NewClimate Institute, Verra

Buildings Efficiency Guidance

Guidance for assessing the greenhouse gas impacts of buildings policies

May 2018

How to identify the GHG impacts of buildings policies to assess

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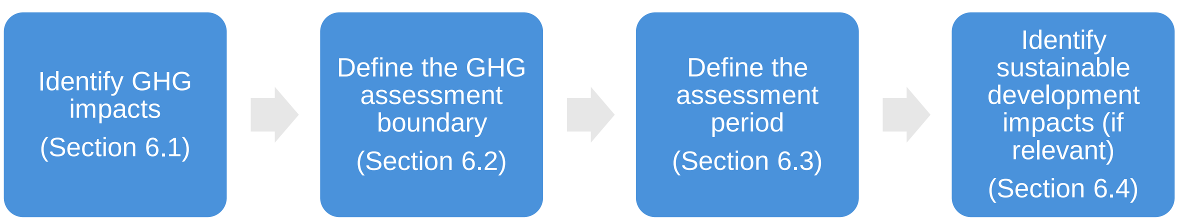
6. Identifying Impacts: How Buildings Policies Reduce GHG Emissions

In order to estimate the GHG impacts of a policy, it is important to understand how the policy is intended to be implemented and how it will achieve the desired GHG outcome. This chapter provides examples of the most common intermediate effects and GHG impacts of buildings policies, and guidance for users to identify additional impacts for specific policies. A map of the causal chain for buildings policies is provided. A subset of impacts that are considered significant is included in the GHG assessment boundary. Guidance is also provided on defining the assessment period. The steps in this chapter are closely interrelated. Users can carry out the steps in sequence or in parallel, and the process may be iterative.

Figure 6.1: Overview of steps in the chapter



Checklist of key recommendations

- Identify the intermediate effects of the policy
- Identify all potential GHG impacts of the policy and all associated GHG source categories
- Develop a causal chain
- Include all significant GHG impacts in the GHG assessment boundary
- Define the assessment period

6.1 Identify GHG impacts

6.1.1 Identify intermediate effects

Intermediate effects are changes in behaviour, technology, processes or practices that result from a policy. The identification of intermediate effects enables a complete and accurate assessment, and is necessary to identify the potential GHG impacts of the policy and develop a causal chain.

It is a *key recommendation* to identify the intermediate effects of the policy. In order to identify these, users should identify the stakeholders, and the inputs and activities that are needed to implement the policy, as set out in the subsequent sections.

Identify stakeholders

Identifying stakeholders affected by the policy is important to ensuring that the list of intermediate effects and GHG impacts is complete. Stakeholders can be people, organisations, communities or individuals. Stakeholders include different agencies and levels of government, as well as civil society and private sector organisations. Stakeholders may be affected by the policy or may influence the policy's implementation.

Users should develop a comprehensive list of stakeholder groups that are impacted by the policy. Some typical stakeholders for the buildings sector include:

- Departments or ministries of energy or buildings
- Building supervisory authorities
- Equipment manufacturers
- Energy efficiency materials and appliance developers
- Architects and designers
- Engineers
- Builders and contractors
- Building owners
- Investors
- Utilities

It is helpful use a participatory process to identify a full range of stakeholders and to understand how they may be affected by or influence the policy. The ICAT *Stakeholder Participation Guidance* provides information on how to identify stakeholders (Chapter 5).

Identify inputs and activities

In order to identify intermediate effects and GHG impacts of a policy, users first identify the inputs and activities involved in implementing a policy. Table 6.1 provides some examples of the inputs and activities for the policies targeted in this guidance.

Table 6.1: Examples of inputs and activities for buildings policies

	Definition	Examples
Inputs	Resources that go into implementing a policy	Investment in establishment and/or enforcement of the following: • Building codes • Minimum energy performance standards for appliances • Mandatory labelling, certification and energy audits • Financial support policies

Activities	Administrative activities involved in implementing the policy (undertaken by the authority or entity that implements the policy)	Heating, cooling, lighting and appliances
		• Labels and certifications issued, audits completed, building permits issued
		• Construction of new energy-efficient housing:
		  ○ Efficient fuel systems (e.g., efficient HVACs, heat pumps)
		• Deep retrofits of existing housing stock:
		  ○ Enhanced heating systems
		  ○ Improved insulation of walls and windows
		  ○ More energy-efficient appliances (e.g., HVACs, mini-split)
		Hot water
		• Use of solar for hot water
		• Installation of more energy-efficient hot water heaters
		Electricity supply
		• Use of solar PV

Identify intermediate effects

Intermediate effects can be categorised as *intended* or *unintended*, depending on the context leading to their occurrence. Unintended intermediate effects can occur as a result of compensating actions. Unintended effects can impact other sectors and stakeholders not targeted by the policy. Users should consider both intended and unintended intermediate effects. When identifying intermediate effects it may help to consider this general framing question: If the effect X happens, what do we expect the reactionary effect to be?

Rebound effects are a type of unintended effect and are a reduction in expected gains from new energy-efficient technologies because of behavioural or other systemic responses. For example, consumers who invest in energy-efficient buildings and appliances often accrue economic savings from the lower cost of energy services. They may in turn use this additional income on other more energy-intensive consumption, or increase the intensity of their use of certain appliances. Thus, rebound effects may potentially increase GHG emissions, but these effects are difficult to predict as they depend on changes in consumer behaviour that are driven by a number of factors.

Examples of intermediate effects for buildings polices include:

- Heating and cooling:
  - Use of, and increased demand for, more energy-efficient fuel systems (e.g., efficient HVACs, heat pumps)
  - Use of, and increased demand for, enhanced heating systems allowing for better user control
  - Increased awareness of energy use
  - Increased demand for efficient window materials
  - Increased demand for insulation materials for walls
  - Downsize of fuel systems
  - Reduced energy demand
  - Reduced household expenditure on energy
  - Increased manufacture of materials and appliances
  - Switch to more energy-efficient appliances (e.g., HVACs, mini-splits) and maybe different fuel types
- Hot water
  - Use of and increased demand for more energy-efficient hot water heaters
  - Reduced energy use
  - Increased use of solar for hot water
  - Decreased fuel use by hot water heater
  - Change in emission source due to switch in fuel
- Lighting and appliances
  - Use of and increased demand for more energy-efficient lighting and appliances
  - Increased manufacture of materials for lighting and appliances
- Electricity supply
  - Switch to solar PV
  - Use of solar PV materials
  - Increased manufacture of solar PV materials
  - Reduced electricity demand from the grid
  - Reduced grid infrastructure enforcement needs due to decentralised solutions
  - Less infrastructure development

6.1.2 Identify potential GHG impacts

It is a *key recommendation* to identify all potential GHG impacts of the policy and all associated GHG source categories. Guidance for this is provided below, and further discussion on the process is available in the *Policy and Action Standard*. There are several types of GHG impacts to consider, as described in Table 6.2.

Table 6.2: Types of GHG impacts

Type of GHG impact	Description	Example of GHG impact
Positive impact vs. negative impact	Impacts that cause decrease or increase in GHG emissions	*Positive*: Reduced GHG emissions due to reduced electricity demand from the grid *Negative*: Increased GHG emissions due to manufacturing of energy efficient equipment
Intended impact vs. unintended impact	Impacts that are both intentional and unintentional based on the original objectives of the policy	*Intended:* Reduced GHG emissions due to fuel switch and downsize of fuel system; reduced GHG emissions where fuel switch for energy-efficient appliances is to a less carbon-intensive emission source *Unintended:* Marginal increase in energy use due to change in behaviour brought about by energy efficiency improvements (i.e., "comfort taking" or rebound effect)
In-jurisdiction impact vs. out-of-jurisdiction impact	In-jurisdiction impacts are those that occur inside the geographic area over which the implementing entity has authority, such as a city boundary or national boundary. Out-of-jurisdiction impacts occur outside of the geopolitical boundary	*In-jurisdiction*: Reduced GHG emissions due to reduced manufacturing of non-energy efficient equipment *Out-of-jurisdiction*: Increased GHG emissions due to manufacturing of imported equipment in other jurisdictions
Short-term impact vs. long-term impact	Impacts that are both nearer and more distant in time, based on the amount of time between implementation of the policy and the impact	*Short-term*: Increased GHG emissions due to disposal of non-energy efficient equipment *Long-term*: Increased emissions due to rebound effect (i.e., increased energy efficiency resulting in improved access and affordability)

Users should identify all GHG source categories associated with the GHG impacts of the policy. Table 6.3 provides the main sources and GHGs affected by policies in the buildings sector.

Table 6.3: Examples GHG sources for buildings policies

Source category	Description	Emitting entity or equipment	Relevant GHGs
Buildings and appliances	Combustion of and fossil fuels for energy generation	Power plants, natural gas network distributor	CO_2, CH_4, N_2O
Grid-connected electricity generation	Fossil fuel combustion to generate grid-connected electricity	Grid-connected power plants	CO_2, CH_4, N_2O
Manufacturing of materials	Manufacturing of materials for energy efficient equipment	Industry	CO_2, CH_4, N_2O, HFCs

Although beyond the scope of the guidance, it is worth noting that emissions in the buildings sector can also be quantified using life-cycle GHG accounting, which does allow for the assessment of the full life-cycle of GHG emissions that are associated with extraction of raw materials, manufacturing, transportation, use and disposal of building materials. The life cycle perspective accounts for all emissions associated with the policy regardless of the timeframe, or the source or sector responsible for producing emissions. This approach is different from the GHG inventory accounting method, which quantifies emissions from certain sources or sectors during a specified quantity of time. This guidance does not cover the life cycle accounting method. However, users should note that due to the long life of buildings, some experts choose to quantify building emissions using the life-cycle GHG accounting method.

6.1.3 Develop a causal chain

It is *a key recommendation* to develop a causal chain. A causal chain is a conceptual diagram tracing the process by which a policy leads to GHG impacts through a series of interlinked and sequential stages of cause-and-effect relationships. The causal chain illustrates how the policy causes intermediate effects, which ultimately result in GHG impacts. Developing a causal chain can help identify intermediate effects and potential GHG impacts not previously identified, and allows users to understand visually how policies lead to changes in emissions.

Figure 6.2: Example of a causal chain for net emissions from heating and cooling shows a high-level, illustrative example of a causal chain for a building code. Causal chains will vary from policy to policy, as will the strength of the links in the causal chain. Users should create their own causal chains, most likely with more (and different) detail from that shown in Figure 6.2: Example of a causal chain for net emissions from heating and cooling.

Start by making a box for the policy, then build from there by adding linkages from the policy to the identified intermediate effects (identified in Section 6.1.1) and GHG impacts (identified in Section 6.1.2). The causal chain represents the flow of changes expected to occur as a result of the policy. Causal chains can also include inputs and activities identified in Section 6.1.1. The *Policy and Action Standard* provides more information about developing causal chains.

The example causal chains in Figures Figure *6.2: Example of a causal chain for net emissions from heating and cooling*, Figure *6.3: Example of a causal chain for net emissions from hot water, lighting and* *appliances* and Figure *6.4: Example of a causal chain for net emissions from electricity supply* are differentiated by the building components that produce GHG emissions: 1) heating and cooling; 2) hot water, lighting and appliances; and 3) electricity supply. Presenting separate causal chains for each building component allows for a simpler visual representation and for users to understand the GHG impacts of the policy on each of these building components.

Where users are also applying the ICAT *Sustainable Development Guidance*, the causal chain can be used as a starting point for a causal chain mapping exercise that includes sustainable development impacts as well as GHG impacts.

Figure 6.2: Example of a causal chain for net emissions from heating and cooling

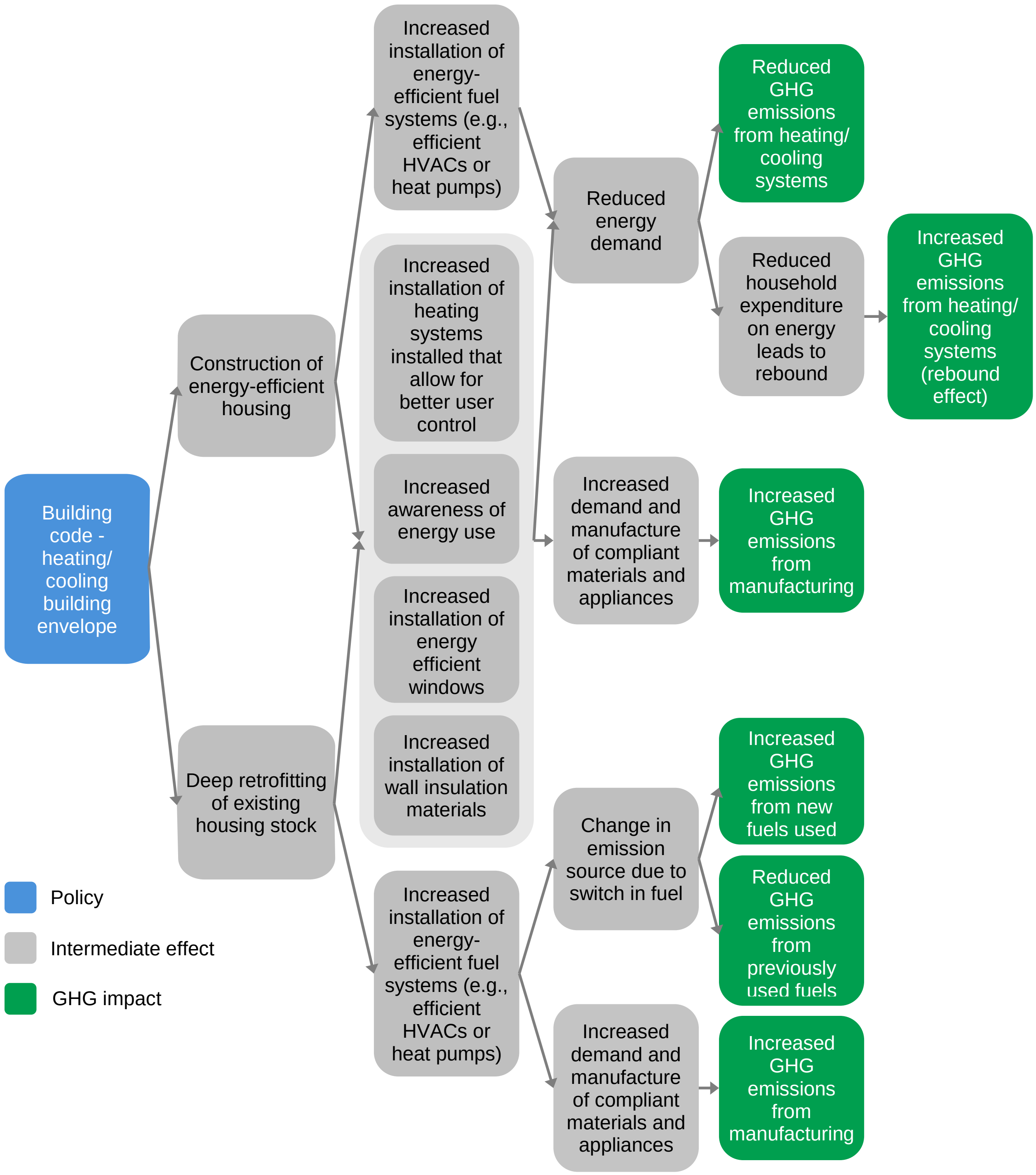
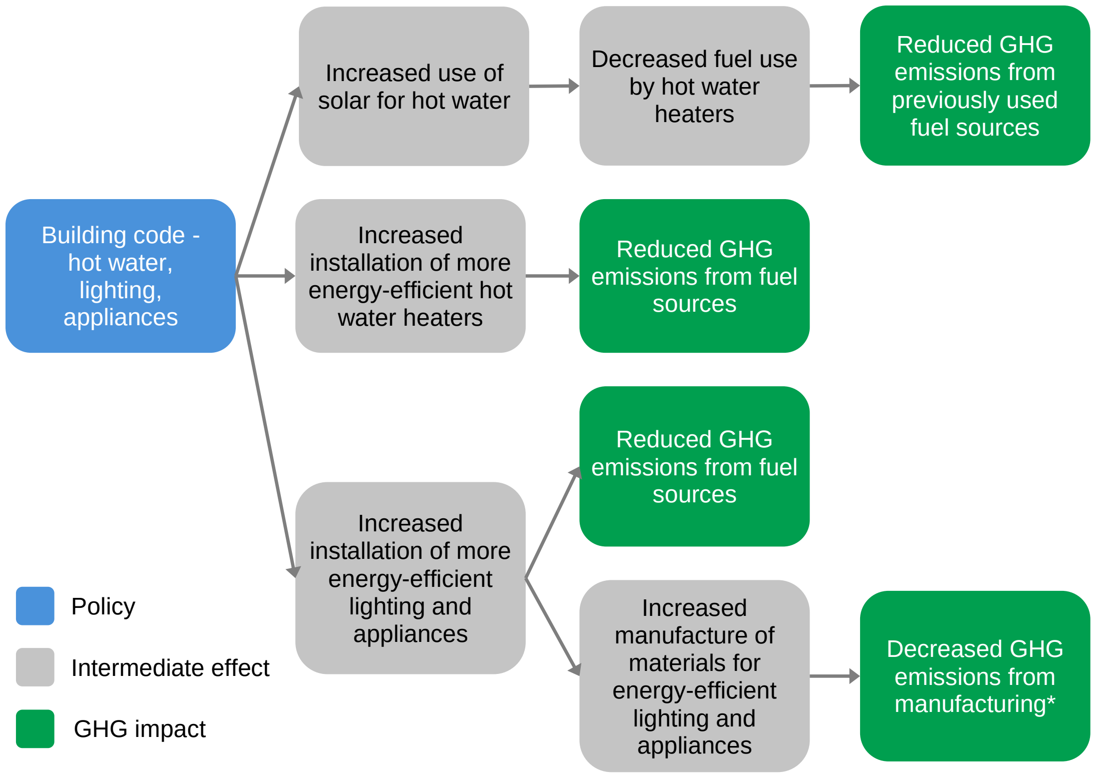
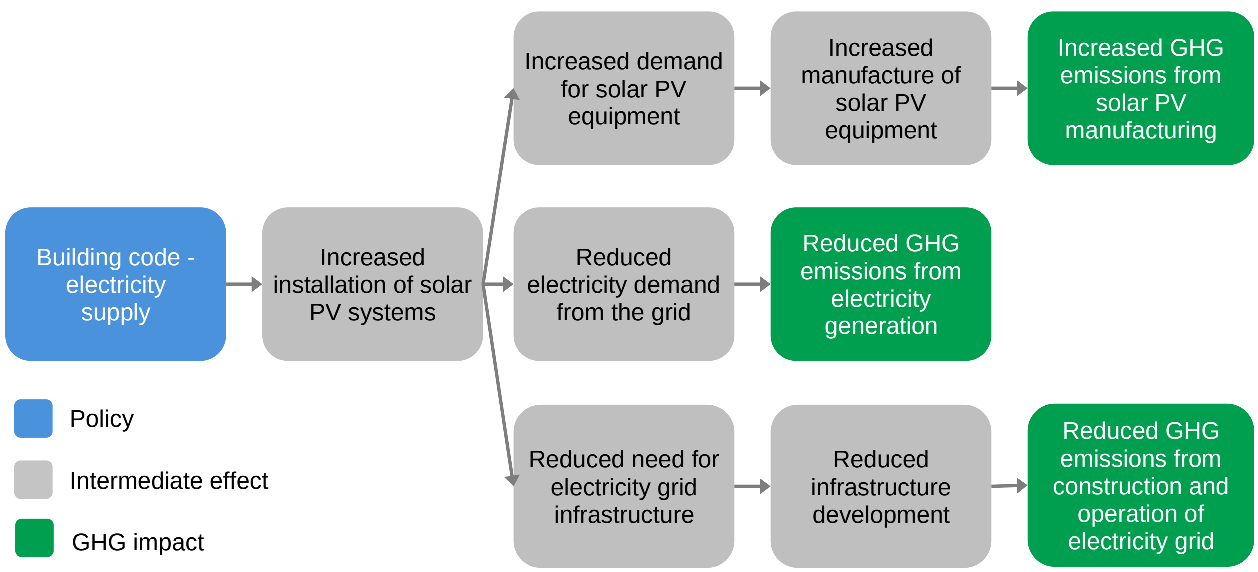


Figure 6.3: Example of a causal chain for net emissions from hot water, lighting and appliances



*LEDs have a longer lifetime and require less maintenance than conventional light bulbs, resulting in reduced life cycle GHG emissions

Figure 6.4: Example of a causal chain for net emissions from electricity supply



6.2 Define the GHG assessment boundary

The GHG assessment boundary defines the scope of the assessment in terms of the range of GHG impacts that are included in the policy assessment. It is a *key recommendation* to include all significant GHG impacts in the GHG assessment boundary.

Determine which GHG sources are significant and should be included in the assessment by evaluating the likelihood and relative magnitude of each of the GHG impacts. Any GHG impacts that are categorised as moderate or major in magnitude and very likely, likely or possible in likelihood should be included in the GHG assessment boundary.

The *Policy and Action Standard* provides further information about categorising GHG impacts. Table 6.4 lists the GHG impacts relevant to the policies covered in the guidance, and indicates whether they are significant based on likelihood and relative magnitude (and should therefore be included in the GHG assessment boundary).

Table 6.4: Examples of GHG impacts included/excluded in the GHG assessment boundary

GHG impact	GHG	Likelihood	Relative magnitude	Included?	Explanation
Emissions from heating and cooling					
Increased GHG emissions from manufacturing	CO_2, CH_4, N_2O, F-gases	Very Likely	Minor	No	Considered insignificant relevant to emissions savings in use phase of equipment
Increased GHG emissions from rebound effect	CO_2	Possible	Moderate	No	High uncertainty in impact
Reduced GHG emissions from reduced energy use	CO_2	Very Likely	Major	Yes	Significant impact for most buildings policies
Increased/reduced GHG emissions due to fuel switch	CO_2, CH_4, N_2O	Likely	Moderate	Yes	May be significant
Emissions from hot water, lighting and appliances					
Increased GHG emissions from manufacturing	CO_2, CH_4, N_2O, F-gases	Very Likely	Minor	No	Considered insignificant relevant to emissions savings in use phase of equipment
Reduced GHG emissions from reduced energy use (due to increased use of energy efficient lighting and appliances)	CO_2	Likely	Major	Yes	Significant impact for most buildings policies

Reduced GHG emissions due to decreased fuel use by hot water heaters	CO_2	Likely	Moderate	Yes	Significant impact for most buildings policies
Emissions from electricity supply					
Increased GHG emissions due to manufacturing of solar PV materials	CO_2, CH_4, N_2O, F-gases	Likely	Moderate	No	Increased emissions offset by reduced emissions from reduced development of grid infrastructure
Reduced GHG emissions due to reduced electricity demand from the grid	CO_2	Very Likely	Major	Yes	Significant impact for most buildings policies
Reduced GHG emissions due to reduced development of grid infrastructure	CO_2	Likely	Moderate	No	See above

Rebound effect

Rebound effects are included in the causal chain as a driver of increased GHG emissions. However, they are not included in the GHG assessment boundary in the guidance, mainly due to the uncertainty and difficulty in predicting the likelihood and magnitude of its impacts in respective country contexts.

Nonetheless, rebound effects can lead to significant GHG impacts in certain circumstances and some users may want to account for them. Users can refer to national expert knowledge, national studies or regional/global analysis[1] on the impact and size of the rebound effect in the buildings sector, where available.

Rebound effects can vary largely between country contexts and depend on a number of factors that cannot be easily quantified (e.g., cultural habits and consumption patterns). Consequently, the quantification of the rebound effect should be based upon informed assumptions. These assumptions on the most relevant aspects should be well documented and justified, which allows for thorough review and revision at later stages.

Users can also opt to apply ranges instead of single values to account for the degree of uncertainty with which a rebound effect impact a policy's results. As the knowledge of how to account for rebound effects increases, these uncertainty ranges can become narrower, reflecting a learning process due to more experience and a better understanding of the dynamics.

[1] See for example rough estimates for developing and developed countries in *SEAD (2015). Rebound Effects in the Context of Developing Country Efficiency.* Available at: http://superefficient.org/~/media/Files/Rebound%20effects%20and%20Developing%20Countries_DRAFT%20FINAL.ashx

6.3 Define the assessment period

The assessment period is the time period over which GHG impacts resulting from the policy are assessed. It is *a key recommendation* to define the assessment period.

For ex-ante assessments, the assessment period is usually determined by the longest-term impact included in the GHG assessment boundary. The assessment period may be longer than the policy implementation period, and should be as comprehensive as possible to capture the full range of significant impacts based on when they are expected to occur.

When determining the end of the assessment period, users can consider the following approaches:

- A timeframe or date that is directly specified in the policy goal or target (e.g., reduce emission by 50% by 2020)
- The length of time for which the policy is funded by the government or expected to be funded by the government
- A period in time that has otherwise been identified as the policy implementation end date

For an ex-post assessment, the assessment period can be the period between the date the policy is implemented and the date of the assessment or it can be a shorter period between those two dates. The assessment period for a combined ex-ante and ex-post assessment should consist of both an ex-ante assessment period and an ex-post assessment period.

In addition, users can separately estimate and report impacts over any other time periods that are relevant. For example, if the assessment period is 2020–2040, a user can separately estimate and report impacts over the periods 2020–2030, 2031–2040, and 2020–2040.

Where possible, users should align the assessment period with other assessments being conducted using ICAT guidance. For example, where users are assessing the buildings policy's sustainable development impacts using the ICAT *Sustainable Development Guidance* in addition to assessing GHG impacts, the assessment period should be the same for both the sustainable development and GHG impact assessment.

6.4 Identify sustainable development impacts (if relevant)

Buildings policies have other sustainable development impacts in addition to their GHG impacts. Sustainable development impacts are changes in environmental, social or economic conditions that result from a policy, such as changes in economic activity, employment, public health, air quality and energy security. Policies that promote energy efficiency in buildings tend to improve health and economic productivity by increasing energy access, decreasing fuel poverty and increasing comfort levels. These policies may also have a profound social impact due to their influence on construction sector jobs.

However there may be trade-offs to consider with regard to sustainable development impacts, since certain positive social impacts can also cause negative GHG emissions impacts. Table 6.5 identifies examples of sustainable development impacts associated with buildings policies. Refer to the ICAT *Sustainable Development Guidance* to conduct a full assessment of sustainable development impacts of the policy.

Table 6.5: Examples of sustainable development impacts

Dimension	Impact category	Examples of specific impacts
Environmental	Indoor environmental conditions	Reduced indoor emissions of local pollutants such as CO_2, NOx, particulates and sulphur oxides due to reduced use of fossil fuels
	Air quality / health impacts of air pollution	Reduced emissions of air pollutants from reduced fossil fuel based electricity generation
	Urban heat island effect	Decreased urban heat island effect; reduced inefficiencies in energy use, lowering the release of thermal energy to the atmosphere
Social	Poverty reduction and financial savings	Economic savings due to cost-effective energy efficiency investments
	Energy access	Increased access to energy products or services due to lower costs
	Thermal comfort	Increased thermal comfort; improved health and quality of life of residents
Economic	Employment	Increased number of jobs in construction and manufacturing sectors
	Energy security	Increased energy security due to reduced dependency on fossil fuels
	Economic value of buildings	Increased value of buildings due to more efficient technologies and materials
	Government budget surplus/deficit	Reduced need for energy subsidies