FEASIBILITY STUDY FOR A WASTE TO ENERGY PLANT: UNIVERSITY OF IDAHO, MOSCOW CAMPUS

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OUTLINE

- University of Idaho energy plant
- Current fuel costs
- Objectives of waste to energy
- Waste characterization
- Municipal solid waste energy content
- Facility sizing and fuel scenarios
- Offsetting CO_2 and CH_4 emissions
- Conclusion
- Future Study

UI ENERGY PLANT – HEATING

Steam Generation Capacity:

- Biomass fuel (95% of load)
  - Boiler 1 – 2.1 MW (60,000 PPH)
- Natural gas fuel (5% of load)
  - Boiler 2 – 2.6 MW (75,000 PPH)
  - Boiler 3 – 1.9 MW (55,000 PPH)
  - Boiler 4 – 1.2 MW (35,000 PPH)

Figure 1. North campus energy plant

UI ENERGY PLANT – COOLING

- Chilled water
  - Thermocline thermal energy storage
    - 7500 m^3 (2 million gallons)
  - 3100 ton cooling capacity from chillers
    - 600 ton single effect absorption chiller
    - 2500 tons from electric chillers

Figure 2. South campus chiller plant and cold TES

STEAM DISTRIBUTION

- 4.6 miles of tunnels
- Heating – 63 buildings, 4.5 million sq. ft.
- Cooling – 46 buildings, 2 million sq. ft.

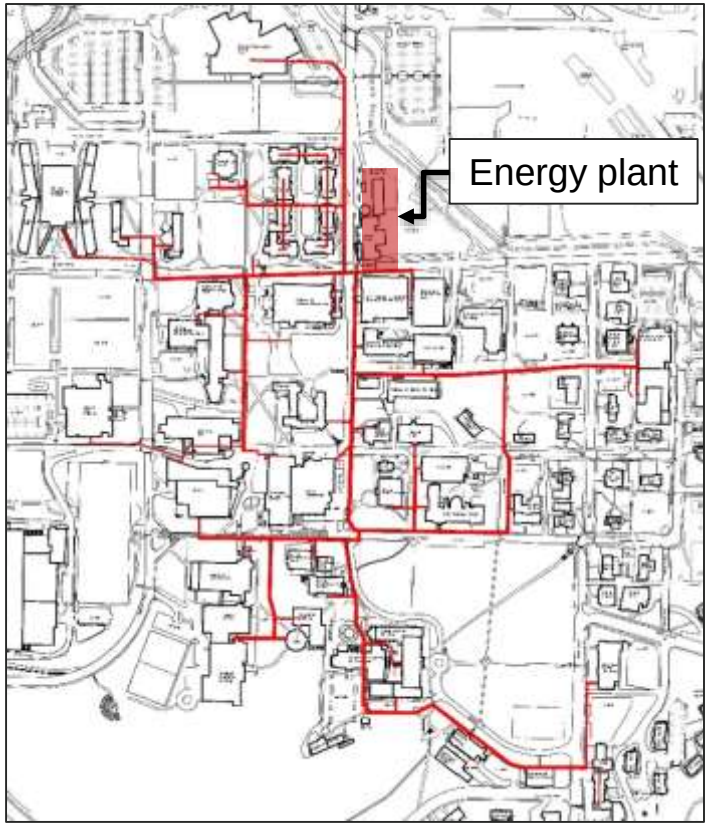

Figure 3. Steam distribution tunnel map

CURRENT FUEL COSTS

Figure 4. Wood chip storage facility

Wood Chips

- $51 per bone dry short ton
- $8.61 per 1000 kg of steam produced ($3.84 per 1000 pounds of steam)

Natural Gas

- $0.60 per therm
- $17.60 per 1000 kg of steam produced ($8.12 per 1000 pounds of steam)

COMPARISON OF FUEL COSTS

- Fuel costs are historically stable
- Wood chip supply is based on local lumber mills
- Need to meet future growth without relying on fossil fuels

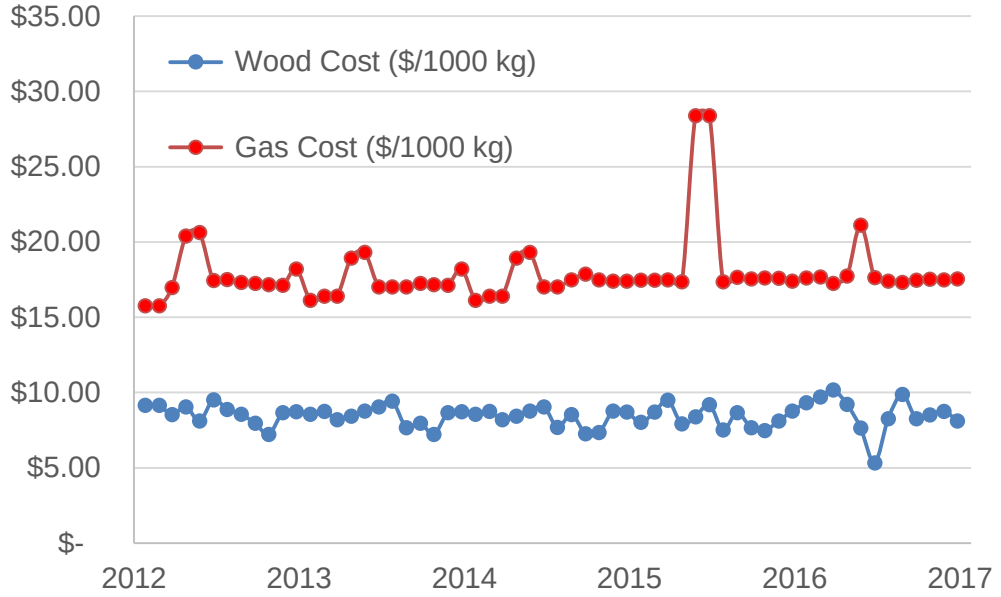

Figure 5. Current fuel costs

WTE OBJECTIVES

- Enhance Moscow campus fuel sustainability
- Enrich local community environmental sustainability
  - Soil
  - Water
  - Air
- Improve the financial advantages by incinerating MSW through WTE technology.

WASTE CHARACTERIZATION

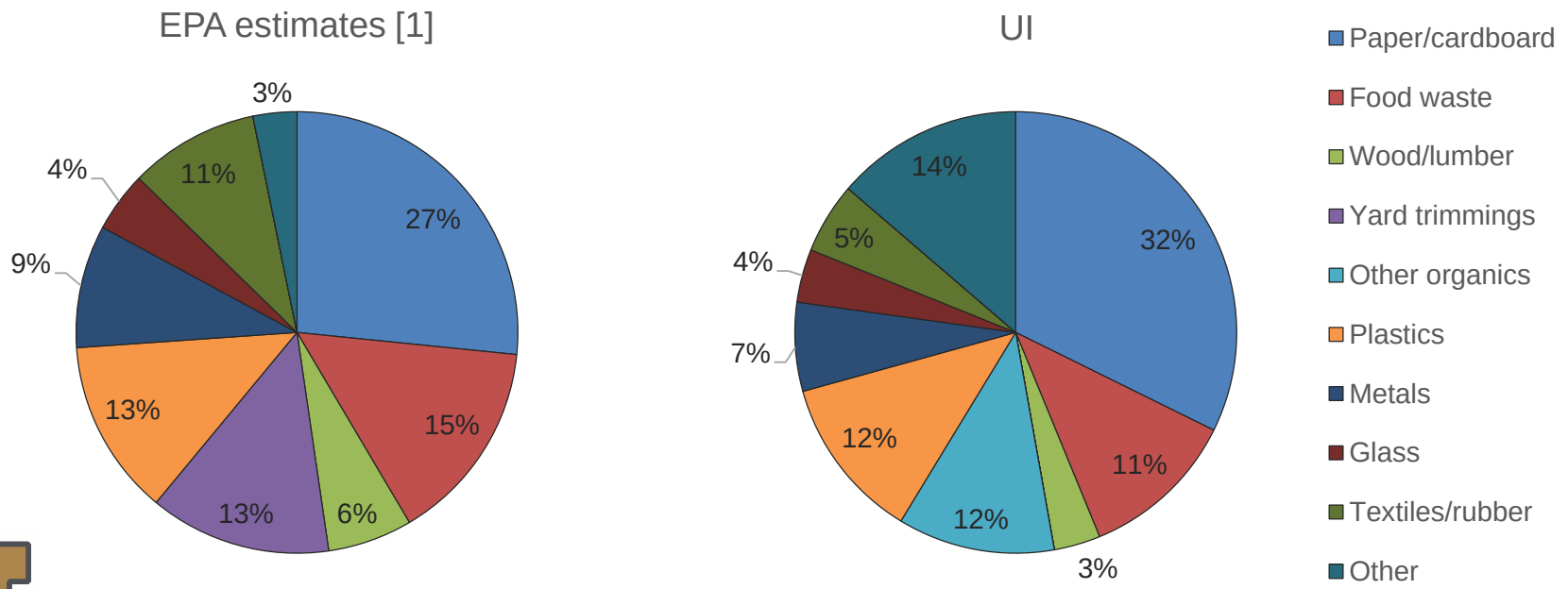

Figure 7. Waste characterization by mass

TYPICAL MSW ENERGY CONTENT

Solid waste material	HHV (MJ/kg)
Textiles	14.33
Rubber	27.93
Leather	14.95
Wood	10.38
Food waste	5.4
Yard trimmings	6.23
Newspaper	16.61
Corrugated cardboard	17.13
Paper	6.96
Other/Landfill	21.6

Table 1. Energy content of common MSW materials [2]

- Low energy content in food waste and yard trimmings
  - Very high moisture content
  - 28% of typical MSW by weight
- Energy content in paper products varies
  - Largest category of MSW

HEATING VALUE OF PLASTICS

- Discrepancies in the values reported by the EIA
- Large portion of energy content on MSW
- Recycling efforts will impact WTE
  - More sustainable than incineration

Plastic	EIA (MJ/kg)	Columbia (MJ/kg)	CCNY (MJ/kg)	Franklin (MJ/kg)	Used in this study (MJ/kg)
PET #1	21.3	23.9	24.4	24.7	**24.3**
HDPE #2	39.5	44.3	40.6	46.5	**43.8**
PVC #3	17.1	19.2	24.4	18.3	**20.6**
LDPE/LLDPE #4	25	44.3	44.1	46.3	**44.9**
PP #5	39.5	44.3	44.1	46.4	**44.9**
PS #6	37	41.5	40.6	41.9	**41.3**
Other #7	21.3	n/a	40.6	n/a	**40.6**

Table 2. Energy content of plastics [2-5]

MSW ENERGY CONTENT ON CAMPUS

- MSW produced on campus
  - 13.67 MJ/kg
- Typical EPA estimates
  - 12.18 MJ/kg
- Higher value is likely due to composting efforts on campus

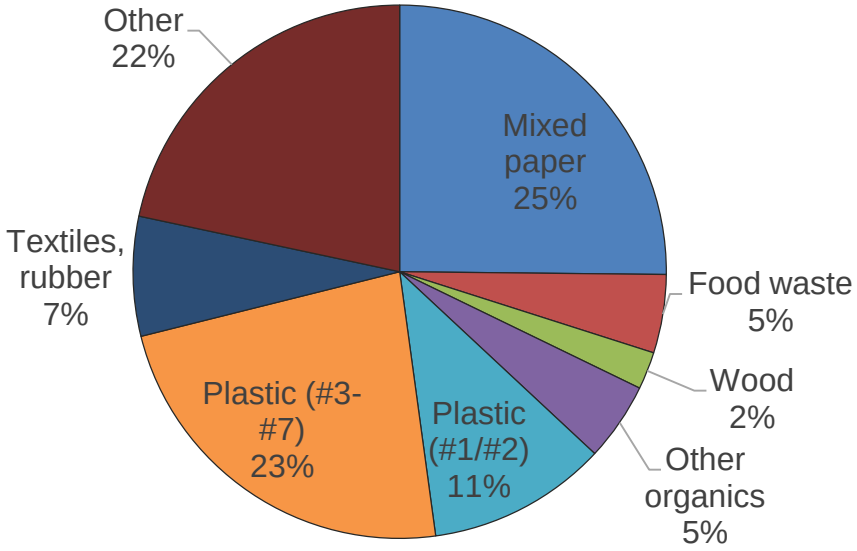

Figure 8. Energy content of MSW

WTE FACILITY SIZING

- Few U.S. WTE facilities that produce only thermal energy
  - Similar performance can be used to estimate UI capacity
- Fuel supply of 94 metric tons per day if mixed with wood chips

Location	Population	Waste (1000 kg/day)	Boilers	Steam capacity (kg/hr)	Steam produced per kg waste (kg)
Huntsville, AL	277000	626	2	81000	3.11
Fosston, MN	90000	73	2	9500	3.15
Red Wing, MN	44000	87	2	6800	1.88
Hampton, VA	180000	218	2	29900	3.3
Alexandria, MN	42000	218	3	34500	3.8
JMU, VA	122000	181	2	25900	3.42
UI Moscow campus only	9350	1.92	-	550	3.11
Surrounding area	**39000**	**44**	**-**	**5700**	**3.11**

Table 3. Comparison of thermal energy WTE facilities [6]

FUEL MIX SCENARIOS

1. Current fuel mix:
   - 95% wood chips
   - 5% natural gas
2. UI campus only:
   - 773 metric tons of MSW landfilled
   - Can only meet 2% of load
3. Surrounding area:
   - 16,000 metric tons of MSW
   - Can meet 42% of load

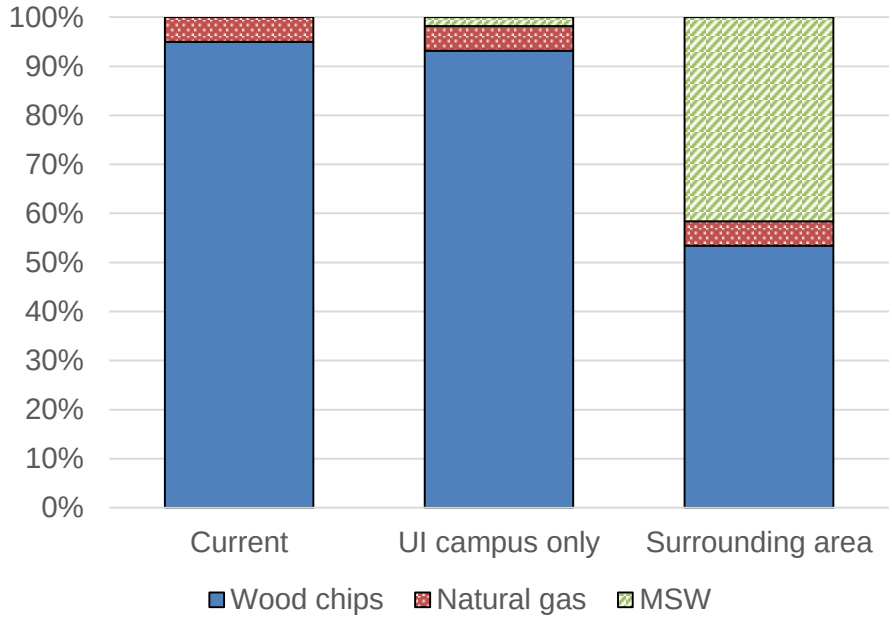

Figure 9. Fuel scenarios

FINANCIAL COMPARISON

- $500,000 annual savings using MSW based on current steam production
  - Includes $90,000 in tipping fees
- $1.5 million in annual savings over using natural gas exclusively

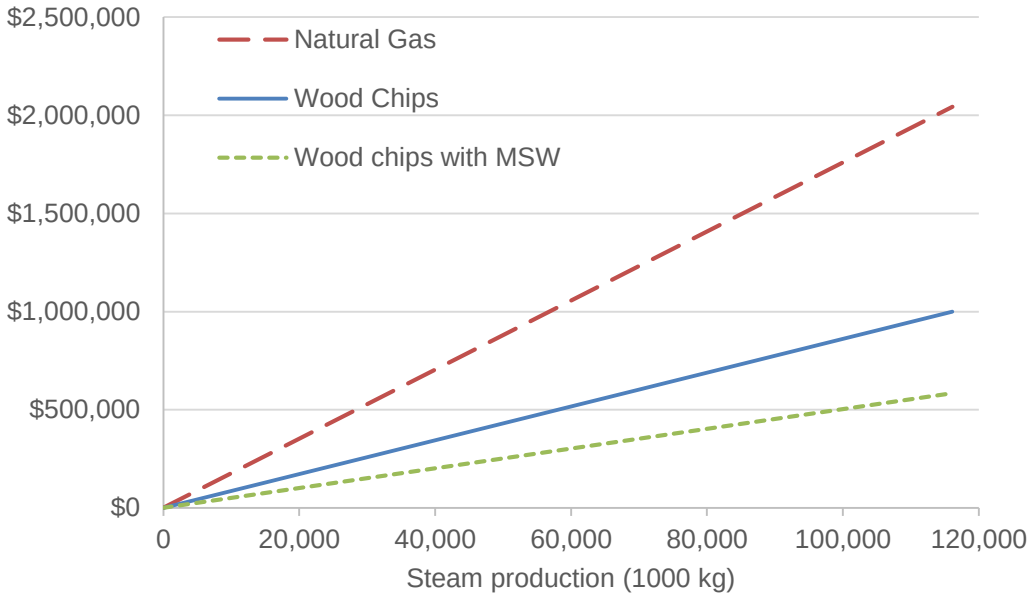

Figure 10. Cost to produce 1000 kg of steam

OFFSETTING CARBON EMISSIONS

- Wood chips are a carbon neutral source of fuel
- MSW in Moscow, ID is shipped by rail 190 km (120 miles) to the landfill
  - Potential to eliminate 53 tons of CO_2 emissions annually
- 1 ton of CO_2 emissions eliminated for each ton diverted from landfills for use in WTE

Would using MSW fuel increase net carbon emissions to the environment?

OFFSETTING CO_2 AND CH_4

- Increase in annual CO_2 emissions of 4200 metric tons
  - MSW fuel is only partially carbon neutral
- Trade off for CO_2 increase:
  - Reduction of **CH_4** emissions by 2400 metric tons
  - Elimination of **landfill** use
  - Protection of **water resources**

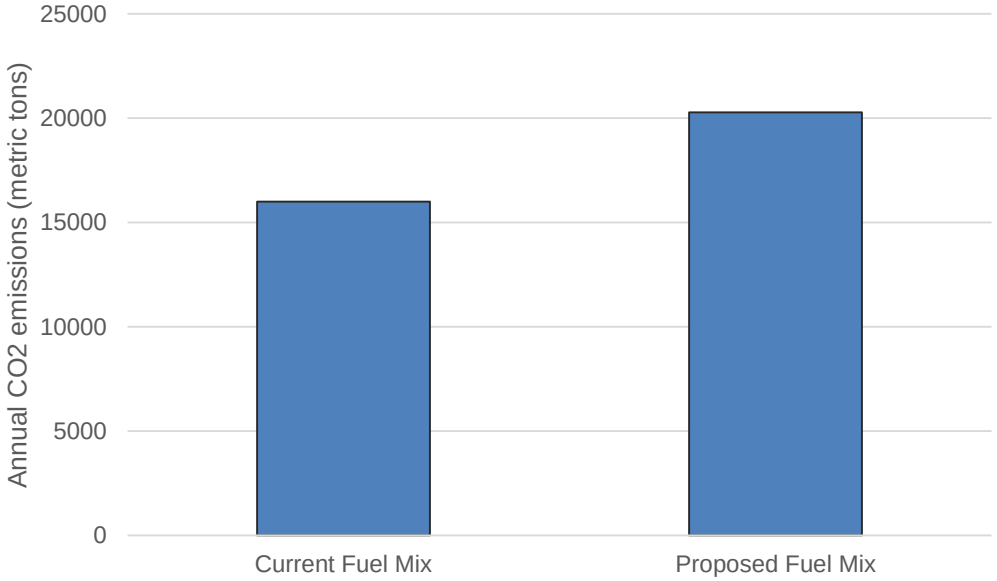

Figure 11. Net CO_2 emissions for each fuel mix

CONCLUSIONS

- UI campus MSW is insufficient to meet load demands
- 42% of current steam load can be met with MSW from the UI campus surrounding community
- $500,000 annual savings in fuel for the UI campus
- Environmental benefits of WTE include:
  - Soil and ground water protection through the diverting MSW from the landfill
  - Increased recycling rates by processing MSW before incineration
  - Increase in CO_2 emissions is offset by reduced methane emissions

FUTURE STUDY

- Investigation of incineration technology options for the UI campus
- A comprehensive feasibility study on WTE technology (MSW fuel + Incineration tech. options)
- Partnership between university and local community to source MSW fuel

QUESTIONS?

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