Development of New York State Greenhouse Gas Abatement Cost Curves

The New York State Energy Research and Development Authority

Albany, NY

Prepared by:

The Center for Climate Strategies (CCS)

NYSERDA Agreement 10850

The Center for Climate Strategies

Helping States and the Nation Tackle Climate Change

Overview

Project Team
Project Purpose / Goals
New York State Greenhouse Gas (GHG) Emissions Inventory and Forecast
Work Group Areas (Sectors) Covered
Process / Work Products
Next Steps
Examples of Potential Results

Project Team

- NYSERDA Project Staff
  - Carl Mas
  - Sandra Meier
- Project Advisory Committee (PAC)
  - Provide work group area (sector)/subject matter expertise
  - Identify NY-specific data
  - Members from: NYSERDA, NYS PSC, NYSDEC, Dept. of Agriculture & Markets, NYSDOT, NYC Mayor's Office, Columbia University, Electric Power Research Institute, Resources for the Future, Environmental Defense
- Center for Climate Strategies (CCS)

CCS Project Team

- Tom Peterson, President and CEO
- Randy Strait, Project Manager
- Jeff Wennberg, Project Manager
- Work Group Area Leads:
  - Residential, Commercial, Industrial (RCI)
    - Michael Bobker, Building Performance Lab, CUNY
    - Hal Nelson, CCS
  - Power Supply (PS)
    - Bill Dougherty and Victoria Clark, Stockholm Environmental Institute (SEI)
  - Agriculture, Forestry, and Waste Management (AFW)
    - Steven Roe, E.H. Pechan & Associates, Inc. (Pechan)
  - Transportation and Land Use
    - Lewison Lem and Mike Lawrence, Jack Faucett Associates, Inc. (JFA)

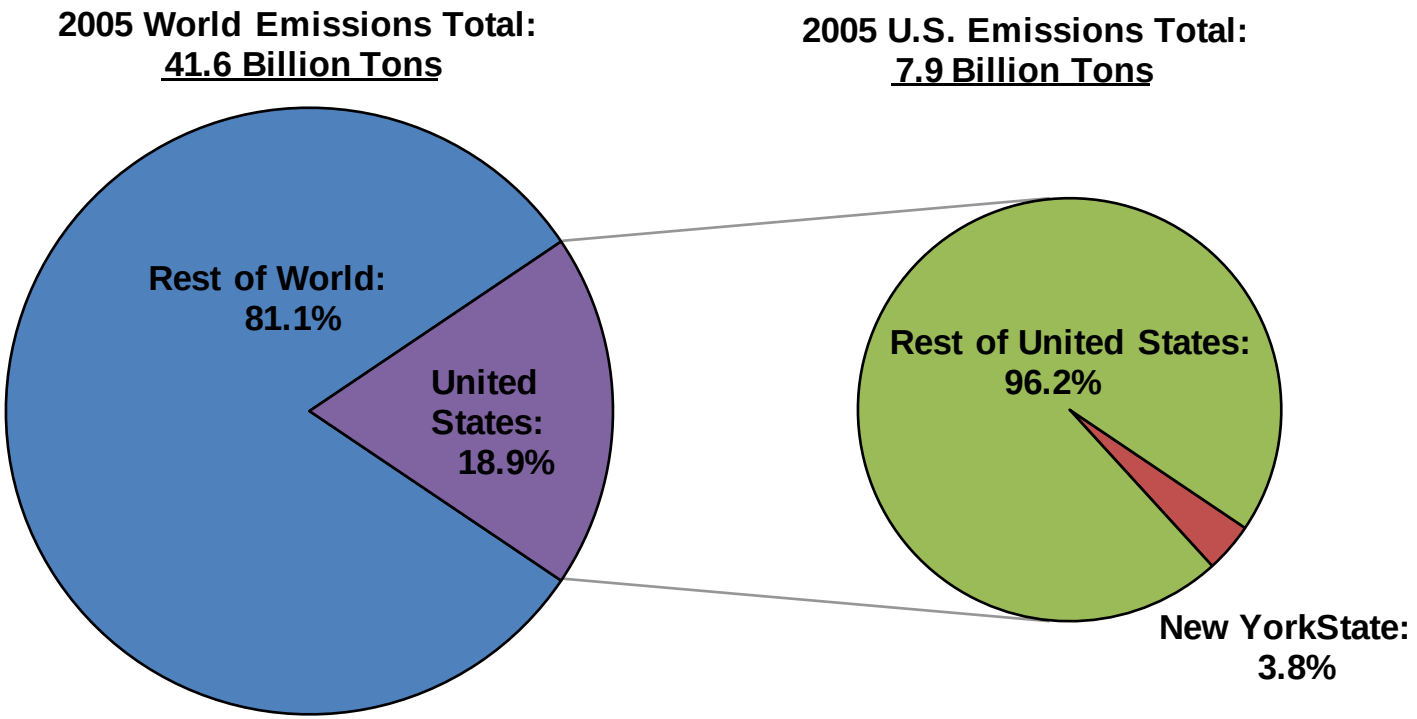
Project Purpose / Goals

- Greenhouse Gas (GHG) Abatement Cost Curve =
  - $/tonne GHG reduction (y-axis) versus GHG reduction (mass- or percentage-basis) for target year (x-axis)
- Bottom-up approach - focus on specific technologies and best practices (TBPs) for New York State (NYS)
- Analyze most promising (current & emerging) TBPs for NYS
- TBP results to provide scientific and technical foundation (building blocks) for wide range of potential policy actions or mechanisms for NYS

New York State

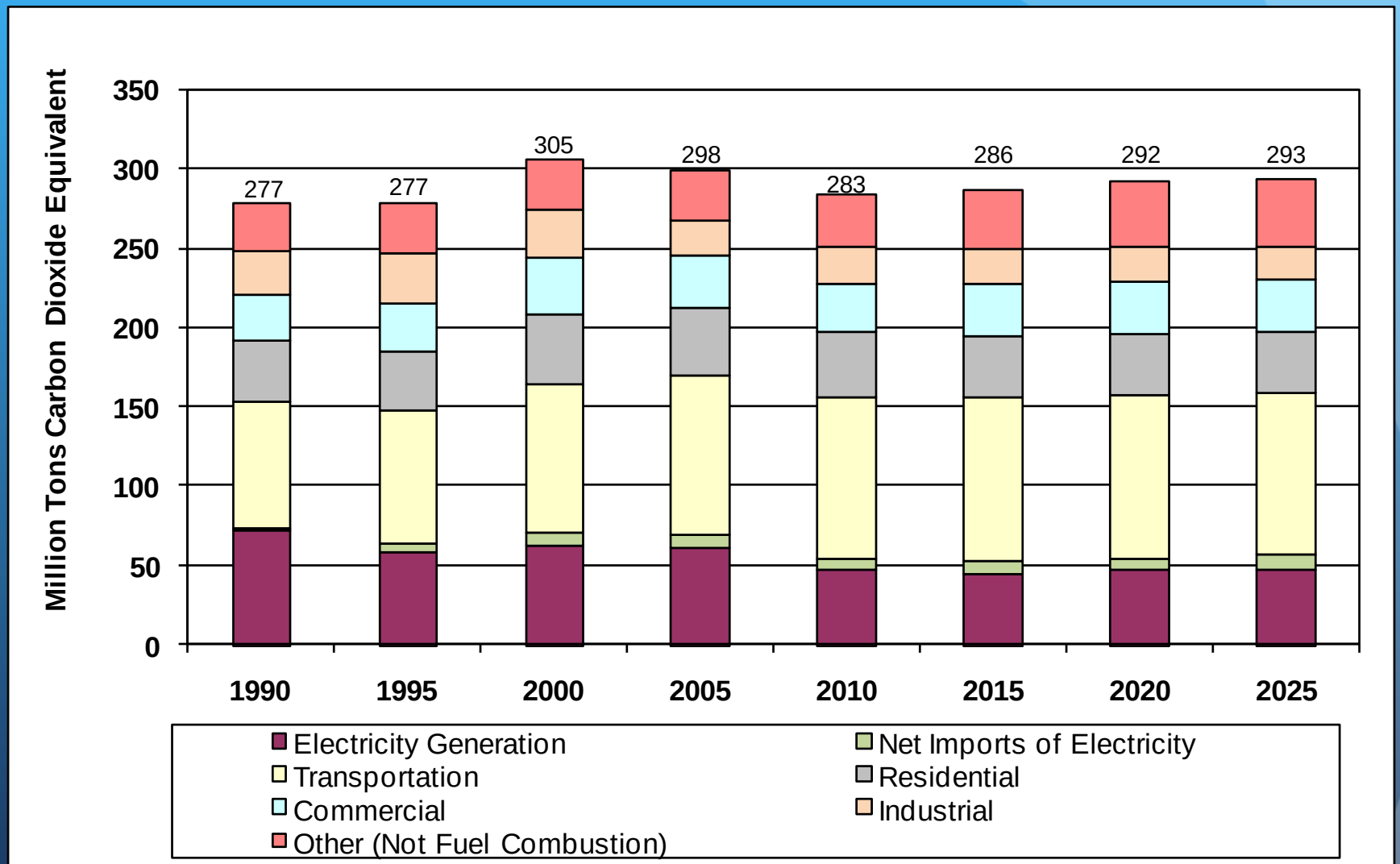
National and Global Context for Greenhouse Gas Emissions

(Carbon Dioxide Equivalent Units)



Note: New York State represents 6.5% of the U.S. population. The U.S. represents 4.6% of the world population.

New York State Greenhouse Gas Emissions by Source Category, 1990 - 2025



Work Group Areas (Sector-Based)

- Residential, Commercial, and Industrial (RCI) – Direct Fuel Use and Non-Energy Emissions
- Power Supply (Electricity)
- Transportation and Land Use (TLU)
- Agriculture, Forestry, and Waste Management (AFW)

Progress to Date

- Technologies and Best Practices Identified
- Quantification Methods Reviewed and Approved
- Model Development Complete
- Technical Potential Analysis under Review by PAC
- Draft Cost Curves based on Technical Potential under Review by PAC

Technologies and Best Practices

- CCS has Developed a Catalog of Technologies and Best Practices (TBPs) by sector for NYS
  - Full universe of TBPs
- Prioritized list of TBPs
- Comprehensive list of data sources to support the analysis (including baseline data)
  - Priority given to identifying NYS-specific data
- Initial Catalog of Policy Actions or Mechanisms

TBPs for the Residential, Commercial, and Industrial (RCI) Sectors

TBP #	Description
RCI-1	Insulation
RCI-2	Windows
RCI-3	Air Sealing
RCI-4	RetroCommissioning
RCI-5	Controls & metering
RCI-6	Boilers, furnaces & heat pumps
RCI-7	Cogen/Heat Recovery
RCI-8	Advanced Refrigeration & HVAC
RCI-9	Lighting & Lighting Controls
RCI-10	Motors & Motor Controls
RCI-11	Appliances
RCI-12	Data Equipment
RCI-13	Photovoltaics
RCI-14	Solar Thermal
RCI-15	Biomass - Wood
RCI-16	Biomass - B20
RCI-17	Improved dryer and furnace designs
RCI-18	Boiler replacement
RCI-19	Economizers and Feedwater Preheaters
RCI-20	Boiler Tuneup
RCI-21	Sensors and controls
RCI-22	Other fuel efficiency measures
RCI-23	Efficient Motors and Management
RCI-24	Compressed air systems mgt and advanced controls
RCI-25	Efficient lighting
RCI-26	Advanced controls and mgt
RCI-27	Efficient curing and heating and drying

Examples

RetroCommissioning
Boilers, furnaces, & heatpumps
Lighting
Photovoltaics
Efficiency curing, heating and drying

Quantification Methods

- Metrics
  - Net GHG emission reductions (tonnes carbon dioxide equivalent - CO2e)
  - Net Costs (2006 dollars)
    - Levelized capital, fuel and avoided fuel, operating & maintenance
    - Discounted using 5% real discount rate
    - Estimate only direct costs (those borne by the entities implementing TBP)
    - Learning curve effects for RCI, PS, TLU included, if available
- Pollutants: CO2, CH4, N2O, HFCs, PFCs, SF6, and Black Carbon
- Geographic Coverage: NY State, NY City, Rest-of-State
- Time period for analysis (2009-2030)
  - Technical potential analysis for TBPs (target years = 2010 and 2020)
  - Scenario analysis (target years = 2020 and 2030)

Quantification Methods: Work Group Area-Specific Approach

- Identifies TBPs to analyze
- Priority list of TBPs to analyze
  - Based on PAC and NYSERDA comments
  - TBP sets developed for RCI and TLU to simplify analysis (resource constraints)
- Define baseline (reference case) for each TBP
  - NYS Draft Energy Plan modeling – Power Supply, RCI
  - NYS GHG emissions forecast – other sectors
- Life-Cycle / Fuel-Cycle analysis used if data are available
- Co-Benefits – Qualitative Assessment
  - Exception – fuel savings estimated for use in co-pollutant analysis

Black Carbon (BC)

- BC: aerosol (particulate matter) species with positive climate forcing potential but currently without a global warming potential defined by the IPCC
- Methods:
  - NYS PM-10 emissions for 2002 and 2018

    [Source: Mid-Atlantic - Northeast Visibility Union (MANE-VU)]
  - Source-specific PM aerosol fractions applied to PM-10 emissions to estimate BC and organic material (OM)

    [Source: EPA's Speciate Database]
  - Climate response effects of BC+OM compared to CO2 (30- or 95-year atmospheric lifetime for CO2)

    [Source: published work by M.A. Jacobson (Journal of Geophysical Physical Research) and others]
  - Source category with OM:BC mass emission ratio >4.0 set to zero

    [Ratio at which cooling effects of OM assumed to cancel warming effects of BC]

Black Carbon (BC)

- NYS Results:
  - In 2002:
    - CO2e emissions range from ~ 7.6 to 16.1 million (MM) tonnes
    - Mid-range = 11.9 MM tonnes
    - Primary sources are oil (diesel) and coal combustion
  - In 2018:
    - CO2e emissions range from ~ 4.2 to 8.9 MM tonnes
    - Mid-range = 6.6 MM tonnes
    - Drop in mid-range emissions due to new engine and fuels standards for onroad and nonroad diesel sectors

Documentation of Technologies & Best Practices (TBPs)

- Mitigation approach description
- GHG reduction technologies and practices
- Mitigation design
  - Goals and timing
  - Parties involved
  - Baseline conditions
- Types and permanence of GHG reductions
- 'Learning Curve' Assumptions
- Implementation Scenarios
- Results: Estimated GHG savings and costs per $MtCO_2e$
- Key assumptions and uncertainties
  - Co-benefits and external costs

Technical Potential Analysis

- Maximum emission reduction potential of a TBP that is technically feasible beyond baseline (existing) conditions without consideration of costs, market barriers, or market acceptability
  - Exception – Power Supply: Limited to TBPs that use a geographically limited resource (e.g., wind & solar)
- Purpose –
  - Potential for application of TBP unit (or set) statewide
  - Establish starting point (baseline) for statewide policy scenario analysis that considers costs, market barriers, or market acceptability
- Includes supply constraints (e.g., NYS capacity for biofuel projection and allocation of capacity to demand side (e.g., transportation and PS sectors)

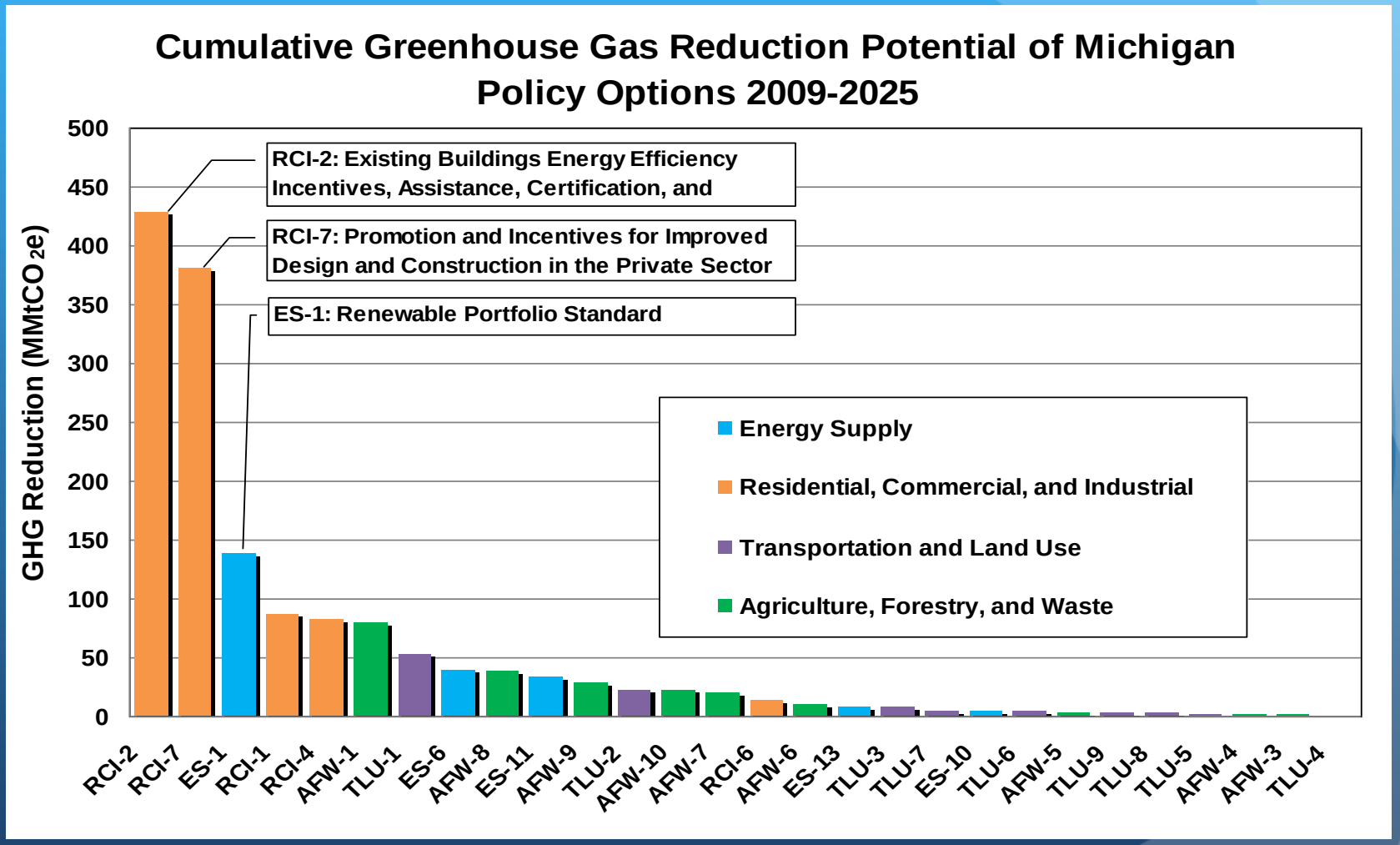
Next Steps

- **Policy Scenario analysis builds upon the Technical Potential results by applying "real world" constraints and limits on TBP implementation (e.g., access to capital, regulatory delays, market acceptance, etc.)**
  - **Reflects a "ramp-up" over time or similar "phase-in" constraint applied to the Technical Potential emissions reductions**
  - **Will account for interactions between TBPs across sectors (where they occur) to avoid double-counting of emission reductions and costs**
- Macroeconomic modeling analysis of scenarios
- Prepare draft report for project
- Final report addressing NYSERDA and PAC comments

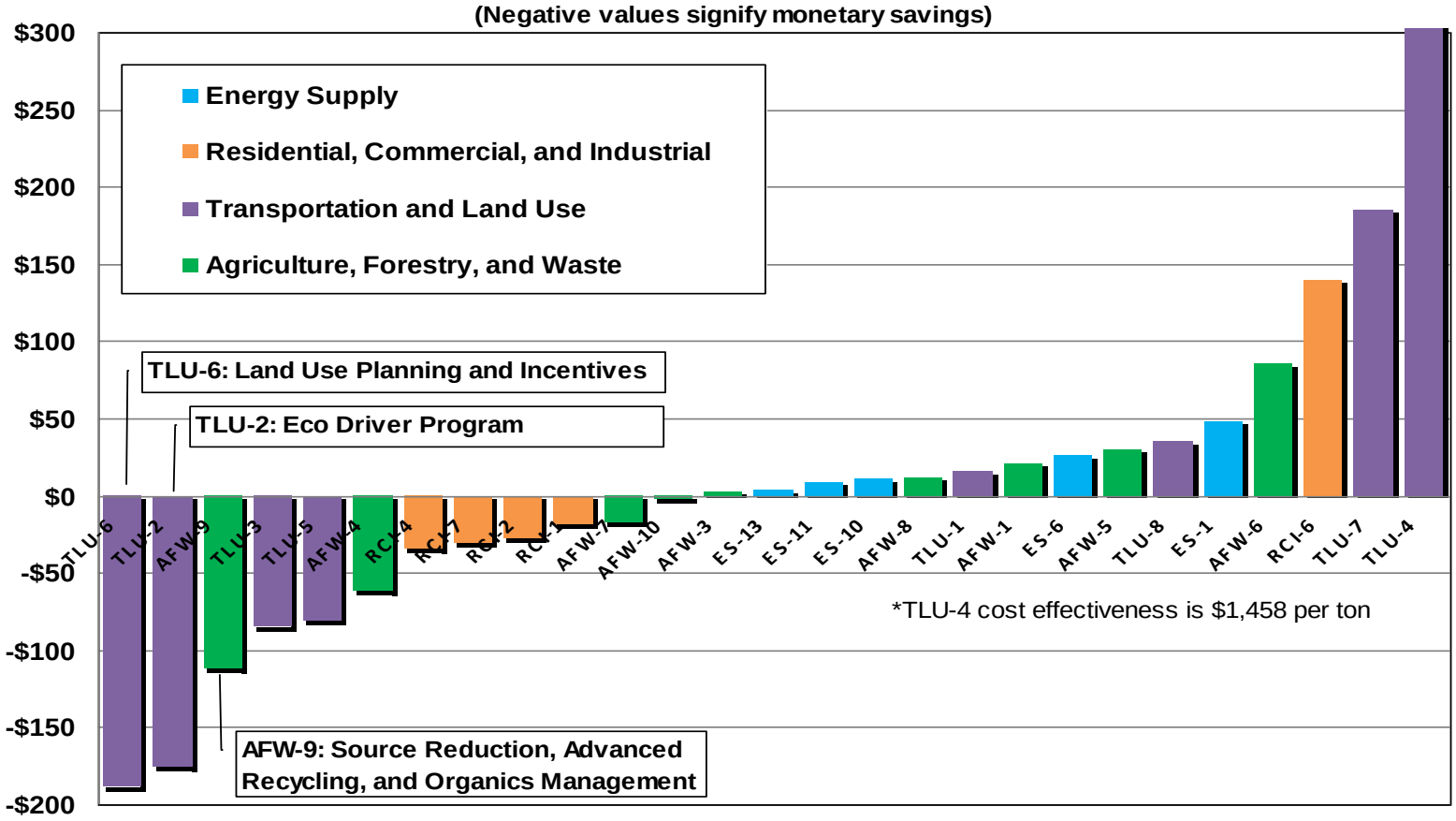
Examples of Cost Curves

- Michigan Climate Action Plan
- Southern Governor's Association – Draft results
- Cost curves –
  - Reflect the expected net GHG emissions reductions for each policy scenario (option) given the expected adoption of each technology for one or more target years in ranked order, from the most cost-effective (lowest $/tonne cost) to the least cost effective

Sample Michigan policy recommendations ranked by cumulative (2009-2025) GHG reduction potential



Sample Michigan policy recommendations ranked by net cost/cost savings per ton of GHG removed

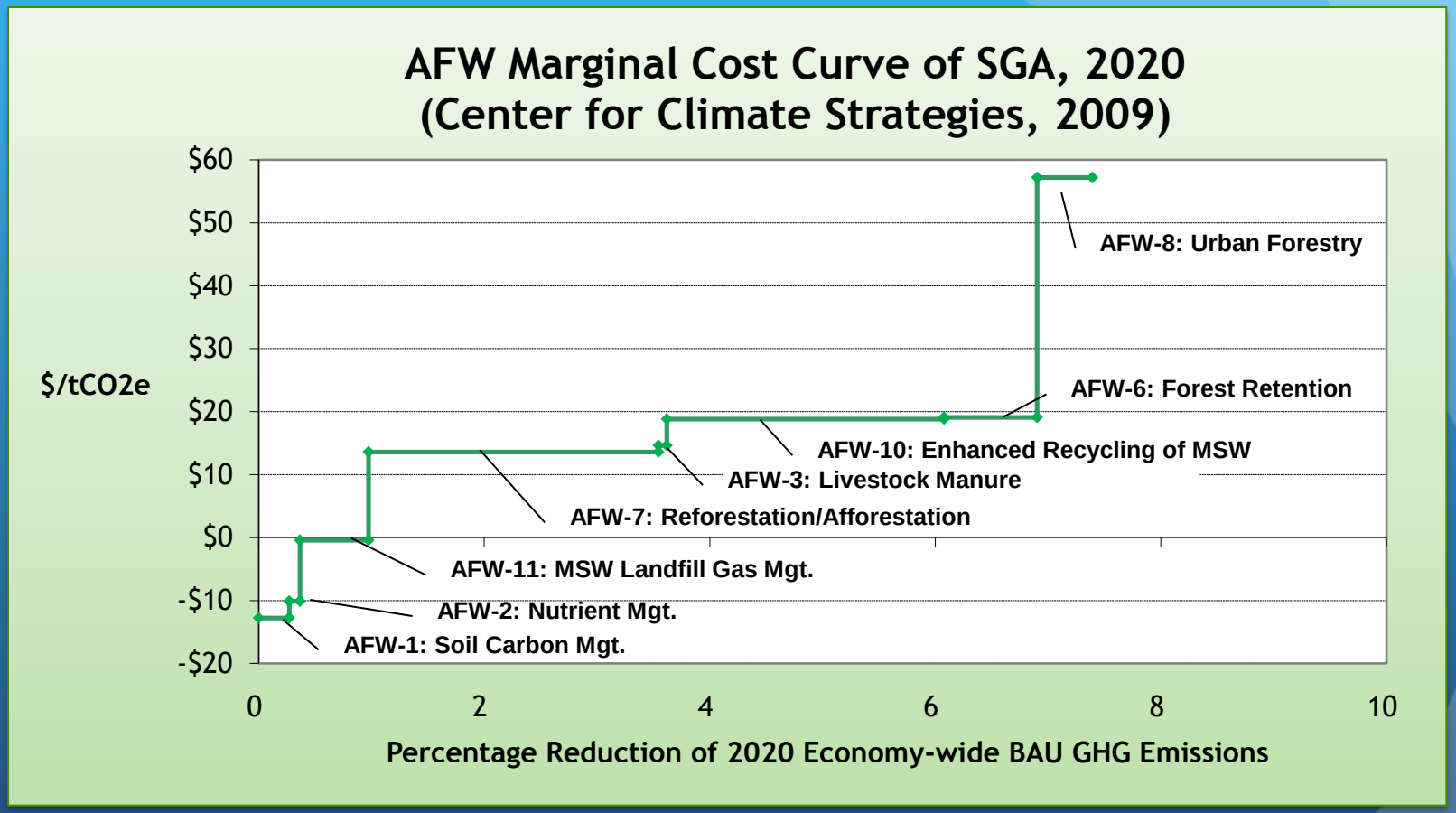


Sample Sector Results, Southern Governor's Association (SGA)

Sector	Policy Options	2020 GHGs Removed (MMtCO2e)	$/Ton GHG Removed	GHGs Removed vs. 2020 Baseline Emissions	Cumulative GHGs Removed
AFW-1	Soil Carbon Management	9.24	-$12.76	0.27%	0.27%
AFW-2	Nutrient Management	3.25	-$10.10	0.10%	0.37%
AFW-11	MSW Landfill Gas Management	20.81	-$0.42	0.61%	0.97%
AFW-7	Reforestation/Afforestation	87.89	$13.60	2.57%	3.55%
AFW-3	Manure Digestion and Methane Utilization	2.53	$14.63	0.07%	3.62%
AFW-10	Enhanced Recycling of Municipal Solid Waste	84.03	$18.84	2.46%	6.08%
AFW-6	Forest Retention	28.22	$19.11	0.83%	6.90%
AFW-8	Urban Forestry	16.75	$57.20	0.49%	7.39%

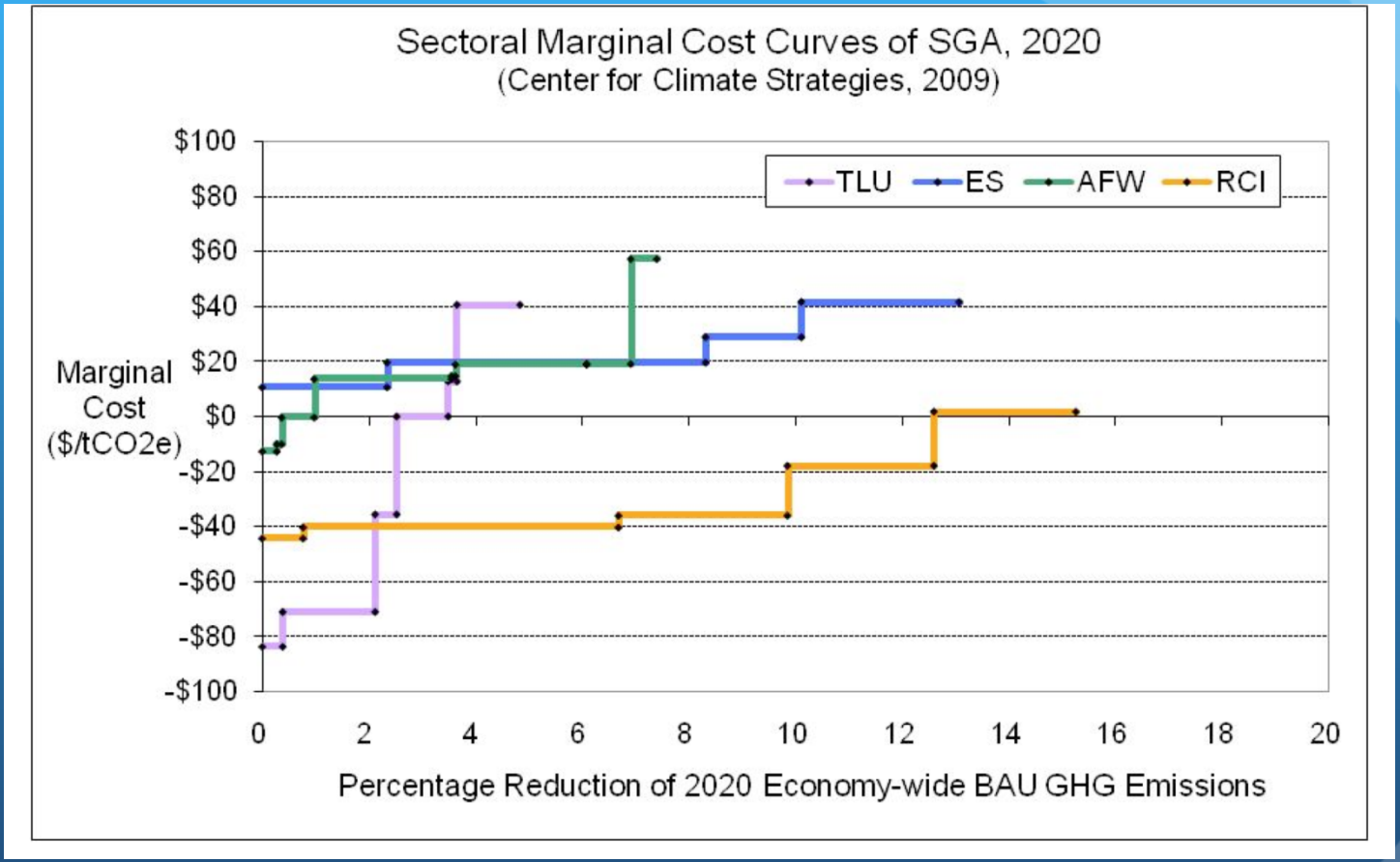
SGA Draft Preliminary Results

Sample Sector Cost Curve, SGA



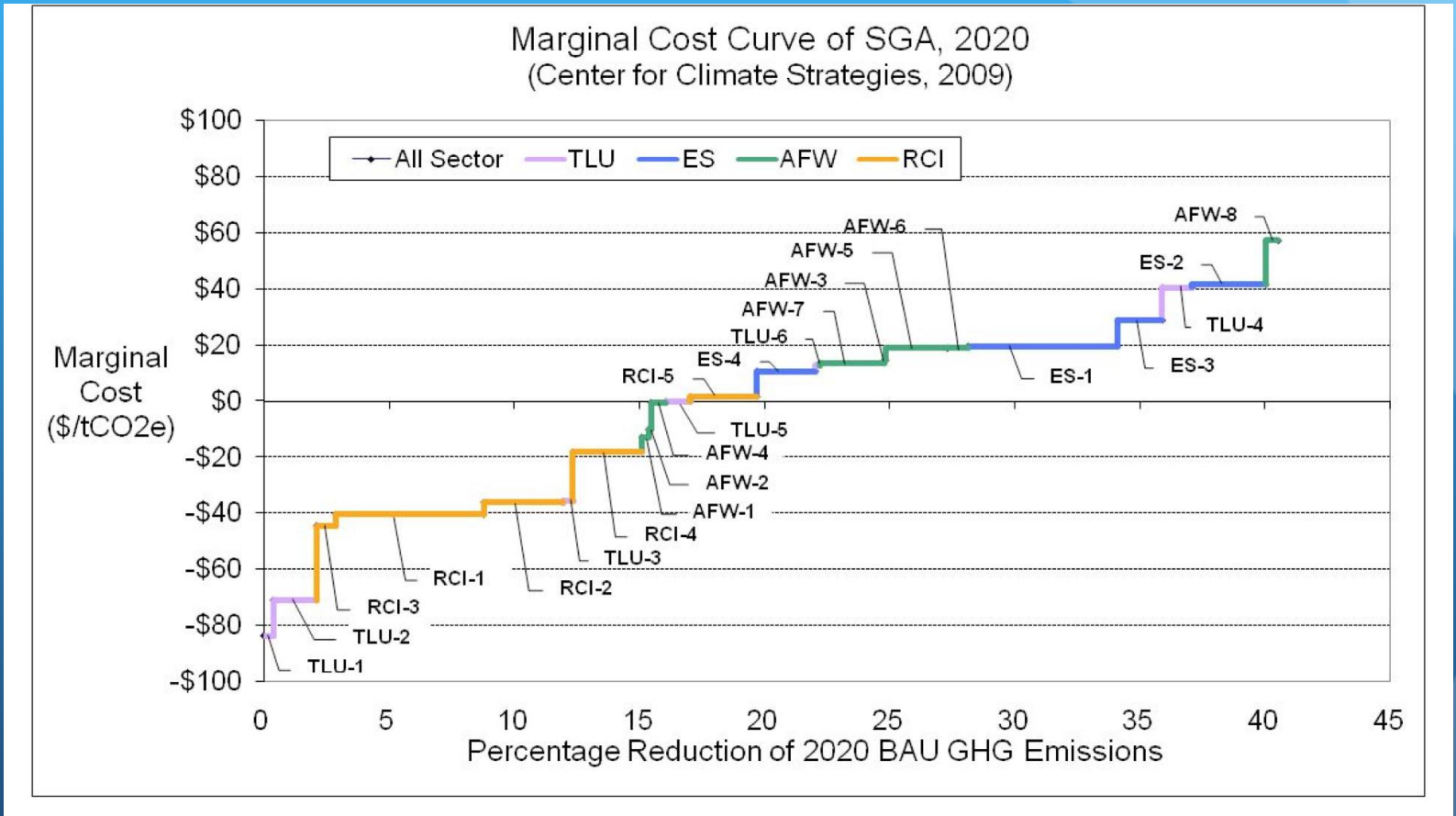
SGA Draft Preliminary Results

Sample Sector Cost Curves, SGA



SGA Draft Preliminary Results

Sample Economy-wide Cost Curve, SGA



SGA Draft Preliminary Results

Thank You