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Converting Washington Lignocellulosic Rich Urban Waste to Ethanol: Part 2, Process modeling and life cycle assessment.

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Goal

To use LCA to evaluate the environmental burdens associated with the conversion of three lignocellulosic rich waste streams (Municipal Solid Waste (MSW), Mixed Waste Paper (MWP), and Yard Waste to ethanol fuel as a waste management option for the State, including all major unit processes within the life cycle.

Approach

Life Cycle Assessment (LCA) is a protocol standardized within ISO 14040 that is used to,
• quantify environmental, social, and economic impacts of emerging technology within the life cycle of a defined system,
• it extends from material and energy acquisition and processing, through system manufacturing/construction, use/maintenance, and ultimate retirement.

LCA has four main phases:
(1) ***Goal & Scope Definition***, outlines the objectives of the study, the intended audience, the systems and subsystems boundaries, a data collection and quality plan, and critical review
(2) ***Inventory Analysis***, a system model is built according to the previous phase and includes: the construction of a flow model, data collection, and calculations of resource use and pollutant emissions
(3) ***Impact Assessment***, is used to indicate the impacts of the environmental loads quantified in the inventory analysis
(4) ***Interpretation***, the interpretation phase assesses the overall context of the LCA and is used to provide recommendations

Table 1: Select inventory emissions and impact categories

	photochemical smog	emissions of CH4, NOx, CO, & NMVOCs (as NOx equiv)
	PM emissions	Sum of particulate matter emissions (as tons PM)
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Table 2: Comparative scenarios and functional unit

		Percent of Waste Sent to Process			
Scenario	**Functional Unit**	**Landfill**	**Recycle**	**Compost**	**Ethanol**
Scenario 1, base case	5,763,904 MT	84%	6%	11%	0%
Scenario 2; All waste to ethanol	5,763,904 MT	0%	0%	0%	100%
Scenario 3; All MSW to ethanol	5,763,904 MT	0%	6%	11%	84%
Scenario 4; All MWP to ethanol	5,763,904 MT	84%	0%	11%	6%
Scenario 5; All YW to ethanol	5,763,904 MT	84%	6%	0%	11%
Scenario 6; All waste to landfill	5,763,904 MT	100%	0%	0%	0%

Results

Figure 1: Normalized impact results for the six scenarios

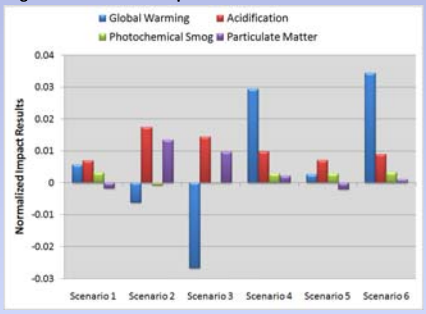


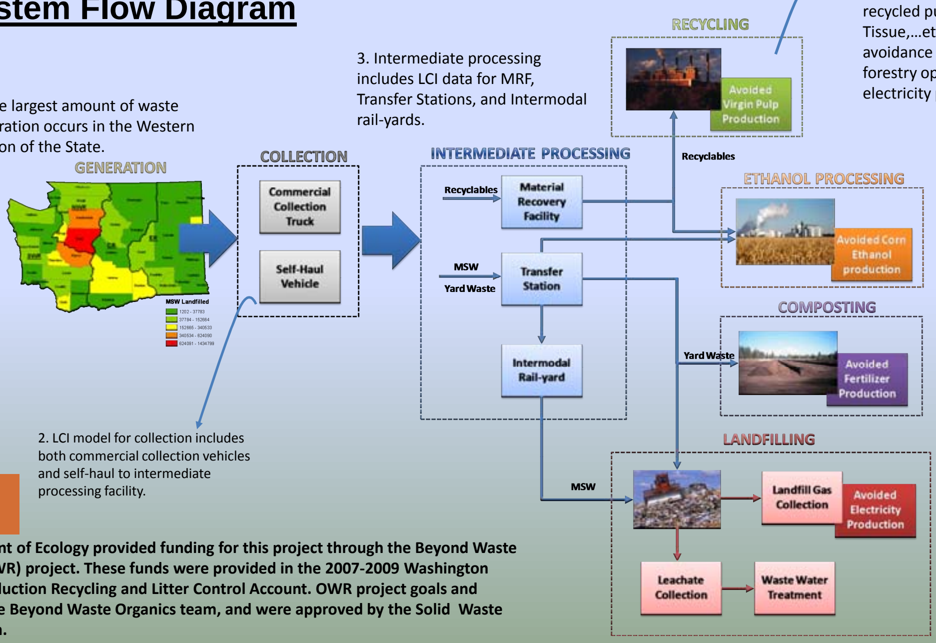
Table 3: Percent change in impacts from baseline

	Scenario 2	Scenario 3	Scenario 4	Scenario 5	Scenario 6
Energy Consumption	-644%	-763%	237%	-118%	305%
Global Warming	-210%	-574%	420%	-56%	509%
Acidification	153%	109%	42%	2%	30%
Photochemical Smog	-121%	-100%	-10%	-12%	2%
Particulate Matter	860%	650%	224%	-13%	153%

Discussion

Converting MSW to ethanol has significant benefits in terms of reducing energy consumption, climate change, and photochemical smog. It may not offer benefits in terms of acidification and particulate matter formation.

System Flow Diagram



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