# Cogeneration

Implies the co-production of electricity and useful heat, for the use in industrial or commercial facilities and for heating and cooling purposes.

Reduces emissions by displacing the consumption of fossil fuels that would otherwise have been used. There are currently 41 CHP facilities in GA with a total installed capacity of 1.44 GW.

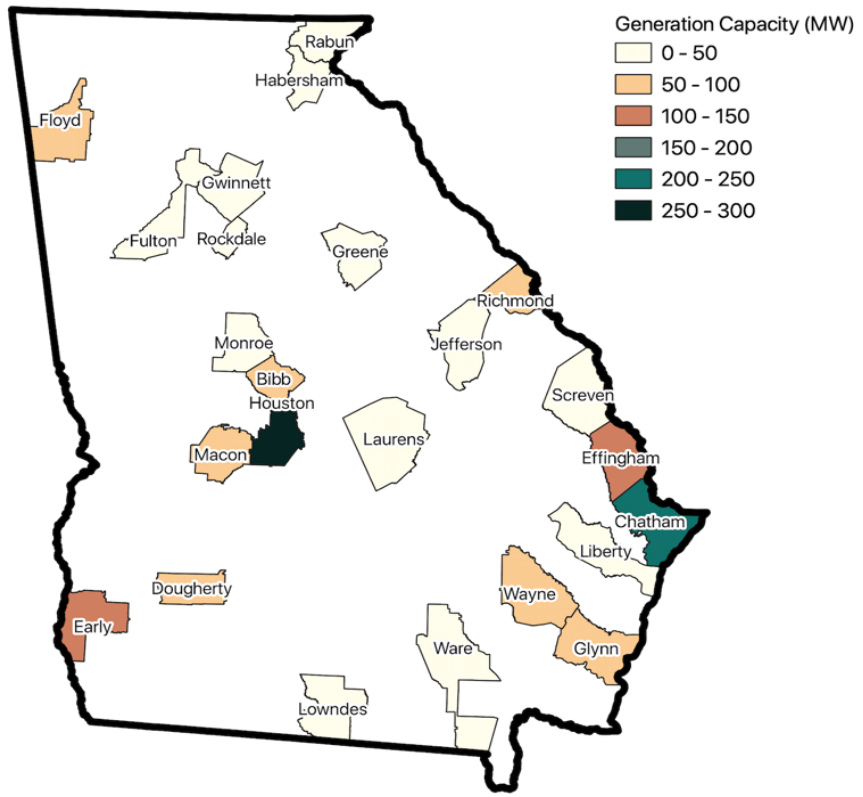
Cogenerating plants could create thousands of jobs in the state throughout their lifecycles and can bring about over $150 million in monetary benefits from the reduction of atmospheric pollutants.

Albany Green Biomass Plant, co-generating ~400 GWh
Source: Energy News Network, 2017

# Cogeneration (CHP)

***Implies the co-production of electricity and useful heat, for the use in industrial or commercial facilities and for heating and cooling purposes.***

- Located where both electricity and thermal energy are needed and can be placed at individual facilities or be a utility resource or district energy .
- Reduces emissions by displacing the consumption of fossil fuels that would otherwise have been used.
- System configuration
  - Topping cycle CHP
  - Bottoming cycle (Waste heat to Power)
- Technologies: gas turbines, reciprocating engines, fuel cells, microturbines and boiler/steam turbines.
- Overall efficiency of 65%-75% (U.S. DOE)
- 41 CHP facilities in GA (installed capacity of 1.44 GW)



# Potential for Carbon Reduction Estimation

Georgia has 5,110 MW of technical potential at 9,374 sites. 835 MW = “achievable”.

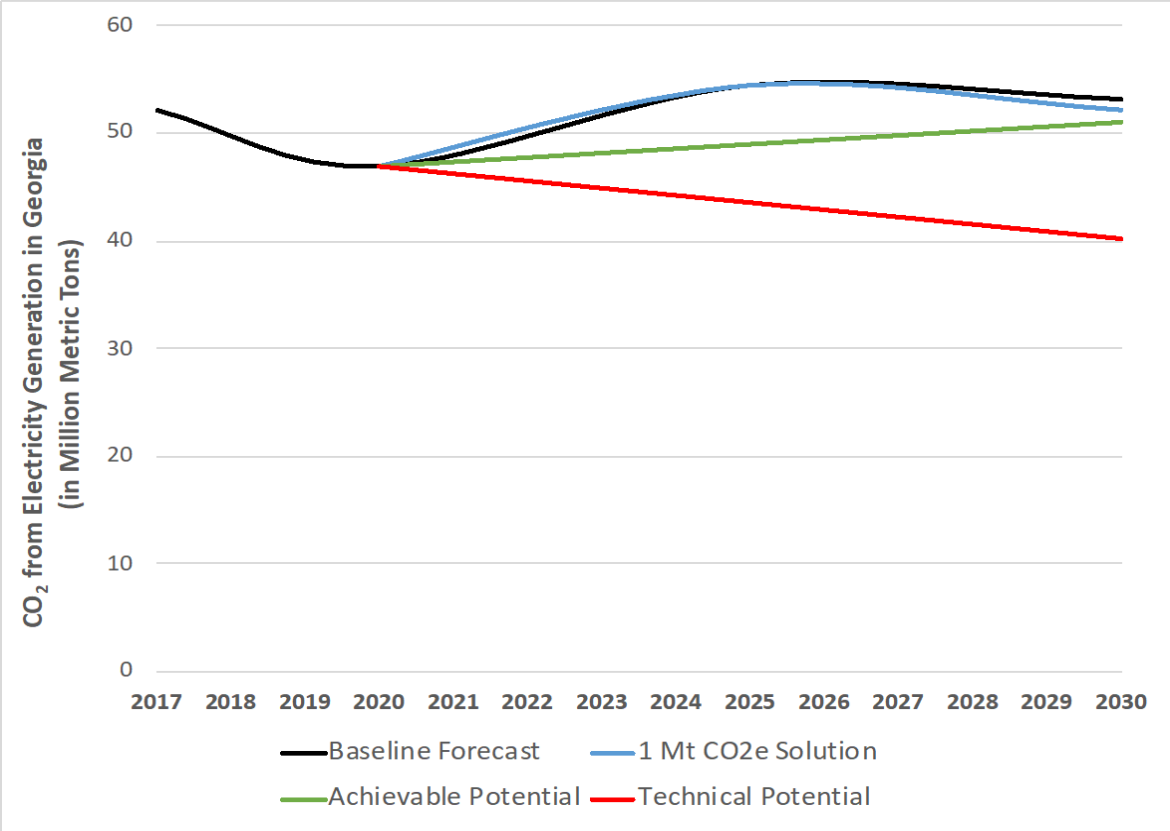
**Methodology:**

- Achievable potential is defined as a percentage of industrial technical potential, by size.
- Assumes a capacity factor of 75%.

| Installed capacity | 50-500 kW | 0.5 - 1 MW | 1 - 5 MW | 5 - 20 MW | > 20 MW |
|---|---|---|---|---|---|
| % of technical potential | 10% | 10% | 20% | 30% | 50% |

| Industry | Achievable total capacity (MW) | Achievable net generation (GWh) | Achievable emissions reduction ($tCO_2$) |
|---|---|---|---|
| Chemicals | 260 | 1,705 | 661,564 |
| Textiles | 210 | 1,382 | 536,403 |
| Paper | 174 | 1,140 | 442,338 |
| Food Processing | 66 | 435 | 168,695 |
| Lumber and Wood | 49 | 321 | 124,383 |
| **Subtotal** | **758** | **4,983** | **1,933,383** |
| Others | 76 | 501 | 194,427 |
| **Total** | **835** | **5,484** | **2,127,809** |

# Drawdown potential in Georgia in 2030




**Baseline =** Emissions from electricity generation in GA in 2020 are estimated to be 49 $MtCO_2$; GT-NEMS forecasts that these will rise to 53 $MtCO_2$ in 2030.

**Achievable Potential** = Reduction of **2.13 $MtCO_2$** in 2030, with the installation of a total of 835 MW of CHP nameplate capacity; favorable NPV of $380M in 2030.

**Technical Potential** = Reduction of **13.02 $MtCO_2$** in 2030, with a total of 5,107 MW nameplate installed capacity (adding 33,600 GWh of low-carbon electricity).

1 $MtCO_2e$ solution in 2030 = sixteen 25 MW CHP plants generating electricity with waste heat from industrial processes.

+Diverse energy supply
+Grid Resilience
+Less air pollution
-High upfront cost
+Local jobs and local taxes
+Public health benefits

# Private Benefits Exceed Private Costs – Achievable Potential

## Assumptions

- Installed and O&M costs were estimated with the costs that correspond to the prime mover.
- Thermal energy was estimated using the P/H ratio that corresponds to the prime mover.

| | Steam Turbine | Reciprocating Engine/Gas Turbine |
|---|---|---|
| **Installed capacity (MW)** | 277 | 557 |
| **Net generation (MWh/year)** | 1,822,387 | 3,661,658 |
| **Capital investment ($2017)** | 189,723,080 | 970,504,800 |
| **O&M costs ($2017/year)** | 11,728,764 | 45,127,490 |
| **Fuel input - natural gas (MMBtu/MWh)** | 54.4 | 11.5 |
| **Fuel cost - natural gas ($/MBtu)** | 5 | 5 |
| **Percent natural gas** | 30% | 90% |
| **Thermal energy (MBtu)** | 852 | 200 |
| **Steam price ($/MBtu)** | 10 | 10 |
| **Avoided cost of electricity (¢/kWh)** | 8 | 8 |
| **Discount Rate (%)** | 7.00% | 7.00% |
| **Financing Interest Rate (%)** | 4.38% | 4.38% |
| **Lifetime (years)** | 25 | 25 |
| **Financing Term (years)** | 20 | 20 |

## Results

| PV Private Costs | PV Private Benefits | NPV |
|---|---|---|
| $5,539 M<br>Avg. per t$CO_2$ removed = $2,603 | $5,918 M<br>Avg. per t $CO_2$ removed = $2,781 | $380 M<br>Avg. per t $CO_2$ removed = $178 |

# Job Creation Benefits are Also Significant

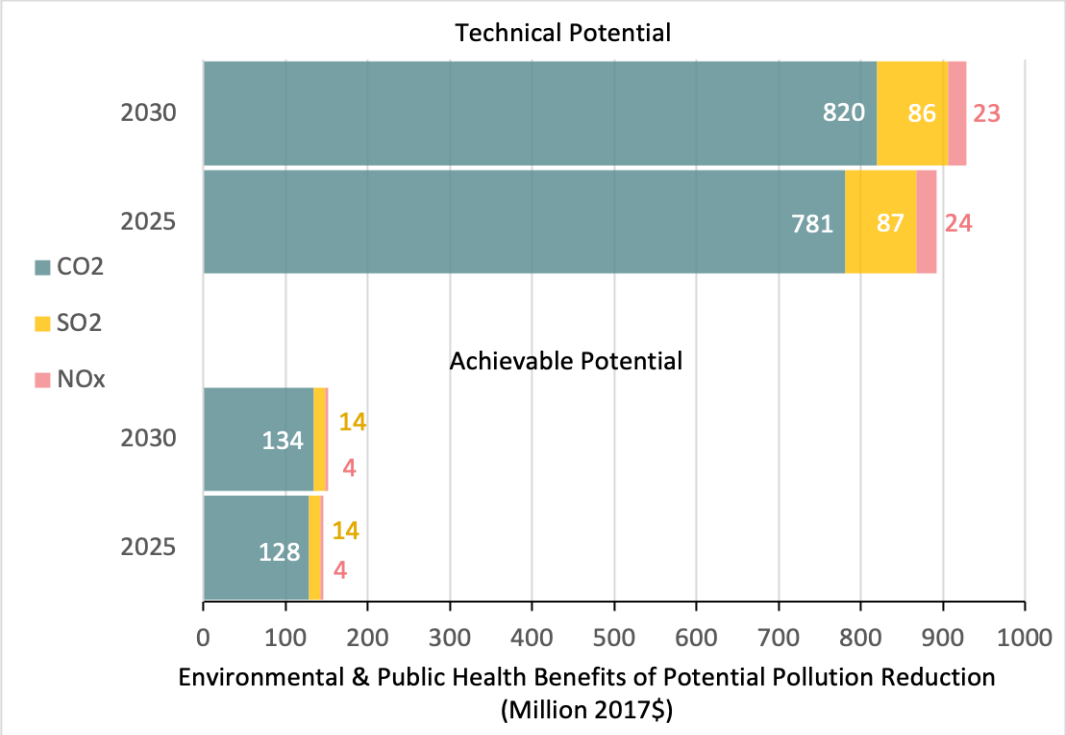
- Jobs are created throughout the lifetime of the CHP system
- Many created jobs are local to the CHP facility
- FTE jobs created include direct jobs in manufacturing, construction, and O&M
- In addition, other indirect and induced jobs are created by the supply chain of CHP installations and from the reduction of utility bills that frees up discretionary funding for the purchase of other goods and services that are more labor intensive than purchasing fuel.

| | Low estimate (0.34 FTE/GWh) | High estimate (0.44 FTE/GWh) |
|---|---|---|
| **Achievable potential (FTE/year)** | 1,865 | 2,413 |
| **Technical potential (FTE/year)** | 11,409 | 14,764 |

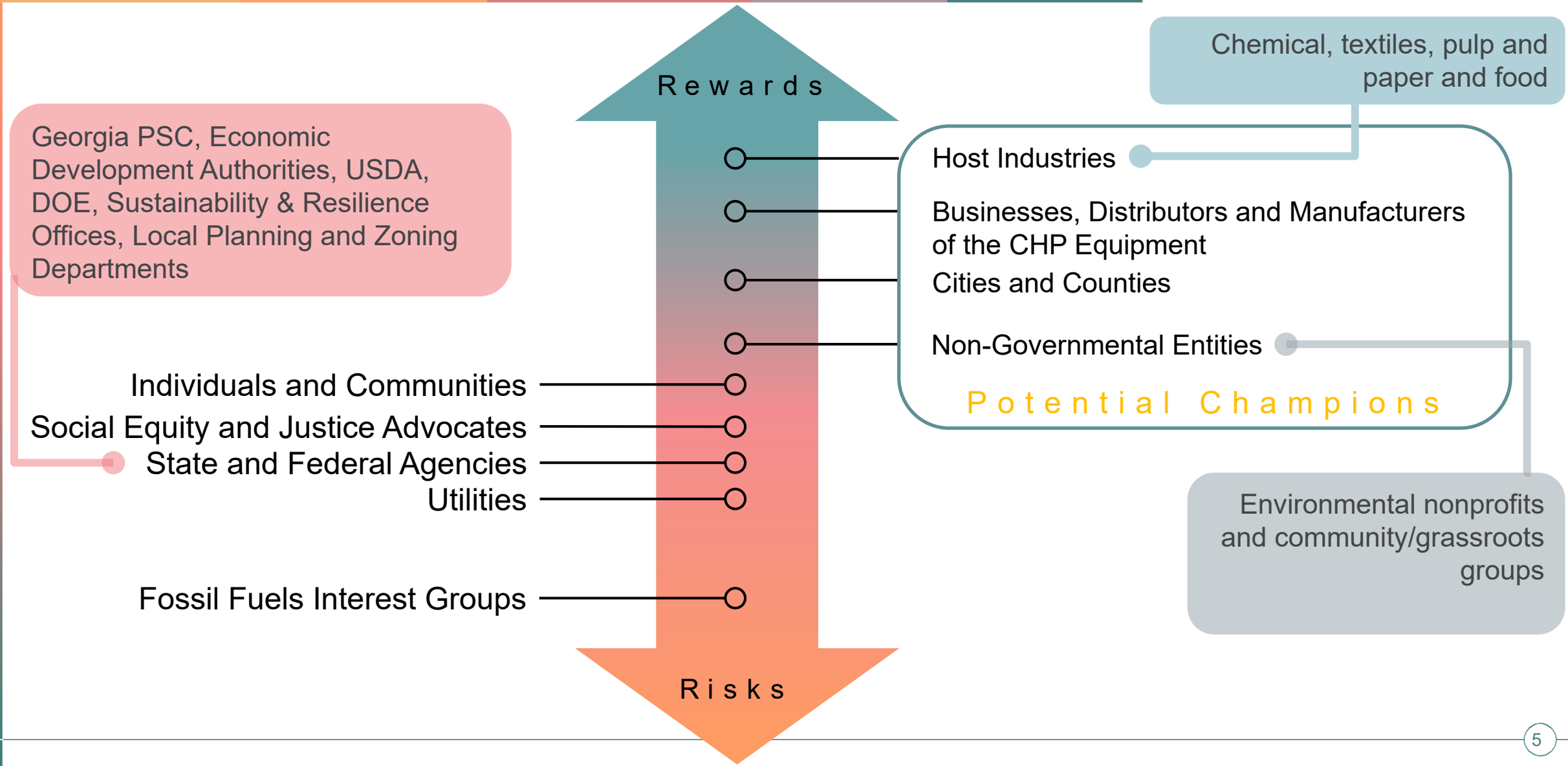
# Air Pollutants Show Sizeable Reductions and Monetary Benefits

- Lower $SO_2$ and NOx levels result in fewer respiratory illnesses such as asthma, particularly in children.
- Reducing fine particulates has significant health benefits:
  - especially for children – lower incidence of preterm birth, low-birth weight, and autism spectrum disorder.
  - also for adults – fewer premature deaths, heart attacks, and respiratory illnesses.
- Other important benefits include increased workforce productivity and quality of life.

- The monetary benefits of reduced $SO_2$ and NOx in the achievable scenario totals $18 million in 2030.
- Adding the avoided costs from $CO_2$ brings the total to $152 million in 2030.



# Stakeholder Analysis of Cogeneration



# Interactions with other solutions

## Demand Response

- CHP can enhance demand-response by generating on-site electricity during the local utility's peak hours.

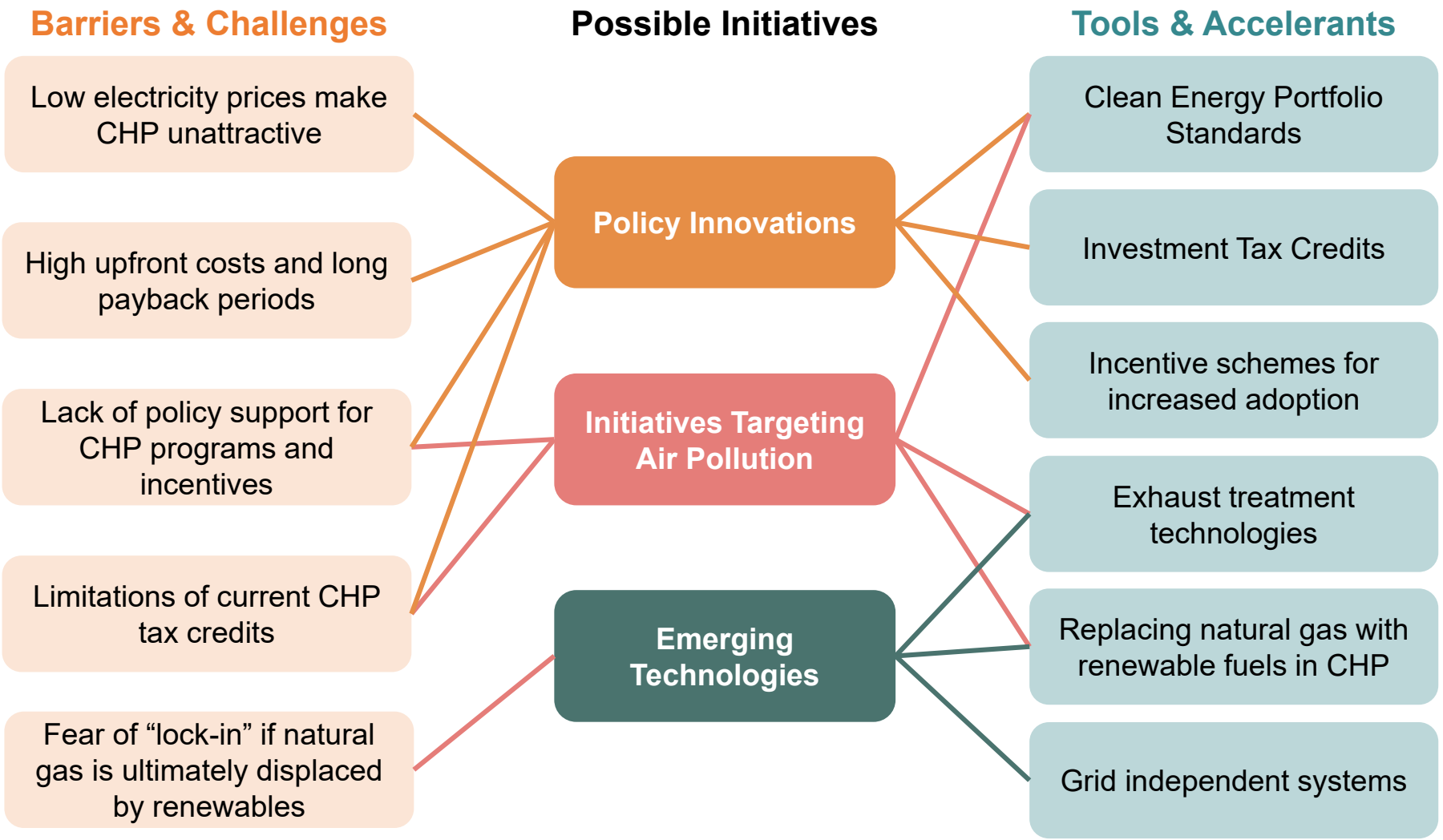
## Large-Scale Solar

- CHP and other dispatchable generation can complement variable renewables such as solar.
- CHP competes with other low-carbon technologies to decarbonize the electric grid.

## Landfill Methane

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

# Challenges and Possible Initiatives for Cogeneration in Georgia



# CONCLUSIONS

- Cogeneration has the potential to significantly reduce $CO_2$ emissions in Georgia by 2030
- Realizing could provide needed jobs and wealth to Georgia communities
- Air quality throughout the state would be improved, with significant associated public health benefits

DRAWDOWN GA

Corresponding author:
Dr. Marilyn A. Brown
Interim Chair, School of Public Policy
Georgia Institute of Technology
Email: mbrown9@gatech.edu
Phone: 404-385-0303
Climate and Energy Policy
Lab: www.cepl.gatech.edu

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