Climate Action Tracker

Summary Report

Elaborating the decarbonisation roadmap

Climate Action Tracker

Paris Agreement Compatible Sectoral Benchmarks

August 2020

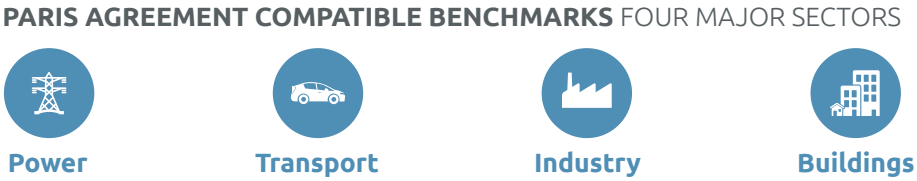
NEW CLIMATE INSTITUTE

CLIMATE ANALYTICS

Executive summary

While national emission trends are a useful tool for measuring government progress towards meeting the Paris Agreement 1.5˚C temperature limit at a global level, each government will have to address its own sectors, each with their own, different baseline. What should government sectoral benchmarks be? Will they meet the global carbon budget?

The Climate Action Tracker has defined and analysed a global-level series of Paris Agreement-compatible benchmarks, across four major sectors: Power, Transport, Industry, and Buildings. Within each sector, we define benchmarks for several separate but complementary indicators.



We have also drilled down to present the benchmarks in these sectors for seven individual countries: Brazil, China, EU, India, Indonesia, South Africa, and the US, taking into account the current technical and infrastructure circumstances in each country. We have developed the benchmarks for both 2030 and 2050, with additional temporal resolution depending on the approach and indicator.

The data from this work has been added to the Climate Action Tracker interactive data portal https://climateactiontracker.org/data-portal.

We have identified the following key lessons:

- **Decarbonisation by 2050**: the Paris Agreement requires the world to decarbonise by 2050: on average, all sectors need to decarbonise in this timeframe, albeit at slightly different rates. In this report, we have identified the potential for such rapid decarbonisation across all sectors.
- **Differences shrink**: in terms of timing, benchmarks differ between countries and sectors, because they all start from a different base. But ultimately, governments must pursue all options in all sectors, and sometimes this will require support between countries
- **Benchmarks useful to assess progress**: policymakers can use the benchmarks to assess the adequacy of interventions with respect to the Paris Agreement. Our benchmarks provide a guide as to the scale of change that needs to happen, and where - and when, leaving governments the freedom to meet them through different decarbonisation strategies.
- **Progress by 2030 is important**: decarbonisation by 2050 alone is not sufficient; to keep carbon budgets within reach, progress must ramp up well before 2030.
- **Power sector is relatively advanced**: the power sector is already making quite some progress in decarbonising, and it should continue to be a government priority, especially in avoiding new infrastructure incompatible with the Paris Agreement, such as coal-fired power plants.
- **Industry, transport, buildings need to advance significantly**: these sectors are not yet moving as quickly as is necessary, and efforts to meet 2030 benchmarks must significantly ramp up.

1 Paris Agreement-compatible sectoral benchmarks

Why do we need sectoral benchmarks?

The Paris Agreement temperature goal is an important global goal and we can track aggregated emission levels to see if we are on track to meeting it.

The Paris Agreement's goal is to limit global temperature increase to well below 2°C and to pursue efforts to limit it to 1.5°C. This means that all sectors and countries will eventually have to reduce emissions to net-zero, with the main question being when and how. To limit global temperature increase to 1.5°C, global net-zero CO_2 emissions need to be reached by 2050, net-zero greenhouse gas emissions by 2070 (IPCC, 2018).

To inform policy improvements and to gauge the state of transformational change - whether it is already underway, or more action is required - we need more granular information. Sectoral indicators and benchmarks (such as, in the power sector, identifying the necessary share of renewable energy required to meet the Paris Agreement temperature goal) allow us to track the various elements of action that together will allow us to meet the global temperature goal.

Compared to national total greenhouse gas emissions, sectoral indicators and benchmarks speak more closely to those making the relevant decisions and help to map out pathways to a Paris-compatible world in more detail.

What are the main challenges in determining sectoral benchmarks?

The main challenge in defining the sectoral benchmarks is that a global temperature goal cannot unambiguously be translated into individual actions. Different strategies could be used to meet the long-term goal; e.g. by assigning more reductions to specific sectors, as long as the overall emissions budget is met (since the overall budget determines the long-term temperature increase).

However, the degree of freedom is limited, as the available emissions budget is small. It is clear from the Paris Agreement goal that all sectors and countries will eventually have to reduce emissions to net-zero. So if one sector is slower than this global trend, another sector needs to be equivalently faster, or emissions need to be removed from the atmosphere. Arguing that a sector needs more time for decarbonisation can only be done in combination with arguing that another can go faster.

A good starting point can be to ask whether a sector can decarbonise by 2050, and if not, why?

In this situation not only the differences between sectors but also the differences between countries disappear in the long run, because all need to reach net zero emissions. Even if the endpoint is the same, the question on *who pays* for the transition still remains (see below).

What is the rationale behind the benchmarks?

The Climate Action Tracker team defines detailed **Paris Agreement compatible sectoral benchmarks** as a level of an indicator that would be "sufficient" for national action to decarbonise sectors in line with the Paris Agreement's 1.5˚C temperature limit.

We set our benchmarks at a level of "**highest plausible ambition,**" which means they:

- are generally technically and economically feasible within the foreseeable future
- take into consideration current circumstances in terms of existing infrastructure and institutions in individual countries
- ensure that the benchmarks push boundaries on all levels and increase our chances of collectively meeting the Paris temperature limit

We prioritise mitigation options and scenarios that lead to the deepest and fastest emission reductions, but ensure the benchmarks also include options that we are confident are feasible, based on the current development of technologies and the time taken to make changes to existing stock or to scale-up new technologies.

We do not predetermine how governments should reach a benchmark but can show that it is possible through one or more decarbonisation routes.

How are the benchmarks determined?

In defining the sectoral benchmarks, we use **multiple lines of evidence** as input and take informed decisions on the basis of the available data. The input data includes:

- **A literature review**
  - **Global scenarios** of what is required to meet the Paris Agreement goal. These usually cover all sectors and countries to check if overall emissions are in line with the Paris Agreement temperature limit. They usually distribute reductions across sectors so that the temperature goal is met in a globally cost-effective manner. But they have limited sector, technology, and country detail.
  - **Sectoral technology scenarios** and assessments that may have much higher technological resolution than the global models, but do not usually capture important cross-sectoral feedbacks.
  - **Recent technological trends and potential new developments** that may not be adequately covered by the sectoral technology model scenarios (which usually lag behind the most recent developments) nor by the global scenarios.
  - **Most ambitious projects, targets, or goals** put forward by nations, regions, cities or companies, as they give an indication of what the ambitious players consider feasible.

- **Our own analysis of scenarios**
  - **Analysis based on existing global model-based scenarios**: starting point of the global scenarios. From those scenarios we select a subset that also adhere to other sustainability requirements, e.g. carbon dioxide removal, but only to the extent that it can be done sustainably (Fuss et al., 2018; Yanguas Parra et al., 2019). Where necessary, regional data was downscaled to the national level. Not all indicators can be assessed using this methodology, given the sectoral or technological restrictions embedded in the starting model pathways.
  - **Development and application of our own sectoral models** that assess the mitigation potential of key mitigation options. These models are particularly useful where global models lack the detailed resolution to assess certain mitigation options, or do not provide information about certain indicators, or do not include recent

technological trends and new developments. With these models, we explore different scenarios and routes to decarbonisation in each sector.

The results of the literature review and our own analysis are combined to identify the "highest plausible ambition" benchmarks for each sector. This step requires explicit decisions or selection of what is considered highest plausible ambition, which we explain individually for each sector in our detailed methods report (Climate Action Tracker, 2020a).

In combining these multiple sources of information, the resulting benchmark may either be a single value or a range. Where the benchmark is a range, it reflects a combination of trade-offs between mitigation options and uncertainties in feasibility. The least ambitious end of the range represents what we are confident can be achieved with known technologies and strategies.

In some cases, the more ambitious end of the range indicates the extent to which emissions (or other indicators) could be improved if strategies and technologies that are known but are not yet fully developed turn out to be successful. In other cases, there is some flexibility in the benchmark, but it implies trade-offs with other activities. For example, an improvement in energy intensity in buildings is clearly required and the stronger the improvement the better. The sector can be decarbonised with the lower end of the benchmark range but that would put more pressure on other mitigation options. In other words, some of these benchmarks are for detailed indicators for which there are still choices to be made and options to be pursued.

How is equity taken into consideration when defining the benchmarks?

The benchmarks defined above consider the extent to which each sector needs to be decarbonised within the bounds of a given nation (or globally) to be compatible with the Paris Agreement, irrespective of who pays for this transition.

The very limited carbon budget does not leave much room for some countries to decarbonise more slowly. As the Paris Agreement requires full decarbonisation by mid-century there will be a need for financial transfers and other support between countries, so the development described by the benchmarks is fair and just. The extent of this support and how it can be achieved is a separate discussion beyond the scope of this analysis.

Nevertheless, some additional aspects of fairness are implicitly taken into consideration when determining the benchmarks. In general, we focus on convergence of efficiencies (e.g. share of renewables or emissions per tonne of steel) while the activities are growing faster in developing countries and are often declining in developed countries. For example, in the buildings sector we focus on technological improvements and a convergence of living standards. The share of buildings' space cooled in 2050 is the same for all countries and we do not restrict growth in floor space.

We also ensure that in terms of the pace and extent of decarbonisation, the demands on higher income countries (e.g. USA, EU) are at least as stringent as the demands on other countries.

In some sectors, e.g. power, the lower carbon development route is now usually the cheaper route with multiple co-benefits compared to the fossil fuel route for energy supply. In such cases the equity dimension relates most strongly to the need for support for transition costs where higher up-front investments in new infrastructure are needed. Poorer countries will still need support for this transition.

Which sectors and countries are the benchmarks for?

In this document we present the analysis and results for benchmark definition across four major sectors: **Power, Transport, Industry, and Buildings**. Within each sector, we define benchmarks for several separate but complementary indicators.

The benchmarks are defined at the **global level** and for seven individual countries: **Brazil, China, EU, India, Indonesia, South Africa, and the US**. National level benchmarks take into account the current technical and infrastructure circumstances in each country. Benchmarks are developed for **2030 and 2050** in all cases, with additional temporal resolution depending on the approach and indicator.

How does the COVID-19 crisis impact these results?

Most of our indicators are intensities: emissions per unit of activity. The COVID-19 crisis has impacted activity levels in the short run, i.e. people travel less or consume less. What will be needed to solve the climate crisis is a full-scale transition to a low-carbon future – with the carbon intensity of human activity moving towards net zero. Economic stimulus packages need to support decarbonization investments in infrastructure as well as innovative solutions (Climate Action Tracker, 2020b).

Further information detailed in methods report

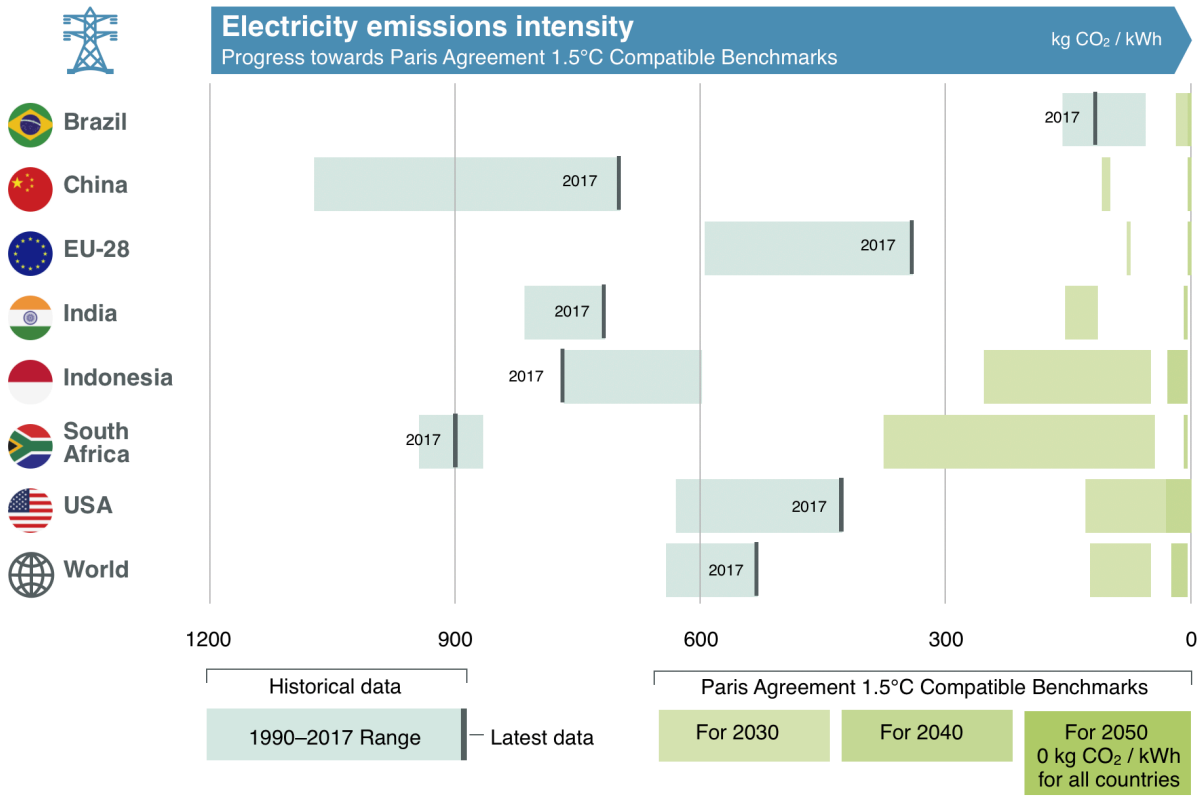
The methods, data, and individual country results are all presented in detail in the accompanying methods document (Climate Action Tracker, 2020a). There we have detailed more about country specific circumstances, the assumptions made in the modelling and analysis, and the details of how to achieve each of the benchmarks.

All of the benchmark results are also shown in the CAT data portal[1], which provides an interactive tool to compare different countries and their progress toward the benchmarks.

1 https://climateactiontracker.org/data-portal/

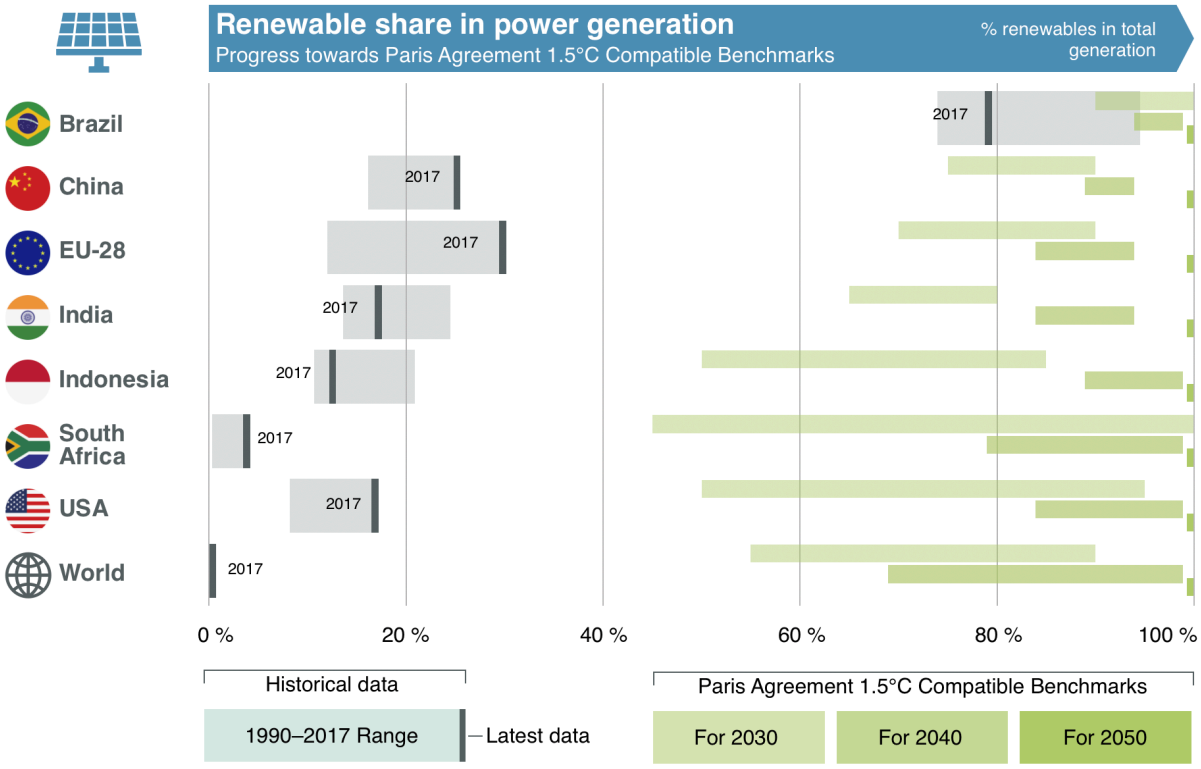
2 Action needed in each sector

Power



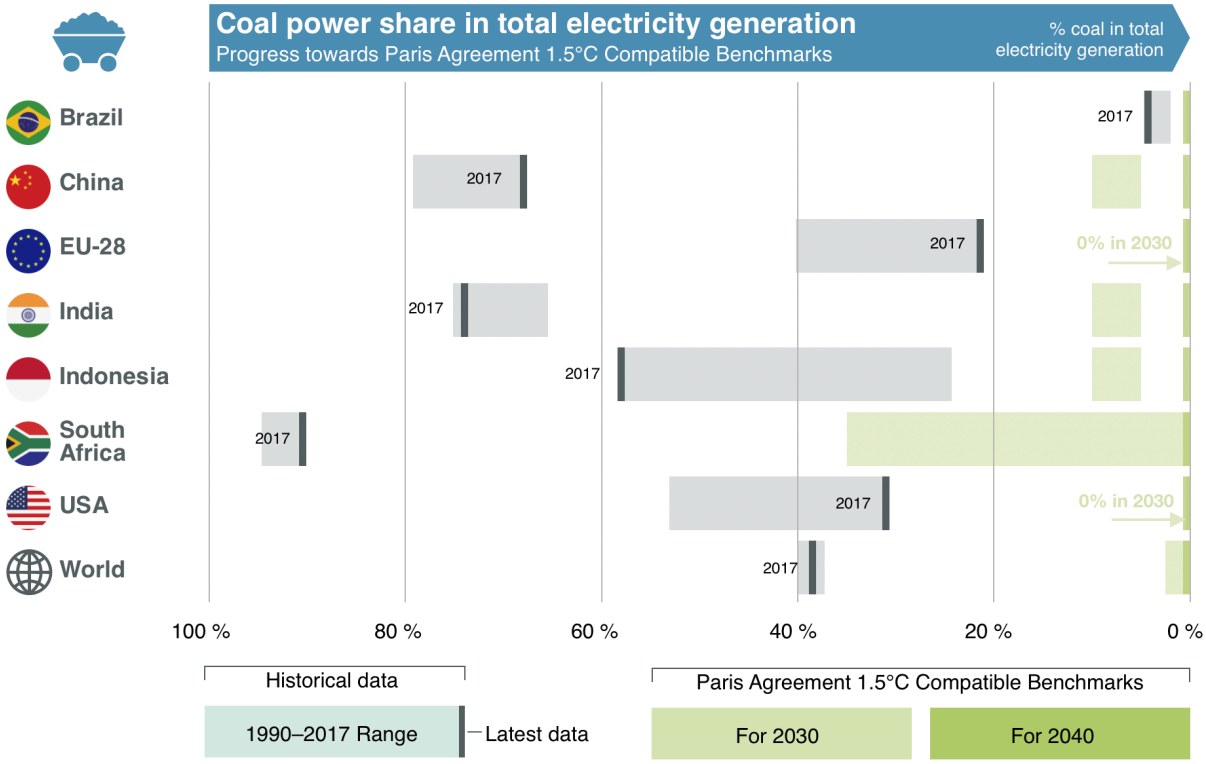
- Action in the electricity sector has a high priority as it directly enables the successful decarbonisation of all other sectors moving from fossil fuels to electricity where possible.
- In all countries, the emissions per unit of electricity need to be rapidly reduced to reach zero, ideally by 2040, but zero or net negative by 2050 at the latest.

Power



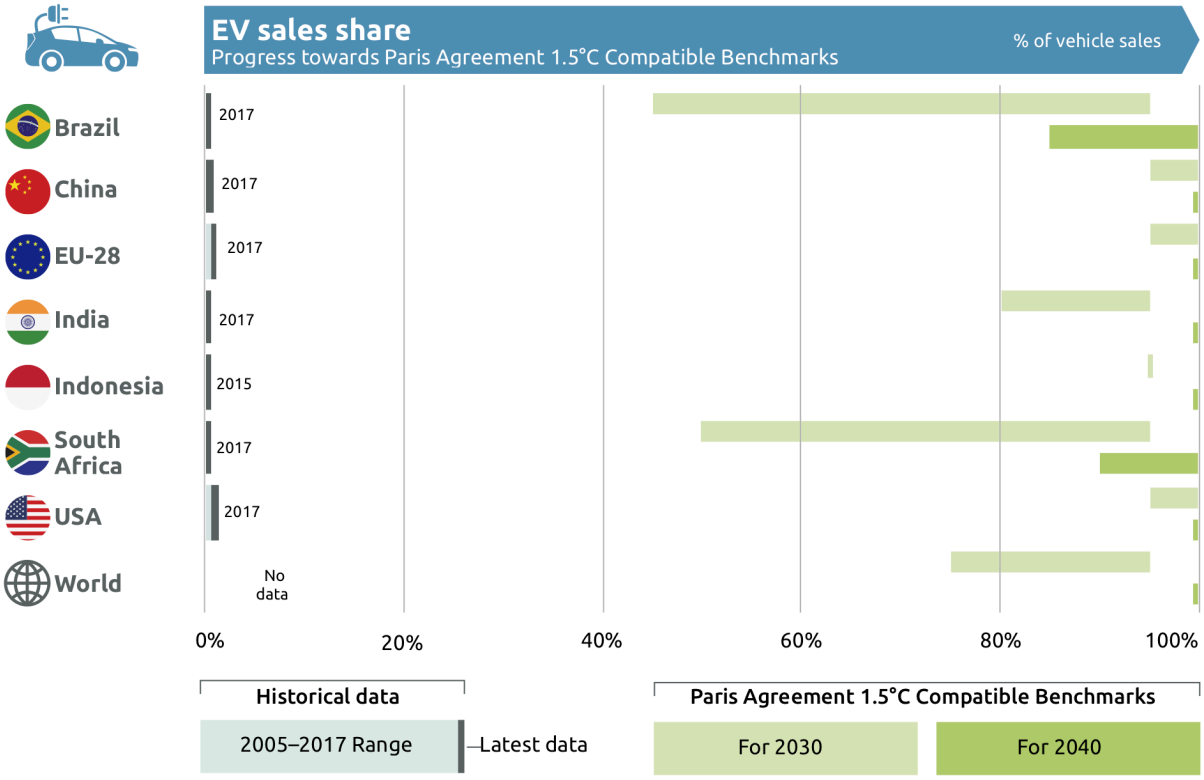
- In all countries, renewables (or other CO_2-free technologies) need to be ramped up at an accelerated pace to reach 98-100%, ideally by 2040 but by 2050 at the latest. From all CO_2 free options, renewables seem to be the most viable. Variable renewable energy sources can be backed with a variety approaches including storage, flexible gas turbines powered with synthetic gas or hydrogen and smart grid developments. We do not see fossil gas with CCS as an option because CCS itself is not emissions free and would require nontrivial negative emissions to compensate. Further, given present cost trends across technologies, CCS is already or soon will be completely uneconomic compared to renewables with storage. The current generation of nuclear is not flexible enough to provide cost-effective backup power.

Power



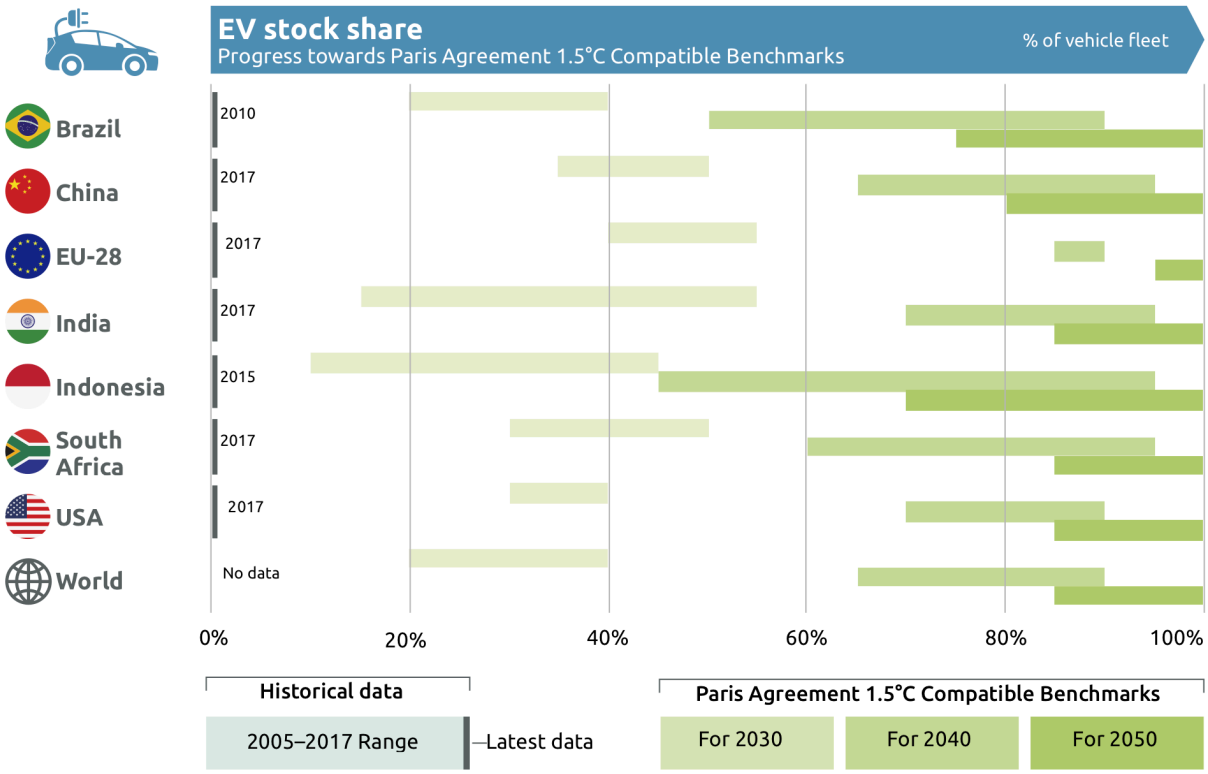
- Coal phase out is the top priority. Coal's share of the electricity sector needs to reduce to zero by 2030 in all developed countries (here the EU-28 and USA) and reduce to zero by 2040 in developing countries and emerging economies where coal currently dominates the electricity supply.
- The significant variation in the values of 2030 benchmarks between countries primarily reflects the differing economic and structural circumstances of the countries analysed. For example, Brazil's high proportion of hydropower infrastructure enables it to achieve very low to zero emissions by 2030, while the USA and the EU's relative wealth and progress to date in decarbonising their electricity system leads to a coal phase-out by 2030. In contrast, South Africa's high concentration of coal-fired power plants and its less developed economy points to phase out by 2040.

- For the total of transport (all modes and passenger/freight), low carbon fuels (electricity, hydrogen or biomass) need to enter the energy mix rapidly: around 15 to 20% by 2030 in all countries and towards 100% in 2050. The considerable variations in the 2030 benchmarks across countries - primarily along structural lines and stages of economic development - decline towards the same end point: a largely decarbonised global transport sector by 2050.



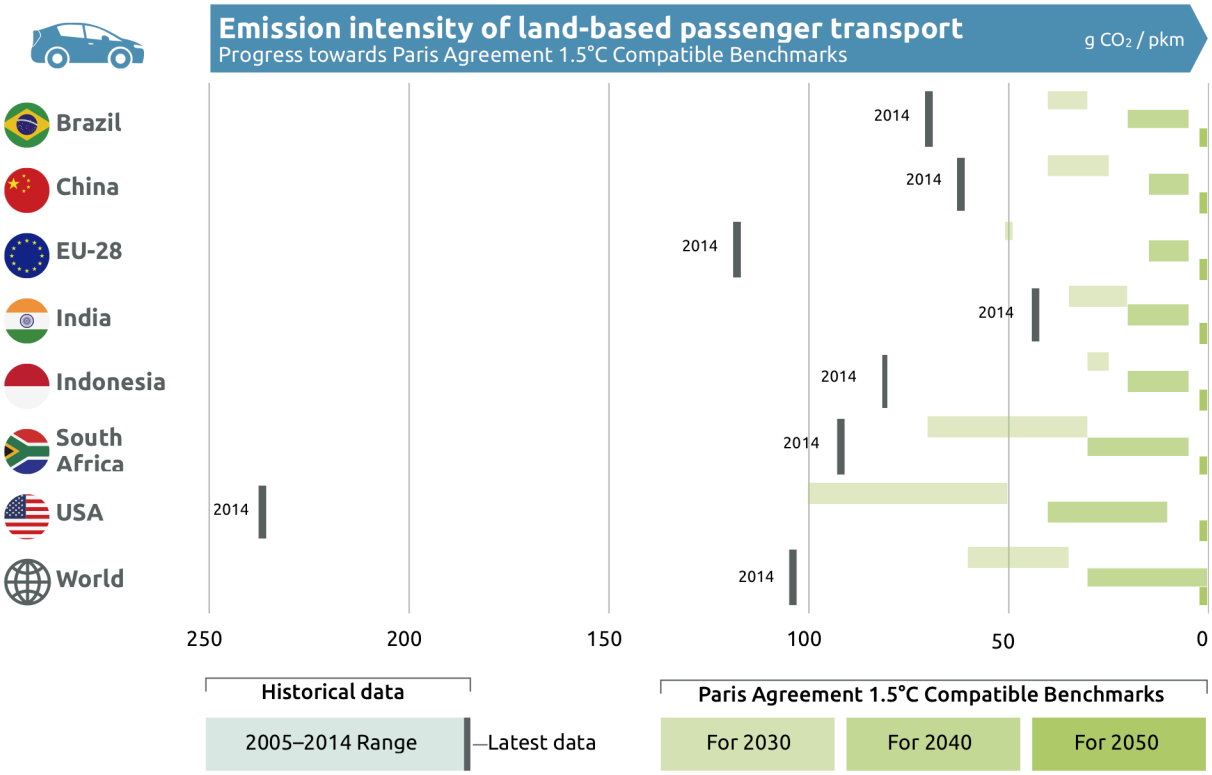
- Electric passenger vehicles (or other zero emission vehicles) need to reach a very high market share by 2030 in almost all countries (for developed countries a 95% market share) and 100% in almost all countries by 2040.

Transport



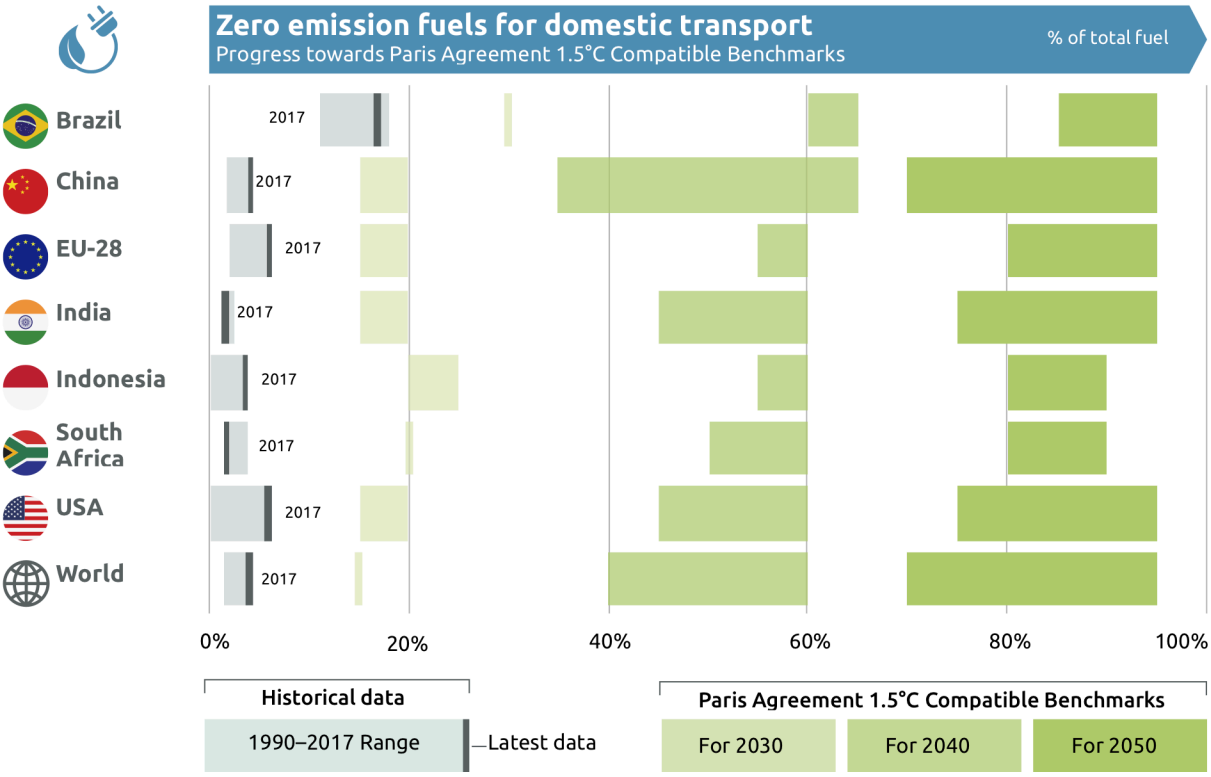
- As a result, the global passenger car fleet will be almost 100% emission free by 2050.

Transport



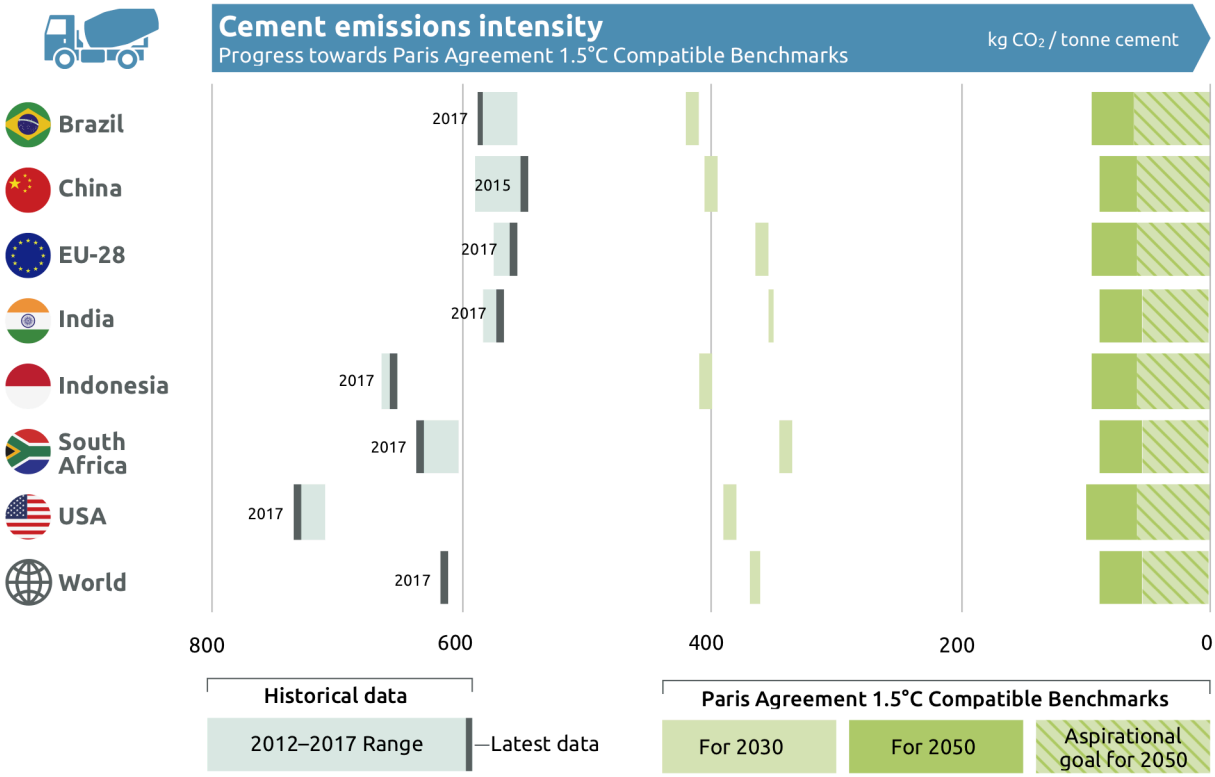
- Taking all land-based transport together (road and rail, passenger and freight), emissions per person km are reduced by 42 to 66% 2030 compared to 2014 and reach almost zero by 2050 for all countries.
- There is also a degree of uncertainty as to the potential for developing countries to achieve zero emissions passenger transport by 2050. Those benchmarks are a range with the lower bound as zero.
- The US sits above the 2030 global benchmark in emissions per passenger km, primarily due to the large and increasing share of large internal combustion engine passenger vehicles such as SUVs.

Transport



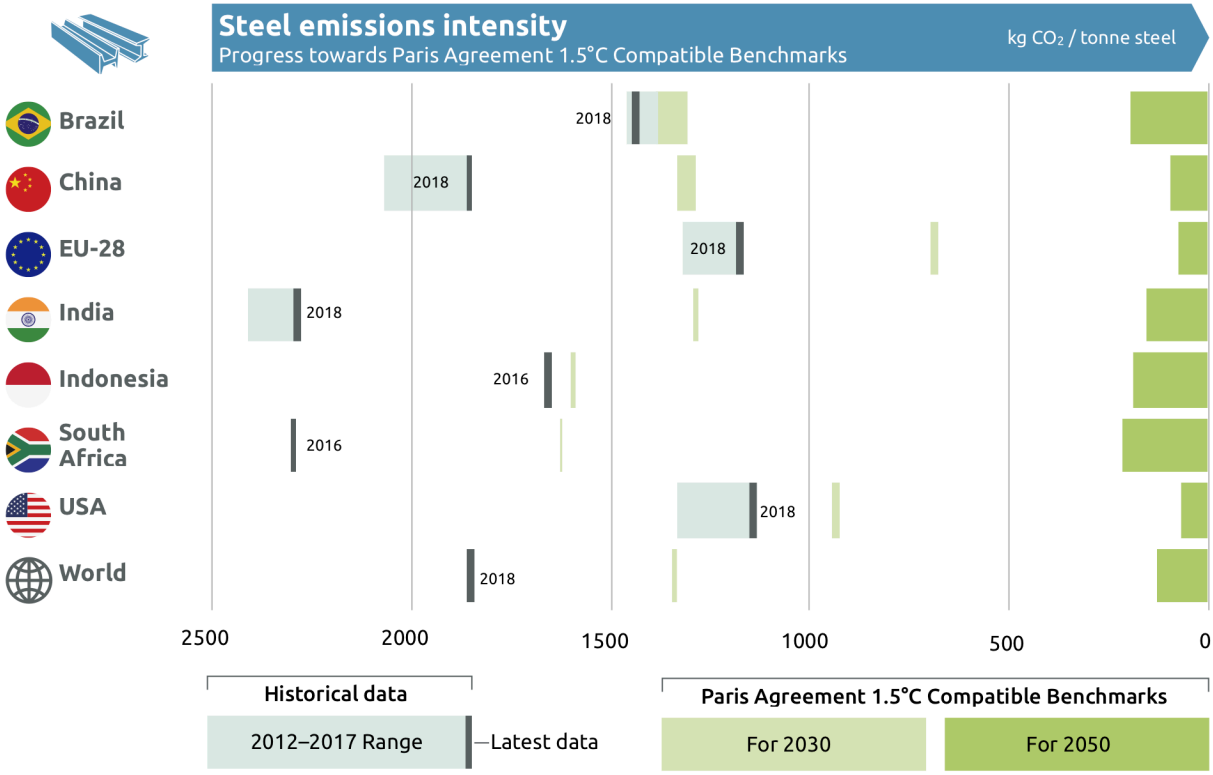
- The share of zero emission fuels for the total of domestic transport (all modes and passenger / freight) need to be reduced close to 100% by 2050.
- A special case is Brazil, whose 2030 benchmark for the percentage of low-carbon fuels in the transport sector is the highest of any countries analysed, primarily due to the high proportion of biofuels already in use.
- Given the technological difficulties in achieving total decarbonisation in shipping and aviation, most 2050 benchmarks for the share of low emission fuels do not quite reach 100%. There is also a degree of uncertainty as to the potential for developing countries to achieve zero emissions passenger transport by 2050, expressed by the fact the 2050 land-based emissions per passenger km benchmarks for these countries are a range with the lower bound as zero. This is also therefore the case for the global 2050 benchmark which is expressed as a range.

Industry



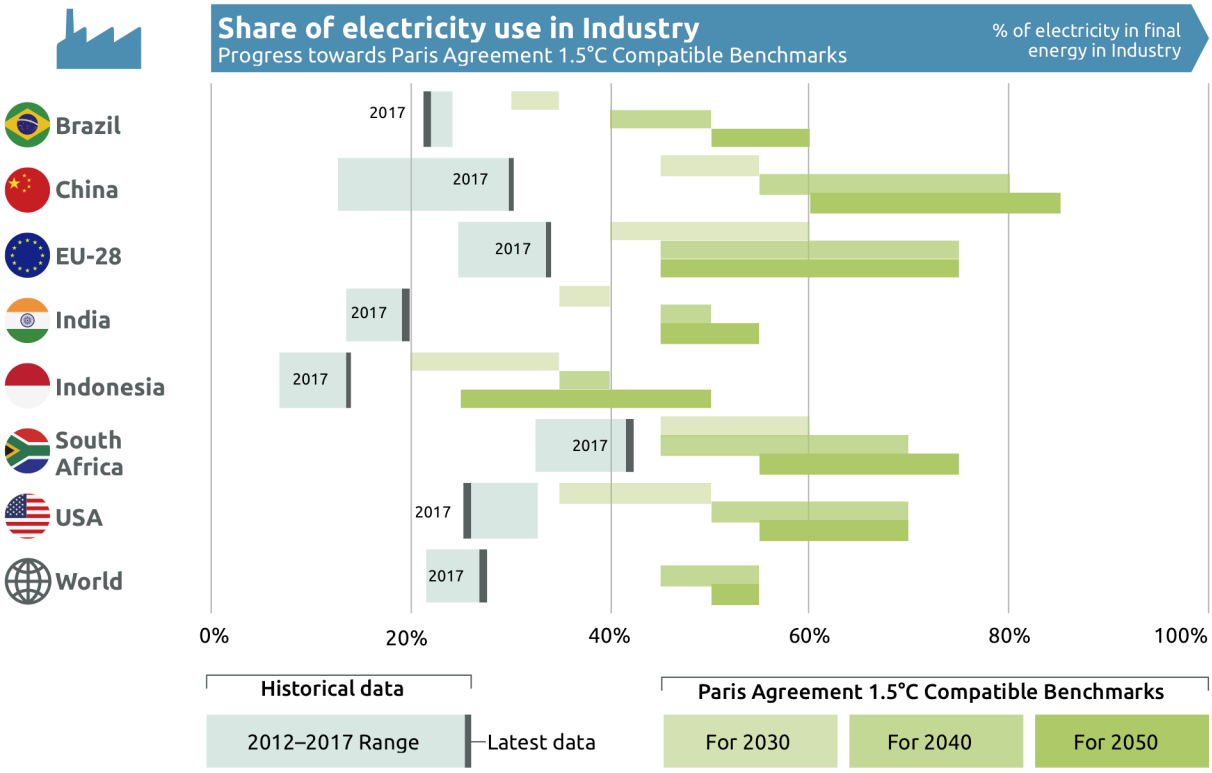
- **Emissions intensity in the cement industry** can be reduced by 90% by 2050, and possibly further, when all cement decarbonisation options are implemented. With additional efforts in material substitution and material efficiency (not considered here in detail), the cement sector as a whole could achieve zero emissions by 2050. This will require significant efforts in terms of investments, research and structural change to eliminate emissions from both fuel combustion and chemical processes.
- By 2030, developing countries can achieve 30% of the reduction and developed countries 40%. They can do this mainly by (1) reducing the share of the emissions-intensive cement clinker from today's levels (up to 90%) to at least 60% by 2030, and 50% by 2050, and (2) transitioning to alternative fuels for thermal energy, including sustainable biomass and waste, with around 20% in developing countries and 40% in developed countries by 2030.
- To achieve decarbonisation in the long term, new decarbonisation options need to be initiated today with research, development and upscaling. Novel cements that have low process emissions (30% by 2050), incorporation of CCS and CCU (covering 65% to 80% by 2050). This would lead to a reduction of around 85% in emissions per tonne of cement by 2050.
- We included an aspirational goal for 2050 of up to zero emissions per tonne of cement if also the promising options of reducing cement demand, including material efficiency and material substitution, were taken into account.

Industry



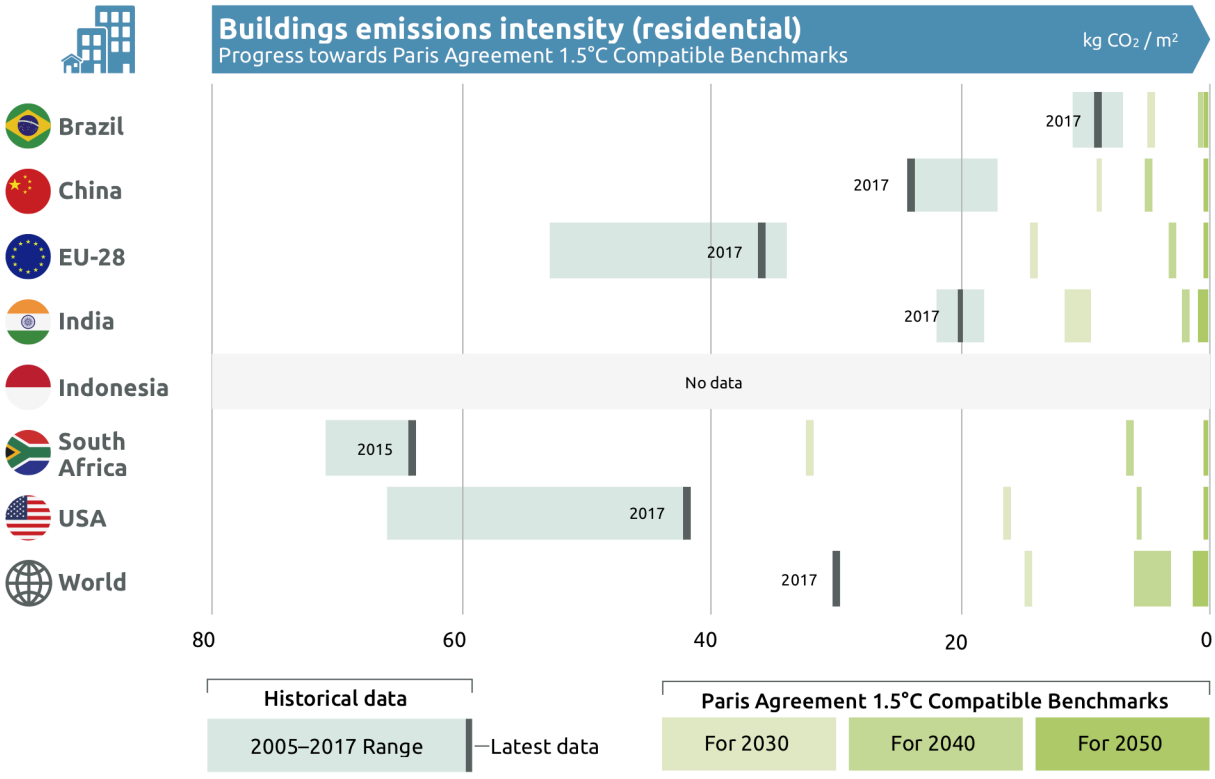
- **Emissions intensity in the steel industry** can be reduced to zero by 2050 by all countries. By 2030, the intensity can be reduced by 25% to 30% with slight variations between countries. There is no clear optimal route to this goal, but country specific choices depend on scrap steel availability, demand, existing stock, captured carbon storage possibilities, and power sector outlook.
- A key route is to maximise the recycling of scrap steel, the maximum share of future production varies between 7-80% based on availability in the respective countries. It reduces energy demand and the improved recycling system can create new jobs. Countries with low scrap availability could explore options to import scrap steel.
- To avoid carbon lock-in, no new conventional primary steel plants (BF-BOF) should be built. All other technology options consume less energy and produce lower emissions. Countries with existing stock should (a) improve energy efficiency, and (b) prepare mid- and long-term strategies for phase-out by 2050 through either technology shift or refurbishment with CCS.
- In the short term, partial fuel switch to charcoal and/or hydrogen or biogas should be considered in conventional plants.
- Significant investment is needed in large-scale demonstration projects for the hydrogen production route to reach between at least 15-30% market share by 2050.
- Material efficiency (using less steel) can result in further emissions reductions. Reducing the amount of steel that is produced, e.g. through material substitution, allows low-carbon technologies to cover higher shares of the final demand.

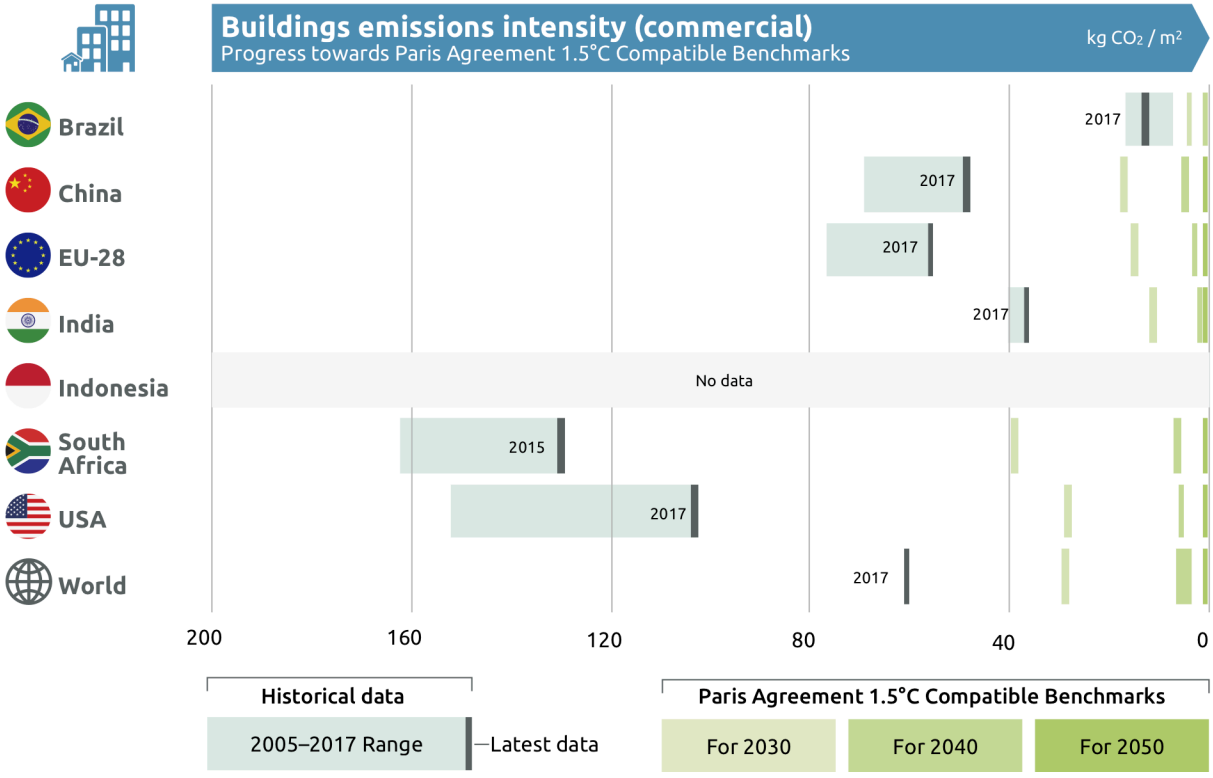
Industry



- **Electrification of industry** (all products, not only cement and steel) needs to increase from its current level of around 27% (2017) to around 50% in 2050 as, for some processes, it provides a potential route for decarbonisation when accompanied by decarbonisation of the power supply. Country differences are relatively small. Not all industrial production processes can be electrified, there other approaches for decarbonisation should be sought.

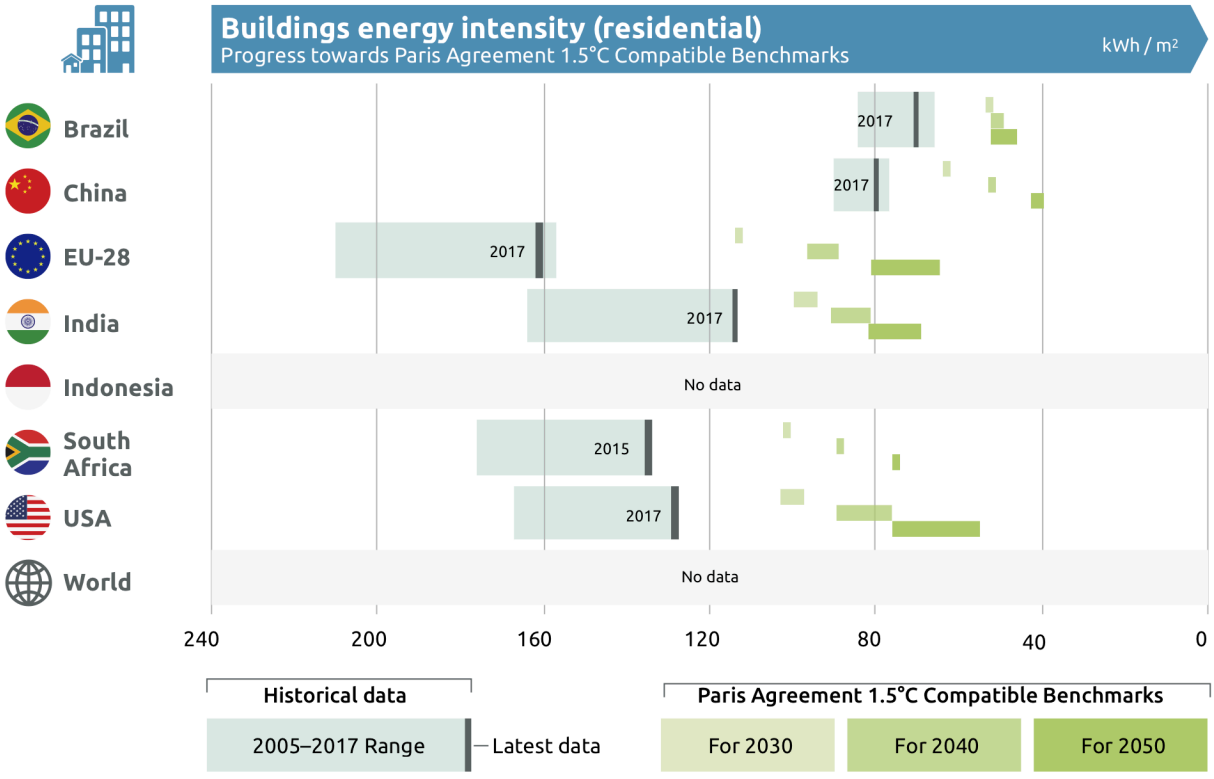
Buildings

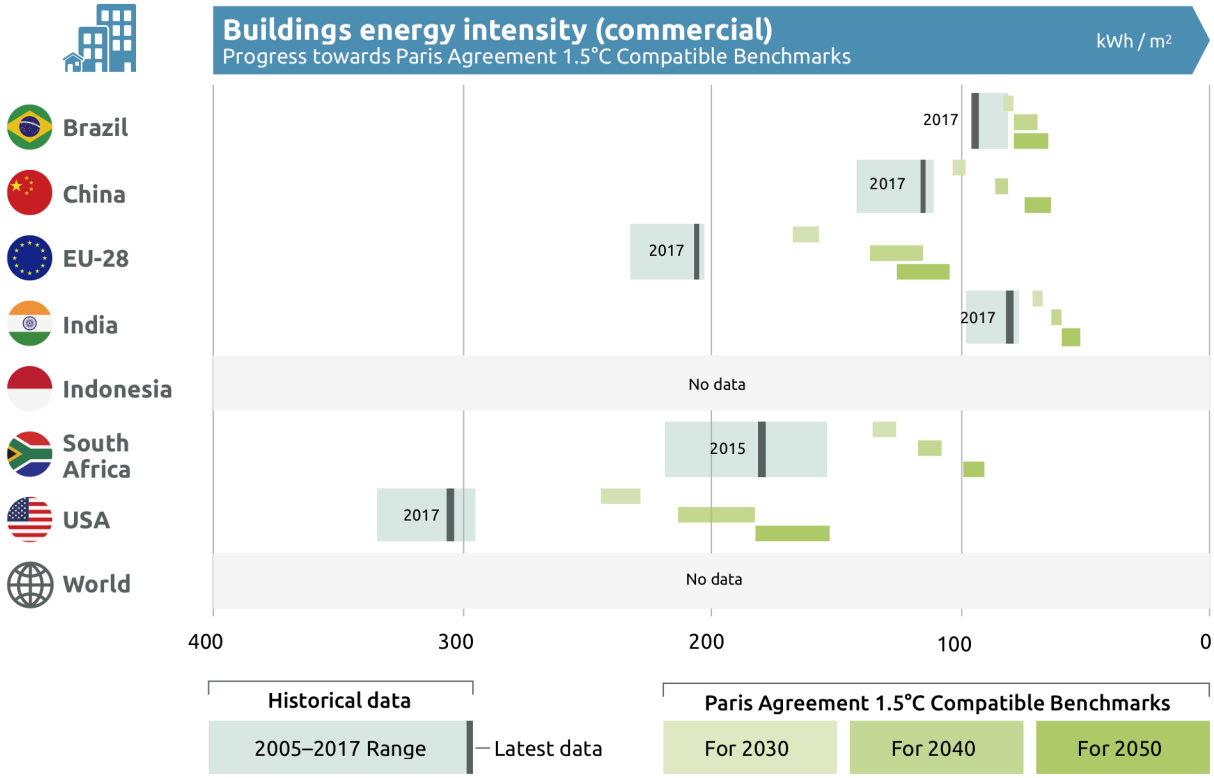




- **Emissions intensity of the building stock** in $kgCO_2/m^2$ converges close to zero by 2040, and 2050 at the latest for all countries. The transition to get to zero varies by country and depends on both current emissions and the energy needs of the country. Heating and cooling needs dominate total energy demand in countries with hot or cold climates.

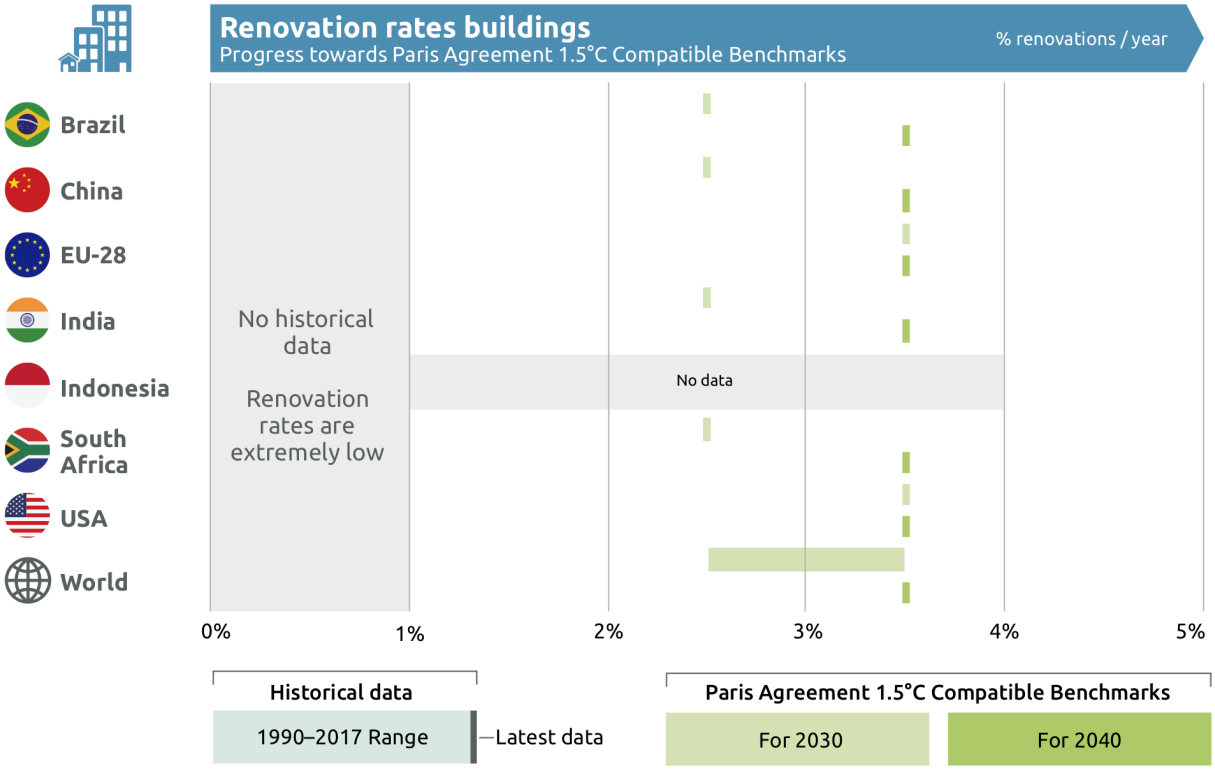
Buildings





- The **energy intensity of the building stock** in kWh/m^2 also needs to be reduced in the order of 50% by 2050 but our benchmarks have a broader range than those for emissions intensities to allow meeting zero emissions through either low energy demand or zero carbon energy.

Buildings



- **All new buildings** from now on in all countries need to be of a high standard and equipped with heating and cooling technologies that either are or can be zero emissions. In many countries, much of the building stock that will exist in 2050 is yet to be built. Heat pumps, solar thermal water heaters and high thermal building standards are key to keeping energy demand and emissions low while providing comfortable living standards.
- **Renovation rates** of existing buildings need to be increased to the order of 3.5% per year, in EU and USA as early as 2030 as in those countries much of the building stock in 2050 has already been built, using the same technologies as the new buildings.

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The Climate Action Tracker (CAT) is an independent scientific analysis produced by three research organisations tracking climate action since 2009. We track progress towards the globally agreed aim of holding warming well below 2°C, and pursuing efforts to limit warming to 1.5°C.

The Consortium

NewClimate Institute is a non-profit institute established in 2014. NewClimate Institute supports research and implementation of action against climate change around the globe, covering the topics international climate negotiations, tracking climate action, climate and development, climate finance and carbon market mechanisms. NewClimate Institute aims at connecting up-to-date research with the real world decision making processes.

newclimate.org

Climate Analytics is a non-profit climate science and policy institute based in Berlin, Germany with offices in New York, USA, Lomé, Togo and Perth, Australia, which brings together interdisciplinary expertise in the scientific and policy aspects of climate change. Climate Analytics aims to synthesise and advance scientific knowledge in the area of climate, and by linking scientific and policy analysis provide state-of-the-art solutions to global and national climate change policy challenges.

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Bibliography

Climate Action Tracker. (2020). *A government roadmap for addressing the climate and post COVID-19 economic crises.*

Climate Action Tracker. (2020). *Sectoral Benchmarks for achieving the Paris Agreement.*

Fuss, S., Lamb, W.F., Callaghan, M.W., Hilaire, J., Creutzig, F., Amann, T., Beringer, T., de Oliveira Garcia, W., Hartmann, J., Khanna, T., Luderer, G., Nemet, G.F., Rogelj, J., Smith, P., Vicente, J.L.V., Wilcox, J., del Mar Zamora Dominguez, M., Minx, J.C., 2018. Negative emissions—Part 2: Costs, potentials and side effects. Environ. Res. Lett. 13, 063002. https://doi.org/10.1088/1748-9326/aabf9f

IPCC, 2018. IPCC Special Report on the impacts of global warming of 1.5°C.

Yanguas Parra, P.A., Ganti, G., Brecha, R., Hare, B., Schaeffer, M., Fuentes, U., 2019. Global and regional coal phase-out requirements of the Paris Agreement: Insights from the IPCC Special Report on 1.5°C.