

Overview of Working Groups 1-3 and Down-selected Solutions:

Electricity Generation (WG1)

Transportation (WG2)

Built Environment (WG3)

Presented by Dr. Rich Simmons on behalf of the WG1-3 leads
November 7, 2019

Agenda

Drawdown topics in this overview:

- Working Group 1: Electricity Generation
- Working Group 2: Transportation
- Working Group 3: Built Environment

Key points to be discussed:

- Brief context
- Expert feedback and insights
- Synopsis of top 5 solutions in: WG1, WG2, and WG3
- Key points and next steps
- How to contact us

Working Group 1 Electricity Generation (23 solutions)	Working Group 2 Transport (13 solutions)	Working Group 3 Built Env't & Materials (27 solutions)	Working Group 4 Food (20 solutions)	Working Group 5 Land Use (10 solutions)	Working Group 6 Beyond Carbon Advisory Group (3 solutions)
<i>categories in the table below are from Drawdown; strike-through indicates topics that do not pertain to Georgia</i>					
<p><u>Energy & Electricity Generation</u></p> <ol style="list-style-type: none"> 1.Wind Turbines (Onshore) 2.Solar Farms* 3.Rooftop Solar 4.Geothermal 5.Nuclear 6.Wind Turbines (Offshore) 7.Concentrated Solar 8.Wave and Tidal 9.Methane Digesters (Large) 10.Biomass* 11.Solar Water 12.In-Stream Hydro 13.Cogeneration 14.Methane Digesters (Small) 15. Waste-to-Energy 16.Micro Wind 17.Energy Storage (Distributed) + Energy Storage (Utilities) + Grid Flexibility 18.Microgrids <p><u>Coming Attractions</u></p> <ol style="list-style-type: none"> 19.Artificial Leaf 20.Hydrogen-Boron Fusion 21.Smart Grids 22.Smart Highways 23.Solid-State Wave Energy 	<p><u>Transport</u></p> <ol style="list-style-type: none"> 24.Electric Vehicles 25.Ships 26.Mass Transit 27.Trucks 28.Airplanes 29.Cars 30.Telepresence 31.High-speed Rail 32.Electric Bikes 33.Trains 34.Ridesharing <p><u>Coming Attractions</u></p> <ol style="list-style-type: none"> 35.Autonomous Vehicles 36.Hyperloop <p style="text-align: center;">Phases I and II: Define solution space and identify top 5 solutions in each WG</p>	<p><u>Buildings and Cities</u></p> <ol style="list-style-type: none"> 37.District Heating 38.Insulation 39.LED Lighting (Household) 40.Heat Pumps 41.LED Lighting (Commercial) 42.Building Automation 43.Walkable Cities 44.Smart Thermostats 45.Landfill Methane 46.Bike Infrastructure 47.Smart Glass 48.Water Distribution 49.Green Roofs 50.Net Zero Buildings 51.Retrofitting <p><u>Materials</u></p> <ol style="list-style-type: none"> 52.Refrigerant Management 53.Alternative Cement 54.Water Saving - Home 55.Bioplastic 56.Household Recycling 57.Industrial Recycling 58.Recycled Paper <p><u>Coming Attractions</u></p> <ol style="list-style-type: none"> 59.Building with Wood 60.Direct Air Capture 61.Enhanced Weathering of Minerals 62.Industrial Hemp 63.Living Buildings 	<p><u>Food</u></p> <ol style="list-style-type: none"> 64.Reduced Food Waste 65.Plant-Rich Diet 66.Silvopasture 67.Regenerative Agriculture 68.Tropical Staple Trees 69.Conservation Agriculture 70.Tree Intercropping 71.Managed Grazing 72.Clean Cookstoves 73.Farmland Restoration 74.Improved Rice Cultivation 75.Multistrata Agroforestry 76.System of Rice Intensification 77.Composting 78.Nutrient Management 79.Farmland Irrigation 80.Biochar <p><u>Coming Attractions</u></p> <ol style="list-style-type: none"> 81.Marine Permaculture 82.Microbial Farming 83.Ocean Farming 84.Pasture Cropping 85.Perennial Crops 	<p><u>Land Use</u></p> <ol style="list-style-type: none"> 86.Tropical Forests 87.Temperate Forests 88.Peatlands 89.Afforestation 90.Bamboo 91.Forest Protection 92.Indigenous Peoples' Land Management 93.Perennial Biomass 94.Coastal Wetlands <p><u>Coming Attractions</u></p> <ol style="list-style-type: none"> 95.A Cow Walks Onto a Beach 96.Intensive Silvopasture 97.Repopulating the Mammoth Steppe 	<p>This advisory group will integrate with Working Groups 1-5 to consider how those solutions might affect:</p> <ul style="list-style-type: none"> •Equity •Health •Jobs & Economic Development •Ecosystems <p>In addition, this group will analyze the following Drawdown solutions:</p> <p><u>Women and Girls</u></p> <ol style="list-style-type: none"> 98.Educating Girls 99.Family Planning 100.Women Smallholders
<small>Derived from: Hawken, Paul, ed. <i>Drawdown: The most comprehensive plan ever proposed to reverse global warming.</i> Penguin, 2017.</small>					

Georgia Drawdown Scope, WGs 1-3

Objective:

To identify most promising solutions in

Electricity Generation, Transportation and the Built Environment and Materials

to maximize GHG reduction by 2030, and to aid in achieving carbon neutrality in GA by 2050

- Will the solution be market-ready at scale over the next decade?
- Do sufficient data exist to adequately consider the solution in a Georgia context?
- Could the solution achieve significant carbon reductions in the 2030 timeframe?
 - A minimum threshold of **1 MMT CO₂-EQ annually** –
 - ≈ 1% of 2017 GA CO₂ emissions from fossil fuels
- Are the implementation costs competitive?
- What “Beyond Carbon” considerations accompany solution? (E.g., health, equity, jobs, environment)

Working Group 1 – Electricity Generation



**ELECTRICITY
GENERATION**



TRANSPORTATION



**BUILDINGS &
MATERIALS**



FOOD SYSTEMS



**FORESTRY &
LAND USE**

Synopsis of WG 1 Top Four

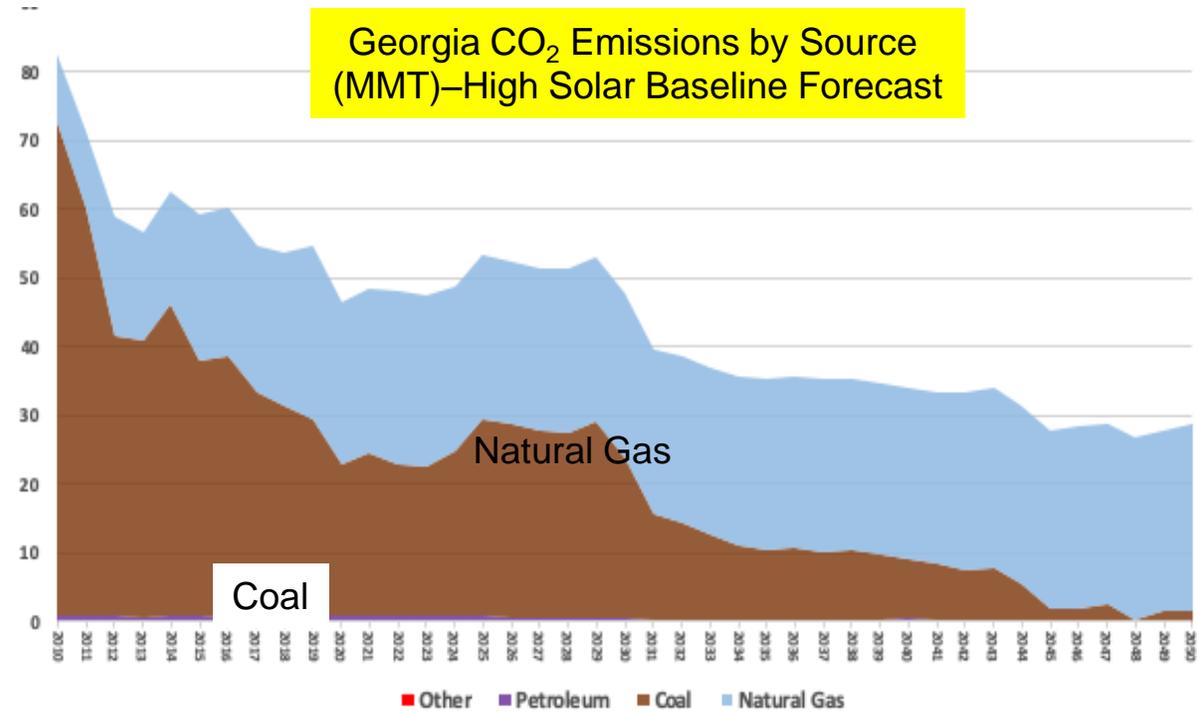
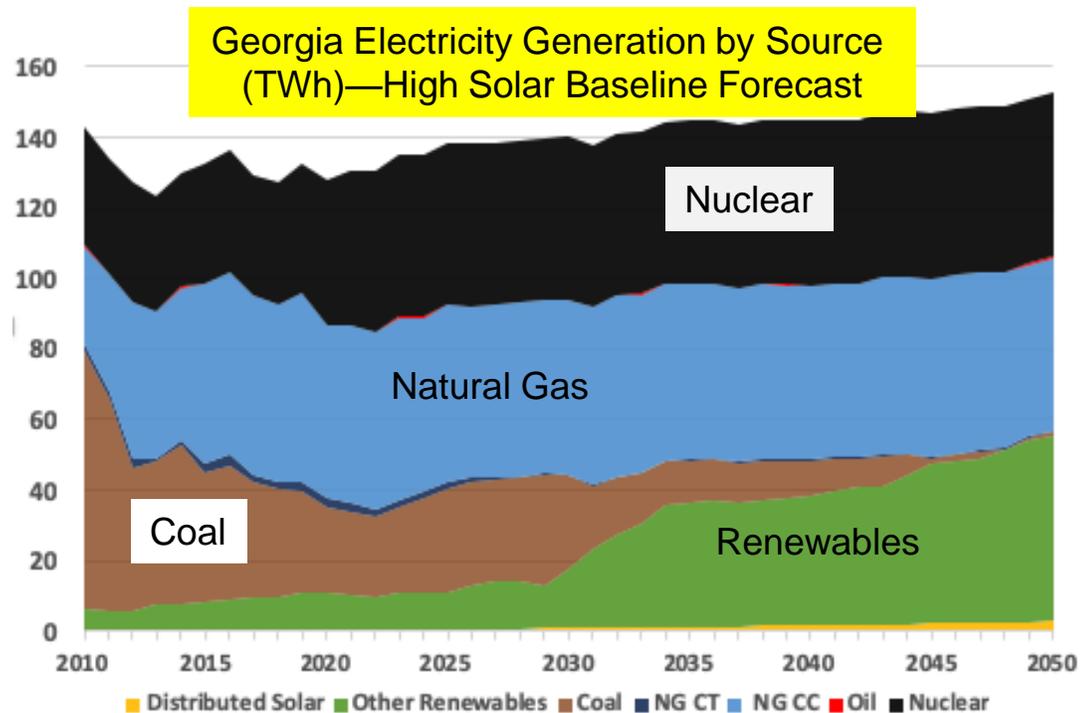
Presented on behalf of Dr. Marilyn A. Brown



Modeling Georgia's Electricity Generation: High Solar Baseline Forecast

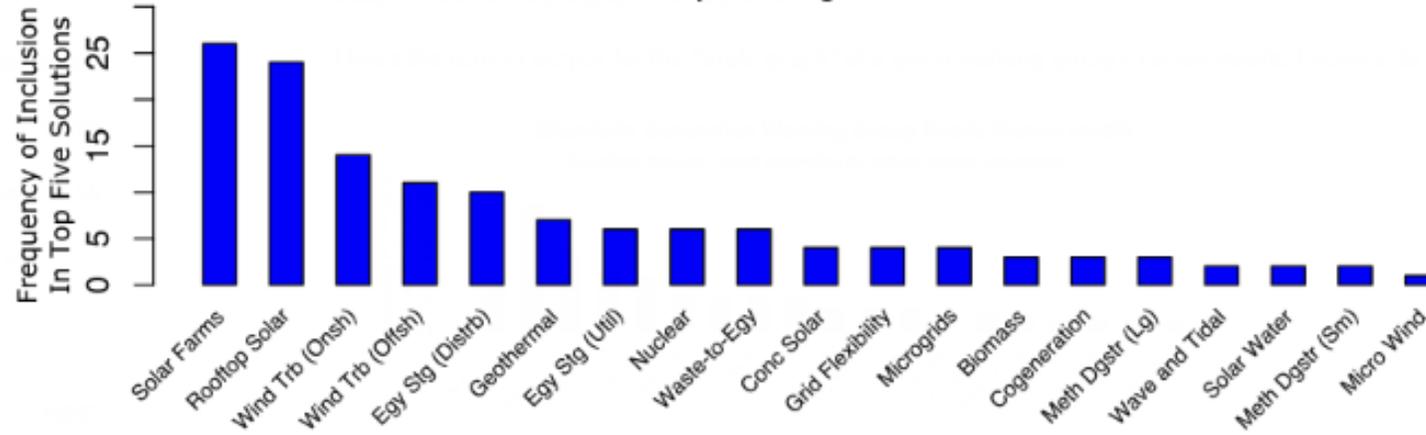
The National Energy Modeling System is being used to create electricity forecasts. It models the SERC-Southeast region, and we proportion down to characterize Georgia.

“Baselining” electricity is key b/c energy systems are increasingly intertwined: (e.g., the fate of solar impacts the CO₂ impacts of EVs and EE).

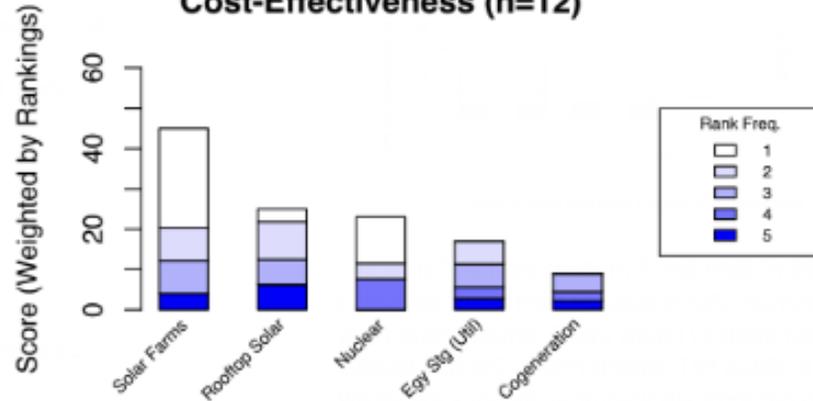


Electricity Generation Working Group Public Survey (n=59)

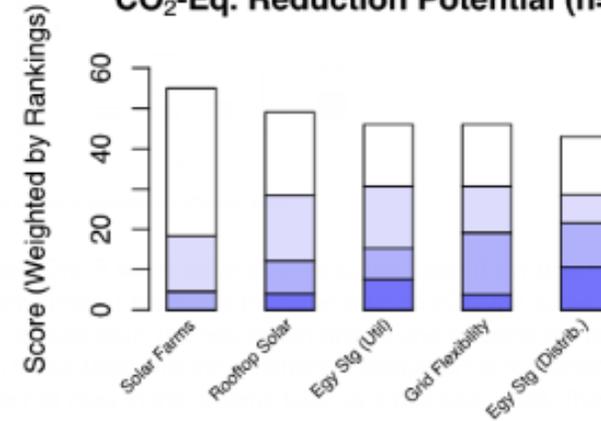
Solutions that are "most promising to reduce carbon emissions"



Cost-Effectiveness (n=12)



CO₂-Eq. Reduction Potential (n=12)



(Each 1st place rank earns 5 points, 2nd place 4 points, 3rd place 3 points, 4th place 2 points, 5th place 1 point)

Flow-Chart of the Down-Select Process

Down-Select Criteria for Electricity Generation Solutions:

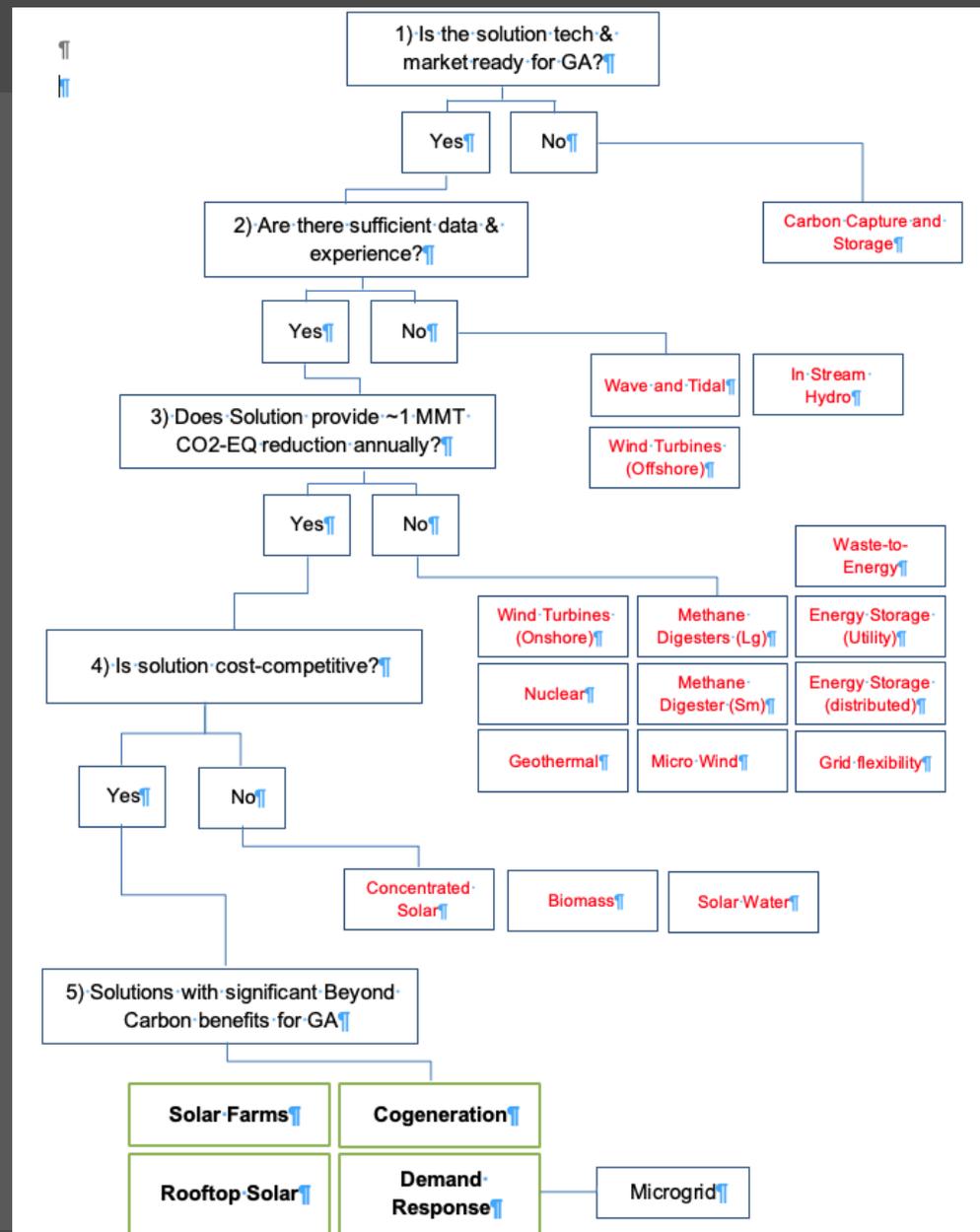
Technology & Market Readiness - Are the components of the Solution ready enough to be launched at significant scale over the next decade? (Can innovation, technology, and policy developments make the Solution workable by 2030, if it is not already?)

Local Experience & Data Availability - Is there sufficient data or qualitative analysis to adequately consider the Solution in a Georgia context? Is there local familiarity with the technology? Are there any local pilot or demonstrations to study? Is the level of complexity of the Solution manageable so that it can be credibly assessed?

Technically Achievable CO2 Reduction Potential - Could the Solution achieve significant carbon reductions in the 2030 timeframe as compared to other Solutions available to this sector? (A minimum threshold might be 1 MMTCO2 annually--about 1% of 2017 CO2 emissions from fossil fuels.)

Cost competitiveness - Is the solution's levelized cost of electricity (LCOE) in Georgia competitive with other Solutions available to the sector? Are the up-front capital costs affordable? Is the payback period competitive with other Solutions?

Other (“Beyond Carbon”) Attributes - Major co-benefits or co-costs beyond carbon on four dimensions: environment, economic development, public health, and equity.)



WG1: Phase II Down-Select of Drawdown Solutions

Highest potential impact to reduce CO₂ in Georgia over next decade, have reasonable economic merit, + can be managed for “beyond carbon” attributes

1. Solar Farms

- WG1 will assess the availability of sites for solar farms and community scale solar in Georgia (brownfields, near T&D, avoiding key conservation and habitat resources,...)
- Will estimate project costs and value of electricity when energy storage is added

2. Rooftop Solar

- Will examine the current generation potential and economics with and without energy storage, across the state
- Plan to quantify size of large potential markets e.g., commercial & industrial, ag operations, and urban markets

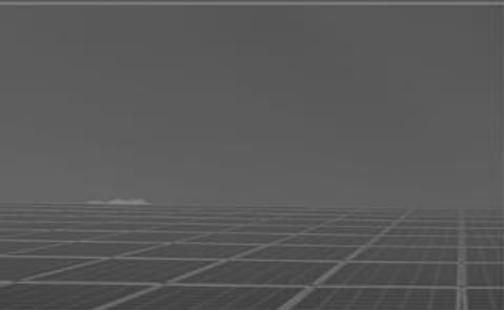
3. Cogeneration

- Will focus on the opportunity for CHP in biomass, chemicals, and other major industries

4. Demand Response

- Will quantify the value of ICT-enabled opportunities to shape the timing and geography of electricity use

Working Group 2 - Transportation



ELECTRICITY



TRANSPORTATION



BUILT ENVIRONMENT
& MATERIALS



FOOD



LAND USE

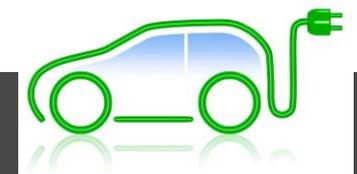
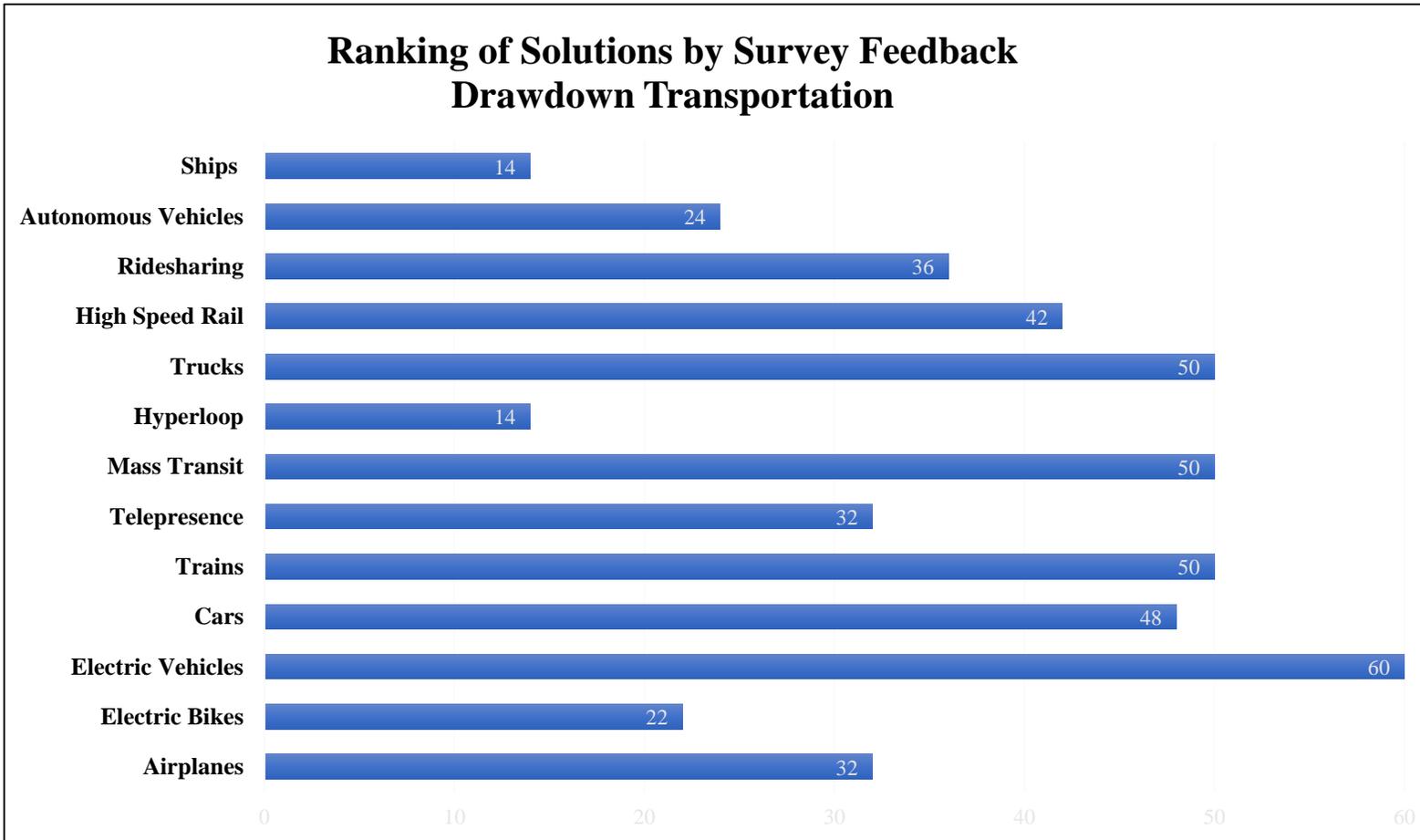
Synopsis of WG 2 Top Five

Presented on behalf of Drs. Rich Simmons & Mike Rodgers

WG2: Preferred Solutions for Georgia Drawdown Based on Survey Feedback

Highest Ranking solutions based on expert feedback (aggregated & weighted):

1. Electric Vehicles
2. Mass Transit
3. Trucks
4. Trains
5. Cars

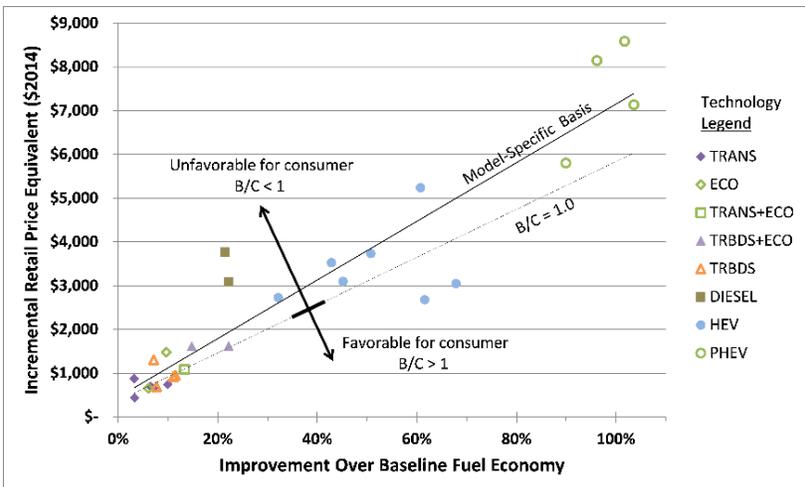
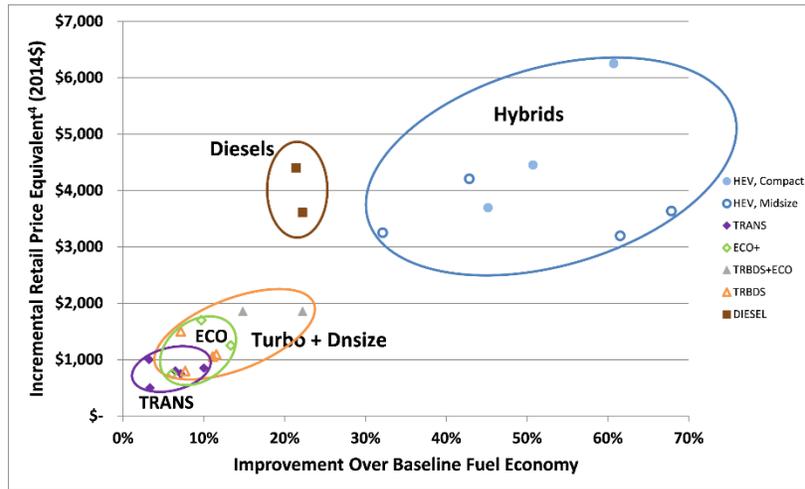


WG2- Top Five Solutions

Highest potential impact to reduce CO2 in Georgia by 2030 and 2050, with reasonable economic merit, and use technological approaches that can be deployable within 3-5 years.

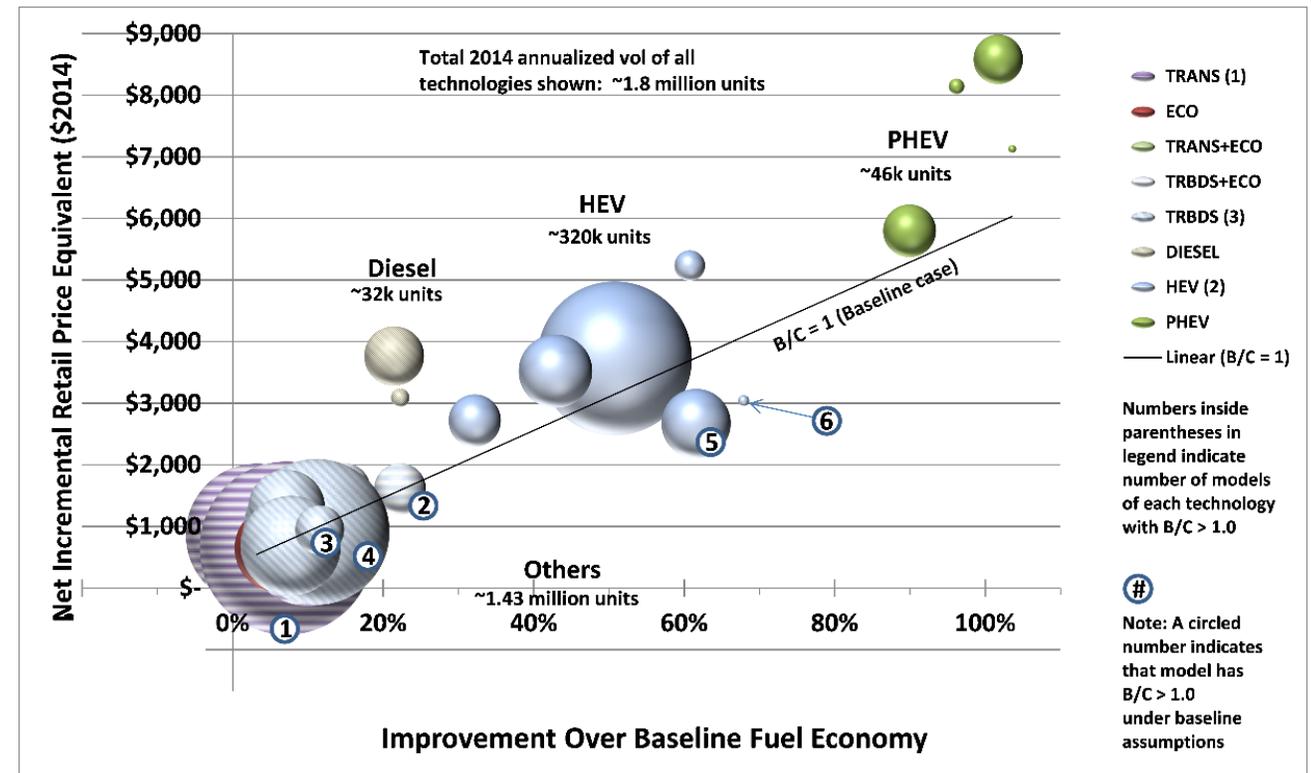
1. Cars
 - Plan to re-label as “Energy Efficient LDV” (passenger cars, SUVs, light trucks)
 - Dominant emissions source, a category with many sub-classification solutions
 - Plan to include a variety of fuel saving/emissions reducing technologies
2. Trucks
 - Will define this to include Class 3-8 vehicles and further subdivide MD/HD
3. Mass Transit
 - Includes urban modes (esp. buses and light rail)
 - Restricted to 10 major public transit systems in primary Georgia urban metro areas
4. Airplanes
 - Of global importance, but reconciling GA allocation is complex;
 - Plan to re-label as aviation (to include ground-transport at airports)
5. Electric Vehicles
 - High potential and warrants closer study across multiple categories
 - Micro-mobility and electrification of ground movements (freight/vehicles/ports) will be considered
 - Example methodology will be presented

WG2: Example of Fuel-Saving Technologies for LDVs



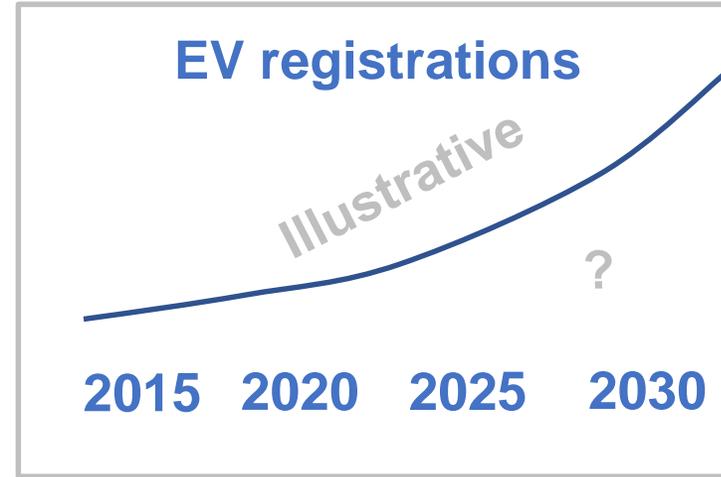
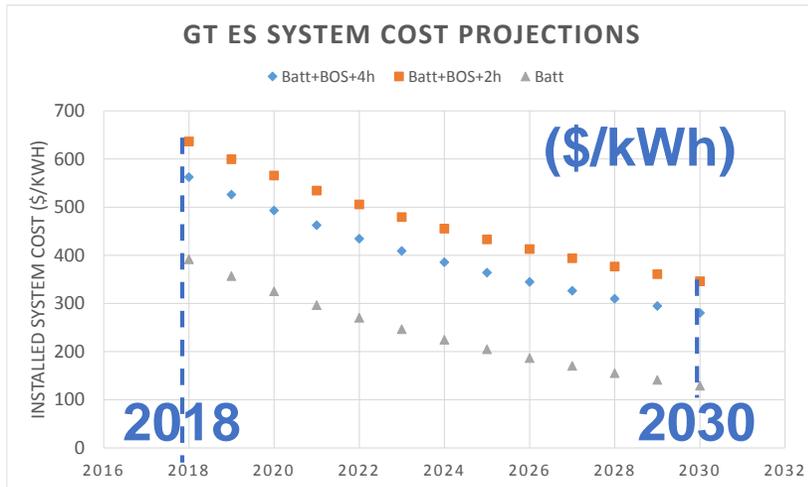
Viable, energy/emission reducing, affordable:

1. Downsized-turbos with GDI
2. Hybrids, PHEVs, and EVs
3. Lightweighting/ECO/Trans

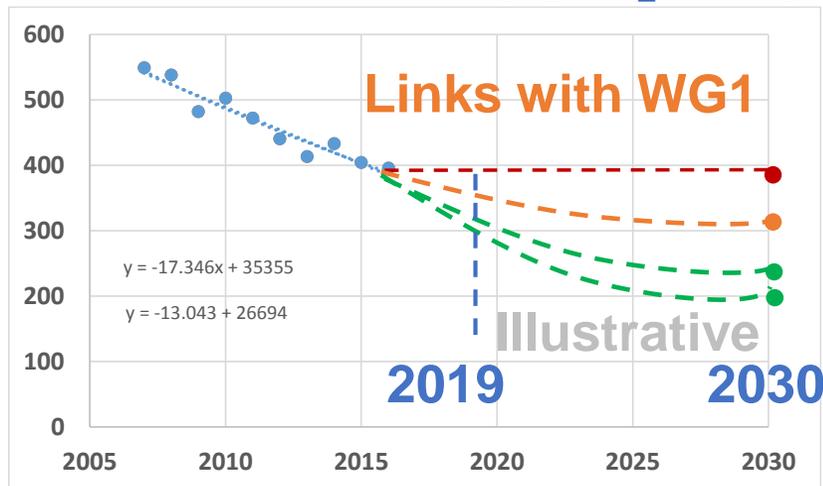


Simmons, Richard A., et al. "A benefit-cost assessment of new vehicle technologies and fuel economy in the US market." *Applied energy* 157 (2015): 940-952.

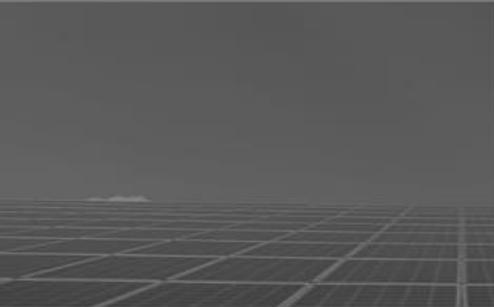
WG2: Trending EV penetration and emissions reduction potential to 2030



Emissions Intensity (CO₂/kWh)



Working Group 3 - Built Environment & Materials



ELECTRICITY



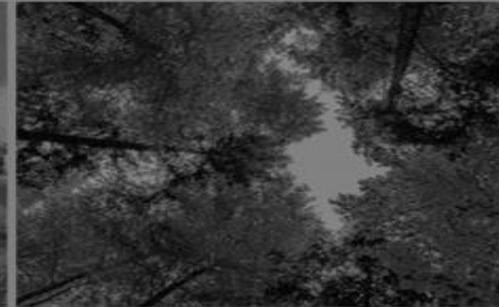
TRANSPORTATION



**BUILT ENVIRONMENT &
MATERIALS**



FOOD



LAND USE

Synopsis of WG 3 Top Five

Presented on behalf of Drs. Dan Matisoff & Fikret Atalay

WG3 - List of Solutions & Phase I Down-Select

Global Drawdown Solutions

Solution	Sector
Refrigerant Management	Materials
District Heating / Energy	Buildings and Cities
Insulation	Buildings and Cities
LED Lighting (Household)	Buildings and Cities
Alternative Cement	Materials
Heat Pumps	Buildings and Cities
LED Lighting (Commercial)	Buildings and Cities
Building Automation	Buildings and Cities
Water Saving - Home	Materials
Bioplastics	Materials
Walkable Cities	Buildings and Cities
Household Recycling	Materials
Industrial Recycling	Materials
Smart Thermostats	Buildings and Cities
Landfill Methane	Buildings and Cities
Bike Infrastructure	Buildings and Cities
Smart Glass	Buildings and Cities
Recycled Paper	Materials
Water Distribution	Buildings and Cities
Green Roofs	Buildings and Cities
Net Zero Buildings	Buildings and Cities
Retrofitting	Buildings and Cities

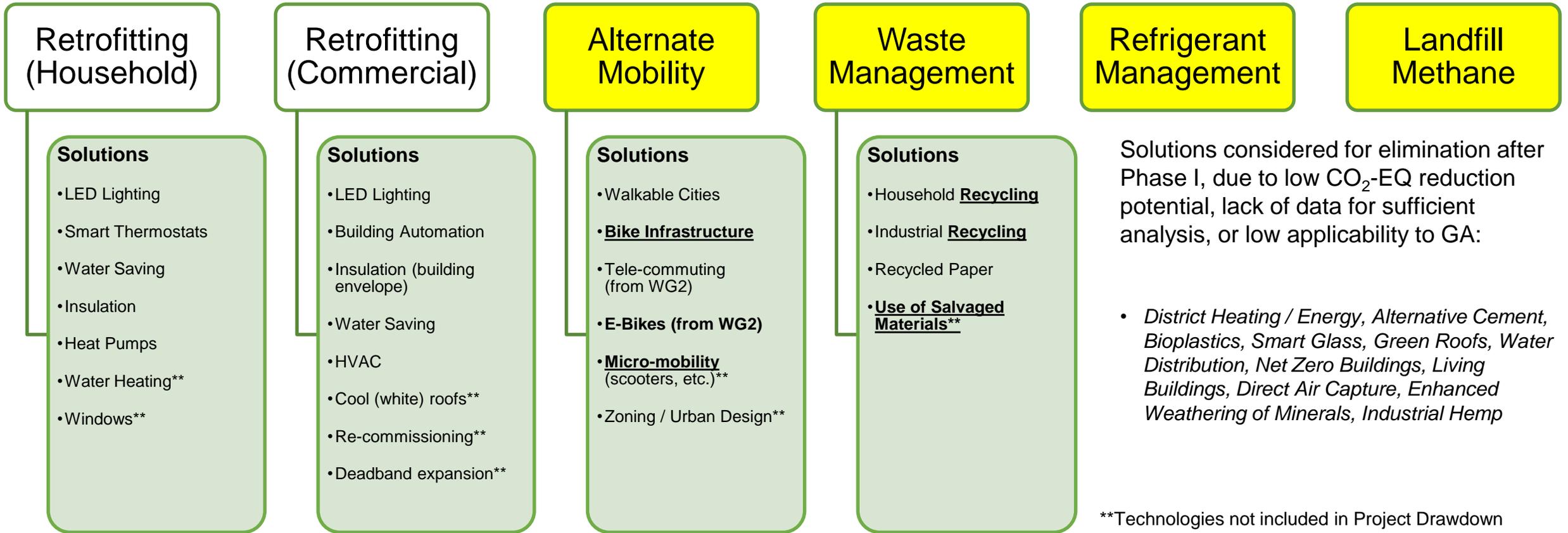
Coming Attractions

Living Buildings
Direct Air Capture
Building with Wood
Enhanced Weathering of Minerals
Industrial Hemp

- Use literature, back-of the envelope (BOE) calculations, and expert feedback to down-select from initial list of solutions to the top 5 or 6 with highest potential for GA
- Consider potential solutions which were not identified by the global Project Drawdown

WG3 – Phase II Down-Select Results

- “Refrigerant Management”, “Landfill Methane” and “Bike Infrastructure” appear to have the potential to meet the threshold of **1 MMT CO₂-EQ reduction annually**
- Energy efficiency solutions have the potential to meet the threshold when bundled together as “Retrofitting”
- Recycling solutions have the potential to meet the threshold when bundles as “Waste Management”



**Technologies not included in Project Drawdown

WG3 – High impact solutions

- “Alternate Mobility” can offer significant CO₂-EQ reduction potential by substituting vehicle miles traveled (VMTs), particularly for **short-distance (<3 miles) urban local trips**, with zero or low-carbon alternatives such as bicycling, walking, e-bikes, or electric scooters
- “**Refrigerant Management**” and “**Landfill Methane**” have high CO₂-EQ reduction potential due to the high global warming potential (GWP) of refrigerants and methane
- “Waste Management” can offer significant CO₂-EQ reduction potential through more wide-spread use of **recycled materials** instead of materials made from virgin stock (which is a much more energy intensive process)
- “**Building with Wood**” may be of particular interest to GA from a **beyond-carbon** perspective, given the size of the timber industry in GA (according to the Georgia Forestry Association, Georgia is #1 nationwide in commercially available timberland and #1 in annual timber harvest volume), in particular given the potential impacts related to the economy / jobs

Phase II Gate Review Discussion Points:

- Are the down-select criteria appropriate & complete?
- Given the scope and timeframe, do the identified solutions require additional considerations?
- How significant are beyond carbon factors?

Next Steps:

- Phase III analysis (detailed modeling) to begin immediately
- Identification/confirmation of relevant data and modeling tools
- Consideration of relevant interactions among solutions and across WGs
- Determination of appropriate geographic resolution for leading solutions

Stay in touch during our next phase of analysis:

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