

# Queretaro Pathway Priority Actions

## Estimated Economy wide GHG Emissions Reduction

This document summarizes the estimated economy wide GHG emission reductions from the Pathway Priority Actions of Queretaro compared to:

- The state BAU GHG emissions levels i.e., 17 TgCO<sub>2</sub>e in 2030 and 33 TgCO<sub>2</sub>e in 2050.
- The state GHG emission reduction targets. For the year 2030, the state GHG emission reduction target is to achieve a GHG emissions level that is 27% below the 2015 emissions level (or 6,9 TgCO<sub>2</sub>e by 2030) (the “2030 Target”). For the year 2050, the state GHG emission reduction target is to achieve a GHG emissions level that is 65% below the 2015 emissions level (or 3,2 TgCO<sub>2</sub>e by 2050) (the “2030 Target”, and together with the 2030 Target, the “Targets”). These Targets are equivalent to GHG emission reductions of 59% in 2030 and 90% in 2050 when measured against the BAU values for those years.

Additionally, the expected cumulative GHG emissions (i.e., emissions for the period 2021 – 2050) remaining after the full implementation of the Pathway Priority Actions are compared to:

- the cumulative emissions that would occur if Queretaro met its 2050 Target.
- cumulative emissions that would occur if Queretaro met the Mexico Nationally Determined Contribution (NDC) target
- possible “carbon budgets” or targets for Queretaro based on varying global carbon budget allocation schemes.

### Summary of the results

Implementation of the Pathway Priority Actions is expected to result in significant decarbonization as summarized below:

- *Expected GHG impacts of the Pathway Priority Actions compared to BAU GHG emissions levels* - By 2030, GHG emission reductions of 4,2 TgCO<sub>2</sub>e are expected (i.e., 25% against BAU levels). By 2050, reductions of 18 TgCO<sub>2</sub>e are expected (i.e., 54% against BAU levels). Most of the GHG emission reductions will come from the Pathway Priority Actions in the Industry and Energy Supply sectors.
- *Expected GHG impacts of Pathway Priority Actions compared to the Targets* - For the year 2030, the GHG emission reductions of the Pathway Priority Actions are estimated to be about half of those needed to achieve the 2030 Target (4,2 TgCO<sub>2</sub>e of the 9,8 TgCO<sub>2</sub>e needed). For the year 2050, the GHG emission reductions of the Pathway Priority Actions are estimated to be more than half of those needed to achieve the 2050 Target (18 TgCO<sub>2</sub>e of the 30 TgCO<sub>2</sub>e needed). The Pathway Priority Actions will largely flatten growth in GHG emissions over the next two decades; however, it will not produce reductions large enough

to meet the Targets. Meeting the 2050 Target requires the state to achieve GHG emissions levels of around 3,2 TgCO<sub>2</sub>e/yr by 2050.

- *Expected Cumulative GHG Emissions (2021 – 2050)* remaining after the full implementation of the Pathway Priority Actions - Likewise, looking at the cumulative GHG emission reductions for the Pathway Priority Actions (i.e., reductions occurring between now and 2050), by 2050 Queretaro will still emit about twice the level of emissions expected should the 2050 Target is met.

Through this Project, Queretaro has set ambitious and transformational decarbonization Targets, and the Pathway Priority Actions represent a significant effort for the state towards achieving them. To meet the Targets, an additional 5,6 TgCO<sub>2</sub>e/yr of reductions are needed by 2030 and another 12 TgCO<sub>2</sub>e/yr are needed by 2050.

Queretaro is well positioned to build on the current set of Pathway Priority Actions to achieve the necessary cumulative GHG emissions reductions along with other socio economic goals through some further strengthening of the Priority Actions and by identifying and developing additional low carbon actions across the economic sectors. Those actions should address the key emission drivers after the full implementation of the Pathway Priority Actions (i.e., transportation, industry, agriculture and livestock, and waste management sectors) and further expand the significant decarbonization results of the Pathway Priority Actions.

### **2030 and 2050 Economy-wide GHG emissions reduction**

Figure 1 below summarizes the economy wide GHG baseline, the Targets (and associated decarbonization path) and the GHG emission reductions attributed to each of the Pathway Priority Actions. It is followed by Table 1 that provides for each Pathway Priority Action and at the sector-level (i) stand-alone GHG emission reductions, (ii) GHG emissions reductions adjusted for overlaps between actions, (iii) percentage reduction against BAU, (iv) percentage reduction compared to the Targets and (v) GHG emissions remaining after the implementation of the Pathway Priority Actions.

The emission levels indicated in the chart are adjusted for overlaps between actions. They represent direct emissions that have been affected by priority actions that produce both: direct emission reductions (e.g., from reductions in fuel use; changes in land management); and indirect emission reductions (e.g., from reductions in electricity use; or production of renewable energy). A common overlap is between actions that address electricity supply (e.g., new renewable energy) and electricity demand (e.g., electrical energy efficiency). In the economy wide GHG results, the emission reductions for cleaner electricity or reduced use of electricity are shown in the Energy Supply sector results. “Stand-alone” results refer to the GHG impacts calculated for an action without consideration of any interactions/overlaps (i.e., as if the action is the only one to be implemented and is evaluated against BAU conditions). As indicated earlier, table 1 provides results for each action on a stand-alone basis as well as with overlap adjustments.

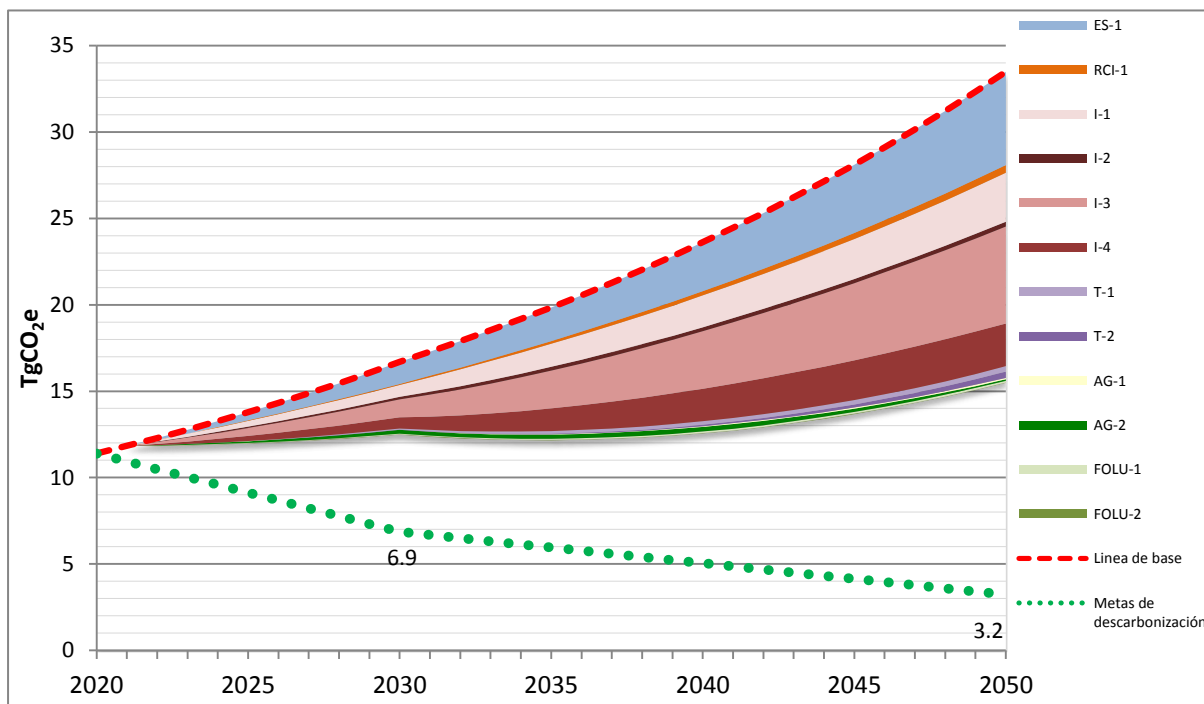


Figure 1. Economy-wide GHG Emissions Impact of the Pathway Priority Actions.

Título de la acción		Reducciones no ajustadas por superposición (TgCO <sub>2</sub> e)		Reducciones ajustadas por superposición (TgCO <sub>2</sub> e)		Reducción de la línea de base (%)	
		2030	2050	2030	2050	2030	2050
ES-1	Energía solar centralizada	1,27	5,40	1,27	5,40	7,6%	16,1%
<b>Total del sector suministro de energía</b>		<b>1,27</b>	<b>5,40</b>	<b>1,27</b>	<b>5,40</b>	<b>7,6%</b>	<b>16,1%</b>
RCI-1	Solar distribuido en el sector comercial e institucional	0,08	0,51	0,07	0,44	0,4%	1,3%
<b>Total del sector residencial, comercial e institucional</b>		<b>0,08</b>	<b>0,51</b>	<b>0,07</b>	<b>0,44</b>	<b>0,4%</b>	<b>1,3%</b>
I-1	Producción de electricidad renovable en el sitio	0,87	5,70	0,69	2,84	4,1%	8,5%
I-2	Producción y uso de combustibles renovables	0,21	1,39	0,14	0,28	0,8%	0,8%
I-3	Producción de calor renovable en el sitio	1,04	5,61	1,04	5,61	6,2%	16,8%
I-4	Eficiencia energética eléctrica	0,80	4,37	0,64	2,46	3,8%	7,4%
<b>Total del sector industrial</b>		<b>2,92</b>	<b>17,06</b>	<b>2,51</b>	<b>11,19</b>	<b>15,0%</b>	<b>33,4%</b>
T-1	Planificación urbana inteligente	0,07	0,32	0,07	0,32	0,4%	0,9%
T-2	Electrificación de vehículos	0,03	0,62	0,01	0,36	0,1%	1,1%
<b>Total del sector transporte</b>		<b>0,10</b>	<b>0,94</b>	<b>0,08</b>	<b>0,67</b>	<b>0,5%</b>	<b>2,0%</b>
AG-1	Sistemas agroforestales	0,00	0,08	0,00	0,08	0,0%	0,2%
AG-2	Regeneración de tierras de pastoreo	0,22	0,17	0,21	0,09	1,3%	0,3%
<b>Total del sector agropecuario</b>		<b>0,22</b>	<b>0,25</b>	<b>0,21</b>	<b>0,17</b>	<b>1,3%</b>	<b>0,5%</b>
FOLU-1	Expansión del ecosistema forestal	0,04	0,10	0,04	0,10	0,2%	0,3%
FOLU-2	Conservación de tierras forestales	0,02	0,02	0,02	0,02	0,1%	0,1%
<b>Total del sector FOLU</b>		<b>0,06</b>	<b>0,13</b>	<b>0,06</b>	<b>0,13</b>	<b>0,4%</b>	<b>0,4%</b>
<b>Reducciones de GEI en toda la economía</b>		<b>4,6</b>	<b>24,3</b>	<b>4,2</b>	<b>18</b>	<b>25%</b>	<b>54%</b>
<b>Linea de Base</b>				<b>17</b>	<b>33</b>		
<b>Metas de descarbonización comparadas con la línea de base</b>				<b>9,8</b>	<b>30</b>	<b>59%</b>	<b>90%</b>
<b>Emisiones restantes después de la implementación de acciones prioritarias</b>				<b>12</b>	<b>15</b>		
<b>Emisiones restantes después de la consecución de los metas de descarbonización</b>				<b>6,9</b>	<b>3,2</b>		

Table 1. Economy-wide GHG Emissions Impact of the Pathway Priority Actions.

As shown the Figure and Table above, the Pathway Priority Actions are expected to achieve:

- A total reduction of 4,2 TgCO<sub>2</sub>e by 2030 (i.e., 25% against BAU levels)
- A total reduction of 18 TgCO<sub>2</sub>e by 2050 (i.e., 52% against BAU levels)
- A reduction of 1,3 TgCO<sub>2</sub>e by 2030 (i.e., 7,7% against BAU levels) and 5,4 TgCO<sub>2</sub>e by 2050 (i.e., 16% against BAU levels) in the *Energy Sector*
- A reduction of 0,07 TgCO<sub>2</sub>e by 2030 (i.e., 0,5% against BAU levels) and 0,44 TgCO<sub>2</sub>e by 2050 (i.e., 1,5% against BAU levels) in the *RCI sector*
- A reduction of 2,5 TgCO<sub>2</sub>e by 2030 (i.e., 17% against BAU levels) and 11 TgCO<sub>2</sub>e by 2050 (i.e., 32% against BAU levels) in the *Industry sector*
- A reduction of 0,08 TgCO<sub>2</sub>e by 2030 (i.e., 0,5% against BAU levels) and 0,67 TgCO<sub>2</sub>e by 2050 (i.e., 2.1% against BAU levels) in the *Transportation sector*
- A reduction of 0,21 TgCO<sub>2</sub>e by 2030 (i.e., 1,3% against BAU levels) and 0,17 TgCO<sub>2</sub>e by 2050 (i.e., 0,5% against BAU levels) in the *Agriculture and Livestock sector*
- A reduction of 0,06 TgCO<sub>2</sub>e by 2030 (i.e., 0,4% against BAU levels) and 0,13 TgCO<sub>2</sub>e by 2050 (i.e., 0,4% against BAU levels) in the *FOLU sector*

After full implementation of the Pathway Priority Actions, GHG emissions of 16 TgCO<sub>2</sub>e are expected to remain in 2050. Achievement of the 2050 Target (65% below 2015 emissions levels) would result in around 3,2 TgCO<sub>2</sub>e remaining in 2050.

Table 2 below summarizes the contribution of each Pathway Priority Action and each sector to the economy wide GHG emissions reduction achieved. For instance, in 2050 the Pathway Priority Actions in the Industry sector will contribute to 61% of the economy-wide GHG emissions reduction achieved, while the Pathway Priority Actions in the FOLU sector will contribute to 0.7% of the economy-wide GHG emission reductions.

Table 2 Contribution of each Pathway Priority Action and of each sector to the total GHG emission reductions achieved

Título de la acción		Contribución a las reducciones totales (%)	
		2030	2050
ES-1	Energía solar centralizada	30%	30%
<b>Total del sector suministro de energía</b>		<b>30%</b>	<b>30%</b>
RCI-1	Solar distribuido en el sector comercial e institucional	1,6%	2,5%
<b>Total del sector residencial, comercial e institucional</b>		<b>1,6%</b>	<b>2,5%</b>
I-1	Producción de electricidad renovable en el sitio	16%	16%
I-2	Producción y uso de combustibles renovables	3,3%	1,5%
I-3	Producción de calor renovable en el sitio	25%	31%
I-4	Eficiencia energética eléctrica	15%	14%
<b>Total del sector industrial</b>		<b>60%</b>	<b>62%</b>
T-1	Planificación urbana inteligente	1,7%	1,8%
T-2	Electrificación de vehículos	0,3%	2,0%
<b>Total del sector transporte</b>		<b>2,0%</b>	<b>3,7%</b>
AG-1	Sistemas agroforestales	0,1%	0,4%
AG-2	Regeneración de tierras de pastoreo	5,0%	0,5%
<b>Total del sector agropecuario</b>		<b>5,1%</b>	<b>0,9%</b>
FOLU-1	Expansión del ecosistema forestal	0,9%	0,6%
FOLU-2	Conservación de tierras forestales	0,6%	0,1%
<b>Total del sector FOLU</b>		<b>1,5%</b>	<b>0,7%</b>

## Sector-level direct GHG emissions remaining after implementation of the Pathway Priority Actions

Figure 2 below provides a summary of the sector level **direct** GHG emissions remaining after implementation of the Pathway Priority Actions. The chart indicates the baseline **direct** GHG emissions for each sector, and the **direct** GHG emissions remaining in 2050 after the Pathway Priority Actions implementation (for energy supply, these include emissions from electricity imports).

Some Pathway Priority Actions will affect **direct** GHG emissions outside of their sector. For example, the vehicle electrification action will reduce **direct** GHG emissions within the Transportation sector; however, it will also increase GHG emissions in the Energy Supply sector due to the demand for more electricity from the grid to power the vehicles.

In this chart, actions that reduce **indirect** emissions from electricity consumption, including those in the RCI and Industry sectors, will not result in **direct** emission reductions in their sector; rather those emission reductions will be reflected in the Energy Supply sector.

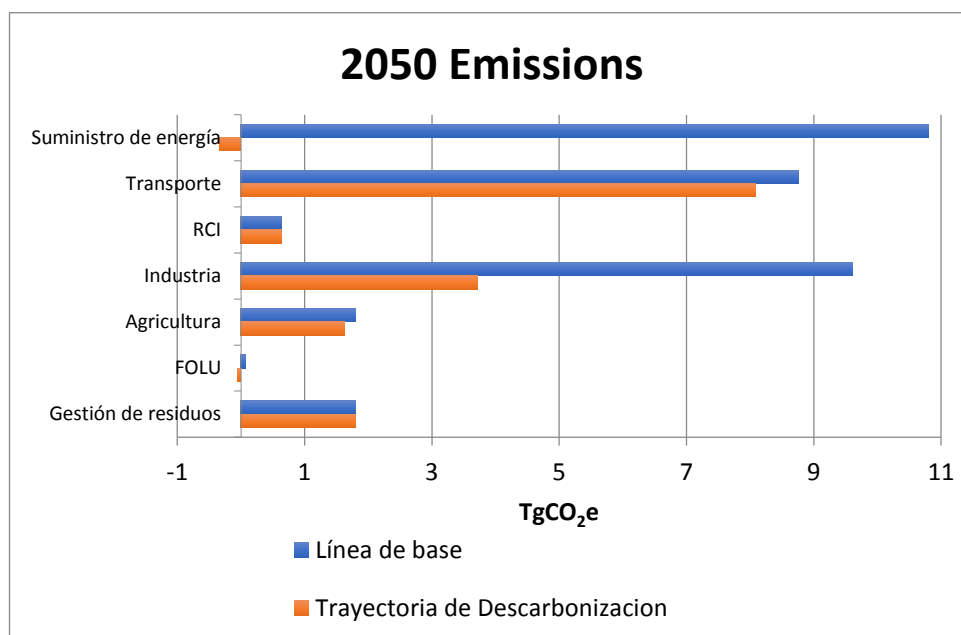


Figure 2. 2050 Sector-level Direct GHG Emissions remaining after implementation of the Pathway Priority Actions.

After full implementation of the Pathway Priority Actions:

- Direct GHG emissions of -0,34 TgCO<sub>2</sub>e will be left in the *Energy Supply* sector, due to the significant reductions indicated resulting from a combination of electrical energy efficiency

and new renewable electricity supply actions. The emissions are negative in 2050 because the combined renewable energy and energy efficiency actions result in a surplus of 523 MW of renewable energy that can be sent to the national grid.

- Direct GHG emissions of 0,64 TgCO<sub>2</sub>e will be left in the *RCI sector* since the related emission reductions resulting from the Pathway Priority Actions have been accounted for in the Energy Supply sector (being related to new renewable energy generation)
- Direct GHG emissions of 3,7 TgCO<sub>2</sub>e will be left in the *Industry sector* since the related emission reductions resulting from the Pathway Priority Actions have been accounted for in the Energy Supply sector (being related to energy efficiency and new renewable energy generation)
- Direct GHG emissions of 8,1 TgCO<sub>2</sub>e will be left in the *Transportation sector*. Also, for Action T-2 (vehicle electrification), the remaining direct emissions are indicated for the Transportation sector (after reductions in fuel consumption); however, the increase in indirect emissions from greater electricity demand is reflected in the Energy Supply sector
- Direct GHG emissions of 1,6 TgCO<sub>2</sub>e will be left in the *Agriculture and Livestock sector*
- Direct GHG emissions of 0,05 TgCO<sub>2</sub>e are expected to be removed from the atmosphere in the FOLU sector
- GHG emissions of 1,8 TgCO<sub>2</sub>e will be left in the *Waste Management sector* since there are no changes in emissions levels due to the absence of actions in this sector in the Pathway.

## Cumulative GHG Emission Reductions

While meeting future year GHG targets is one way to manage GHG emissions, the cumulative emissions that occur between now and any future year are what really matter (if the most dangerous impacts from climate change are to be avoided). Jurisdictions should not wait until the last minute to reduce GHG emissions at a transformational scale and must begin now with steady progress along the way.

The total global remaining GHG emissions that can be emitted while still staying under 2 degrees Celsius of warming is sometimes referred to as the “global carbon budget.” Allocation of the global carbon budget among developed and developing countries was a key issue during the formulation of the Paris Agreement. A common responsibility toward GHG mitigation for all countries was recognized; however, it was also understood that there are differentiated responsibilities and capabilities among countries. Differentiated responsibility could be viewed through an understanding of historical GHG emissions, while differentiated capability could be viewed through the current stage of economic development for a country. Developed (also referred to as industrialized or Annex I countries) agreed to absolute emission reduction targets. Non-Annex I countries have no such obligation.

Several schemes have been proposed for allocating the global GHG budget among nations.<sup>1,2</sup> None of these schemes have been formalized as methods for countries to use to indicate conformance

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<sup>1</sup> IPCC, 2014. *Climate Change 2014: Mitigation of Climate Change, Chapter 6 Assessing Transformation Pathways*. [http://www.ipcc.ch/pdf/assessment-report/ar5/wq3/ipcc\\_wq3\\_ar5\\_chapter6.pdf](http://www.ipcc.ch/pdf/assessment-report/ar5/wq3/ipcc_wq3_ar5_chapter6.pdf).

The global carbon budget numbers will probably be revised downward in the next set of IPCC estimates.

<sup>2</sup> “The right to development in a climate constrained world”, EcoEquity and the Stockholm Environment Institute, 2008. [http://gdrights.org/wp-content/uploads/2009/01/gdrs\\_execsummary.pdf](http://gdrights.org/wp-content/uploads/2009/01/gdrs_execsummary.pdf).

with the Paris Agreement. However, all of the schemes recognize fundamentally that jurisdictions should not wait until the last minute to reduce GHG emissions at a transformational scale.

More specifically, most of these schemes are based on one or more of the following factors:

- Equity – based on population
- Inertia – based on current share of global emissions
- Capability – based on gross national income (GNI)
- Responsibility – based on past cumulative emissions
- Other metrics, including hybrid approaches

The equity basis allocates the carbon budget solely on population. The inertia basis, also known as “grandfathering,” allocates the carbon budget based on the current share of world emissions. To estimate the budget for Querétaro based on this scheme, the ratio of Querétaro emissions to world emissions in 2015 was applied to the global carbon budget emissions.

While the equity- and inertia-based schemes allocate the future global carbon budget, the capability- and responsibility-based schemes estimate the budget by allocating required global reductions. The required reductions for Querétaro based on capability are determined by the GNI for Mexico compared to global GNI.<sup>3</sup> The ratio of GNI for Mexico to global GNI was scaled to the proportion of Mexico’s population in Querétaro and multiplied by the total global reduction requirements in each year.

For the responsibility-based scheme, cumulative emissions from 2000-2015 were summed for Queretaro and the world. The proportion of Queretaro’s cumulative emissions to the global cumulative emissions provides the responsibility index. This index was then multiplied by the total global reduction requirements in each year.

Figure 3 provides a comparison of cumulative GHG emissions for the Pathway Priority Actions with (i) cumulative emissions that would occur if Queretaro met its 2050 target (assuming a straight-line reduction from current levels to the 2050 target), (ii) cumulative emissions that would occur if Queretaro met the national NDC target (a straight-line reduction from current levels to levels in-line with the NDC target), and (iii) possible “carbon budgets” or targets for Queretaro based on the above allocation schemes. As shown in the chart:

- The cumulative emissions for the Pathway Priority Actions are still about twice the level of emissions inferred for Queretaro to meet its 2050 target (assuming a straight-line reduction from current levels to the 2050 target).
- They are also over 100 TgCO<sub>2</sub>e above the cumulative emissions inferred from a straight-line reduction from current levels to Mexico’s NDC target.
- The Queretaro Pathway Priority Actions cumulative emissions level meets 1 of the 4 indicators based on global allocation schemes (i.e., Responsibility).

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<sup>3</sup> The World Bank, 2020. *World Development Indicators*, <https://databank.worldbank.org/source/world-development-indicators/preview/on#>. A better estimate for this scheme would be based on GNI estimates specifically for Queretaro, rather than national GNI; however, GNI data for Queretaro have not been identified.

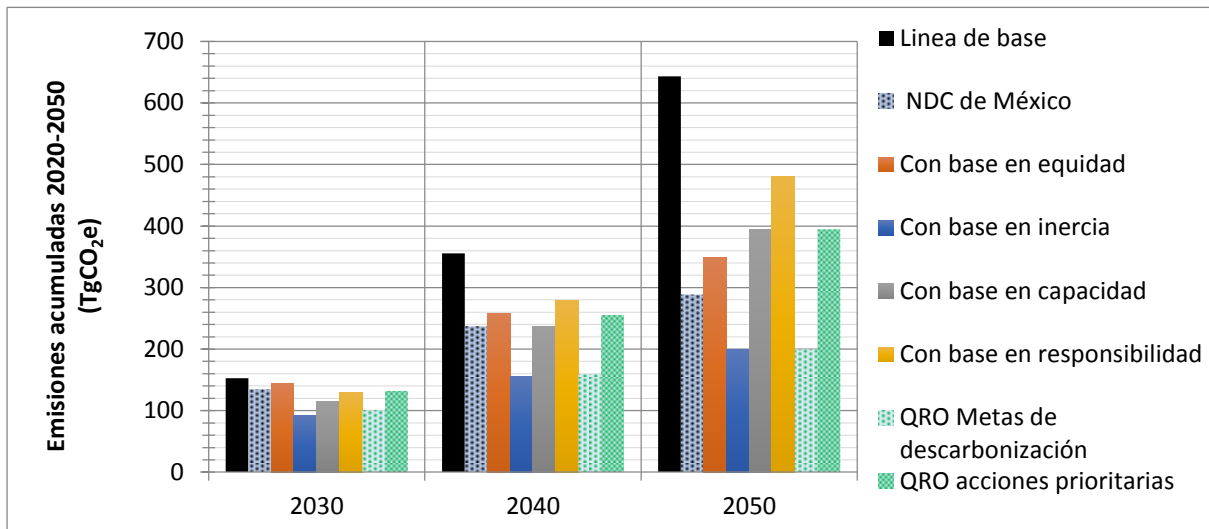


Figure 3. Pathway Priority Actions Cumulative GHG Emissions Compared to Alternative Globally Allocated Targets.

By 2050, cumulative emissions for the Pathway Priority Actions are about 240 Tg lower than BAU emissions. However, cumulative emissions are still well above those that are expected to result from Queretaro meeting its 2050 emissions Target (cumulative emissions levels of around 200 TgCO<sub>2</sub>e).

Reducing further cumulative emissions to levels in line with the 2050 Target would also produce more reductions than those consistent with Mexico's NDC. It would also meet reductions consistent with all four global emissions allocation schemes.