Construction & Demolition (C&D) wood waste incineration chapter
Excerpt from upcoming Energy Justice Network report on biomass incineration [DRAFT]

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Wood waste – or "urban wood" – is a broad category that is used to describe wood from land clearing, Christmas trees, tree and shrub trimmings, wood pallets, paper and lumber mill waste, wood products industry wastes, and most dangerously, construction and demolition debris (known as "C&D" waste), which sometimes now also includes disaster debris.

Old painted wood can contain lead and mercury. While lead in paint was phased out in 1978 and mercury in 1991, this toxic painted wood can still end up in wood waste stream from demolition and remodeling of older homes.[1,2] One biomass incinerator that threatened to reopen to burn C&D wood in Hopkinton, New Hampshire was permitted in 2003 to release an astounding 2.6 tons of lead per year and up to 31 pounds of mercury (nearly four times the mercury released when the plant burned "clean wood chips").[3,4]

Utility poles and railroad ties can be treated with chlorine-containing pentachlorophenol, which is used as a fungicide and wood preservative. This highly toxic chemical comes heavily contaminated with dioxins[5] and is banned in at least 26 countries. In the U.S., it was one of the most widely-used biocides, but has been banned for most uses since 1987. It is still permitted for use in wood treatment and limited pesticide uses. 80% is used to treat utility poles.[6,7,8,9] A study of construction and demolition wood waste supply from New England Recycling found pentachlorophenol at "higher than expected concentrations" and detected dioxins and furans in the treated wood.[10]

Wood pallets can also be contaminated with bromine-containing wood treatment chemicals, such as highly toxic ozone-depleting fumigant, methyl bromide, the noxious flame retardant, tribromophenol and the fungicide 2,4,6-Tribromoanisole, which is now used in place of pentachlorophenol.[11,12]

Nails and staples in wood manufacturing waste, pallets, utility poles and construction, demolition and disaster debris can also be sources of iron and zinc, which boost dioxin emissions when burned.

Wood waste from wood product manufacturing plants can come contaminated with wood preservatives, binders, paints, stains, varnishes, dyes, lacquers, glues, fillers, strength additives, chlorine bleach, chlorinated plastic laminating materials, chlorinated adhesives, phenol and urea formaldehyde resins, or other non-wood materials, many of which can contribute to emissions of dioxins or other organic hazardous air pollutants. A 1995 study of plywood and particleboard combustion found that when oxygen levels are lower than optimal in the burner, "high concentrations of benzene, PAH's and formaldehyde were observed, with major abundances of

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[1] "CPSC Announces Final Ban On Lead-Containing Paint," Consumer Product Safety Commission press release, September 2, 1977. http://www.cpsc.gov/cpscpub/prerel/prhtml77/77096.html

[2] U.S. Environmental Protection Agency, "Mercury: Consumer and Commercial Products," http://www.epa.gov/hg/consumer.htm#pai "In the past mercury was used in many water-based latex paints as a fungicide to prevent the growth of bacteria. Its use in interior and exterior latex paint was discontinued in the United States in 1991."

[3] Modification of Title V Operating Permit issued to Bio Energy LLC by New Hampshire Department of Environmental Services, July 25, 2003. http://www2.des.state.nh.us/OneStopPub/Air/3301300101FY03-0132TypePermit.pdf

[4] Stephanie Ebbert, "N.H. plant's plan to burn debris fuels town fears," Boston Globe, September 20, 2004. http://www.boston.com/news/local/articles/2004/09/20/nh_plants_plan_to_burn_debris_fuels_town_fears/

[5] 53 Federal Register 53284 (December 30, 1988).

[6] Eddie Scher, "Is Your Power Company Trying to Kill You? – That tar-like secretion oozing out of utility polls is an incredibly toxic substance," AlterNet, August 13, 2010. http://www.alternet.org/story/147839/is_your_power_company_trying_to_kill_you

[7] "Basic Information about Pentachlorophenol in Drinking Water," U.S. EPA, May 2012. http://water.epa.gov/drink/contaminants/basicinformation/pentachlorophenol.cfm

[8] "Pentachlorophenol," Washington Toxics Coalition Factsheet, February 2004. http://watoxics.org/files/penta

[9] "Pentachlorophenol: Dossier prepared in support of a proposal of pentachlorophenol to be considered as a candidate for inclusion in the Annex I to the Protocol to the 1979 Convention on Long-Range Transboundary Air Pollution on Persistent Organic Pollutants (LRTAP Protocol on POPs)," Institute of Environmental Protection, May 2008, p.46. http://www.unece.org/fileadmin/DAM/env/lrtap/TaskForce/popsxg/2008/Pentachlorophenol_RA%20dossier_proposal%20for%20submission%20to%20UNECE%20POP%20protocol.pdf

[10] Massachusetts Environmental Energy Alliance, "Comments on the draft Beneficial Use Determination (BUD) issued to Palmer Renewable Energy (PRE) for its fuel supply," November 16, 2009, p.18. http://www.pfpi.net/wp-content/uploads/2011/03/MEEA-commnents-on-Palmer-BUD-11-18-09.pdf

[11] "The Truth about Pallets," http://www.woodsmokehealth.org/09/the-truth-about-pallets/

[12] "2,4,6-Tribromoanisole," Wikipedia. http://en.wikipedia.org/wiki/2,4,6-Tribromoanisole

benzene, naphthalene, acenapthylene and anthracene." Benzene and toluene emissions "increase rapidly," along with higher carbon monoxide emissions when burning at temperatures below 1,200^{o} F.[13]

Creosote is another wood treatment chemical, used primarily for railroad ties, but also in utility poles, bridge ties and marine pilings.[14,15] Like the other wood treatment chemicals, creosote itself is toxic, containing cancer-causing polycyclic aromatic hydrocarbons (PAHs), phenol, and cresols.[16,17,18] These chemicals can be destroyed when burned, but some may survive the combustion process and be re-emitted, or may recombine into other toxic organic compounds. In Europe, creosote has been banned for residential use in 2003 and is being banned for most industrial uses effective May 2013, but is still legal for use in the U.S.[19]

In construction and demolition wastes, as well as in disaster debris, there is likelihood of polyvinylchloride (PVC, or "vinyl" plastic) contamination from many sources common in building materials.[20] The chlorine in the plastic contributes heavily to dioxin formation.[21,22]

Studies of construction and demolition (C&D) waste in Florida in 2001 found that the percentage of wood in each of 14 C&D waste piles ranged from 5 to 73%, averaging 13%.[23,24] As you might expect, there was more non-wood material in the demolition waste (which was only 10% wood, on average) than in the construction waste (16% wood). Even so, there are large portions of non-wood material in both wood waste streams, with many toxic materials present. A study done for EPA on construction and demolition waste lists over 100 materials that can be present in this waste, including hazards such as asbestos, asphalt shingles, mercury-containing fluorescent lighting and electrical switches, PVC plastics, and sulfur-containing gypsum.[25]

The most dangerous wood treatment chemical in an incinerator is chromated copper arsenate (CCA). This chemical is used in pressure-treated wood for decks, playgrounds, fence posts, park benches and many other residential, commercial and industrial purposes. It is sometimes obvious from the greenish tinge on the wood, which is from the copper in CCA.

Introduced in the U.S. in 1938, CCA's use grew dramatically in the 1970s, to the point where around 80% of all wood treatment between 1984 and 1995 was with CCA or similar waterborne preservatives, and by 2004, chromated arsenicals were used to treat 99% of all treated lumber, timber and plywood, and 44% of all treated poles.[26,27,28,29,30,31]

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13 Jeffrey M. Hoerning, et. al., "Organic Emissions From Combustion of Plywood And Particleboard," Argonne National Laboratory Symposium on Direct Coal Liquefaction, Chicago, 1995. http://web.anl.gov/PCS/acsfuel/preprint%20archive/Files/40_3_CHICAGO_08-95_0676.pdf

14 "Emission Factor Documentation for AP-42, Section 10.8, Wood Preserving - Final Report," Table 2-3: "Production of Treated Wood in the United States, 1995," U.S. Environmental Protection Agency, p.2-12, August 1999. http://www.epa.gov/ttnchie1/ap42/ch10/bgdocs/b10s08.pdf

15 Creosote Council. http://www.creosotecouncil.org

16 "Petition For Suspension and Cancellation of Creosote," Beyond Pesticides, February 2002. http://www.beyondpesticides.org/wood/creosote_petition.htm

17 "Creosote and its Use as a Wood Preservative," U.S. EPA, November 2008. http://www.epa.gov/opp00001/factsheets/chemicals/creosote_main.htm

18 53 Federal Register 53284 (December 30, 1988). "Wastes from the preservation of wood with creosote contain high concentrations of polynuclear hydrocarbons (PAHs)."

19 "Environment: Tighter restrictions on industrial creosote use," European Commission press release, July 26, 2011. http://europa.eu/rapid/pressReleasesAction.do?reference=IP/11/925

20 Polyvinylchloride, EJNet.org. http://www.ejnet.org/plastics/pvc/

21 Pat Costner, "Chlorine, Combustion and Dioxins: Does Reducing Chlorine in Wastes Decrease Dioxin Formation in Waste Incinerators?," Greenpeace 2001. http://archive.greenpeace.org/toxics/reports/chlorineindioxinout.pdf

22 Michael Belliveau and Stephen Lester, "PVC Bad News Comes in 3s: The Poison Plastic, Health Hazards and the Looming Waste Crisis," The Center for Health, Environment and Justice & The Environmental Health Strategy Center, 2004. http://chej.org/wp-content/uploads/Documents/PVC/bad_news_comes_in_threes.pdf

23 Helena Solo-Gabriele, et. al., "On-Line Sorting Technologies for CCA-Treated Wood," September 30, 2001, p. 31-41. http://www.ccaresearch.org/final_sara_draft_m7_web.pdf

24 Monika Blassino, Helena Solo-Gabriele & Timothy Townsend, "Pilot scale evaluation of sorting technologies for CCA treated wood waste," Waste Manage Res 2002: 20: 290–301, 295. http://wmr.sagepub.com/content/20/3/290.abstract

25 ICF Incorporated, "Construction and Demolition Waste Landfills," prepared for U.S. Environmental Protection Agency, February 1995, p. 2-2 to 2-3. http://www.epa.gov/osw/hazard/generation/sqg/const/cdrpt.pdf

26 "Timeline of Efforts to Ban CCA and Arsenic in Treated Wood Products – The Rise and Fall of CCA Treated Wood Products," BANCCA.org. http://www.bancca.org/CCA_Timeline/CCA_Eventschart.html

27 "Fact Sheet: Chromated Copper Arsenate (CCA) – Treated Wood Used in Playground Equipment," U.S. Consumer Product Safety Commission. http://www.cpsc.gov/phth/ccafact.html

28 Jenna Jambeck, Keith Weitz, Helena Solo-Gabriele, Timothy Townsend, Susan Thorneloe, "CCA-Treated wood disposed in landfills and life-cycle trade-offs with waste-to-energy and MSW landfill disposal," Waste Management, Vol. 27: S21-S28 (2007). http://www.sciencedirect.com/science/article/pii/S0956053X07000773

29 "Arsenic and Chromium Treated Wood," Washington Department of Ecology. http://www.ecy.wa.gov/programs/hwtr/dangermat/wood_arsenic_chromium_treated.html

30 "Emission Factor Documentation for AP-42, Section 10.8, Wood Preserving - Final Report," Table 2-3: "Production of Treated Wood in the United States, 1995," U.S. Environmental Protection Agency, p.2-12, August 1999. http://www.epa.gov/ttnchie1/ap42/ch10/bgdocs/b10s08.pdf

31 "Reregistration eligibility decision for chromated arsenicals. List A, Case No. 0132. EPA 739-R-08-006," U.S. Environmental Protection Agency, September 2008, p.13. http://epa.gov/oppsrrd1/REDs/cca_red.pdf

The southeastern U.S. suffers disproportionately from the toxic legacy of wood treatment chemical production, use and disposal. In 1995, 52% of the nation's 451 wood treatment plants were located in the southern coastal states from Virginia through Texas.[32] Because of its warm, wet climate, Florida alone is home to 15% of the CCA-treated wood used in the U.S.[33] These southern states have also been hit the hardest with proposals for new biomass incinerators in recent years. To the extent that southern U.S. biomass incinerators would be burning waste wood, they'd be receiving a greater share of treated wood in their waste stream. All told, these impacts are disproportionately harming low-income communities and communities of color.

CCA-treated wood leaches toxic arsenic and chromium to the degree that it qualifies as hazardous waste under the federal Toxicity Characteristic Leaching Procedure.[34,35,36,37] However, unlike the European Union, U.S. EPA specifically exempts arsenic-based wood and wood products from hazardous waste regulation, allowing this toxic wood to be disposed of as regular solid waste.[38,39]

Arsenic is highly toxic and is considered a known human carcinogen by U.S. EPA and the International Agency for Research on Cancer (IARC).[40,41] Arsenic leaches from CCA-treated wood both in its use and when disposed of in landfills.[42,43,44] Arsenic is a serious air pollution concern when this wood is burned, as the arsenic can escape particulate control devices by riding on tiny submicron particles.[45,46] In 1988, EPA reported that arsenic used in wood treatment was typically contaminated with lead.[47]

Chromium comes in two forms: a trivalent form (chromium III) – an essential nutrient toxic at high doses – and the highly toxic hexavalent form (chromium VI), which is well known to cause cancer when inhaled.[48,49] Chromium in CCA wood treatment chemicals starts off in the toxic chromium VI form, but becomes "fixed" in the wood as chromium III.[50] However, when the chromium-contaminated wood is burned, much of the chromium is converted back to the highly toxic form, where some is released as air pollution and the rest concentrates in the ash and, in this hexavalent form, leaches out of the ash more readily, becoming quite dangerous for groundwater wherever the ash is dumped.[51,52] These hazards have caused researchers to infer that the biggest concern with chromium in discarded CCA-treated wood is combustion.[53]

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[32] "Emission Factor Documentation for AP-42, Section 10.8, Wood Preserving - Final Report," Table 2-2: "Wood Preserving Plants by State," U.S. Environmental Protection Agency, p.2-11, August 1999. http://www.epa.gov/ttnchie1/ap42/ch10/bgdocs/b10s08.pdf

[33] "Arsenic-treated wood may have a long toxic legacy," Science News, December 21, 2005. http://lists.iatp.org/listarchive/archive.cfm?id=116738

[34] Townsend, T., Tolaymat, T., Solo-Gabriele, H., Dubey, B., Stook, K., Wadanambi, L., "Leaching of CCA treated wood: implications for waste disposal," Journal of Hazardous Materials 114, 75–91 (2004). http://www.sciencedirect.com/science/article/pii/S0304389404003656

[35] Solo-Gabriele, H., Townsend, T., Messick, B., Calitu, V., "Characteristics of chromated copper arsenate-treated wood ash," Journal of Hazardous Materials 89, 213–232 (2002). http://www.ccaresearch.org/CCA_Ash_Paper.pdf

[36] Jenna Jambeck, Keith Weitz, Helena Solo-Gabriele, Timothy Townsend, Susan Thorneloe, "CCA-Treated wood disposed in landfills and life-cycle trade-offs with waste-to-energy and MSW landfill disposal," Waste Management, Vol. 27: S21-S28 (2007). http://www.sciencedirect.com/science/article/pii/S0956053X07000773

[37] Bill Hinkley, Satish Kastury and Richard Tedder, "Florida CCA Regulatory Issues," slides 9-20. http://www.ccaresearch.org/tag13/Regulatory_Issues_m2.ppt

[38] "Arsenic-treated wood may have a long toxic legacy," Science News, December 21, 2005. http://lists.iatp.org/listarchive/archive.cfm?id=116738

[39] 40 CFR 261.4 (b)(9), Code of Federal Regulations, 2012. http://ecfr.gpoaccess.gov/cgi/t/text/text-idx?rgn=div5&view=text&node=40:27.0.1.1.2&idno=40#40:27.0.1.1.2.1.1.4 The regulations exempt "[s]olid waste which consists of discarded arsenical-treated wood or wood products which fails the test for the Toxicity Characteristic for Hazardous Waste Codes D004 through D017 and which is not a hazardous waste for any other reason if the waste is generated by persons who utilize the arsenical-treated wood and wood products for these materials' intended end use."

[40] "Arsenic Compounds, Hazard Summary-Created in April 1992; Revised in January 2000," U.S. Environmental Protection Agency, 2000. http://www.epa.gov/ttn/atw/hlthef/arsenic.html

[41] "IARC Monographs on the Evaluation of Carcinogenic Risks to Humans: Arsenic and Arsenic Compounds," International Agency for Research on Cancer, Volume 100C (2012). http://monographs.iarc.fr/ENG/Monographs/vol100C/mono100C-6.pdf

[42] Bernine I. Khan, Helena M. Solo-Gabriele, Timothy G. Townsend, and Yong Cai, "Release of Arsenic to the Environment from CCA-Treated Wood. 1. Leaching and Speciation during Service," Environmental Science & Technology, 2006, 40 (3), pp. 988–993. http://pubs.acs.org/doi/abs/10.1021/es0514702

[43] Bernine I. Khan , Jenna Jambeck , Helena M. Solo-Gabriele , Timothy G. Townsend , and Yong Cai, "Release of Arsenic to the Environment from CCA-Treated Wood. 2. Leaching and Speciation during Disposal," Environmental Science & Technology, 2006, 40 (3), pp 994–999. http://pubs.acs.org/doi/abs/10.1021/es051471u

[44] "Arsenic-treated wood may have a long toxic legacy," Science News, December 21, 2005. http://lists.iatp.org/listarchive/archive.cfm?id=116738

[45] Lisbeth M. Ottosen, Anne Juul Pedersen, Iben V. Christensen, "Characterization of Residues from Thermal Treatment Of CCA Impregnated Wood Chemical and Electrochemical Extraction," Environmental Impacts of Preservative-Treated Wood Conference, Febuary 2004, p.2. http://www.ccaresearch.org/ccaconference/pre/pdf/Ottosen.pdf

[46] Zeng, T., Sarofim, A.F., Senior, C.L., "Vaporization of Arsenic, Selenium and Antimony during Coal Combustion," Combustion and Flame, (2001), 126, 1714-1724.

[47] December 30, 1988 Federal Register Vol. 53 No. 251, p. 53284.

[48] "Chromium Compounds, Hazard Summary-Created in April 1992; Revised in January 2000," U.S. Environmental Protection Agency, 2000. http://www.epa.gov/ttn/atw/hlthef/chromium.html

[49] "IARC Monographs on the Evaluation of Carcinogenic Risks to Humans: Chromium (VI) Compounds," International Agency for Research on Cancer, Volume 100C (2012). http://monographs.iarc.fr/ENG/Monographs/vol100C/mono100C-9.pdf

[50] Jinkun Song, Brajesh Dubey, Yong-Chul Jang, Timothy Townsend, Helena Solo-Gabriele, "Implication of chromium speciation on disposal of discarded CCA-treated wood,"Journal of Hazardous Materials B128 (2006): 280-288. http://www.sciencedirect.com/science/article/pii/S0304389405004590

[51] *Id.*

[52] "2005 National Emissions Inventory Data & Documentation: Inventory Documentation: Point: Chromium Speciation," U.S. Environmental Protection Agency, January 12, 2009. http://www.epa.gov/ttn/chief/net/2005inventory.html EPA assumes that 56% of the chromium released from biomass incineration is in the hexavalent form.

[53] Song, et. al. (2006) at 286.

Copper – the third metal ingredient in CCA – is the most potent catalyst for dioxin formation in an incinerator. A little bit of copper added to the burner will dramatically increase dioxin emissions.[54]

Metals (like copper, chromium, arsenic and lead) cannot be destroyed when burned, and will concentrate in the ash.[55,56] Burning treated wood waste and landfilling the ash threatens groundwater with more toxic chromium than directly landfilling the same waste without burning it first. Because burning chromium converts it to the more toxic and more mobile chromium VI form, more chromium leaches out of ash than would leach out of unburned CCA-treated wood in the same landfill.[57] Furthermore, many incinerators inject lime as part of their pollution control process. Those that do cause even more chromium to leach out of their ash because of the alkaline pH.[58]

Ash from burning construction and demolition waste frequently fails leaching tests and must be treated as a hazardous waste, increasing cost – even when CCA-treated wood makes up as little as 5% of the wood waste.[59,60,61] Higher rates are typical. Two 2001 studies of construction and demolition waste in Florida found that the percentage of CCA-treated wood in each of 14 wood waste piles ranged from 4%-65% by weight, with an average of 22%.[62,63]

While certain uses of CCA were phased out in 2004, the amount hitting the waste stream is peaking in 2008-2012 and will remain high for years to come, since it can take 10 to 40 years before CCA-treated wood is discarded.[64] Based on data on Southern Pine, it is estimated that as much as 40 to 50% of all wood sold in the U.S. between 1985 and 1995 was treated with CCA.[65] Most treated wood, such as lumber and fence posts, lasts an average of 25 years, while utility poles and railroad ties last an average of 40 years before hitting the waste stream.[66]

Biomass facilities sometimes claim to burn "clean" wood that they'd pull out of C&D sources. This is next to impossible due to the prevalence of painted and treated wood, and the expense and difficulty of separating the contaminated wood from the rest. A biomass burner's wood stream must have no more than 2% treated wood for the ash to pass leaching tests as non-hazardous.[67] However, a study of three C&D facilities where workers had manually separated out the CCA-treated wood, there were still contamination rates of 9%, 10% and 30% in the sorted piles that were then considered to be untreated. The piles with contamination rates of 9-10% had been sorted by employees who had a "considerable amount" of training on sorting CCA-treated wood from other wood types. At the facility with a sorted pile with a contamination rate of 30%, the workers were encouraged to separate the wood, but did not have extensive training.[68] Even a 1-2% rate of CCA-contaminated wood can result in significant toxic emissions when burned.

Biomass facilities usually rely on these inefficient visual inspection and hand sorting techniques. Visual detection of CCA is challenging, since the signature greenish tint of the copper fades with time, and the staple-sized slits that line some treated wood (to allow deeper penetration of the treatment chemical) are not always used.[69] At a proposed C&D wood burning incinerator in Massachusetts, the developer planned to "instruct its workers to reduce the quantity of CCA treated wood in the wood fuel product to

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54 Mike Ewall, "Metals as Catalysts for Dioxin Formation," (compilation of over a dozen published research papers documenting the phenomenon), December 2003. http://www.ejnet.org/dioxin/catalysts.html

55 Solo-Gabriele, H., Townsend, T., Messick, B., Calitu, V., "Characteristics of chromated copper arsenate-treated wood ash," Journal of Hazardous Materials 89, 213–232 (2002). http://www.ccaresearch.org/CCA_Ash_Paper.pdf

56 Iida, K., Pierman, J., Tolaymat, T., Townsend, T., Wu, C., "Control of heavy metal emissions and leaching from incineration of CCAtreated wood using mineral sorbents," Journal of Environmental Engineering, ASCE 1302 (2), 184–192 (2004).

57 Jenna Jambeck, Keith Weitz, Helena Solo-Gabriele, Timothy Townsend, Susan Thorneloe, "CCA-Treated wood disposed in landfills and life-cycle trade-offs with waste-to-energy and MSW landfill disposal," Waste Management, Vol. 27: S21-S28 (2007). http://www.sciencedirect.com/science/article/pii/S0956053X07000773

58 Jinkun Song, Brajesh Dubey, Yong-Chul Jang, Timothy Townsend, Helena Solo-Gabriele, "Implication of chromium speciation on disposal of discarded CCA-treated wood," Journal of Hazardous Materials, B128: 280-288 (2006). http://www.sciencedirect.com/science/article/pii/S0304389405004590

59 Jambeck, et. al. "Elevated arsenic and chromium concentrations in the ash leachate may increase leachate management costs."

60 Solo-Gabriele, H., Townsend, T., Messick, B., Calitu, V., "Characteristics of chromated copper arsenate-treated wood ash," Journal of Hazardous Materials 89, 213–232 (2002). http://www.ccaresearch.org/CCA_Ash_Paper.pdf

61 Bill Hinkley, Satish Kastury and Richard Tedder, "Florida CCA Regulatory Issues," http://www.ccaresearch.org/tag13/Regulatory_Issues_m2.ppt "Ash from the combustion of CCA treated wood contains thousands of parts per million of arsenic, is highly toxic and fails TCLP."

62 Helena Solo-Gabriele, et. al., "On-Line Sorting Technologies for CCA-Treated Wood," September 30, 2001, p. 31-41. http://www.ccaresearch.org/final_sara_draft_m7_web.pdf

63 Monika Blassino, Helena Solo-Gabriele & Timothy Townsend, "Pilot scale evaluation of sorting technologies for CCA treated wood waste," Waste Manage Res 2002: 20: 290–301, 295. http://wmr.sagepub.com/content/20/3/290.abstract

64 Jenna Jambeck, Keith Weitz, Helena Solo-Gabriele, Timothy Townsend, Susan Thorneloe, "CCA-Treated wood disposed in landfills and life-cycle trade-offs with waste-to-energy and MSW landfill disposal," Waste Management, Vol. 27: S21-S28 (2007), pp.S22-S23. http://www.sciencedirect.com/science/article/pii/S0956053X07000773

65 Timothy Townsend & Helena Solo-Gabriele, "New Lines of CCA-Treated Wood Research: In-Service and Disposal Issues," March 19, 2001, pp.36, 54 & 115. http://www.ccaresearch.org/solo-gabrielle_00-12.PDF

66 *Id.* at 38, 40.

67 Helena Solo-Gabriele, et. al., "On-Line Sorting Technologies for CCA-Treated Wood," September 30, 2001, p.79. http://www.ccaresearch.org/final_sara_draft_m7_web.pdf

68 Monika Blassino, Helena Solo-Gabriele & Timothy Townsend, "Pilot scale evaluation of sorting technologies for CCA treated wood waste," Waste Manage Res 2002: 20: 290–301, 297. http://wmr.sagepub.com/content/20/3/290.abstract

69 Sonoma County Waste Management Agency, "Treated wood." http://www.recyclenow.org/toxics/treated_wood.asp

the lowest practicable level by kick sorting and by not picking identifiable treated wood," and admitted that such wood could be hard to identify. A table from the developer's sorting study showed an amount of CCA-treated wood (4.86%) that was considerably higher than the standard of 3% that they were supposed to meet, and far higher than the target of 1.5%. The study showed that they failed to meet the 3% limit 70% of the time.[70]

Facilities accepting C&D wood waste don't find it economically-viable to devote the proper staff to test each piece of wood for the hard-to-recognize characteristics of various treatment chemicals. At a minimum, such facilities ought to install automated X-ray fluorescence (XRF) systems that detect and divert treated wood from their fuel stream. These XRF systems can reduce the arsenic-treated wood to around 1-2%.[71,72] If coupled with well-trained workers diverting treated wood entering the facility, it can do even better. These systems can also detect chromium, but are not as effective at detecting and diverting copper, which will be an increasing problem as copper-based CCA alternatives take over the market.

Since C&D waste is such a variable waste stream, with concentrations of contaminated material, it's important that continuous, automated testing of the fuel must be conducted at all times to keep toxic emissions within limits. Requirements for infrequent sampling of the waste stream are inadequate and easily manipulated by carefully selecting the waste to be tested. Biomass facilities often are not in control of the fuel stream they obtain, as they typically contract with suppliers for their fuel. Neither the supplier or the biomass incinerator operator have an incentive to carefully test for and remove contaminated wood, as any fuel removed and disposed of as waste is lost profit and added expense. Real-time third party testing of the fuel is necessary.

Since unburned CCA-treated wood tests hazardous in leach tests, any treated wood separated from the fuel stream should be stored in an indoor, lined area to avoid exposure to rain and to avoid contaminating soils and groundwater.

CCA wood has been banned in Germany since the mid-1970s, Sweden since 1993, and the rest of Europe by mid-2004, while Australia banned CCA just for playground equipment in 2005. Canada and the U.S. have agreed to industry-proposed voluntary phase-outs of CCA for residential uses by January 2004. This follows the lead of at least five states, three cities and two counties that had banned or restricted CCA wood between 1994 and 2003.[73]

The phase-out in the U.S. was a matter of the EPA granting the industry's "voluntary cancellation and use termination request." It is likely that the industry saw the writing on the wall and chose to voluntarily limit their market rather than risk the possibility that all uses of CCA would be banned by federal action. In order to protect human health (especially children's health) from exposure to arsenic, the agreement with EPA banned new CCA wood treatment for residential uses, including wood used in playground structures, decks, picnic tables, landscaping timbers, residential fencing, patios, walkways and boardwalks. However, CCA-treated wood and structures already in use have been allowed to stay in use, and existing stocks of residential CCA-treated wood were allowed to be sold until used up. CCA is also still allowed to be produced and used in permanent wood foundations, agricultural fence posts, utility poles, railway ties and other commercial, industrial and agricultural uses.[74] EPA is in the process of "re-registering" CCA, which might allow for wider use again, so long as it's labeled.[75]

Although CCA and other arsenic-containing wood treatment chemicals aren't going away, the alternatives are not much of an improvement. Almost every replacement for CCA still contains copper and some, such as acid copper chromate (ACC), still contain chromium (and at higher concentrations).[76,77,78,79] Copper-based preservatives such as alkaline copper quat (ACQ) and micronized copper quat (MCQ) are expected to dominate the residential treated wood market.[80,81] The percentage of copper hitting the waste

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[70] Massachusetts Environmental Energy Alliance, "Comments on the draft Beneficial Use Determination (BUD) issued to Palmer Renewable Energy (PRE) for its fuel supply," November 16, 2009, p.5. http://www.pfpi.net/wp-content/uploads/2011/03/MEEA-commnents-on-Palmer-BUD-11-18-09.pdf

[71] A.R. Hasan, H. Solo-Gabriele, T. Townsend, "Online sorting of recovered wood waste by automated XRF-technology: Part II. Sorting efficiencies," Waste Manag., 31, pp. 695-704, 2011. http://www.sciencedirect.com/science/article/pii/S0956053X10005672

[72] Diane Gow McDilda, "CCA Treated Wood: The End of the Line," MSWManagement.com, August 1, 2010. http://www.mswmanagement.com/MSW/Articles/11300.aspx

[73] "Timeline of Efforts to Ban CCA and Arsenic in Treated Wood Products -- The Rise and Fall of CCA Treated Wood Products," "Timeline of Efforts to Ban CCA and Arsenic in Treated Wood Products – The Rise and Fall of CCA Treated Wood Products," BANCCA.org. http://www.bancca.org/CCA_Timeline/CCA_Eventschart.html

[74] "Response to Requests to Cancel Certain Chromated Copper Arsenate (CCA) Wood Preservative Products and Amendments to Terminate Certain Uses of other CCA Products," 68 Federal Register 68 (9 April 2003), pp. 17366 - 17372. http://www.epa.gov/fedrgstr/EPA-PEST/2003/April/Day-09/p8372.htm

[75] U.S. Environmental Protection Agency, "Chromated Copper Arsenate (CCA)," July 2011. http://www.epa.gov/oppad001/reregistration/cca/

[76] American Wood Protection Association Standard, "Brands Used on Preservative Treated Materials," 2010. http://www.clp-inc.com/app/download/6767987504/M06-07.pdf

[77] U.S. Environmental Protection Agency, "Chromated Copper Arsenate (CCA): Alternatives to Chromated Copper Arsenate," May 9, 2012. http://www.epa.gov/oppad001/reregistration/cca/alternativestocca.htm

[78] "Emission Factor Documentation for AP-42, Section 10.8, Wood Preserving - Final Report," Table 2-6: "Compositions of Common Wood Preservatives," U.S. Environmental Protection Agency, p.2-14, August 1999. http://www.epa.gov/ttnchie1/ap42/ch10/bgdocs/b10s08.pdf

[79] Jinkun Song, Brajesh Dubey, Yong-Chul Jang, Timothy Townsend, Helena Solo-Gabriele, "Implication of chromium speciation on disposal of discarded CCA-treated wood,"Journal of Hazardous Materials B128 (2006): 280-288, p.286. http://www.sciencedirect.com/science/article/pii/S0304389405004590

[80] Mike Freeman & Craig Mclntyre, "A comprehensive review of copper-based wood preservatives with a focus on a new micronized or dispersed copper systems," Forest Products Journal 58 (11), 6–27, November 2008.

stream is likely to increase, in part because the useful life of copper-treated wood is less than arsenic-treated wood and it will need to be replaced more often.[82] While the U.S. moves more into copper for wood treatment, The Netherlands has been working to ban all use of copper compounds as wood preservative, since it exceeds their standards for persistent biocides affecting water.[83]

Burning treated and painted wood is usually not considered renewable in state and federal renewable energy policies.[84,85] Some states specifically even ban the burning of C&D wood waste because of the toxic hazards involved. New Hampshire has banned the burning of C&D waste, and Massachusetts has a moratorium on it.[86] The (loophole-ridden) private green energy certification standard, Green-e, disallows burning of more than 1% of certain painted and treated wood in the energy products they'll certify.[87] Environmental organizations – even those who still believe that biomass burning is renewable – are in nearly universal agreement that burning C&D wood waste is not "renewable biomass" that they'd support. Nonetheless, in all of these schemes, enforcement mechanisms are sorely lacking, enabling some highly contaminated wood burning to benefit from renewable designations even when such laws and standards disallow it.

There are two main markets for processed C&D wood waste: burning it as boiler fuel, or chipping it up as landscape mulch.[88] Neither is "environmentally acceptable" according to the leading researchers in the field, due to metal contamination that generates hazardous ash when burned and leaches too much arsenic if used as mulch.[89]

Instead of burning or mulching treated wood, the best solutions are to reuse or recycle the wood. To do this properly, the first step (if the wood is in a building structure) is to deconstruct the structure instead of demolishing it. Deconstruction involves carefully dismantling the building so that valuable materials can be reused and recycled, resulting in more local jobs avoiding the creation of demolition waste.[90] Clean and treated wood that can be reused should be. Treated wood not suitable for reuse can be purified. Technology exists to remove the copper, chromium and arsenic from CCA-treated wood.[91,92] The purified chipped or powdered wood can then be recycled into paper products or used for landscaping mulch, as can any clean wood that is not suitable for reuse.

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81 A.R. Hasan, H. Solo-Gabriele, T. Townsend, "Online sorting of recovered wood waste by automated XRF-technology: Part II. Sorting efficiencies," Waste Manag., 31, pp. 695-704, 2011. http://www.sciencedirect.com/science/article/pii/S0956053X10005672

82 *Id.* at 703.

83 Scientific Committee on Toxicity, Ecotoxicity and the Environment, "Opinion on The Justification of a Notification by the Netherlands to Introduce National Measures Concerning Wood Treated with Copper Substances," Opinion expressed at the 33rd CSTEE plenary meeting, Brussels, 24 September 2002, p.3. http://ec.europa.eu/food/fs/sc/sct/out163_en.pdf

84 "Biomass: Comparison of Definitions in Legislation Through the 111th Congress," Congressional Research Service, March 7, 2012. http://www.fas.org/sgp/crs/misc/R40529.pdf.

85 Database of State Incentives for Renewables & Efficiency. http://www.dsireusa.org. Website has profiles and comparison spreadsheets of state renewable portfolio standard (RPS) definitions, including biomass definitions.

86 "Combustion Ban," New Hampshire Revised Statutes Annotated 125-C:10-c. http://www.gencourt.state.nh.us/rsa/html/x/125-c/125-C-mrg.htm

87 "Green-e Energy National Standard Version 2.1," Center for Resource Solutions, February 2011, p.3. http://www.green-e.org/docs/energy/Appendix%20D_Green-e%20Energy%20National%20Standard.pdf The standard – weaker than most state and federal legislation – excludes painted wood, railroad ties and wood treated with arsenic or halogens (like pentachlorophenol), but fails to address chromium or copper contamination. It also allows up to 1% contamination with painted, or arsenic- or halogen-treated wood, which is still a significant level of contamination.

88 Jinkun Song, Brajesh Dubey, Yong-Chul Jang, Timothy Townsend, Helena Solo-Gabriele, "Implication of chromium speciation on disposal of discarded CCA-treated wood,"Journal of Hazardous Materials B128 (2006): 280-288, p.286. http://www.sciencedirect.com/science/article/pii/S0304389405004590

89 Helena Solo-Gabriele, et. al., "On-Line Sorting Technologies for CCA-Treated Wood," September 30, 2001, p.70. http://www.ccaresearch.org/final_sara_draft_m7_web.pdf

90 Institute for Local Self-Reliance, "Waste-to-wealth – Deconstruction." http://www.ilsr.org/initiatives/deconstruction-waste-to-wealth/

91 Kazem Eradat Oskoui, "Recovery and Reuse of the Wood and Chromated Copper Arsenate (CCA) from CCA-Treated Wood," presented at Environmental Impacts of Preservative-Treated Wood Conference, Orlando, Florida, February 8-11, 2004. http://www.ccaresearch.org/ccaconference/pre/pdf/Oskoui.pdf When wood is chipped to 1/2 to 1 inch size, study showed 80% to 90% removal of Arsenic, 78% to 82% removal of Chromium and 95% to 99% removal of total Copper concentration.

92 Tomo Kakitani, Toshimitsu Hata, Takeshi Kajimoto, Yuji Imamura, "Designing a purification process for chromium-, copper- and arsenic-contaminated wood," Waste Management, Volume 26, Issue 5, pp. 453-458. http://www.sciencedirect.com/science/article/pii/S0956053X05001546 When wood was ground to a powder, study showed 100% removal of Arsenic and Chromium and 95.8% removal of Copper.