Resource Conservation Planning

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Everything is a resource

- Energy
- Water
- Raw Materials
- Waste
- Money
- Time

How to mine the highest return

- Mass balance
- Energy balance
- Benchmark
- Regulatory screen
- Economic evaluation
- Efficiency

Does this sound like TUR to you?

Case 1: Energy/Raw Materials/Money

- Raw materials (organic solvents) have energy value; regulated to be burned via air permit
- Energy is captured during this process and recycled back to process coaters as heat
- Coater natural gas consumption is reduced (energy saved)
- Carbon footprint drops 6,000 TPY (carbon footprint reduced)
- This was presented at a TURI conference and can be found here: https://www.turi.org/Our_Work/Training/Continuing_Education/Recent_Training_Presentations/Continuing_Education_Conference_Fall_2012/Energy_Recovery_MADICO

Heat recovery oxidizer used to burn VOCs

Option	Annual Energy Change (Kwhrs)	Annual Energy Change (Therms)	Annual Cost Savings	Reduction in CO2 Footprint (tons/year)
Old Oxidizer Retired Subtotal	-28,970,076	-988,459	$1,285,000	5,931
2002-2009 Facility Consolidation Subtotal	-2,201,995	-75,132	$97,672	451

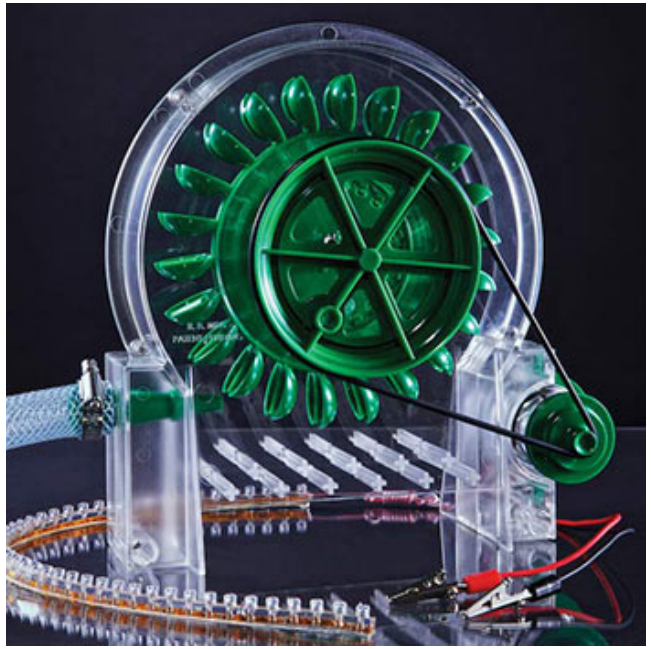
Case 2: Food Waste/Energy/Manure

- Maine's largest dairy farm had an issue with manure disposal
- They now run three biodigesters in the state, producing electricity, converting the waste to fertilizer to be reused on land used to graze cows
- The digesters run 40% food waste/60% manure produce CH4 that is burned to generate electricity (enough for 1600 homes)
- https://www.agricycleenergy.com/about-us/what-is-anaerobic-digestion/

Case 3: Water/Energy/Money

- Water turbines produce energy using pressure drop (DP) & water flow (GPM)
- Water turbines have HIGH efficiency of energy transfer (99% for Pelton shown below)
- Finding the right fit depends of the two variables the turbine uses
- Three residential water turbines power profiles below; then two industry examples

Design Parameter	Joe	Dan	Andy
Head (ft) -same as DP	1.7	35	75
Flow (gpm)	75	35	6
Water Turbine Supply			
Watts	24	230	78
Watt-Hrs/day	576	5,520	1,872
Kwhrs/month	17	165	57
Home Kwhrs/month Demand	400	400	400
Water Turbine Percent	4%	41%	14%
of Home Energy Demand			



Co-Gen Facility

https://www.calpine.com/westbrook-energy-center

- Calpine generates 552 MW electricity
- A co-generator has two turbines generating electricity, one uses steam, the other waste heat from the first pass turbine
- To generate steam for the first pass, water from Portland Water District (PWD) is the source. PWD gets the water from Sebago Lake.
- If a slipstream of incoming water could be run through water turbine, stepping down line pressure, energy could be extracted.
- You are tapping power from pressurized incoming city water from PWD pumping station.

Calpine Co-Gen (con’t)

- Incoming water flow = 174,000 GPM
- Water line pressure = 60 PSI
- Assume water turbine is 99% efficient
- Assume 10% slipstream run through turbine
- Power generated by water turbine: **300,000 watts** = 300 KW
- 300 KW x 24 hr/day =7,200 KWhr/day x 30 day/month **= 216,000 kwhr/month**
- Yes-- we are dealing with a power plant that doesn’t need extra power
- Or maybe it does, during a brownout or other emergency
- Let’s take a look at an electroplater using a water turbine

Electroplating

- Water use = 10 million gallons annually (~275 lb_m/min)
- Since the water flows through various tanks before hitting waste treatment and being discharged, why not grab some of that energy?
- Incoming water line pressure 70 PSI x 2.31ft head/PSI= **162 ft head**
- 162 ft lb_f / lb_m x 1.356 watt sec/ ft lb_f = **220 watt sec/ lb_m**
- 220 watt sec/ lb_m x 275 lb_m /min x min/60 sec = **1,007 watts**
- 1,007 watts x 24 hr/day x KW /1,000 watts x 30 day/month = **725 KWHR/month**
- This might help with the office lights, but for electroplating, this is a small contribution

Calpine Co-gen – Water Conservation

- During a field trip to the facility with SMCC students, one picked Calpine for his energy capstone project in the Intro to Engineering class
- Forrest noted the cooling towers were losing tremendous amounts of water vapor and wanted to capture the loss; Calpine spends $500,000/year for water
- His solution was an adaptation of fog nets used to condense water in arid climates, saving 30% of water used (108,765,936 gallons of Sebago Lake)

Forrest on left; these are the two water intakes at Calpine