Greenhouse Gas Emission Forecast for 2020: Data Sources, Methods, and Assumptions
AB 32 Baseline Forecast

October 28, 2010

Overview

This document describes the data sources, projection methods, and basic assumptions used for forecasting statewide greenhouse gas (GHG) emissions in 2020. The forecast is an estimate of the emissions expected to occur in the year 2020 if none of the foreseeable measures included in the Scoping Plan were implemented[1]. The base year used for forecasting emissions is the average of statewide emissions in the GHG inventory for 2006, 2007, and 2008[2]. Using the average of the last three years of known emissions dampens variations in any given year that may make it unsuitable as the basis for forecasting. For example, using a hot and dry year, with higher power consumption and less hydroelectric power generation as the forecasting base year, would skew the expected emissions associated with power generation.

The 2020 greenhouse gas emissions forecast provides a baseline for the proposed Cap-and-Trade (C&T) regulation. The forecast of total emissions expected in 2020 includes reductions anticipated from Pavley I and the RPS (38 $MMTCO_2e$ total). With these reductions in the baseline, the estimated 2020 statewide greenhouse gas emissions forecast is 507 $MMTCO_2e$ (Table 1).

Table 1: 2020 Greenhouse Gas Emissions Forecast by Sector

Sector	*2020 Forecast*
Transportation	183.9
Electric Power (In-State & Imported)	110.4
Commercial and Residential	45.3
Industrial	91.5
Recycling and Waste	8.5
High GWP Gases	37.9
Agriculture	29.1
Forest Net Emissions	0.0
TOTAL	**507**

Note: The Transportation sector is affected by Pavley I; RPS affects the Electric Power, Commercial & Residential, and Industrial sectors

[1] See: http://www.arb.ca.gov/cc/inventory/data/tables/reductions_from_scoping_plan_measures_2010-10-28.pdf

[2] For In-state electricity generation and industrial sources emitting ≥25,000 MTCO2e/year, 2008 data from ARB's GHG mandatory reporting program were used.

Forecast Sources

The forecast sources include data and information from reports issued by other State and Federal agencies, the ARB's criteria pollutant emissions forecasting system (CEFS), and outputs from source-specific models. The emission source, forecast parameter, and data source are summarized in Table 2.

Table 2: Forecast Sources

Emission Source	*Forecasted Parameter*	*Forecast Source*
Electricity Generation and Cogeneration (in-state, imported)	Electricity Demand	2009 IEPR[1]
Transportation Fuels (gasoline, ethanol, diesel, jet fuel, aviation gasoline, natural gas, propane)	Transportation Fuel Demand	2009 IEPR[1]
Refineries, Commercial and Residential Fuel Use, General Stationary Source Combustion	Natural Gas Demand	2009 IEPR[1]
Ships and Harborcraft	Fuel Use	Marine Inventory Model[2] (Developed by ARB staff)
Landfills	Waste Deposition	Landfill Model[3] (Developed by ARB staff); waste deposition data from CalRecycle
Wastewater, Agricultural burning residue and fuel use, Recreational Boats, Fugitive Emissions	Emissions	California Emissions Forecasting Systems (CEFS)[4]
High GWP Gases	Emissions	USEPA Vintaging Model; U.S. Census Bureau data for population

[1] Electricity and transportation fuel demand forecast is from the California Energy Commission, *2009 Integrated Energy Policy Report*, Final Commission Report, December 2009, CEC-100-2009-003-CMF. Data and information contained in documents drafted in support of the 2009 IEPR were also included.
[2] More information on the Marine Inventory Model for ocean-going vessels and harborcraft may be obtained from: http://www.arb.ca.gov/diesel/mobile.htm
[3] Includes future estimates of waste deposition from CalRecycle.
[4] Forecast in CEFS is based on information developed by ARB staff, outputs from specific ARB models (i.e., OFFROAD) and data provided by local air districts.

Forecasting Methods and Assumptions

Emission projections from energy consuming sectors of the statewide GHG inventory depend primarily on the assumptions in the energy demand models used by the California Energy Commission for their biennial Integrated Energy Policy Report (IEPR). The 2009 IEPR forecasts future demand for electricity, natural gas, and transportation fuels while considering the effects of the recent recession. For electricity and natural gas, the 2009 IEPR provides a single, recession-adjusted demand estimate. For

transportation fuels, IEPR provides both high and low demand scenarios. ARB staff used the average of the high and low demand cases for its emission projections.

Emission estimates for the electricity generation sector in 2020 were developed by determining the type and amount of fuel likely to be used to meet the forecasted demand and by calculating the corresponding emissions using fuel-specific emission factors. For certain source categories, ARB emission forecasting models were used instead of the 2009 IEPR demand, but only where the model incorporated the impact of the current recession. Methods used to project emissions from non-energy sectors varied by source.

In all cases, the forecasting calculations reflect economic data or some other activity patterns to estimate future emissions. The 2020 forecasts use the following general equations to estimate emissions by sector:

2020 Emissions = Base Year Emissions x 2020 Multiplier

2020 Multiplier = 2020 Activity Data / Base Year Activity Data

The base year is the average of emissions (or activity) of the last three years of the GHG emissions inventory, that is 2006, 2007 and 2008. The calculated "2020 multipliers" can reflect growth (greater than one), no change (equal to one), or reduction in emissions (less than one).

A description of each of the main sectors included in the forecasts follows, including a description of the specific forecast sources by category, where appropriate.

Transportation

The 2020 on-road transportation emissions estimate is based on the 2009 IEPR demand forecasts. The level of demand used for estimating on-road gasoline and diesel consumption is the average of the high and low demand cases presented in the 2009 IEPR. These high and low demand cases reflect different assumptions regarding the recovery of demand for petroleum fuels after the recession and the increase in use of competing fuels. For these 2020 forecasts, future ethanol percentages in gasoline were held constant at 2006-2008 levels (approximately 6 percent).

The 2020 emissions from gasoline use in recreational boats are derived from outputs of fuel consumption from CEFS. Staff chose to use CEFS for estimating future emissions from recreational boats because it provides more specific estimates for this category than are otherwise available from the 2009 IEPR. Similarly, 2020 emissions from diesel and residual oil use in ocean-going vessels and commercial harborcraft are based on the marine vessel models developed by ARB staff. These models were designed for detailed analysis and to support regulatory development work.

Estimates of 2020 emissions from off-road equipment, trains, and aircraft, including gasoline, diesel, jet fuel, aviation gasoline, propane, and natural gas are based on the average of the high and low cases of the 2009 IEPR demand forecasts.

Electric Power

In-state and imported electricity generation emissions in 2020 were derived from the statewide electricity demand forecasts in the 2009 IEPR. The CEC's Energy Demand Forecast, which supports the IEPR, has been revised to account for lower personal income growth, lower employment, lower industrial output, and less total commercial floor space. Increased efficiency was also considered as a factor in the final demand forecast for 2009 to 2020.

Staff assumed that the in-state electricity generated from fuels other than natural gas such as coal, coke, diesel, and LPG, would remain constant over time. This assumption is based on air district permitting requirements for Best Available Control Technology (BACT) standards for new sources. The increase in use of fuels other than natural gas for power generation in the future is therefore expected to be negligible or non-existent. Then staff assumed that the remaining demand would have to be met through renewable power, natural gas-fired generation, imports, or a combination of these sources depending on the particular forecast.

The amount of imported electricity was kept constant from the base year to 2020. Staff assumed that no new long-term contracts would be established with out-of-state fossil power sources because of 1) limitations in transmission capacity; and, 2) the increase use of in-state electricity generation from combined-cycle power plants. Emission estimates for unspecified electricity imports were based on an emission factor of 959.7 lbs/MWh[3].

Commercial and Residential

Emissions from the commercial and residential sectors result predominantly from natural gas use from smaller sources of combustion, including small boilers, water heaters, and appliances. Future emission estimates for this sector rely on the 2009 IEPR natural gas demand forecast.

The consumption of fuels other than natural gas, including coal, coke, diesel, LGP, and gasoline, was assumed to remain constant through 2020 in the commercial and residential sectors. An increase in use of these fuels in the future is precluded given the regulatory requirement for BACT in new facilities.

Industrial

For forecasting purposes, the industrial sector is separated into facilities combusting natural gas and those combusting fuels other than natural gas. 2020 emissions from industrial facilities using natural gas, including a portion of the emissions from refineries and hydrogen plants, are derived from the 2009 IEPR demand forecast. The consumption of most fuels other than natural gas, including the use of coal by cement plants, was assumed to remain constant over time.

[3] The default emission factor of 959.7 lbs/MWh was recently updated. The updated factor may be obtained from the Western Climate Initiative (WCI) website: http://www.westernclimateinitiative.org/component/remository/Electricity-Team-Documents/Default-Emission-Factor-Calculators/

Emissions from the combustion of certain fuels, e.g., “associated gas”, used by a limited number of facilities within the industrial sector were estimated by extrapolating the historical emission trend spanning 1990 to 2008. Associated gas is a byproduct of oil production facilities.

Emission forecasts for clinker production and other processes were estimated on a source-specific basis. Clinker production emissions from cement plants are dependant on the amount of fuel combustion by the plants and were therefore not expected to change significantly from the base year to 2020. Future emissions from fugitive sources, including wastewater treatment plants, were based on estimates from CEFS.

Recycling and Waste

Landfill emissions were projected based on a 2020 estimate of waste deposition in California landfills. Waste deposition data was then used to determine future methane generation from landfills statewide. The forecast of landfill emissions applies the same estimation technique used to develop current inventory estimates, but uses the projected amounts of waste in landfills. Staff assumed that the composition of the waste and the number of landfills with landfill gas collection systems would remain the same.

High GWP Gases

High global warming potential (GWP) gases consist of a family of chemical compounds that are potent greenhouse gases. These gases include sulfur hexafluoride (SF6), chlorofluorocarbons (CFCs), hydrochlorofluorocarbons (HCFCs), hydrofluorocarbons (HFCs), and perfluorocarbons (PFCs). Among these gases, the CFCs and HCFCs contribute to stratospheric ozone depletion and are often referred to as ozone depleting substances (ODSs). ODSs are used as refrigerants and in a variety of industrial applications, including solvent cleaning, and production of foams and aerosols. ODSs are typically not included in greenhouse gas inventories as their control is included under the terms of the Montreal Protocol.

HFCs and PFCs contribute to climate change, but not directly to ozone depletion. In many industrial applications, HFCs and PFCs may be used as substitutes for ODSs and are therefore termed “ODS substitutes”. Since the mid-1980s the production and use of ODSs has decreased and their replacement with ODS substitutes has increased. Emissions from ODS substitutes have therefore increased over time and are expected to continue to grow as ODSs are replaced.

The forecast for ODS substitutes uses a source-specific USEPA model which forecasts emissions of ODS substitutes nationwide. California emissions in 2020 were determined by prorating national emissions based on population. Emissions of specific high GWP gases used in semiconductor manufacturing are expected to remain constant through 2020 according to industry surveys and other information obtained by ARB regulatory staff.

SF6 emissions from the power sector now and in the future are expected to occur solely as the result of leaks. Leaks from transmission equipment are not expected to increase over time from current estimates. Improvements in leak prevention are assumed to balance any potential expansion of the transmission grid and increased use of SF6.

Agriculture

Emissions associated with the growing and harvesting of crops (i.e., fertilizer use) and from fuel use are expected to remain constant or decrease through 2020. The 2020 forecast of emissions from the use of natural gas in the agricultural sector is based on the 2009 IEPR fuel demand projections.

Emissions in 2020 from the use of gasoline and diesel in the agricultural sector are derived from outputs of ARB's OFFROAD model and specific growth factors assigned to the use of stationary diesel-driven agricultural pumps. All growth factors for gasoline and diesel use in the agricultural sector are based on recommendations from the Agricultural Advisory Committee for Air Quality (2005) for agricultural operations in the San Joaquin Valley. Growth factors for other areas of the State are based on anticipated future economic output. The use of fuels in the agricultural sector other than natural gas, gasoline, and diesel was assumed to remain constant in the future.

Future emissions from livestock are based on a state-specific forecast of California dairy cow population for years 2010 to 2019 established by the Food and Agricultural Policy Research Institute. This forecast was extended to 2020 using a best-fit regression of the 2010 to 2019 values.