

**California Department of Forestry and Fire Protection and
California Air Resources Board**

**Greenhouse Gas Interim Quantification Methodology for the
California Department of Forestry & Fire Protection (CAL FIRE)
Urban and Community Forestry Program
Greenhouse Gas Reduction Fund
Fiscal Year 2014-15**

A. Introduction

The California Air Resources Board (ARB) is required to develop quantification methods for agencies receiving Greenhouse Gas Reduction Fund (GGRF) appropriations per SB 862 (Senate Budget and Fiscal Review Committee, Chapter 36, statutes of 2014).

Some administering agencies receiving appropriations of Fiscal Year (FY) 2014-15 GGRF funds developed interim quantification methodologies in consultation with ARB. For FY 2015-16 and future years, ARB will continue to develop or update quantification methodologies for GGRF funded programs.

B. Quantification Methodology

The California Department of Forestry and Fire Protection (CAL FIRE) developed the GGRF Urban and Community Forestry Program to assist disadvantaged communities in implementing multi-benefit urban forest projects with a focus on reducing greenhouse gas (GHG) emissions. ARB, in consultation with CAL FIRE, developed the following interim quantification methodology for use in estimating the net GHG benefit from Urban and Community Forestry Program projects proposed for funding with FY 2014-15 GGRF monies.

There are five Urban and Community Forestry project types for FY 2014-15:

- Golden Trees for the Golden State;
- Urban Forest Management for GHG Reduction;
- Woods in the Neighborhood;
- Green Innovations; and
- Urban Wood and Biomass Utilization.

The first four project types listed all involve urban tree planting. The interim GHG quantification method for these project types estimates the net GHG benefit based on the carbon sequestration of planted trees, the avoided GHG emissions due to the effects of tree shade on residential heating and cooling energy use, and the GHG emissions resulting from project activities. ARB recommends use of the Tree Planting Project quantification method below to estimate the net GHG benefit of these projects.

Urban Wood and Biomass Utilization projects divert removed urban trees from landfills and use them for their highest and best use to achieve a net GHG benefit. Removed trees can be used to produce wood products or generate renewable energy. The interim GHG quantification method for this project type estimates the net GHG benefits based on the long-term carbon storage in wood products, the avoided GHG emissions from the displacement of fossil fuel-based energy, and the GHG emissions resulting from project activities. ARB recommends use of the Urban Wood and Biomass Utilization Project quantification method below to estimate the net GHG benefit of these projects.

Tool

For all urban forest project types, this interim quantification methodology relies on the Center for Urban Forest Research (CUFR) Tree Carbon Calculator (CTCC), developed by the USDA Forest Service in partnership with CAL FIRE, to estimate a project's GHG benefit. The tool is used statewide, publicly available, and is free of charge and available to anyone with internet access. The tool can be downloaded from: http://www.fire.ca.gov/resource_mgt/downloads/TREES_WC.zip. A help document containing step-by-step instructions for using the calculator is available at: http://www.fire.ca.gov/resource_mgt/downloads/CCTC_Help.pdf. The user inputs project characteristics such as the climate zone, tree species, tree age, and tree location relative to a building and CTCC provides quantitative output on individual trees including carbon sequestration and storage, the dry weight of aboveground biomass, and the estimated energy savings due to the effects of tree shade on residential heating and cooling. The CTCC interface is shown with examples in the images below.

Tree Planting Project Quantification

A project's estimated GHG benefit is calculated for a minimum of 40 years, the minimum project life length. Applicants will report a project's direct carbon sequestration, avoided GHG emissions (if tree planting sites have been selected), and project GHG emissions separately.

To calculate carbon sequestration, applicant will input values into the following grey cells:

- Flag1:** Enter 0 to compute values based on age, or 1 for diameter at breast height (DBH).
- Flag2:** Enter 0 to compute values based on shade effects only, or 1 for shade and climate effects.
- Climate Zone:** One of the six California regions that applies to the project according to the CTCC help document.
- Species code and scientific name:** The tree species to be planted for the project.
- Age (years):** The age at which carbon sequestration will be assessed.

If tree planting sites have been selected, avoided GHG emissions from energy savings can also be taken into consideration. If tree planting sites have not yet been selected, applicants can leave boxes relating to shade and energy use blank. To calculate energy savings, applicants will input values into the following grey cells:

- Tree azimuth:** The compass bearing of the tree from the nearest building (i.e., N, NE, E, SE, S, SW, W, or NW).
- Tree distance class:** The distance from tree to nearest air-conditioned/ heated space (i.e., <20 ft, 20-40 ft, 40-60 ft, or >60 ft).
- Building vintage:** The vintage of the nearest building (i.e., pre-1950, 1950-80, or post-1980).
- Air conditioning equipment:** Enter 1 for central air/heat, 2 for evaporative cooler, 3 for wall/window unit, 0 for none.
- Heating equipment:** Enter 1 for natural gas, 2 for heat pump, 3 for electric resistance, 4 for oil or other fossil fuel, or 0 for none.
- Electricity and heating emission factor:** The region appropriate and utility-specific emission factor from the help document.

The carbon storage and energy reduction output fields, circled in red in the example below, are used to calculate the estimated GHG benefit of each tree to be planted. The CTCC does not sum the individual tree outputs so applicants must do that separately. Applicants may sum the “Total CO₂ Stored” CTCC output for all trees to be planted to estimate the project’s total direct carbon sequestration. Applicants may sum the “Cooling + Heating” CTCC output for all trees to be planted to estimate the project’s total avoided GHG emissions.

CUFR Tree Carbon Calculator

Developed by the Center for Urban Forest Research
Pacific Southwest Research Station
US Forest Service

In partnership with the California Department of
Forestry and Fire Protection






Figure 1

Project Data entry				
Data name	Data entry	Units	Description	
Flag1	0		Tree age selected	
Flag2	0		Shade only selected	
Climate Zone	3 (Inland Empire)		Inland Empire	
Electricity CO2 emissions factor§	395	(kg/MWh)		
Electricity CH4 emissions factor§	0.0030	(kg/MWh)		
Electricity N2O emissions factor§	0.0017	(kg/MWh)		

§required for energy project

Figures 6 & 9

Tree and Building Data entry				
Enter Tree data below one tree at a time, then record results				
Data name	Data entry	Units	Description	
Species code and scientific name	EUSI (Eucalyptus sideroxyton)		red ironbark	
Age (years)	27	Age (years)	17.8 in DBH & 46.5 ft high	
Tree azimuth	7		W	
Tree distance class	3		Far	
Building vintage	3		post-1980	
air conditioning equip.	1		Central air/heat pump	
Heating equip.	1		natural gas	
Heating emissions factor- CO ₂ §	53.1	(kg/MBtu)		
Heating emissions factor CH ₄ §	0.0059	(kg/MBtu)		
Heating emissions factor N ₂ O§	0.0001	(kg/MBtu)		

Figures 7-10

Carbon Calculator Results (annual)							
Energy reductions		Emission reductions (CO ₂ equivalents)			CO ₂ Sequestration	Total CO ₂ Stored	Above ground biomass
Cooling	Heating	Cooling	Heating	Cooling + Heating	(A value of 0.0 indicates no tree growth)		(dry weight)
kWh/tree	MBtu/tree	(kg/tree)	(kg/tree)	(kg/tree)	(kg/tree)	(kg/tree)	(kg/tree)
85.12	-0.014	33.7	-0.8	32.9	114.6	1549.9	658.8
kWh/tree	GJ/tree	lb/tree	lb/tree	lb/tree	(lb/tree/year)	(lb/tree)	(lb/tree)
85.12	-0.015	74.2	-1.7	72.6	252.7	3,416.9	1,452.4

Applicants will also estimate project GHG emissions (e.g., emission from vehicles and equipment used for planting and tree maintenance) for a minimum of 40 years using sections 5.2 and 5.3 of ARB’s Urban Forest Compliance Offset Protocol. The urban forest protocol can be accessed at:

<http://www.arb.ca.gov/regact/2010/capandtrade10/copurbanforestfin.pdf>.

Urban Wood and Biomass Utilization Project Quantification

A project's estimated GHG benefit is calculated for a minimum of 40 years, the minimum project life length. The applicants will report a project's long-term carbon storage, avoided GHG emissions (if removed trees are used to generate renewable energy), and project GHG emissions separately.

To calculate long-term carbon storage applicants will first determine the aboveground biomass of the trees expected to be removed by entering values into the following grey cells:

Flag1: Enter 0 to compute values based on age, or 1 for diameter at breast height (DBH).

Flag2: Enter 0 to compute values based on shade effects only, or 1 for shade and climate effects.

Climate Zone: One of the six California regions that applies to the project according to the CTCC help document.

Species code and scientific name: The tree species to be planted for the project.

Age (years) or DBH (in): The age or diameter at breast height (DBH) at which carbon sequestration will be assessed (i.e., when the tree is removed).

Applicants will use the aboveground biomass output field, circled in green in the example below, to calculate the estimated GHG benefit of each tree to be utilized.

CUFR Tree Carbon Calculator

Developed by the Center for Urban Forest Research
Pacific Southwest Research Station
US Forest Service

In partnership with the California Department of
Forestry and Fire Protection




Figure 1

Project Data entry				
Data name	Data entry	Units	Description	
Flag1	0		Tree age selected	
Flag2	0		Shade only selected	
Climate Zone	3 (Inland Empire)		Inland Empire	
Electricity CO2 emissions factor		(kg/MWh)		
Electricity CH4 emissions factor		(kg/MWh)		
Electricity N2O emissions factor		(kg/MWh)		
§required for energy project				

Help Commands
Help for Selected Cell
Help Menu

Figures 6 & 8

Tree and Building Data entry				
Enter Tree data below one tree at a time, then record results				
Data name	Data entry	Units	Description	
Species code and scientific name	EUSI (Eucalyptus sideroxyton)		red ironbark	
Age (years)	27	Age (years)	17.6 in DBH & 45.5 ft high	
Tree azimuth			#N/A	
Tree distance class			> 60 ft	
Building vintage			#N/A	
air conditioning equip			Not air conditioned	
Heating equip			Not heated	
Heating emissions factor- CO2		(kg/MBtu)		
Heating emissions factor CH4		(kg/MBtu)		
Heating emissions factor N2O		(kg/MBtu)		

Output Help

Figures 7-10

Carbon Calculator Results (annual)							
Energy reductions		Emission reductions (CO ₂ equivalents)			CO ₂ Sequestration	Total CO ₂ Stored	Above ground biomass
Cooling	Heating	Cooling	Heating	Cooling + Heating	A value of 0.0 indicates no tree growth		(dry weight)
kWh/tree	MBtu/tree	(kg/tree)	(kg/tree)	(kg/tree)			
#VALUE!	#VALUE!	#VALUE!	#VALUE!	#VALUE!	114.6	1549.9	658.8
kWh/tree	GJ/tree	lb/tree	lb/tree	lb/tree	(lb/tree/year)	(lb/tree)	(lb/tree)
#VALUE!	#VALUE!	#VALUE!	#VALUE!	#VALUE!	252.7	3,416.9	1,452.4

For Urban Wood and Biomass Utilization projects that propose to use removed trees to produce wood products, applicants may use the “Aboveground biomass” CTCC output along with other data such as mill efficiencies, classes of wood products produced, and long-term carbon storage factors to estimate the amount of carbon stored in wood products in accordance with Appendix C of ARB’s U.S. Forest Compliance Offset Protocol. The forest protocol can be accessed at:

<http://www.arb.ca.gov/regact/2014/capandtrade14/ctusforestprojectsprotocol.pdf>.

For Urban Wood and Biomass Utilization projects that propose to use removed trees to generate renewable energy, applicants may quantify the GHG benefit of converting biomass to energy by using the “Aboveground biomass” CTCC output and applying an emission reduction factor of -0.24 MTCO₂e per bone dry ton of biomass published in ARB and CalRecycle’s biomass conversion study available at:

<http://www.arb.ca.gov/cc/waste/biomassconversion.pdf>. This methodology assumes that the wood waste is delivered to a biomass energy facility that produces electricity through combustion of the biomass in a boiler to produce steam which is then used to power a turbine-driven generator. If the biomass facility uses a different process (e.g., gasification) or produces a different form or power (e.g., ethanol), applicants may propose and submit modified quantification methods applicable to the project.

All Urban Wood and Biomass Utilization project applicants may also estimate project GHG emissions (e.g., emission from vehicles and equipment used for tree removal) using sections 5.2 and 5.3 of ARB’s Urban Forest Compliance Offset Protocol. The urban forest protocol can be accessed at:

<http://www.arb.ca.gov/regact/2010/capandtrade10/copurbanforestfin.pdf>.

C. Next Steps

ARB will continue to evaluate and update the GHG emission reduction quantification methodologies as necessary for future FY GGRF appropriations. Quantification methods are posted on ARB’s auction proceeds webpage at:

<http://www.arb.ca.gov/cc/capandtrade/auctionproceeds/quantification.htm>