What should Phoenix-Metro do with 200,000 tons per year of organic 'waste?'

RISN Resource Innovation and Solutions Network

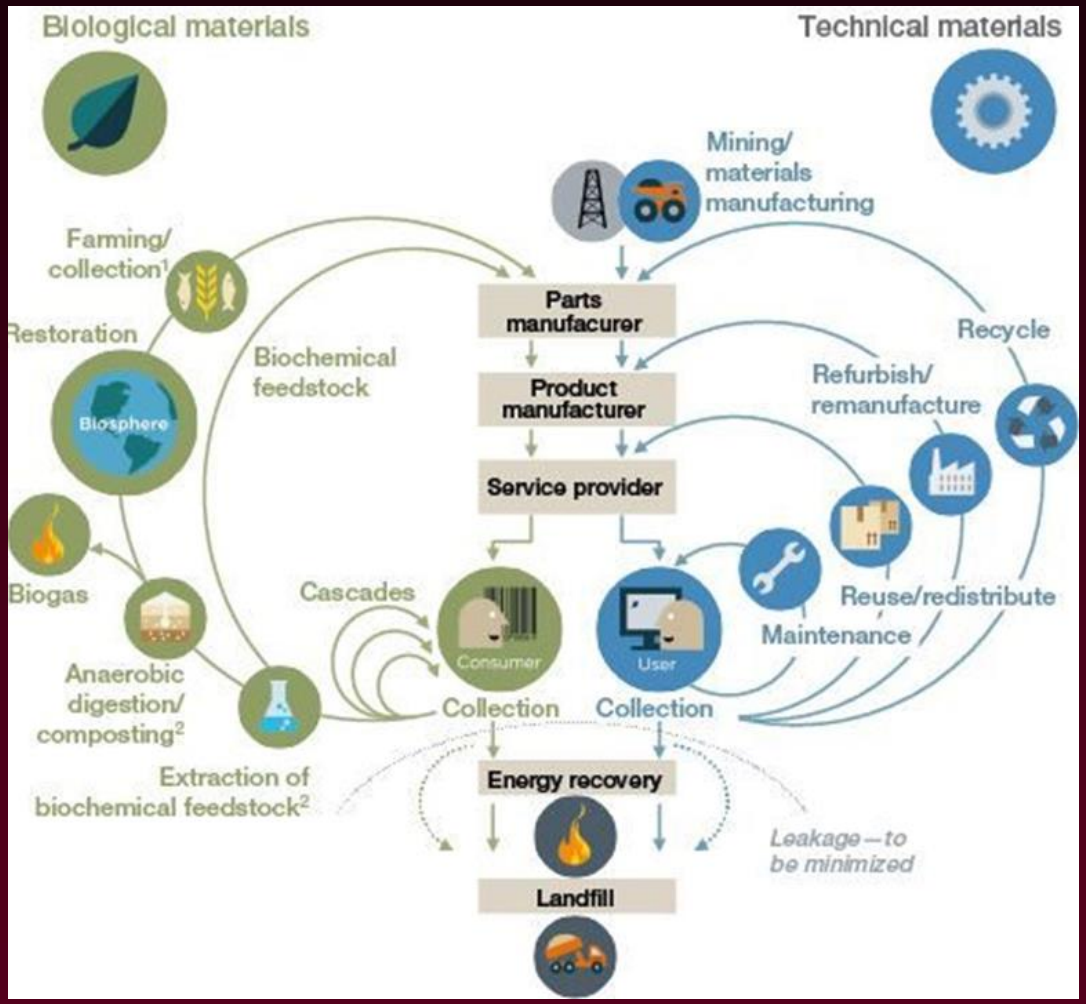
Creation of a Circular Economy for Organic Waste in the Phoenix-Metro Region

Haley Gilles, MSUS

Kimberly Kruse, MSUS & MPA

Circular Economy: an regenerative economy by design

Biological materials - designed to cycle the biosphere



Technical materials - designed to circulate with minimal loss of quality

Source: Ellen MacArthur Foundation

Powered by renewable energy

Project Definitions

- **Feedstock:** raw material supplied to a machine or processing plant (e.g. food waste/organics, plastic, paper, metals, etc.)
- **Green Organics:** grass and trimmings from trees and shrubs
- **Regionalization of Feedstock**: a regional systems approach for businesses and technologies as part of a strategy; a combination of consolidation from large sources and local use from smaller sources

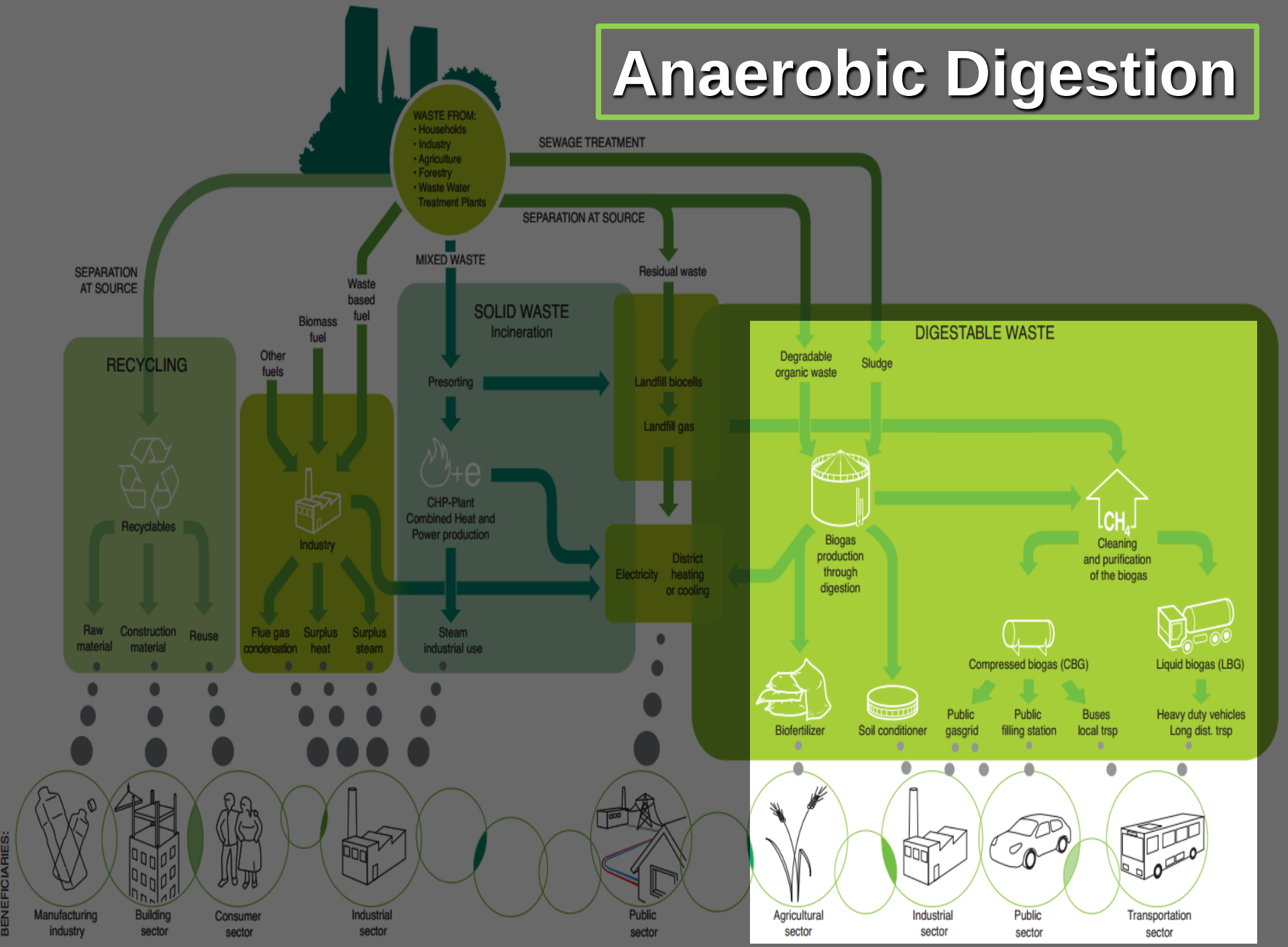
Phoenix Municipal Waste Characterization Study 2014

29 % Non-food waste (mostly green organics)

End-of-Life Options

- Circular Economy
  - Waste-to-Energy
    - Anaerobic Digestion
    - Incineration (not recommended)
  - Waste-to-Products
    - Mulch
    - Compost / Fertilizer
- Linear Economy - Landfill

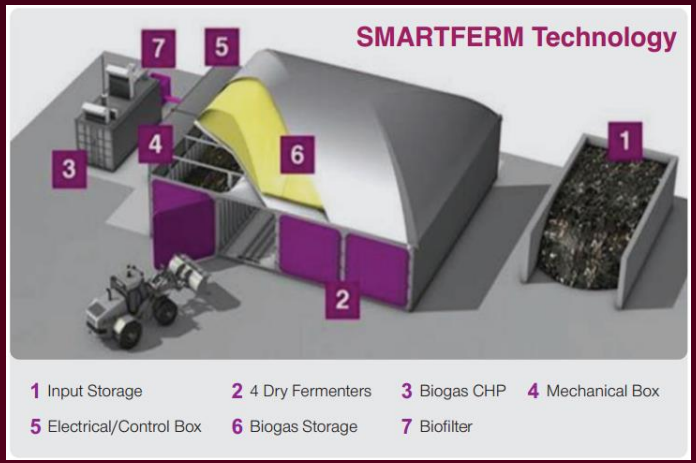
Anaerobic Digestion



Monterey Regional Waste District

SMARTFERM AD Process	Results
Annual Volume	Up to 5,000 TPY
Digester Dimensions	40' (L) x 12' (W)
Steel Digesters	4
Residence Time	21 Days
Mode of Operation	Thermophilic (125-131°F)
Biogas Yield (CF/Ton)	3,000 - 3,200
Methane Content (%)	58 - 60
Electrical Output	100 kW
Finished Compost @ 40% Moisture Content	2,200 TPY
Total Diversion	+99%

- Opened Feb 2014
- 5,000 TPY
- 21 day batch process
- Fuels 5 dump trucks routes annually



Financials on AD in Phoenix

Revenue opportunities	5 Digester Concrete 25,000 TPY	$/ton (25,000 TPY)
tipping fees/landfill avoidance of organics ($55/ton)	$ 1,375,000.00	$ 55.00
Biogas Upgrade ($2.25/DGE) 298,981 DGE for 5 concrete digesters	$ 672,707.25	$ 26.91
Digestive composting after processing ($10/ton at 90%)	$ (225,000.00)	$ (9.00)
Carbon Credits @ $12.47/MTCO2 or $2.94/inbound ton	$ 73,535.71	$ 2.94
Renewable Identification Number (RINs) @ $.80/RIN or $1.35/DGE	$ 402,264.80	$ 16.09
TOTAL REVENUE OPPORTUNITIES:	**$ 2,298,507.76**	**$ 91.94**
Operating and SG&A Costs		
Transportation and Disposal of Residual	$ -	$ -
Labor (equipment operators, PT Mechanic and Laborers)	$ 66,937.00	$ 2.68
Equipment variable (PMs, routine maintenance, equipment ops and consumables)	$ 186,345.00	$ 7.45
Utilities, Indirect, and Operations Support	$ 255,250.00	$ 10.21
SG&A	$ 63,329.00	$ 2.53
TOTAL OPPERATING AND SG&A COSTS	**$ (571,861.00)**	**$ (22.87)**
SMARTFERM Capital Costs		
Systems Design, Permitting Support and Engineering	$ 445,000.00	$ 17.80
Base SMARTFERM Technically Package and Civil Construction	$ 6,689,227.00	$ 267.57
Biogas Upgrading System	$ 1,970,207.00	$ 78.81
SMARTFERM Installation	$ 661,111.00	$ 26.44
STARTFERM Start-up and Performance Testing	$ 113,000.00	$ 4.52
Total SMARTFERM Capital Costs	**$ 9,878,545.00**	**$ 395.14**
Composting System		
Aeration Bay/Receiving Bay/Mixing Hall	$ 395,000.00	$ 15.80
In Vessel Composting (Ammonia Scrub)	$ 894,832.00	$ 35.79
In Vessel composing (capital)	$ 4,474,160.00	$ 178.97
TOTAL COMPOSTING CAPITAL COSTS	**$ 5,763,992.00**	**$ 230.56**

Initial: $3.1 million for 5,000 TYP

Recommendations

- **Regionalization but not Consolidation**
  - Create market demand for product
  - Economies of Scale
  - Consistent messaging for residents/providers
  - Compartmentalized, non-continuous
  - AD facilities at every MRF
    - Decrease dump truck miles
    - Increase access for locals to compost
    - Create more local jobs

Compost - Current State

Table 25. Residential food waste collection and composting programs in the U.S., 2012

State	Households Served
California	1,269,724
Colorado	19,014
Iowa	39,400
Massachusetts	3,600
Michigan	43,500
Minnesota	38,665
Ohio	73,813
Oregon	213,728
Pennsylvania	3,400
Vermont	2,700
Washington	770,458
Total U.S. Households Served	2,478,002
Total U.S. Households	114,991,725
Households served percent of total households	2%

BioCycle March 2013. Residential Food Waste Collection In The U.S. — BioCycle Nationwide Survey. Supplemental tables. Additional web search to supplement *BioCycle* survey.
In addition, New York City initiated a pilot program in 2012. In 2013, over 30,000 households were served.

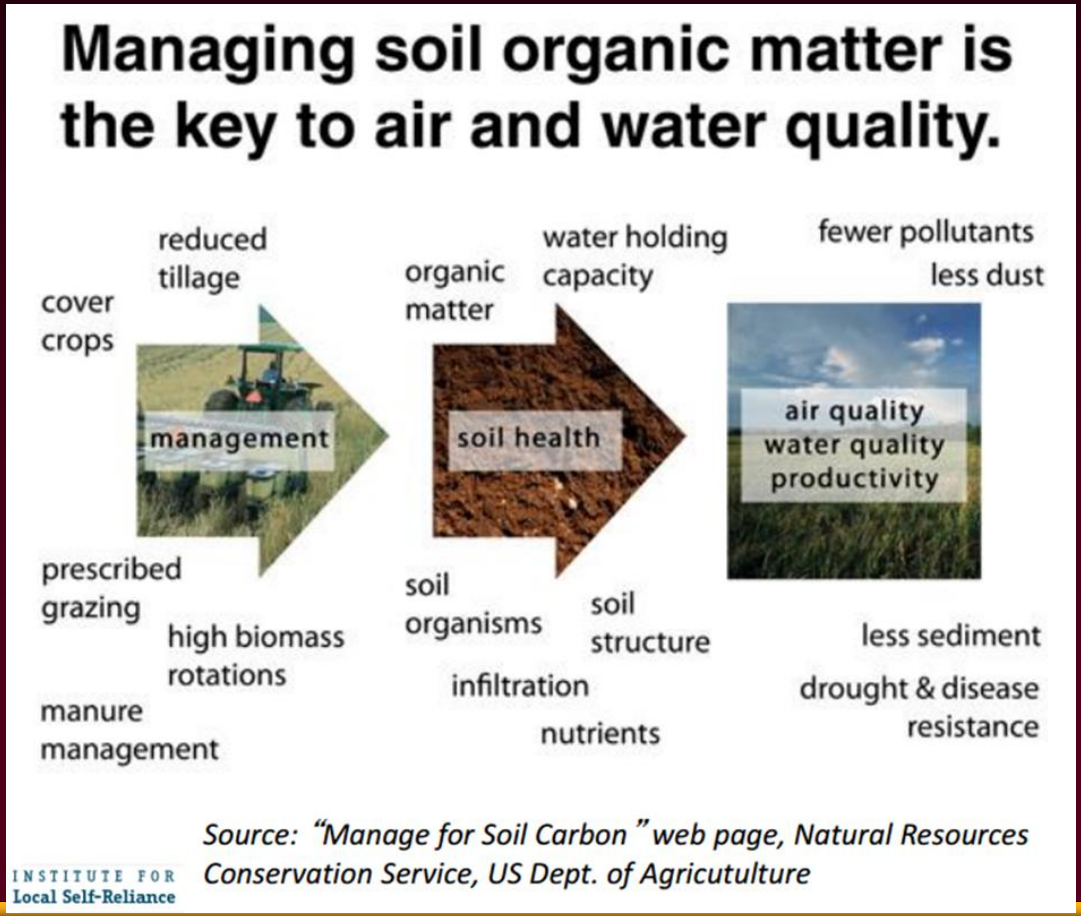
http://www.epa.gov/epawaste/nonhaz/municipal/pubs/2012_msw_dat_tbls.pdf

Compost

- controlled, biological decomposition of organic matter, such as food and yard waste

Nationally

- **$27 billion/year** associated with the loss of topsoil, nutrients, water quality, and production caused by water erosion



Sources: BoulderColorado.gov; EPA.gov

Health & Environmental Benefits of Composting

Table 5. Greenhouse Gas Benefits Associated with Recovery of Specific Materials, 2012*
(in millions of tons recovered, $MMTCO_2E$ and in numbers of cars taken off the road per year)

Material	Weight Recovered (millions of tons)	GHG Benefits $MMTCO_2E$	Numbers of Cars Taken Off the Road per Year
Food, other^	1.74	1.4	290 thousand
Yard trimmings	19.6	0.8	170 thousand

^ Includes recovery of other MSW organics for composting.

Source: WARM model (www.epa.gov/warm)

Every year about 3M people worldwide suffer severe pesticide poisoning

Summary of Per Ton Emissions by Management Method

(Pounds of Emissions (Reductions)/Increase Per Ton)*

MANAGEMENT METHOD	Climate Change (eCO_2)	Human Health – Particulates ($ePM_{2.5}$)	Human Health – Toxics (eToluene)	Human Health – Carcinogens (eBenzene)	Eutrophication (eN)	Acidification (eSO_2)	Ecosystem Toxicity (e2,4-D)
Recycle/Compost	(3,800)	(5.00)	(1,400)	(0.47)	(1.80)	(20.0)	(5.90)
Disposal	(112)[59]	0.61	301	0.06	0.16	3.8	0.46

**Based on Green Economy composition of recycled/composted materials and of disposed materials. Disposal emission factors are the Green Economy Scenario weighted average (by tonnage) of those for landfilling and incineration. See Appendix E for MEBCalc™ documentation.*

Recommendations

- **Sell it**
  - Agricultural use
  - DOTs (EPA's Compost Use on State Highways)
  - Parks – create city contract
  - Nurseries & Landscapers
  - Big-box home & garden retailers
  - Golf courses (low demand in Phoenix-Metro)
- **Donate it**
  - "We (City of Phoenix) need to show how easy it is and the benefits of growing your own food."
    – Terry G.
    - Home gardens
    - Community and school gardens

California's Circular Economy
from (all) recycled feedstocks support:

- 5,300 businesses
- 85,000 estimated jobs
- $4 billion annual payroll
- $10 billion annual goods/services

Products from Organic Waste

Compost	33%
Mulch	13%
Boiler Fuel	22%
ADC	23%
Beneficial Reuse at Landfills	5%
Other	4%

Source: CalRecycle

Economic Impacts of a Circular Economy

- **Economic Development**
  - **New businesses** – new generation of designers and engineers
  - **Job creation** – for every 1 million tons of organic material composted and used locally, almost **1,400 jobs (at $16-20/hr)** are created each year
  - **Capital investment** – new infrastructure
  - **Revenue stream** – commodity, sell for profit
  - **Tax Revenues** – nationally, recycling and reuse industries are reported to generate **~$12.9 billion** in federal, state, and local tax revenues (NERC 2009)

Source: Institute for Local Self-Reliance, 2014

Economic Impacts of a Circular Economy

- **Business partnerships** – join together for entire supply chain: collection, processing, distribution, use
- **Industry clusters** – include the entire industry of funders, support systems, etc. (e.g. Silicon Valley)
- **Innovation** – new technology and processes
- **Reduce recycling costs** – products are made to be recycled or reused
- **Recognition / Marketing** – branding as green, eco-hub to attract:
  - Tourism
  - Recruitment – Talent and Business

Economic Impacts of a Circular Economy

- **Resource efficiency** – better use and reuse assures less materials input
  - **Price stabilization** – not reliant on fluctuating commodity market
  - **Resource security** – not reliant on outside or scarce resources
  - **Risk reduction** – decreased vulnerability due to decreased material needs
- **Value creation** – materials used over and over again in lifecycle

Environmental Impacts of a Circular Economy

- **Healthier systems**
  - Land productivity and soil health
  - Avoided hauling and landfill use
  - Utilizing gases as a resource for its next useful life (e.g. fuel)
- **Lower GHG emissions** from
  - Waste transportation – fewer miles travels
  - Landfill gases (mostly methane)– greater diversion rates

Social Impacts of a Circular Economy

- **Community Empowerment - empower people to make the city by acknowledging citizens to be the driving force in creating, keeping and sustaining the city (Almere Principle #7)**

- **Eliminate the *concept of waste* – shift to a more sustainable mindset (Hanover Principle #6)**

Challenge	Solution
Logistics & Standardization	**High-diversion Community**
Collections, diversion, and contamination are all difficult to manage	One that is under private management with exclusive franchise to the local government. These communities have enforceable, mandatory participation but also offer collection of more types of feedstocks, “pay-as-you-throw” fee for refuse, and a flat monthly fee for recycling. The average cost per ton to collect multifamily recycling in the low-diversion group is $177 vs. $113 in the high-diversion group.

Challenge	Solution
Policy and the Public:	**Education and Outreach:**
Implementation and compliance can be challenging when people are asked to change their behaviors.	Enact diversion mandates and disposal bans, such as mandating that city departments (e.g. Parks and Recreation) use only city-produced mulch/compost and residential organics collection. Then provide training and educational courses, hold community outreach events, and encourage home composting and gardening

Challenge	Solution
Offtake	**Market development with pricing structure**
There is less demand for compost and mulch in the Phoenix area due to the desert climate	The benefits and users of compost are vast. However, a closed loop must be created with market development and a commodity pricing structure similar to recycled bottles, cans, paper, etc
Ground Level Ozone	**Capture all emitted gasses**
VOCs that discharge from compost can influence the Phoenix area to be in "non-attainment" and frequently in violation of EPA requirements	Covered or indoor composting with gas capture, or anaerobic digestion systems like SMARTFERM®

Challenge	Solution
Technology	**Partnerships & Financing**
Today's technology is still new and evolving ; is sensitive to inputs	Build partnerships and create financial programs to encourage AD improvements to accept a larger variety of feedstocks. Ex: grants for research and pilot programs, and loans for new infrastructure and market development.
Low Quality Compost	**Add Food Waste**
There is not enough nitrogen content in final product	Collect food waste with the green organics to have a higher value product

Recommendations

- **Education & Community Outreach**
  - “We (the City of Phoenix) have been selling thousands of composters for only $5 each for at least 20 years. With that gives us an opportunity to educate on how to use them. We might have these, but not many come and those that do, they don't last long as gardening takes patience and time...which our society doesn't do well yet. That's what we need to show is how easy it is and the benefits of growing your own food.”

Source: Anonymous employee, City of Phoenix, Public Works

Recommendations

- **Research**
  - **Collect data on avoidance savings such as cleaner air from not hauling and less landfill decomposition**

Solution	Soft Approach	Strong Approach
Eco-design	Recommend use of “preferred” plants	Mandate plant use
Landfilling	Incentive for greeen dumping	Fines for mis-dumping
Change Framework	Education and communtiy outreach, voluntary participation	Mandatory participation

State	Grants	Loans	Technical Assistance	Diversion Mandates	Disposal Bans	Outreach & Education	Operator Training Courses
Arizona	No	No	No	No	No	No	No

Source: State of Composting in US, ILSR, 2014. Research by BioCycle