Inventory of Energy Recovery Opportunities

Energy Recovery Opportunities	Material Available for Recovery (million tons/year)	Potential Energy Recovery/Savings (billions Btu/year)	Percent of U.S. Energy Production[1]	Current Activities
MSW[2] **BioCycle *Data*** ***Franklin Data***	 266 137	 2,729,160 1,405,620	 3.90% 2.01%	~90 MSW incinerators, process ~30e6 tons/year; RCC (EPA)
Biomass, Ag Residues[3]	100	1,000,000	1.43%	Renewable Energy Biomass Program (DOE)
Biomass, Animal Manure/Gaseous Fuels[4]	35	420,000	0.60%	AgSTAR (EPA, DOE, USDA)
C&D, Land Clearing Debris[5]	27	394,200	0.56%	RCC (EPA)
C&D, Wood Building Materials[6]	19.6	353,000	0.50%	RCC (EPA); LEED Stds (NGO); Forest Products Laboratory (USDA)
Landfill Methane Gas[7]	N/A	144,000	0.21%	LMOP (EPA)
Coal Combustion Products, Fly Ash[8]	20	80,000	0.11%	RCC (EPA)
Biomass, Pulp and Paper Residues[9]	3	30,000	0.043%	Most pulp and paper residues recovered.
Used Oil[10]	0.788	28,000	0.04%	Various state/local collection programs
Scrap Tires[11]	0.6	16,800	0.024%	State/local programs
Wastewater Treatment Sludge[12]	1.19	13,090	0.019%	National Biosolids Partnership (EPA, NGOs)
Gasification II[13]	2.9	11,000	0.016%	None
Comparable Fuels Exclusion[14]	0.049	782	0.00078%	Current Rulemaking
Comparable Alternative Resources Exclusion[15]	0.046	747[16]	0.00075%	None
C&D, Disaster Debris[17]	Variable generation rates, limited value to compare in annual context			
Coal Refuse	Current generation and legacy material being increasingly recovered[18]			
Scrap Plastics	Most material is already recovered/recycled; excludes MSW plastics			
Spent Solvents	Most material is already recovered/recycled			

Color Coding Key:

	= Opportunity for new ORCR involvement. See attached Energy Inventory Background Reports.
	= Existing OSW involvement.
	= Categories excluded given high recycling/recovery rates, robust markets, lack of new opportunities.
	= Existing programs dedicated to energy recovery for this material.

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[1] Approximately 70 quadrillion (70e15) British thermal units (Btu) produced domestically in 2007, includes energy from renewable sources currently used as fuel. The U.S. consumed about 100 quadrillion Btu; petroleum imports account for most of the 30e15 difference. Energy Information Association, Annual Industry Power Summary Statistics.

[2] *BioCycle* reports 413 million tons of MSW generated in 2006 (their most recent report); 65% (or 266 million tons) is landfilled. *BioCycle* data based on state surveys. Franklin and Associates report 137 million tons of MSW were landfilled in 2007. Commonly used average heating value of MSW is 5,130 Btu/lb. Note that 56-66% of MSW is biogenic in origin, i.e. not derived from fossil fuels and therefore considered carbon neutral.

[3] Excludes MSW organics. Approx. 6 million tons of ag residues (primary/secondary) burned as fuel. Approx. 500 million tons primary ag residue generated per year. No primary ag residues are landfilled; data not readily available for secondary residues/foodscraps from storage, processing, and wholesaling. Estimated 100 million tons of ag residues available for energy recovery at 5,000 Btu/pound; assuming about 400 million tons needed to remain on land to maintain soil health. Data derived from Material Characterization Paper supporting ANPR - Identification of Non-hazardous Materials That Are Solid Waste, available at: http://www.epa.gov/waste/nonhaz/definition.htm

[4] Manure from domestic livestock production is typically not landfilled; quantity not used for biogas purposes is usually applied to the land to maintain soil health. Approx. 35 million dry tons of current manure production could be used for bioenergy once sustainability concerns are met. Assumed energy content of 6000 Btu/lb. Data derived from Material Characterization Paper.

[5] Assumed 7,300 Btu/lb, typical Btu value for mixed wood debris with some green wood. Potential for asbestos contamination, barrier to energy recovery. Data derived from Material Characterization Paper.

[6] In 2003, estimated 40% of 164 million tons of building related C&D already recycled/recovered. Of remaining 98 million tons, assume 20% is wood available for recovery at 7,300 Btu/lb. Data derived from Material Characterization Paper.

[7] Based on energy recovery potential of approximately 540 candidate landfills with a total gas generation potential of 240 billion cubic feet per year. Landfill gas energy content estimated at 600 Btu per cubic foot. Data from Landfill Methane Outreach Program available at www.epa.gov/lmop.

[8] Fly ash can be used a raw material substitute in cement kilns; high carbon fly ash can also provide fuel value. Assumed 50% of fly ash that is landfilled is “high carbon”. Estimated energy content of high-carbon fly ash 2,000 Btu/lb. Data derived from Material Characterization Paper. This estimate does not include the 100-500 million tons of legacy fly ash in monofills or holding ponds. Upstream energy savings from using fly ash as a material is not considered.

[9] Sludges are the only pulp and paper mill residue that is landfilled to an appreciable extent. Other residues such as those from logging and primary mill operations as well as black liquors are beneficially reused. Average energy content estimated at 5,000 Btu/lb for primary and secondary sludges generated by pulp and paper industry. Data derived from Material Characterization Paper.

[10] Approximately 1.35 billion gallons of used oil generated annually; estimated 15% or 200 million gallons disposed of in landfills or improper locations, primarily from residential users. Assumed density of 7.88 pounds/gallon; heating value estimated at 140,000 Btu/gallon. Data derived from Material Characterization Paper.

[11] Approximately 4.4 million tons of scrap tires generated annually, about 14% or 0.6 million tons land disposed. Estimated heating value of 14,000 Btu/lb. Data derived from Material Characterization Paper.

[12] Approx. 17% of 7 million dry tons of biosolids generated are landfilled yearly. Average energy content of dry biosolids estimated at 5,500 Btu/pound. All data derived from Material Characterization Paper.

[13] Annual average of incinerated, non-wastewater material from 2001, 2003, and 2005 Biennial Reports; average used because rule would make gasification more viable to those industries with constant, predictable waste streams. Assumed 5,000 Btu/lb with the understanding that hazardous waste with >5,000 Btu/lb is typically used to combust lower heating value wastes, including aqueous streams. Thus, there may be little energy recovery potential. However, efficiency increases from gasification can be expected.

[14] Data from the pre-amble of the Emissions Comparable Fuel Expansion rule. Assume that total quantity of fuels that will qualify for exclusion that are not currently classified as being burned for energy recovery will be viable fuels with estimated energy content of 8,000 Btu/lb, though it is likely that hazardous waste with significant heating value is already burned for energy recovery regardless of disposal classification.

[15] Material/energy estimates for this category exclusively for K088 (spent Aluminum pot liner). Other wastes, such as K0170 (clarified slurry oil sediment) likely candidates for this type of exclusion; these could be discovered via NODA. CAR is similar to Comparable Fuels except that it enables *solids* with energy/resource value to be eligible for exclusion.

[16] Includes energy savings from material use as well as fossil fuel use avoided. See CAR Energy Recovery Inventory Report.

[17] For example: Hurricane Andrew in 1992 generated 43 million cubic yards of debris, Hurricane Katrina in 2006 generated 100 million cubic yards. Potential contamination (asbestos, arsenic, lead) barrier to recovery. Data from Material Char. Paper.

[18] Assuming 50% of raw mined product ends up as refuse, up to 1,145 million tons of coal rejects may have been generated in 2007.While the energy potential is high, power plants dedicated to this material are in operation and others are planned to handle current generation as well as large quantities of material from legacy refuse piles. Coal refuse/mining rejects is currently being used as primary fuel and/or secondary fuel in over 30 power plants.