Enabling the Future: Advancing Resource Recovery From Biosolids

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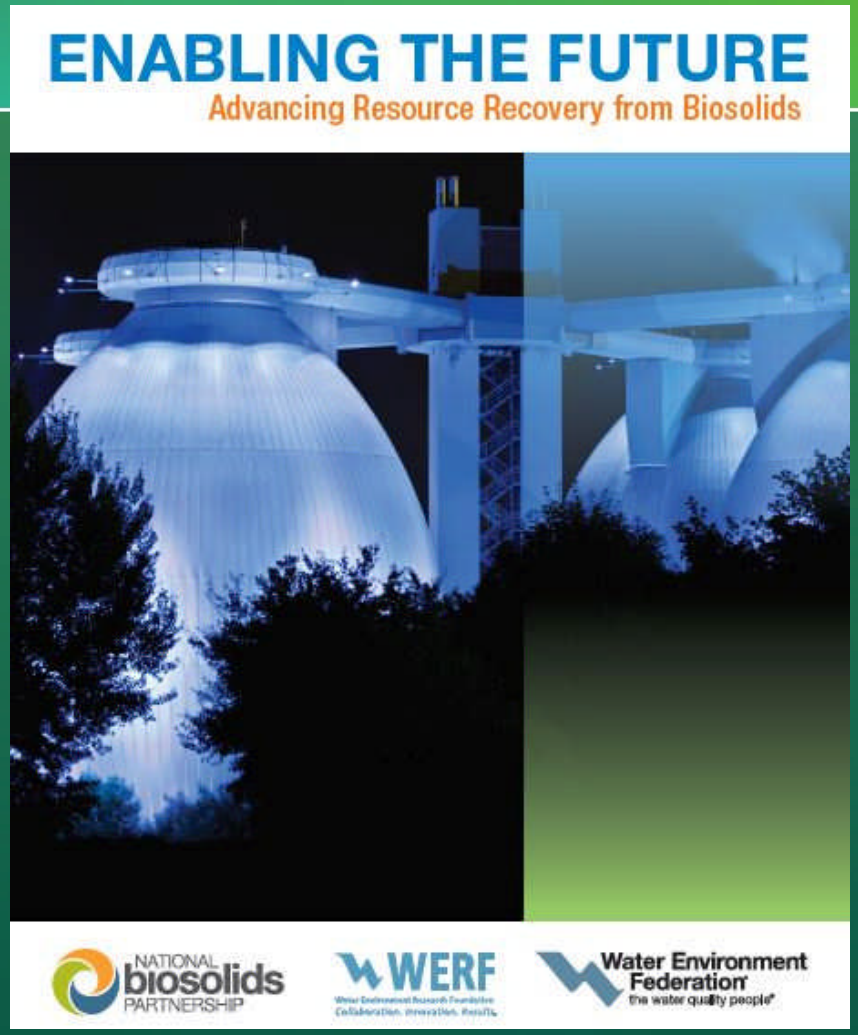


Today's Focus Areas: Regulation, Policy, Resources

Wastewater solids are recognized as a source of multiple recoverable assets.

Nutrients

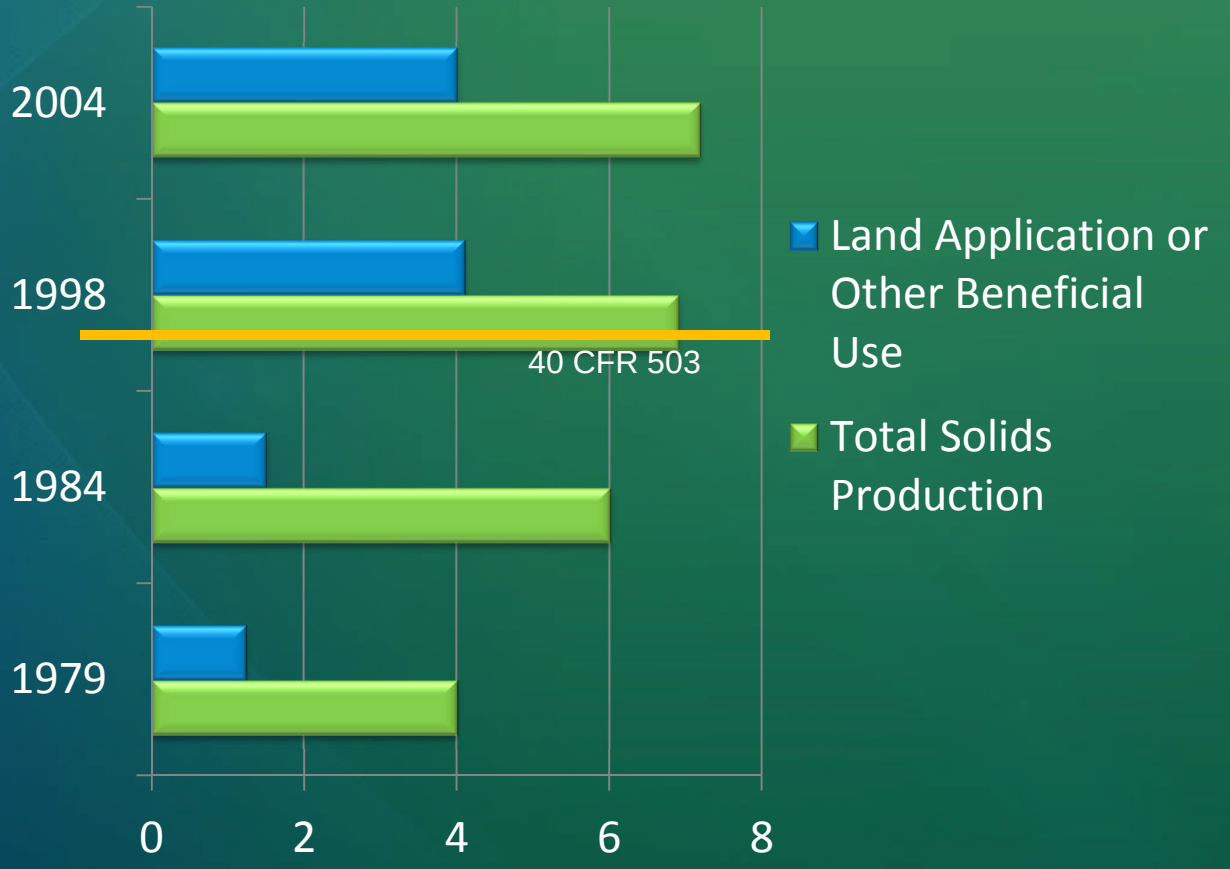
Energy

Organics

Water

Resource Recovery

Regulation as a Driver for Practice



Derived from: Metcalf and Eddy, 1978; EPA, 1984; Rios, 1992; EPA, 1999; Beecher et al., 2007

Regulatory Trends: Stringency Varies

Federal/National:

- SSI/Sludge Definition
- NRCS Code 590
  (Nutrient Management)

State:

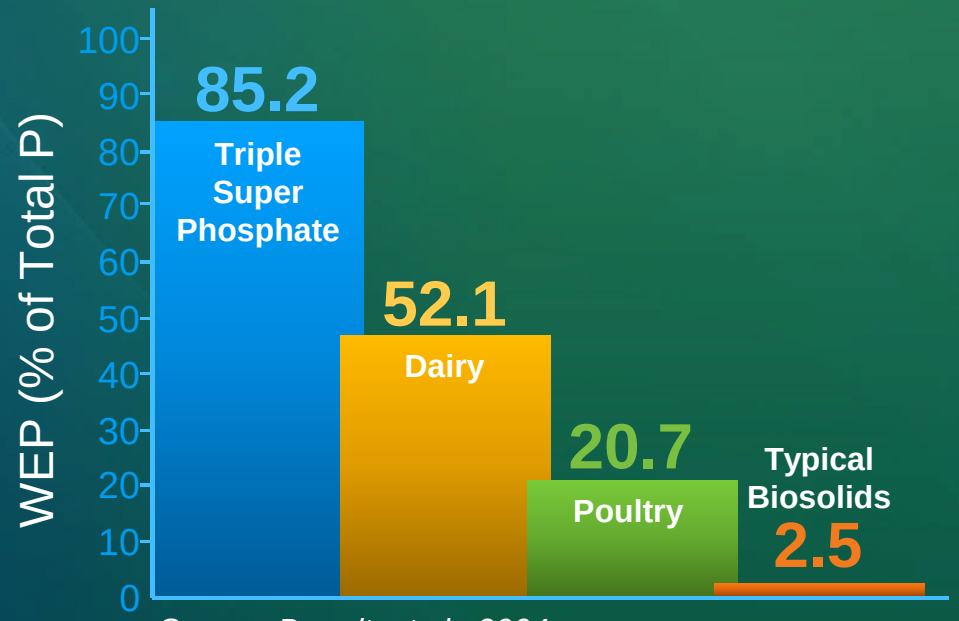
- Co-digestion/Co-composting

EPA Sewage Sludge Definition and Legitimacy Criteria

- March 2011: EPA expressly clarified that sludge is non-hazardous waste if combusted
  - Can be considered "renewable fuel if:
    - Has meaningful heat value
    - Is managed as valuable commodity
    - Contaminants ≤ traditional fuels
- February 2013: New categorical non-waste determination process promulgated
  - Possible mechanism to demonstrate biosolids as renewable fuel

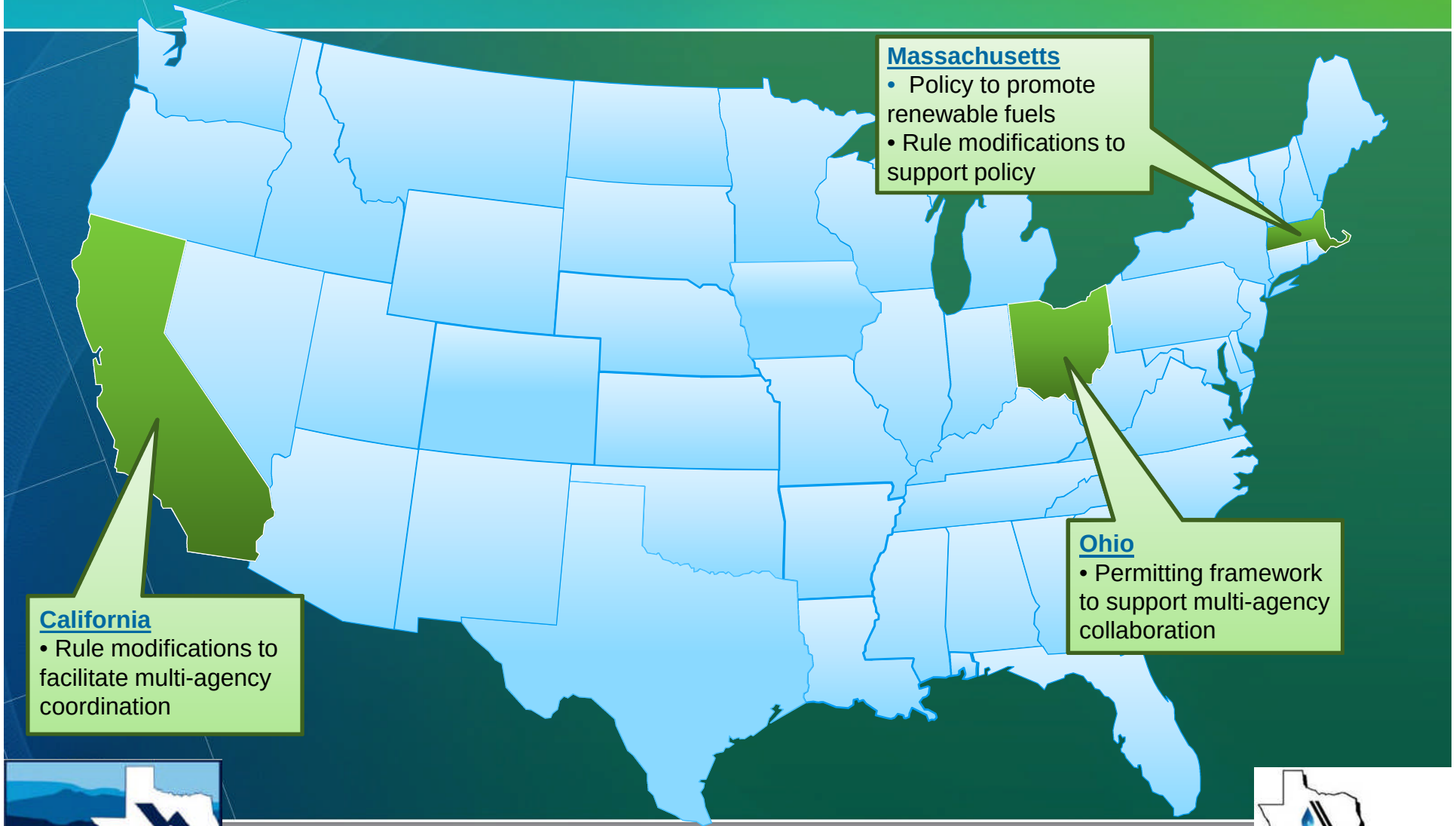
NRCS Code 590 Standard Revision (Nutrient Management)

- National standard issued 2012, states to tailor by early 2013
- Explicitly includes biosolids
- Concerns: weight of law, P Index, lack of source coefficients

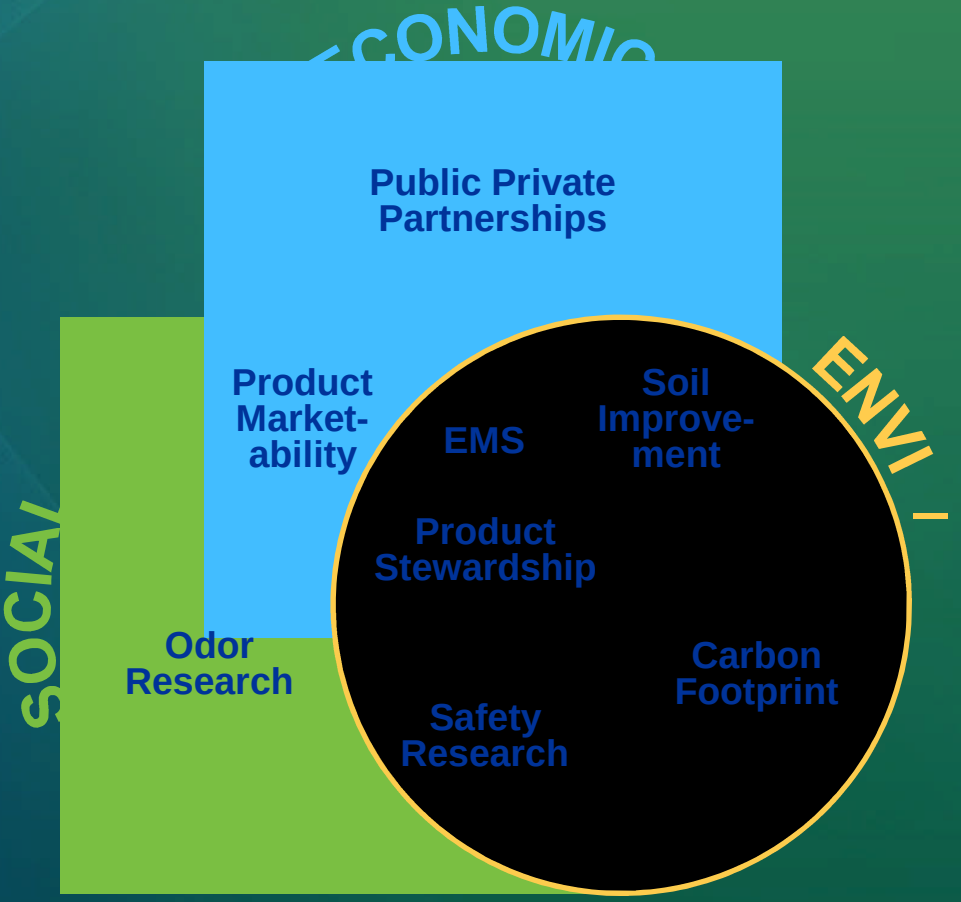


Source: Brandt, et al., 2004

"Zero Waste" Initiatives are Driving State Efforts to Facilitate Co-digestion



Resource Recovery Viewed Through Sustainability Perspective



Product Marketability Criteria vs. Regulatory Criteria

Compost	Heat-dried Product
• pH • Soluble salts/Salt Index • Nutrient content • Water-holding capacity • Bulk density • Moisture content • Organic matter content • Particle size • Maturity (phytotoxicity) • Stability • Odor	• Particle Size • Nutrient content • Durability (hardness) • Dust • Odor • Bulk density • Soluble salts • Heating value

Industry Will Need to Lead Marketability Criteria Development: For Compost, Consider USCC Model

- Seal of Testing Assurance (STA) Program
  - Underpinned by robust product/process-specific test methods
  - Goal is uniformity
- Rigorous enough to support specification development. Result in Texas:
  - Included in TxDOT specs
  - TxDOT is largest single compost user in nation (300,000 cy/yr)
  - Almost all Texas composters are STA members

US Composting Council

Voluntary Programs Support the Move to Improved Biosolids Quality

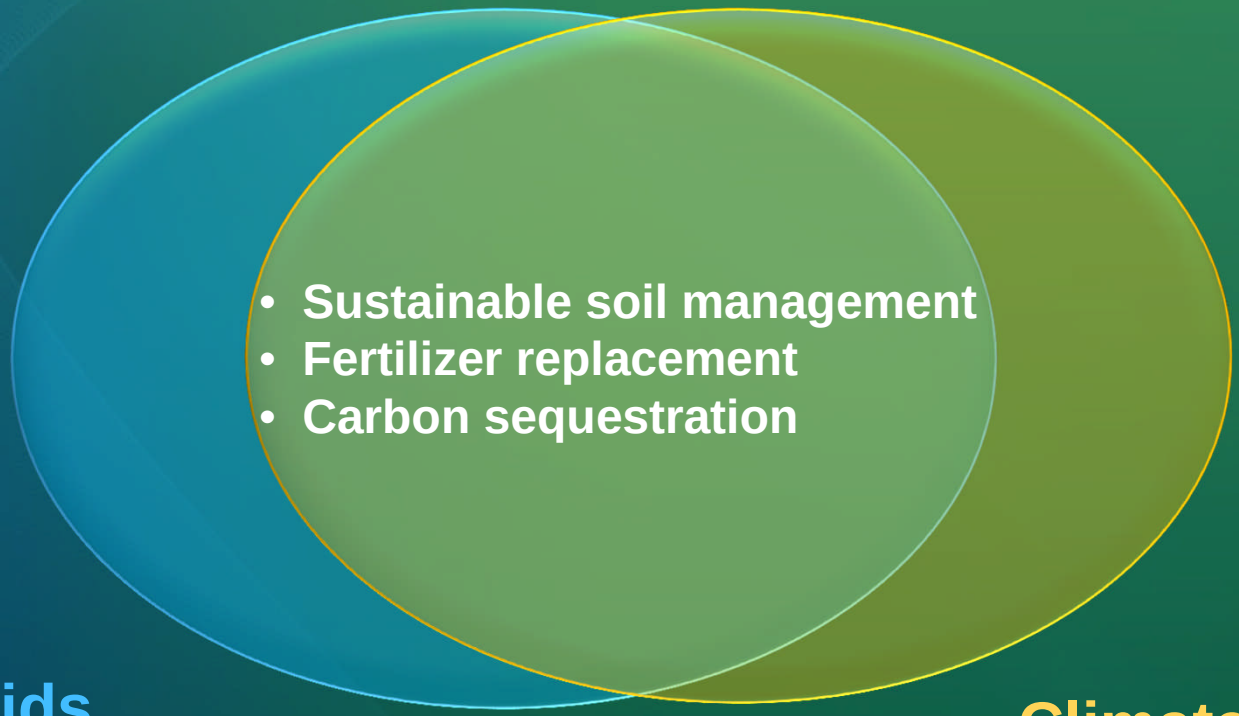
NBP EMS

- New tiered system increases flexibility
- Platinum certification remains
- Bronze, Silver, Gold recognition tiers

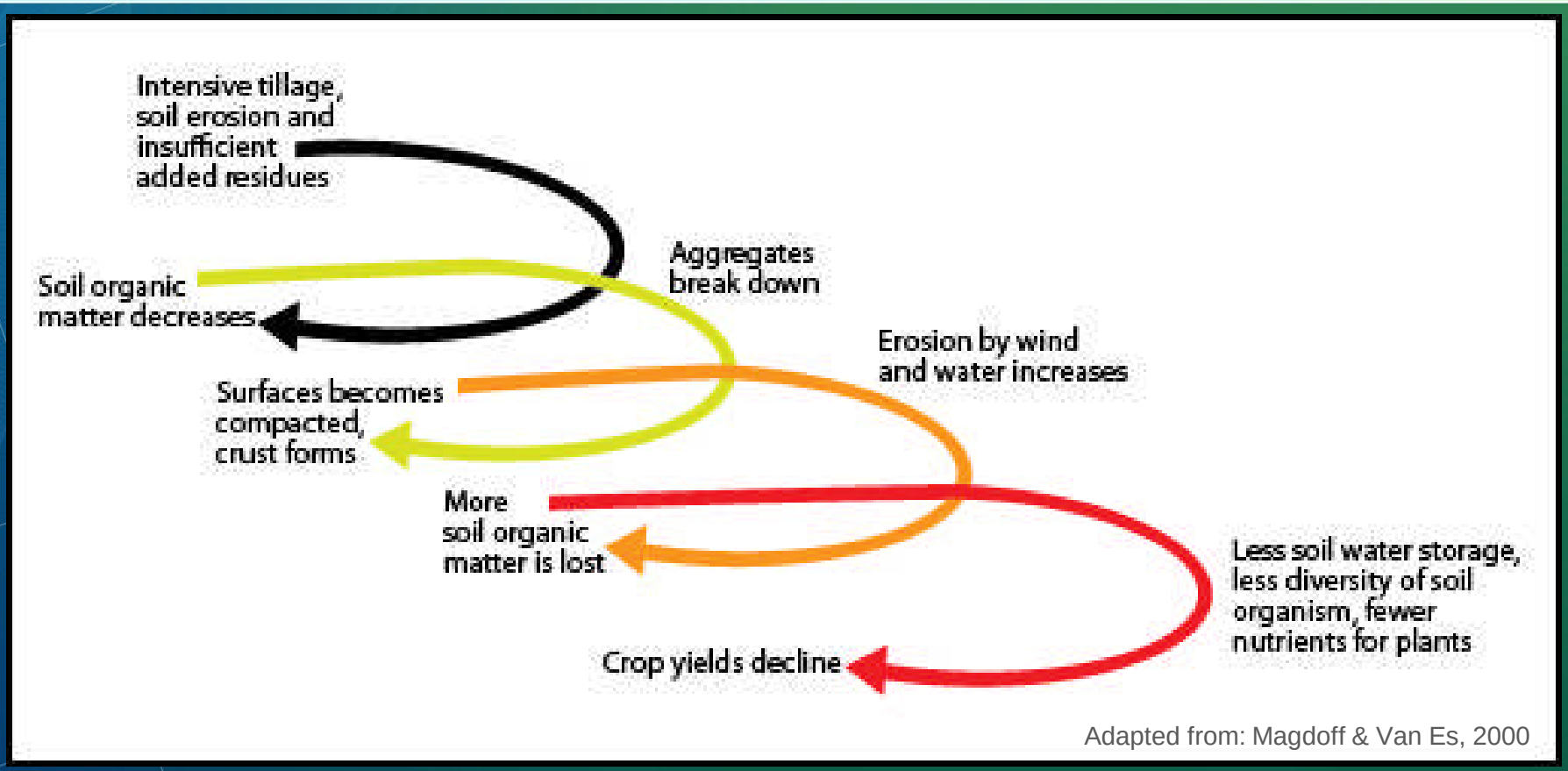
Product Stewardship

- Focus is near-term reduction of PPCPs
- SMAR$_x$T Disposal™ collaboration of USFW, Walmart and others
  - Promotes alternatives to flushing medications
- Product Stewardship Institute
  - Working with manufacturers to minimize environmental impacts

A New Perspective on Organics Recycling: Biosolids and Climate Change



The Soil Degradation Spiral

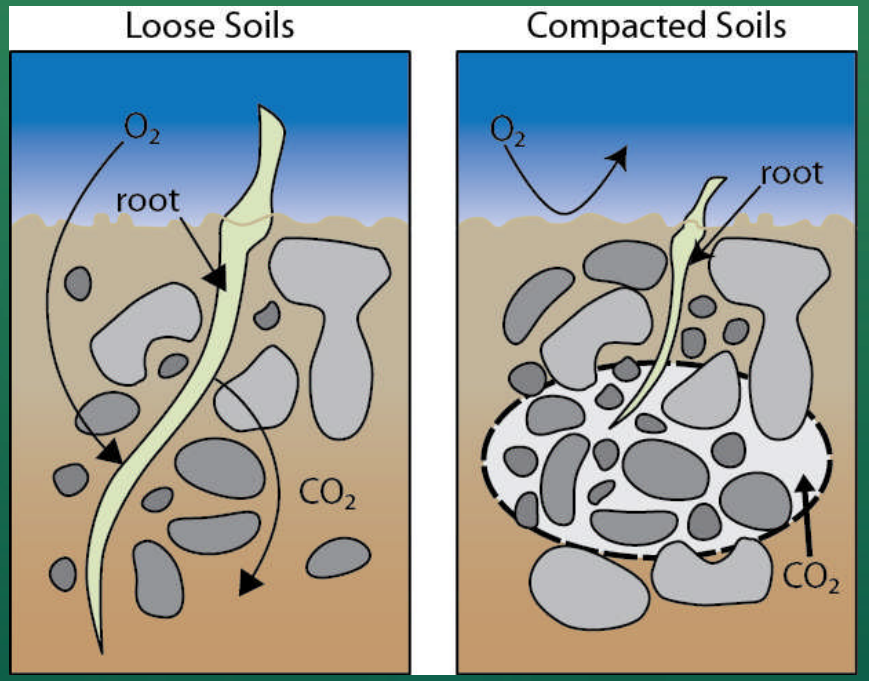


Adapted from: Magdoff & Van Es, 2000

Organic matter levels have declined 30% to 50% in many areas of the US

Poor Soils Bring Increased Energy Requirements

- Low SOM = compaction = weaker crops
  - ↑ Fertilizer
  - ↑ Pesticides
- Can increases energy for tillage by 50%
- Can reduce yields 10-20%
- Reduces water penetration

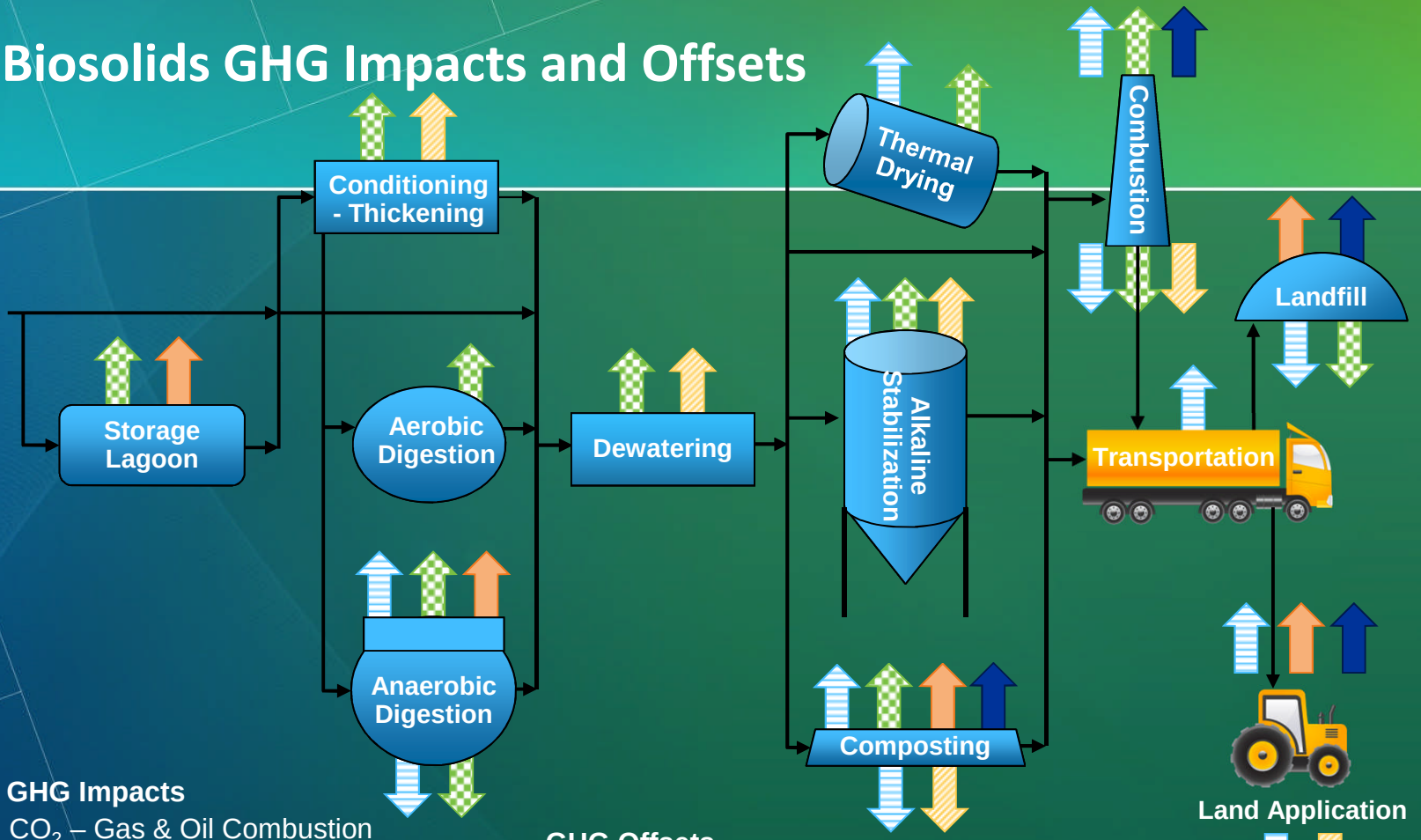


Adapted from: Magdoff & Van Es, 2000

Biosolids Can Replenish Poor Soils

About 60 to 70% of the soil organic matter lost from US mid-western soils could be replenished through the adoption of recommended soil and crop management practices, such as the conversion from plow till to no till, the “liberal use of biosolids” and other practices. (Lal, 2002)

Biosolids GHG Impacts and Offsets



GHG Impacts

- CO_2 – Gas & Oil Combustion
- CO_2 – Purchased Electricity
- CO_2 – Polymer Use & Lime Use
- CH_2 – Methane Emissions
- N_2O – Nitrous Oxide Emissions

GHG Offsets

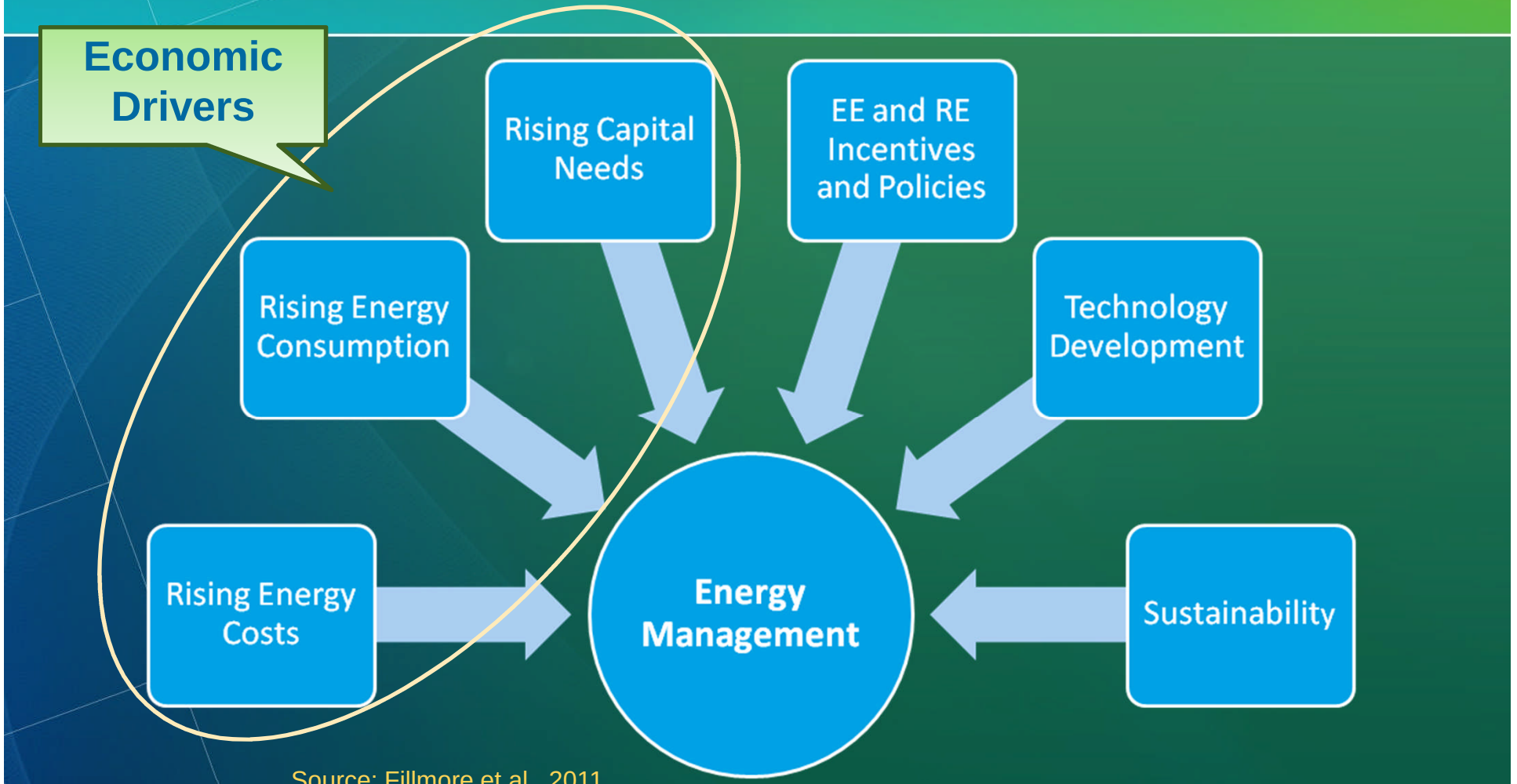
- CO_2 – Avoided Gas & Oil Combustion, Carbon Sequestration
- CO_2 – Avoided Purchased Electricity
- CO_2 – Avoided Fertilizer Use, Avoided Cement Manufacture

Source: Brown, Beecher and Carpenter, 2010

Carbon Accounting for Biosolids

- Biosolids Emissions Assessment Model (BEAM) includes default credit values:
- Fertilizer Replacement
  - Based on total nutrient content
  - 4 kg CO_2 per kg N
  - 2 kg CO_2 per kg P
- Carbon sequestration
  - 0.25 Mg CO^2 per dry Mg biosolids
- Values conservative
- Additional data needed:
  - practice diversity, nitrous oxide emissions

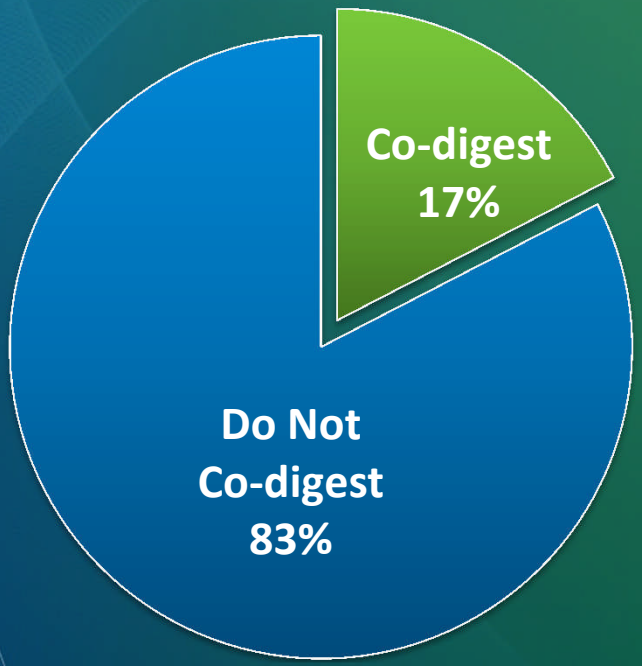
Energy Recovery: Economics are Driving Change



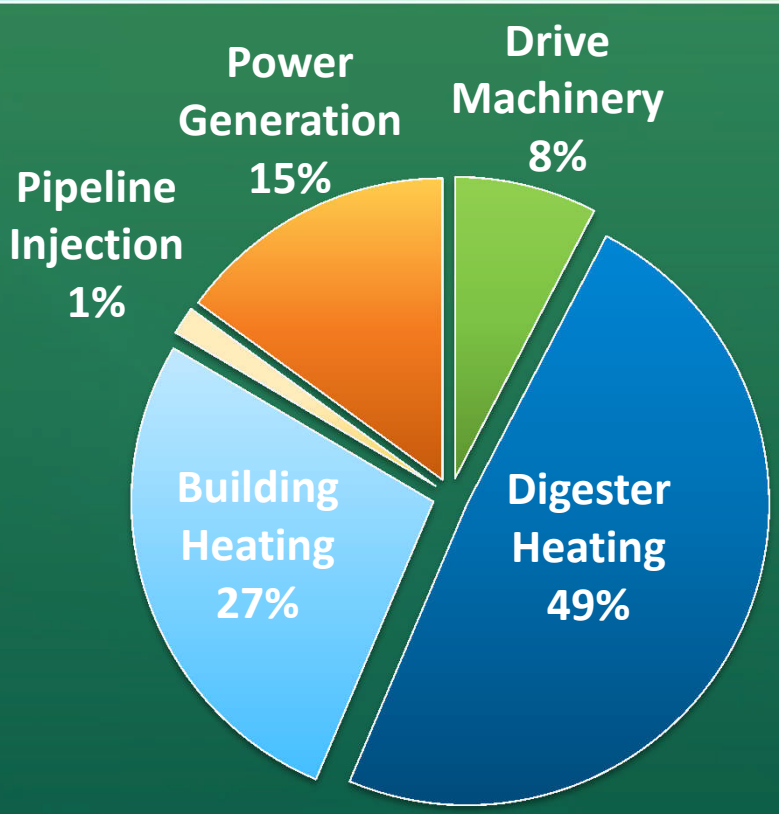
Source: Fillmore et al., 2011

National 2012 Survey on Biogas Generation and Use

Source:
www.biogasdata.org



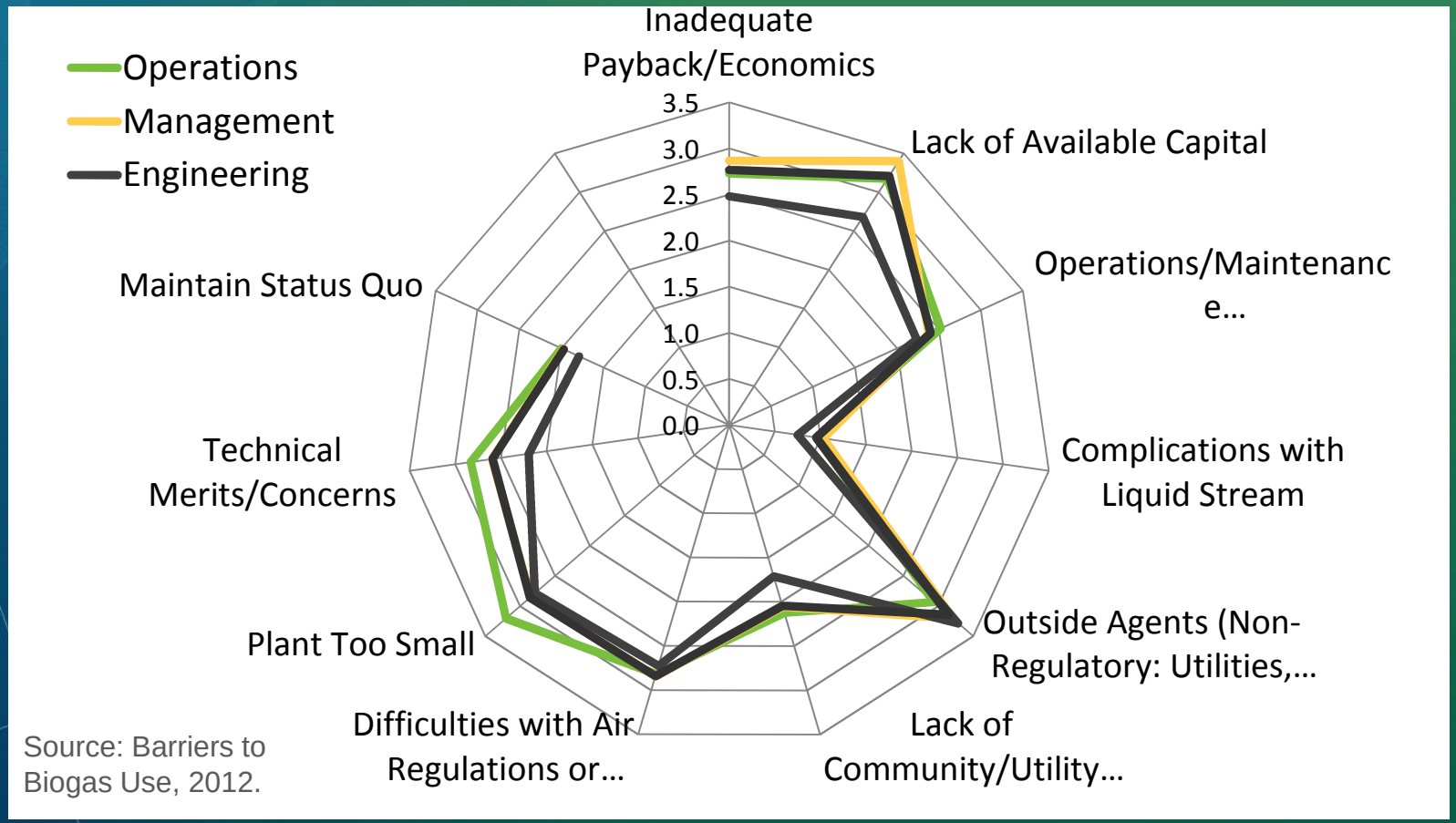
Increasing focus on maximizing biogas via co-digestion or other means



Only about 300 WWTPs currently use gas for power production

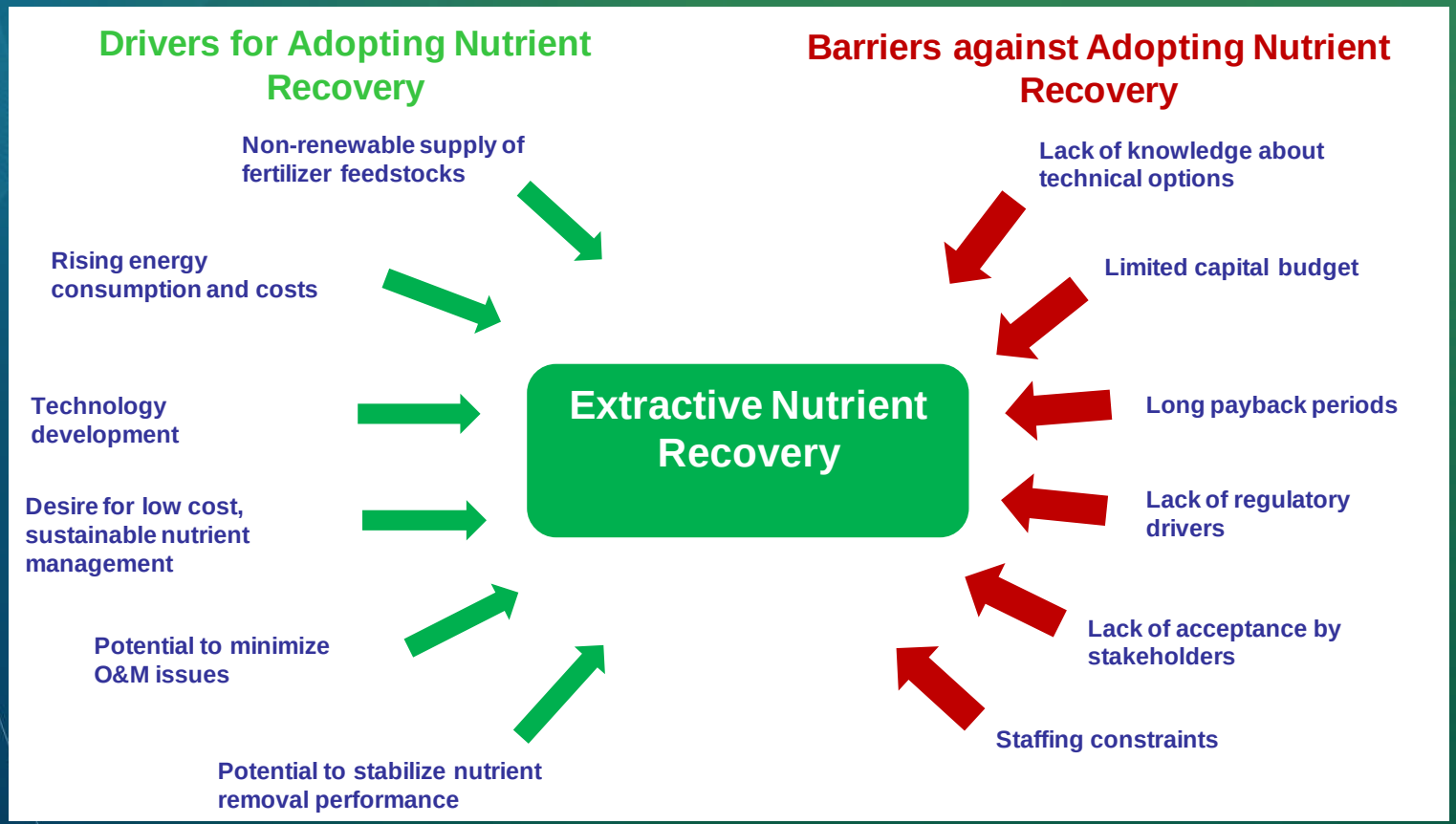
Biogas Use Barriers

Based on a survey of over 200 utilities, economic barriers dominate. Given sufficient funding, the other barriers can be overcome.



Source: Barriers to Biogas Use, 2012.

Nutrient Recovery: Opportunities and Challenges



Approaches to Nutrient Recovery

- Accumulation step to increase N content > 1000 mg N/L and P content > 100 mg P/L
- Release step to generate low flow and high nutrient stream
- Extraction/Recovery step produces high nutrient content product

Extractive Recovery Options

Accumulation → **Release** → **Extraction**

- Enhanced biological phosphorus removal (EBPR)
- Algae
- Purple non-sulfur bacteria
- Membrane filtration
- Adsorption/Ion exchange
- Solvent extraction

- Anaerobic digestion
- Thermolysis
- WAS release
- Sonication
- Microwave
- Chemical extraction

- Chemical precipitation
- Electrodialysis
- Gas permeable membrane and absorption
- Gas stripping
- Solvent extraction

- Numerous options to chose from
- Not all systems require all three components

Most Mature Extractive Approach is Recovery via Struvite

- Struvite recovery can:
  - Reduce energy and chemical consumption
  - Minimize nuisance struvite formation and reduce O&M costs
  - Reduce the P content of biosolids
- Struvite recovery can be economical:
  - Sidestreams ≥ 20% P load
  - Struvite mitigation
- Several commercial technology providers with proven track record
  - Recovered struvite is marketed as a slow release fertilizer
  - Technology providers have different business models for this purpose

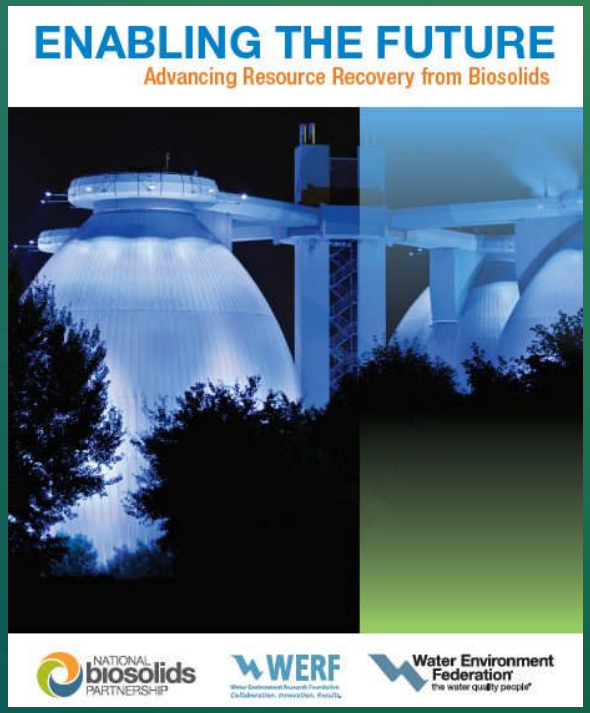
Nitrogen Only Recovery is Currently an Expensive Undertaking

- Low resale value of N only products and high operating and capital costs makes N only recovery challenging
- Nitrogen only recovery also limited by potentially more attractive sidestream N treatment options
  - Deammonification
- N recovery as part of combined N and P product is typically a more attractive option at present

5 Steps Toward Maximum Resource Recovery

1. Increase the capacity of the biosolids profession through education, training, and support
2. Advance policies, legislation, and regulations that allow for – and incentivize – resource recovery
3. Continue to improve biosolids quality and programs
4. Enhance education/outreach with environmental groups, agricultural community and the general public
5. Advocate for funding and infrastructure needed to maximize resource recovery

Thank you!!



Available at:
www.biosolids.org