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Sustainability Opportunities - Upcoming Technologies

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OBJECTIVES

- Research and develop novel waste-to-resource technologies capable to convert organic wastes into value-added fuel and chemical products
- Fulfill commercialization and technology transfer of new waste-to-resource concepts
- Educate the next generation of engineers, scientists and policymakers on waste utilization design and practice






MSU South Campus Anaerobic Digester

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Food Waste Recovery

Food waste in the U.S.

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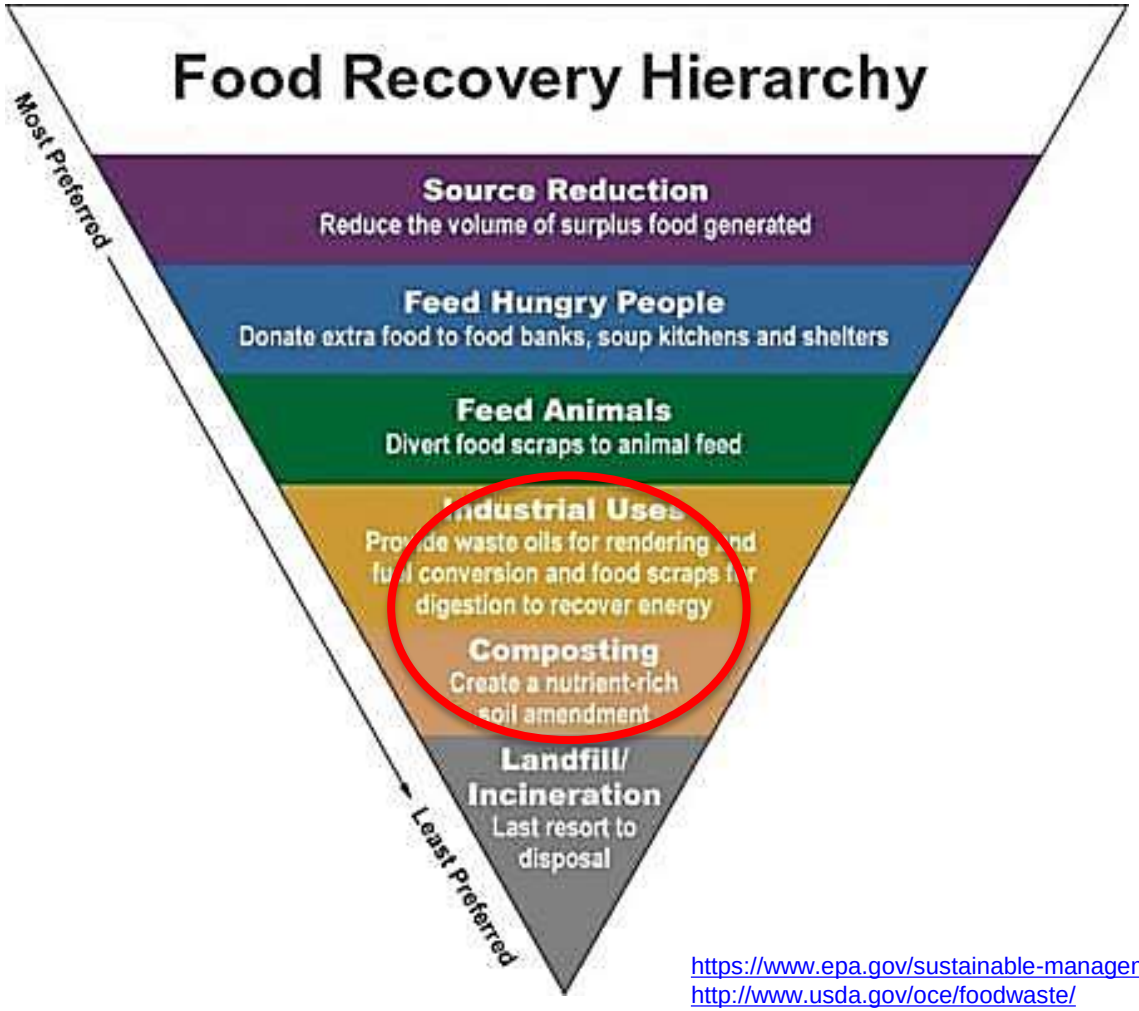
Approximately 40% of the food produced in the U.S. is wasted annually from farm to table

- Largest individual constituent of MSW at 21%
- 0.65 lb/person/day
- 37 million ton/yr (2013)
  - Only 5% beneficially reused
- Equivalent to $165 billon in lost value
- Worldwide food waste is about 33%

https://www.nrdc.org/food/files/wasted-food-ip.pdf
https://www.epa.gov/sustainable-management-food/sustainable-management-food-basics

EPA Food Recovery Hierarchy & Challenge



https://www.epa.gov/sustainable-management-food/food-recovery-hierarchy
http://www.usda.gov/oce/foodwaste/

EPA/USDA – National Food Waste Reduction Goal of 50% by 2030

State by State Organic Waste Regulation

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- Disposal bans, yard waste (24), food waste (5)
- Landfill diversion targets (7)
- Renewable portfolio standards (37)
- Organics recovery programs
  - Massachusetts (2014)
  - Vermont (2014) – commercial food waste, 104 ton/yr
  - Connecticut (2014) – commercial food waste, 104 ton/yr
  - Rhode Island (2016) – commercial food waste, 104 ton/yr
  - New York City (2015) – based on business size
  - California (2016) – commercial food waste, 8 yd/wk
  - San Francisco (EBMUD) – 120 tpd, 4.5 MW CHP
  - Ann Arbor – summer time collection, ongoing study

Michigan Organic Waste Opportunity

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Source	Approx. #	Food Waste Potential (ton/yr)	Assumption
Processors	550 - 700	260,000	1 ton/d, 350 d/yr
Retail	300	20,000	400 lb/d
Hospitals	110	2,000	0.6 lb/d/person
Correctional	31	5,000	0.6 lb/d/person
Universities	105	60,000	0.6 lb/d/person
Schools	930	80,000	0.6 lb/d/person
Food service	35,000	300,000	50 lb/d
Residential	4,540,000	1,000,000	0.6 lb/d/person
Sum		**1,727,000**	

Michigan Organic Waste Opportunity

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Source	Approx. #	Food Waste Potential (ton/yr)	Assumption
Processors	550 - 700	260,000	1 ton/d, 350 d/yr
Schools	930	80,000	0.6 lb/d/person
Food service	35,000	300,000	50 lb/d
Residential	4,540,000	1,000,000	0.6 lb/d/person
Sum		**1,727,000**	

- Landfill disposal fee $45,000,000 @ $25/ton
- 40 to 50 MW of baseload electric power potential
- Reduced greenhouse gas emission
- Fertilizer value???

Organic Waste Planning

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- Challenges
  - Packaging & contamination
  - Seasonality
  - Cleaning agents
  - Consistency
  - Unloading
  - Water content
- Pretreatment
  - Depacking
  - Grinding/maceration
  - Sterilization
  - Other

Biogas Utilization

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Renewable Fuel Standard

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The Energy Policy Act (2005) required EPA to implement a renewable fuels standard program (RFS)

- Version 2 effective July 2010
- Volumetric goals:
  - 36 billion gallons of renewable vehicle fuel by 2022
- Imposed obligations on petroleum refiners and importers called Renewable Volume Obligations (RVOs)
- Created “Renewable Identification Numbers” (RINs):
  - The “currency of compliance”
  - Generated by producers of renewable fuels
  - Used by gasoline refiners and importers to prove compliance

http://biomassboard.gov/pdfs/tac_2015_q3_dunphy.pdf
http://www.ascension-publishing.com/Disproving-Blend-Wall.pdf

Renewable Identification Numbers (RINs)

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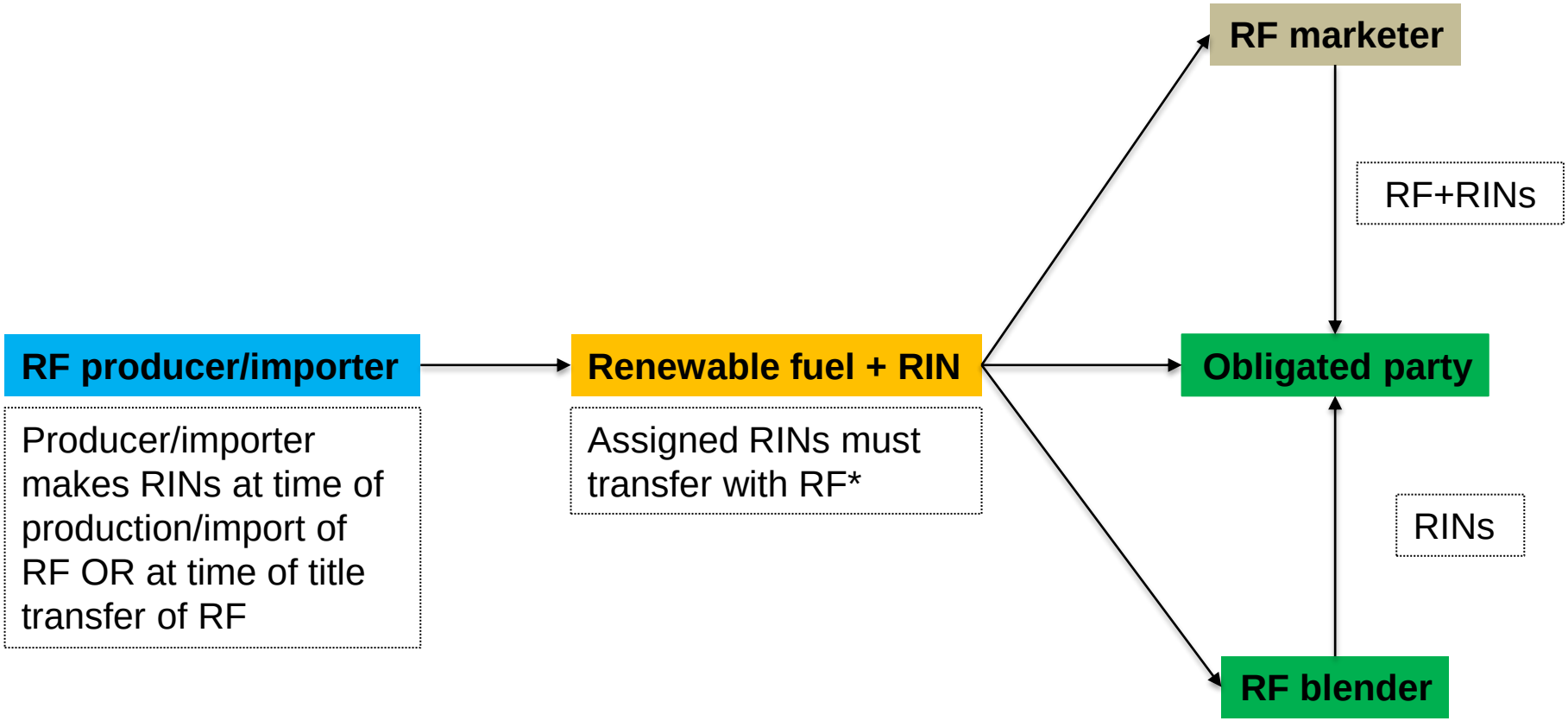
- Producers & importers generate RINs based on production volume & the Btu content of the fuel
- RINs can ONLY be generated if:
  - Fuel is used for transportation fuel, heating oil or jet fuel
  - Feedstock meets the definition of “Renewable Biomass”
  - Produced under an EPA-approved pathway (or grandfathered)
- Renewable fuels qualify only if produced from “Renewable Biomass”:
  - Products from planted crops & crop residue / trees & tree residue
  - Animal waste material & byproducts
  - Algae
  - Biomass cleared from the vicinity of buildings & other areas to reduce wildfire risk
  - Separated yard or food waste
- Multiple classifications based on fuel and GHG impact

Renewable Fuel/RIN Transaction Model



*RINs are fungible; can be transferred with any type of renewable fuel e.g. Today, a 2014 renewable diesel RIN can be transferred with a 2016 ethanol gallon

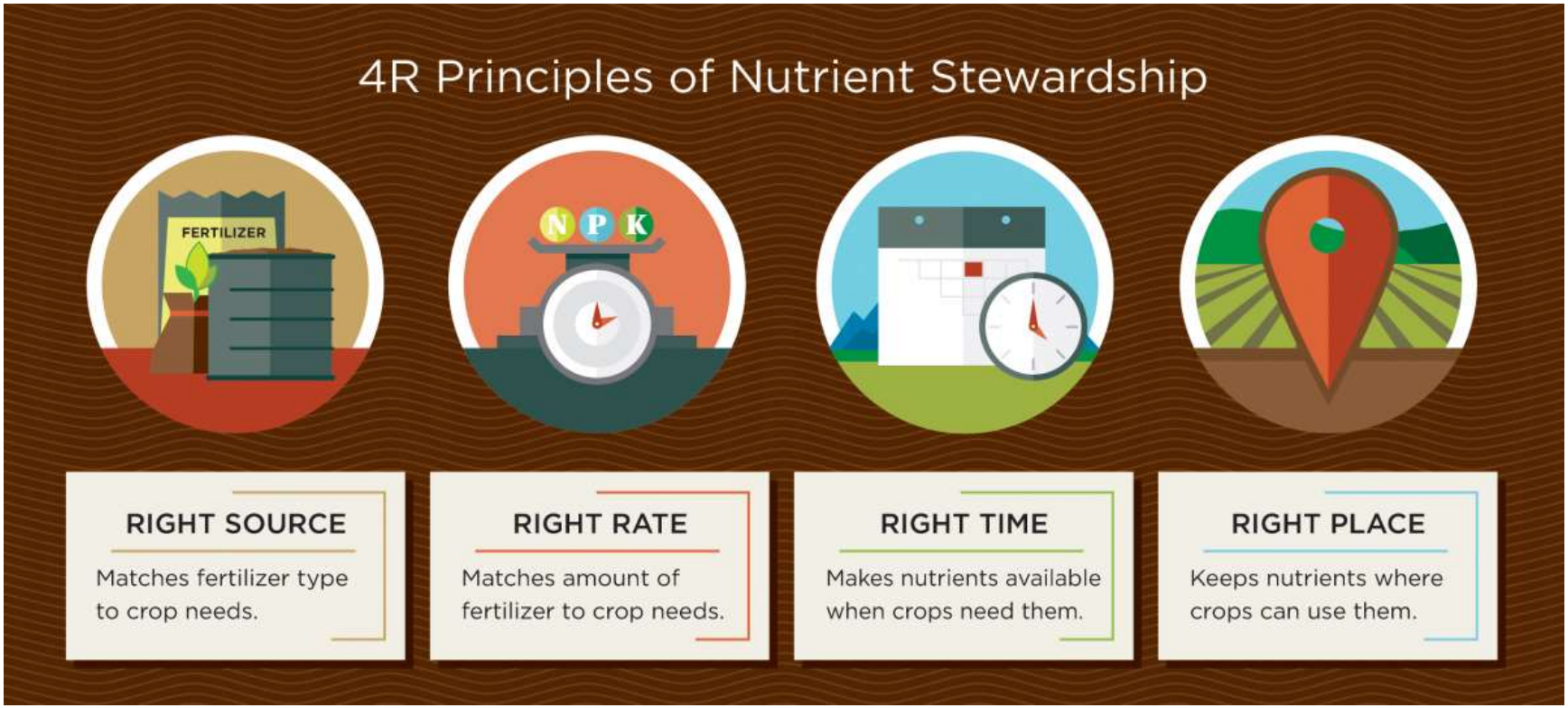
http://biomassboard.gov/pdfs/tac_2015_q3_dunphy.pdf

Biogas & RINs

- RIN D Code – D5, advanced biofuel
- Must be used for vehicle fuel
- Documented components & pathway
  - Electrical production used for electric cars
  - Upgraded to pipeline quality, converted to compressed natural gas (CNG) or liquefied natural gas (LNG) for use at a fueling station
- Projects need to registered with EPA and California Air Resources Board to maximize value
- Biogas (77,000 Btu's) has equivalence value of 1

Digestate Management

Nutrient Stewardship



Products & Markets

http://www.fertikal.be/en/process-distribution

Questions

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