, including power turbines, heavy electrical machinery intended for fixed-use and large electrical systems. Excludes cables and wires, classified in the Electrical Components & Equipment Sub-Industry.
				20106020	Industrial Machinery	Manufacturers of industrial machinery and industrial components. Includes companies that manufacture presses, machine tools, compressors, pollution control equipment, elevators, escalators, insulators, pumps, roller bearings and other metal fabrications.
				25201010	Consumer Electronics	Manufacturers of consumer electronics products including TVs, home audio equipment, game consoles, digital cameras, and related products. Excludes personal home computer manufacturers classified in the Technology Hardware, Storage & Peripherals Sub-Industry, and electric household appliances classified in the Household Appliances Sub-Industry.
				25201040	Household Appliances	Manufacturers of electric household appliances and related products. Includes manufacturers of power and hand tools, including garden improvement tools. Excludes TVs and other audio and video products classified in the Consumer Electronics Sub-Industry and personal computers classified in the Technology Hardware, Storage & Peripherals Sub-Industry.

IEA Sector	SDA Sector	Subsector	Description	Global Industry Classification Standard subindustry		Global Industry Classification Standard descriptions
Industry	Other Industry	Manufacture of machinery and equipment	Includes the manufacture of machinery and equipment that act independently on materials either mechanically or thermally or perform operations on materials (such as handling, spraying, weighing or packing), including their mechanical components that produce and apply force, and any specially manufactured primary parts. This includes the manufacture of fixed and mobile or hand-held devices, regardless of whether they are designed for industrial, building and civil engineering, agricultural or home use. Corresponds to ISIC Division 28, Manufacture of machinery and equipment n.e.c.	20106020	Industrial Machinery	Manufacturers of industrial machinery and industrial components. Includes companies that manufacture presses, machine tools, compressors, pollution control equipment, elevators, escalators, insulators, pumps, roller bearings and other metal fabrications.
				25201010	Consumer Electronics	Manufacturers of consumer electronics products including TVs, home audio equipment, game consoles, digital cameras, and related products. Excludes personal home computer manufacturers classified in the Technology Hardware, Storage & Peripherals Sub-Industry, and electric household appliances classified in the Household Appliances Sub-Industry.
				25201040	Household Appliances	Manufacturers of electric household appliances and related products. Includes manufacturers of power and hand tools, including garden improvement tools. Excludes TVs and other audio and video products classified in the Consumer Electronics Sub-Industry and personal computers classified in the Technology Hardware, Storage & Peripherals Sub-Industry.
		Mining and quarring	Includes the extraction of minerals occurring naturally as solids (coal and ores). Extraction can be achieved by different methods such as underground or surface mining, seabed mining, etc. Includes supplementary activities aimed at preparing the crude materials for marketing, for example, crushing, grinding, cleaning, drying, sorting, concentrating ores and agglomeration of solid fuels. These operations are often carried out by the units that extracted the resource and/or others located nearby. ISIC divisions 05, Mining of coal and lignite; 07, Mining of metal ores; and 08, Other mining and quarrying.	15104010	Aluminum	Producers of aluminum and related products, including companies that mine or process bauxite and companies that recycle aluminum to produce finished or semi-finished products. Excludes companies that primarily produce aluminum building materials classified in the Building Products Sub-Industry.
				15104020	Diversified Metals & Mining	Companies engaged in the diversified production or extraction of metals and minerals not classified elsewhere. Including, but not limited to, nonferrous metal mining (except bauxite), salt and borate mining, phosphate rock mining, and diversified mining operations. Excludes iron ore mining, classified in the Steel Sub-Industry, bauxite mining, classified in the Aluminum Sub-Industry, and coal mining, classified in either the Steel or Coal & Consumable Fuels Sub-Industries.

IEA Sector	SDA Sector	Subsector	Description	Global Industry Classification Standard subindustry		Global Industry Classification Standard descriptions
Industry	Other Industry			15104030	Gold	Producers of gold and related products, including companies that mine or process gold and the South African finance houses which primarily invest in, but do not operate, gold mines.
				15104040	Precious Metals & Minerals	Companies mining precious metals and minerals not classified in the Gold Sub-Industry. Includes companies primarily mining platinum.
				15104045	Silver	Companies primarily mining silver. Excludes companies classified in the Gold or Precious Metals & Minerals Sub-Industries.
		Manufacture of food products	Includes the processing of the products of agriculture, forestry and fishing into food for humans or animals, and includes the production of various intermediate products that are not directly food products. Corresponds to ISIC division 10, Manufacture of food products.	30202030	Packaged Foods & Meats	Producers of packaged foods including dairy products, fruit juices, meats, poultry, fish and pet foods.
		Manufacture of beverages	Includes the manufacture of beverages, such as nonalcoholic beverages and mineral water, manufacture of alcoholic beverages mainly through fermentation, beer and wine, the manufacture of distilled alcoholic beverages and the production of fruit and vegetable juices (ISIC class 1030). ISIC Division 11, Manufacture of beverages, applies.	30201010	Brewers	Producers of beer and malt liquors. Includes breweries not classified in the Restaurants Sub-Industry.
				30201020	Distillers & Vintners	Distillers, vintners and producers of alcoholic beverages not classified in the Brewers Sub-Industry.
				30201030	Soft Drinks	Producers of non-alcoholic beverages including mineral waters. Excludes producers of milk classified in the Packaged Foods Sub-Industry.
		Manufacture of tobacco products	Includes the processing of tobacco into a form suitable for final consumption. Corresponds to ISIC division 12, Manufacture of tobacco products.	30203010	Tobacco	Manufacturers of cigarettes and other tobacco products.

IEA Sector	SDA Sector	Subsector	Description	Global Industry Classification Standard subindustry		Global Industry Classification Standard descriptions
Industry	Other Industry	Manufacture of paper derived products	Includes production of paper and paper products, including corrugated paper and paperboard, paper containers, solid board, sacks and bags of paper, office boxes, household and personal hygiene paper and other cellulose products. Excludes activities already described in "Pulp & Paper". ISIC division 17, Manufacture of paper and paper products, with exclusion of code 1701, Manufacture of pulp, paper, and paperboard, applies.	15103020	Paper Packaging	Manufacturers of paper and cardboard containers and packaging.
				15105020	Paper Products	Manufacturers of all grades of paper. Excludes companies specializing in paper packaging classified in the paper packaging sub-industry.
		Manufacture of wood and cork products	Includes the manufacture of wood products, such as lumber, plywood, veneers, wood containers, wood flooring, wood trusses, and prefabricated wood buildings. The production processes include sawing, planing, shaping, laminating, and assembling of wood products starting from logs that are cut into bolts, or lumber that may then be cut further, or shaped by lathes or other shaping tools. The lumber or other transformed wood shapes may also be subsequently planed or smoothed, and assembled into finished products, such as wood containers. Corresponds to ISIC division 16, Manufacture of wood and of products of wood and cork, except furniture; manufacture of articles of straw and plaiting materials.	15105010	Forest Products	Manufacturers of timber and related wood products. Includes lumber for the building industry.

IEA Sector	SDA Sector	Subsector	Description	Global Industry Classification Standard subindustry		Global Industry Classification Standard descriptions
Industry	Other Industry	Construction industry	Includes general construction and specialized construction activities for buildings and civil engineering works. It includes new work, repair, additions and alterations, the erection of prefabricated buildings or structures on the site and also construction of a temporary nature. General construction is the construction of entire dwellings, office buildings, stores and other public and utility buildings, farm buildings etc., or the construction of civil engineering works such as motorways, streets, bridges, tunnels, railways, airfields, harbours and other water projects, irrigation systems, sewerage systems, industrial facilities, pipelines and electric lines, sports facilities etc. Also included is the repair of buildings and engineering works. Corresponds to ISIC divisions 41, Construction of buildings; 42, Civil engineering and 43, Specialized construction activities .	20102010	Building Products	Manufacturers of building components and home improvement products and equipment. Excludes lumber and plywood classified under Forest Products and cement and other materials classified in the Construction Materials Sub-Industry.
				20103010	Construction & Engineering	Companies engaged in primarily non-residential construction. Includes civil engineering companies and large-scale contractors. Excludes companies classified in the Homebuilding Sub-Industry.
				25201030	Homebuilding	Residential construction companies. Includes manufacturers of prefabricated houses and semi-fixed manufactured homes.
		Manufacture of textiles	Includes preparation and spinning of textile fibers as well as textile weaving, finishing of textiles and wearing apparel, manufacture of made-up textile articles, except apparel (e.g. household linen, blankets, rugs, cordage etc.). Growing of natural fibers is not included as well as manufacturing of synthetic fibers (which is a chemical process). Corresponds to ISIC Division 13, Manufacture of textiles.	25203030	Textiles	Manufacturers of textile and related products not classified in the Apparel, Accessories & Luxury Goods, Footwear or Home Furnishings Sub-Industries.
				25201020	Home Furnishings	Manufacturers of soft home furnishings or furniture, including upholstery, carpets and wall-coverings.

IEA Sector	SDA Sector	Subsector	Description	Global Industry Classification Standard subindustry		Global Industry Classification Standard descriptions
Industry	Other Industry	Manufacture of wearing apparel	Includes all tailoring (ready-to-wear or made-to-measure), in all materials (e.g. leather, fabric, knitted and crocheted fabrics etc.), of all items of clothing (e.g. outerwear, underwear for men, women or children; work, city or casual clothing etc.) and accessories. Correspondens to division 14, Manufacture of wearing apparel.	25203010	Apparel, Accessories and Luxury Goods	Manufacturers of apparel, accessories & luxury goods. Includes companies primarily producing designer handbags, wallets, luggage, jewelry and watches. Excludes shoes classified in the footwear sub-industry.
				25203020	Footwear	Manufacturers of footwear. Includes sport and leather shoes.
				25201020	Home Furnishings	Manufacturers of soft home furnishings or furniture, including upholstery, carpets and wall-coverings.
				25203030	Textiles	Manufacturers of textile and related products not classified in the apparel, accessories and luxury goods, footwear or home furnishings sub-industries.
		Manufacture of leather and related products	Includes dressing and dyeing of fur and the transformation of hides into leather by tanning or curing and fabricating the leather into products for final consumption. It also includes the manufacture of similar products from other materials (imitation leathers or leather substitutes), such as rubber footwear, textile luggage etc. The products made from leather substitutes are included here, since they are made in ways similar to those in which leather products are made (e.g. luggage) and are often produced in the same unit. Corresponds to ISIC division 15, Manufacture of leather and related products.	25203030	Textiles	Manufacturers of textile and related products not classified in the apparel, accessories, and luxury goods, footwear or home furnishings sub-industries.

IEA Sector	SDA Sector	Subsector	Description	Global Industry Classification Standard subindustry		Global Industry Classification Standard descriptions
Industry	Other Industry	Manufacture of rubber and plastics products	Includes the manufacture of rubber products (such as tires, inner tubes, rubber plates, tubes, pipes, hoses, fittings, balloons, brushes, etc) and plastics products (such as plates, sheets, blocks foil, windows, frames, tanks, reservoirs, flooring materials, etc). This does not imply that the manufacture of all products made of these materials is under this sector. Corresponds to ISIC division 22, Manufacture of rubber and plastics products.	25101020	Tires & Rubber	Manufacturers of tires and rubber.
		Manufacture of furniture	Includes the manufacture of furniture and related products of any material except stone, concrete and ceramic. Corresponds to ISIC division 31, Manufacture of furniture.	25201020	Home Furnishings	Manufacturers of soft home furnishings or furniture, including upholstery, carpets and wall-coverings.
		Other manufacturing / processing	Includes all other industrial activities not included in the other industry sectors. Includes activities of ISIC division 32, Other manufacturing.	20101010	Aerospace and Defense	Manufacturers of civil or military aerospace and defense equipment, parts or products. Includes defense electronics and space equipment.
				20102010	Building Products	Manufacturers of building components and home improvement products and equipment. Excludes lumber and plywood classified under Forest Products and cement and other materials classified in the Construction Materials Sub-Industry.
				25201040	Household Appliances	Manufacturers of electric household appliances and related products. Includes manufacturers of power and hand tools, including garden improvement tools. Excludes TVs and other audio and video products classified in the Consumer Electronics Sub-Industry and personal computers classified in the technology hardware, storage and peripherals sub-industry.

IEA Sector	SDA Sector	Subsector	Description	Global Industry Classification Standard subindustry		Global Industry Classification Standard descriptions
Industry	Other Industry			25201040	Household Appliances	Manufacturers of electric household appliances and related products. Includes manufacturers of power and hand tools, including garden improvement tools. Excludes TVs and other audio and video products classified in the Consumer Electronics Sub-Industry and personal computers classified in the technology hardware, storage and peripherals sub-industry.
				25201050	Housewares and Specialties	Manufacturers of durable household products, including cutlery, cookware, glassware, crystal, silverware, utensils, kitchenware and consumer specialties not classified elsewhere.
				25202010	Leisure Products	Manufacturers of leisure products and equipment including sports equipment, bicycles and toys.
				30301010	Household Products	Producers of nondurable household products, including detergents, soaps, diapers and other tissue and household paper products not classified in the paper products sub-industry.
				30302010	Personal Products	Manufacturers of personal and beauty care products, including cosmetics and perfumes.
				35101010	Health Care Equipment	Manufacturers of health care equipment and devices. Includes medical instruments, drug delivery systems, cardiovascular , and orthopedic devices, and diagnostic equipment.
				35101020	Health Care Supplies	Manufacturers of health care supplies and medical products not classified elsewhere. Includes eye care products, hospital supplies, and safety needle, and syringe devices.
				35202010	Pharmaceu-ticals	Companies engaged in the research, development or production of pharmaceuticals. Includes veterinary drugs.

IEA Sector	SDA Sector	Subsector	Description	Global Industry Classification Standard subindustry		Global Industry Classification Standard descriptions
Transport Services[36]	Other Passenger transport - Air		Includes transport of passengers by air over regular routes and on regular schedules; charter flights for passengers; scenic and sightseeing flights; renting of air-transport equipment with operator for the purpose of passenger transportation; general aviation activities, such as transport of passengers by aero clubs for instruction or pleasure. National as well as international flights are included. Corresponds to ISIC code 5110, Passenger air transport. This also includes combined and dedicated freight transport by air. Energy consumption of transport-related infrastructure is not included here but in the service/buildings sector.	20302010	Airlines	Companies providing primarily passenger air transportation.
	Passenger transport - Light Road		All passenger transport made by light-duty vehicles, including transportation by own vehicles. ISIC codes 4921, Urban and suburban passenger land transport and 4922, Other passenger land transport will generically apply.	20304020	Trucking	Companies providing primarily goods and passenger land transportation. Includes vehicle rental and taxi companies.
	Passenger transport - Heavy Road		All passenger transport made by non light-duty vehicles. ISIC codes 4921, Urban and suburban passenger land transport and 4922, Other passenger land transport will generically apply. Energy consumption of transport-related infrastructure is not included here but in the service/buildings sector.	20304020	Trucking	Companies providing primarily goods and passenger land transportation. Includes vehicle rental and taxi companies.

[36]Confirmation from IEA pending

IEA Sector	SDA Sector	Subsector	Description	Global Industry Classification Standard subindustry		Global Industry Classification Standard descriptions
Transport Services	Passenger transport – Rail		Includes rail transportation of passengers and/or freight using railroad rolling stock on mainline networks, usually spread over an extensive geographic area, such as passenger transport by inter-urban railways; operation of sleeping cars or dining cars as an integrated operation of railway companies. Excludes tramways and elevated railways and other suburban railway passenger transport. Corresponds to ISIC code 4911, Passenger rail transport, interurban. Energy consumption of transport-related infrastructure is not included here but in the service/buildings sector.	20304010	Railroads	Companies providing primarily goods and passenger rail transportation.
	Other transport		All other transport, in particular freight transport by land, water and air. This excludes combined and dedicated freight transport by air, since this is already included in passenger transport - air. Corresponds to ISIC codes 5120, Freight air transport; 5022, Inland freight water transport; 5012, Sea and coastal freight water transport; 4923, Freight transport by road; and 4912, Freight rail transport.	20301010	Air Freight and Logistics	Companies providing air freight transportation, courier and logistics services, including package and mail delivery and customs agents. Excludes those companies classified in the Airlines, Marine or Trucking Sub-Industries.
				20303010	Marine	Companies providing goods or passenger maritime transportation. Excludes cruise-ships classified in the hotels, resorts, and cruise lines sub-industry.
				20304020	Trucking	Companies providing primarily goods and passenger land transportation. Includes vehicle rental and taxi companies.

IEA Sector	SDA Sector	Subsector	Description	Global Industry Classification Standard subindustry		Global Industry Classification Standard descriptions
Services / Commercial Buildings		Trade / Retail	Includes wholesale and retail sale (i.e. sale without transformation) of any type of goods and the rendering of services incidental to the sale of these goods. Wholesaling and retailing are the final steps in the distribution of goods. Corresponds to ISIC section G, Wholesale and retail trade; repair of motor vehicles and motorcycles.	20107010	Trading Companies & Distributors	Trading companies and other distributors of industrial equipment and products.
				20201010	Commercial Printing	Companies providing commercial printing services. Includes printers primarily serving the media industry.
				25501010	Distributors	Distributors and wholesalers of general merchandise not classified elsewhere. Includes vehicle distributors.
				25502010	Catalog Retail	Mail order and TV home shopping retailers. Includes companies that provide door-to-door retail.
				25502020	Internet Retail	Companies providing retail services primarily on the internet, not classified elsewhere.
				25503010	Department Stores	Owners and operators of department stores.
				25503020	General Merchandise Stores	Owners and operators of stores offering diversified general merchandise. Excludes hypermarkets and large-scale super centers classified in the hypermarkets and super centers sub-industry.
				25504010	Apparel Retail	Retailers specialized mainly in apparel and accessories.
				25504020	Computer and Electronics Retail	Owners and operators of consumer electronics, computers, video and related products retail stores.
				25504030	Home Improvement Retail	Owners and operators of home and garden improvement retail stores. Includes stores offering building materials and supplies.
				25504040	Specialty Stores	Owners and operators of specialty retail stores not classified elsewhere. Includes jewelry stores, toy stores, office supply stores, health and vision care stores, and book and entertainment stores.
				25504050	Automotive Retail	Owners and operators of stores specializing in automotive retail. Includes auto dealers, gas stations, and retailers of auto accessories, motorcycles and parts, automotive glass, and automotive equipment and parts.

IEA Sector	SDA Sector	Subsector	Description	Global Industry Classification Standard subindustry		Global Industry Classification Standard descriptions
				25504060	Home furnishing Retail	Owners and operators of furniture and home furnishings retail stores. Includes residential furniture, home furnishings, housewares, and interior design. Excludes home and garden improvement stores, classified in the home improvement retail sub-industry.
				30101010	Drug Retail	Owners and operators of primarily drug retail stores and pharmacies.
				30101020	Food Distributors	Distributors of food products to other companies and not directly to the consumer.
				30101030	Food Retail	Owners and operators of primarily food retail stores.
				30101040	Hypermarkets and Super Centers	Owners and operators of hypermarkets and super centers selling food and a wide-range of consumer staple products. excludes food and drug retailers classified in the food retail and drug retail sub-industries, respectively.
				35102010	Health Care Distributors	Distributors and wholesalers of health care products not classified elsewhere.
				45203030	Technology Distributors	Distributors of technology hardware and equipment. Includes distributors of communications equipment, computers & peripherals, semiconductors, and electronic equipment and components.
		Finance	Includes financial service activities, including banking, insurance, reinsurance, pension funding activities, activities to support financial services, activities of holding assets and the activities of trusts, funds and similar financial entities. Corresponds to ISIC section K, Financial and insurance activities	40101010	Diversified Banks	Large, geographically diverse banks with a national footprint whose revenues are derived primarily from 40101015 conventional banking operations, have significant business activity in retail banking and small and medium corporate lending, and provide a diverse range of financial services. Excludes banks classified in the regional banks and thrifts and mortgage finance sub-industries. Also excludes investment banks classified in the investment banking and brokerage sub-industry.

IEA Sector	SDA Sector	Subsector	Description	Global Industry Classification Standard subindustry		Global Industry Classification Standard descriptions
				40101015	Regional Banks	Commercial banks whose businesses are derived primarily from conventional banking operations and have significant business activity in retail banking and small and medium corporate lending. Regional banks tend to operate in limited geographic regions. Excludes companies classified in the diversified banks and thrifts and mortgage banks sub-industries. Also excludes investment banks classified in the investment banking and brokerage sub-industry.
				40102010	Thrifts and Mortgage Finance	Financial institutions providing mortgage and mortgage related services. These include financial institutions whose assets are primarily mortgage related, savings and loans, mortgage lending institutions, building societies and companies providing insurance to mortgage banks.
				40201020	Other Diversified Financial Services	Providers of a diverse range of financial services and/or with some interest in a wide range of financial services including banking, insurance and capital markets, but with no dominant business line. Excludes companies classified in the regional banks and diversified banks sub-industries.
				40201030	Multi-Sector Holdings	A company with significantly diversified holdings across three or more sectors, none of which contributes a majority of profit and/or sales. Stakes held are predominantly of a non-controlling nature. Includes diversified financial companies where stakes held are of a controlling nature. Excludes other diversified companies classified in the industrials conglomerates sub-industry.
				40201040	Specialized Finance	Providers of specialized financial services. Includes credit agencies, stock exchanges and specialty boutiques. Companies in this sub-industry derive a majority of revenue from one, specialized line of business.

IEA Sector	SDA Sector	Subsector	Description	Global Industry Classification Standard subindustry		Global Industry Classification Standard descriptions
				40202010	Consumer Finance	Providers of consumer finance services, including personal credit, credit cards, lease financing, travel-related money services and pawn shops. Excludes mortgage lenders classified in the thrifts and mortgage finance sub-industry.
				40203010	Asset Management and Custody Banks	Financial institutions primarily engaged in investment management and/or related custody and securities fee-based services. Includes companies operating mutual funds, closed-end funds and unit investment trusts. Excludes banks and other financial institutions primarily involved in commercial lending, investment banking, brokerage and other specialized financial activities.
				40203020	Investment Banking and Brokerage	Financial institutions primarily engaged in investment banking and brokerage services, including equity and debt underwriting, mergers and acquisitions, securities lending and advisory services. Excludes banks and other financial institutions primarily involved in commercial lending, asset management and specialized financial activities.
				40203030	Diversified Capital Markets	Financial institutions primarily engaged in diversified capital markets activities, including a significant presence in at least two of the following area: large/major corporate lending, investment banking, brokerage and asset management. Excludes less diversified companies classified in the asset management and custody banks or investment banking and brokerage sub-industries. Also excludes companies classified in the banks or insurance industry groups or the consumer finance sub-industry.
				40301010	Insurance Brokers	Insurance and reinsurance brokerage firms.
				40301020	Life and Health Insurance	Companies providing primarily life, disability, indemnity or supplemental health insurance. Excludes managed care companies classified in the managed health care sub-industry.

IEA Sector	SDA Sector	Subsector	Description	Global Industry Classification Standard subindustry		Global Industry Classification Standard descriptions
				40301030	Multi-line Insurance	Insurance companies with diversified interests in life, health and property and casualty insurance.
				40301040	Property and Casualty Insurance	Companies providing primarily property and casualty insurance.
				40301050	Reinsurance	Companies providing primarily reinsurance.
		Real Estate	Includes acting as lessors, agents and/or brokers in one or more of the following: selling or buying real estate, renting real estate, providing other real estate services such as appraising real estate or acting as real estate escrow agents. Activities in this section may be carried out on own or leased property and may be done on a fee or contract basis. Also included is the building of structures, combined with maintaining ownership or leasing of such structures and real estate property managing activities. Corresponds to ISIC section L, Real estate activites.	40402010	Diversified REITs	A company or trust with significantly diversified operations across two or more property types.
				40402020	Industrial REITs	Companies or trusts engaged in the acquisition, development, ownership, leasing, management and operation of industrial properties. Includes companies operating industrial warehouses and distribution properties.
				40402030	Mortgage REITs	Companies or trusts that service, originate, purchase and/or securitize residential and/or commercial mortgage loans. Includes trusts that invest in mortgage-backed securities and other mortgage related assets.
				40402035	Hotel and Resort REITs	Companies or trusts engaged in the acquisition, development, ownership, leasing, management and operation of hotel and resort properties.
				40402040	Office REITs	Companies or trusts engaged in the acquisition, development, ownership, leasing, management and operation of office properties.
				40402045	Health Care REITs	Companies or trusts engaged in the acquisition, development, ownership, leasing, management and operation of properties serving the health care industry, including hospitals, nursing homes, and assisted living properties.
				40402050	Residential REITs	Companies or trusts engaged in the acquisition, development, ownership, leasing, management and operation of residential properties including multifamily homes, apartments, manufactured homes and student housing properties.

IEA Sector	SDA Sector	Subsector	Description	Global Industry Classification Standard subindustry		Global Industry Classification Standard descriptions
				40402060	Retail REITs	Companies or trusts engaged in the acquisition, development, ownership, leasing, management and operation of shopping malls, outlet malls, neighborhood and community shopping centers.
				40402070	Specialized REITs	Companies or trusts engaged in the acquisition, development, ownership, leasing, management and operation of properties not classified elsewhere. Includes trusts that operate and invest in storage properties. It also includes REITs that do not generate a majority of their revenues and income from real estate rental and leasing operations.
				40403010	Diversified Real Estate Activities	Companies engaged in a diverse spectrum of real estate activities including real estate development and sales, real estate management, or real estate services, but with no dominant business line.
				40403020	Real Estate Operating Companies	Companies engaged in operating real estate properties for the purpose of leasing and management.
				40403030	Real Estate Development	Companies that develop real estate and sell the properties after development. Excludes companies classified in the homebuilding sub-industry.
				40403040	Real Estate Services	Real estate service providers such as real estate agents, brokers and real estate appraisers.
		Public Administration	Includes activities of a governmental nature, normally carried out by the public administration such as administration of justice, taxation, public order, defence, foreign affairs and public administration services, including social security. Excludes health and education services provided by the state. Corresponds to ISIC section O, Public administration and defence; compulsory social security.	35102015	Health Care Services	Providers of patient health care services not classified elsewhere. Includes dialysis centers, lab testing services, and pharmacy management services. Also includes companies providing business support services to health care providers, such as clerical support services, collection agency services, staffing services and outsourced sales and marketing services

IEA Sector	SDA Sector	Subsector	Description	Global Industry Classification Standard subindustry		Global Industry Classification Standard descriptions
		Health	Includes the provision of health and social work activities. Activities include a wide range of activities, starting from health care provided by trained medical professionals in hospitals and other facilities, over residential care activities that still involve a degree of health care activities to social work activities without any involvement of health care professionals. Corresponds to ISIC section Q, Human health and social work activities.	35102020	Health Care Facilities	Owners and operators of health care facilities, including hospitals, nursing homes, rehabilitation centers and animal hospitals.
				35102030	Managed Health Care	Owners and operators of Health Maintenance Organizations (HMOs) and other managed plans.
				35103010	Health Care Technology	Companies providing information technology services primarily to health care providers. Includes companies providing application, systems and/or data processing software, internet-based tools, and IT consulting services to doctors, hospitals or businesses operating primarily in the health care sector.
		Food and lodging	Includes the provision of short-stay accommodation for visitors and other travellers and the provision of complete meals and drinks fit for immediate consumption. The amount and type of supplementary services provided can vary widely. Excludes the preparation of food or drinks that are either not fit for immediate consumption or that are sold through independent distribution channels, i.e. through wholesale or retail trade activities. Corresponds to ISIC section I, Accommodation and food service activities.	25301020	Hotels, Resorts and Cruise Lines	Owners and operators of hotels, resorts and cruise-ships. Includes travel agencies, tour operators and related services not classified elsewhere . Excludes casino-hotels classified in the casinos and gaming sub-industry.
				25301040	Restaurants	Owners and operators of restaurants, bars, pubs, fast-food or take-out facilities. Includes companies that provide food catering services.

IEA Sector	SDA Sector	Subsector	Description	Global Industry Classification Standard subindustry		Global Industry Classification Standard descriptions
		Education	Includes education at any level or for any profession, oral or written as well as by radio and television or other means of communication. It includes education by the different institutions in the regular school system at its different levels as well as adult education, literacy programmes etc. Also included are military schools and academies, prison schools etc. at their respective levels. The section includes public as well as private education. Corresponds to ISIC section P, Education.	25302010	Education Services	Companies providing educational services, either on-line or through conventional teaching methods. Includes, private universities, correspondence teaching, providers of educational seminars, educational materials and technical education. Excludes companies providing employee education programs classified in the human resources and employment services sub-industry
		Other commercial services	All other commercial activities that have not been specified elsewhere.	20201050	Environmental and Facilities Services	Companies providing environmental and facilities maintenance services. Includes waste management, facilities management and pollution control services. Excludes large-scale water treatment systems classified in the water utilities sub-industry.
				20201060	Office Services and Supplies	Providers of office services and manufacturers of office supplies and equipment not classified elsewhere.
				20201070	Diversified Support Services	Companies primarily providing labor oriented support services to businesses and governments. Includes commercial cleaning services, dining and catering services, equipment repair services, industrial maintenance services, industrial auctioneers, storage and warehousing, transaction services, uniform rental services, and other business support services.

IEA Sector	SDA Sector	Subsector	Description	Global Industry Classification Standard subindustry		Global Industry Classification Standard descriptions
				20201080	Security and Alarm Services	Companies providing security and protection services to business and governments. Includes companies providing services such as correctional facilities, security and alarm services, armored transportation and guarding. Excludes companies providing security software classified under the systems software sub-industry and home security services classified under the specialized consumer services sub-Industry. Also excludes companies manufacturing security system equipment classified under the electronic equipment and instruments sub-industry.
				20202010	Human Resource and Employment Services	Companies providing business support services relating to human capital management. Includes employment agencies, employee training, payroll and benefit support services, retirement support services and temporary agencies.
				20202020	Research and Consulting Services	Companies primarily providing research and consulting services to businesses and governments not classified elsewhere. Includes companies involved in management consulting services, architectural design, business information or scientific research, marketing, and testing and certification services. Excludes companies providing information technology consulting services classified in the IT consulting and other services sub-industry.
				20305010	Airport Services	Operators of airports and companies providing related services.
				20305020	Highways and Railtracks	Owners and operators of roads, tunnels, and rail tracks.
				20305030	Marine Ports and Services	Owners and operators of marine ports and related services.
				25301010	Casinos and Gaming	Owners and operators of casinos and gaming facilities. Includes companies providing lottery and betting services.

IEA Sector	SDA Sector	Subsector	Description	Global Industry Classification Standard subindustry		Global Industry Classification Standard descriptions
				25301030	Leisure Facilities	Owners and operators of leisure facilities, including sport and fitness centers, stadiums, golf courses and amusement parks not classified in the movies and entertainment sub-industry.
				25302020	Specialized Consumer Services	Companies providing consumer services not classified elsewhere. Includes residential services, home security, legal services, personal services, renovation and interior design services, consumer auctions and wedding and funeral services.
				25401010	Advertising	Companies providing advertising, marketing or public relations services.
				25401020	Broadcasting	Owners and operators of television or radio broadcasting systems, including programming. Includes, radio and television broadcasting, radio networks, and radio stations.
				25401025	Cable and Satellite	Providers of cable or satellite television services. Includes cable networks and program distribution.
				25401030	Movies and Entertainment	Companies that engage in producing and selling entertainment products and services, including companies engaged in the production, distribution and screening of movies and television shows, producers and distributors of music, entertainment theaters and sports teams.
				25401040	Publishing	Publishers of newspapers, magazines and books, and providers of information in print or electronic formats.
				35201010	Biotechnology	Companies primarily engaged in the research, development, manufacturing and/or marketing of products based on genetic analysis and genetic engineering. Includes companies specializing in protein-based therapeutics to treat human diseases. Excludes companies manufacturing products using biotechnology but without a health care application.

IEA Sector	SDA Sector	Subsector	Description	Global Industry Classification Standard subindustry		Global Industry Classification Standard descriptions
				35203010	Life Sciences Tools and Services	Companies enabling the drug discovery, development and production continuum by providing analytical tools, instruments, consumables and supplies, clinical trial services and contract research services. Includes firms primarily servicing the pharmaceutical and biotechnology industries.
				45101010	Internet Software and Services	Companies developing and marketing internet software and/or providing internet services including online databases and interactive services, as well as companies deriving a majority of their revenues from online advertising. Excludes companies classified in the internet retail sub-industry.
				45102010	IT Consulting and Other Services	Providers of information technology and systems integration services not classified in the Data Processing and Outsourced Services or Internet Software and Services Sub-Industries. Includes information technology consulting and information management services.
				45102020	Data Processing and Outsourced Services	Providers of commercial electronic data processing and/or business process outsourcing services. Includes companies that provide services for back-office automation.
				45103010	Application Software	Companies engaged in developing and producing software designed for specialized applications for the business or consumer market. Includes enterprise and technical software. Excludes companies classified in the home entertainment software sub-industry. Also excludes companies producing systems or database management software classified in the systems software sub-industry.
				45103020	Systems Software	Companies engaged in developing and producing systems and database management software.

IEA Sector	SDA Sector	Subsector	Description	Global Industry Classification Standard subindustry		Global Industry Classification Standard descriptions
				45103030	Home Entertainment Software	Manufacturers of home entertainment software and educational software used primarily in the home.
				50101010	Alternative Carriers	Providers of communications and high-density data transmission services primarily through a high bandwidth/fiber-optic cable network.
				50101020	Integrated Telecom-munication Services	Operators of primarily fixed-line telecommunications networks and companies providing both wireless and fixed-line telecommunications services not classified elsewhere.
				50102010	Wireless Telecom-munication Services	Providers of primarily cellular or wireless telecommunication services, including paging services.
				55104010	Water Utilities	Companies that purchase and redistribute water to the end consumer. Includes large-scale water treatment systems.
	Sectors and activities not covered by the methodol-ogy	Coal mining	Includes the extraction of solid mineral fuels includes through underground or open-cast mining and includes operations (e.g. grading, cleaning, compressing and other steps necessary for transportation etc.) leading to a marketable product. Corresponds to ISIC division 05, Mining of coal and lignite.	10102050	Coal and Consumable Fuels	Companies primarily involved in the production and mining of coal, related products and other consumable fuels related to the generation of energy. Excludes companies primarily producing gases classified in the industrial gases sub-industry and companies primarily mining for metallurgical (coking) coal used for steel production.

IEA Sector	SDA Sector	Subsector	Description	Global Industry Classification Standard subindustry		Global Industry Classification Standard descriptions
		Oil and Gas extraction	Includes the production of crude petroleum, the mining and extraction of oil from oil shale and oil sands and the production of natural gas and recovery of hydro-carbon liquids. This includes the overall activities of operating and/or developing oil and gas field properties, including such activities as drilling, completing and equipping wells, operating separators, emulsion breakers, desilting equipment and field gathering lines for crude petroleum and all other activities in the preparation of oil and gas up to the point of shipment from the producing property. Corresponds to ISIC division 06, Extraction of crude petroleum and natural gas.	10102010	Integrated Oil and Gas	Integrated oil companies engaged in the exploration and production of oil and gas, as well as at least one other significant activity in either refining, marketing and transportation, or chemicals.
				10102020	Oil and Gas Exploration and Production	Companies engaged in the exploration and production of oil and gas not classified elsewhere.
		Oil and Gas refining	Includes the manufacture of liquid or gaseous fuels or other products from crude petroleum, bituminous minerals or their fractionation products. Petroleum refining involves one or more of the following activities: fractionation, straight distillation of crude oil, and cracking. Includes also gas refining. ISIC code 1920, Manufacture of refined petroleum products, will generically apply to this category.	10102010	Integrated Oil and Gas	Integrated oil companies engaged in the exploration and production of oil and gas, as well as at least one other significant activity in either refining, marketing and transportation, or chemicals.
				10102030	Oil and Gas Refining and Marketing	Companies engaged in the refining and marketing of oil, gas and/or refined products not classified in the integrated oil and gas or independent power producers and energy traders sub-industries.
		Energy industry own use and loss	This is included within Power generation sector, but not included as a specific sector.			

IEA Sector	SDA Sector	Subsector	Description	Global Industry Classification Standard subindustry		Global Industry Classification Standard descriptions
		Land use change				
		Agriculture	Includes the exploitation of vegetal and animal natural resources, comprising the activities of growing of crops, raising and breeding of animals, harvesting of timber and other plants, animals or animal products from a farm or their natural habitats. Corresponds to ISIC section A, Agriculture.	30202010	Agricultural Products	Producers of agricultural products. Includes crop growers, owners of plantations and companies that produce and process foods but do not package and market them. Excludes companies classified in the forest products sub-industry and those that package and market the food products classified in the packaged foods sub-industry.
				30202020	Meat, Poultry and Fish (discontinued, effective March 28 2002)	Companies that raise livestock or poultry, fishing companies and other producers of meat, poultry or fish products.

Sources:
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Note 1:
This table has been developed to clarify which activities are included within the sector methodology. For easier reference we have tried to establish a correspondence with common industrial classification systems, such as ISIC (UN) and GICS (MSCI). This correspondence, however, is prone to error due to interpretation of the different categories and often overlaps and gaps in the information available about exactly who would fit into each category. Classification system are rarely straightforward and most often prone to interpretation. Carefull interpretation should be used for this table.

Note 2:
As an illustration of some of the issues mentioned in previous note, consider activities related with aluminum. While primary and secondary aluminum extraction within classified within the generic "aluminum sector" of the methodology, activities related to the mining and extraction of bauxite would be classified in "other Industry - mining and quarrying." This would correspond well with ISIC classification ISIC Code 2420: manufacture of basic precious and other non-ferrous metals applies, where aluminum activities are concerned, but less well with the GICS 15104010: aluminum, which includes companies that mine or process bauxite. Many other examples could be sited in this sector correspondence.

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