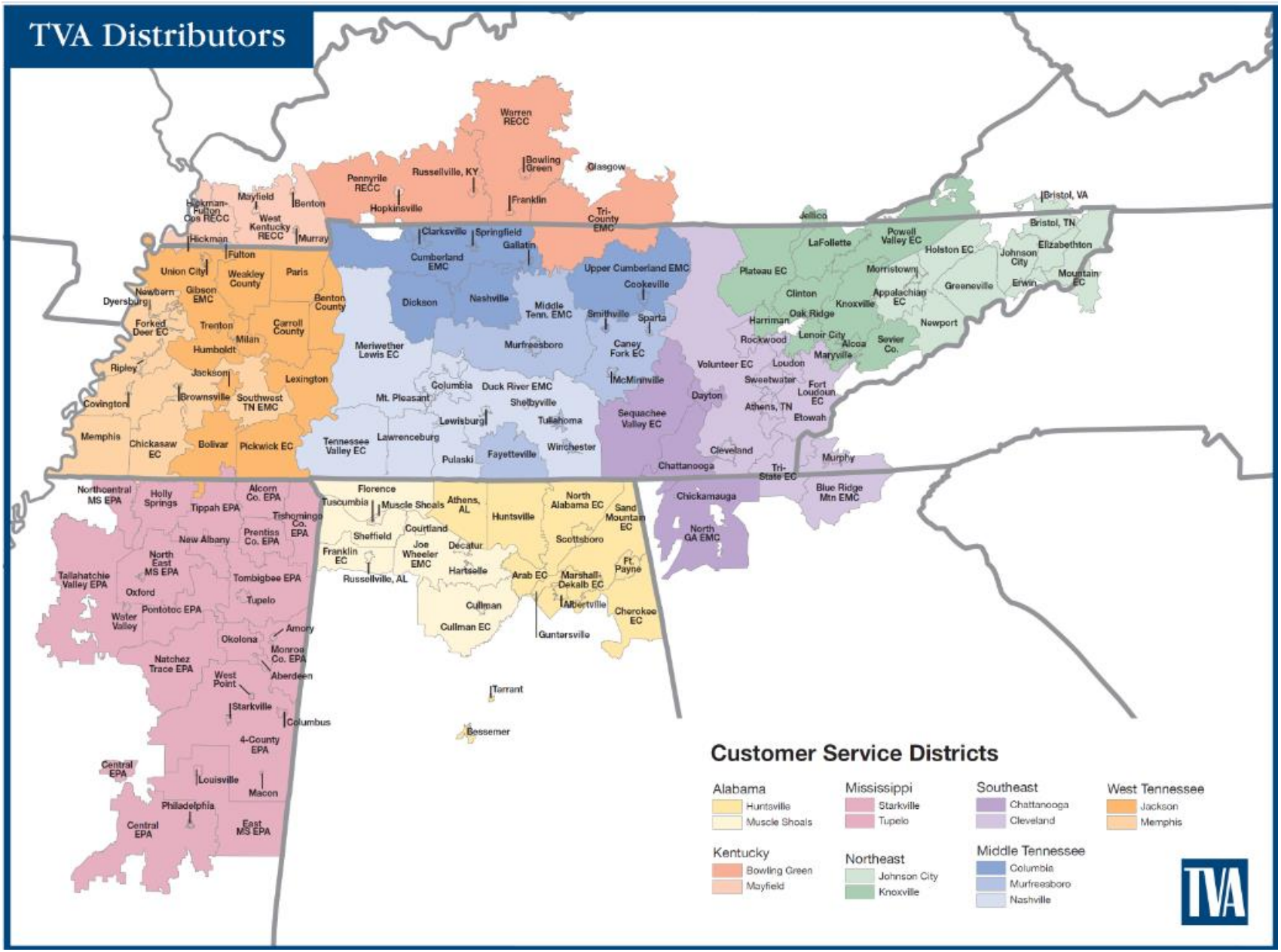
Goal: Efficiently and equitably integrate distributed solar generation (DSG) onto the TVA grid

Objective: Design, estimate, and implement an agent-based computational economic (ACE) model of grid evolution in response to DSG diffusion.

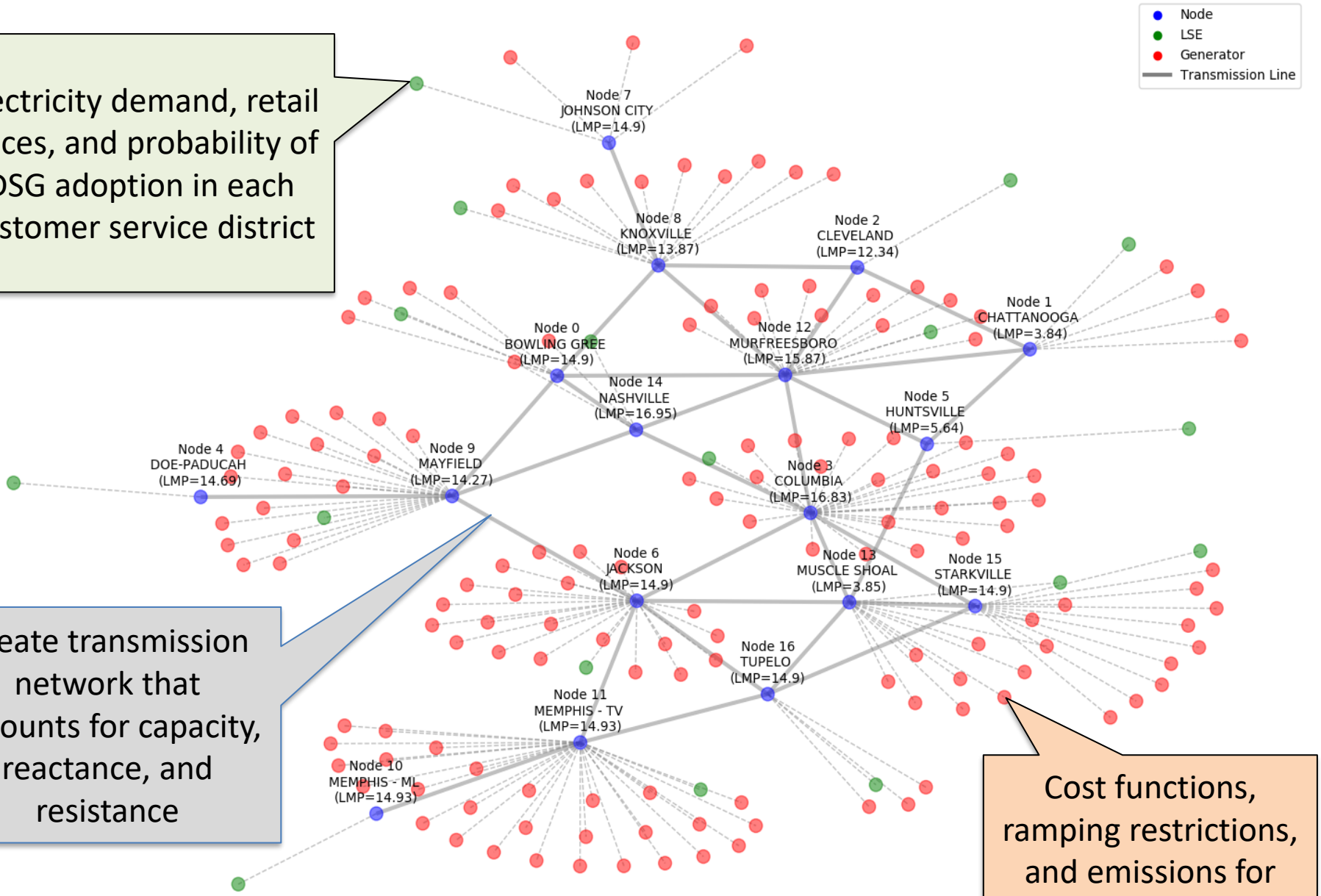
Advantages and Innovation:

1. ACE allows us to relax restrictive assumptions about the behavior of grid stakeholders (e.g., sunk cost fallacy, representative agent, rational economic behavior) and incorporate insights from behavioral economics and social psychology.
2. ACE allows us to investigate distributional concerns whereby the cost and benefits of increased penetration of DSG fall on different segments of the population.

Website: https://abm-distributed-solar.utk.edu/home/


TVA Distributors
Warren RECC
Bowling Green
Glasgow
Pennyrile RECC
Russellville, KY
Hopkinsville
Franklin
Tri-County EMC
Mayfield
Benton
Hickman-Fulton Cos RECC
West Kentucky RECC
Murray
Hickman
Fulton
Union City
Weakley County
Paris
Newbern
Dyersburg
Gibson EMC
Benton County
Forked Deer EC
Trenton
Carroll County
Milan
Humboldt
Ripley
Jackson
Lexington
Covington
Brownsville
Southwest TN EMC
Memphis
Chickasaw EC
Bolivar
Pickwick EC
Clarksville
Springfield
Gallatin
Cumberland EMC
Dickson
Nashville
Middle Tenn. EMC
Upper Cumberland EMC
Cookeville
Smithville
Sparta
Meriwether Lewis EC
Murfreesboro
Caney Fork EC
McMinnville
Columbia
Duck River EMC
Mt. Pleasant
Shelbyville
Lewisburg
Tullahoma
Tennessee Valley EC
Lawrenceburg
Pulaski
Fayetteville
Winchester
Sequachee Valley EC
Jellico
Bristol, VA
Bristol, TN
LaFollette
Powell Valley EC
Holston EC
Elizabethton
Johnson City
Plateau EC
Morristown
Mountain EC
Greeneville
Erwin
Clinton
Knoxville
Appalachian EC
Oak Ridge
Harriman
Newport
Rockwood
Lenoir City
Alcoa
Sevier Co.
Maryville
Volunteer EC
Loudon
Sweetwater
Fort Loudoun EC
Dayton
Athens, TN
Etowah
Cleveland
Chattanooga
Murphy
Tri-State EC
Blue Ridge Mtn EMC
Chickamauga
North GA EMC
Northcentral MS EPA
Holly Springs
Alcorn Co. EPA
Tippah EPA
Tishomingo Co. EPA
New Albany
Prentiss Co. EPA
North East MS EPA
Tallahatchie Valley EPA
Tombigbee EPA
Oxford
Tupelo
Pontotoc EPA
Water Valley
Okolona
Amory
Monroe Co. EPA
Natchez Trace EPA
Aberdeen
West Point
Starkville
Columbus
4-County EPA
Central EPA
Louisville
Macon
Philadelphia
Central EPA
East MS EPA
Florence
Tuscumbia
Muscle Shoals
Athens, AL
Huntsville
North Alabama EC
Sand Mountain EC
Sheffield
Courtland
Scottsboro
Franklin EC
Joe Wheeler EMC
Decatur
Russellville, AL
Hartselle
Arab EC
Marshall-Dekalb EC
Ft. Payne
Albertville
Cullman
Cullman EC
Cherokee EC
Guntersville
Tarrant
Bessemer
Customer Service Districts
Alabama
Huntsville
Muscle Shoals
Kentucky
Bowling Green
Mayfield
Mississippi
Starkville
Tupelo
Northeast
Johnson City
Knoxville
Southeast
Chattanooga
Cleveland
Middle Tennessee
Columbia
Murfreesboro
Nashville
West Tennessee
Jackson
Memphis
TVA

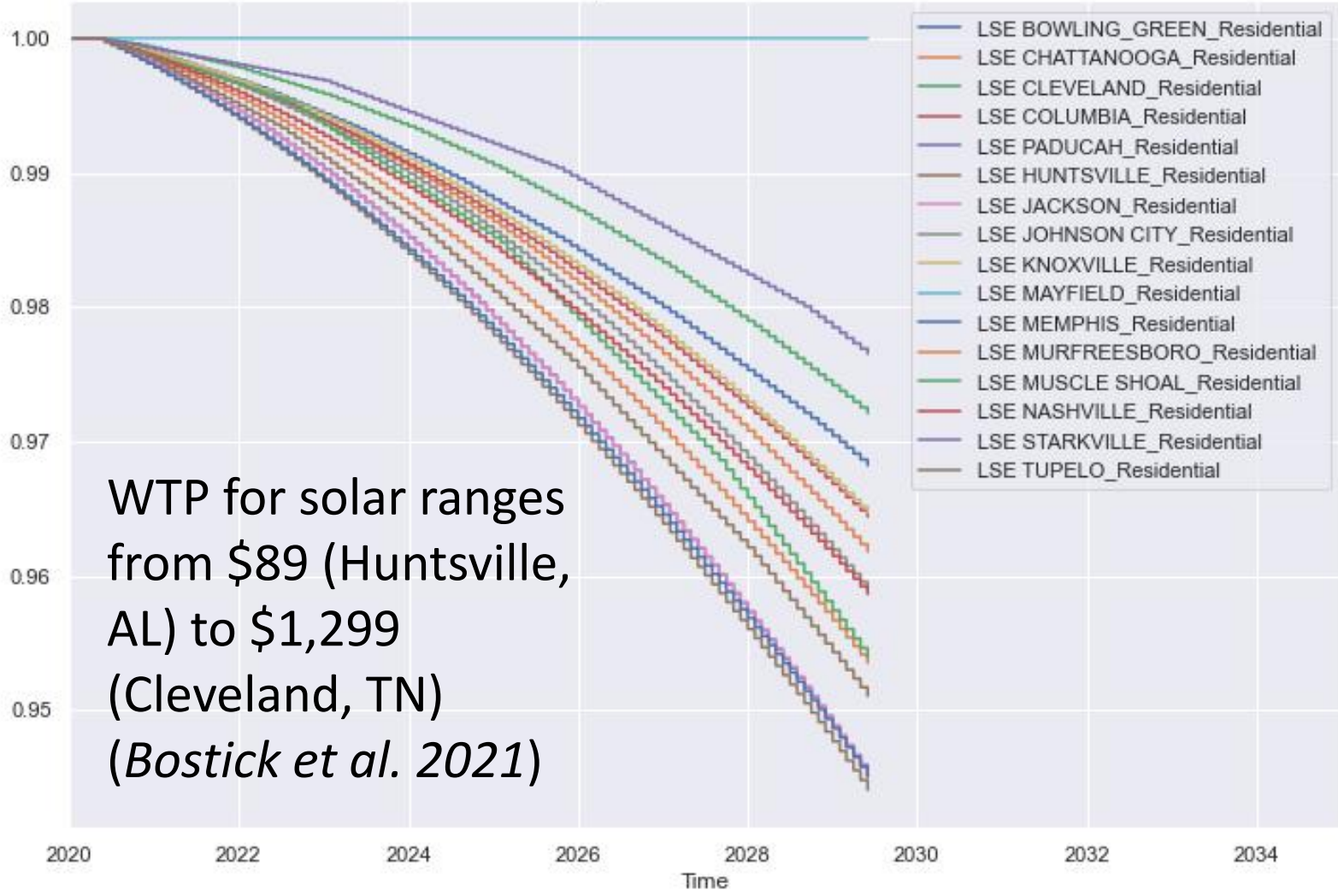
Electricity demand, retail prices, and probability of DSG adoption in each customer service district



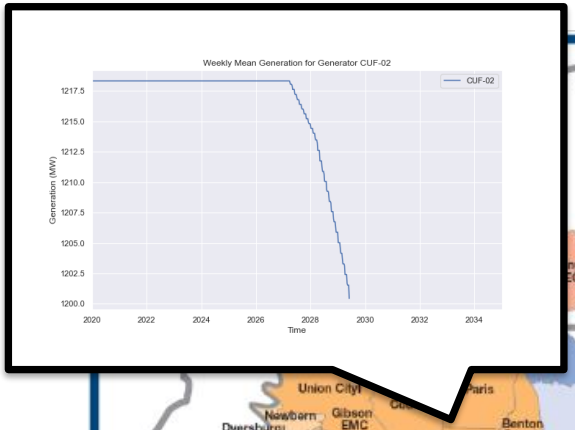
Create transmission network that accounts for capacity, reactance, and resistance

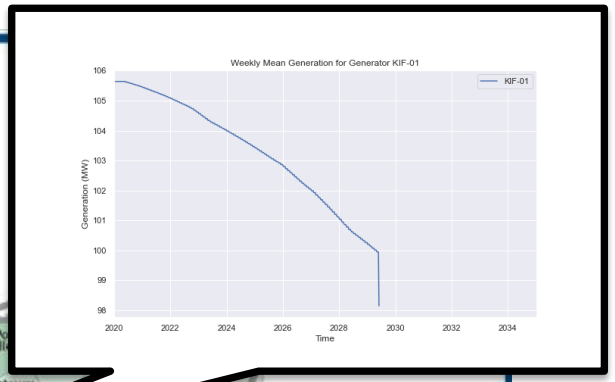
Cost functions, ramping restrictions, and emissions for each generator

Percent of residential population that adopts DSG



WTP for solar ranges from $89 (Huntsville, AL) to $1,299 (Cleveland, TN) (*Bostick et al. 2021*)





Customer Service Districts

Alabama
- Huntsville
- Muscle Shoals

Kentucky
- Bowling Green
- Mayfield

Mississippi
- Starkville
- Tupelo

Northeast
- Johnson City
- Knoxville

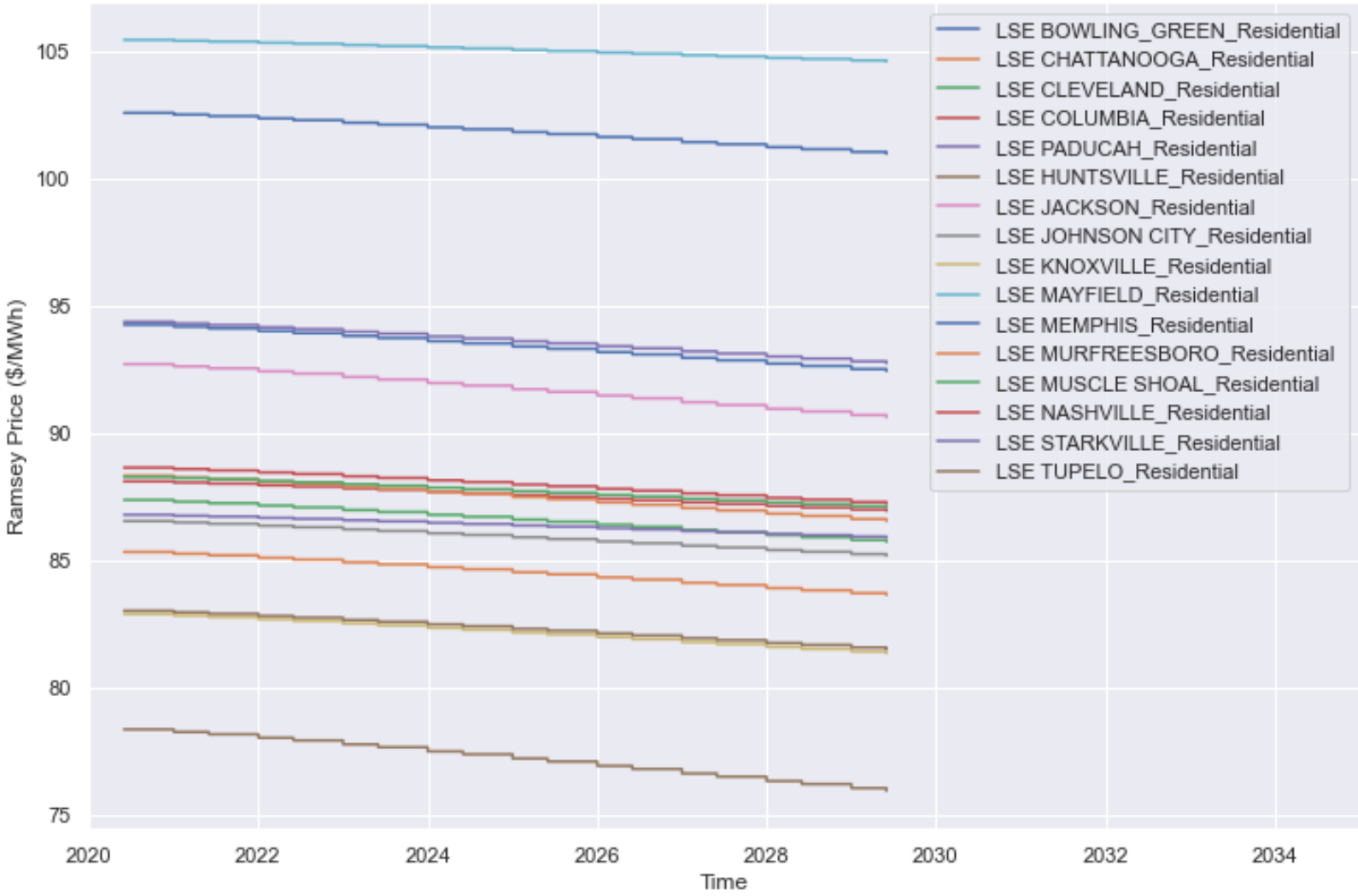
Southeast
- Chattanooga
- Cleveland

Middle Tennessee
- Columbia
- Murfreesboro
- Nashville

West Tennessee
- Jackson
- Memphis

TVA

Retail prices fall slightly in all areas



Ongoing simulation experiments

1. Coal-fired power plant retirements and utility-scale renewable investments
   - Estimated shutdown costs and retirement times for remaining coal units (*Davis et al. 2020*)
   - DSG crowds out utility-scale solar (*Roberson et al. 2021*)

2. Introduction of two solar incentive programs not available in TVA area (Xu et al. 2021)
   - **low-income assistance programs** have helped close the gap between low- and high-income solar adoption
   - **net metering** associated with an increase in the gap between low- and high-income solar adoption

Project Team

Co-Pis and Post-docs

- Charles Sims, Howard H. Baker Jr. Center for Public Policy and Department of Economics, University of Tennessee, Knoxville
- Chien-fei Chen, Department of Electrical Engineering and Computer Science and Department of Sociology, University of Tennessee, Knoxville
- J. Scott Holladay, Department of Economics, University of Tennessee, Knoxville
- Islam H. El-adaway, Department of Civil, Architectural, and Environmental Engineering/Department of Engineering Management and Systems Engineering, Missouri University of Science and Technology
- Tim Roberson, Howard H. Baker Jr. Center for Public Policy, University of Tennessee, Knoxville

Graduate and undergraduate students

- Gasser G. Ali, Department of Civil, Architectural, and Environmental Engineering, Missouri University of Science and Technology
- Xiaojing Xu, Department of Business Analytics and Statistics, University of Tennessee, Knoxville
- Gerald Jones Jr., Department of Industrial and Systems Engineering, University of Tennessee, Knoxville
- Odysseus Bostick, Department of Economics, University of Tennessee, Knoxville