A methodology for tracking decarbonisation action and impact of the buildings and construction sector globally

Developing the GlobalABC Building Climate Tracker

10 YEARS BPIE

Global Alliance for Buildings and Construction

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Background and objective

This paper develops a methodology to track decarbonisation in the buildings and construction sector worldwide. A set of individual indicators is used to identify trends in decarbonisation action and impact. The methodology is based on the OECD approach for developing composite indicators1 and is applied to data collected from the existing GlobalABC Global Status Reports and other sources to create the Buildings Climate Tracker or 'decarbonisation index', a composite indicator. The approach and methods are described, discussed and extended in this paper.

Objective of the tracker

The primary objective of the tracker is to show the efforts made towards – and the impact of – decarbonisation of buildings worldwide, using suitable and reliable data aggregated in a transparent, consistent and continuous way.

In the context of the tracker, the definition of the term "decarbonisation" and its measurement go beyond mere observations of greenhouse gas (GHG) emissions and reflect the efforts made by policymakers, governments, regulators, industries, and other key institutional and regional actors towards the decarbonisation of the building and construction sector globally.

Scope of the tracker

The Buildings Climate Tracker focusses on the decarbonisation of buildings worldwide. In its current state it considers indicators related to building construction, use and renovation, but it excludes the demolition phase and social indicators such as living conditions or housing shortages.

While the focus is on the climate change mitigation of the building sector (i.e. reduction of CO_2 emissions or energy savings), the tracker also contains information about adaptation and resilience to climate change. Some measures such as building codes incorporate and address all three aspects – i.e. mitigation, adaptation and resilience – by outlining the requirements for new and existing buildings to face current and future risks accordingly.

Approach and methods

The approach and methodology are based on the OECD approach for composite indicators[1] and applied to data collected from the existing GlobalABC Global Status Reports and other sources to create the Buildings Climate Tracker or 'decarbonisation index', a composite indicator. The developed, structured approach consists of five steps. Data collection, analysis, and selection precede the normalisation and aggregation of the indicators into a composite index.

[1] Based on the Handbook on Constructing Composite Indicators (OECD & JRC) 2008 [1]

Data collection

To develop the methodology of the tracker an initial data collection exercise was conducted on two main sources of information available from GABC:

I. Global Building Status Reports (2016 – 2019) [2]–[5]
II. Global and Regional Roadmaps for Building and Construction [6], [7]

Global Building Status Reports from the past have documented the status and trends of key indicators of energy use, emissions, technologies, policies and investments to track the progress of the building and construction sector globally. These reports functioned as the first source of information for development of an initial list of 47 data or information points that could potentially serve as indicators (see Table 1). They were identified based on topic areas covered in the annual reports published since 2016, and from the relevant activity and action areas from the Global and Regional Roadmaps for Building and Construction.

Table 1: List of possible indicators extracted from different topic areas

1. Global final energy use (kWh/m^2/year)
2. Global share of space and water heating technologies (%)
3. Global building sector energy consumption (EJ)
4. Cement and steel demand for buildings by region (million tonnes)
5. Building sector energy intensity (global) (kWh/m^2/year)
6. Global building structure material (%) and material intensity (kg/m^2)
7. Building energy carbon intensities by country (CO_2 per TJ)
8. GHG emissions per m² of floor area renovated
9. Building sector energy consumption by sub-sector (EJ)
10. Building envelope improvements (EJ)
11. Global energy-related CO_2 emissions share (%)
12. Government and policy-related spending on energy efficiency in buildings in a range of countries ($billion)
13. Global buildings sector energy-related emissions ($GtCO_{2/year}$)
14. Data and measurement (global trends)
15. Global final energy consumption share (%)
16. Human factors and energy demand
17. Energy saving potential from digitalisation (EJ)
18. Energy technology intensities (kWh/m^2)
19. Global building sector GHG emissions saving potential ($GtCO_2$)
20. Energy saving potential of technologies (EJ)
21. Building energy codes and standards (no. of countries)
22. Global building sector end-use energy consumption (index)
23. Building energy certification (no. of countries)
24. Building sector energy consumption by fuel share (%)
25. Global building technology policy (recommendations)
26. Energy saving from improved air-conditioner performance (PJ)
27. Global building sector emissions coverage in NDCs (%)
28. Influence factors on global buildings energy use (EJ)
29. Share of building emissions covered by NDCs, policies or both (%)
30. Factors influencing global appliance energy use (EJ)
31. NDC with building sector actions (no. of countries)
32. Global residential fuel and access to electricity (%)
33. Resilient buildings
34. GHG emissions per m² of floor area constructed
35. Material policy trends (NDCs)
36. Building floor area growth by region (billion m^2)

37. Circular economy
38. Energy efficiency investment by region (global) ($billion)
39. Clean energy transition
40. Incremental energy efficiency investments in buildings (global) ($billion)
41. Urban solutions
42. Specific technologies mentioned in NDCs
43. Architecture solutions
44. Lighting sales (%) and lamp efficacy (lumen/watt)
45. Share of equipment stock in key energy efficiency technologies (%)
46. Labelled green bonds (%)

From the building sector energy consumption by fuel share (%) we determined the share of renewables use decentrally, in order to track the decentral substitution of fossil fuels. As the energy certification progress is not meaningfully tracked by the number of countries with such schemes, we researched and found further data sources. These are explained in the description of the indicators on page 7.

Review and identification of indicators

After the data collection, the potential quantitative and qualitative indicators listed in Table 1 were reviewed to identify those that indicate status or progress over time and thus contribute to the tracking objective: *decarbonisation*. The review considered the aspects of measurability, source of data, detail of data, geographical coverage and added relevance to decarbonisation, and the extent to which the indicators could be tracked through quantification during the selection process.

For each of the 47 potential indicators the following aspects were analysed to assess their suitability for the tracker:

a) Measurability (e.g. quantitative or qualitative data)
b) Source of data (e.g. quality and availability)
c) Detail of data (e.g. sector or subsector, residential or non-residential buildings etc.)
d) Geographical coverage

A few examples from the analysis are given below:

- 'Human factors' could not be included because the section in the Global Status Reports (GSRs) describing human factors did not allow conclusions about the progress between years nor about how far these measures come from the perspective of decarbonisation. Heating behaviour or the choice of setpoint temperature are two examples.
- 'Material intensity' is the material used per floor area. It could not be included because the data was only available for one year. The indicators for material and floor area did not allow a composite indicator to be created because the data had different scopes. For example, the floor area only showed the scope of new construction for residential and non-residential buildings but did not include any renovation activities. This indicator has the potential to be included in the list but may need additional analysis.
- 'Data and measurement' could not be included as it merely highlights non-quantifiable information such as the barriers and challenges in data availability across the countries and a few examples of how data is being made available in the public domain. To use it as an indicator in

the tracker, one direction could be to identify principal areas of data capture and measurement or interest areas based on geographical coverage.

As a result of this deeper review, a lot of the identified topic areas (potential indicators) had to be excluded from the available set, as they consisted only of examples without giving a complete picture of the topic's evolution and did not indicate a status or progress over time.

Seven quantitative indicators were considered for further evaluation for a meaningful analysis: see Table 2.

Table 2: Identified indicators for the tracker

- Global buildings sector energy-related emissions ($GtCO_2$/year)
- Building sector energy intensity (global) (kWh/m^2/year)
- Renewable energy share in final energy in global buildings (%)
- Building energy codes and standards (no. of countries)
- Incremental energy efficiency investments in buildings (global) ($billion/year)
- NDCs with building sector action (no. of countries)
- Green building certifications (cumulative growth)

Description of the indicators

Details of the meaning, scope, measurement unit, and source of each indicator were then analysed. This information was essential for the weighting and aggregation that followed.

Global buildings sector energy-related emissions ($GtCO_2$/year)

This indicator refers to the direct and indirect emissions (from electricity and commercial heat production) in buildings. Global buildings sector emissions are dominated by indirect sources, mostly power generation, and reflect the fuels used to meet end-use demand for heating, lighting, cooking etc.

Source: Indicator available from Global Status Report (GSR) (2019) [2] using data from the IEA [8]

Renewable energy share in final energy in global buildings (%)

This indicator refers to the share of renewables in the final energy use of the building sector globally. The indicator is derived from the global buildings sector final energy use by fuel type (EJ). Renewables includes solar thermal technologies as well as modern biomass resources (e.g. pellets and biogas).

Source: Derived indicator from GSR (2019) [2] using data from the IEA [8]

Building energy codes and standards (no. of countries)

This indicator refers to the global coverage of voluntary or mandatory building energy codes and standards. Building energy codes and standards are regulatory instruments that set minimum requirements for energy efficiency and/or use of resources in buildings (e.g. requirements for energy efficiency and renewable energy sources).

Source: Indicator available from GSR (2016 – 2019)[2]–[4], [9] using data from the IEA [8]

Incremental energy efficiency investment in buildings (global) ($billion/year)

This indicator refers to the total energy efficiency project costs, including the sum of incremental energy efficiency investments and all other costs for energy efficiency services and products.

Source: Indicator available from GSR (2016 – 2019) using data from the IEA [8]

NDCs with building sector action (no. of countries)

This indicator refers to the number of Parties (countries) that have submitted an NDC mentioning specific actions related to buildings.

Source: Indicator available from GSR (2016 – 2019) using data from the IEA [8]

Green building certification (cumulative growth)

This indicator refers to the cumulative growth of voluntary green building certifications globally under leading schemes LEED, BREEAM and DGNB that evaluate the performance of a building and its energy service systems. Certification may focus on rating operational energy use or the expected (or notional) energy use of the building.

These schemes were researched and included because they provide information on the growth of certification development that was not available in the original data set. They show the number of annual worldwide certifications and are the three biggest in the world.

Source: Developed indicator using databases from LEED, BREEAM and DGNB

Building sector energy intensity (global) (kWh/m^2/year)

This indicator refers to the final energy used in buildings per unit of floor area. The final energy includes space heating and cooling, cooking, water heating, lighting, appliances and other. Appliances and other includes household appliances (e.g. refrigerators, washers and televisions), smaller plug loads (e.g. laptops, phones and other electronic devices) and other services equipment.

Source: Indicator available from GSR (2016, 2019)

Weighting

The tracker combines the seven indicators in order to monitor the progress of decarbonisation in the building sector. When all the indicators are aggregated into one number to demonstrate this progress (decarbonisation index), their individual contributions are balanced through weighting to address the tracker objective adequately and not over- or under-represent certain aspects.

In the analysis, the indicators could be categorized in two groups. Its results are robust and calculated for two key aspects: (i) decarbonisation impact[2] (e.g. CO_2 emissions, energy unit intensity, renewable

[2] Decarbonisation impact is defined as an outcome of the actions that influence CO_2 emissions, final energy demand or the share of renewable energy sources used in buildings.

energy share) and (ii) decarbonisation action[3] (e.g. policy action, green building certifications, energy efficiency investments). Each indicator is either categorised as impact or effort: see Table 3.

Table 3: Weighting of the indicators composing the tracker

	Indicator	Impact vs. Effort	Weight
Impact	Global buildings sector energy-related emissions ($GtCO_2$)	applied as a factor	
Impact	Building sector energy intensity (global) (kWh/m2/year)	37%	19%
	Renewable fuel share (%)		19%
Effort	Building energy codes and standards (global)	63%	18%
	Energy efficiency investment by region (global) ($billion)		11%
	NDC actions (global)		15%
	Green building certification (global)		19%

The indicators for impact together make up 37% of the tracker results while the effort contributes 63% of the weight. Figure 1 visualises them and the resulting weighting that is based on the expert judgement and the interpretation of the objective defined for the tracker. This weighting was reviewed by the GABC GSR task force members. The normalised CO_2 emissions are applied as a factor to all indicators as they represent the central goal of climate mitigation. This is further described in the normalisation and aggregation section.

[3] Decarbonisation action is defined as those actions that aim to contribute or enable the reduction of CO_2 emissions such as policy and industry actions.

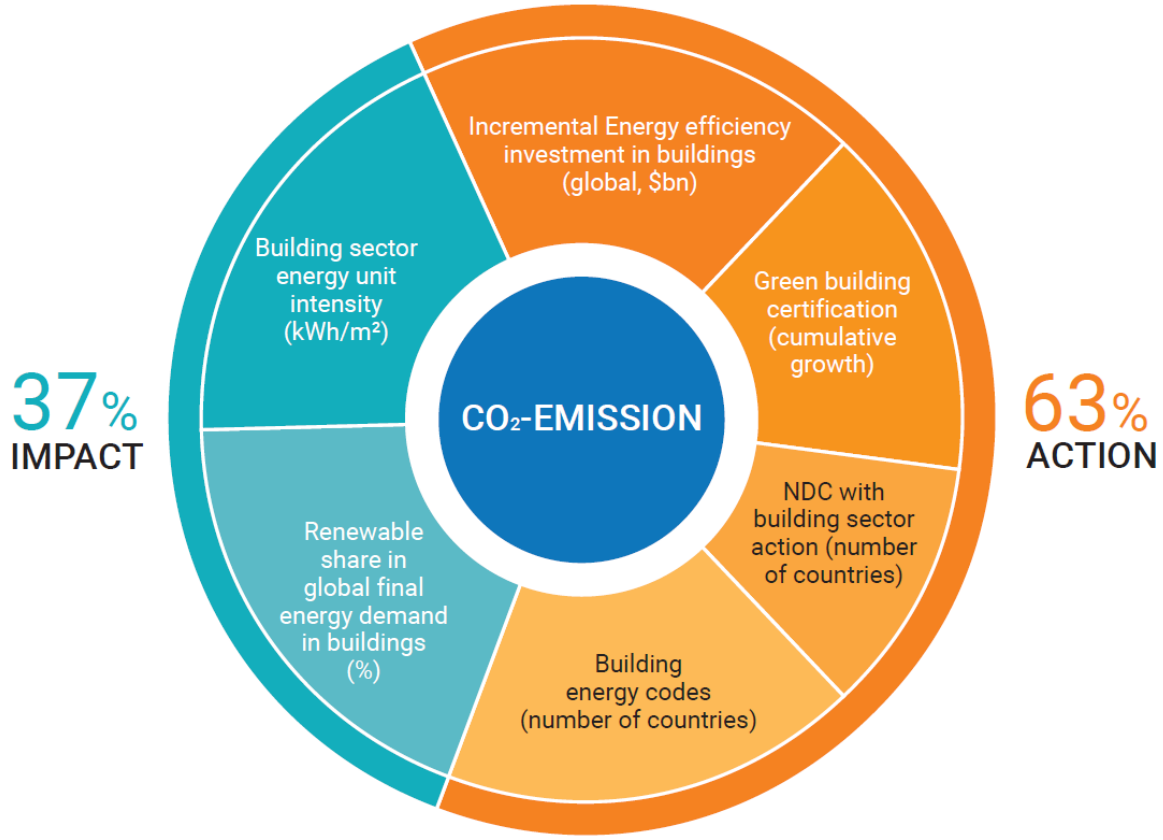

Figure 1: Weighted composition of the tracker

Normalisation and aggregation

Before the aggregation, the indicators had to be transformed and normalised.

To be able to aggregate all the indicators, compositional data were transformed to real space using the isometric log ratio transformation[10]. All indicators need the same space from a statistical perspective. In other words, there are indicators that have no theoretical limit, such as the emissions or the investments. Other indicators cannot grow beyond a certain value, such as the number of countries with building codes or the share of renewables. The latter were transformed using the isometric log ratio transformation[11].

Normalisation including rescaling is necessary prior to aggregating indicators with different scales and to show the current decarbonisation index as a share of the goal of 100% decarbonisation by 2050. The normalisation requires the definition of a starting point and the goal[12]. As a starting point we define the year 2015. As a goal, for example, for the indicator “building energy codes (number of countries)”, we assumed that all 197 countries have building energy codes. For simplification, it is assumed that all indicators have the same distribution between their start and their goal value. In other words, for example, it is assumed that it would be just as hard to replace the last 5% of fossil fuel burners in buildings as it is to equip the 5% of countries with building codes.

The goals are defined independently for each indicator reflecting the state-of-the-art and expert knowledge of what is necessary to achieve decarbonisation. As the indicators are in fact not completely independent and there are different ways to achieve decarbonisation some of these indicators may not reach their goal although the overall decarbonisation is achieved. To ensure that when CO_2 emissions are zero the tracker will show 100%, the normalised CO_2 emissions are used as a factor on all indicators.

The last step is the actual aggregating where the normalised, transformed and weighted indicators are added, with the exception of the CO_2 emissions. As this indicator forms the main measure for tracking decarbonisation it is applied as a factor to all indicators.

Limitations

The current index version is the first effort at establishing such a global tool. It is limited by data availability, the reliability of data and the (lack of) provision of historical data series. Its limitations highlight the need to improve data collection and provision for the buildings and construction sector globally. Nevertheless, the index is a useful step to monitor the decarbonisation development of the sector.

The index composition is currently limited to the inputs from the Global Status Reports and the Regional Roadmaps. More indicators are needed to enlarge the picture on decarbonisation and on the efforts in the building sector. For example, the complete building life cycle covering emissions during construction, renovation and at the end of the building life could be included in the future. Other indicators for effort could be considered to give credit to innovations and their market diffusion, as well as to the change in the industry and its value chain. These additional indicators need to be assessed and data needs to be found on a worldwide scale to provide the necessary facts.

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