MEMORANDUM

To:	Jared Patton and Kristin Ihnchak, CMAP
From:	Emily Golla, Rich Walter, and Cory Matsui, ICF
Date:	June 1, 2018
Re:	REVISED: Potential ON TO 2050 Emission Targets (Contract No. C-18-0026)

This memorandum provides a summary of potential emission targets for CMAP's ON TO 2050 report. This memorandum is a revised version of the memorandum delivered on April 17, 2018. The memorandum includes a quantitative assessment of potential emission targets, taking into account an updated back-cast of 1990 emissions, and is organized as follows:

- Background on Target Setting
- GO TO 2040 Emission Targets
- Potential Targets for ON TO 2050

Please contact Emily Golla at (202) 862-1246 with any questions or comments.

I. Background on Target Setting

Greenhouse Gas Reduction Target Fundamentals

The foundation for a greenhouse gas (GHG) emissions reduction target consists of three components:

- A **base year** that serves as a point of comparison for evaluating the trajectory of future emissions. A base year is a one-year period most commonly in the recent (e.g., 2015) to distant past (e.g., 1990), and GHG emissions typically increase in the years that follow the base year in the absence of any action to reduce emissions.[1] A base year can also be a one-year period in the future. For a base year in the future, such as 2020 for example, the emissions reductions achieved in 2020 are compared to the GHG emissions that would occur in the absence of any action to reduce GHG emissions in 2020 (i.e., a business-as-usual, or BAU, scenario).
- A **target year**(s) that establishes a timeframe that the GHG reduction goal should be achieved by. To achieve a GHG reduction goal with a target year in the distant future (e.g., 2050), jurisdictions typically choose multiple target years in the interim period to guide the path of emissions downward to the long-term goal (e.g., 2020, 2035, 2040).
- A **reduction amount** that identifies the magnitude of GHG emissions that will be reduced relative to the base year and before or during the target year.

The GHG emissions reduction target can take several distinct forms. There are three primary types of reduction targets:

- A **mass emissions target** is an absolute amount of emissions that needs to be reduced and does not depend on any past year (e.g., reduce GHG emissions by 500,000 $MTCO_2e$ relative to the BAU scenario by 2020). This type of target may be chosen if a GHG emissions inventory for a past year (i.e., 1990) are unknown.
- A **per capita emissions target** is a goal to reduce the rate of emissions relative to the population. This type of target may or may not include a base year and does not necessarily result in an absolute decrease in total emissions (e.g., reduce per capita GHG emissions by 40 $MTCO_2e$ per person by 2020). This type of target may be chosen if a jurisdiction is anticipating substantial population growth, as it allows for an increase in the absolute amount of GHG emissions so long as the rate of emissions per capita is reduced sufficiently to meet the target.
- A **percent reduction target** is the most commonly adopted type of target and defines the reduction goal in terms of emissions reductions relative to the base year (e.g., 20% below 2010 GHG emissions). This type of target is consistent with recommendations by regulating bodies to reduce future GHG emissions levels to previously occurring levels.

Precedents in Greenhouse Gas Reduction Target Setting

Cities, counties, regional agencies, transportation districts and other governing bodies worldwide have adopted GHG reduction targets in various forms. The call for action that sparked the widespread adoption of GHG reduction targets was the outcome of computer modeling conducted by climate researchers that concluded that worldwide GHG emissions in developed counties must be reduced to 80% below 1990 levels by 2050 in order to constrain global temperature increases to no more than 2

[1] GHG emissions typically increase with time as population and economic activity increase within a jurisdiction. A scenario in which no actions to reduce GHG emissions are taken is known as a business-as-usual (BAU) scenario.

degrees Centigrade to avoid the more catastrophic effects of global warming. Consequently, the trajectory of GHG emissions required to meet the 2050 target came to be known as the climate stabilization path.

A number of cities and states in the United States have adopted GHG reduction targets. For example, the City of Chicago adopted a target of 25% below 1990 levels by 2020. In California, the legislature mandated a reduction to 1990 levels by 2020 and 40% below 1990 levels by 2030.[2] Worldwide, over 90 cities have adopted GHG reduction targets through the C40 agreement. The majority of these cities have adopted percent-reduction targets consistent with the climate stabilization path that aim to reduce either city-wide or sector-specific emissions by a certain percentage. The GHG reduction targets adopted by some of the C40 cities are presented in Attachment A.

II. GO TO 2040 Emission Targets

In CMAP's comprehensive regional plan, GO TO 2040, GHG reduction targets were identified for three years: 2015, 2020, and 2040. These targets, also based on the climate stabilization path, are shown below in Table 1 along with the region's GHG emissions in 1990, 2000, 2005, and 2010.

Table 1: GO TO 2040 Inventory Estimates (2000-2010) and Emission Targets (2015-2040)

Year	1990[a]	2000	2005	2010	2015	2020	2040
Total Emissions and Reduction Targets ($MMTCO_2e$)	93.2	118.5	131.2	126.3	119.0	104.6	47.0
Per Capita Emissions ($MTCO_2e$/person)	12.8	14.5	15.8	15.2	13.7	11.5	4.3

Sources: GO TO 2040 Update Appendix: Indicator Methodology, January 2015 (Years 2000-2040); The Chicago Region Greenhouse Gas Baseline Inventory and Forecast, December 2009 (Year 1990); 1990 Census.

[a] The prior estimate of GHG emissions for 1990 for GO TO 2040 was not an actual GHG inventory due to lack of activity data for 1990. Instead, the GHG emissions estimate was based on a linear back-cast using the 2000 to 2005 trend.

III. Updated Regional Inventory Results and Projections

ICF has prepared and updated the regional GHG inventory emissions estimates for 2010 and 2015. The emissions results, which serve as the basis for GHG emissions projections to future years, are summarized in Table 2.

Table 2: Regional Inventory Update Estimates, 1990, 2010-2015

Emissions Metric	1990[a]	2010	2015
Total Emissions ($MMTCO_2e$)	128.5	127.6	119.8
Per Capita Emissions ($MTCO_2e$/person)	17.6	15.1	14.1

[a] As explained in Attachment B, an inventory of GHG emissions was not prepared for 1990 due to lack of activity data. Instead, emissions were roughly estimated using various sources of data to prepare a "back-cast" estimate.

Future year emissions are necessary for determining a BAU-based reduction target and for assessing the quantity of emissions reductions that will be needed to meet a future year target. However, forecasting GHG emissions presents a challenge because future year emissions are often the result of unpredictable

[2] California's 2020 goal to reduce emissions to 1990 levels is a near-term target interpolated based on the 80% below 1990 levels by 2050. In 2016, California adopted Senate Bill 32, which establishes a GHG target of 40% below 1990 levels by 2030. The SB 32 reduction goal is also an interpolation of the 2050 target.

economic forces, and an emissions trend in the past is not always a reliable indicator of how emissions will change in the future. Additionally, the magnitude and effectiveness of emissions-reducing steps taken in the past by a local or regional government may change in the future.
Using the 2010 and 2015 regional GHG inventory estimates (presented in Table 2 above), ICF has developed three different scenarios to forecast future year emissions to show how emissions may change in the future. The three scenarios are described below.

- **Scenario 1:** The first scenario is a BAU scenario that assumes no change in GHG efficiency per capita from 2015 in all future years. In other words, under this scenario, emissions increase at the rate of population growth in the region.
- **Scenario 2:** The second scenario is an alternative BAU scenario that assumes in the future GHG efficiency per capita improves at the same rate as that between 2010 and 2015. Based on the per capita values in Table 2, per capita emissions decreased by 8.5% between 2010 and 2015. This scenario assumes that, every five years, per capita emissions will decrease by roughly 8.5%.
- **Scenario 3:** The third scenario assumes more aggressive improvements in GHG efficiency per capita. This scenario assumes that the 8.5% decrease in per capita emissions that were realized from 2010-2015 will double and be achieved every 5 years (i.e., per capita emissions will decrease by 17% every 5 years).

The results of the GHG emissions forecast analysis for all three scenarios are presented in Table 3.

Table 3: Regional Inventory Projections, 2020-2050

Scenario/Emissions Metric	2020	2025	2030	2035	2040	2045	2050
Scenario 1: No Change in GHG Efficiency after 2015							
Total Emissions ($MMTCO_2e$)	125.36	130.16	134.66	139.04	143.23	147.20	151.29
Per Capita Emissions ($MTCO_2e$/person)	13.97	13.97	13.97	13.97	13.97	13.97	13.97
Scenario 2: Change in GHG Efficiency Based on 2010-2015 Trend							
Total Emissions ($MMTCO_2e$)	114.75	109.06	103.29	97.62	92.06	86.60	81.48
Per Capita Emissions ($MTCO_2e$/person)	12.79	11.71	10.72	9.81	8.98	8.22	7.53
Scenario 3: Change in GHG Efficiency Double of 2010-2015 Trend							
Total Emissions ($MMTCO_2e$)	104.14	89.83	77.21	66.23	56.68	48.39	41.32
Per Capita Emissions ($MTCO_2e$/person)	11.61	9.65	8.01	6.66	5.53	4.59	3.82

IV. Potential Targets for ON TO 2050

Overall Emission Targets

ICF has identified three potential GHG reduction target options for CMAP's consideration for the ON TO 2050 report. The potential targets, which vary in their aggressiveness, are described below, summarized in Table 4 on a mass emissions and per capita emissions basis, and graphically depicted in Figure 1.

Option 1 – Climate Stabilization Path: Reduce GHG emissions to 80% below 1990 levels by 2050, or 80% below 2005 levels
Option 1 aligns with the scientific consensus regarding the level of emissions necessary in developed countries (e.g., United States, Europe, and Japan) to stabilize the climate with a global temperature increase of no more than 2 degrees Centigrade. This target is the outcome of extensive climate modeling conducted by researchers and is consistent with many cities' GHG reduction targets worldwide. While this target is considered to be critical to climate stabilization, it may be difficult to

explicitly demonstrate a feasible path for the region to achieve this level of reduction in the absence of large scale commitments at the local, state, and federal level. Although many jurisdictions have 2050 targets, few have developed climate action plans outlining strategies to meet those targets. As such, Option 1 would represent an ambitious but potentially challenging target for the CMAP region. It does however, represent an aspirational goal.

As part of its Climate Action Plan, in 2008 the City of Chicago adopted a goal to reach an 80% reduction in GHG emissions from 1990 levels by 2050. However, in the City's 2015 GHG inventory report, the City of Chicago identified its intention to revise its target base year from 1990 to 2005 because of the inherent difficulties in preparing a 1990 inventory due to lack of available activity data. The City has indicated that they intend to keep the same ambitious level of emissions reductions as committed to in their 1990 target but will discuss the regional target in terms of a 2005 base year rather than 1990.[3] Therefore, to be consistent with Chicago's long term reduction goal, CMAP could similarly use 2005 as a base year rather than 1990.

Using readily available regional, state, and national data related to GHG emissions sources for the years between 1990 and 2015, ICF has developed a 1990 back-cast estimate of emissions for the region. The methods used to estimate 1990 emissions are outlined in Attachment B.[4] Based on the 1990 GHG emissions estimate by ICF, 1990 emissions for the CMAP region were 128.5 $MMTCO_2e$. A reduction goal of 80% below this 1990 level is equal to 25.7 $MMTCO_2e$. This level of emissions would be 80% below the region's 2005 levels. Although the target level of emissions for 2050 would be the same (25.7 $MMTCO_2e$), framing the reduction goal with the same base year as the City is recommended as it will ease coordination and progress tracking between the City and the region.

Option 2 – Enhanced Per Capita GHG Reductions

Option 2, a per capita-based reduction target, may be a more demonstrably feasible approach to establishing a target for the region's GHG emissions, because it is derived from the region's per capita emissions reductions already achieved. This option is consistent with Scenario 3 of the emissions forecast, which uses the rate of decline in per capita emissions between 2010 and 2015 and doubles it to determine the reduction achieved every 5 years. As discussed above, the region's per capita emissions have been calculated to decrease by 8.5% between 2010 and 2015; thus, with this target approach, per capita emissions would need to decrease by 17% every 5 years out to 2050. As shown in Table 3, this would result in 2050 emissions of 41.3 $MMTCO_2e$ and per capita emissions of 3.8 $MMTCO_2e$/person, which would correspond to a 65% reduction in overall GHG emissions and a 73% reduction in GHG emissions per capita relative to 2015.

This per capita reduction target has the advantage of providing a conceptualization of the level of effort needed to meet the target. CMAP can infer the magnitude of action required by assessing what actions were taken in the 2010-2015 period, and, roughly speaking, doubling the level of effort of those actions. This target would be less climate-protective than the stabilization path discussed for Option 1, however, and may be considered too limited by some individuals or organizations. Few jurisdictions have developed plans outlining a strategy to achieve a 2050 target, and, within this context, a less ambitious but feasible path to a 2050 target could be an appropriate option. Further, 2050 is more than 30 years in

[3] Based on input from the City, there has been no formal change to the 2050 emissions target presented in the Chicago Climate Action Plan.

[4] As explained in Attachment B, ICF did not prepare an actual inventory of 1990 GHG emissions for the region due to the lack of activity data for 1990. Instead, ICF used various sources of existing data to roughly approximate GHG emissions for the region for 1990.

the future, and the state and federal climate action landscape could change in that timeframe to reduce the burden of action on municipal governments.

Option 3 – Chicago Climate Action Plan Achievable Reductions

The third potential GHG reduction target utilizes the percentage of reduction expected by the City of Chicago through the implementation of the City's 2010 Climate Action Plan (CAP). The strategies to reduce emissions in the City's CAP are comprised of individual actions in the following four areas: building energy, renewable energy resources, transportation, and waste. The City identified a fifth strategy in the area of adaptation that would not result in any direct emissions reductions. GHG emissions reductions achieved in 2020 through the four strategies would reduce the City's BAU emissions in 2020 by approximately 38%. Under Option 3, CMAP would adopt a reduction target based on the effectiveness identified in the City's CAP, which would be expected to result in a roughly similar reduction in emissions relative to a BAU scenario. Although the City's CAP identified a 38% reduction from 2020 BAU, the reduction for the region needs to be adjusted to account for differences in forecasting methods. The City's CAP used a higher population estimate for its forecast than ICF's emissions forecast for the City; as such, the percentage reduction in emissions was adjusted to account for the discrepancy. The adjusted reduction percentage in BAU emissions is 35%.

ICF expects that the individual actions in the City's CAP to reduce GHG emissions would largely be applicable to the CMAP region. Some actions would require commitment at the level of each jurisdiction, such as retrofitting buildings and updating energy codes. Other actions would likely require a regional commitment, such as investing in more transit. Overall, the region would be expected to attain approximately the same percentage reduction in GHG emissions as attained by the City.

Table 4: Three Options of Target Recommendations for ON TO 2050

Scenario/Emissions Metric	Option 1[a]		Option 2[b]		Option 3[c]	
	2025	2050	2025	2050	2025	2050
Total Emissions ($MMTCO_2e$)	91.16	25.69	89.83	41.32	84.47	98.19
Per Capita Emissions ($MTCO_2e$/person)	9.8	2.4	9.6	3.8	9.1	9.1

[a] Based on ICF's 1990 estimate of 128.5 MMT and Climate Stabilization goal of 80% below 1990 by 2050 (and 29% below 1990 by 2025). This is also equivalent to a goal of 80% below 2005 levels.

[b] Based on doubling of 2015-2010 per capita trend.

[c] Based on City of Chicago CAP reductions.

Figure 1: Future Emissions Trajectory: BAU, Option 1, Option 2, and Option 3