Landfill Methane

Generated from the anaerobic decomposition of organic waste in landfills.

- Composition: about 50% methane, 50% CO_2 and other non-methane organic compounds.
- Collection:
  1. Extracted from landfills using wells and a blower/flare system.
  2. Transports to a central point where it can be processed (up to three stages).
  3. Ultimate use
- Project type:
  1. Electricity generation (72%)
  2. Direct (replace another fuel) (18%)
  3. Upgraded to renewable natural gas (10%).
- Georgia has 93 landfills totaling more than 495 Mt of waste.
  - 21 operational (15 generate electricity, total installed capacity of 56 MW)

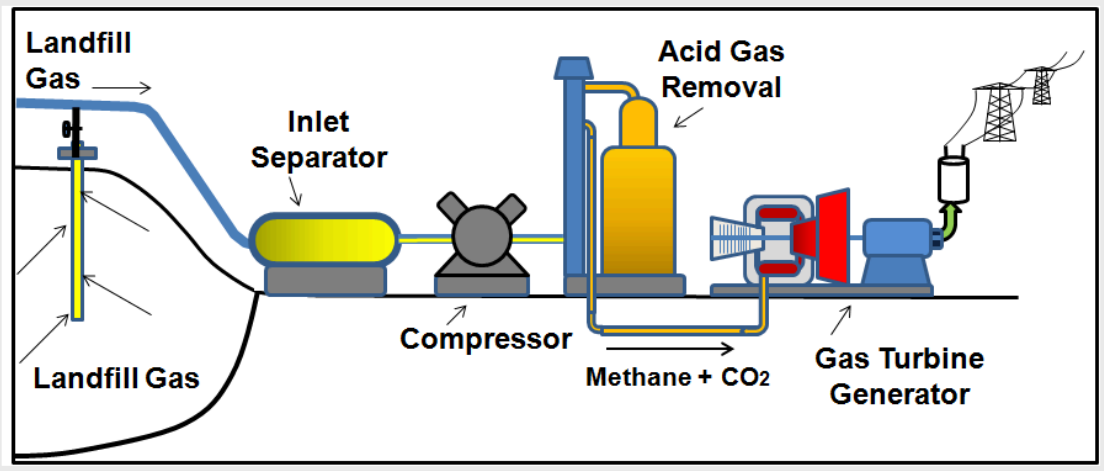


Photo: Ramon Rivera, "Harnessing Landfill Gas," December 27, 2015, https://diamondsci.com/blog/harnessing-landfill-gas/.

Potential for Carbon Reduction Estimation

1. **Achievable potential**: estimated taking into account direct and avoided emissions reduction from 21 candidate landfills with LCOEs below $70/MWh.
2. **Technical potential:** estimated considering direct and avoided emissions reduction from 22 candidate landfills.

Methodology:

1. Outputs from EPA LMOP LFGcost-Web tool for candidate landfills:
    - Emissions reductions (direct and avoided)
    - Capital Investment
    - O&M Cost
    - Electricity generation
2. LCOE assumptions:
    - Discount rate = 3%
    - Lifetime = 25 years

Private Costs and Benefits Estimation - Achievable Potential

Assumptions

- Energy project type: standard reciprocating engine-generator set if the system was greater than 800 kW or a small reciprocating engine-generator set if the system was 100 kW-800 kW

Installed capacity (MW)	45
Capacity Factor	75%
Net generation (MWh/year)	341,400
Capital investment ($)	104,199,166
O&M costs ($/year)	12,419,391
General inflation rate (applied to O&M costs)	2.5%
Avoided cost of electricity (¢/kWh)	8
Discount Rate (%)	8.00%
Financing Interest Rate (%)	6.00%
Lifetime (years)	15
Financing Term (years)	10

Results

PV Private Costs	PV Private Benefits	NPV
$217M Avg. per tCO_2 removed = $155	$233 M Avg. per t CO_2 removed = $167	$16 M Avg. per t CO2 removed = $11

EPA LMOP LFGcost-Web tool

LFGcost-Web Model (Version 3.3)

LANDFILL METHANE OUTREACH PROGRAM

Tool developed by the EPA's Landfill Methane Outreach Program to estimate the costs of a landfill gas energy project in the U.S.

https://www.epa.gov/lmop/lfgcost-web-landfill-gas-energy-cost-model

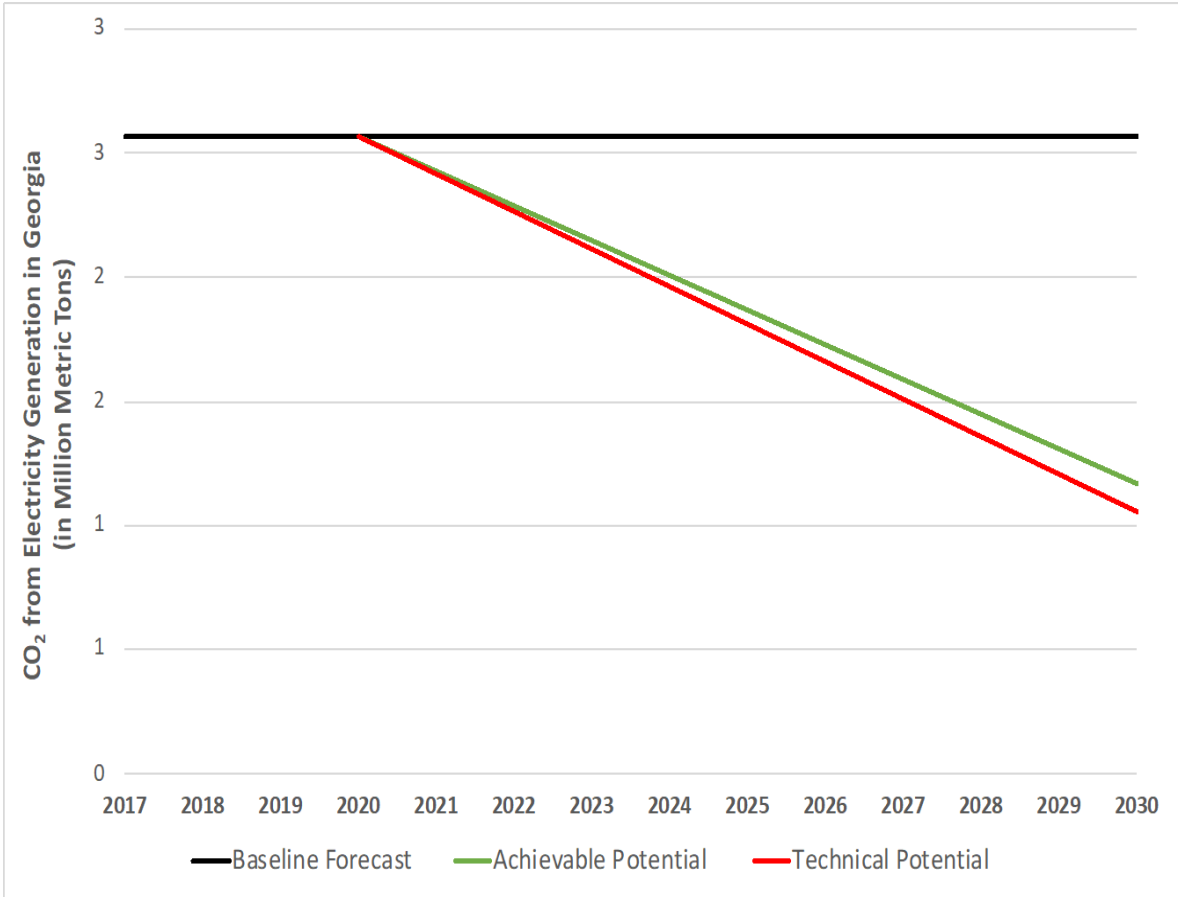
Required User Inputs:

Type of Input Required		Required Input Data
Year landfill opened		1997
Year of landfill closure		2070
Area of LFG wellfield to supply project (acres) [assumes 1 well/acre]		37
Method for entering waste acceptance data [CHOOSE ONLY ONE METHOD]:	Average annual waste acceptance rate (tons/yr)	49,438
	Waste acceptance rate calculator (in WASTE worksheet)	Go to WASTE
	Annual waste disposal history (in WASTE worksheet)	Go to WASTE
LFG energy project type [refer to recommended sizes in INST worksheet when selecting]		Small engine
Will LFG energy project cost include collection and flaring costs? (Y)es or (N)o		N
For Leachate Evaporator projects: Amount of leachate collected (gal/yr)		
For Boiler Retrofits: Will boiler retrofit costs be combined with direct-use project costs? (Y)es or (N)o		
For Boiler Retrofits: Distance between end user's property boundary and boiler (miles)		
For Direct-use, High Btu, and CHP projects: Distance between landfill and end use, pipeline, or CHP unit (miles)		
For CHP projects: Distance between CHP unit and hot water/steam user (miles)		0.5
Year LFG energy project begins operation		2025
Will model calculate avoided CO2 from energy generation at electricity projects? (Y)es or (N)o. If (Y)es, go to the **Avoided CO2- Elec** worksheet to select the appropriate value.		Y

Outputs: *Go to Report*

Type of Output		Output Data
Economic Analysis:		
Design project size (ft3/min LFG)		265
Generating capacity for projects generating electricity (kW)		441
Average project size for projects NOT generating electricity: [based on actual LFG use]	(million ft^3/yr LFG)	--
	(ft^3/min LFG)	--
Average project size for projects generating electricity (kWh/yr)		3,305,112
Average project size for CHP projects producing hot water/steam (million Btu/yr)		--
Total installed capital cost for year of construction ($)		$1,392,329
Annual costs for initial year of operation ($)		$131,194
Internal rate of return (%)		Negative
Net present value at year of construction ($)		($1,085,788)
Years to Breakeven*		None
Environmental Benefits:		
Total lifetime amount of methane collected and destroyed (million ft3)		1,514
Average annual amount of methane collected and destroyed (million ft3/yr)		101
GHG value of total lifetime amount of methane utilized in energy project (MMTCO2E)		4.65E-01
GHG value of average annual amount of methane utilized in energy project (MMTCO2E/yr)		3.10E-02
Total lifetime carbon dioxide from avoided energy generation (MMTCO2E)		2.14E-02
Average annual carbon dioxide from avoided energy generation (MMTCO2E/yr)		2.14E-02

Drawdown potential in Georgia in 2030



1 $MtCO_2e$ solution in 2030 = six 4 MW plants generating electricity from landfill methane.

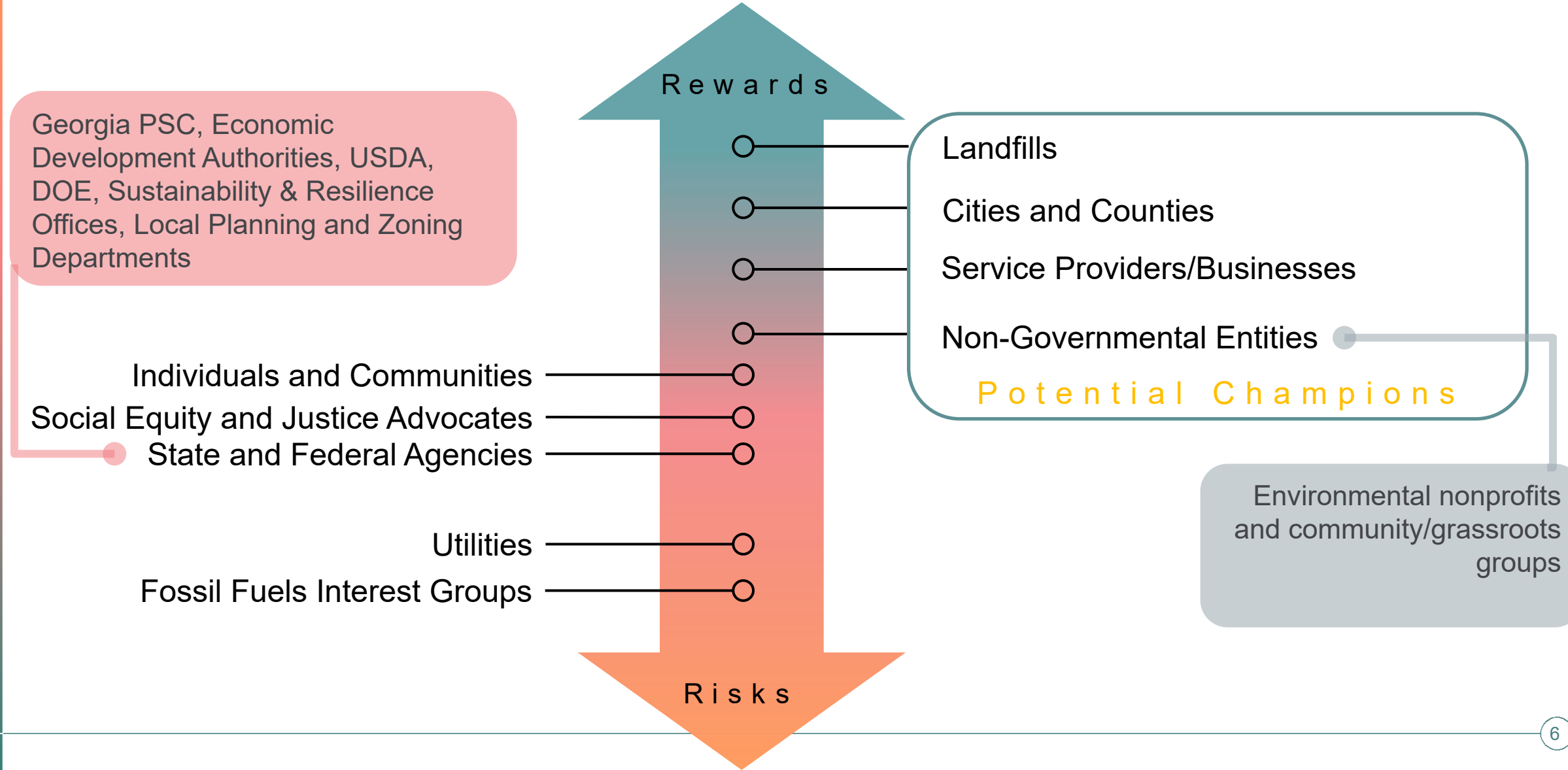
Baseline = Total potential emissions to be reduced from non-operational landfills are estimated to be 2.6 $MtCO_2e$ in GA in 2030.

Achievable Potential = Reduction of 1.4 $MtCO_2e$ in 2030, considering direct and avoided emissions reduction from 21 candidate landfills with LCOEs below $70/MWh by 2030. The average LCOE for these landfills is $57/MWh.

Technical Potential = Reduction of 1.51 MtCO2e in 2030, considering direct and avoided emissions reduction from 22 candidate landfills by 2030.

+Diverse energy supply -High upfront cost
+Less air pollution
+Local jobs
+Public health benefits

Stakeholder Analysis of Landfill Methane



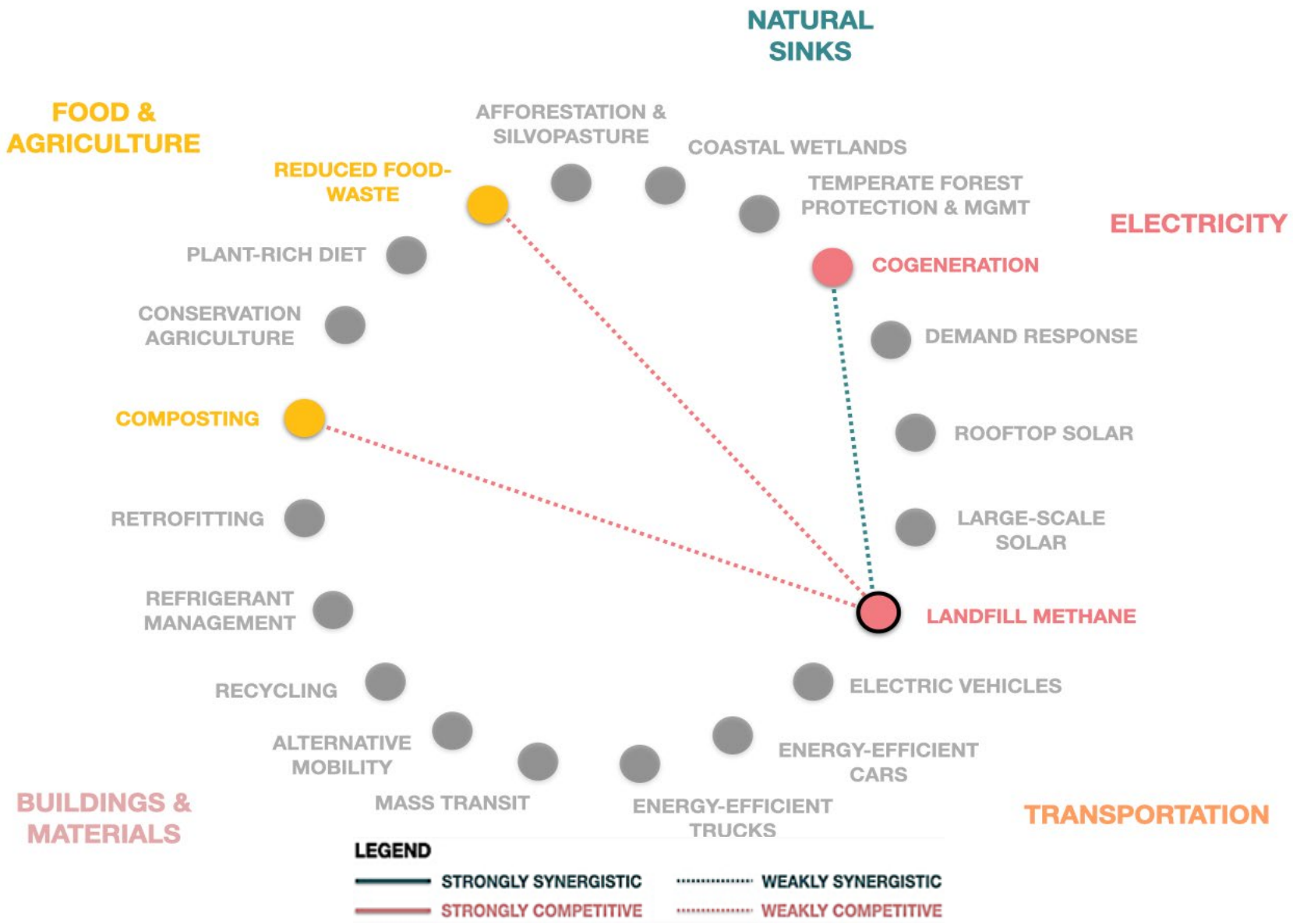
Interactions with other solutions

Cogeneration

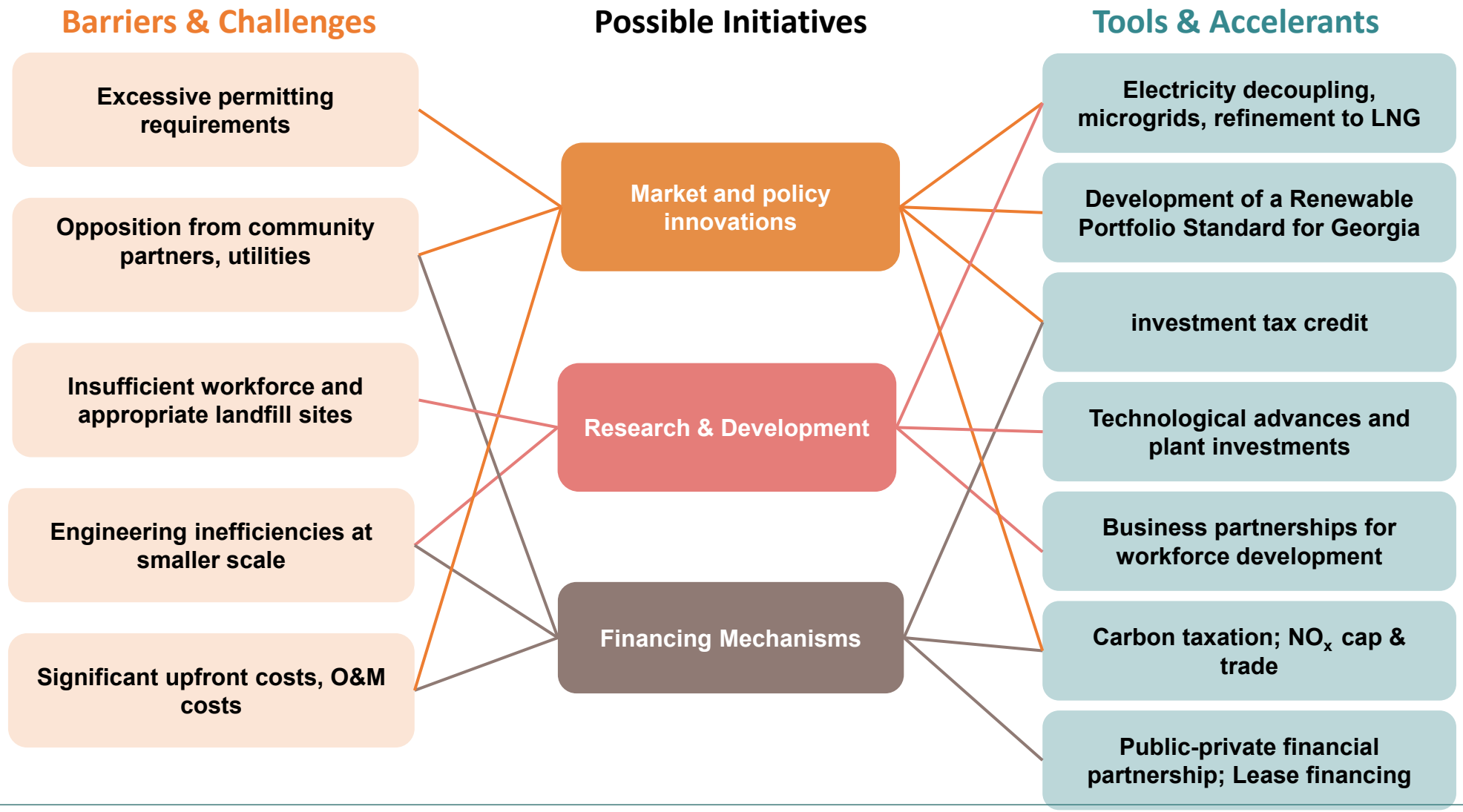
- Landfill methane can be used to generate electricity with a CHP system

Composting and Reduced Food Waste

- These solutions decrease the amount of waste that goes to the landfill reducing the implementation of this solution and the carbon reduction potential.



Landfill Methane: Challenges and Possible Initiatives



Other considerations

Challenges

- Inadequate state policy and legislation
- High upfront costs
- Decreasing landfill waste
- Inadequate identification of candidate landfills

Promising Policies

- Enact a clean energy portfolio standard for utilities in Georgia
- Federal government 10% ITC
- Increasing ITC to 30% for highly efficient landfill gas energy projects

DRAWDOWN GA

Corresponding author:

Dr. Daniel Matisoff
Associate Professor,
School of Public Policy
Georgia Institute of Technology
Phone: 404-385-0504
Climate and Energy Policy
Lab: www.cepl.gatech.edu

Georgia Tech | University of Georgia | Emory University | The Ray C. Anderson Foundation