# APPENDIX F:

# ESTIMATION OF PEAK ANNUAL AIR EMISSIONS AND TOTAL PROGRAM GHG EMISSIONS, SOCIAL COSTS, AND EMISSION EQUIVALENCIES

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# APPENDIX F:

# ESTIMATION OF PEAK ANNUAL AIR EMISSIONS AND TOTAL PROGRAM GHG EMISSIONS, SOCIAL COSTS, AND EMISSION EQUIVALENCIES

## F.1 ESTIMATION OF PEAK ANNUAL AIR EMISSIONS

Air emissions associated with decommissioning activities were estimated using the Decommissioning Emissions Estimation for Platforms (DEEP) tool and database. DEEP was created as part of a project sponsored by the Bureau of Ocean Energy Management (BOEM) to develop detailed estimates of the emissions associated with the future decommissioning of platforms in the Pacific Outer Continental Shelf (POCS) Region (BOEM 2019a,b). DEEP is based on a series of phases associated with the future decommissioning of POCS region facilities, including: (1) pre-abandonment (which includes conductor removal); (2) topside removal; (3) jacket removal; (4) debris removal (which includes removal of shell mounds); and (5) pipelines and power cable removal. It also provides emission estimates per facility for each of those decommissioning phases. For disposal, materials would be transported to a shore-based port on cargo barges, offloaded at the ports, cut and sectionalized, and hauled to recycling or disposal facilities. Platform jacket and deck modules would primarily be recycled as scrap at Los Angeles area scrap and/or recycling yards, such as SA Recycling, or transported to the Gulf of Mexico (GOM) or foreign locations via barges. Conductors, power cables, and pipelines might be transported from the offloading sites to local disposal sites near the ports, disposal sites near Bakersfield, California, or similarly transported to the GOM or foreign locations via barges. The only emissions not analyzed herein are from transport of disassembled materials from the California ports to foreign ports, because their locations are uncertain (BOEM 2019a). In DEEP, the pre-abandonment phase is the same as the pre-severance phase in the current analysis; the next four phases combined represent the severance phase and the disposal phase combined.

The DEEP tool estimates both air emissions for criteria pollutants ($NO_x$, ROC, CO, $SO_x$, and $PM/PM_{10}/PM_{2.5}$) and greenhouse gases (such as $CO_2$, $CH_4$, and $N_2O$).

To perform evaluations of impacts (such as air emissions or socioeconomic impacts) that are measured annually, the analyses evaluated the peak-year activities for decommissioning the largest platform, Platform Harmony. Air emissions are limited to three air districts (Santa Barbara County Air Pollution Control District [SBCAPCD], Ventura County Air Pollution Control District [VCAPCD], and South Coast Air Quality Management District [SCAQMD]). In the DEEP tool, 2025 is assumed to be the first year of decommissioning, and the Port of Los Angeles is selected as the demobilization port for topsides and jackets. The Port of Los Angeles is also selected for barge origins, except derrick barges from the GOM.

The decommissioning activities at Platform Harmony would last more than a year, so annual emissions are approximated by assuming part of the pre-abandonment phase, and all four other phases for all alternatives, but only limited activities of two phases of debris removal and pipelines and power cable removal for Alternatives 2 and 3. For example, in Alternative 1, durations with and without conductor removal are 591 and 301 days, respectively. Then

emissions of part of pre-abandonment phase (64 days out of 290 days) and emissions from the following four phases (301 days) are summed to arrive at annual air emissions. Figure F-1 presents parameters input to the DEEP tool, which are fairly self-explanatory, for Platform Harmony, for Alternatives 1, 2, and 3, both with and without conductor removal.

## F.2 ESTIMATES OF TOTAL PROGRAM GHG EMISSIONS AND DURATION

GHG emissions from all 23 platforms were estimated using the DEEP tool (BOEM 2019a,b). Unlike the GHG emissions described in Section F.1, total emissions were estimated over the entire duration of decommissioning activities (more than a year for Platforms Eureka, Harmony, and Heritage) and over all areas (including three air districts, and areas outside of the districts and of California). GHG emissions and durations of decommissioning activities by alternative and by platform are shown in Figures F-2 and F-3, respectively.

For all alternatives, GHG emissions at Platform Harmony are highest, while those at Platform Elly are lowest, as shown in Figure F-2. Total GHG emissions from all platforms combined are about 536,640; 315,120; and 312,600 MT $CO_2e$ for Alternatives 1, 2, and 3, respectively, and are provided in Figure F-4.

As shown in Figure F-3, for Alternative 1, total durations range from 106 days at Platform Gina to 591 days at Platform Harmony. For Alternatives 2 and 3, total durations range from 99 days at Platform Gina to 408 days at Platform Harmony. All estimates include conductor removal, which occurs over a relatively long time. Total durations of decommissioning activities for all 23 platforms combined are 5,769; 4,478; and 4,478 days (15.8, 12.3, and 12.3 years) for Alternatives 1, 2, and 3, respectively. Note that these values are estimated under the assumption that decommissioning would occur at each platform independently. However, decommissioning activities are likely to occur in campaigns at several nearby platforms simultaneously due to availability of equipment (e.g., barges or tugboats) and specialized workers and other economic reasons. In that case, actual emissions, workdays, and monetized values would be smaller than the aforementioned values. Considering removal campaigns, total duration of decommissioning activities is estimated to be around 10 years.

| | Alt 1 (Full) | | Alt 2 (Partial Onshore) | | Alt 2 (Partial Offshore) | |
|---|---|---|---|---|---|---|
| Conductor removal --> | No | Yes | No | Yes | No | Yes |
| **Emission Calculations Parameters and Queries** | Return to | Return | Return | Return | Return | Return |
| **General** | **Item** | **Item** | **Item** | **Item** | **Item** | **Item** |
| Year of Decommissioning | 2025 | 2025 | 2025 | 2025 | 2025 | 2025 |
| Defined Area (emissions only within in a specific area); Total or Air District | Total | Total | Total | Total | Total | Total |
| Demobilization port for Topsides and Jacket (Asia, GOM, POLA, Seattle) | POLA | POLA | POLA | POLA | POLA | POLA |
| **Jacket Removal Options** | Item | Item | Item | Item | Item | Item |
| Removal option (Full, Partial Laydown, Partial Disposal Offshore, Partial Disposal Onshore) | Full | Full | Partial Disposal Onshore | Partial Disposal Onshore | Partial Disposal Offshore | Partial Disposal Offshore |
| Partial Removal Option, transport distance, mi (if applicable) | | | | | 10 | 10 |
| **Pipelines and Power Cables** | **Item** | **Item** | **Item** | **Item** | **Item** | **Item** |
| OCS Pipeline removal options: All (remove all OCS pipelines), None or Shallow Only? | All | All | None | None | None | None |
| Remove state water pipelines? | Yes | Yes | No | No | No | No |
| Remove power cable in OCS? | Yes | Yes | No | No | No | No |
| Remove power cable in State Waters? | Yes | Yes | No | No | No | No |
| | | | | | | |
| **Barge Origins** | **Item** | **Item** | **Item** | **Item** | **Item** | **Item** |
| Derrick Barge Source (Asia, Europe, GOM) | GOM | GOM | GOM | GOM | GOM | GOM |
| Lifting Barge Source (GOM, POLA, Seattle) | POLA | POLA | POLA | POLA | POLA | POLA |
| Cargo Barges (GOM, POLA, Seattle) | POLA | POLA | POLA | POLA | POLA | POLA |
| Derrick-Lay Barges (GOM, POLA, Seattle) | POLA | POLA | POLA | POLA | POLA | POLA |
| | | | | | | |
| **ShellMounds** | **Item** | **Item** | **Item** | **Item** | **Item** | **Item** |
| Remove Shell Mounds? | Yes | Yes | No | No | No | No |
| | | | | | | |
| **Emission Estimates** | **Item** | **Item** | **Item** | **Item** | **Item** | **Item** |
| Include Well P&A? | No | No | No | No | No | No |
| Include conductor removal? | No | Yes | No | Yes | No | Yes |
| Overide all Emission Factors with Tier 4? | No | No | No | No | No | No |

**FIGURE F-1 Parameters Input to the DEEP Tool by Alternative (Source: BOEM 2019a,b)**

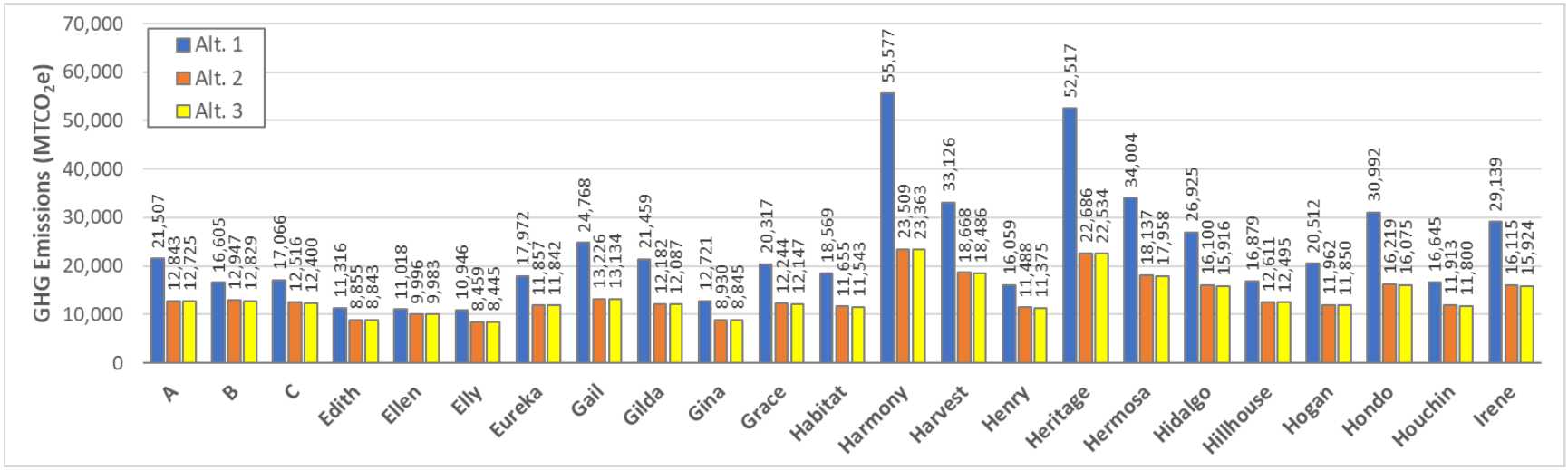


**FIGURE F-2 GHG Emissions of Decommissioning Activities by Alternative and by Platform (Source: BOEM 2019a,b)**



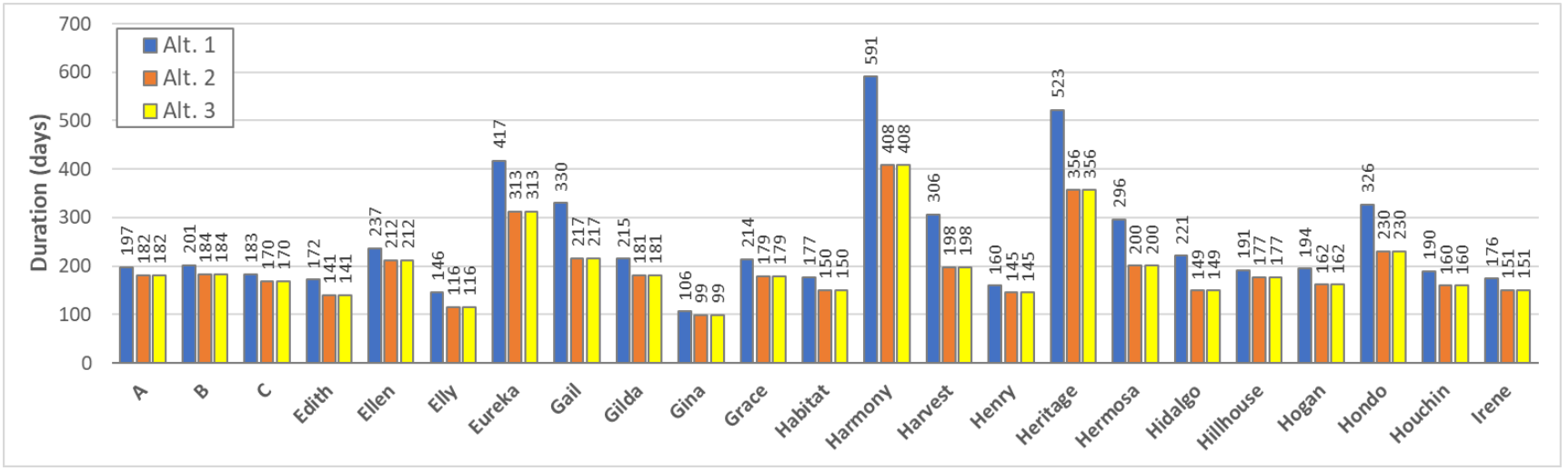


**FIGURE F-3 Durations of Decommissioning Activities by Alternative and by Platform (Source: BOEM 2019a,b)**

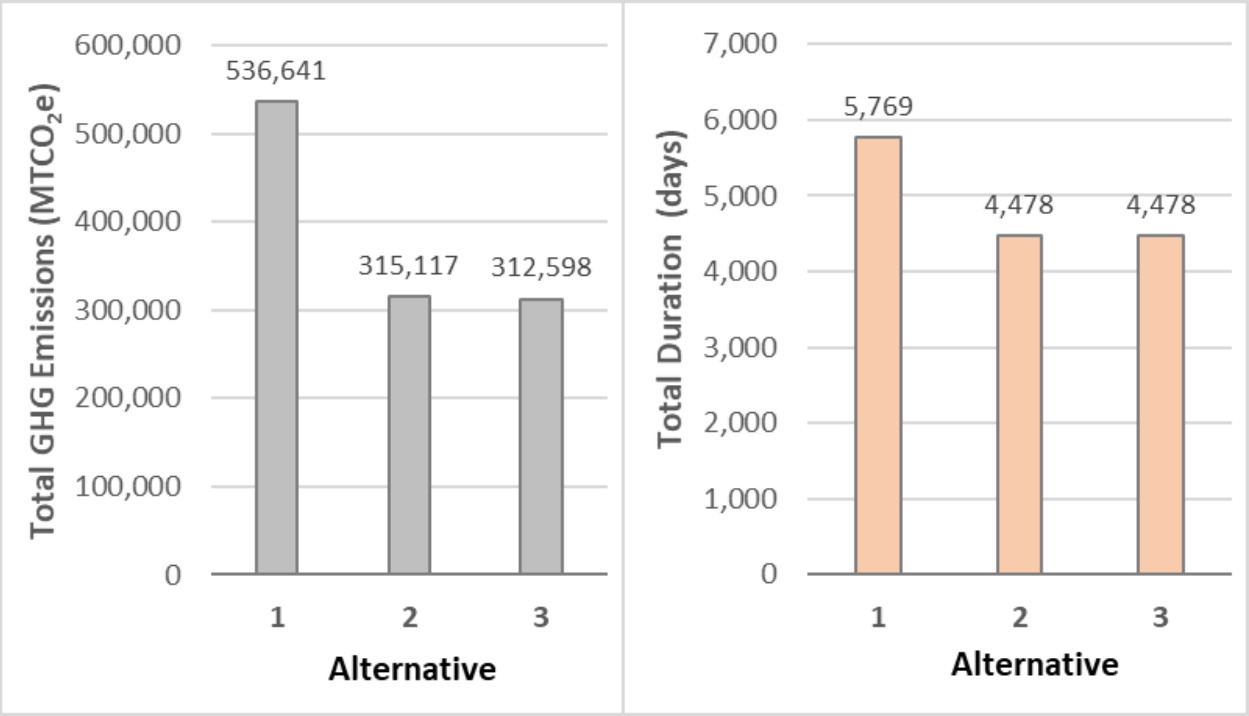


**FIGURE F-4 Total GHG Emissions and Durations of Decommissioning Activities by Alternative**

## F.3 SOCIAL COSTS OF GREENHOUSE GASES

Estimates of the social costs (SCs) of greenhouse gases (GHGs) provide an aggregated monetary measure (in 2020 U.S. dollars) of the future stream of damages associated with an incremental metric ton (MT) of emissions and associated physical damages in a particular year. In this way, SC-GHG estimates can contextualize the potential impacts of GHG emissions (including $CO_2$, $CH_4$, and $N_2O$). Along with information on other potential environmental impacts, they can inform a comparison of alternatives. In principle, SC-GHG includes the value of all climate change impacts, including (but not limited to) changes in net agricultural productivity, human health effects, property damage from increased flood risk and natural disasters, disruption of energy systems, risk of conflict, environmental migration, and the value of ecosystem services. The SC-GHG, therefore, reflects the societal value of reducing emissions of a given GHG by 1 MT. Figure F-5 provides estimates of the annual SC-$CO_2$, SC-$CH_4$, and SC-$N_2O$ per MT (in 2020 dollars) are provided in 5-year increments from 2020 to 2050 (IWG SCGHG 2021).

In Figure F-5, GHG emissions estimated from the DEEP tool as $CO_2e$ (i.e., $CO_2$, $CH_4$, and $N_2O$ combined) were speciated by each GHG based on the emission factors for tugboats, crew boats, supply boats, and cranes (BOEM 2019a). As a result, emissions of $CO_2$, $CH_4$, and $N_2O$ account for 99.636%, 0.004%, and 0.001%, respectively, of GHG emissions in $CO_2e$. Note that sum of three contributions does not add up to 100% due to differences in the applied GHG speciation to that assumed in the DEEP model.

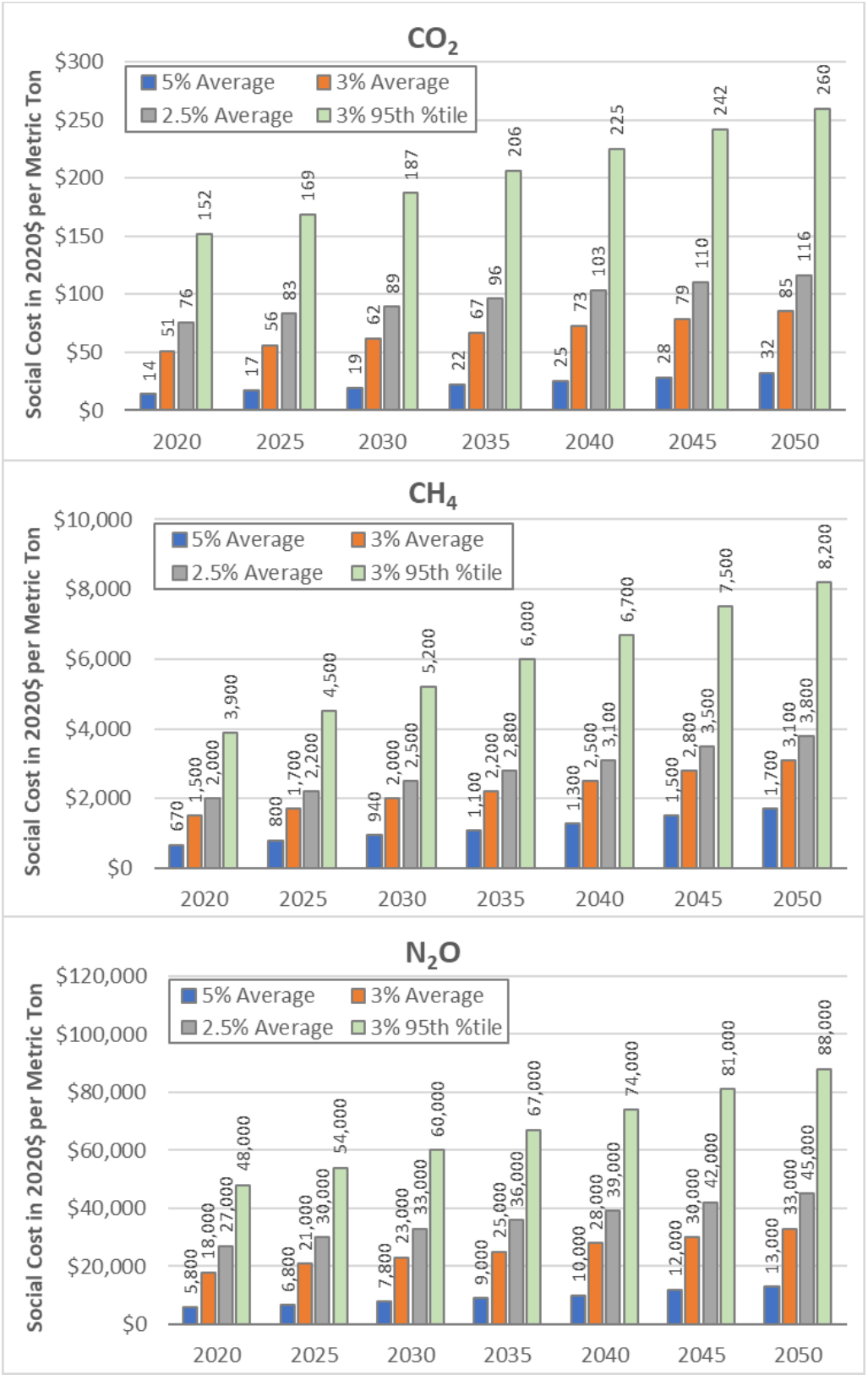


**FIGURE F-5 Social Cost (SC) of $CO_2$, $CH_4$, and $N_2O$ in 2020 Dollars per Metric Ton, 2020–2050 (Source: IWG SCGHG 2021)**

The estimated monetary values of GHG emissions ($CO_2$, $CH_4$, and $N_2O$ combined) for each of three discount rates (2.5%, 3%, and 5%), plus a fourth value selected as the 95th percentile of estimates based on a 3% discount rate for the three alternatives are illustrated in Figure F-6. For a discount rate of 3% and selecting year 2030, for example, total GHG emissions for Alternative 1 and Alternatives 2 or 3 equate to about 33.3 and 19.5 million (in 2020 dollars), respectively. Accordingly, GHG emissions for Alternative 2 or 3 would give monetized benefits of about 14 million (2020 dollars) compared to those for Alternative 1.

## F.4 GHG EQUIVALENCIES

The Greenhouse Gas Equivalencies Calculator allows users to convert various emissions or energy use to an equivalent amount of $CO_2$ emissions (EPA 2022). The calculator helps translate abstract measurements into concrete terms that are more understandable, such as the annual emissions from cars, households, or power plants. This calculator may be useful in communicating GHG reduction strategy, reduction targets, or other initiatives aimed at reducing GHG emissions.

Agencies also can provide accessible comparisons or equivalents to help the public and decision makers understand GHG emissions in more familiar terms. Techniques may include placing a proposed action's GHG emissions in more familiar metrics, such as household emissions per year, annual average emissions from a certain number of cars on the road, or gallons of gasoline burned. Such comparisons may be a useful supplement. They can, for example, be presented along with monetized damage estimates using SC-GHG values. Agencies should use disclosure and contextualization methods that best fit their proposed actions and alternatives.

As shown in Table F-1, GHG emissions for Alternative 1 are equivalent to those from energy use in about 68,000 homes annually, from about 120,000 gasoline-powered passenger vehicles annually, or from about 60 million gallons of gasoline consumed (EPA 2022). GHG emissions for Alternatives 2 and 3 are roughly equivalent to emissions from energy for about 39,000 homes annually, from driving about 67,000 gasoline-powered passenger vehicles annually, or from consuming about 35 million gallons of gasoline.

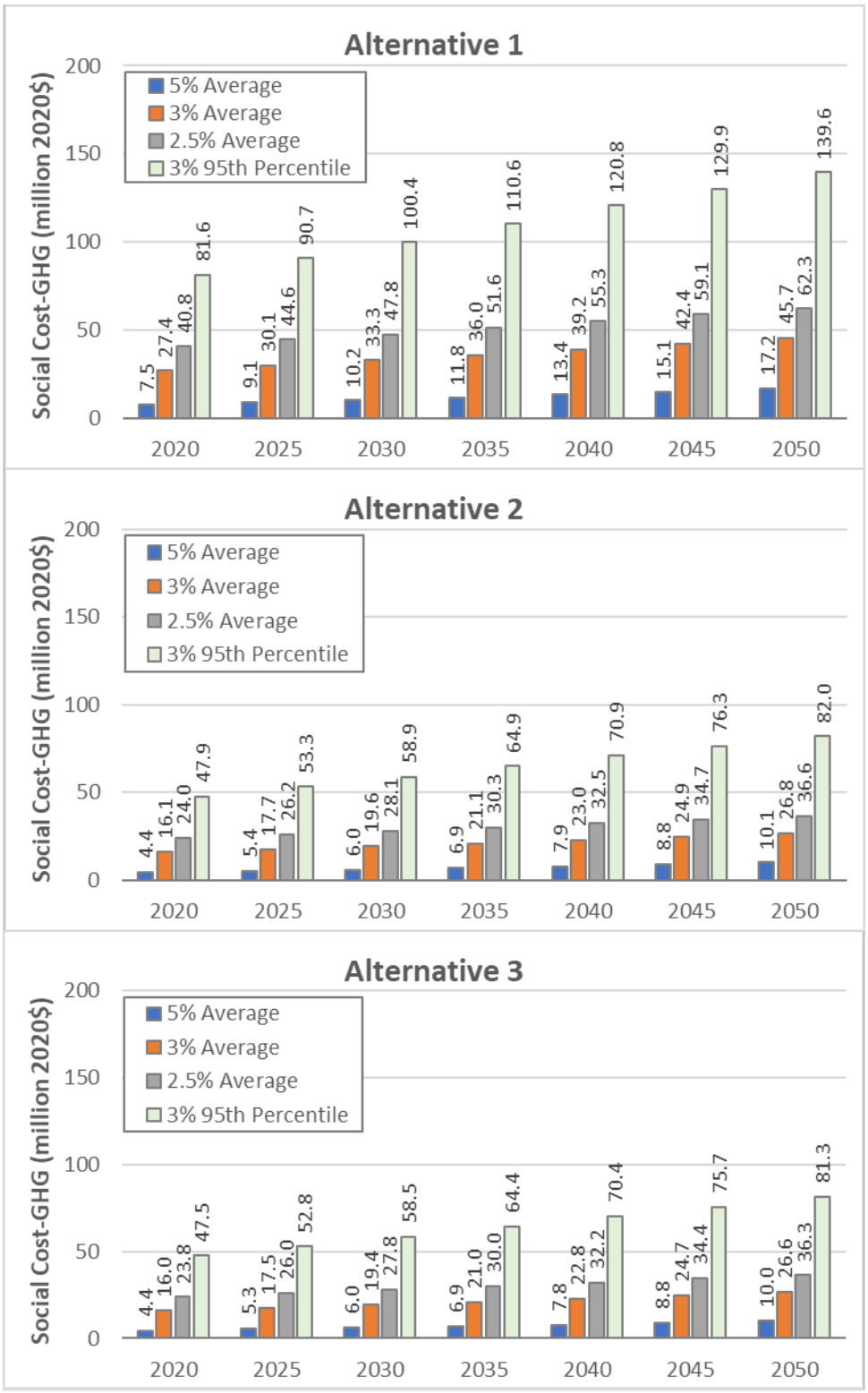


**FIGURE F-6 Monetized Values (Social Cost) of GHG Emissions by Alternative and by Discount Rate**

**TABLE F-1 Equivalencies of GHG Emissions by Alternative**

| Description | Alternative 1 | Alternative 2 | Alternative 3 |
|---|---|---|---|
| Total GHG emissions (MT $CO_2e$) | 536,641 | 315,117 | 312,598 |
| **This is equivalent to GHG emissions from:** | | | |
| Gasoline-powered passenger vehicles driven for 1 year | 115,630 | 67,898 | 67,355 |
| Miles driven by an average gasoline-powered passenger vehicle | 1,332,053,274 | 782,185,170 | 775,932,494 |
| **This is equivalent to $CO_2$ emissions from:** | | | |
| Gallons of gasoline consumed | 60,384,944 | 35,458,197 | 35,174,750 |
| Gallons of diesel consumed | 52,715,226 | 30,954,519 | 30,707,073 |
| Pounds of coal burned | 593,744,552 | 348,648,355 | 345,861,310 |
| Tanker trucks worth of gasoline | 7,104 | 4,172 | 4,138 |
| Homes' energy use for 1 year | 67,597 | 39,693 | 39,376 |
| Homes' electricity use for 1 year | 104,417 | 61,314 | 60,824 |
| Railcars worth of coal burned | 2,963 | 1,740 | 1,726 |
| Barrels of oil consumed | 1,242,437 | 729,562 | 723,730 |
| Propane cylinders used for home barbeques | 21,913,592 | 12,867,718 | 12,764,856 |
| Coal-fired power plants in one year | 0.144 | 0.084 | 0.084 |
| Natural gas-fired power plants in 1 year | 1.3 | 0.792 | 0.786 |
| Number of smartphones charged | 65,278,431,351 | 38,331,665,773 | 38,025,247,947 |
| **This is equivalent to GHG emissions avoided by:** | | | |
| Tons of waste recycled instead of landfilled | 185,689 | 109,037 | 108,165 |
| Garbage trucks of waste recycled instead of landfilled | 26,527 | 15,577 | 15,452 |
| Trash bags of waste recycled instead of landfilled | 23,228,848 | 13,640,041 | 13,531,004 |
| Wind turbines running for a year | 146 | 85.7 | 85 |
| Incandescent lamps switched to LEDs | 20,339,237 | 11,943,253 | 11,847,781 |
| **This is equivalent to carbon sequestered by:** | | | |
| Tree seedlings grown for 10 years | 8,873,405 | 5,210,487 | 5,168,835 |
| Acres of U.S. forests in 1 year | 635,080 | 372,921 | 369,940 |
| Acres of U.S. forests preserved from conversion to cropland in 1 year | 3,620 | 2,125 | 2,108 |

Source: EPA (2022).

## F.5 REFERENCES

BOEM (Bureau of Ocean Energy Management), 2019a, *Air Emissions Associated with Decommissioning Operations for Pacific Outer Continental Shelf Oil and Gas Platforms, Volume I: Final Report*, BOEM 2019-016, Pacific OCS Region. Available at https://www.boem.gov/sites/default/files/environmental-stewardship/Environmental-Studies/Pacific-Region/Studies/BOEM-2019-016-Vol1.pdf.

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