

Victorian Government Emissions Measurement Guidelines

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Introduction

Background

Under the *Climate Change Act 2017*, the Victorian Government committed to considering climate change in government decision making and has set interim emissions reduction targets to achieve net zero emissions by 2045. The Victorian Government is working to embed climate action in Victorian Government investment decisions to help achieve Victoria’s climate action goals in an efficient and cost-effective way. This includes providing guidance and tools to assist Departments to estimate the greenhouse gas emissions from initiatives.

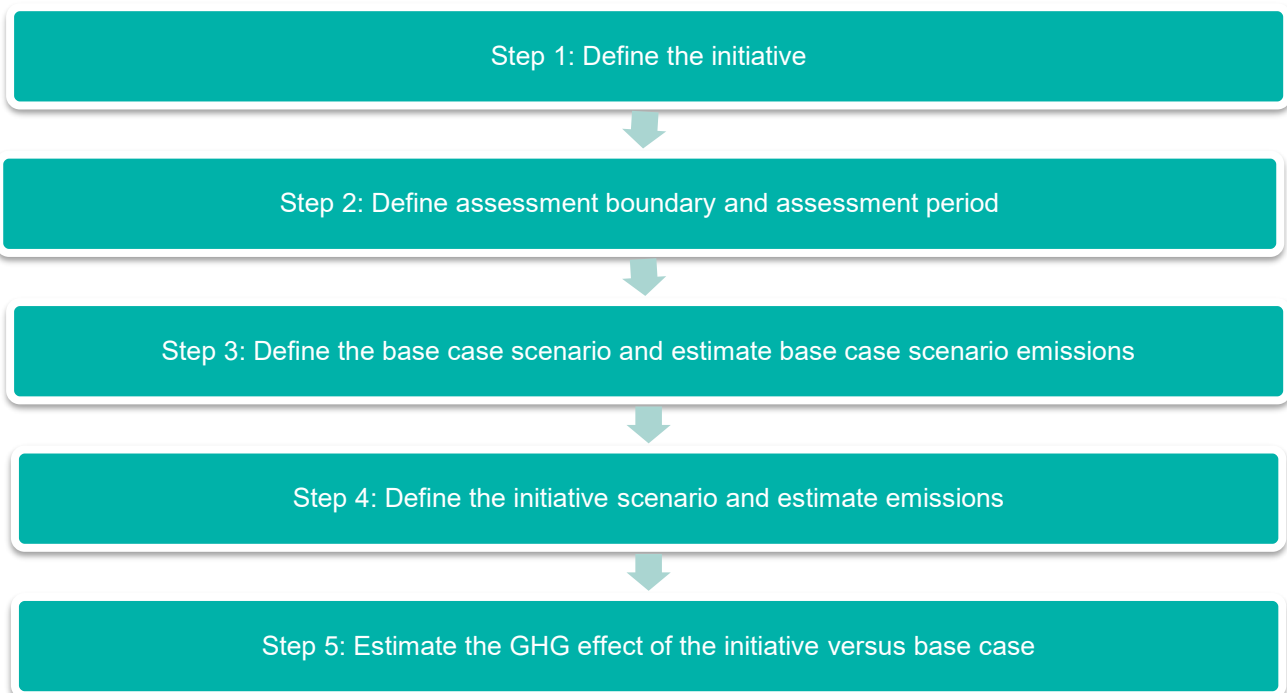
Purpose of this guide

This guidance has been developed with a focus on assisting anyone wishing to estimate greenhouse gas (GHG) emissions of a proposal that will apply emissions valuation to an initiative. For advice on how to apply emissions *valuation* refer to the [Emissions Valuation Guidance](#).

These guidelines may also be used to estimate GHGs for a variety of decision-making purposes, including economic analyses for business cases or regulatory impact statements, reporting on climate change goals, and policy development. The term *initiative* is used throughout to refer to any type of policy, project or proposal.

Calculating greenhouse gas emissions

The following information outlines the general approach to undertaking a GHG assessment, using the framework provided by the GHG Protocol’s *Policy and Action Standard* as a model.



Step 1: Define the initiative

Before estimating the GHG effects of an initiative, you will need to develop a complete and accurate definition and description of the proposal to be assessed. For instance, an investment proposal to replace existing vehicles used for a place-based community outreach program, or a regulatory proposal to introduce a cap for waste-to-energy, limiting production output. Gather as much relevant detail as possible on the initiative, such as quantities, outputs, product types, and expected activities (for example: number of vehicles, vehicle types, expected kilometres driven; number of projects affected, timelines for regulatory implementation).

Step 2. Define assessment boundary and assessment period

Identify possible sources of GHG emissions

The scope should include direct sources or sinks of GHG emissions arising from activities in the initiative. Emissions sources are anything that releases GHG emissions into the atmosphere, while emissions sinks refer to any natural or artificial process, activity, or mechanism that removes carbon dioxide from the atmosphere and stores it. See Table 1 for a list of examples.

Table 1. Examples of GHG emissions sources and sinks.

Examples of emissions sources	Examples of emissions sinks
<ul style="list-style-type: none">• The use of conventional (internal combustion engine) vehicles, including cars, buses, trucks, or diesel trains• The use of gas equipment/appliances• Land clearing activities• Increased waste generation and disposal• Increased livestock numbers• Manufacture and/or transport of materials• Air conditioner use• New refrigerators• New diesel generators or increased use of diesel generators• New mobile equipment such as cranes, diggers, excavators or increased use of those equipment	<ul style="list-style-type: none">• Tree planting• Improving land to increase growth of vegetation• Direct air carbon capture and storage• Protecting and restoring coastal ecosystems

Assessment boundary

The assessment boundary is important as it defines what will be included in the GHG assessment. The assessment boundary should include all significant, direct emissions. Please include a note in your analysis of the emissions boundaries you have put in place, including how electricity emissions and emissions outside Victoria are considered.

Assessment period

The assessment period for GHG emissions should be consistent with the appraisal period considered in the economic analysis of the proposal. Note, some emissions sources can be excluded if they fall outside of the assessment period, for instance, disposal of assets whose lifetimes are longer than the appraisal period.

Emissions Activity

Once the assessment boundary and period are defined, list all sources of emissions (both emissions increases and reductions) associated with the initiative that are in scope (e.g. change in ICE vehicle, reduction in petrol use, increase in electric vehicle use) and list the relevant activity that will need to be gathered to estimate emissions (e.g. number of vehicles, distance travelled, type of vehicles). Note that you may want to list emissions activity associated with more than one initiative option.

Step 3. Define the base case scenario and estimate GHG emissions

When assessing the impact an initiative will have on a GHG emissions source, it is important to understand what would happen to these sources in its absence. This default course of action is known as the “business as usual” option and provides the “base case”, or “counterfactual”. The base case is crucial in GHG emissions assessment as the carbon balance of the initiative (“net emissions”) is derived from the difference between the overall effect of the initiative and the base case scenario.

If calculating GHG emissions and removals for the purpose of an economic evaluation, the emissions base case or ‘counterfactual’ should be the same as the base case developed for the purpose of the economic appraisal (such as a Regulatory Impact Statement or Business Case).

Once the base case has been defined, the emissions for each source or sink category needs to be estimated for the base case. Any change in activity associated with a particular source needs to be converted into a volume of GHG emissions (for example, the number of cars using a road converted into the amount of GHG emissions that this would result in). This requires:

- (1) Understanding what would happen (i.e. activity change) to any sources of emissions under the base case scenario for the assessment period
- (2) Finding sources of information to convert this information into an amount of GHGs (through activity data and emissions factors - refer to *Using Activity Data & Emissions Factors to estimate GHG emissions* section below.)
- (3) Using these factors/data to estimate the emissions that would result from the base case using an established estimation methodology and formula (see method below).

A clearly defined base case

When undertaking an initiative, costs and benefits will be incurred. These are a result of deviating from a default course of action that would have occurred in the absence of the proposed initiative. This default course of action is known as the “base case” or “counterfactual” and is used as the reference point to which the options are compared.

A clearly defined base case should:

- Include all policies and projects the government has already committed to and has funding for
- Assume the continuation of current or forecasted production practices and technologies
- Reflect the current business outlook.

The projected impact of an initiative may be highly dependent on the base case used. It is important that analysts clearly identify, define and document the base case, and assess all proposed options relative to this scenario.

This will assist in minimising the risk of double counting of emissions. For example, including emissions reductions already accounted for in other projects will overstate the actual effectiveness of the proposed intervention. It is also important to consider how your proposed action may interact with existing initiatives, as complementary initiatives could have the potential to increase the success of the intervention. It is important to ensure only the emissions directly attributable to your initiative are being included.

Questions to consider in establishing the base case or counterfactual include:

- What would GHG emissions and energy consumption be/have been without this action?
- What is/would have been likely to happen without the initiative?
- Would some of the identified impacts of this initiative already be accounted for under the base case?
- Could existing policy increase or decrease the success of the intervention?

Some examples of Base Cases from a range of GHG emissions-producing activities can be found in Appendix 2.

Using Activity Data & Emissions Factors to estimate GHG emissions

Activity data is numerical data that allows for estimating the GHG emissions impact of an emitting or abating activity. For example, the quantity of fuel consumed (GJ) to run certain types of farm equipment or the number of internal combustion engine (ICE) cars impacted by your initiative.

The GHG emissions released or avoided because of a specified amount of an emitting or abating activity is calculated by multiplying the activity data value by the relevant activity specific emission factor.

An **emission factor** is the quantity of greenhouse gases emitted per unit of some specified activity.

$$\text{Example: GHG Emissions (tCO}_2\text{e)} = \text{Activity Data (GJ)} \times \text{Emission Factor (tCO}_2\text{e/GJ)}$$

Common activities and emissions factors:

Type	Activity	Emission factor	Alternate EF units
Fuel combustion (stationary)	Natural Gas in pipeline	51.53 kg CO ₂ -e/GJ	
Fuel combustion (stationary)	LPG	60.6 kg CO ₂ -e/GJ	1.56 kgCO ₂ -e/L
Fuel combustion (stationary)	Petrol	67.8 kg CO ₂ -e/GJ	2.32 kgCO ₂ -e/L
Fuel combustion (stationary)	Diesel	70.2 kg CO ₂ -e/GJ	2.71 kgCO ₂ -e/L
Transport	Petrol	67.62 kg CO ₂ -e/GJ	2.32 kgCO ₂ -e/L
Transport	Diesel	69.9 kg CO ₂ -e/GJ	2.70 kgCO ₂ -e/L

For a more comprehensive list of emissions factors, energy content factors and instructions for estimating GHG emissions see the National Greenhouse Gas Accounts.

Step 4: Define the initiative and estimate GHG emissions

Once the base case emissions have been calculated, the most likely scenario arising from an intervention or option should be defined. This scenario should represent the conditions most likely to occur in the presence of the intervention for each source (e.g. fossil fuel combustion, agriculture) or sink (e.g. forestry, carbon capture and storage) category included in the GHG assessment boundary (and over the assessment period).

The process for estimating emissions from the initiative is the same as for the base case. To ensure consistency, the same emissions accounting methodologies used to estimate base case emissions should be used to estimate emissions associated with different scenarios or options for the initiative. If emissions activity varies over the assessment period, estimate GHG emissions for each year as done in the worked example.

This will need to account for policy interactions, as discussed in the “Base Case or Counterfactual” box above.

Step 5: Estimate the GHG effect of the initiative versus base case

The final step of the emissions estimation process is to calculate the GHG effect of the initiative by subtracting base case emissions from the initiative emissions for each source/sink category included in the GHG assessment boundary.

$\begin{aligned} &\text{Total net change in GHG emissions resulting from the initiative (tCO}_2\text{-e)} = \\ &\text{Total net emissions of the initiative (tCO}_2\text{-e)} - \text{Total net base case scenario emissions (tCO}_2\text{-e)} \end{aligned}$

The estimated total net change in GHG emissions and removals resulting from the initiative, in tonnes of carbon dioxide equivalent, will need to be calculated annually over the GHG assessment period.

External references

- For calculating emissions within Australia see the [National Greenhouse Account Factors](#).
- For calculating emissions occurring outside Australia see the International Panel on Climate Change (IPCC) [Emission Factor database](#).
- For assessing your emissions and energy against reporting thresholds and reporting GHG emissions and energy see [Clean Energy Regulator NGER calculators](#).
- For help and guidance in developing comprehensive and reliable inventories see [Calculation Tools and Guidance | GHG Protocol](#).

Glossary

Term	Definition
Activity data	Numerical data that allows for estimating the greenhouse gas emissions impact of an emitting or abating activity, for example, the quantity of fuel consumed (GJ) to run certain types of farm equipment or the number of internal combustion engine (ICE) cars impacted by your initiative.
Base case (or counterfactual)	The default course of action, business-as-usual approach that would most likely have occurred in the absence of an initiative.
Embodied emissions	Emissions that result from construction, maintenance, and end-of-life disposal of an asset. Embodied emissions can be separated into 'upfront', 'in use' and 'end of life' emissions.
Emission factor	The quantity of greenhouse gases emitted per unit of a specified activity.
Emissions measurement	Calculating the (expected) greenhouse gas emissions from an initiative. This is distinct from emissions valuation (below) as the units are given in tCO ₂ -e (tonnes of carbon dioxide equivalent), as opposed to a dollar value.
Emissions sink	Any process, activity or mechanism which removes a greenhouse gas, an aerosol or a precursor of a greenhouse gas from the atmosphere.
Emissions value or emissions valuation	The practice of applying a dollar value to greenhouse gas emissions for decision-making purposes only (for instance, comparing two business case options). See the introduction of this document for more information. Refer to Emissions Valuation Guidance for advice on calculating emissions.
GHG	Greenhouse gas emissions, including carbon dioxide, methane, nitrous oxide, sulphur hexafluoride (as well as a list of hydrofluorocarbons, hydrochlorofluorocarbons and perfluorocarbons). For full list refer to the Australian Government's National Greenhouse Accounts Factors (Appendix 2 Global Warming Potentials).
GWP	Global Warming Potential. Different greenhouse gases have varying warming effects, and the GWP is a measure of how much heat a greenhouse gas traps in the atmosphere over a specific time compared to a similar mass of carbon dioxide (CO ₂).
Initiative	Any Victorian Government policy, project or proposal.
tCO ₂ -e	Tonnes of carbon dioxide equivalent. Since different greenhouse gases have varying warming effects, tCO ₂ -e is used to standardise the impact of greenhouse gases relative to carbon dioxide (CO ₂).
Upfront Carbon	Upfront carbon emissions are the carbon emissions occurring before a building or infrastructure is used, including from relevant manufacture, transport, and construction activities. Upfront carbon represents a significant proportion of embodied carbon, but embodied carbon can also refer to 'in use' and 'end of life' emissions.

Appendix 1 – Worked examples

Worked Example 1

Step 1: Define the initiative

An agency puts forward an investment proposal to replace existing vehicles used for a place-based community outreach program. The new vehicles will be more fuel efficient.

Emissions activity: Transport road activity (vehicle kilometres travelled)

Step 2. Define assessment boundary and assessment period

For the purposes of this example, the assessment boundary has been defined as all significant, direct emissions that occur in Victoria and manufacturing and/or transport of materials where information is readily available.

The relevant activity data for car use:

- Number of internal combustion (ICE) vehicles
- Petrol and diesel consumption from ICE vehicles
- Number of electric vehicles (EVs)
- Electricity demand from EVs
- Disposal and recycling

The change in activity:

- Change in ICE vehicles
- Reduction in petrol and diesel consumption
- Increase in electricity vehicles
- Increase in electricity demand from EVs

Out of scope due to lack of readily available information:

- Materials extraction and production of car components and fuels
- Transport and storage associated with distribution of vehicles

Appraisal period: 10 years.

Step 3. Define base case scenario and estimate GHG emissions

Base case: Retain existing fleet of high emitting petrol van

Common assumptions:

- Program activity growth: 3% p.a.
- Vehicle kilometres travelled (VKT) in year 1: 30,000 per vehicle
- Fleet size: 150 vans
- Disposal and recycling emissions are assumed to be consistent between options

Base case data:

- Fleet make: Example van A
- Fuel consumption: 12.6 L/100 km
- Fuel (petrol) energy content: 34.2 GJ/kL
- Petrol emissions factors: 67.6 kgCO₂-e/GJ or 2.31 kg CO₂-e/L

Step 4. Define initiative scenario and estimate GHG emissions

Option 1: Replace fleet with less efficient petrol vans

Option 2: Replace fleet with more efficient petrol vans

Option 3: Replace fleet with zero emissions vehicles

Option 1 data:

- Fleet make: – Example van B
- Fuel consumption: 12 L/100km
- Petrol emissions factor: 2.31 kg CO₂-e/L

Option 2 data:

- Fleet make: – Example van C
- Fuel consumption: 5.9 L/100km
- Petrol emissions factor: 2.31 kg CO₂-e/L

Option 3 data:

- Fleet make: Example van D (electric)
- Fuel consumption: 175 Wh/km
- Grid electricity emissions factor: null (note, electricity emissions factors do not need to be applied)

Step 5. Estimate the GHG effect of the intervention versus base case

GHG emissions under base case and the initiative scenarios:

	Unit	2025	2026	2027	2028	2029	2030	2031	2032	2033	2034
VKT	km pa per vehicle	30,000	30,900	31,827	32,782	33,765	34,778	35,822	36,896	38,003	39,143
Baseline	tCO ₂ -e pa	1,311	1,351	1,391	1,433	1,476	1,520	1,566	1,613	1,661	1,711
Option 1	tCO ₂ -e pa	1,249	1,286	1,325	1,365	1,406	1,448	1,491	1,536	1,582	1,629
Option 2	tCO ₂ -e pa	614	632	651	671	691	712	733	755	778	801
Option 3	tCO ₂ -e pa	-	-	-	-	-	-	-	-	-	-

Net GHG effect of the intervention versus base case (emissions savings, positive value; emissions increases, negative value):

	Unit	2025	2026	2027	2028	2029	2030	2031	2032	2033	2034
Option 1	tCO ₂ -e pa	62	64	66	68	70	72	75	77	79	81
Option 2	tCO ₂ -e pa	697	718	740	762	785	808	833	858	883	910
Option 3	tCO ₂ -e pa	1311	1351	1391	1433	1476	1520	1566	1613	1661	1711

Worked Example 2

Step 1: Define the initiative?

A school is replacing its space heating system with a more efficient system.

Emissions activity: Operating heating equipment

Step 2. Define assessment boundary and assessment period

The assessment boundary should include all significant, direct emissions that occur in Victoria.

The relevant activity data for operating heating equipment:

- Gas consumed
- Electricity consumed
- Disposal and recycling.

The change in activity:

- Reduction in gas use
- Reduction in electricity consumption
- Potential increase in electricity if heating equipment is electrified

Out of scope due to lack of readily available information:

- Materials extraction and production of heating units and fuels
- Transport and storage associated with heating units

Appraisal period: 10 years.

Step 3. Define base case scenario and estimate GHG emissions

Base case: Retain existing gas space heating system

Common assumptions:

- Daily operation: 8 hours
- Days operation: 183 days
- Disposal and recycling emissions are assumed to be consistent between options

Base case data:

- Model: Example system A
- Fuel (gas) consumption: 999 MJ/h
- Heating output: 225 W
- Number of units: 1
- Gas emissions factor: 51.53 kg CO₂-e/GJ

Step 4. Define initiative scenario and estimate GHG emissions

Option 1: Replace with condensing gas boilers

Option 2: Replace with electric resistive heating

Option 3: Replace with high efficiency heat pump

Option 1 data:

- Model: Example system B
- Number of units: 2
- Fuel (gas) consumption: 900 MJ/h
- Heating output: 240 kW
- Gas emissions factor: 51.53 kg CO₂-e/GJ

Option 2 data:

- Model: Example system C
- Number of units: 6
- Average Coefficient of performance: 3.72
- Heating output: 37.5 kW (single unit)
- Total heating output: 225 kW
- Electrical power: 60 kW
- Electricity emissions factor: null
- GWP of Refrigerant of R410A: 3,943
- Refrigerant charge per unit: 9.6 kg
- Leakage rate: 2.5%

Option 3 data:

- Model: Example system D
- Number of units: 3
- Average Coefficient of performance: 3.92
- Heating output: 78.4 kW (single unit)
- Total heating output: 235.2 kW
- Electrical power: 60 kW
- Electricity emissions factor: null (note, electricity emissions factors do not need to be applied)
- GWP of Refrigerant of R744 (CO₂): 1
- Refrigerant charge per unit: 11.3 kg
- Leakage rate: 2.5%

Step 5. Estimate the GHG effect of the intervention versus base case

GHG emissions under base case and the initiative scenarios:

	Unit	2025	2026	2027	2028	2029	2030	2031	2032	2033	2034
Electricity Grid factor	kgCO ₂ -e/kWh	-	-	-	-	-	-	-	-	-	-
Baseline	ktCO ₂ -e pa	75	75	75	75	75	75	75	75	75	75
Option 1	ktCO ₂ -e pa	68	68	68	68	68	68	68	68	68	68
Option 2	ktCO ₂ -e pa	6	6	6	6	6	6	6	6	6	6
Option 3	ktCO ₂ -e pa	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001

Net GHG effect of the intervention versus base case (emissions savings, positive value; emissions increases, negative value):

	Unit	2025	2026	2027	2028	2029	2030	2031	2032	2033	2034
Option 1	ktCO ₂ -e pa	7	7	7	7	7	7	7	7	7	7
Option 2	ktCO ₂ -e pa	69	69	69	69	69	69	69	69	69	69
Option 3	ktCO ₂ -e pa	75	75	75	75	75	75	75	75	75	75

Appendix 2 - Examples of GHG emissions-producing activities

Type of initiative	Proposal and relevant activities	Baseline activity examples	Determination of activity changes in comparison to baseline (for example only)
New activity centre (emissions increase)	New stadium to host international sporting events and concerts: <ul style="list-style-type: none"> Embodied emissions of the stadium construction Electricity for stadium lighting Temperature control for indoor spaces Refrigeration for kitchens Gas heated hot water 	No activity	<p><i>Significant activity changes</i></p> <ul style="list-style-type: none"> Refrigerant leakage from HVAC units Fuel consumption change Infrastructure elements including construction and production of materials. <p>Insignificant activities</p> <ul style="list-style-type: none"> Installation of assets Maintenance of assets Disposal of assets
New asset purchase (emissions increase)	Purchase of a new high temperature industrial gas furnace <ul style="list-style-type: none"> Fossil gas consumption for production of steam used in industrial process 	No activity	<p><i>Significant activity changes</i></p> <ul style="list-style-type: none"> Fuel consumption change <p><i>Insignificant activity changes</i></p> <ul style="list-style-type: none"> Delivery of furnace to site Installation and commissioning Maintenance activities (repairs, delivery of required parts/accessories to site, etc.)
Energy efficiency (emissions reduction)	Improve energy efficiency of lighting by using energy-efficient light bulbs <ul style="list-style-type: none"> Consumption of electricity for lighting 	Keep using inefficient light bulbs <ul style="list-style-type: none"> Consumption of electricity for lighting 	<p><i>Significant activity changes</i></p> <ul style="list-style-type: none"> Fuel consumption change <p><i>Insignificant activity changes</i></p> <ul style="list-style-type: none"> Installation of light bulbs Replacement of light bulbs <p><i>Excluded:</i></p> <ul style="list-style-type: none"> Production of light bulbs
Transport fuel switch (emissions reduction)	Replacement of older ICE vehicles with electric vehicles <ul style="list-style-type: none"> Electricity consumption due use of the electric vehicles 	Replacement of older ICE vehicles with newer ICE vehicles <ul style="list-style-type: none"> Fossil fuel consumption from the use of the newer ICE vehicles 	<p><i>Significant activity changes</i></p> <ul style="list-style-type: none"> Fuel type change Fuel consumption quantity change <p><i>Insignificant activity changes</i></p> <ul style="list-style-type: none"> Maintenance requirement and routine change <p><i>Excluded</i></p> <ul style="list-style-type: none"> Production of vehicles
Industrial/commercial fuel switch (emissions reduction)	Electrification of a gas boiler <ul style="list-style-type: none"> Electricity consumption from use of the electric boiler 	Keep using the gas boiler <ul style="list-style-type: none"> Fossil gas consumption from the use of the gas boiler 	<p><i>Significant activity changes</i></p> <ul style="list-style-type: none"> Fuel type change Fuel consumption quantity change <p><i>Insignificant activity changes</i></p> <ul style="list-style-type: none"> Delivery of new electric boiler to site Activity associated with the installation and commissioning of the new electric boiler unit Maintenance requirement and routine change <p><i>Excluded</i></p> <ul style="list-style-type: none"> Production of equipment
Industrial/commercial renewable energy	Installation of solar panels to generate on-site electricity	Keep using grid electricity	<p><i>Significant activity changes</i></p> <ul style="list-style-type: none"> Generation of renewable electricity

Type of initiative	Proposal and relevant activities	Baseline activity examples	Determination of activity changes in comparison to baseline (for example only)
generation (emissions reduction)	<ul style="list-style-type: none"> On-site electricity generation period – with surplus electricity exported to the grid 	<ul style="list-style-type: none"> Grid electricity consumption 	<ul style="list-style-type: none"> Reduction in grid electricity consumption due to on-site renewable electricity generation Export of surplus renewable electricity <p><i>Insignificant activity changes</i></p> <ul style="list-style-type: none"> Delivery of solar panels to site Activity associated with installation and commissioning the solar panels <p><i>Excluded</i></p> <ul style="list-style-type: none"> Production of equipment
Appliance electrification (emissions reduction)	<p>Gas space heater replacement with heat pump</p> <ul style="list-style-type: none"> Electricity consumption from use of the heat pump Leakage rate of refrigerant gas 	<p>Keep using gas heater</p> <ul style="list-style-type: none"> Fossil gas consumption from the use of gas heater 	<p><i>Significant activity changes</i></p> <ul style="list-style-type: none"> Fuel type change Fuel consumption quantity change Leakage of refrigerant gas <p><i>Insignificant activity changes</i></p> <ul style="list-style-type: none"> Delivery of new heat pump to site Activity associated with the installation and commissioning of the heat pump <p><i>Excluded</i></p> <ul style="list-style-type: none"> Production of equipment