INITIATIVE FOR Climate Action Transparency

NewClimate Institute, World Resources Institute, CDP, The Climate Group

Non-State and Subnational Action Guidance

Guidance for integrating the impact of non-state and subnational mitigation actions into national greenhouse gas projections, targets and planning

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How to assess impact and aggregate non-state and subnational actions

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8. Converting Non-State and Subnational Actions and National Policies to Suitable Metrics

This chapter explains how to process collected data to convert the diverse range of non-state and subnational climate mitigation targets to suitable metrics for comparison to national policies or inclusion into existing climate models. Options are also provided to determine emission reduction potentials. By doing so, users will be able to determine the impact of non-state and subnational actions.

In addition, the chapter discusses relevant metrics, detailed guidance for each IPCC sector (description and conversion tables, including examples) and how to proceed for comprehensive assessments.

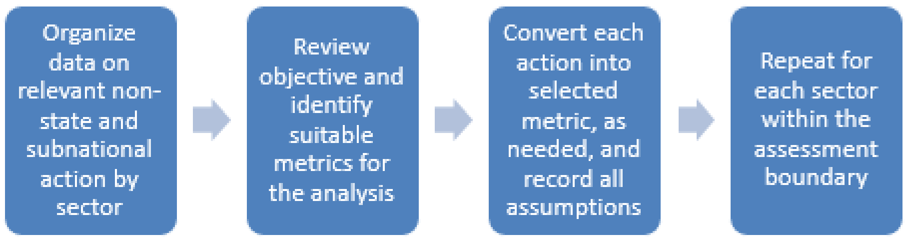
Checklist of key recommendations

- Identify suitable metrics and convert non-state and subnational actions to those metrics
- Identify metrics that work for existing climate mitigation models and/or scenarios and check whether non-state and subnational actions need to be converted to emission reduction potentials

8.1 Preparing for data processing and identifying suitable metrics

Users will need to process collected information on non-state and subnational action into a comparable form for the analysis. This requires a number of steps as shown in Figure 8.1 below.

Figure 8.1: Steps to process data



If the user has not already done so, the data collected on non-state and subnational actions should be organised by sector. Any data gaps that still exist should be highlighted as these actions may require additional processing (for example, to determine missing base year emissions if still unknown) or may require assumptions to be made.

Users should also review their objective at this time. To quantify the impact of non-state and/or subnational actions, many users conducting targeted assessments will not need to translate non-state and subnational actions to GHG emission reduction potentials, especially if their primary interest (objective of assessment) is to revise specific sector or subsector-level targets which is not expressed as emission reduction. In fact, in some cases, users can compare the impact of non-state and subnational actions and national policies at the level of a non-emissions based metric, for example, the share of renewable energy or energy efficiency improvements in a certain sector. In other cases, users can take non-emissions based metrics as a result of the analysis conducted with this guidance and integrate them in climate mitigation models or scenarios which are already being used in the country, including those under development. It is therefore a *key recommendation* to identify metrics that work for existing climate mitigation models and/or scenarios and check whether non-state and subnational actions need to be converted to emission reduction potentials.

In the case of comprehensive assessments involving integration into national emissions pathways, users should also review the metrics used in their selected models from Chapter 7. This will mostly likely require the use of quantified emissions reductions as the primary metric. See Section 8.3 for further details on a comprehensive assessment.

Non-state and subnational climate actions may use a variety of target types and metrics which may differ from those used in national policies or climate models.[1] Thus, they are not all equally suitable for calculating emission reduction potentials, a comparison to national policies, or the inclusion into existing climate models. It is therefore a *key recommendation* to identify suitable metrics and convert non-state and subnational actions to those metrics.

It is important to be able to recognise the types and characteristics of actions that may be encountered when using this guidance. Actions containing absolute GHG emission reduction target types may include: base year emissions target; fixed-level target; base year intensity target; and baseline scenario target. Other targets such as non-GHG targets, and emission reductions to be achieved by policies, actions, or

[1] Climate models may be understood as mathematical representations of the climate system and the transfer of energy through the system.

projects may also be encountered. Please see Chapter 3 for additional details. Compounding the challenges of establishing a uniform metric for aggregation and integration, actions may differ in the characteristics by time frame, geographical boundary, scope of emissions, and target level.

Characteristics of suitable metrics for users aiming to determine emission reduction potentials include:

- Absolute values (e.g., decrease emissions to under 2 tonnes CO_2e per capita by 2050)
- Energy or emissions related (e.g., procure 5 MW of energy consumption from renewable energy sources by 2030)

In practice, users should revisit the lists they put together in Chapters 5 and 7 and check against the characteristics detailed above to determine which targets are already in the form of a suitable metric and which ones need to be converted. Energy or emissions related metrics, in addition to absolute values are critical to determine emission reductions against a certain base year or target year.

8.2 Examples of suitable metric by sector

This section provides examples of metrics for various sectors. As users go through their list of actions, any that need to be converted into comparable metrics should be processed. This processing may take considerable time as users may need to collect supplemental information such as emission factors, sector specific data, economic or demographic data, etc. All additional data points and assumptions should be used consistently within sectors and should be documented for each action that is processed. The subsections and tables below, provide examples of how actions may be processed for each sector.

8.2.1 Agriculture, forestry and other land use

Non-state actors, including private sector entities, are playing an increasingly large role for climate change mitigation and adaptation in many sectors, including in the agriculture, forestry and other land use (AFOLU) sector.[2] Across international cooperative initiatives agriculture was the third most frequently covered sector in 2015, after energy supply and transport, and is also covered under many more forestry oriented collaborative actions.[3]

A general challenge for the sector when quantifying mitigation action is the time delay between the action (e.g., planting a tree) and its impact on emissions. Users need to keep this in mind when aiming to quantify the emission reduction potential and comparing it to the NDC or existing climate efforts. In addition, countries have different definitions for what constitutes a forest. Users should adjust their calculations to reflect the definition and forest types used in focus country as this will impact carbon sequestration rates.

Table 8.1 provides an overview of some common non-state and subnational targets in this sector, their conversion to suitable metrics, and a few options to calculate emission reduction potentials including necessary data points and assumptions. In addition, Box 8.1 provides an overview of data sources which can be consulted for specific data points users might need for the analysis, if national data is not available. Box 8.2 describes an example of determining the emission reduction potential of an international cooperative action in the agriculture sector.

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[2] UNFCCC 2016; Hsu et al. 2016

[3] UNEP 2016b

Table 8.1: Example of metrics for the agriculture, forestry and other land use sector

Agriculture, forestry and other land use sector		
Examples of non-state/subnational climate mitigation targets	**Suitable metrics for comparison to national policies or inclusion into existing climate mitigation models/ scenarios**	**Options for the conversion to emission reduction/ sequestration potential**
Restore X ha of forests	Total forest area (ha); Afforestation/reforestation rate (kha/year) Assumptions: • Density of restored forest (equal to average)	Look up the CO_2 emission reduction potential of one ha of forest (how much CO_2 domestic forests sequester annually) and multiply by the amount of ha forest to be restored (simplistic approach). Data needs (use FAO resources): • Total CO_2 emission/ha • CO_2 emissions sequestered/ha; • Forest density (m^2/ha) • Carbon stock per type of forest (tC/ha) *For a more sophisticated approach, users should follow the IPCC guidelines on forest land.*[4]
Stop deforestation (from supply chains)	Put deforestation rate to zero; all other variables remain unaffected	*Stopping deforestation means zero emissions and no further conversion is needed at this point.*
Zero degradation	Put degradation to zero; all other variables remain unaffected	*Zero degradation means zero emissions and no further conversion is needed at this point.*
Reduction of X% CO_2 emissions from deforestation	Total CO_2e emissions from deforestation ($MtCO_2e$); Assumptions: • Base year	Convert by looking at total CO_2e emissions from deforestation domestically. Assumptions: • Base year
Decrease CO_2e emissions from agriculture by X% compared to base/target year reference	Total CO_2e emissions in base year and projected CO_2e emissions in target year Assumptions: • Specific sources of CO_2e reductions (if applicable)	Convert from relative reduction to absolute target by looking at total CO_2e emissions from agriculture and projected emission growth rates Data points needed (use national emissions projections, or if not available World Bank Data, US EPA global anthropogenic GHGs): • Emissions growth rate for agriculture ($GtCO_2e$) • CO_2e emissions from agricultural processes and products
Increase sustainable food production by X%	Total food production (tonne/person); total	Look at the emissions caused by agriculture destined to food production. Then look at the share of sustainable food production and its CO_2e impact. Users should then

[4] A tool to calculate emissions removals from reforestation is available at: http://www.environment.gov.au/climate-change/emissions-reduction-fund/cfi/reforestation-tools; another method is described here, although it has a limited geographical coverage: http://calfire.ca.gov/Grants/downloads/Methods_for_Evaluating_GHG_Emission_Reductions.pdf

	sustainable food production (tonne/person) Assumptions: • Definition of sustainable food production (e.g., certified food; certified production only; type of certification)	translate the relative target into an absolute one, calculate the estimated CO_2e emissions and compare to CO_2e of estimated non-sustainable food production. Assumptions: • Definition of sustainable food production (e.g., certified food; certified production only; type of certification) Data points needed (use World Bank, UN World Populations Prospects if no national data is available): • Food production per person (tonne/person) • Demographic development • Share of sustainable food production in country (x%) and its CO_2e impact (tCO_2e/person)

Box 8.1: Relevant international sources of information

FAO database (FAOSTAT), Available at: http://www.fao.org/faostat/en/#home

Other relevant FAO resources to get information among others on forest cover, forest carbon stock, reforestation/afforestation and deforestation rates:

- Global Forest Resources Assessment 2015. Available at: http://www.fao.org/3/a-i4808e.pdf
- State of the World's Forests 2016. Available at: www.fao.org/3/a-i5588e.pdf

World Bank open data covering several metrics including forest cover, agriculture, food production). Available at: http://data.worldbank.org/indicator

US EPA global GHG emissions data covering emissions by gas, sector, country as well as trends. Available at: https://www.epa.gov/ghgemissions/global-greenhouse-gas-emissions-data

UN World Population Prospects. Available at: https://esa.un.org/unpd/wpp/

Additional information on methods and tools:

IPCC Guidelines on Forest Land, provides methods for estimating carbon stock changes and greenhouse gas emissions and removals associated with changes in biomass and soil organic carbon on forest lands and lands converted to forest land. Available at: www.ipcc-nggip.iges.or.jp/public/gpglulucf/gpglulucf_files/Chp3/Chp3_2_Forest_Land.pdf

Tools to calculate emission reductions from reforestation. Available at: www.environment.gov.au/climate-change/emissions-reduction-fund/cfi/reforestation-tools and http://calfire.ca.gov/Grants/downloads/Methods_for_Evaluating_GHG_Emission_Reductions.pdf

Box 8.2: Example of how to determine the emission reduction potential of an international cooperative action in the agriculture sector

An international cooperative action aims to mobilise 100 million USD for sustainable forestry, out of which 5 million would be mobilised in the user's country. Assuming the user wants to look at the effect of non-state and subnational action on the overall forest volume content domestically, the area of forest restored is the suitable metric for comparison with national policies here.

Users can convert the 5 million USD mobilised into ha of forests restored. This could be done by using domestic data, if available, on the average amount of investment needed to restore 1 ha of forest or, if no data is readily available, using international sources that provide such data while acknowledging that it may not be the most accurate data for their context. For example, users could check restoration projects financed by developments banks, assuming that efficiency of resources remains unvaried or from surveys of companies and non-profits engaged in restoration. So, for instance, 100 USD is needed to restore a hectare of forest in the country, 5mn USD can restore 5,000,000/100= 50,000 ha.

8.2.2 Energy

In line with IPCC guidance, this non-state and subnational action guidance considers energy-related emissions by sector: energy supply, industry, buildings and transport. The following sub-chapters look at each of those sectors separately and provide specific guidance on how to convert energy related non-state and subnational action targets to suitable metrics and illustrates some options on how to estimate their emission reduction potentials.

Energy supply

Accounting for approximately 35% of global GHG emissions in 2010, the energy supply sector is the largest contributor to global GHG emissions among all sectors.[5] The energy supply sector, together with the transport sector, is one of the most frequently targeted by subnational and non-state mitigation action.[6] In some instances, these targets are energy demand or consumption specific but can be translated into energy supply targets (which need to be met for consumption targets to be achieved). A range of suitable metrics in the energy supply sector exists to compare them to national policies, include them into existing climate mitigation models or convert them to emission reduction potentials (Table 8.2). Box 8.3 provides an overview of data sources that can be consulted if national data is not available. Box 8.4 describes an example of determining the emission reduction potential of a non-state initiative in the energy supply sector.

Table 8.2: Examples of metrics for the energy supply sector

Energy supply		
Examples of non-state/ subnational climate change mitigation targets	**Suitable metrics for comparison to national policies or inclusion into existing climate mitigation models/ scenarios**	**Options for the conversion to emission reduction potential**
Increase the share of electricity generated from RE to X (% or absolute amount in MW) /	RE electricity generation capacity installed (MW), share of RE electricity in national grid; Assumptions: • Potential RE electricity generation from additional	If capacity (MW) target, convert to generation (TWh) using full load hours. If % target, convert to generation (TWh) using total electricity generation in target year. To calculate the emission reduction potential, users can derive different estimates of emission impacts depending on whether RE electricity displaces natural gas first, then oil and

[5] Bruckner et al 2014.

[6] Yale University 2015.

Procure X amount or % of total energy supply by renewables	capacities installed is equal to additional RE electricity consumed (no idle capacities)
	Data points needed:
	• To convert % to MW or the other way around:
	  ○ full load hours, either average over all technologies or technology specific, if available
	  ○ total electricity generation
		then coal (low estimation[7]) or coal first, then oil and then gas (high estimation)
		Assumptions:
		• RE electricity installed is equal to RE electricity generated
		• National fuel mix remains unvaried (once the change in RE has been accounted for)
		Data points needed (use IEA World Economic Outlook/Statistics if no national data is available)
		• Projected electricity generation and fuel mix
		• Emission factors for fossil fuels

Drive down the cost of RE and/or its generation by X amount (USD/MWh)	Cost of one unit of RE generated (USD/MWh) Assumptions: • Linear cost trend (costs do not change if more RE capacity is installed)	Recommended to use an existing model if available due to the many complex assumptions needed to calculate realistic emission reduction potentials.
Reduce electricity consumption by X% compared to base/target year reference	Total electricity demand (MWh) Assumptions: • Consumption is equal to supply	Look at total projected electricity consumption and convert relative target to an absolute one. To calculate the emission reduction potential, please follow the process detailed in the earlier examples. Assumptions: • Consumption is equal to supply • National fuel mix remains unvaried Data points needed (Use IEA resources if no national data is available): • Projected demand for electricity (in MW) • Total CO_2 emissions from generated electricity ($MtCO_2$) • National fuel mix • Emission factor for fossil fuels

Box 8.3: Relevant international sources of information

- IEA statistics which include indicators such as carbon intensity of electricity generated with oil, gas and coal, Available at: http://www.iea.org/statistics/
- IEA's World Energy Outlook 2016 including estimates about energy demand, renewable energy under the New Policies and 450 scenarios, Available at: http://www.iea.org/newsroom/news/2016/november/world-energy-outlook-2016.html

[7] This is due to their different carbon contents.

- IEA's Energy Technology Perspectives 2016 report detailing energy transition pathways including relevant data about energy demand and projected CO_2 emissions, Available at: http://www.iea.org/etp/
- IRENA Roadmap for a Renewable Energy Future, Available at: http://www.irena.org/DocumentDownloads/Publications/IRENA_REmap_2016_edition_report.pdf
- IPCC emission factor database, Available at: http://www.ipcc-nggip.iges.or.jp/EFDB/main.php
- World Bank Open Data covering several metrics including renewable energy consumption and renewable electricity output, Available at: http://data.worldbank.org/indicator
- IPCC Guidelines on 'Energy', Available at: http://www.ipcc-nggip.iges.or.jp/public/2006gl/vol2.html

Box 8.4: Example of how to calculate emission reduction potential of a non-state initiative in the energy supply sector

In this example, a user wants to look at the effect of non-state and subnational action on the overall necessary RE capacity installed (in MW) to determine additional demand from RE targets, whether this demand can be met by current RE generation capacity, and the associated emission reduction potential. The user includes a non-state initiative in its assessment which aims to engage 100 companies to procure 100% of their energy demand by RE. Four of these companies will be mobilised in the user's country (both the company offices and the utility from which the company sources its power are physically located in the user's country). The user collects data on current RE generation capacities and RE procurement levels of the four companies. The user then converts the four companies' targets into (additional) RE generation capacity requirements by subtracting how much they already procure through RE from the 100% target, compares the results to current capacities and, in case, add this amount to future domestic RE generation capacity requirements.

To calculate the emission reduction potential for this difference, the user can derive different estimates of emission impacts depending on whether RE displace natural gas first, then oil and then coal (low estimation) or coal first, then oil and then gas (high estimation) using emission factors for example from the IEA's World Economic Outlook (WEO) data. More location-specific information on the marginal grid mix can be collected and applied in this assessment for improved accuracy.

Industry

The industry sector is very diverse and emissions-intense. At the same time, non-state and subnational actions targeting the sector are rather rare, but growing.

The sector contributed to approximately 21% of GHG emissions in 2010 with one of the biggest contributions coming from the production of steel and cement. The industry sector includes energy-related emissions as well as non-energy emissions from industrial processes and product use.[8]

Table 8.3 provides information on how to convert common non-state and subnational mitigation targets into suitable metrics for comparison to national policies or inclusions into existing climate mitigation models and outlines options for calculating emission reduction potentials. Box 8.5 provides an overview of data sources that can be consulted if national data is not available.

[8] IPCC 2014a.

Table 8.3: Examples of metrics for the industry sector

Industry sector		
Examples of non-state/ subnational climate change mitigation targets	**Suitable metrics for comparison to national policies or inclusion into existing climate mitigation models/scenarios**	**Options for conversion to emission reduction potential**
Decrease CO_2e intensity per tonne of steel/cement produced	Absolute values from the reduction of CO_2e intensity per tonne of steel/cement produced	Look at projected CO_2e intensity per tonne of steel/cement produced and target values (% or fixed reduction). On this basis and using emission factors, the emission reduction potential can be calculated per tonne (or unit of industry product) first and, by multiplying with projected production levels, for the entire sector. Data points needed: • Projected growth for steel/ cement production (in tonnes or per capita income/population) • Projected steel or cement intensity (CO_2e per tonne per capita etc.) • Emission factors • If applicable, population trends
Adopt best practice industry standards	Specific steel/cement intensity per tonne (or capita income/population) Assumptions: • All steel/cement production could reasonably be compliant with best practice industry standards Data points needed: • Best practice industry standard specific information • If applicable, population trends	Look at what best practice standards mean for a specific industry sector (translate into CO_2e emissions per tonne or other unit of product) and compare to projected CO_2e emissions per tonne produced following non-best practice industry standards. To determine emission reduction potentials, multiply the amount of CO_2e saved per unit of product with total amount of projected production. Data points needed: • Best practice industry standard specific information • Projected growth for steel/ cement production (in tonnes or per capita income/population) • Projected steel or cement intensity (CO_2e per tonne per capita etc.) • Emission factors • If applicable, population trends
Decrease total CO_2e emissions from steel/cement production by X amount, X%	Total reduction in CO_2e emissions per tonne of steel/cement produced	Look at projected CO2e emissions per tonne of steel/cement produced. Then multiply by projected total amount of production and subtract the targeted decrease (% or fixed reduction). Data points needed: • Steel or cement CO_2e emissions • Projected growth for steel/ cement production (in tonnes or per capita income/population)

Box 8.5: Relevant international sources of information

- IPCC emission factor database, Available at: http://www.ipcc-nggip.iges.or.jp/EFDB/main.php
- IEA's *technology roadmap for the chemistry industry,* Available at: https://www.iea.org/publications/freepublications/publication/TechnologyRoadmapEnergyandGHGReductionsintheChemicalIndustryviaCatalyticProcesses.pdf
- UN World Population Prospects, Available at: https://esa.un.org/unpd/wpp/
- Additional information on methods and tools:
- IPCC *guidelines on 'Industrial Processes and Product Use'*, Available at: http://www.ipcc-nggip.iges.or.jp/public/2006gl/vol3.html
- WBCSD Cement Sustainability Initiative *containing data on cement and a detailed roadmap for the sector*, Available at: http://wbcsdcement.org/

Buildings

Several non-state actor and subnational actions are increasingly targeting the building sector which represents one of the key sectors for climate mitigation. The building sector accounts for 32% of global energy consumption, half of global electricity consumption and around 18% of GHG emissions, making it a key sector for GHG mitigation.[9]

Table 8.4 provides information on how to convert common non-state and subnational mitigation targets into suitable metrics for comparison to national policies or inclusions into existing climate mitigation models and outlines options for calculating emission reduction potentials. Box 8.6 provides an overview of data sources which can be consulted if national data is not available.

Table 8.4: Examples of metrics for the building sector

Buildings		
Examples of non-state/ subnational climate change mitigation targets	**Suitable metrics for comparison to national policies or inclusion into existing climate mitigation models/scenarios**	**Options for conversion to emission reduction potential**
Improve energy performance of buildings by X%	Energy performance of buildings (kWh/ m^2) Assumptions: • Linear trend in the energy consumption per m^2 • Linear trend in the share between commercial and residential buildings	Look at projected average energy consumption of residential and commercial buildings and divide by total floor area to determine estimated future energy performance of buildings. Where available, otherwise users could consult international sources such as the IAE's World Economic Outlook. In addition, the data availability for commercial and public buildings is usually better and so the user could start with those. To determine the emission reduction potential, users need to look at the country's projected energy fuel mix and from that information derive the potential GHG impact. Assumptions:

[9] IEA 2016a.

	Data points needed: • Total (projected) national floor area • Heating and cooling requirements	• Linear trend in the energy consumption per m^2 • National fuel mix remains unvaried • Linear trend in the share between commercial and residential buildings Data points needed (use IEA's Energy Technology Perspective or other IEA resources if no national data is available): • Projected growth in floor area • Total (projected) energy consumption from commercial and residential buildings (kWh/m^2) • National fuel mix • Emission factors for oil, gas, coal
Increase the renovation rate of buildings by X%	Renovation rate of buildings (%) Data points needed: • Current renovation rate (%)	Look at the average buildings intensity of new built vs retrofitted buildings. Determine the CO_2 emission savings for a renovated building compared to a non- renovated one, based on the difference in the buildings intensity and calculating for how the energy was produced (taking into account the national fuel mix and emission factors). Then determine the additional number of projected renovated buildings by converting the relative renovation target to an absolute number. Users should then assume that additional renovations will proportionally reduce the CO_2 emissions. Assumptions: • Additional renovations will proportionally reduce CO_2 emissions • Linear trend in the buildings' intensity • Number of buildings remains unchanged • National fuel mix remains unvaried Data points needed (use IEA's Energy Technology Perspective or other IEA resources if no national data is available): • Total (projected) buildings' intensity (kWh/m^2) • National fuel mix • Emission factors

Box 8.6: Relevant international sources of information

- IEA's *World Energy Outlook 2016 with data trends on buildings emissions by fuel and final energy consumption by end-use*, Available at: http://www.iea.org/newsroom/news/2016/november/world-energy-outlook-2016.html
- IEA's *Energy Technology Perspectives 2016 including estimates about floor area growth and floor area per household and buildings' energy consumption*, Available at: http://www.iea.org/etp/

- IRENA *Roadmap for a Renewable Energy Future with data on share of modern renewable energy in building energy use,* Available at: http://www.irena.org/DocumentDownloads/Publications/IRENA_REmap_2016_edition_report.pdf
- IPCC *emission factor database*, Available at: http://www.ipcc-nggip.iges.or.jp/EFDB/main.php
- IPCC *Guidelines on 'Energy'*, Available at: http://www.ipcc-nggip.iges.or.jp/public/2006gl/vol2.html

Transport

The transport sector is a popular target for both subnational and non-state actors. Together with the energy supply sector, it represents the sector most often targeted by non-state actions.[10]

The sector accounted for approximately 14.3% of global GHG emissions in 2010.[11] Approximately 15% of transport emissions in 2014 were associated with bunkers i.e., emissions from fuels used for international aviation and maritime transport which are not accounted for within the boundaries of national GHG inventories and would therefore be outside the scope of this guidance which focuses on national emissions.[12] Although a user could assess the impact of non-state and subnational action related to bunkers as a distinct exercise.

Table 8.5 provides information on how to convert common non-state and subnational mitigation targets into suitable metrics for comparison to national policies or inclusions into existing climate mitigation models and outlines options for calculating emission reduction potentials.

Table 8.5: Examples of metrics for the transport sector

Transport sector		
Examples of non-state/ subnational climate mitigation targets	**Suitable metrics for comparison to national policies or inclusion into existing climate mitigation models/scenarios**	**Options for conversion to emission reduction potential**
X% reduction in average car fuel consumption	Average fuel consumption by cars (in km/l) Data points needed: • Current average fuel consumption by cars (km/l)	Look at the projected fuel consumption of an average car. Calculate the relative % reduction of fuel consumption and the corresponding fuel consumption avoided. Then determine the corresponding CO_2 emission reduction potential, taking into account projected fuel mix and emission factors; and multiply by the projected number of cars on the road and the average distance driven. Assumptions: • Average km travelled by car remain unvaried Data points needed (use resources from the list of information sources in Box 8.7 if no national data available): • Projected fuel consumption of average car (km/l)

[10] Yale University 2015.

[11] Sims et al. 2014.

[12] IEA 2016b.

		• Number of projected cars on road • National fuel mix • Emission factors
Increase the number of EV domestically to X%	Number of EVs (in thousand) Data points needed: • Current number of EVs • Average final energy consumption of EVs (kJ/pkm)	Look at projected number of domestic vehicles on the road and their projected average final energy consumption. Then look at the average final energy consumption of EVs and determine the difference to traditional cars. Then convert the relative EV target to an absolute one, multiply the difference in final energy consumption with the number of EVs and converting to CO_2e emissions, by using emission factors, to determine potential savings from fossil fuels. Users should then calculate additional electricity demand from the increase in EVs, and multiply this with the grid emission factor, and hold this against the savings from fossil fuel to determine the overall emission reduction potential. Assumptions: • Distance travelled by traditional and EV cars are equal • Distance travelled remains unchanged or follows linear growth trend Data points needed (use resources from the list of information sources in Box 8.7 if no national data available): • Projected number of vehicles sold (incl. EVs) • Average projected final energy consumption of traditional cars and EVs • National fuel mix • Emission factors
Increase rail share of freight land transport to X%	Share of rail freight land transport Data points needed: • Current rail share of freight land transport • Total freight land transport traffic volume	Look at current share of freight land transport and the average freight rail distance ridden (as well as average CO_2 emissions per unit distance). The user should then look at road freight transport, average distance and average CO_2 emissions per unit distance. Finally, look at projections about freight transport and on this basis, calculate and compare emissions to determine emissions savings potential. Data points needed (use resources from the list of information sources in Box 8.7 if no national data available): • Average final energy consumption from train operations (kJ/tkm) • Total freight land transport traffic volume • Fuel mix • Emission factors
Increase rail share of passenger travel to X%	Share of rail passenger travel	Look at existing rail share of passenger travel and train distance travelled (as well as average CO_2 emissions per unit distance). The user should then look at road

	Data points needed: • Current share of rail passenger travel • Total rail traffic volume	passenger travel, average distance and average CO_2 emissions per unit distance. Finally, look at projections about passenger travel and on this basis, calculate and compare emissions to determine emissions savings potential. Data points needed (use resources from the list of information sources in Box 8.7 if no national data available): • Average final energy consumption from train and road operations (kJ/tkm and pkm) • Total rail traffic volume • Fuel mix • Emission factors
Increase public transport by X amount or X%	Modal split (as share of bus/train etc. in public transport)	Look at existing share of public transport, relative to total passenger transport and distance travelled (as well as average CO_2 emissions per unit distance). The user should then look other passenger travel transport, average distance and average CO_2 emissions per unit distance. Finally, look at projections about public transport travel and on this basis, calculate and compare emissions to determine emissions savings potential. Data points needed (use resources from the list of information sources in Box 8.7 if no national data available): • Average final energy consumption from public transport and other forms of transport • Current share of public transport • Fuel mix • Emission factors For more sophisticated calculations, users should proceed per technology due to different efficiencies of different public transport modes.

Box 8.7: Relevant international sources of information

- IEA's World Energy Outlook 2016 *which provides information on trends in energy demand by source in the transport sector and the renewable energy outlook for the transport sector*, Available at: http://www.iea.org/newsroom/news/2016/november/world-energy-outlook-2016.html
- IEA's Energy Technology Perspectives 2016 *which contains, among others, information on trends in energy demand from the transport sector, emissions intensity of new EVs and developments in passenger and freight transport*, Available at: http://www.iea.org/etp/
- IRENA Roadmap for a Renewable Energy Future *with information on renewable energy share in transport for key countries*, Available at: http://www.irena.org/DocumentDownloads/Publications/IRENA_REmap_2016_edition_report.pdf
- IPCC emission factor database, Available at: http://www.ipcc-nggip.iges.or.jp/EFDB/main.php
- World Bank Open Data covering several metrics, Available at: http://data.worldbank.org/indicator

- Additional information on methods and tools:
- IPCC Guidelines on 'Energy', Available at: http://www.ipcc-nggip.iges.or.jp/public/2006gl/vol2.html
- ICCT Transport Roadmap 2012 *provides an excel-based tool to assess emissions from transport and estimates changes in actual transportation activity by country and region, based on changes in forecasts of population, GDP and relative fuel*, Available at: http://www.theicct.org/global-transportation-roadmap-model
- SloCat *Transport Greenhouse Gas Emissions Research Briefs*, Available at: http://slocat.net/node/1538
- Paris Process on Mobility and Climate *An Actionable Vision of Transport Decarbonization Implementing the Paris Agreement in a Global Macro-Roadmap Aiming at Net-zero Emission Transport*, Available at: http://www.ppmc-transport.org/wp-content/uploads/2016/04/Global-Macro-Roadmap-Consultation-Draft-March-2017.pdf

8.2.3 Waste

The waste sector is of particular important to subnational actors, in particular cities as they are ultimately the actors who have to deal with waste-related issues. Non-state actors can be an important source of waste on the other hand. Looking at existing databases on non-state and subnational action, few non-state and subnational actors and initiatives currently target the waster sector. In 2010, the sector contributed to approximately 3% of global GHG emissions, due mainly to wastewater handling (54%) and solid waste disposal on land (43%) and followed by waste incineration.[13]

Table 8.6 provides an overview of suitable metrics for inclusion into existing national models that look at waste as well as the conversion of non-state and subnational action targets into emission reduction potentials. Box 8.8 provides an overview of data sources which can be consulted if national data is not available.

Table 8.6: Examples of metrics for the waste sector

Waste sector		
Examples of non-state/subnational climate change mitigation targets	**Suitable metrics for comparison to national policies or inclusion into existing climate mitigation models/scenarios**	**Options for conversion to emission reduction potential**
Recover methane emissions from waste	Eliminate methane emissions. Assumptions: • All methane emissions from waste can technically be recovered	If all methane emissions from waste can be recovered, then methane emissions from waste would be equal to zero. The emissions reduction potential can be calculated by looking at the projected amount of waste and the projected waste intensity (CO_2e/kt). By multiplying both, users have the potential emission reduction potential. Users also need to

[13] IPCC 2014a.

		take into account previous years' wastes (using a 1st order decay equation)[14] Assumptions: • Linear growth trend in waste intensity (composition of waste remains unvaried) • The decrease in X amount of waste will proportionally reduce CO_2e emissions Data points needed (use UN or IPCC resources if no national data is available): • Waste intensity
Decrease amount of waste by X tonne (decrease GHG emissions from waste by X amount/X %)	Remaining amount of waste (in kt)	First calculate the CO_2e emissions of 1 kt of waste, by multiplying it with the waste intensity. To determine the emission savings potential from the decrease in waste, multiply the absolute reduction in waste (in kt) with projected CO_2e emissions of 1 kt of waste. Assumptions: • Linear growth trend in waste intensity (composition of waste remains unvaried) • The decrease in X amount of waste will proportionally reduce CO_2e emissions • Ignore emissions from decay of waste on landfills from previous years • It is assumed there is no change in recycling or re-use Data points needed (use UN or IPCC resources if no national data is available): • Waste intensity

Box 8.8: Relevant international sources of information

- UN Environment/International Solid Waste Association's *Global Waste Management Outlook,* Available at: http://www.iswa.org/nc/home/news/news-detail/browse/1/article/press-release-global-waste-management-outlook-gwmo/109/
- IPCC *report on waste management*, Available at: https://www.ipcc.ch/pdf/assessment-report/ar4/wg3/ar4-wg3-chapter10.pdf
- IPCC emission factor database, Available at: http://www.ipcc-nggip.iges.or.jp/EFDB/main.php
- Additional information on methods and tools:
- IPCC *guidelines on 'Waste'*, Available at: http://www.ipcc-nggip.iges.or.jp/public/2006gl/vol5.html
- California's landfill methane emissions calculation tool, Available at: https://www.arb.ca.gov/cc/protocols/localgov/localgov.htm

[14] For more information on how to calculate emissions reduction potential from waste, please see the IPCC guidelines on waste.

8.3 Comprehensive assessments

Users aiming for a comprehensive assessment will need to go through all identified sectors in Chapter 4 (define assessment boundary) and perform the steps outlined above. Comprehensive assessments are likely to focus on emission reduction potentials from non-state and subnational action. Box 8.9 provides an example on how this assessment might look like in practice.

Box 8.9: Determining emission reduction potentials in a comprehensive assessment

The objective of the assessment is to quantify the emission reduction potential from all non-state actors on the emission pathway of country X. In this step, the user should quantify the earlier identified suitable non-state actions. In the example below, the user has identified one major suitable industry company target and another in the energy sector. The user should proceed with the calculation by sector. Users should bear in mind that at this stage, base years and target years are not harmonised and overlaps have not been checked for, therefore users will *not* yet be able to add up emission reduction potentials.

Actor	**(Sub)sector(s)**	**Target (including reference levels, target year and assumption(s) if available)**	**Base year emissions in user country's boundary (tCO_2e)**	**Estimated emissions in target year in user country's boundary (tCO_2e)**	**Estimated emission reduction potential in user country's boundary (tCO_2e) for stated target year**	**Notes**
Information provided	*Identified by user*	*Information provided*	*Information provided*	*Information calculated by user*	*Information calculated by user*	*Assumptions made by user*
Company A	Energy supply	25% renewable electricity excl. large hydro in 2030 (10% renewables in 2005 base year)	9,000,000 (in 2005)	In year 2005, 90% of electricity is generated by fossil fuel, accounting for 9,000,000 tCO_2e in total. In 2030, 75% is generated by fossil fuel. To calculate the emissions in 2030: x= 0.75*9,000,000= 6,750,000 tCO_2e	2,250,000 (in 2030)	Between 2005 and 2030 no changes assumed in total electricity generation levels and the fuel mix for electricity generation from non-renewables.

In the above example of Company A, the user calculates the emissions in the target year, 7,500,000 tCO_2e in 2030. However, users should note that the result is sensitive to the assumptions taken ("Notes" column). For example, if the user assumed a 20% increase in total electricity generation by the target year, the target GHG emission level would be 6,750,000 * (1 + 20%) = 8,100,000 tCO_2e, meaning that the absolute emissions reduction impact compared to the base year would be much smaller (900,000 tCO_2e compared to 2,250,000 tCO_2e). Similarly, if the user assumed a 10% reduction in emission intensity for electricity generated from non-renewable sources by 2030 due to the renewables mainly replacing coal, the target GHG emission level would be 6,750,000 * (1 – 10%) = 6,682,500 tCO_2e and the resulting absolute emissions reduction impact would be 2,317,500 tCO_2e compared to the base year.

In the example below, the user has information about the target and base year emissions in the user country's boundary. To calculate the emissions in the target year and associated emission reduction potential, the user needs to determine the share of operational emissions as part of total emissions. To do so, users should check the data source to see if the company has provided that information if they had not noted that down previously. In case no information has been detailed, users can assume that a company's operational emissions cover its total scope 1 and 2 emissions Again, the estimated target year emissions and emission reduction potential are sensitive to assumptions, in this case that the non-operational emissions remain unvaried ("Notes" column).

Actor	**(Sub)sector(s)**	**Target (including reference levels, target year and assumption(s) if available)**	**Base year emissions in user country's boundary (tCO_2e)**	**Estimated emissions in target year in user country's boundary (tCO_2e)**	**Estimated emission reduction potential in user country's boundary (tCO_2e) for stated target year**	**Notes**
Information provided	*Identified by user*	*Information provided*	*Information provided*	*Information calculated by user*	*Information calculated by user*	*Assumptions made by user*
Company B	Industry	Reduce operational CO_2e emissions by 100% from 2015 to 2021	4,580,000	Scope 1+2 emissions cover 70% of emissions and account for 4,580,000 tCO_2e. Operational emissions in base year are thus 0.7*4,580,000= 3,206,000 tCO_2e Emissions in the target year will thus be 4,580,000-3,206,000= 1,374,000 tCO_2e	3,206,000	Operational emissions cover a company's total scope 1 and 2 emissions; non-operational emissions remain unvaried

9. Assessing Overlaps, Adding Impacts and Comparing Ambition

This chapter provides guidance on how to add non-state, subnational and national climate mitigation actions, while avoiding double counting, and how to compare their respective ambition level and impact on emission pathways.

Checklist of key recommendations

- Check for potential overlaps between various non-state and subnational actions in the same sector, across sectors and between non-state/subnational actions and national policies to avoid double counting
- Harmonise the target year with the non-state and subnational target years when comparing ambition

9.1 Relationship and interactions between actions

Based on the converted (or suitable) metrics identified and/or the emission reduction potentials calculated in Chapter 8, users should check for overlaps to avoid double counting of impacts. Users should assess the relationships and interactions between actions to understand where these actions reinforce each other to achieve the same outcome and to not double count their effect at the metric or emission reduction potential level. It is a *key recommendation* to check for potential overlaps between various non-state and subnational actions in the same sector,[15] across sectors and between non-state/subnational actions and national policies to avoid double counting and record any justifications to include or exclude specific actions in the assessment.

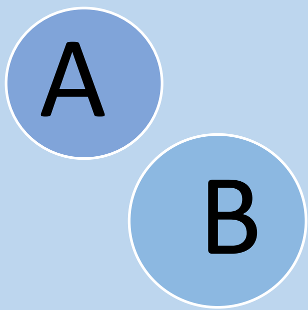
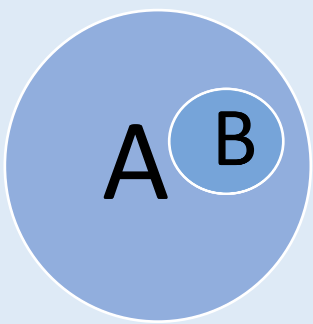
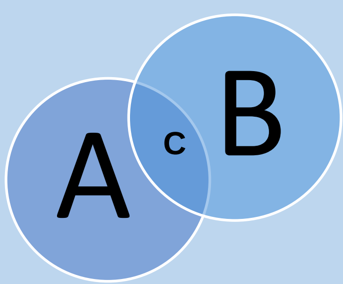
Table 9.1 specifies types of relationships between national policies and non-state/subnational actions with a specific focus on cases of double counting and how users can avoid it *(A and B stand for different non-state, subnational and/or national policies/actions, C stands for their overlap and D for the combined effect of A and B together).* Overlaps do not necessarily always constitute a problem, in some cases actions can work in the same direction and reinforce each other rather than decrease the overall impact. It should be noted that some double counting may be inevitable when actions pull in the same direction. There is no one size fits all approach to determine overlaps and the analysis should be carried out on a case by case basis.

Users should also consult with relevant stakeholders on how the different actions and policies qualify, that is, if they are independent, overlapping, reinforcing or overlapping and reinforcing. Depending on resource availability, they might also want to have a look at the studies in the Annex that quantify non-state and subnational action and how they handle this issue. In general, the more diverse the different targets (use of different metrics, discussed in Chapter 8) and the sector, the lesser the chances for overlap between the different targets. The more overlaps users identify, the more cautious they should be when adding impacts. Box 9.1 and Box 9.2 provide examples for addressing overlaps and for calculating emissions coverage overlaps among actors.

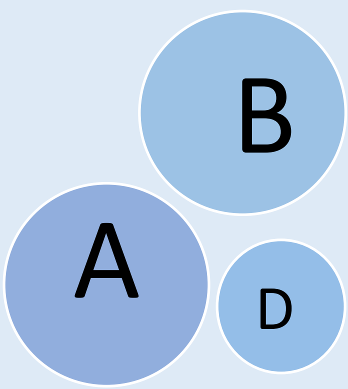
[15] This can include checking for overlaps at collaborative action level

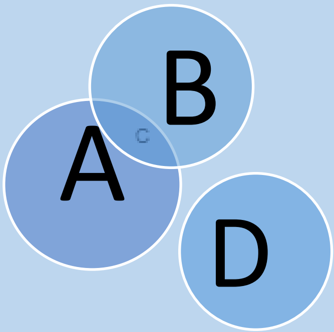
Users should also report results as well as the approach used to determine overlaps.

Table 9.1: Type of relationships between policies and non-state and subnational actions[16]

Type	Description	What to do
Independent 	Multiple national policies/actions do not interact with the non-state and subnational action being assessed. The combined effect of implementing the policies and non-state and subnational action together is equal to the sum of the individual effects of implementing them separately (A + B). In practice, users will encounter this situation in a very limited number of cases.	No further action required. Users will be able to compare actions once data is harmonised (all targets are harmonised against a specific target year/base year if applicable).
Encompassing 	Some national policies/actions may fully encompass the actions of non-state and subnational actions. In this case, there is full overlap and the encompassed action may be considered an additional indication that the broader action is likely to be achieved.	Users should not include the encompassed action in the final aggregation.
Overlapping 	Multiple national policies and non-state and subnational actions interact, and the combined effect of implementing the policies and non-state and subnational action together is less than the sum of the individual effects of implementing them separately (A + B – C). This includes policies/actions that have the same or complementary goals (for example national energy efficiency standards for buildings and non-state action aimed at reducing the GHG impact of buildings), as well as actions that have different or opposing goals	Overlap should be determined and subtracted from overall assessment. Carefully check if the potential combined impact is realistic/possible. Never include an impact that could not be realistic. If in doubt, users should consult with sector experts. In case of overlaps between regional and city-level actions, it can be recommended that the actions of cities that are located in regions with action should entirely be excluded to avoid

[16] Adapted from WRI 2014b and based on Boonekamp 2006.

	(such as a national fuel subsidy and a non-state initiative calling for a price on carbon) and actions/initiatives that replace the same emissions (e.g. the targets of a solar and a wind initiative both striving for a certain share of electricity generation could together account for a higher share of generation than there are non-renewables to replace). This also includes actions that are counted twice, i.e., when the same company/city/etc.is subscribed to two different initiatives with a similar target; or listed both as singular action and within one initiative. An indication for a potential overlap is the use of the same metric for different targets.	double-counting, unless those city-level actions are significantly more ambitious than the actions of the regions they are located in. In case of overlaps between company-level and region/city-level actions, the share of company emissions generated in cities/regions with action needs to be quantified. If cities/regions with action account for x% of national total GHG emissions, a simplified approach would be to assume that x% of the impact from company-level actions are overlapping.
Reinforcing  	Multiple national policies and non-state and subnational actions interact, and the combined effect of implementing the policies and non-state and subnational actions together is greater than the sum of the individual effects of implementing them separately (A + B + D). An example could be a business initiative aimed at decreasing deforestation and a national policy aiming to discourage the use of uncertified forest-risk commodities. Both the initiative and the policy pull in the same direction and might mutually reinforce each other.	The combined effect should be calculated and added to the overall impact.
Overlapping and reinforcing	Multiple policies and non-state and subnational actions interact, and have both overlapping and reinforcing interactions. The combined effect of implementing the policies and non-state and subnational actions together may be greater than or less than the sum of the individual effects of implementing them separately. An example could be a non-state target to increase the amount of RE procured and a national	Overlap should be calculated and added or subtracted from the overall impact; combined effect should also be calculated and added.

	policy aimed at increasing the amount of RE generated within the country. Both the non-state action and the national policy pull in the same direction, while their combined effect could either be greater than the sum of the individual effects or less.	

9.2 Identify relationships between actions and calculate overlap

To avoid double counting impact, users should quantify potential overlap between actions. Overlap may be estimated by comparing the calculated impact of each action against other actions where boundaries or interaction may be suspected. The methodology applied to calculate overlap may require a number of assumptions of potential interaction and these should be recorded. For example, some city-level actions may help larger jurisdictions achieve the intended impact of their actions, and therefore, may not be considered additional in terms of overall impact, even though they are important contributions. In another example, actions by private corporations may in fact be responding to a governmental mandate, or public action and therefore may not necessarily be considered additional. All potential relationships between actions should be examined to calculate overlaps.

9.2.1 Calculate overlaps within each sector

For each sector, users should calculate overlaps among actor groups included in the analysis. If subnational actions are included in the analysis, users may want to begin with these actors, followed by non-state actors. If subnational actions are not included, users may go directly to calculate overlaps of non-state actors. Calculations for overlap should be repeated for each sector included in the assessment.

Subnational actions

As a first step, users may want to calculate the overlaps between subnational actors such as regions with GHG targets and cities with GHG targets. Users may assume that all electricity consumed by cities (scope 2) is generated in regions in which the cities are located and may apply additional assumptions to calculate overlaps.

- **Full overlap**: Users may assume subnational action, regardless of the level of ambition, yields no additional effect if the scope of the action is within the scope of a larger jurisdiction with its own action. In this case, the action of the smaller jurisdiction would not be included in the final aggregation as there is full overlap.
- **Partial overlap**: If cities within the assessment boundary are known to have highly ambitious targets compared with larger jurisdictions, users may want to assume there is some additional impact and that overlap is not complete. In this situation, users would compare the actions of cities and larger jurisdictions and if the city target is more ambitious than the target of the larger

jurisdiction, any additional impact above and beyond the action of the larger jurisdiction can be included in the final aggregation.

- **No overlap**: For cities and other subnational entities where no larger governing jurisdiction has an action of its own, the entirety of the subnational actions' calculated impact may be included in the final aggregation.

Non-state actions

As a second step, users should determine the geographic overlaps between the actions of non-state actors including end-use companies and electric generating companies and the actions of subnational actors. If subnational actions are excluded from the analysis, this step may not be necessary.

It is important to note that this step will require significant time and data on geographical details for non-state actions. If users can determine the geographic overlaps between business actors and subnational actors (not only for headquarter locations, but at the facility level to determine which GHG emissions pools they exist), they could calculate overlaps following a similar set of assumptions to step 2.1.1.

- **Full overlap**: In this case, users may determine that non-state actions are the result of public actions, such as public policies to guide businesses toward climate action. If the action of the governing jurisdiction is included in the assessment, full overlap can be assumed and the non-state actions' impact should be excluded from the final aggregation. In some cases, the private sector action may not be the result of public policy, but may still contribute toward achievement of the governing jurisdictions' action, and should also be excluded from the final aggregation.
- **Partial overlap**: Users may encounter relationships between non-state and subnational action where a business or corporation may dramatically exceed the ambition of the governing jurisdiction. In this case, users may assume there is some additional impact and may want to include this in the final aggregation.
- **No overlap**: If a non-state action exists within a jurisdiction where there are no public actions by a governing body, the full effect of the actions' impact may be included in the final aggregation.

Without specific facility-level data it may be impossible to calculate overlaps with subnational action as you will not be able to determine which subnational GHG emissions pools they may overlap with. In some sectors, geographical data may be available, but in many cases, it may not be specific enough to calculate overlaps with smaller subnational actors such as cities. In this case, users will need to make a best-guess estimate of potential overlaps. One approach could be to assume that the percentage of GHG emissions for the overlap between energy end-use companies with GHG targets and sub-nationals with targets is the same as that between sub-nationals and the national target (*non-state / subnational = subnational / national*). Therefore, if the net coverage of GHG emissions of sub-national actors with commitments is xx% of national total GHG emissions, the same percentage may be assumed for the overlap between end-use companies and subnational actors. In practice, users would calculate the percentage that cities and regions cover in total national emissions. Then assume that this same percentage of scope 1 + 2 GHG emissions from all energy end-use companies with targets overlaps with subnational GHG emissions.

Separately, the overlaps between electricity-generating companies with commitments and all other non-state actors with commitments may be quantified. This overlap is calculated to avoid double counting of emissions from electricity production by electric and gas utilities (Scope 1), and the use of electricity by other sectors (Scope 2).

Users could assume that the overlap rate for electricity-generating companies is equal to the net coverage rate of electricity-related GHG emissions by subnational actors and energy end-use companies. However, the shares of Scope 2 emissions in energy end-use companies' total Scope 1 plus Scope 2 emissions may not be available. In this case, users may use the median values for companies with the data available. In practice, sum electricity related GHG (scope 2) emissions of energy end use companies and subnational actors and calculate their combined share in the given country's national power sector emissions. Then assume that this this same percentage overlaps with the electricity generating companies GHG emissions. If subnational actions are excluded, users could look at non-state action for each sector in aggregate and consider potential overlaps with the national level.

International cooperative action

As a third step, users should calculate overlaps of any international cooperative action included in the assessment. As noted in Chapter 6, many international cooperative actions can be excluded from the analysis if their membership have individual actions of their own included independently of the international cooperative action. In other cases, the activity described in the international cooperative action may be an implementing element of a broader GHG emissions reduction action, and can therefore also be excluded. For example, an international cooperative action aims to increase the share of bicycle transportation in cities. If the participating cities have broader emissions reduction actions, or specific transport sector actions, the impact from the international cooperative initiative may help the cities achieve their broader action, but may not necessarily be additional. If in this case, the participating cities do not have broader actions that would encompass this specific activity, the expected emissions reduction impact from the international cooperative initiative can be included in the aggregation.

However, cooperative initiatives should also be evaluated for their potential impact, if for example, their aim is to increase the number of actors taking action. In a non-conservative approach, users may wish to include such cooperative initiatives and consider the additional impact if they achieve their intentions to grow the number of actors. In this case, users can estimate the potential impact of these additional actors and include their potential in the aggregation assessment

For international corporations with global actions, the expected impact should be disaggregated to the assessment boundary and assessed for overlaps following the procedures for non-state actors as noted above.

Users may want to categorise the actions as "primary" and "secondary," or "tier 1" and "tier 2" where primary or tier 1 actions are those in of higher subnational jurisdictions such as regions, states or other designation and secondary or tier 2 actions are from actors within larger jurisdictions such as counties, cities, businesses and corporations. Actions within sectors could then be further organised by geographical location to help users identify relationships where overlaps are likely and where the necessary calculations should be made as described above.

Calculations should be repeated for all sectors and all actions and all assumptions should be recorded. If relationships or overlap are unknown, users pursue a conservative approach and assume full overlap of all actions taking place within larger jurisdictions with actions even if they may appear more ambitious. A conservative approach may help compensate for unknown activity of non-actors within the same jurisdiction who could in fact increase emissions during the action time period.

9.2.2 Consider possible reinforcing impacts

In most cases, actions will be independent, encompassing, or overlapping. In rare instances, actions may reinforce each other to produce impact beyond the intended impact of each action combined. For example, two or more actions aimed at helping businesses set climate targets, are operating in the same pool of actors and could potentially overlap, but at the same time, they may drive more businesses to take on more ambitious targets than originally intended. Depending on the situation, users could set assumptions about the number of estimated businesses that are expected to take on targets as being larger than the combined number from both actions independently. This would allow the user to examine a more far-reaching scenario of the potential impact of the actions if more businesses (for example) took on more targets. This approach is, however, very hypothetical and all assumptions should be clearly explained that this assessment goes beyond the stated expected impact of the examined actions.

Box 9.1: Example of how to address overlaps

Province A has committed to a 30% target share of RE in their total final energy consumption by 2020, but A could use electricity imported from other provinces to meet its commitment. Province B has a renewable electricity generation goal of 30%, and they sell most of their renewables to Province A. Although Provinces A and C both meet their commitments in real and measurable ways, at the national level the amount of renewable electricity generation may be smaller than they appear on the surface and the risk of double counting is high. To parse out this kind of double counting, additional data collection and quantitative analysis is recommended. To solve this case, the user would need detailed data on electricity sales between the Provinces. Many regional governments now document their yearly electricity imports and exports. In the absence of data, it is recommended to provide a realistic range of RE generation.

Box 9.2: Example calculation of emissions coverage overlaps among actors

In Country A, 8 regions, 84 cities and 297 companies from different sectors have set targets to reduce overall GHG emissions. These three actor groups accounted for 940 $MtCO_2e$, 690 $MtCO_2e$ and 680 $MtCO_2e$ in 2016. The overlap estimation can be done in a number of steps.

First, there are overlaps between regions and cities. 33 cities that accounted for 570 $MtCO_2e$, or 83% of emissions from the 84 cities, were located in one of the above eight regions and none of the 33 had targets that are more ambitious than their region-level targets. It is recommended that these 33 cities' targets are excluded, meaning that the remaining 51 city targets would be counted as additional to regional targets.

Second, there are overlaps between company targets and subnational (regional and cities) targets. Users could first consider non-energy supply companies, which are energy end-users. Because companies usually do not provide information on the emissions per office or factory location, users could assume that the GHG emissions from non-energy supply companies are distributed proportionately to region- and city-level emissions. The GHG emissions from the above 8 regions and

51 cities accounted for 16% of current national total GHG emissions (excluding LULUCF). It can therefore be assumed that 16% of non-energy supply companies' targets is overlapping.

Following this, users could consider the overlaps between the direct emissions from energy supply companies and indirect emissions from regions, cities and non-energy supply companies. The 8 regions, 51 cities and the non-energy supply companies were found to account for 20% of the country's total CO_2 emissions from the energy supply sector. It can therefore be assumed that the 20% of the energy supply company targets are overlapping.

9.3 Aggregate impacts

Users should repeat calculations for overlaps for all sectors within the assessment boundary and should aggregate the results. The formula for aggregation should include adding all impacts from actions by non-state and subnational actors and subtracting the overlaps. At this stage, users will now have a total estimate of the impact of non-state and subnational actors within the assessment boundary.

The calculation for aggregation can be summarised as follows:

$$E_{NSA}(\mathrm{t}) = E_R(\mathrm{t}) + (E_C(t) - E_{C,R}(\mathrm{t})) + (E_B(\mathrm{t}) - E_{B,RC}(\mathrm{t})) + (E_P(\mathrm{t}) - E_{P,RCB}(\mathrm{t})), \qquad (2)$$

where

E_R(t): Sum of GHG emissions from state actors;

E_C(t): Sum of GHG emissions from city actors;

$E_{C,R}$(t): GHG emissions from city actors overlapping with U.S. state-level actions;

E_B(t): Sum of GHG emissions from company actors (excluding electric utilities);

$E_{B,RC}$(t): GHG emissions from energy end-use company actors overlapping with state- and city-level actions;

E_P(t): Sum of GHG emissions from electric utilities actors;

$E_{P,RCB}$(t): GHG emissions from electric utilities actors overlapping with state-, city-level, and energy end-use company-level actions.

If the objective of the assessment was to determine the landscape of climate action by non-state and subnational actors, and identify key sectors and action areas, the user has completed the exercise. However, it is important to note the results of the assessment so far have not accounted for potential overlap with national action and therefore may not be considered independent or additional to national action without further analysis.

9.4 Analyse aggregation results and compare ambition

Once overlaps have been determined and impacts have been aggregated, users will be able to analyse results and compare the total impact (ambition[17]) of non-state and/or subnational action to the national level. This can be done in three basic ways and will differ in the level of complexity and potential limitations Depending on the objective of the assessment, further analysis may be necessary.

9.4.1 Compare aggregated impact to a national-level target or action

For assessment objectives that aim to determine how non-state and subnational action will help achieve a specific national target or action, users should already have identified the appropriate metric in Chapter 8 and the aggregation results should be in that metric. This may be a cumulative amount for a given time period, or maybe a single annual sum for a given individual target year depending on the action selected. It is a *key recommendation* to harmonise the target year with the non-state and subnational target years when calculating potential impact so that results are comparable. For the sake of simplicity, in the absence of data, this guidance recommends to not assume any additional impact of the actions after they have reached their goals. In other words, if an action aims to achieve a certain emission reduction in 2020, but the user is looking for the action's emission reduction potential in 2030, the user should assume that the reduction potential achieved in 2030 is equal to the one of 2020, under the condition that the baseline remains unvaried. Users should bear in mind however that some 'autonomous' improvement', due to market developments, technological improvements or population change for example , in certain sectors might take place even without the non-state or subnational action being implemented.

Users should review the results of the impact aggregation against the national level action now that potential overlaps will have been calculated.

This guidance suggests users complete a table to clearly indicate the difference in ambition levels (Table 9.2 and Table 9.3). This can be done by looking at specific metrics from the national action, such as in the example below. The tables also indicate which comparison in ambition is relevant for which assessment objective.

Table 9.2: Compare ambition at the metric level

(Sub)Sector/ National Level	Potential of non-state/ subnational action without overlap in a specific (sub)sector or at national level (A)	Corresponding current (sub)sector or national policy scenario (B)	Combined effect of non-state/ subnational action and (sub)sector or national policy incl. overlap (C = maximum of A and B)	Additional impact (or gap) from non-state action at (sub)sector or national level (D)	National or (sub)sector requirements under NDC (E)	Gap between NDC requirements and combined impact of all actions (E-C)
Relevant for which objective of assessment	All	All	Determine how non-state and subnational action contribute to the (sub)sectoral or	For all assessments that relate to the NDC	Determine opportunities for engagement; Improve climate mitigation projections or revise target(s);	

[17] Ambition level is used a benchmark relative to climate change mitigation goals (such as those expressed in NDCs for example).

			national climate change plan; Determine opportunities for engagement; Improve climate mitigation projections or revise target(s);			
Example: Renewable energy	10 GW added by 2020	7 GW added by 2020	10 GW added by 2020	3 GW added by 2020	12 GW added by 2020	2 GW by 2020

Table 9.3: Compare ambition at the emission level

(Sub)Sector / National Level	Emission reduction potential of non-state/ subnational action without overlap (A)	GHG emission reductions resulting from current sectoral/ national policy scenario (B)	Combined effect of non-state/ subnational action and (sub)sector or national policy incl. overlaps (C = maximum of A and B)	Additional impact (or gap) from non-state action at (sub)sector or national level (D)	National or (sub)sector requirements under NDC (E)	Gap between NDC requirements and combined impact of all actions (E-C)
Relevance for which assessment objectives	All	All	Determine how non-state and subnational action contribute to the (sub)sectoral or national climate change plan; Determine emissions gap at the (sub)sector or national level; Determine opportunities for engagement; Improve climate mitigation projections or revise target(s); Determine untapped (sub)sector or nationwide emission reduction potential to decide how to meet national climate change targets		For all assessments that relate to the NDC	Determine emissions gap at the (sub)sector or national level; Determine opportunities for engagement; Revise NDC; Determine untapped (sub)sector or nationwide emission reduction potential to decide how to meet the NDC
Example: Electric Vehicles	20 $MtCO_2e$ by 2030	60 $MtCO_2e$ by 2030 (sectoral/ transport sector)	70 $MtCO_2e$ by 2030	10 $MtCO_2e$ by 2030	80 $MtCO_2e$ by 2030	10 $MtCO_2e$ by 2030

9.4.2 Compare aggregated impact to a national-level scenario

For comprehensive assessments where users aim to compare the overall emission reduction potential from non-state and subnational action at national level to a business as usual scenario, current national policy scenario, or other emissions projections, users require information on national/sectoral emission projections and/or GHG implications of national policy scenarios. If there is currently no such information available or has been gathered as part of Chapter 7, users could consult international scientific analysis for reference scenarios which track the effects of current policies on national emissions, such as those developed by the Climate Action Tracker for some selected countries.[18]

9.4.3 Integrate results and metrics from assessment into a climate systems model

As explained in Chapter 3, results may be integrated into an existing model. This approach is more complex and comprehensive but would allow users to fully account for overlaps between sectors and also account for other extraneous systems interactions, such as non-climate actor activity, energy supply-demand interactions and technological advancement. In this case, users could apply the results of the aggregation assessment into climate systems models that could analyse the total impact of non-state, subnational and national action and fully account for overlaps.

Users would need to adapt specific results of the impact of sectoral climate action by non-state and subnational action into the corresponding metric used in the climate systems model. In this approach, users would only add non-state and subnational action if they are not already included in the model.

[18] Further information is available at: http://climateactiontracker.org/