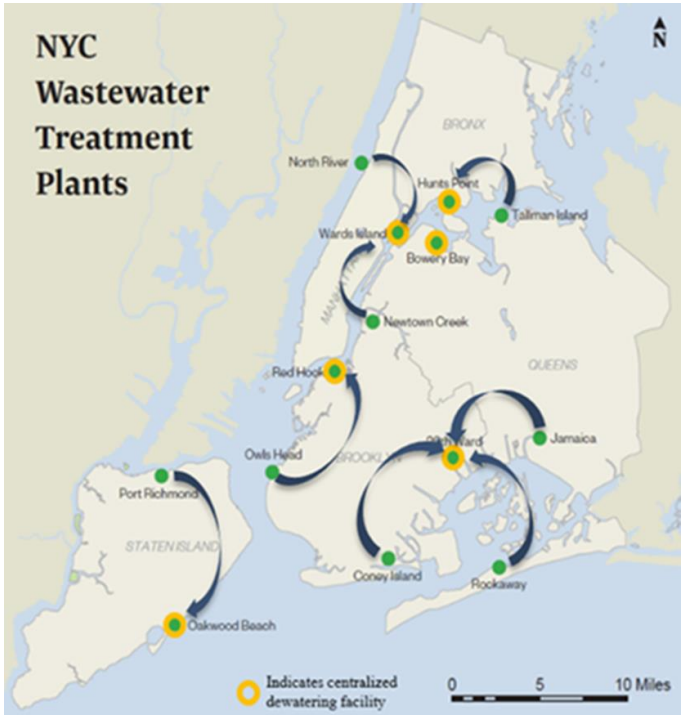
Hazen



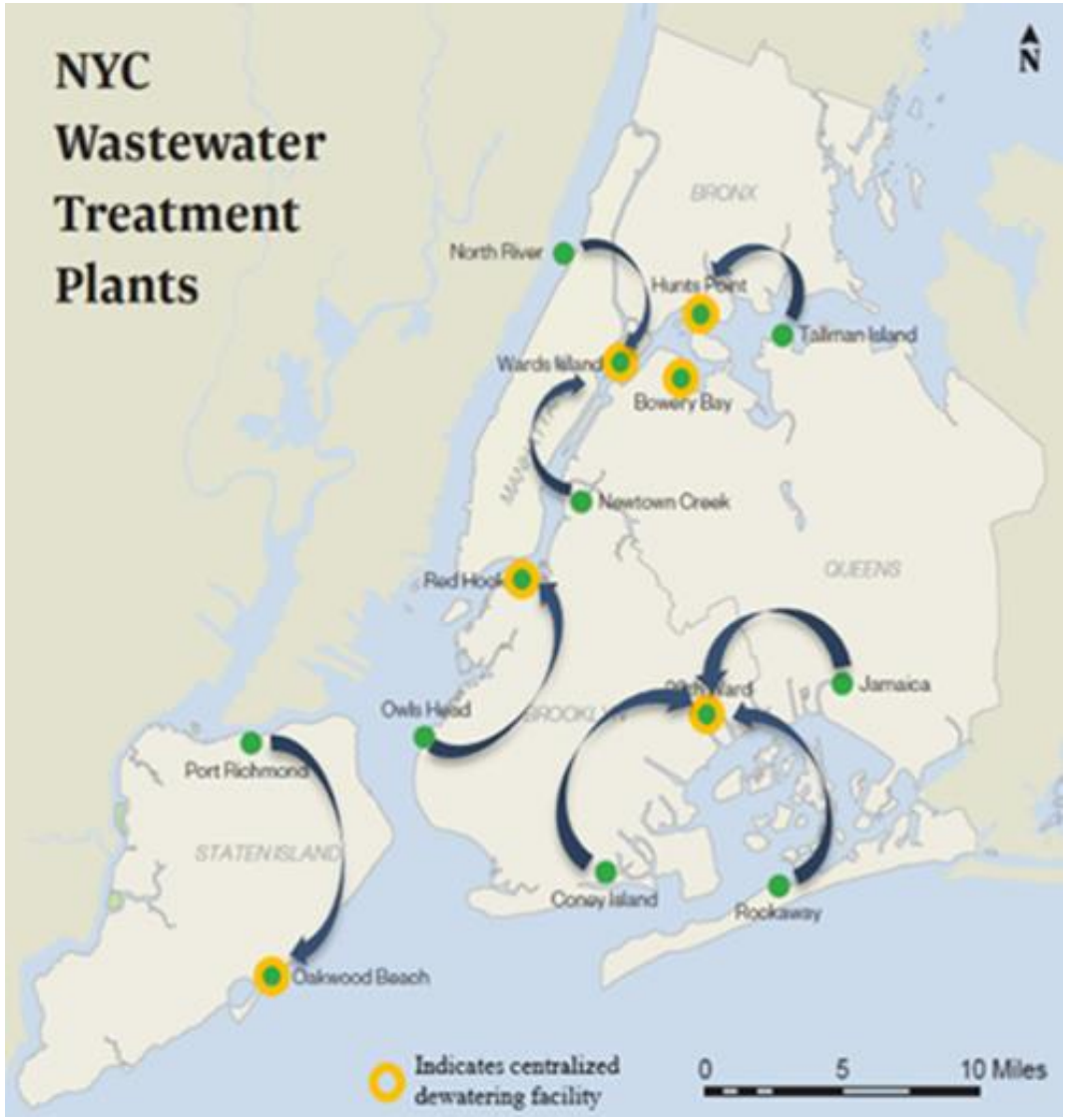
Biosolids Management Decisions Considering Climate Change and Future Pollutants

Mohammad Abu-Orf, PhD, National Biosolids Practice Leader

March 26 , 2024

Case Study: NYCDEP

- DEP is the largest combined water and wastewater utility in the United States, with 6,000 employees and an annual budget of more than $1 billion.
- DEP's Bureau of Wastewater Treatment (BWT) operates 14 in-City WRRFs treating more than 1 billion gallons of wastewater per day and producing approximately 500,000 wet tons per year of residual biosolids.
- DEP's Office of Energy and Resource Recovery (OERR) is guiding DEP's efforts to meet Citywide energy and carbon reduction goals through the Energy and Carbon Neutrality Plan



NYC DEP Biosolids and Energy Plan

2025

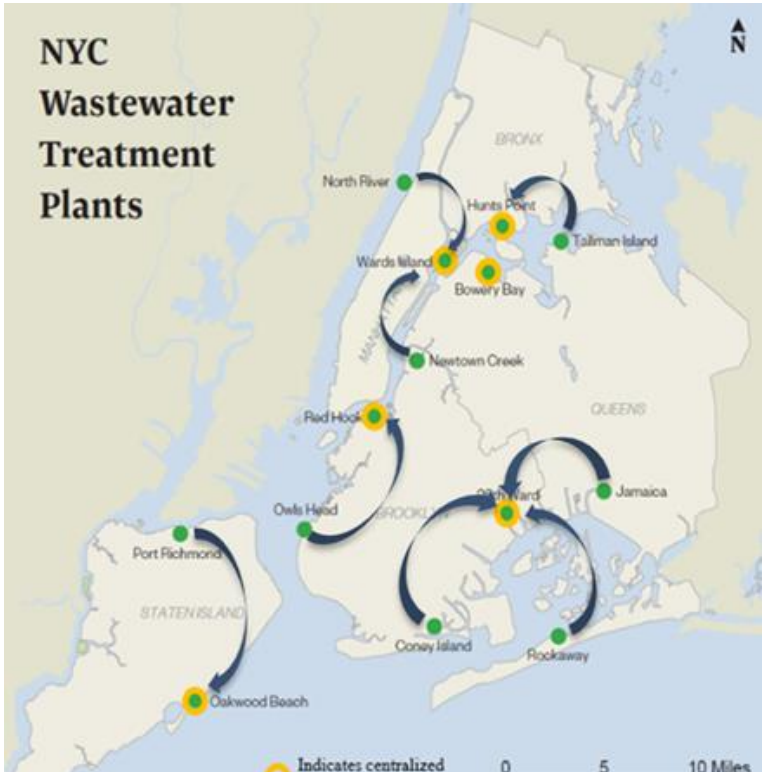
- 35% GHGe Reduction
- 20% Reduction in Energy Usage

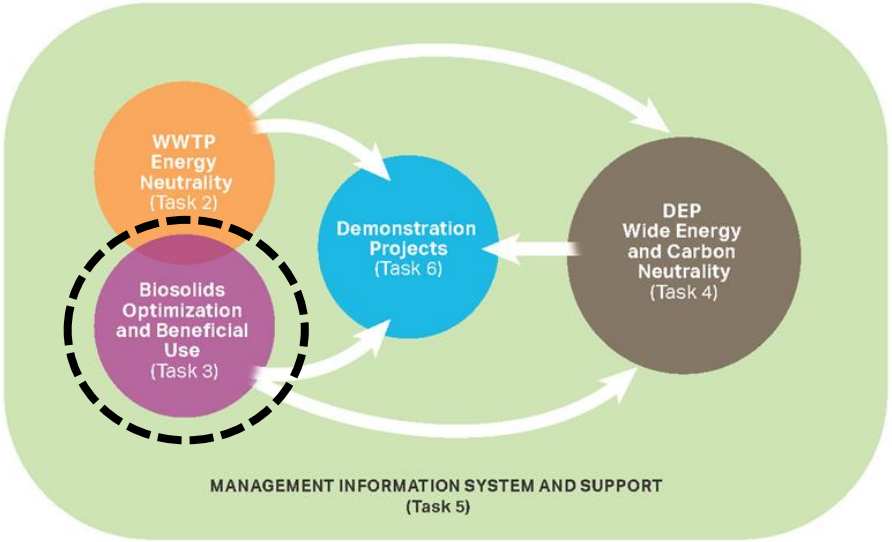
2030

0 Waste to Landfills

2050

- 80% GHGe Reduction
- Energy Neutral Operations at WWTPs





A strategic plan to optimize biosolids management and increase resource recovery through beneficial use

Objectives

- Provide a tool that allows DEP flexibility to evaluate the carbon footprint impacts for portfolio wide biosolids management
- Provide data to evaluate the potential impact of different decisions
- Develop example Roadmap to 2050

Approach

1. Developed DEP Biosolids Working Group

2. Developed Biosolids Program Guiding Principles

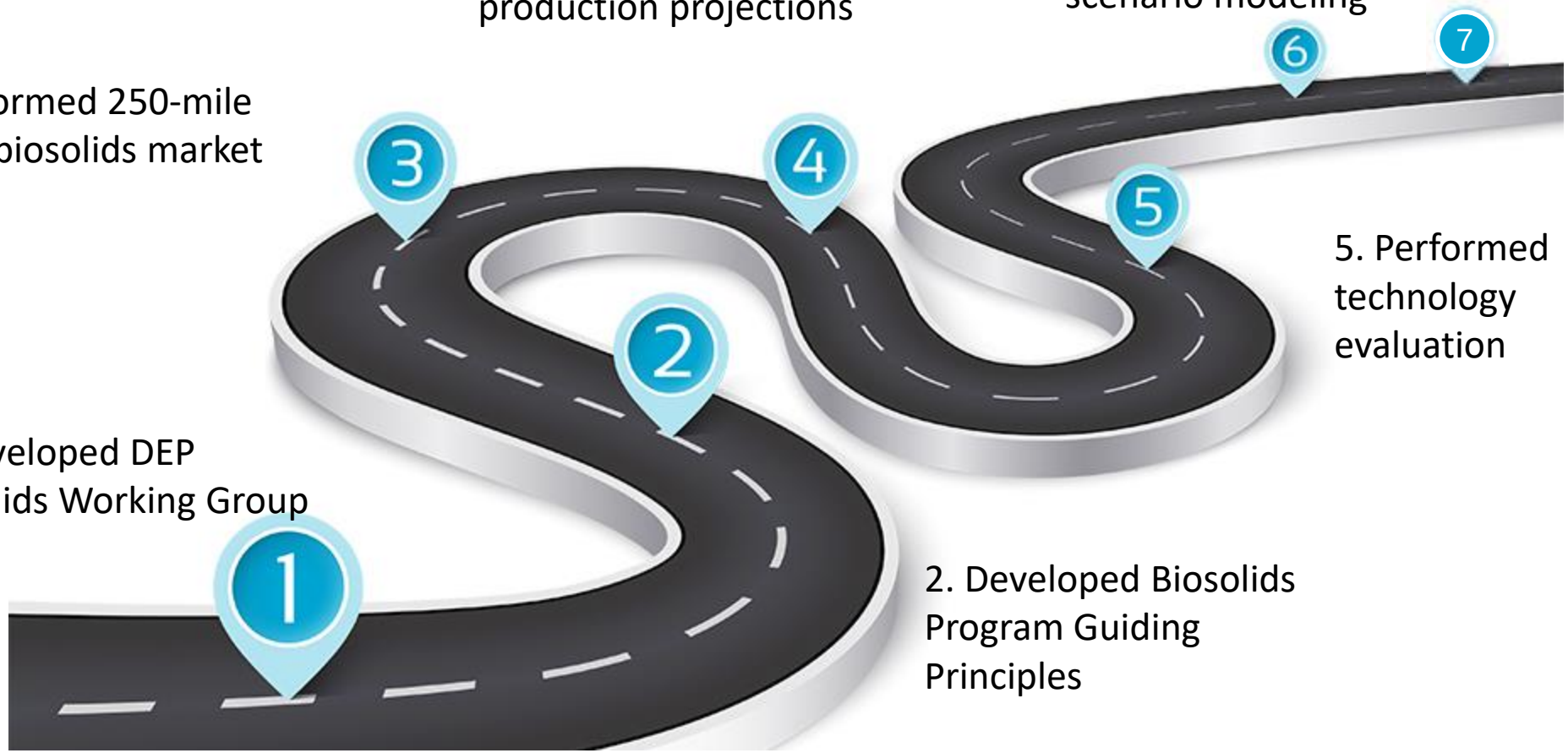
3. Performed 250-mile radius biosolids market study

4. Developed solids production projections

5. Performed technology evaluation

6. Performed scenario modeling

7. Performed multi-criteria decision analysis



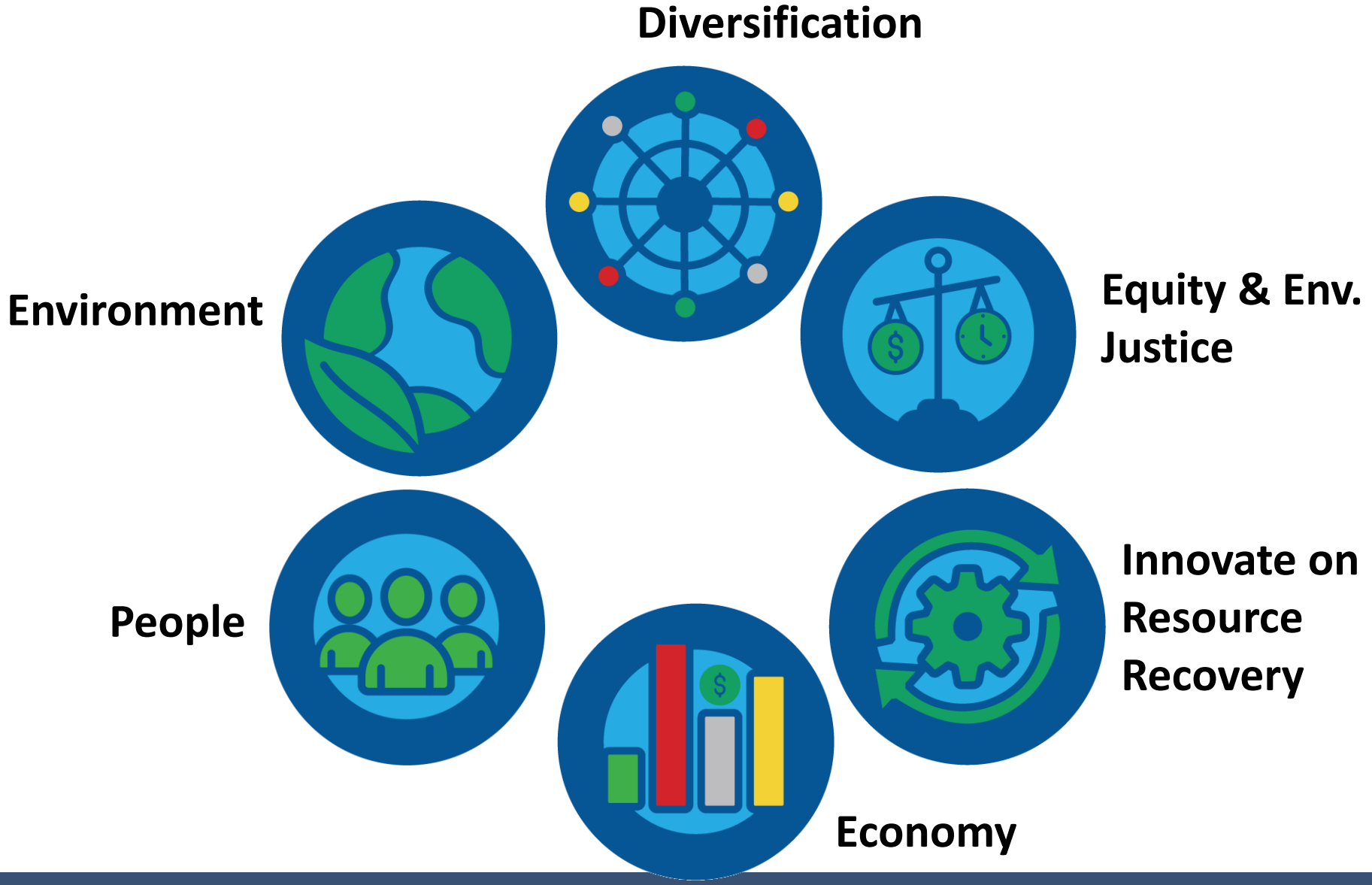
Multi-Criteria Decision Analysis (MCDA)

"We can't just consider cost! What about the other stakeholders' concerns…"

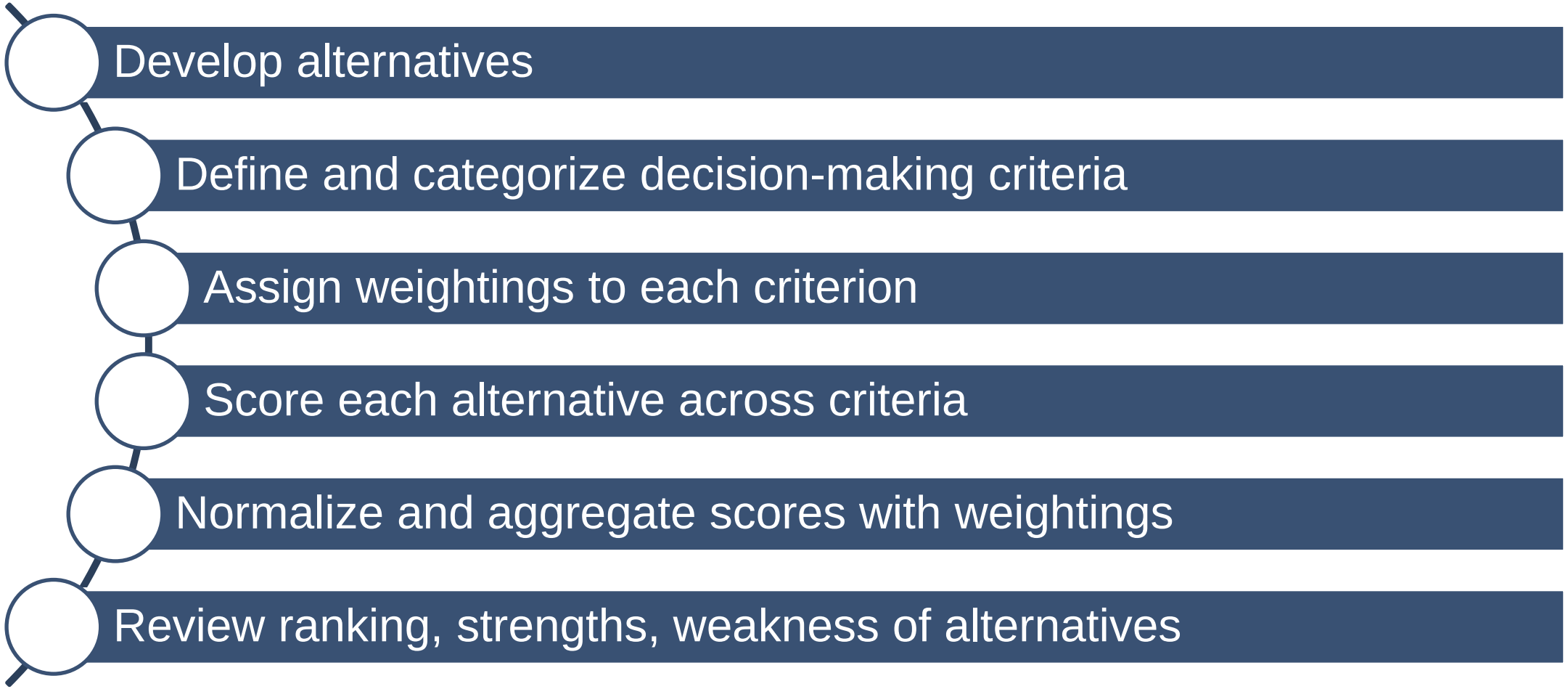
- Breaks Complex problems down into smaller and more consistent pieces
- Competing pros and cons are documented
  - Different stakeholders:
  - Different objectives and priorities
  - Different hopes and fears

Biosolids Program Guiding Principles

Developed by the working group and in alignment with DEP's Strategic Plan



MCDA Process



Initiate

- Technologies GHGe
- Product Market Analysis
- Products GHGe

Comprehend

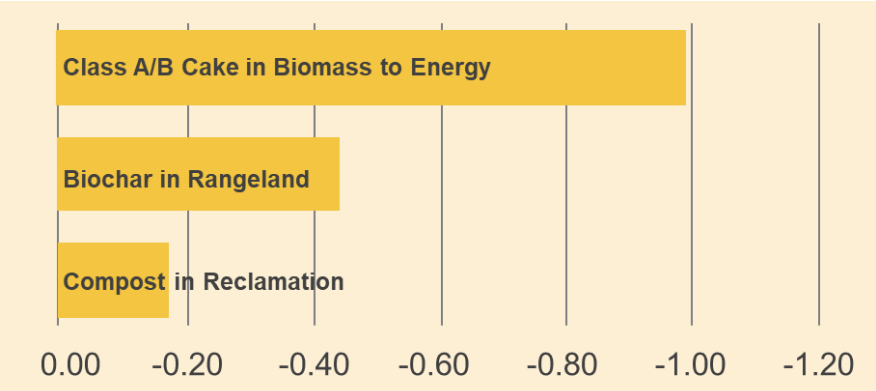
Identify Top Technologies/ Products Scenarios GHGe

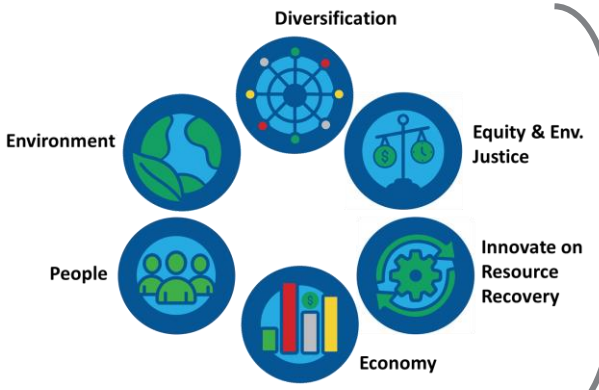
Explore

Multi-Facility Tool

Converge

Winning Technologies/ Products Scenarios





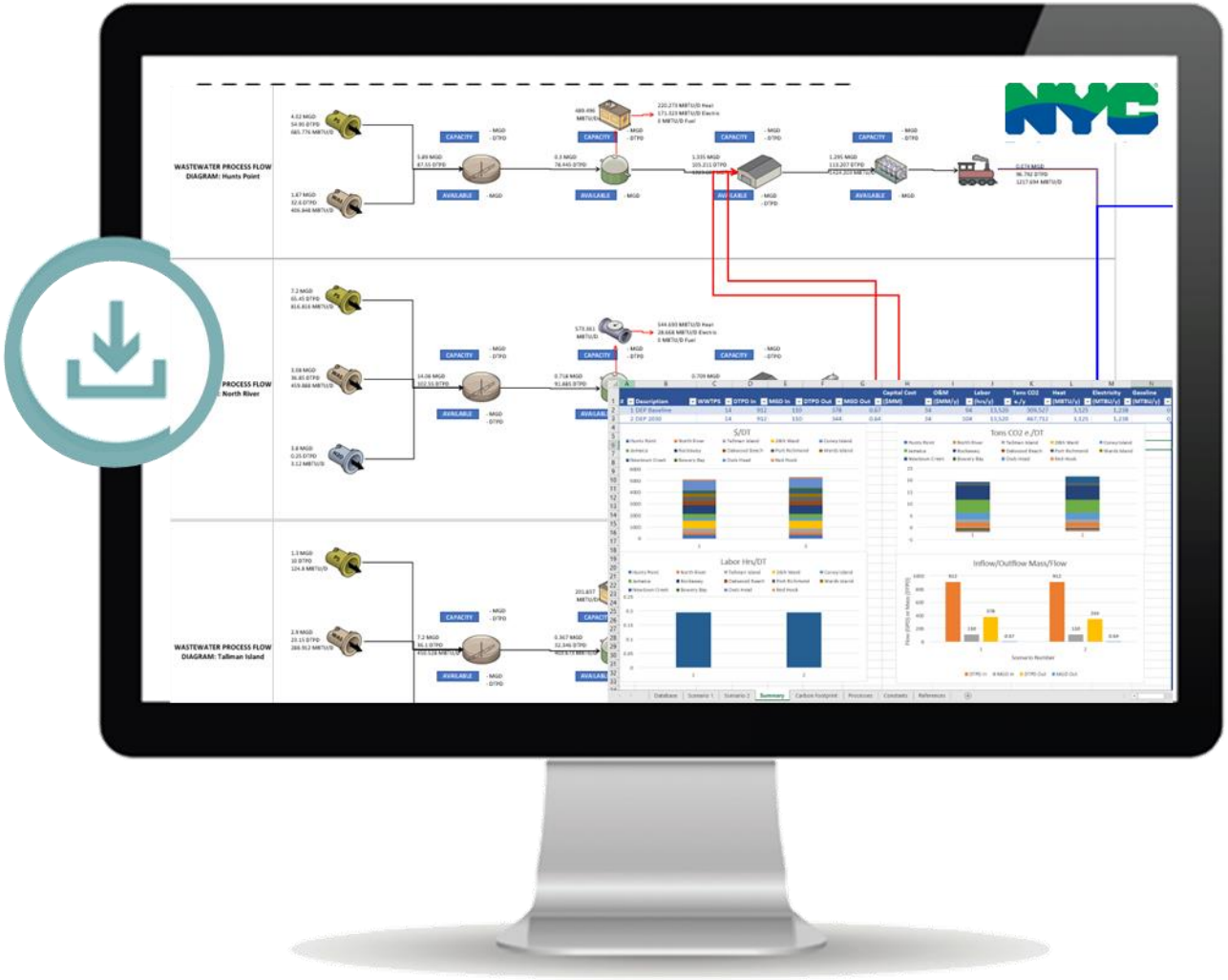
HazenConverge
Multi-Criteria Decision Tool

Short-term Recommendations & Long-term Plan (Roadmap)

Environmental Stewardship Can Drive Biosolids Decision Making

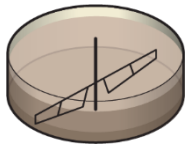
Model Blocks

- Process Blocs
- Product Blocks
- End-use Blocks

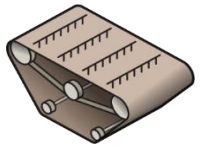


Process Blocs

Thickening



Gravity Thickener



Gravity Belt Thickener

Volatile Solids Reduction

Digestion

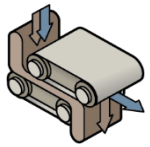
Pre Hydrolysis

Intermediate Hydrolysis

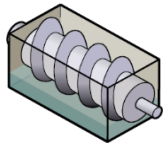
Post Hydrolysis

Wet Air Oxidation

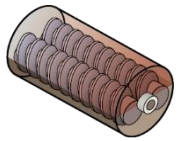
Dewatering/ Drying



Belt Filter Press

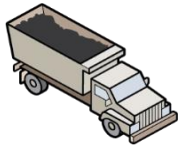


Centrifuge

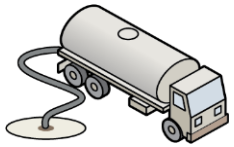


Drying

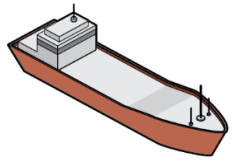
Transport



Hauled Cake



Hauled Sludge



Hauled Sludge

Hauled Cake

Thermal Conversion

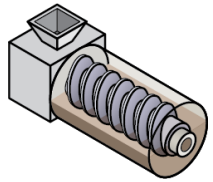
Super Critical Water Oxidation

Hydrothermal Liquefaction

Gasification

Pyrolysis

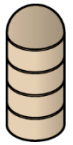
Conditioning



Alkaline Stabilization

Composting

Blending/Bagging



Gas Conditioning

Note – not all process blocks need to be onsite

Products Blocks

- Undigested Sludge
- Class A Liquid Biosolids
- Class B Liquid Biosolids
- Unclassified Digested Sludge
- Class A Cake
- Class B Cake
- Unclassified Cake
- Class A Dried
- Blended Product (e.g. Bloom)
- Compost
- Raw Biogas
- Conditioned Biogas
- Syngas
- Biochar
- Biodiesel
- Biomass/Energy Crops
- Ash

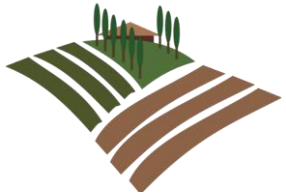
End-Use Blocks

Disposal/ Destruction

Landfill

Incineration

Beneficial Use



Land Application

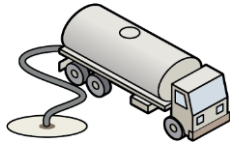
Rangeland

Urban Agriculture

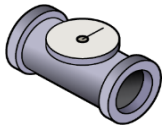
Land Reclamation

Land Application to Grow Energy Crops

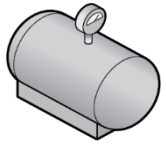
Energy Recovery



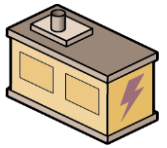
Vehicle Use



Pipeline Injection



Solid Fuel



Engine

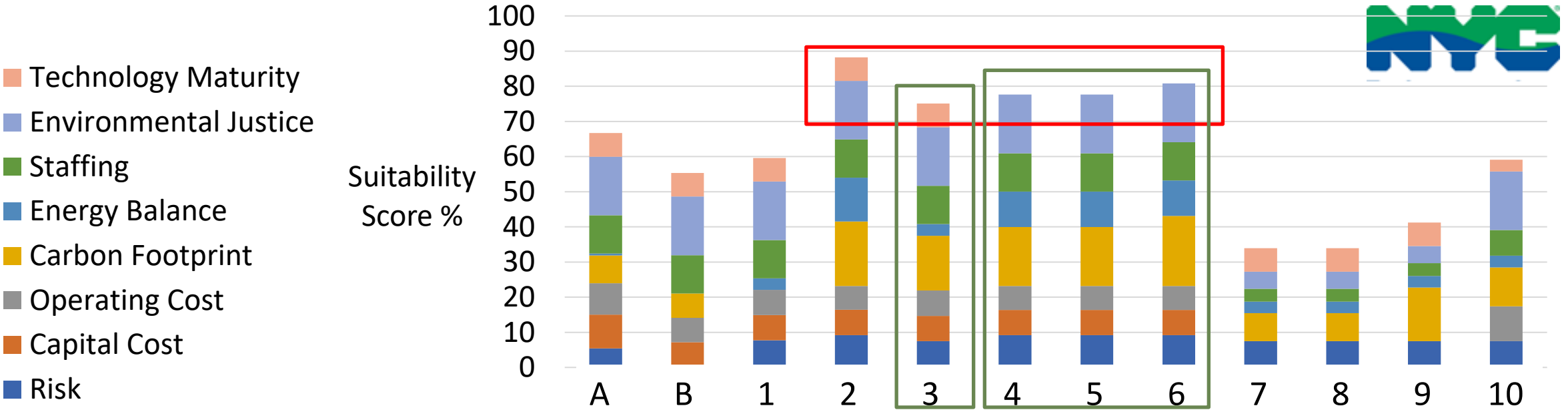
2050 Final Scenarios

RNG = Renewable Natural Gas
ICE = Internal Combustion Engine
MVR = Mechanical Vapor Recompressing

Scenario	1.	2.	3.	4.	5B	6	Digester Gas	Post-processing	End to Energy	End-Product Fate*
1	Yes	No	Yes	-	-	-	RNG to Pipeline	Compost	-	Class A to Agriculture
2	Yes	No	No	No	No	Yes	RNG to Pipeline	MVR	Biomass Boiler	Ash to concrete
3	Yes	No	Yes	-	-	-	RNG to Pipeline	-	-	Residuals to Land reclamation
4	Yes	No	No	No	No	No	RNG to Pipeline	MVR/Pyrolysis	Syngas to ICE	Biochar to Urban Ag
5	Yes	No	No	No	No	No	RNG to Pipeline	MVR/Pyrolysis	Syngas to ICE	Biochar to Agriculture
6	Yes	No	No	No	No	No	RNG to Pipeline	MVR/Pyrolysis	Syngas to ICE	Biochar to Land Reclamation
7	Yes	Yes	Yes	-	-	-	RNG to Pipeline	-	-	Class A to Urban Ag
8	Yes	Yes	Yes	-	-	-	RNG to Pipeline	-	-	Class A to Agriculture
9	Yes	Yes	Yes	-	-	-	RNG to Pipeline	-	-	Class A to Land Reclamation
10	Yes	No	Yes	-	-	-	Fuel Cells	-	-	Residuals to Agriculture

**DEP is targeting minimum Class B for dewatered residuals applied to land*

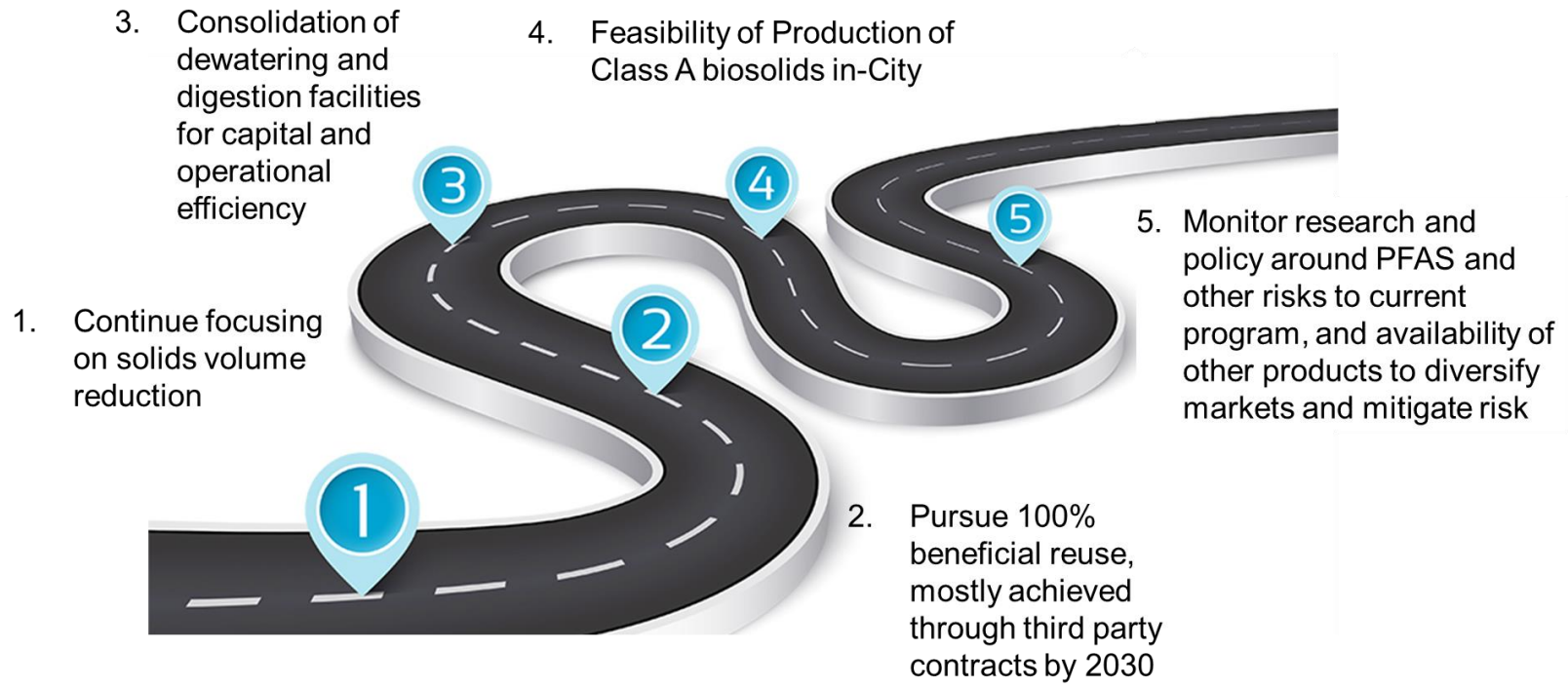
Technologies that Meets NYC Future



Scenario	Scenario Description	Scenario	Scenario Description
A	2018 Baseline	5	2050 Digested, dried residuals to Pyrolysis, Biochar to Agriculture
B	2030 Baseline	6	2050 Digested, dried residuals to Pyrolysis, Biochar to Land Reclamation
1	2050 Compost – Class A to Land	7	2050 THP, Class A to Urban Agriculture
2	2050 Digested, dried residuals to Solid Fuel	8	2050 THP, Class A to Agriculture
3	2050 Digested residuals to Land Reclamation	9	2050 THP, Class A to Land Reclamation
4	2050 Digested, dried residuals to Pyrolysis, Biochar to Urban Agriculture	10	2050 Biogas to Fuel Cells, Digested residuals to Agriculture

Conclusion and Path forward

- Example of cutting edge biosolids planning **using carbon footprint reduction as the lens for planning**
- Portfolio of technologies able to meet **future pollutants**
- Study produced new information **regarding impact of end-use and markets on life cycle carbon footprint, including different methods of land application**
- Justifies **diversified portfolio** with multiple beneficial use options



Hazen

Thank you

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Example Scenario Model Run