Urban Biomass Market Report

California Refuse Recycling Council

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Introduction:

California's wood waste primarily originates from three sectors, the forest sector, the agriculture sector, and the urban sector. The primary common market for waste wood from these sectors has been managed through biomass energy plants which have utilized an average of 5.3 million bone dry tons (BDT) annually from 2001 to 2013[1]. Biomass energy capacity throughout California has been in dramatic decline since 2014 as facilities have closed indefinitely or been temporarily idled. Other markets, such as mulch and landscape, currently do not have the capacity to absorb to accept all of the wood waste previously used by shuttered bioenergy facilities or the new wood waste tons coming on the market as they are increasingly diverted from landfills. With the impacts of prolonged drought and climate change on the forest sector and new landfill diversion legislation, there will likely be a significant increase in the amount of wood waste that is expected to be utilized by biomass energy plants, which will have increasingly limited capacity to accept material.

This report examines the impacts of these market forces which will result in a decrease in demand for urban woody biomass. These impacts are expected to decrease the demand for urban woody biomass from 1.5 million BDT/year in 2014 to as low as 232,861 BDT/year by 2020. During this same period, an *additional* 1.3 million BDT/year of new urban biomass will need to be diverted from landfills through implementation of AB 1826. This report will discuss three major forces contributing to this situation: Decreasing Biomass Energy Capacity, Growth of Wood Waste Quantities, and Absence of Substitute Markets. Lastly, the environmental impacts of the decline of bioenergy plants are explored, and by extension, implications of the stalled biomass market.

Decreasing Biomass Energy Demand

Within the last two years, from 2014 to 2016, the biomass energy demand in California has fallen 27% from approximately 5,651,200 BDT/year to 4,148,000 BDT/year. This trend is expected to continue through 2020 as more facilities close permanently or are idled. Holding current closure patterns, by 2020 only 2,272,000 BDT/year, or 40% of 2014 capacity, will remain.

The dramatic decline in operating biomass energy plants in California is a result of expiring 25-30 year utility power purchase agreements (PPA), competition from increasingly inexpensive solar energy, and aging facilities. These facilities, many of which came online in the late 1980's, were party to agreements which offered compensation based on fixed and increasing prices for 10 year terms. After the first 10 years, pricing shifted to a "short-run avoided cost" (SRAC) model which is closely tied to natural gas prices. Most of these PPA's were for thirty years, and are now approaching termination *[Kotrba]*. Since SRAC energy prices have been lower than the bioenergy plant's operating costs, most plants have been operating the past 20 years under a series of 5-year PPA amendments which fixed the energy price at higher levels than SRAC in order to keep the plants operating.

Concurrently, the rapid growth of solar energy production has put downward pressure on renewable energy prices within the state. Despite its fluctuating impact on grid electricity, solar energy remains an

[1] One BDT is 2,000 pound of woody material that has a moisture content of zero percent (0%)

increasingly popular choice for electricity generation due to favorable economic conditions. Thus, even in the event of contract renewals, biomass plants are faced with strong competition from solar energy which set market prices for energy below what many biomass plants can offer.

Given the relatively high operating cost structure of existing biomass energy plants, continued operations will not be sustainable at the current market prices for renewable energy in CA. Thus the current renewable energy market will not incentivize contract renewal or new bioenergy plant construction.

The resulting 1,503,200 BDT loss of bioenergy demand from 2014 to 2016 is therefore attributable to a combination of market forces and expiring PPA's or fixed-price amendments. Many more PPA's are set to expire within the next few years. At termination of these contracts, the wood markets will be flooded with 1.2 million BDT in 2016 and another 2.4 million BDT in 2017.

The impacts of this demand reduction have affected biomass suppliers. From 2001 to 2014, the haulers of urban biomass material once received $25-$30 per BDT delivered to biomass facilities. This supported the high diversion rates from construction and demolition (C&D) debris programs that were launched in the early 2000's. Boiler fuel quality urban wood waste represented 30% to 40% of C&D debris, and was responsible for the C&D program's ability to recycle over 75% of the material[2]. Today, some biomass energy plants are requesting that the processed urban wood waste gets tipped for free on current contracts, or at a nominal cost of $10 per BDT, to prevent the premature closure of these plants. This is a downward price swing of $25 to $35 per BDT and will require the solid waste industry to raise disposal fees to their customer base in order to sustain their high recycling rates for C&D debris. These disposal fees are projected to be higher than the fees to dispose the materials at a typical landfill.

Although tax credits and other incentives are available for the construction of new community-scale (<3MW) biomass gasification facilities, replacing the aged facilities with new ones compliant with modern emissions standards will be both challenging and expensive *[Birdsall 7]*. Existing market structures are unattractive to existing facilities, and large capital investments for new or upgraded facilities are unlikely under present and forecasted market conditions. The new biomass gasification plants are of community-scale (small-capacity) and, as such, cannot possibly accommodate the current displaced tons from large-capacity biomass plants, or the new tons coming on the market as they are diverted from landfill.

The continuous loss of facilities, without new operations or contracts to renew processing, will result in progressively lower capacities for biomass electrical generation as shown in the table below *[CT]*.

[2] See Attachment C, Morris for basis of these calculations.

Table 1: Estimated Change in Biomass Fuel Demand 2014-2020

	Demand Changes - Bone Dry Tons (BDT)						
	2014	2015	2016	2017	2018	2019	2020
Forest Sector	0	-185,600	-318,080	-727,920	0	0	0
Agriculture Sector	0	-270,400	-218,400	-359,280	0	-212,000	-40,000
Urban Sector	0	-228,000	-282,720	-376,800	0	0	-160,000
Total:	0	-684,000	-819,200	-1,464,000	0	-212.000	-200,000

Increase of Wood Waste Quantities:

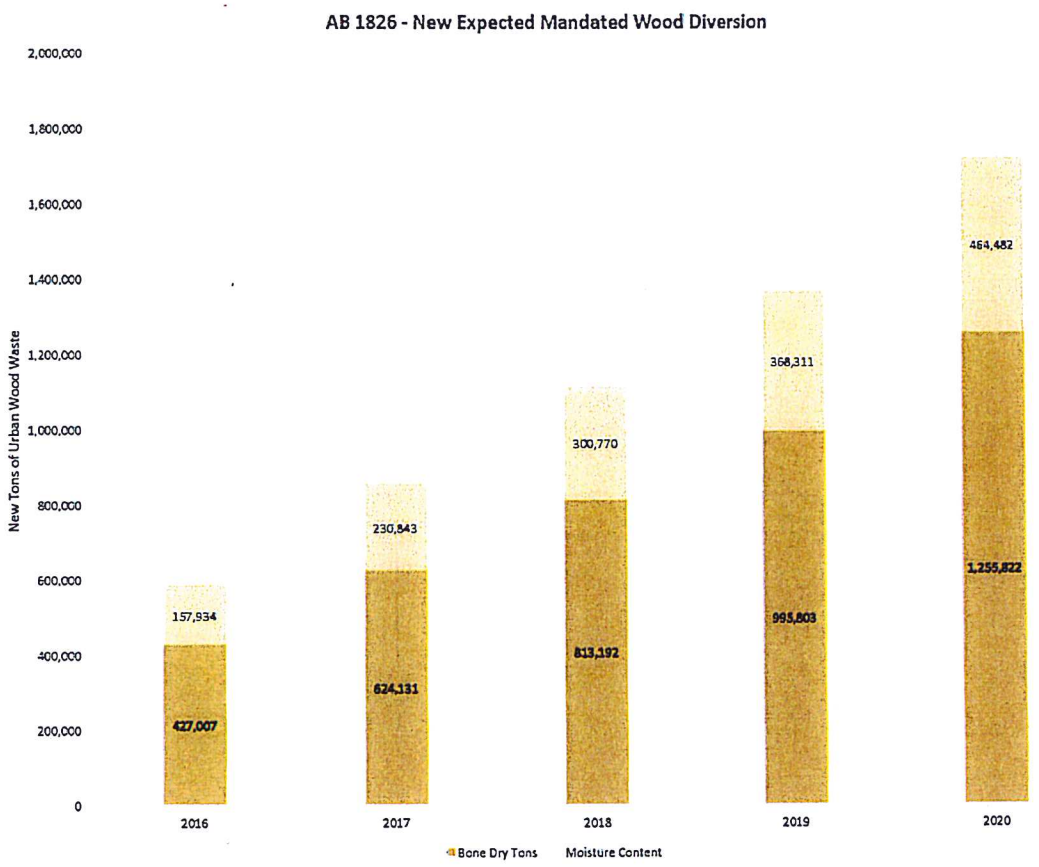
Waste from Forestry Management: As a consequence of four years of unprecedented drought in California, stressed trees throughout the state's forests have become susceptible to infestations of bark beetles and diseases, and consequently die-off. These dead and dying trees, expected to approach 50 million BDT in 2016, are a threat to public safety and significantly increase the risk of catastrophic, uncontrollable wildfire. In response to this threat, Governor Brown proclaimed a Tree Mortality State of Emergency, which, among other things, directs the California Public Utility Commission (CPUC) to extend contracts for existing forest bioenergy facilities receiving feedstock from areas with high tree mortality, or High Hazard Zones (HHZ's) *[Brown]*.

In response, the CPUC issued Resolution E-4770, which mandates that Investor Owner Utilities (IOU's)[3] procure a minimum of 50 MW of energy under PPA's with terms of at least 5 years from biomass plants that use large amounts of fuel from the HHZ's *[CPUC 13]*. The California Forestry Association estimates that approximately 1.9 million BDT of HHZ wood waste could enter the bioenergy market as a result of this mandate *[Brink 4]*. CFA's report, including methodology for this calculation is attached as Attachment A.

Organics Legislation: New California state laws mandate increasing amounts of urban wood waste to be diverted from landfills. AB 341, sets forth statewide landfill diversion goals for recoverable material, and AB 1826 similarly mandates organic material, including wood waste, be diverted from landfills. AB 1826, which is implemented in phases, sets a goal of reducing the amount of commercially generated organic material sent to landfills to 50% of 2014 levels by 2020. This law serves as a bridge to the further-reaching the Short-Lived Climate Pollutants (SLCP) strategy goals of 90% organics diversion by 2025 *[CARB-2]*.

As a result, a total of **1,720,304 new tons/year**[4] of commercial wood waste will be expected to be diverted from landfills by 2020 to meet AB 1826's goal of 50% 2014 levels of organic material disposal by 2020. In addition to a 2025 landfill ban, a total of 3.1 million tons of wood each year will be looking for beneficial markets.

[3] Major California IOU's are Pacific Gas and Electric, San Diego Gas and Electric, and Southern California Edison.
[4] See Attachment B for detailed calculation of this projection.



Combined Increase in Wood Waste Tonnage: Given California Forestry Association's estimate of 1.9 million BDTs/year of HHZ forest wood waste, and the 1.3 million BDT/year required for California's landfill diversion goals (assuming an average 23% moisture content for the 1,720,304 feedstock tons). A total of 3.2 million BDT/year of new wood waste will need to be managed by 2020. Using a rate of 8,000 BDT/MW of capacity, these new tons will require 235 MW of capacity for the forestry waste, and another 166 MW of capacity for the urban waste mandated for diversion in 2020 if it were all used for bioenergy.

This new tonnage alone exceeds the entire feedstock needs of the projected 284-336 MW of biomass plants that will remain operating post 2020, in the absence of contract renewal *[CT, CFA]*. The total 401 MW equivalent of new wood waste would fill 77% of today's existing fuel demand, and 119% of 2017's projected fuel demand. Again, this surplus would be, *in addition to* the current amounts of material currently being used at the facilities. As the chart below illustrates, even the currently operating woody biomass to energy capacity is not sufficient to process the new tons of material in the year 2018. Further, what limited capacity exists will largely be dedicated to forest-sector wood waste from drought-impacted trees, leaving demand for urban and agricultural boiler fuel greatly diminished.

Decreased Use of Urban Biomass by Biomass Energy Plants: Wood waste from the urban and agricultural sectors do not qualify as the preferred feedstock for the new PPA's that will result from CPUC E-4770. As such, agricultural and urban wood wastes will constitute an ever-decreasing share of

the fuel blends for facilities that benefit from this expedited Renewable Auction Mechanism ("BioRAM") process. This is due to the E-4770 condition that California Investor Owned Utilities (IOUs) must procure specified amounts through their RAM auction process from biomass facilities that use large proportions (40-80% of total fuel use) of HHZ forestry wood waste. These minimum requirements are as follows *[CPUC]*:

Table 2: Forestry Waste Requirements for Biomass Facility RAM Eligibility

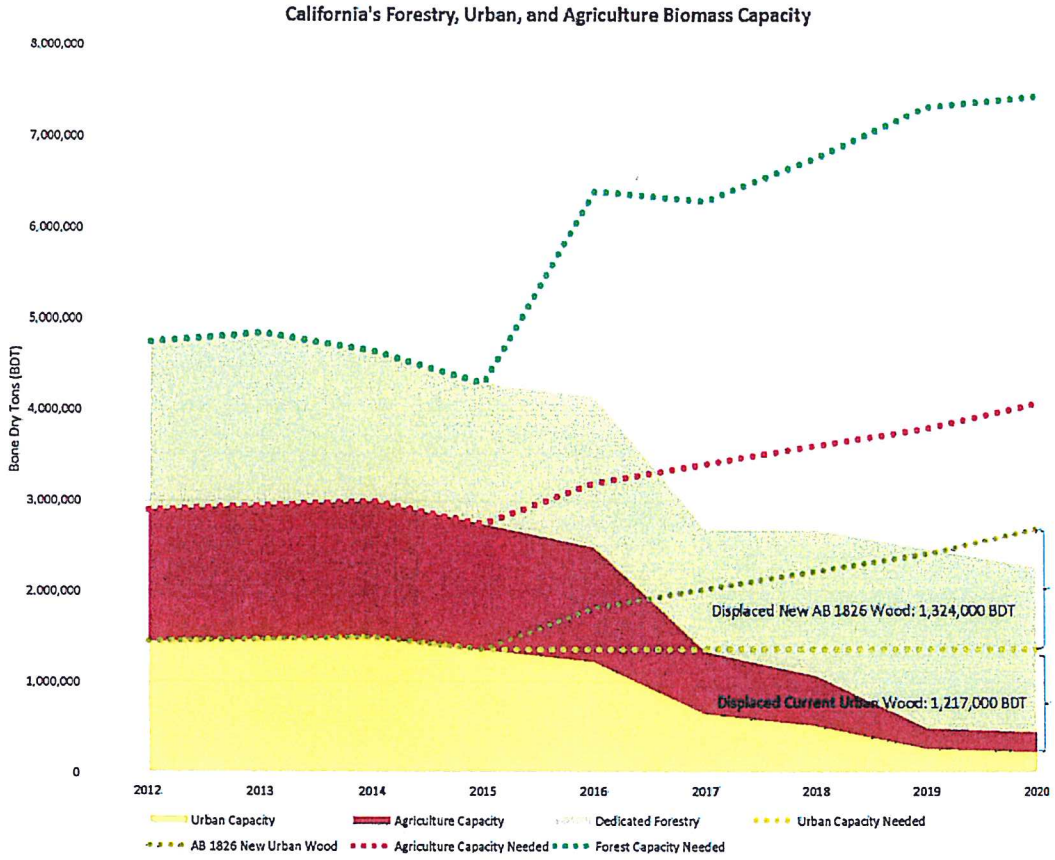
CPUCC E-4770 Forestry Waste Minimums for RAM Eligibility from High Hazard Zones (HHZ)				
Year	**2016**	**2017**	**2018**	**2019+**
Tons from High Hazard Zone – Forest Waste HHZ percentage	40%	50%	60%	80%
Estimated Bone Dry Tons From Forest Sector HHZ tons	1,659,200	1,342,000	1,610,400	1,977,600
Statewide Total Capacity BDT	4,148,000	2,684,000	2,684,000	2,472,000

**Tonnage calculations are based off of existing capacity. As such mandated HHZ waste may decline in some years despite increasing percentages due to the diminishing size of the biomass infrastructure.*

Biomass energy facilities that do not meet the above requirements for HHZ feedstock shall be offered the option to terminate their contract or contract at the current Renewable Market Adjusting Tariff (ReMAT) baseload price of $89.23/MWh for the duration of their contract [CPUC]. This baseload price, equivalent to roughly $0.09/kWh, falls below the estimated Levelized Cost of Electricity (LCOE) $0.14-17 cents/kWh that a new biomass facility will need *[TSS 3, TSS-2 15]*. As such, energy pricing for facilities without other economic incentives suggests that either new or existing facilities are unlikely to accept the ReMAT baseload rate.

Given that portions of the already-limited woody biomass to energy infrastructure will be dedicated to using mainly forestry waste, wood wastes from the urban and agricultural sectors are more likely to encounter discrimination either in the form of price factors (e.g. lower wood fuel prices, tipping fees) or non-price factors (e.g. limited access to markets, farther travel distances, high grading of feedstock).

The chart below shows the likely scenario that the remaining biomass energy capacity will continue to decrease with the current and planned closures. The remaining capacity will increasingly favor forest biomass to accommodate the Governor's State of Emergency. As a result the urban biomass will be crowded out where urban biomass capacity could be diminished by 1.2 million BDT tons by 2020, and completely without the ability to accommodate the new 1.3 million BDT coming onto the market from AB 1826. This is tantamount to a 2.5 million BDT shortfall in needed capacity for these materials. Meanwhile, the agricultural sector will also be crowded out of the biomass energy market causing existing "burn permits" to be increasingly exercised.



Absence of Substitute Markets:

Limitations of Mulch Market: As an alternative to biomass to energy, wood waste can be ground, screened, and processed into mulch and sold to market. Although significant efforts at developing markets for mulch material have been made over the last 25 years, opportunities to produce and sell mulch remain limited[5].

Limitations of Compost and Anaerobic Digestion: Woody biomass is a lignitic material that is not readily compostable. Anaerobic digestion facilities do use about 25% to 30% green waste mixed with food waste to add porosity and structure. However, use of wood waste such as lumber is extremely limited in favor of leaves, grass, and smaller branches. Lumber decomposition does not readily produce biomethane and restricts the performance of anaerobic digestion facilities. Compost facilities seek a balanced carbon/nitrogen (C:N) ratio where biosolids compost facilities, that once paid for these bulking agents, are now accepting wood chips for free, and have capacity limits on how much more they can accept. Compost facilities have a balanced C:N ratio with the current green waste and food waste

[5] Failed legislation, SB 1345 (Chesbro) developed in 2006, would have mandated state agencies such as CalTrans to use compost, mulch, and other waste derived organic products to offset the use of chemical fertilizers. As written, the bill would have diverted upwards of 1,000,000 tons/year of material, much of it ground wood directly used as mulch for erosion control, by the year 2010.

blends, where wood chips are not readily compostable and can be cycled through the composting process for years breaking down, adding operational costs and opportunity costs.

Limitations of Alternative Daily Cover: Alternative Daily Cover (ADC) is the substitution of landfill cover material with a suitable waste material. Although the use of wood waste as ADC is practiced and presently counts as diversion for AB 939 goals, the diversion credit for such material will be completely phased out by the year 2020 per AB 1594 *[AB 1594]*. Furthermore, per CARBs "Short-Lived Climate Pollutant Reduction Strategy" an effective ban on all organic material including wood being sent to landfill could be in place by 2025 *[CARB-2]*. The combined effects of these strategies will likely result in further limitation on the use of wood waste for ADC by 2020.

Environmental Impacts

Forgone Environmental Benefit: The absence of large-scale substitute markets for wood waste materials, particularly urban and agricultural wood wastes, will result in alternative management options for these materials being pursued. Consequently, the benefits of diverting such materials from landfills (as would be the likely alternative for urban wood waste) and open burning (more likely with agricultural wood wastes than urban) could be forgone. These unrealized environmental benefits, on a bone dry ton (BDT) basis are analyzed below:

GHG reduction: Biomass electricity produced from gasification is a substitute for electricity produced from California's existing grid infrastructure. Based on the California Air Resources Board's 2011 Study, "Method for Estimating Greenhouse Gas Emission Reductions from Recycling" electricity produced from biomass gasification has a lower carbon impact than California's existing energy blend. CARB calculates this net benefit of renewable biomass electricity as a reduction of 0.21 Metric Tons of Carbon Dioxide Equivalent ($MTCO_2e$) for every short ton of biomass feedstock used for gasification. This benefit is calculated as follows *[CARB 19]*:

Net Emissions: G_e (Emissions from Gasification) – G_a (Avoided Emissions from Offset Electricity)

G_e = 19.8 kg CO_2e/hour at 3.3 dry tons/hour
Feedstock weight = Twice dry weight
G_e = 3 kg CO_2e per Feedstock ton

G_a = 1MWh/dry ton at -418.9 kg CO_2e/MWh
G_a = -209 kg CO_2e per Feedstock ton

3 kg CO_2e per Feedstock ton – 209 kg CO_2e per Feedstock ton =
Net Emissions: **-206 kg CO_2e** per Feedstock ton

This GHG reduction noted above quantifies the benefit of displacing carbon intensive fuels required to produce electricity for California. Gasification also eliminates the need to burn biomass openly, which emits significant quantities of criteria pollutants and greenhouse gases, and Black Carbon. A 2011 study from the Placer County Air Pollution Control District, researched the magnitude of this offset. A summary of the findings of this study are included below.

Criteria Pollutants Reduction: Although an unlikely fate for urban biomass, open burning for agricultural and forestry wood wastes is a potential disposal outlet for tons without other options. As a result of being combusted in the absence of environmental controls present in a biomass conversion facility, open burning produces significantly more greenhouse gas and criteria pollutant emissions. These differences between these emissions rates were the object of study in the 2011 Technical Paper titled "Emissions Reductions from Woody Biomass Waste for Energy as an Alternative to Open Burning". This study demonstrated that the emissions reductions from converting wood waste to electricity in a biomass facility had the following advantages over open burning *[Springsteen 1]*.

Table 3: Comparison of Conversion to Open Burning

Criteria Pollutants: Conversion to Energy Compared to Open Burning		
Pollutant	**Reduction per BDT**	**% Reduction**
NO_X	1.6 kg	54%
Particulate Matter	6 kg	98%
Non-Methane Volatile Organics	4.6	99%
Carbon Monoxide	58	97%
Carbon Dioxide Equivalents	.38 tons	17%

Source: Emission Reductions from Woody Biomass Waste for Energy as an Alternative to Open Burning," Springsteen, Bruce. 2011

Impacts to the AB 341 Recycling Rate: AB 341 set a statewide goal that not less than 75% of solid waste generated be source reduced, recycled, or composted by the year 2020. In 2015, California has slipped to at a 49% recycling rate from a 50% recycling rate in prior years, and has just 5 years remaining to recycle almost 21 million tons to reach the 75% goal in 2020. With up to 2.5 million BDT of urban wood waste being displaced from the bioenergy market and without other viable markets, this wood waste would most likely be landfilled and would weigh 3.3 million tons with 23% moisture content, as described below. CalRecycle has estimated that 80 million tons will be generated in 2020, should this urban wood waste stay in the landfill, the recycling rate could drop 4%. California is not on track to reach the 75% recycling rate in 2020, and has been slipping backwards. The increased disposal of urban wood waste will further impact the recycling rate and AB 341 will not be achieved.

The forecasted diminishment of the biomass market will have two distinct and profound negative effects on California's diversion rate. The first impact, the foregone diversion from AB 1826, is the 1,720,304 new tons of wood waste that would be diverted in 2020 had the biomass market retained the capacity for these tons. The second impact, is the 1,580,519 tons of urban wood waste that will be crowded out of the market from existing levels of diversion by 2020. In other words, instead of diverting 1,720,304 tons more than current levels in 2020, California will be diverting 1,580,519 tons *less* than current levels in 2020.

Altogether, 3,300,823 tons of urban woody material will be landfilled in 2020 that would otherwise be diverted. Given the Department of Finance's forecasts of population growth and current disposal rates, California's annual disposal will be approximately 27,146,978 tons by 2020. Successful implementation of wood waste diversion under AB 1826 would reduce this disposal amount to 25,426,674 tons. However, given the reduction in biomass infrastructure described in this report, this amount is expected to instead *grow* to 28,727,497 tons. This increase in landfill disposal will be a significant hurdle in accomplishing AB 341's goals of 75% diversion by 2020.

Table 4: Impacts on Statewide Disposal

Scenario	Statewide Disposal (tons)
AB 1826 – Wood Waste Diverted	25,426,674
At Current Diversion Rate	27,146,978
Projected with Biomass Industry Reduction	28,727,497

Conclusion

The rapid decline of California's capacity to manage wood waste, namely biomass to energy, will lead to an unwieldy surplus of wood without viable markets. The CPUC Resolution E-4770 forces facilities with new BioRam PPA's who do not receive the minimum annual requirements for HHZ fuel to accept $0.09 /kWh for the balance of the PPA term serves as a de facto reduction of the urban and agricultural sector's access to this dwindling market, further exacerbating the capacity shortfall for these materials. This, in the absence of other high capacity economically viable alternative markets, leaves these materials without proper market channels.

Without access to resource recovery opportunities, the environmental benefits of this wood material is likely to be forfeited. Agricultural and urban wood wastes that have been crowded out of the energy market are susceptible to non-optimal disposal strategies such as open burning and landfilling.

The solid waste industry will likely need to demand tipping fee increases to continue to recycle urban wood waste. Given the market price received by the solid waste industry has dropped $25 to $35 per BDT, these companies will need to raise rates to their customer base in order to sustain their high recycling rates for C&D debris. In the absence of these raised rates, the companies may be unable to leverage a position into the remaining biomass energy capacity. Higher tipping fees will discourage source separation of woody materials, resulting in lower diversion from C&D facilities and increased landfill disposal.

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ATTACHMENT A

California Forestry Association Calculation of BDT

California Forestry Association Calculation of HHZ Waste for Processing

Amount	Assumption
50,128,000 Bone Dry Tons of Wood Waste	Estimated Volume of Forest Mortality
37,596,000 Bone Dry Tons	75% of Mortality is Economically Recoverable
12,532,000 Bone Dry Tons/Year	Recovery of Material over Three Years
1,879,800 HHZ Bone Dry Tons/Year	15% of Material From High Hazard Zone
235 MW Capacity Required to Process HHZ	8,000 BDT/MW

Enclosure #5 – Estimated Mortality on National Forests Projected to October 2016

Estimated Mortality on National Forests projected to October 2016 (by Steve Brink (CFA)
13-Feb-16

Mortality Calculations - **National Forest**	Standing Volume on Avail. Productive Forest Land (Billion Board Feet)	Projected to 10/2016, Estimated Standing Volume Dead Percent	Volume (billion board feet)	
Sierra	14.6	16%	2.336	
Sequoia	9.9	16%	1.584	
Stanislaus	10.9	12%	1.31	
Eldorado	10.5	10%	1.05	
Tahoe	14.4	8%	1.152	
Plumas	25.8	5%	1.29	
Lassen	10.5	5%	0.525	
Modoc	5.2	5%	0.26	
Shasta-Trinity	26.7	5%	1.335	
Klamath	20.5	4%	0.82	
Six Rivers	22.8	3%	0.684	
Mendocino	6.2	3%	0.186	
		Total Dead	12.532	
Total (Bone Dry Tons)				50,128,000

% of Standing Volume Dead is an Assumption of What Will Be Dead October 2016
Assuming 3 years to remove 75% of the Dead Material = 12,532,000 BDT/year which is **1,567 MW**
Assuming a need of $48/BDT on average to cut, skid, pile, chip and haul - $24 paid at delivery to the **plant means a total need of $600 million over 3 years.**
No estimate of mortality on private land was done because there's no known data.
15% in High Hazard Zones = 1.8798 million BDT/year for 3 years = 235 MW
Buena Vista by court settlement can only take 15% forest wood waste
Currently 13 Closed/Idle Powerplants since 2007 total 238 MW -- (excluding Bieber and Brawley)
None of the currently operating powerplants are taking any of the mortality
563 MW operating capacity today + 235 MW (to absorb the mortality from High Hazard Zones) = 798 MW
235 MW (HHZ Mortality) / 798 total MW = 29% should be required to come from mortality; not 80%

ATTACHMENT B

Calculation of AB 1826 Wood Waste Tons Entering Market

AB 1826 New Urban Wood Tons by 2020

2014 Disposal	43% Organic	AB 1826 50% Target
30,864,279	13,322,296	6,661,148

2020 Disposal	43% Organic	New Tons to Reach Target
32,309,413	13,946,075	7,284,927

Sources: Population growth: Department of Finance, Tons disposed and % of wood waste: 2014 & 2008 Waste Characterizations.

Commercial Wood	6% of New Diverted Organics	471,877 Tons
Residential Wood	7% of New Diverted Organics	492,908 Tons
Self-Haul Wood	10% of New Diverted Organics	755,518 Tons
	TOTAL:	**1,720,304 Tons**

For the purposes of estimating quantities of new wood waste that will require processing as a result of this legislation, data from the California Department of Resources Recycling and Recovery (CalRecycle) are used. These data, namely the Waste Characterization Studies and Disposal Reporting Service, are available from CalRecycle's homepage.

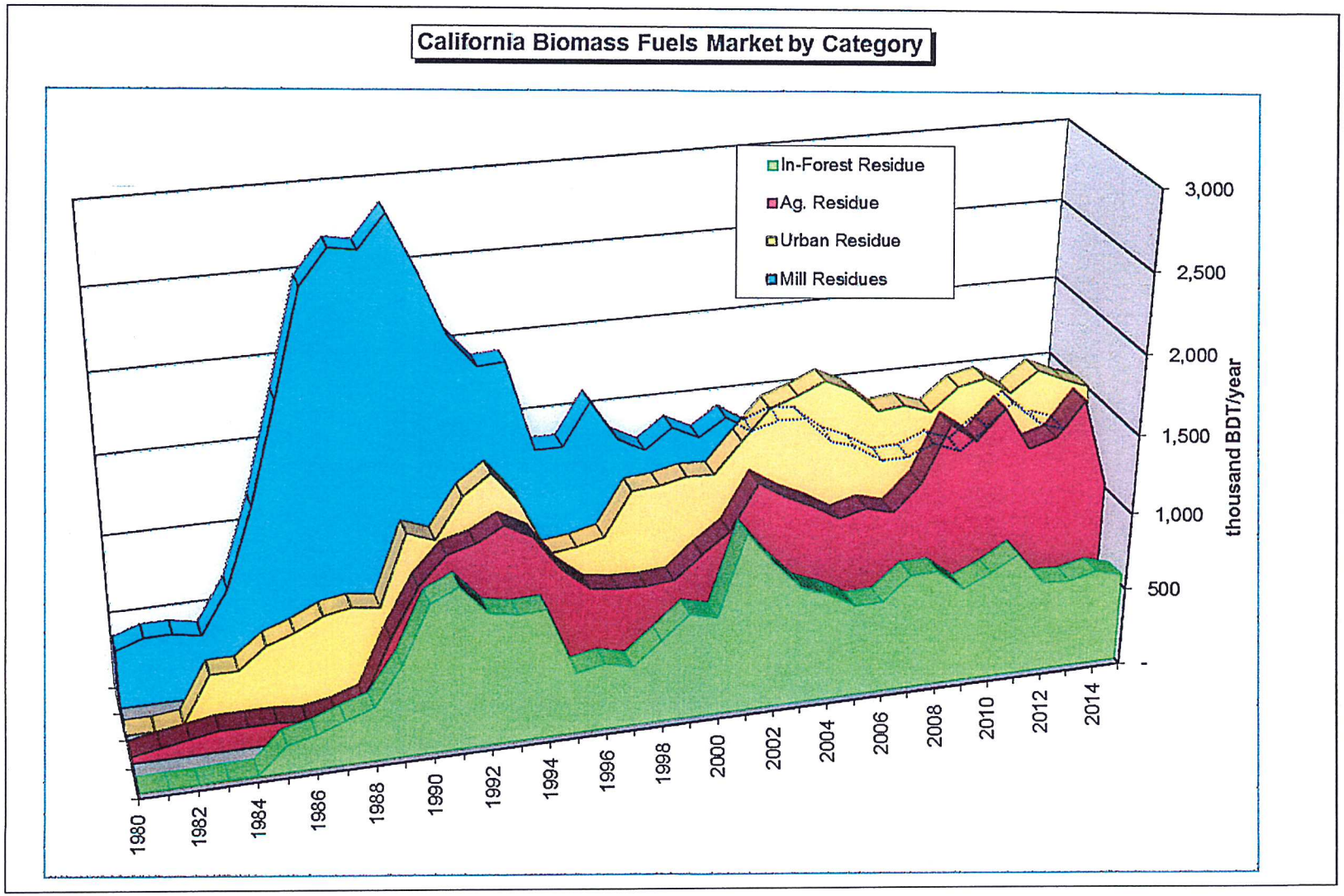
CalRecycle's 2014 Waste Characterization Study sampled generators, waste processors, and disposal sites to estimate the types and quantities of waste generated throughout the state. The study identified waste streams with respect to sector (i.e. residential, commercial, self-haul) as well as with respect to final use (landfill, compost, recycling, etc.). As this study is the most detailed and up-to-date report of its kind, it is used as the basis for calculating the targets of Statewide waste diversion goals such as AB 1826, SLCP and AB 341.

Likewise, this study is invaluable when projecting the amount of urban wood waste expected to enter California's markets as diversion goals are implemented. This study establishes that percentages of material sent to landfills that are classified as "lumber" by sector. Statewide population growth from 2014 to 2020 is expected to be 4.4% *[DOF]*.

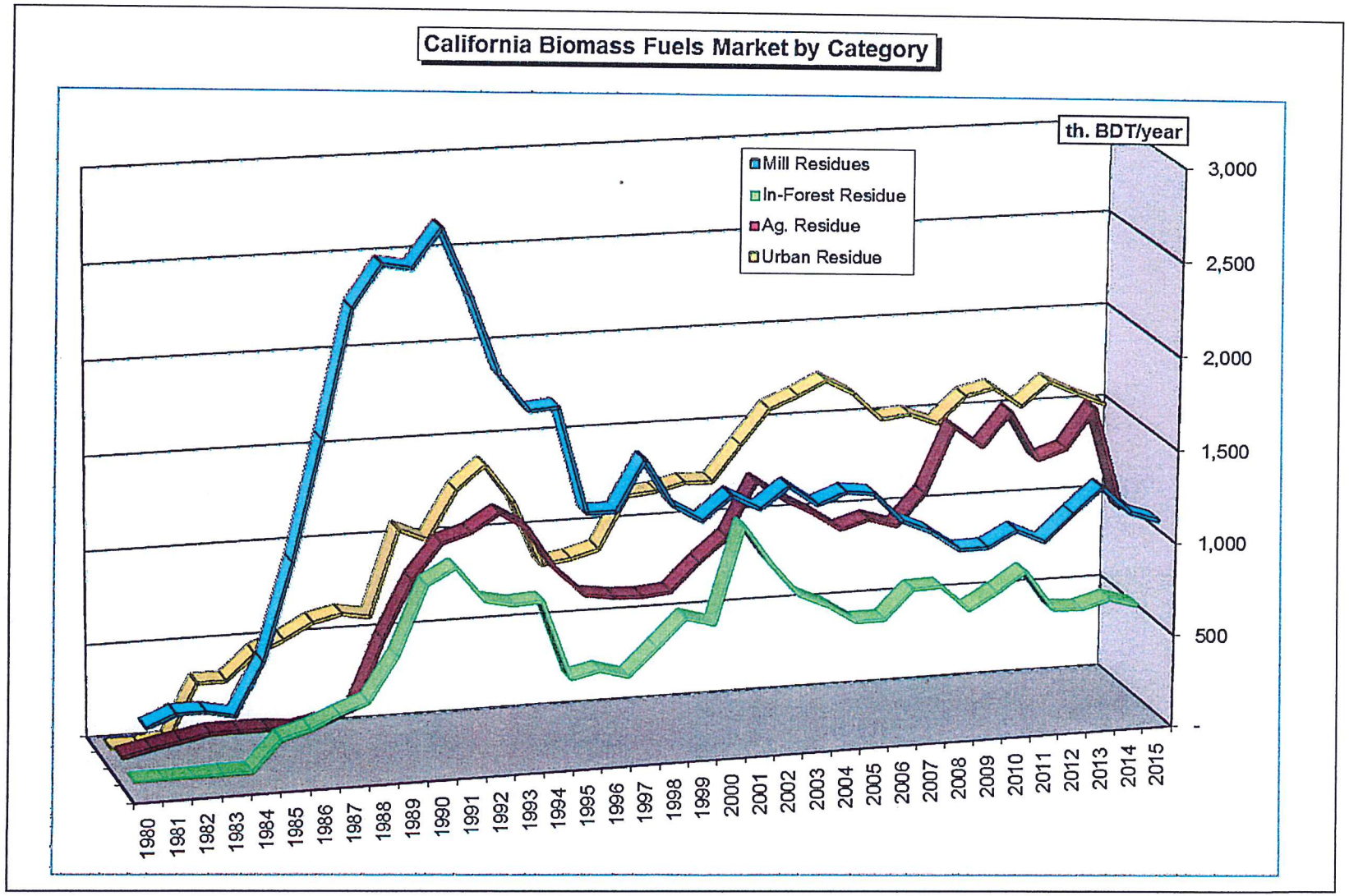
ATTACHMENT C

California Biomass Fuels Market by Category

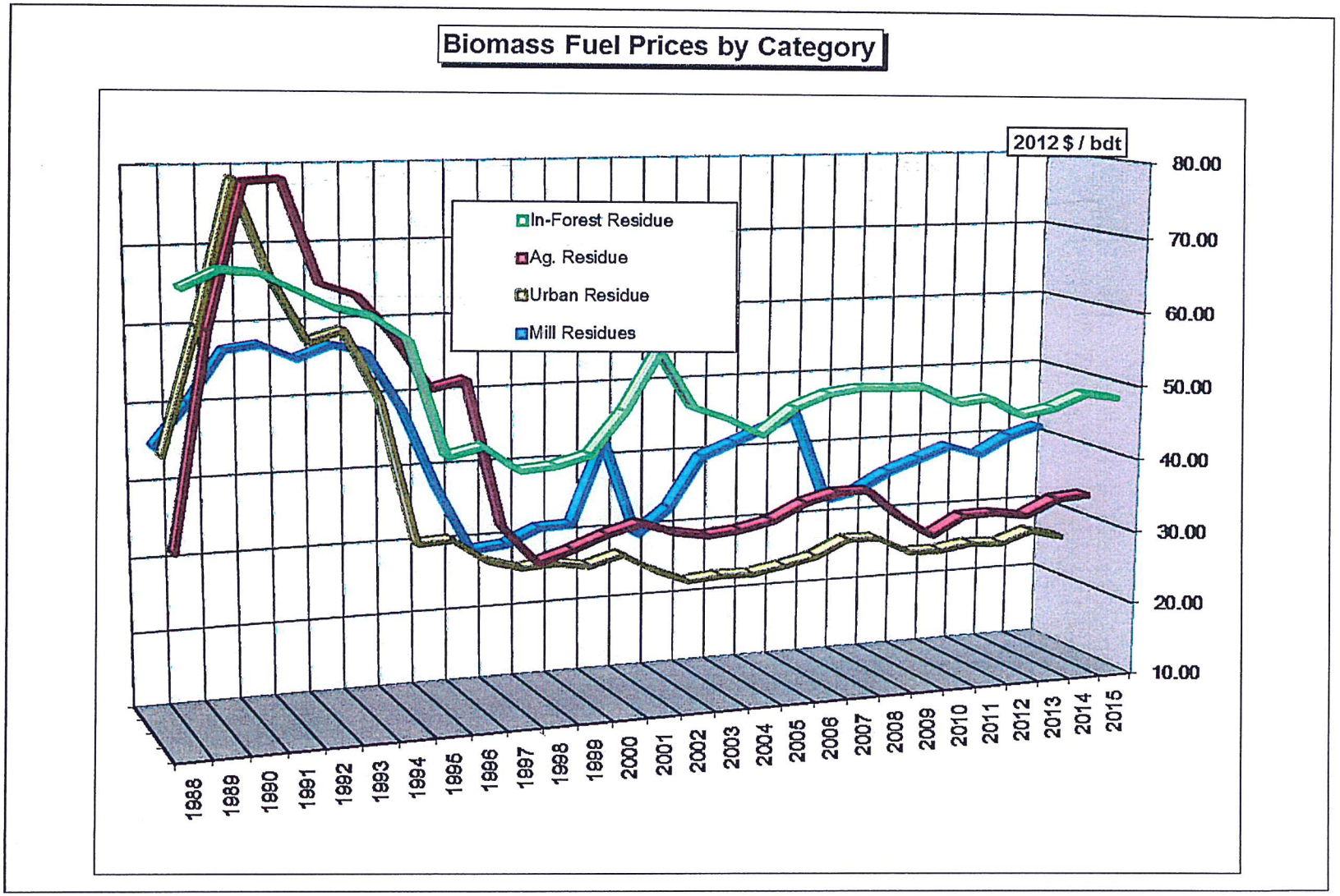
Old


California Biomass Fuels Market by Category
In-Forest Residue
Ag. Residue
Urban Residue
Mill Residues
3,000
2,500
2,000
1,500
1,000
500
-
thousand BDT/year
1980
1982
1984
1986
1988
1990
1992
1994
1996
1998
2000
2002
2004
2006
2008
2010
2012
2014

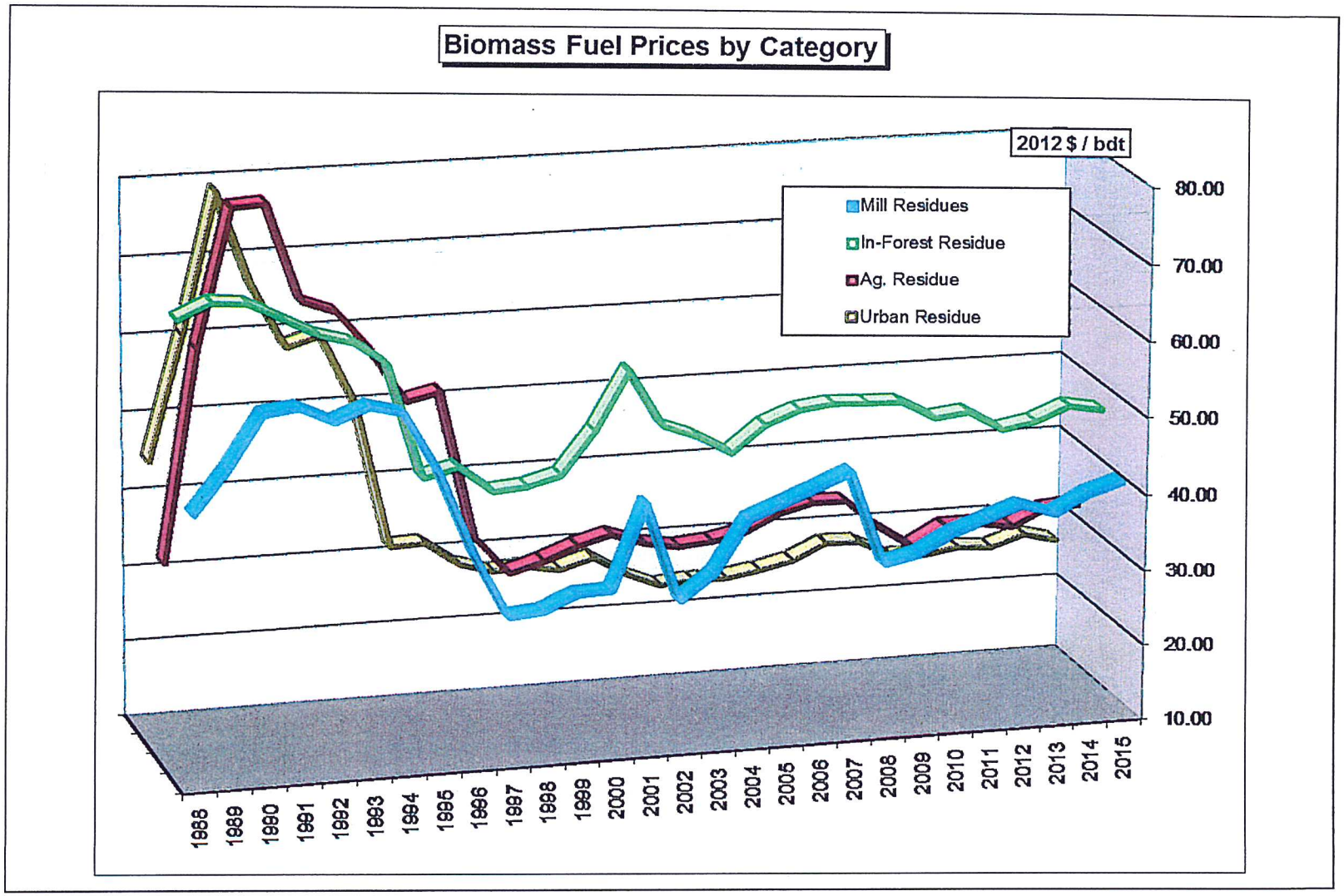
New


California Biomass Fuels Market by Category
th. BDT/year
Mill Residues
In-Forest Residue
Ag. Residue
Urban Residue
3,000
2,500
2,000
1,500
1,000
500
-
1980
1981
1982
1983
1984
1985
1986
1987
1988
1989
1990
1991
1992
1993
1994
1995
1996
1997
1998
1999
2000
2001
2002
2003
2004
2005
2006
2007
2008
2009
2010
2011
2012
2013
2014
2015

Old

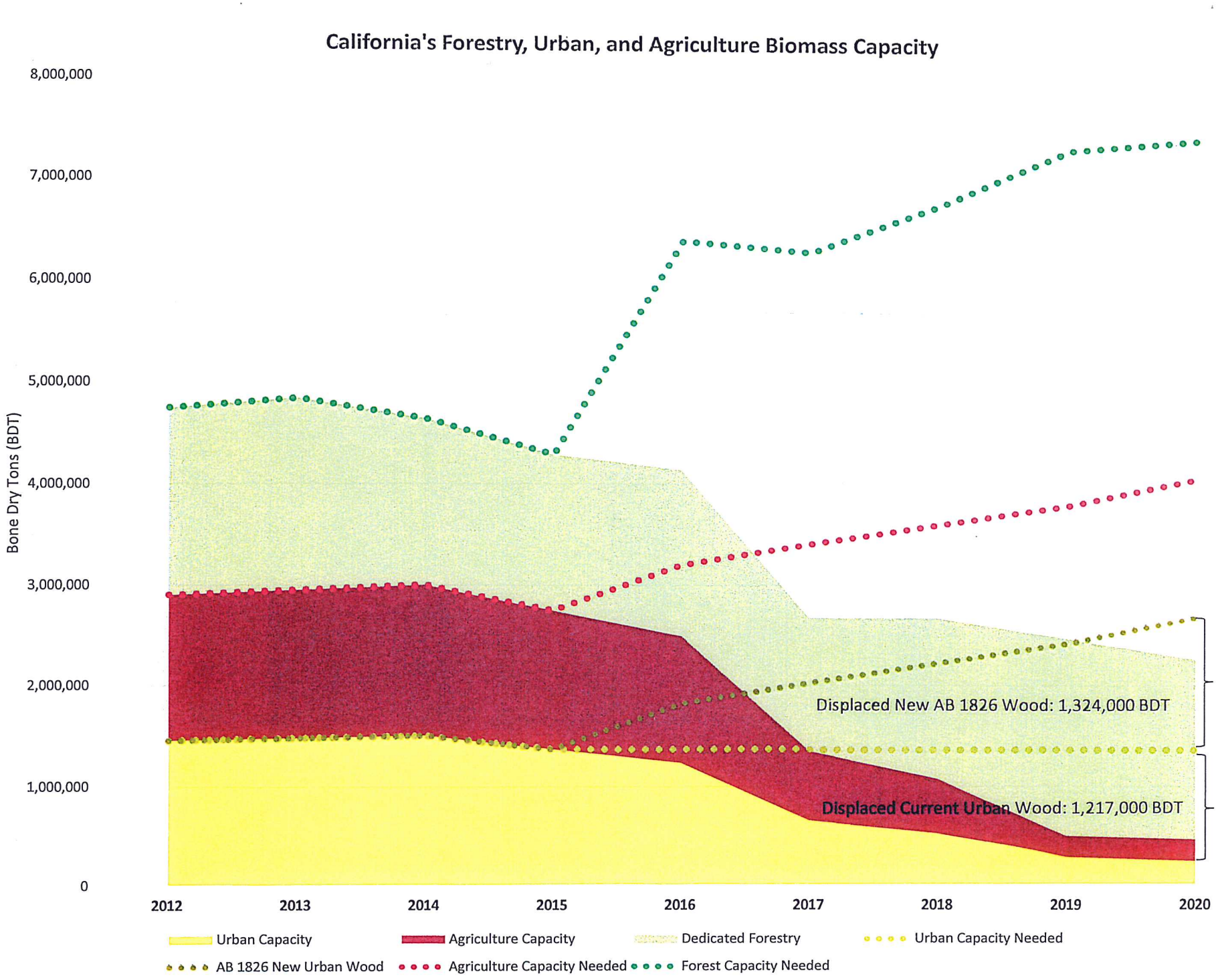

Biomass Fuel Prices by Category
2012 $ / bdt
80.00
70.00
60.00
50.00
40.00
30.00
20.00
10.00
In-Forest Residue
Ag. Residue
Urban Residue
Mill Residues
1988
1989
1990
1991
1992
1993
1994
1995
1996
1997
1998
1999
2000
2001
2002
2003
2004
2005
2006
2007
2008
2009
2010
2011
2012
2013
2014
2015

New


Biomass Fuel Prices by Category
2012 $ / bdt
Mill Residues
In-Forest Residue
Ag. Residue
Urban Residue
80.00
70.00
60.00
50.00
40.00
30.00
20.00
10.00
1988
1989
1990
1991
1992
1993
1994
1995
1996
1997
1998
1999
2000
2001
2002
2003
2004
2005
2006
2007
2008
2009
2010
2011
2012
2013
2014
2015

ATTACHMENT D

California's Forestry, Urban, and Agriculture Biomass Capacity


California's Forestry, Urban, and Agriculture Biomass Capacity
8,000,000
7,000,000
6,000,000
5,000,000
4,000,000
3,000,000
2,000,000
1,000,000
0
Bone Dry Tons (BDT)
2012
2013
2014
2015
2016
2017
2018
2019
2020
Displaced New AB 1826 Wood: 1,324,000 BDT
Displaced Current Urban Wood: 1,217,000 BDT
Urban Capacity
Agriculture Capacity
Dedicated Forestry
Urban Capacity Needed
AB 1826 New Urban Wood
Agriculture Capacity Needed
Forest Capacity Needed