Identifying the most promising solutions for reducing carbon emissions in Georgia

Overview of the Drawdown Georgia Sessions at The Southface Institute’s Greenprints Conference
August 6, 2020
Georgia Drawdown Updates

Dr. Marilyn Brown, Regents Professor
Georgia Institute of Technology

On behalf of the Drawdown Georgia team
Rapid declines in CO₂ emissions would be required to reach a 1.5 degree pathway

Starting Point: Project Drawdown Solutions

21 High Impact Solutions
• Climate change presents real risks to Georgia and the rest of the world.

• Proactively managing those risks presents real opportunities.

• Addressing this challenge at scale will require creativity and innovation.

• Project Drawdown pioneered this type of new thinking at the global level.

• Drawdown Georgia brings a Georgia lens to this analysis.

https://www.exploregeorgia.org/article/georgias-famous-foods-you-just-have-to-try-when-you-visit
Down-Select Criteria:

- Is the solution technology & market ready for Georgia?
- Is there sufficient local experience and available data?
- Can the solution reduce 1 MTCO$_2$e annually by 2030?
- Is the solution cost-competitive?
- What are the “beyond carbon” considerations?

PHASE 1

A Working Paper and ~200-page appendix describing the “down-select” can be found [here](#).
21 High-Impact Drawdown Georgia Solutions

**Energy**
- Cogeneration: Achievable, Technical
- Demand Response: Achievable, Technical
- Rooftop Solar: Achievable, Technical
- Solar Fields: Achievable, Technical
- Landfill Methane: Achievable, Technical

**Transportation**
- Aviation Groundworks: Achievable, Technical
- Electric Vehicles: Achievable, Technical
- Energy Efficient Cars: Achievable, Technical
- Energy Efficient Trucks: Achievable, Technical
- Mass Transit: Achievable, Technical
- Alternative Mobility: Achievable, Technical

**Food Systems**
- Composting: Achievable, Technical
- Conservation Agriculture: Achievable, Technical
- Plant Rich Diet: Achievable, Technical
- Reduced Food Waste: Achievable, Technical

**Built Environment & Materials**
- Recycling: Achievable, Technical
- Refrigerant Management: Achievable, Technical
- Retrofitting: Achievable, Technical

**Forests & Land Use**
- Afforestation & Silvopasture: Achievable, Technical
- Coastal Wetlands: Achievable, Technical
- Temperate Forest Protection & Mgmt: Achievable, Technical
Drawdown Scenarios of the 21 High-Impact Solutions

**Baseline Forecast** = The “no new action” scenario – the status quo + changes and trends already underway.

**Achievable Potential:** A more optimistic scenario still considering costs, impacts, and stakeholder acceptance, but consistent with a greater commitment to success.

Growing solar fields from 1 to 11% of electricity generated, EVs are 15% of new sales by 2030.

**Technical Potential:** Maximum realistic application without regard to cost or other impacts, up to hard limits on resources such as available land and materials.

Increasing forest cover by 10%, recycling 95% of disposed recyclable materials.
Electric Vehicles

EVs can contribute additional CO₂ reductions beyond a favorable baseline trend by 2030

- Improved Air Quality
- Approaching TCO price parity
- Lower operating and maintenance costs
- Affordability on capital cost basis

Baseline = Assumes business as usual for fuel economy and CO₂ reductions, driven by new vehicle technologies and Federal CAFÉ regulations

Achievable Potential = Approximately 310,000 electric vehicles in the Georgia Light Duty Vehicle Fleet (i.e., about 4% of the total fleet), and accounting for 15% of new LDV sales in 2030

Technical Potential = Approximately 680,000 EVs in the Georgia LDV fleet (9% of the total fleet), and 35% of new LDV sales by 2030. Contributing 2.3MMT/yr in CO₂ reductions compared to baseline.

1 MtCO₂e solution in 2030 = ~250,000 cars taken off the road
For the three scenarios approximately 100 on-peak hours were modeled by GT-NEMS with the following parameters set for each.

Under the baseline forecast, a maximum load shift of 4% is assumed.

The achievable potential increases the maximum load shift to 20% between 2020 and 2030.

The larger technical potential, in addition to the 20% maximum load shift, also models for a 50% reduction in the cost of storage.

*Georgia Power designated on-peak months Jun-Sep
Costs and Benefits of Rooftop Solar Installations
Improvements in efficiency and costs leading to greater net-present value

Residential payback periods:
15.2 - 15.8 years in 2020
12.7 - 13.3 years in 2022
10.6 - 11.1 years in 2024

Commercial payback periods:
9.3 - 12.6 years in 2020
7.6 - 10.3 years in 2022
6.1 - 8.4 years in 2024

Source: System Analysis Model (SAM) results
Challenges and Promising Policies

Challenges

- High upfront costs
- Information asymmetry
- Transaction and administrative costs
- Principal-agent problems
- Split/misplaced incentives and subsidies.
- Lack of a decoupling policy in Georgia
- Issues arising from discount rates of individuals and businesses

Promising Policies

- Electricity decoupling, providing easier access to capital at attractive interest rates
- Programs such as on-bill financing and property assessed clean energy (PACE)
- Information campaigns to reduce information asymmetry
- Improved standards
- Information campaigns to promote more energy-efficient replacements of equipment at end-of-life
Stakeholder Analysis of Conservation Agriculture

- **Risks**
  - Consumers
  - Trade/Commodity Groups
  - Farmers Group

- **Rewards**
  - U.S. Department of Agriculture (USDA)
  - State and County Extension Agencies
  - Natural Resources Conservation Service (NRCS), Economic Research Services (ERS)

- **Potential Champions**
  - Georgia Department of Agriculture, UGA Extension Services
  - GA Farm Bureau
  - GA Cotton Commission, GA Peanut Commission
  - Conservation & Environmental NGOs
Solar Fields

Electric Vehicle
- Solar fields enable EVs to lower their CO₂ emissions.

Cogeneration
- A potentially more affordable low-carbon electricity option.

Retrofitting
- With lots of solar fields, retrofitting buildings saves less carbon.

Afforestation & Silvopasture
- New solar fields would occupy lands that otherwise could be used for growing trees or crops.
Wedge Diagram – Achievable Potential

- Shows annual Mt CO$_2$ reductions relative to the Baseline (black) and current carbon sinks.
- Includes baseline annual sequestration (grey) at 46 Mt CO$_2$ per year from Georgia’s natural carbon sinks.
- All 21 solutions are set to their achievable potential.
- Electric vehicles in this model are enhanced by solar fields, with more such overlaps yet to be added.

By 2030, Georgia’s GHG footprint could be cut by 43%: from 122 to 69 Mt CO$_2$-e
All 21 solutions are set to their technical potential.

Carbon emissions reduced by 118% in 2030.

Electric vehicles in this model are greatly enhanced by solar fields.

More such overlaps yet to be added.

Georgia has the potential to achieve a net zero GHG footprint and sell excess credits into carbon offset markets.
Rooftop Solar

Presenter
Dr. Marilyn Brown, Georgia Institute of Technology

Lead Analysts
Dr. Marilyn Brown and Vincent Gu
Georgia Institute of Technology
Rooftop Solar

Current Capacity:
5.9 MW (4.0 MW from Solarize Programs)

Technical Potential:
Reduction of 3.7 Mt CO₂ in 2030

Achievable Potential:
Reduction of 0.8 Mt CO₂ in 2030

Most of the existing capacity is in large cities: Atlanta, Savannah and Athens

Key obstacles:
• High capital costs
• Buyback rates = relatively low retail rates
• Fees and cumbersome permitting procedures

Current growth is driven by community campaigns that:
• Reduce costs through bulk purchasing
• Streamline procedures

Solar PV on Georgia rooftops in 2019
Source of data: Google Project Sunroof
Rooftop Solar
A gradual learning curve, with Solarize campaigns and PulteHomes as first-movers

**Baseline** = GT-NEMS forecasts a 6.4 MtCO₂ rise in yearly emissions by 2030.

**Achievable Potential** = Reduction of 0.8 MtCO₂ in 2030, totaling 2.1 MtCO₂ between 2020 and 2030.

**Technical Potential** = Maximum south-facing rooftop capability of abating 3.7 MtCO₂, flattening the growth of CO₂ in GA over the decade

1 MtCO₂e solution in 2030 = 2,580 GWh of zero-carbon generation from solar panels

7.2 GW available capacity from south-facing rooftops
4.01 MW current installed capacity from Solarize
11-year residential payback period anticipated mid-2020’s

+ Enhanced reductions with electric vehicles and demand-side response
+ Less air pollution
– High capital costs
– Low buyback rates in GA
Rooftop Solar Technical Potential
Substantial reductions possible by 2030

Solar radiation levels
(208 to 228 W/m²)

47.35 km² available space
from south-facing rooftops

7.2 GW total available capacity

9,153 GWh annual generation capacity

3.7 MtCO₂ annual reduction
(1 MMt per 2,580 GWh)

5,858 kW existing rooftop capacity in 2019

4,008 kW capacity installed from Solarize projects

Rooftop PV Generation Potential per Capita

Source: Authors, based on Google Project Sunroof data explorer (March 2020)
Rooftop Solar Achievable Potential
Substantial reductions possible by 2030

5,858 kW existing installed rooftop capacity

4,008 kW capacity installed from Solarize projects

Annual Solarize abatement:

Projected growth of carbon-abatement from further expansion of rooftop solar:

Achievable Potential
0.8 MtCO₂ annual reduction by 2030
Demand-Side Response

Presenter
Dr. Matt Cox, The Greenlink Group

Lead Analysts
Dr. Marilyn Brown and Oliver Chapman
Georgia Institute of Technology
Why Demand-Side Response?

Demand-side response is a tool for clipping expensive and polluting demand peaks and tackling the intermittency of variable renewable energy in Georgia.

DSR can facilitate the integration of more solar energy, when coupled with:

- battery storage
- smart devices
- direct load control
- real-time pricing
Demand-Side Response
Our working scenarios suggest sizable carbon mitigating potential by 2030

Baseline = GT-NEMS forecasts a 6.4 MtCO₂ rise in yearly emissions by 2030.

Achievable Potential = Reduction of 2 MtCO₂ in 2030, totaling 19.1 MtCO₂ between 2020 and 2030.

Technical Potential = Reduction of 1.6 MtCO₂ in 2030, totaling 31.3 MtCO₂ between 2020 and 2030.

1 MtCO₂e solution in 2030 = 187,000 households participating in a DSR program, shift 10% of their peak to off-peak demand.

- 8.5% of households served by Georgia Power.
- 4.39 kW peak load per household.

+ Bill savings for Georgia households
+ Low capital costs
+ Enables greater integration of solar
+ Less air pollution
-/+ Costs/tCO₂ averted = yearly average of $5 to $6
Georgia Households would see Lower Prices and Bills for the Same Levels of Consumption

**Baseline** = Prices increase from 11.9¢/kWh in 2017 to 13.4¢/kWh by 2030.

**Achievable Potential** = Prices increase to 13.4¢/kWh by 2030 but average 0.15% lower over the decade, saving Georgia households approximately $87 million.

**Technical Potential** = Prices increase to 13.2¢/kWh by 2030 averaging 0.51% lower over the decade, saving Georgia households approximately $330 million.
Demand-Side Response

A solution for Georgia that

- Reduces carbon emissions
- Saves consumers money
- Features low costs for utility providers
- Is compatible with other solutions
Composting

Dr. Sudhagar Mani
University of Georgia
Composting

Current Capacity: 2.6 million tons of organic wastes landfilled

Technical Potential: Reduction of 0.7 Mt CO$_2$ in 2030

Achievable Potential: Reduction of 1.4 Mt CO$_2$ in 2030

- Biological aerobic process to decompose organic wastes by microorganisms into stable organic materials - compost
- A valuable soil conditioner or fertilizer that improves plant growth, sequester soil carbon and prevents soil erosion
- Scale ranges from commercial, community to home composting sizes. Georgia currently operates about 38 composting facilities at various commercial scales
- Key obstacles include lack of awareness, large initial investment and operating costs, odor issues and contamination

Figure 1: Location of 38 Georgia composting facilities, which participated in the survey, represented as municipal, institutional and private operations

Source: GA EPD
Composting
A simple solution to zero landfill Georgia

Baseline = Estimate based on the emissions due to landfilling of organic wastes including food waste.

Achievable Potential = 50% diversion of organic wastes from landfill reduce 0.7 MtCO$_2$ in 2030,

Technical Potential = Complete diversion of organic wastes from landfill reduces 1.4 MtCO$_2$ in Georgia

\[
\text{Avoided CO}_2 (\text{MMt}) \text{ in 2030}
\]

<table>
<thead>
<tr>
<th>Achievable</th>
<th>Technical</th>
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<tbody>
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<td>0.7</td>
<td>1.4</td>
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Centralized composting with federal and state grants and private investments will reduce costs and promotes widespread deployment across the state (-source-separation collection)

Home composting can be cheaper to residents and can save from waste disposal costs (-packaging materials)

Organic fertilizer can displace fossil derived fertilizers for crop production

Compost promotes organic agriculture and urban gardening practices
Electric Vehicles

Dr. Richard Simmons
Georgia Institute of Technology
Electric Vehicles

Electric vehicles (EVs) are powered by electric batteries instead of conventional fuels such as gasoline and diesel. The emissions profile of these vehicles is lower, however the exact emissions vary depending on the generation mix providing the electricity.

In this Drawdown GA solution, we assess the CO$_2$ reduction potential of EVs in the light duty vehicle category. However, electrification is an option that can provide CO$_2$ benefits in additional vehicle segments including MD/HD truck, public transit, and aviation groundworks.
Electric Vehicles
EVs can contribute additional CO$_2$ reductions beyond a favorable baseline trend by 2030

**Baseline** = Assumes business as usual for fuel economy and CO$_2$ reductions, driven by new vehicle technologies and Federal CAFÉ regulations

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1 MtCO$_2$e solution in 2030 = ~250,000 cars taken off the road

+ Improved Air Quality
+ Approaching TCO price parity
+ Lower operating and maintenance costs
- Affordability on capital cost basis
Grid CO₂ intensity reductions propel per vehicle EV contributions
Despite an aggressive baseline

Conventional vehicles improve at 1.5% y/y through 2025

EVs approach a relative CO₂ intensity of 50% compared to conventional cars

But, adoption rate will dictate overall impact from this solution

R. Simmons, Strategic Energy Institute, Georgia Institute of Technology, 2020
EV costs approach price parity by 2030 on TCO basis, with qualifiers

New EV sticker prices are currently more than similar conventional cars.

Subsidies currently offset most of this differential. In the next decade, price parity is anticipated on a total cost of ownership basis.

However, a few significant unknowns remain:
- Continued decline in battery prices
- Cost of conventional fuel
- Cost of charging equipment
- Federal/State EV tax credits
- Interest rates and financing costs
- Carbon policy
- CAFE regulations
Electric Vehicles

A solution for Georgia that

• Reduces carbon emissions
• Is synergistic with a cleaner grid
• Results in air quality benefits
• Helps diversify transportation energy resources
• Can generate new jobs
Retrofitting the Built Environment

Presenter
Shane Totten, Southface

Lead Analysts
Dr. Daniel Matisoff and Fikret Atalay
Georgia Institute of Technology
We asked a focus group about the following technologies for retrofitting:

- Improving air sealing/insulation
- LED lighting
- High-efficiency heat pumps & water heaters
- Smart thermostats
- Automated control systems
- Water-saving devices
- Alternative roof designs (green roofs or cool roofs)
- Improved windows
- Recommissioning / retro-commissioning
- Deadband range expansion
Private Costs and Benefits Estimation - Achievable Potential

Assumptions

Technologies
- Smart Thermostats/Building Automation
- LED Lighting
- Insulation
- Water Heaters
- Heat Pumps
- Windows (Residential)
- Recommissioning

Cumulative retrofit rate by 2030

<table>
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<tr>
<th>Technology</th>
<th>ST</th>
<th>LED</th>
<th>INS</th>
<th>WH</th>
<th>HP</th>
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<td>Residential</td>
<td>20%</td>
<td>20%</td>
<td>20%</td>
<td>20%</td>
<td>20%</td>
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<tr>
<td>Commercial</td>
<td>20%</td>
<td>20%</td>
<td>20%</td>
<td>0%</td>
<td>0%</td>
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Financial
- Discount rate = 12%
- Values are based on current estimated installed costs for retrofitting, with a learning rate of 3% between now and 2030 and constant relative savings over the lifespan of each technology using an energy price of $0.08/kWh for commercial and $0.10/kWh for residential.
- Difference in maintenance and other costs are negligible
- Administrative costs were excluded

Results

<table>
<thead>
<tr>
<th>NPV Private Costs</th>
<th>NPV Private Benefits</th>
</tr>
</thead>
<tbody>
<tr>
<td>$2.5B – $5.4B initial costs</td>
<td>$2.0B – $8.0B avoided energy costs</td>
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Current State of Retrofitting in Georgia

No state-wide program. Georgia Power offers:
- Incentives for single family homes for energy saving solutions ($50 - $300 up to a combined maximum of $1,000)
- Rebates on residential LED lighting and other energy savings options.
- Incentives for commercial buildings for energy saving solutions (up to $75,000/building/year).

Georgia Environmental Finance Authority offers:
- Low-interest financing for energy efficiency and renewable energy projects for local governments at water, sewer, and solid waste facilities.

Nationwide demolish rate is about 2%. GA residential is closer to 1% and commercial is closer to 3%
Baseline = From 44.1 MtCO$_2$e in 2017 for commercial and residential buildings, GT-NEMS growth rate forecasts ~43 MtCO$_2$e in GA in 2030.

Achievable Potential = Reduction of 2.6-4 MtCO$_2$e in 2030, considering a cumulative retrofit rate of 20% for deep residential retrofits and for the cost-effective commercial retrofit solutions by 2030.

Technical Potential = Reduction of 9-13.7 MtCO$_2$e in 2030, with a cumulative retrofit rate of 50% for all retrofit solutions by 2030.

1 MtCO$_2$e solution in 2030 = retrofitting around 20% of Georgia’s single-family residential homes (approximately 600,000 homes) to achieve an average energy savings of 20% per home by 2030.

- Less air pollution
- Local jobs
- Less energy burden
- Public health benefits
- High upfront cost
Beyond Carbon Impacts

Michael Oxman
Georgia Institute of Technology
Objectives:

1. Add/integrate an additional lens to carbon-related technology solution assessments by incorporating beyond-carbon impacts

2. Identify cross-cutting beyond-carbon themes for enhancing impact of carbon mitigation solutions

1. Consult with beyond-carbon experts and key stakeholders in order to promote engagement with the Georgia Drawdown Project
Initial Beyond Carbon Assessments
A Range of Intersecting Attributes Considered

Environment
- Air quality
- Water quality, quantity, and access
- Land use
- Ecosystems/ biodiversity
- Material disposability

Equity
- Affordability
- Diversity of Economic Development & Jobs
- Distribution of Public Health Impacts
- Accessibility of Solutions
- Cultural Fit & Way of Life

Economic Development
- Local Economy & Employment
- Input Prices
- Workforce composition
- Wages and benefits
- Property values / Tax Base
- Infrastructure requirements

Public Health
- Premature Mortality
- Morbidity
- Quality of Life
- Education
- Public Safety
# Initial Assessments Across Multiple Solutions

Material Benefits/Concerns Flagged

<table>
<thead>
<tr>
<th>Environment</th>
<th>Equity</th>
<th>Economic Development &amp; Jobs</th>
<th>Public Health</th>
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**Example:** Rooftop Solar

**Benefits and Impacts to Manage**
- Air quality improvements
- End of life panel disposability
- Installation & maintenance jobs
- Diversity in workforce
- Property values
- Accessibility of solution
- Impact on energy burdens

**Promising Approaches**
- SEIA/other recycling initiatives
- PSE “just energy” circles
- Targeted entrepreneurial grants
- Community solar programs/net metering
- Low income financing (on-bill, pays, etc.)
### Benefits and Impacts to Manage

- Air quality improvements
- Resilience
- Customer Savings
- Accessibility and/or “penalties” for customers without targeted appliances or less flexible schedules

### Promising Approaches

- Awareness of demand response potential
- Rate design options
- Easing cost barriers for smart grid technologies & tailored offerings for homes with less flexible loads or schedules

**Example:** Demand Response
For More Information Contact Us: Drawdown@gatech.edu