Alternative Modeling Approaches EPA SAB Panel on Economy-Wide Modeling

Adam Rose

University of Southern California

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Alternative Models

- Input-Output (I-O) – not up to the task
- Maroeconometric Models – ?
- Conjoined Input-Output/ Macroeconometric – maybe
  - Regional Economic Models Inc. (REMI)
  - The following slides focus on this approach to analyzing various aspects of environmental policies in general but does not address the relative strengths of the approach to particular aspects of social costs, benefits, or impacts
- Hybrid Top-Down/Bottom Up – great potential

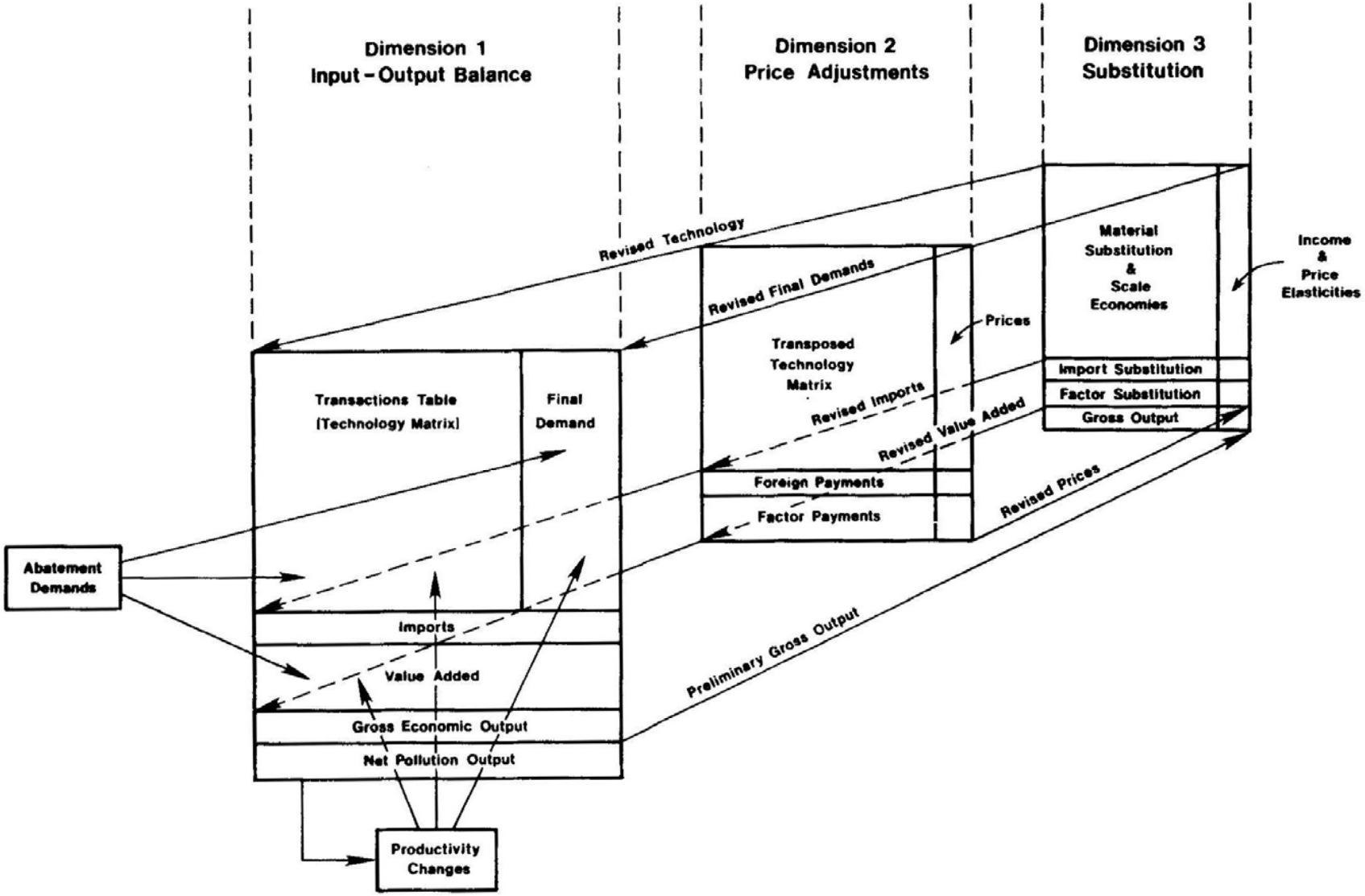


FIGURE 1: Schematic Diagram of the Model.

REMI Model History

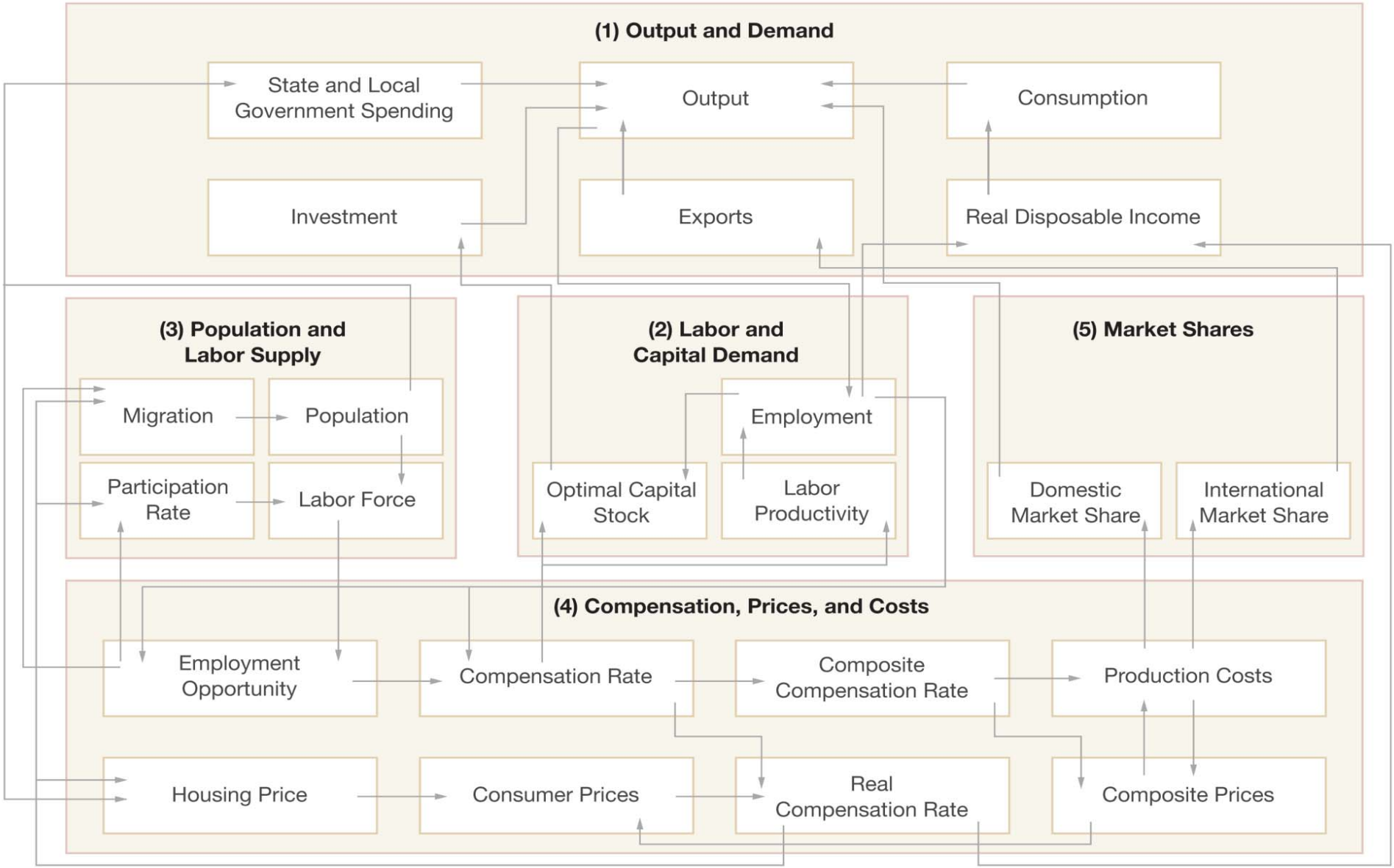
- Developed by George Treyz, Ann Friedlander, Ben Stevens in 1980s
- Upgraded
  - Mike Greenwood: migration
  - Krugman inspired: New Econ Geography
- Pieced together
  - uneven/inconsistent
  - but holds potential for upgrade/template

    (see EPA reformulation of Second Generation Model)
- Most widely used

REMI Overview

- Structural economic forecasting & policy analysis:
  - integrates I-O,CGE, econometric & economic geography
  - dynamic, with annual forecasts & simulations
  - behavioral responses to changes in wages, prices, technology
- Up to 169 industry sectors across 3,089 U.S. counties
- 6,000+ adjustable policy variables
- Five major blocks:
  1. Output and Demand
  2. Labor and Capital Demand
  3. Population and Labor Supply
  4. Wages, Prices and Costs
  5. Market Shares

REMI Policy Insight Plus

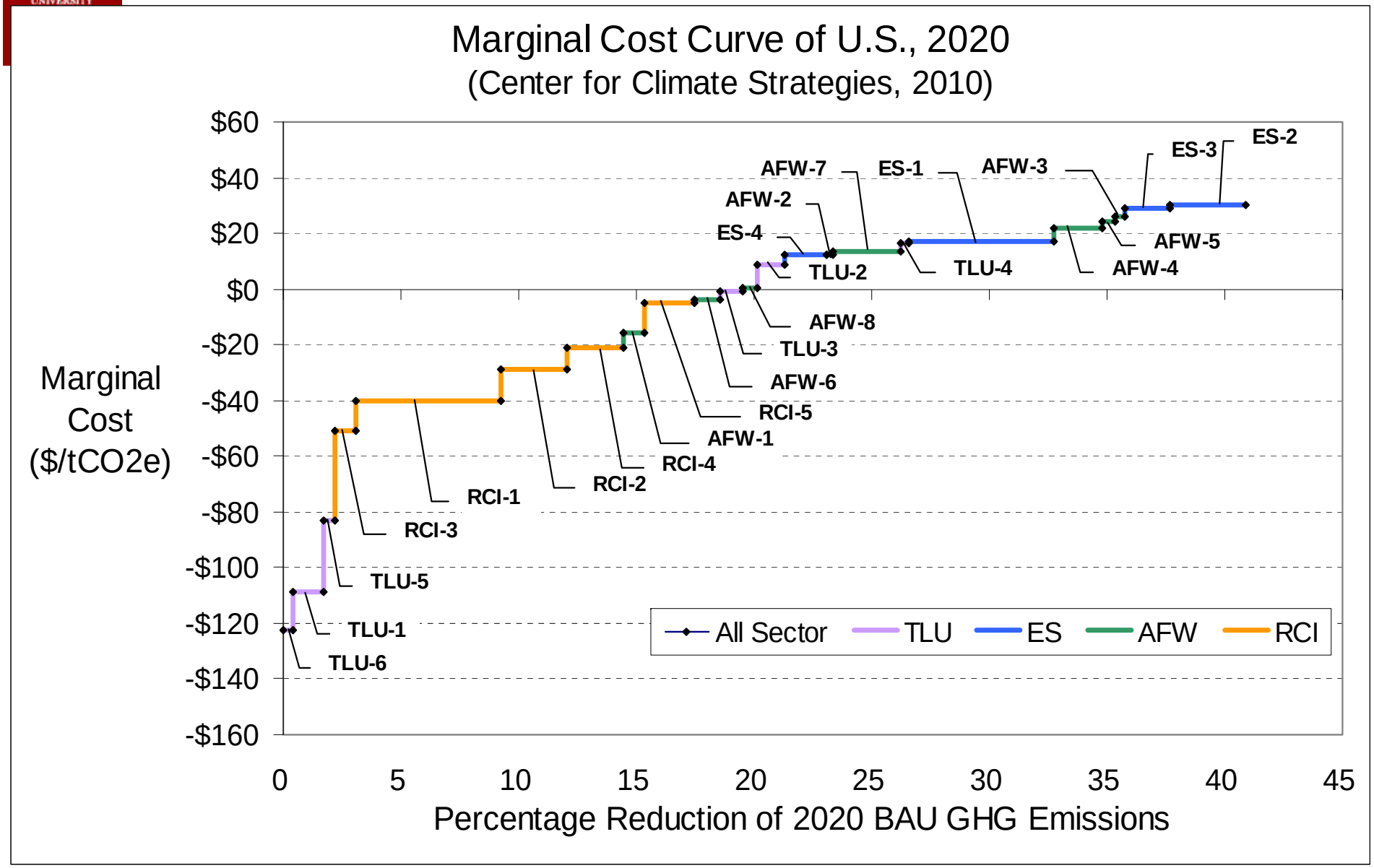


USC Studies of Climate Action Plans

- FL Governor's Office (*Climate Policy* 2012)
- PA Department of Environmental Protection (*Regional Science Policy and Practice,* 2011)
- MI Department of Environmental Quality
- WI Public Service Commission
- NY Energy Research & Development Authority
- CA -- Next 10 Foundation (*Contemporary Econ Policy* 2012)
- Southern California Association of Governments (*Economics of Energy and Environmental Policy* 2014)

GHG Reduction Potentials and Cost-Effectiveness of "Big Ticket" Options for the U.S., 2020

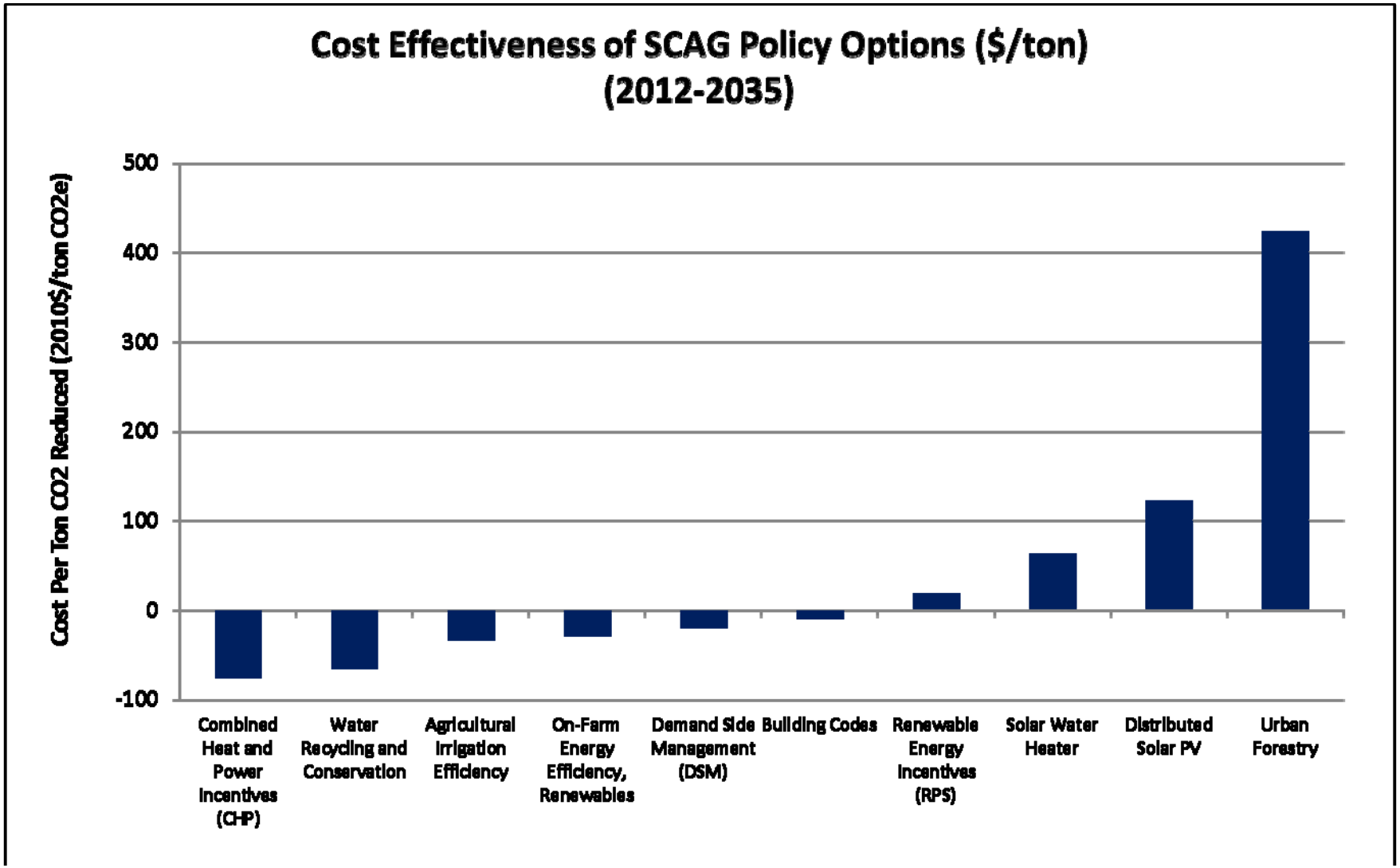
Sector	Climate Mitigation Actions	Estimated 2020 Annual GHG Reduction Potential (MMtCO2e)	Estimated Cost or Cost Savings per ton GHG Removed ($)	GHG Reduction Potential as Percentage of 2020 Baseline Emissions	Cumulative GHG Reduction Potentials	Price-responsive options
TLU-6	Mode Shift from Truck to Rail	33.73	-$122.16	0.44%	0.44%	N
TLU-1	Vehicle Purchase Incentives, including rebates	100.56	-$108.67	1.31%	1.75%	Y
TLU-5	Anti-Idling Technologies and Practices	32.89	-$82.81	0.43%	2.17%	N
RCI-3	Appliance standards	70.34	-$50.99	0.91%	3.09%	N
RCI-1	Demand Side Management Programs	471.85	-$40.33	6.13%	9.22%	30% of the emission reductions are price-responsive
RCI-2	High Performance Buildings (private and public sector)	218.93	-$29.08	2.85%	12.06%	30% of the emission reductions are price-responsive
RCI-4	Building Codes	184.81	-$20.88	2.40%	14.47%	N
AFW-1	Crop Production Practices to Achieve GHG Benefits	66.36	-$15.95	0.86%	15.33%	50% of the emission reductions are price-responsive
RCI-5	Combined heat and power	162.83	-$5.10	2.12%	17.44%	30% of the emission reductions are price-responsive
AFW-6	MSW Source Reduction	85.69	-$3.72	1.11%	18.56%	N
TLU-3	Smart Growth/Land Use	71.75	-$1.10	0.93%	19.49%	N
AFW-8	MSW Landfill Gas Management	47.86	$0.12	0.62%	20.11%	Y
TLU-2	Renewable Fuel Standard (biofuels goals)	91.98	$8.82	1.20%	21.31%	Y
ES-4	Coal Plant Efficiency Improvements and Repowering	138.00	$12.09	1.79%	23.10%	Y
AFW-2	Livestock Manure - Anaerobic Digestion and Methane Utilization	17.65	$12.55	0.23%	23.33%	Y
AFW-7	Enhanced Recycling of Municipal Solid Waste	225.21	$13.49	2.93%	26.26%	N
TLU-4	Transit	27.16	$16.71	0.35%	26.61%	N
ES-1	Renewable Portfolio Standard	473.03	$17.16	6.15%	32.76%	N
AFW-4	Reforestation/Afforestation	155.83	$22.06	2.03%	34.78%	Y
AFW-5	Urban Forestry	41.21	$24.03	0.54%	35.32%	Y
AFW-3	Forest Retention	32.33	$26.14	0.42%	35.74%	Y
ES-3	CCSR	148.19	$29.24	1.93%	37.66%	Y
ES-2	Nuclear	250.23	$29.92	3.25%	40.91%	Y


Marginal Cost Curve of U.S., 2020
(Center for Climate Strategies, 2010)
Marginal Cost ($/tCO2e)
$60
$40
$20
$0
-$20
-$40
-$60
-$80
-$100
-$120
-$140
-$160
0
5
10
15
20
25
30
35
40
45
Percentage Reduction of 2020 BAU GHG Emissions
AFW-7
ES-1
AFW-3
ES-3
ES-2
AFW-2
ES-4
TLU-2
TLU-4
AFW-4
AFW-5
AFW-8
TLU-3
AFW-6
RCI-5
AFW-1
RCI-4
RCI-2
RCI-1
RCI-3
TLU-5
TLU-1
TLU-6
All Sector
TLU
ES
AFW
RCI

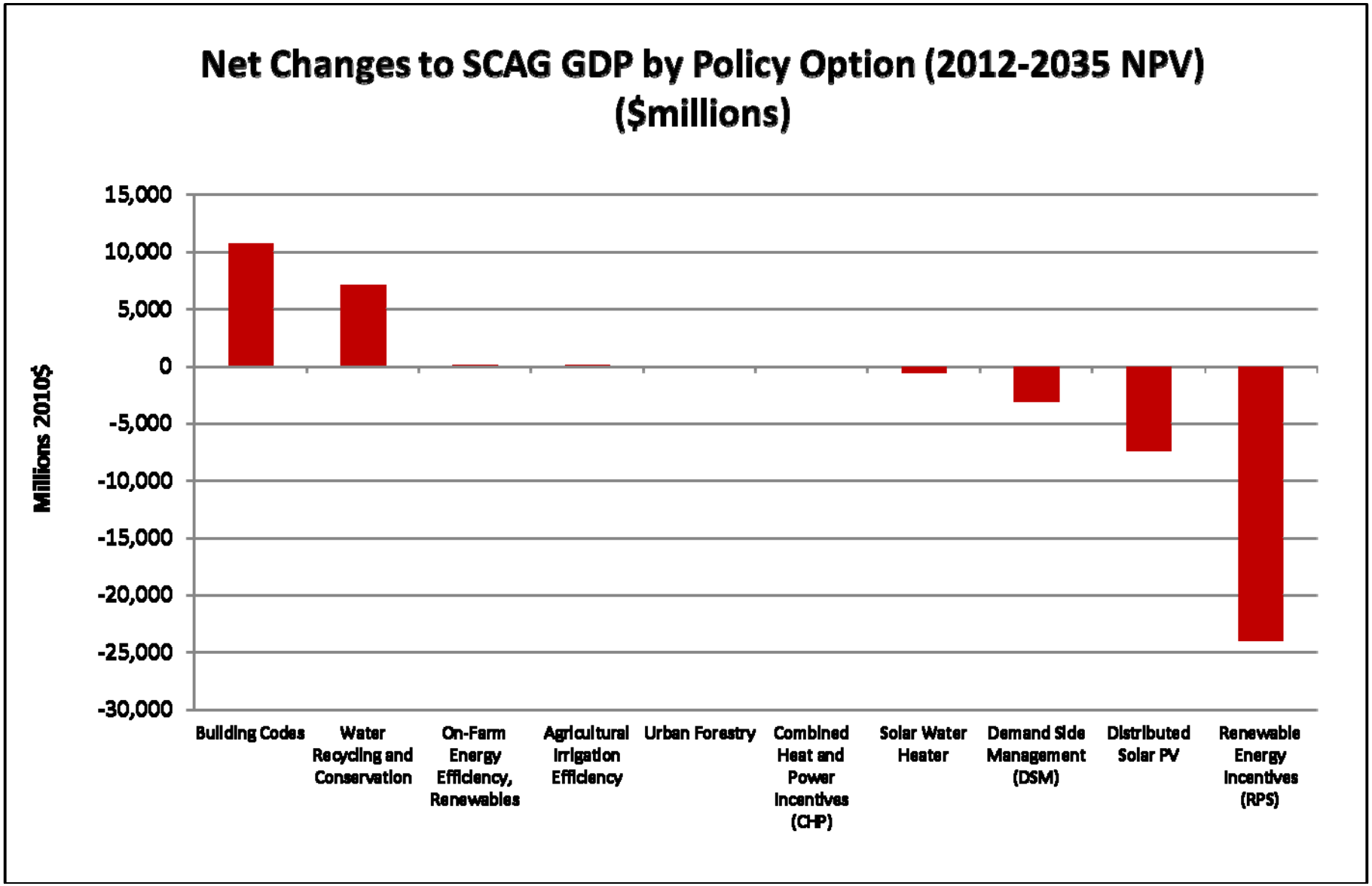
Linkages of Micro Analysis Results and REMI Modeling Inputs (DSM)

	Direct Economic Impact		Policy Variable Selection in REMI
Positive Stimuli	Increased Spending on EE Technologies and Equipment		Output and Demand Block →Exogenous Final Demand (amount) for Ventilation, Heating, Air-conditioning, and Commercial Refrigeration Equipment Mfg sector, Industrial Machinery Mfg sector, Commercial and Service Industry Machinery Mfg sector, Audio and Video Equipment Mfg sector, Electric Lighting Equipment Mfg sector, Household Appliance Mfg sector, Electrical Equipment Mfg sector, and Other Electrical Equipment and Component Mfg sector→Increase
	Increased Demand of Efficiency Audit		Output and Demand Block →Exogenous Final Demand (amount) for Construction sector→Increase
	Administrative Spending		Output and Demand Block →Exogenous Final Demand (amount) for Electric Power Generation Sector →Increase
	Professional and Technical Services Spending		Output and Demand Block →Exogenous Final Demand (amount) for Management, Scientific, and Technical Consulting Services sector→Increase
	Energy Savings of the Customers	Businesses (Commercial and Industrial Sectors)	Compensation, Prices, and Costs Block→ Electricity and Natural Gas (Commercial Sectors) Fuel Cost (amount) of Individual Commercial and Industrial Sectors→Decrease
		Households (Residential Sector)	Output and Demand Block →Consumption Reallocation (amount)→All Consumption Sectors →Increase
	Increased Demand of Services from Financial Sector		Output and Demand Block →Exogenous Final Demand (amount) for Monetary Authorities, Credit Intermediation sector→Increase
Negative Stimuli	Customer Outlay on Energy Efficiency (EE)	Businesses (Commercial and Industrial Sectors)	Compensation, Prices, and Costs Block →Capital Cost (amount) of Individual Commercial and Industrial Sectors→Increase
		Households (Residential Sector)	Output and Demand Block →Consumption Reallocation (amount)→All Consumption Sectors →Decrease
	Energy Demand Decrease from the Energy Supply Sectors		Output and Demand Block →Exogenous Final Demand (amount) for Electric Power Generation, Transmission, and Distribution sector; Natural Gas Distribution sector; Coal Mining sector; and Petroleum and Coal Products Manufacturing sector→Decrease

Cost-Effectiveness of GHG Mitigation Policy Options



GDP Impact Results



CGE: Bottom-Up vs. Top-Down

- Ironically, CGE is considered top-down despite micro foundation of individual decision-makers
- Straightforward applicability
  - inter-fuel substitution/inter-technology substitution
  - conservation
  - output demand reduction
- Difficult applicability
  - substitution between energy & other intermediate goods
  - technological change
  - land-use planning

CGE Hybrid: Kiuila & Rutherford

- Early approaches
  - implicit marginal cost (MC) curve
  - MC curve generated by carbon tax/permits
- K&R two approaches

  1. non-linear optimization/OLS regression
     (results implemented into top-down as parameters)
  2. direct integration using activity analysis
     (specifies technologies in fixed-coefficient terms)
- Main Finding: Two methods yield the same results