Assignment 4

Question 1

The energy chain has 5 steps:

1. Energy extraction
2. Distributed for processing
3. Converted to usable form
4. Distributed to consumers
5. Infrastructure built to allow distribution

There are some known sources of energy loss. For one, the convertion of heat to motion in the turbine is typically only 36% efficient. Then, the transfer of electricity across the power grid is only 93% efficient. Many appliances are also grossly inefficient. For example, a lightbulb is only 5% efficient. Combined, this is very inefficient.

Question 2

Energy justice is a new-emerging agenda that aims to "apply justice principles to energy policy, energy production and systems, energy consumption, energy activism, energy security, the energy trilemma, political economy of energy, and climate change." (Jenkins et al., 2016) I believe this an essential movement that would impact thousands of people worldwide without energy security. It is important because of the dependency of humankind on energy in the modern era. As such, not having access to electricity strongly limits development of third-world countries. However, I also think it is ambitious. Because so much of energy is privitized, it will require economic incentive to fulfull energy justice completely.

Jenkins et al. (2016) *Energy Justice: A Conceptual Review.* Retrieved from https://research-repository.st-andrews.ac.uk/handle/10023/9733%3E. Web.

Question 3

Recycling allows for the reuse of materials. This reduces or completely eliminates the energy use caused through

- raw material extraction
- raw material transportation
- raw material processing
- solid waste treatment

Question 4

Landfills are a big contributor to poor air quality. Over time, as garbage decomposes, gases (LFG) are released from the landfill site and enter the atmosphere.

These include gases like CO_2, CH_4, and NH_x. In the aerobic stage of the landfill, CO_2 is produced. However, when the landfill becomes more full and less oxygen is available, CH_4 production accelerates.

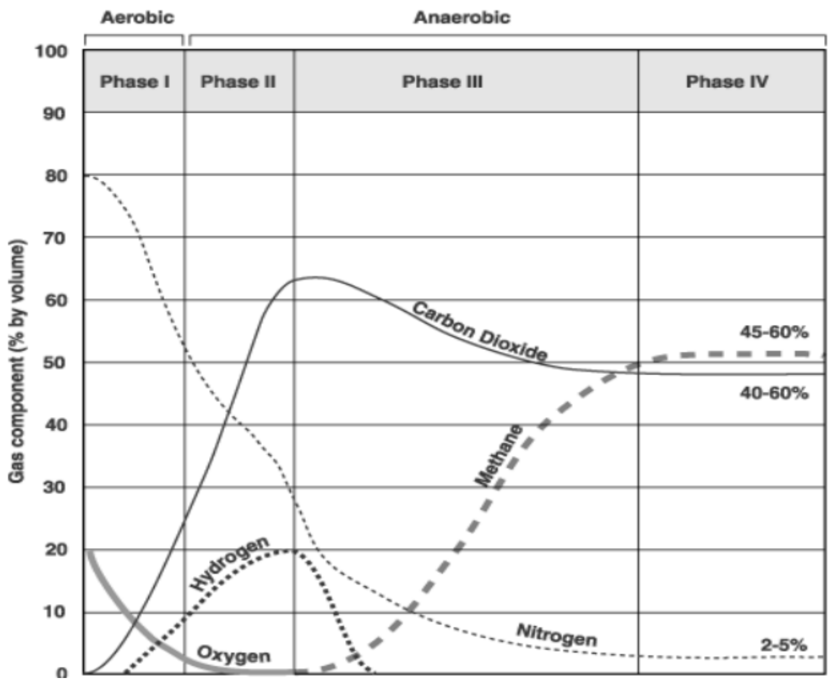


Figure 1: LFG Gases

Question 5

There are 4 factors that influence composting efficiency.

1. **Temperature**: 30°C is optimal
2. **Oxygen Content**: 15% is optimal
3. **C-N ratio**: 30:1 is optimal
4. **Moisture Content**: >50% is optimal

Assignment 4

Benjamin Klassen
July 2 2020

(6) a) 12.773 MW·hr

$587 \frac{kg\ CO_2}{MW \cdot hr}$

$\frac{12.773}{0.93} = 13.7344 * 587 = 8062.0978\ kg\ CO_2$

b) $8062.0978 * 166M = 1.3383E12\ kg\ CO_2$

(7) 300 kg/hr

40% efficient

$h_{out} = 3191.1 \frac{kJ}{kg}$

$h_{in} = 1925.6 \frac{kJ}{kg}$

$HV_{oil} = 42500$ kJ/kg

$HV_{gas} = 54400$ kJ/kg

$m_{steam} = 300$ kg

$n = 0.4$

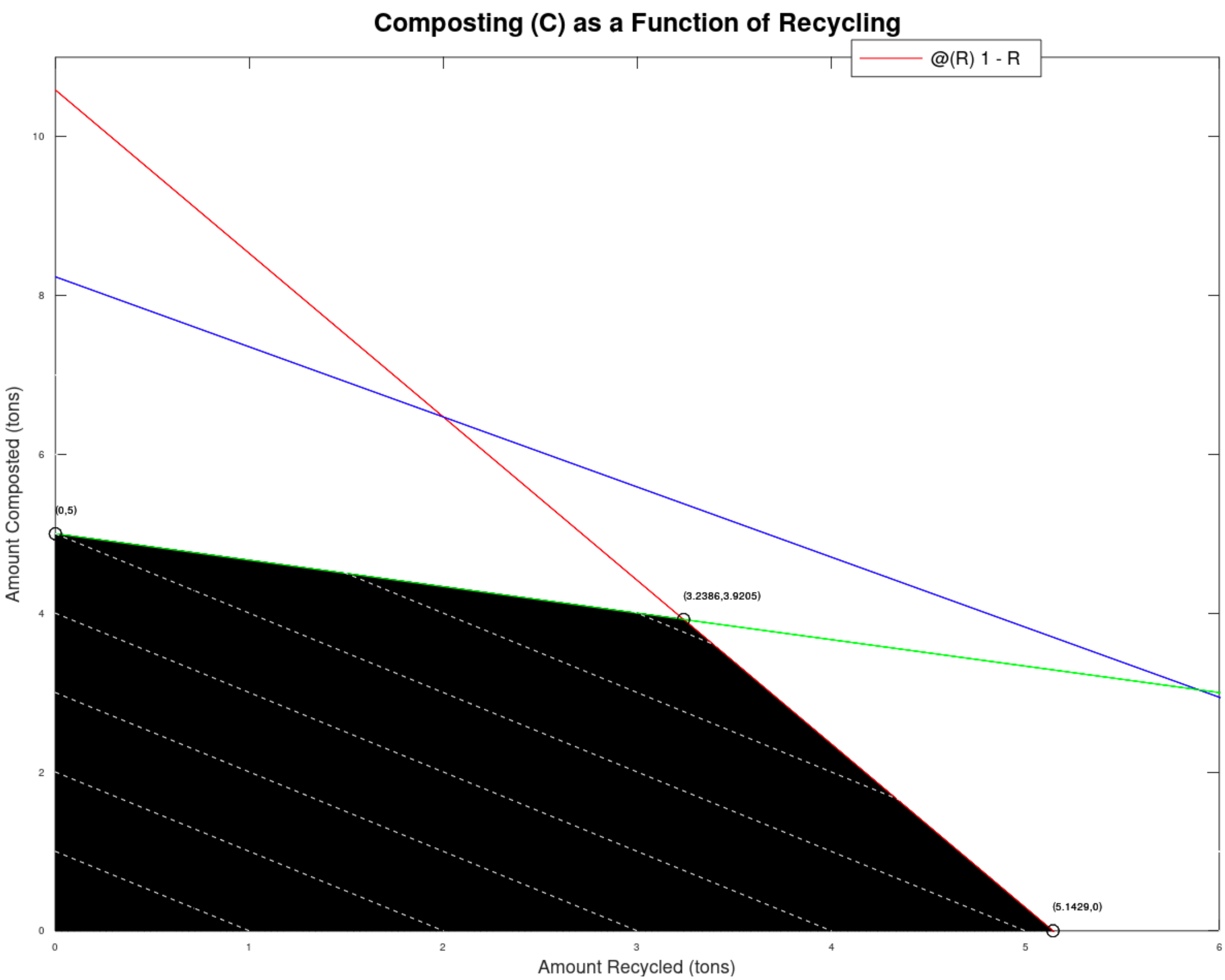
a) $n = \frac{m_{steam}(h_2 - h_1)}{m_{fuel}(HV)}$

$0.4 = \frac{300(3191.1 - 1925.6)}{m_{fuel}(42500)}$

$m_{fuel} = 22.33$ kg

b) $m_{gas} = \frac{300(3191.1 - 1925.6)}{0.4(54400)}$

$= 17.447$ kg



Composting (C) as a Function of Recycling
@(R) 1 - R
Amount Composted (tons)
Amount Recycled (tons)
(0,5)
(3.2386,3.9205)
(5.1429,0)
0
2
4
6
8
10
0
1
2
3
4
5
6

⑧ let recycled = R

a) composted = C

$Z = C + R$ (Objective function)

In graph,

Red = resources

Blue = area available

Green = trucks

White = Objective lines

$35R + 17C \geq 180$ cost ~~red~~ red C_1

$1.5R + 1.7C \leq 14$ area ~~available~~ table C_2

$R + 3C \leq 15$ truck green

e) From MATLAB Code, (R, C) points are (0,0) (0, 5), (3.9205, 3.2386), & (5.1429, 0)

(0, Since optimal solution is when amount of wast processed is maximized,

Optimal solution = 3.9205 + 3.2386

= 7.1591 tons processed

g) No, not all of the constraints impact the optimum solution. As seen in the graph, the area didn't impact the decision as it was outside of the feasible region defined by available trucks and budget.

9) 50000 ppl
40000 tons
22% recovered
landfill density is 1000 lb/yd^3
cell depth = 10 ft
80% = MSW

$1000 \frac{lb}{yd^3} \times \frac{1\ yd^3}{27 ft^3} = \frac{1000}{27} \frac{lb}{ft^3}$

1 acre = 43560 ft^2 × 40 acres = 1742400 ft^2

a) $40000\ ton \times \frac{2000\ lb}{ton} = 80\,000\,000$ lbs * 0.78 = 62.4 M

∴ Garbage = $62.4E6 \times \frac{27}{1000}$
= 1.6848 E6

Cell volume × 0.8 = Garbage Volume

$10 \cdot A = \frac{1.6848E6}{0.8}$, A = 210600 ft^2

b) From above, 40 acres = 1742400 ft^2. Since 2 lifts envisioned,

$30 \cdot A = \frac{1.6848E6}{0.8}$

A = 70200 /year

∴ total years = $\frac{1742400}{70200}$ = 24.82 years

c) Garbage Volume = 80E6 * 0.6 = 48E6 × $\frac{27}{1000}$ = 1296000

$30 \cdot A = \frac{1.29E6}{0.8}$

A = 53750/year ∴ $\frac{1742400}{53760}$ = 32.4167 years

∴ 32.4167 − 24.82
= 7.57 years

(10) 19000 tons $\frac{SW}{yr}$

12 tons Al

2021 cardboard

527 office paper

89 newspaper

17 glass

921 plastic

271 foodwaste

a) $\sum_{MT_c} = 12(3.71) + 2021(0.96) + 527(1.31) + 89(0.52) + 17(0.5)$

$+ 921(0.43) + 271(0.25)$

$= 3193.61 \; MT_c$

b) $(12 + 2021 + 527 + 89 + 17 + 921 + 271)(80) = \$308640$

c) c) $= 3193.61E6 \cdot 10$

$= \$3.19661E10/yr$