Enabling Place-Based Renewable Power Generation Using Community Energyshed Design

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University of Vermont

11 UVM Faculty (4 leads, 7 co-investigators)

Mads Almassalkhi – power systems
Jon Erickson – community collaboration
Greg Rowangould – transportation
Jeff Marshall – heating/cooling

8 Graduate Research Assistants

1 Research Staff (Claire Hamilton)

1 Post-Doctoral Associate (Dakota Hamilton)

3 National Laboratories

Pacific Northwest National Lab
National Renewable Energy Lab
Sandia National Lab

4 Vermont Utilities

Stowe Electric Company
Vermont Electric Cooperative
Green Mountain Power
Vermont Electric Power Company (VELCO)

3 Vermont NGOs

Energy Action Network
Vermont Natural Resources Council
Vermont Sustainable Jobs Fund

Project goal:

Assist community **stakeholders** in **evaluating** the trade-offs of energyshed characteristics to enable a more **just** and **resilient** energy transition.

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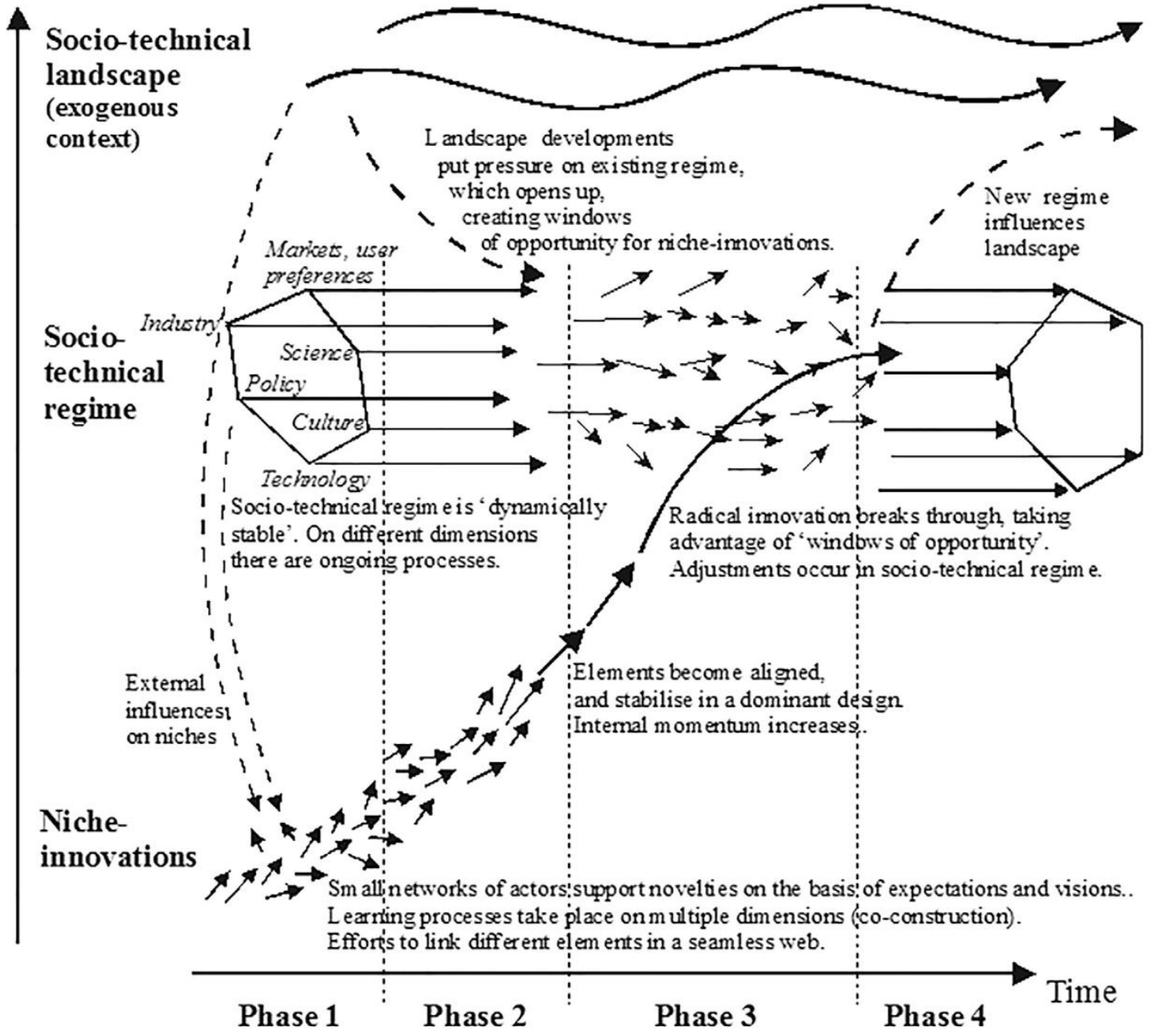
Sociotechnical Transition

Geels, F. W. (2018). Disruption and low-carbon system transformation: Progress and new challenges in socio-technical transitions research and the **multi-level perspective**. *Energy Research and Social Science*, *37*, 224-231.



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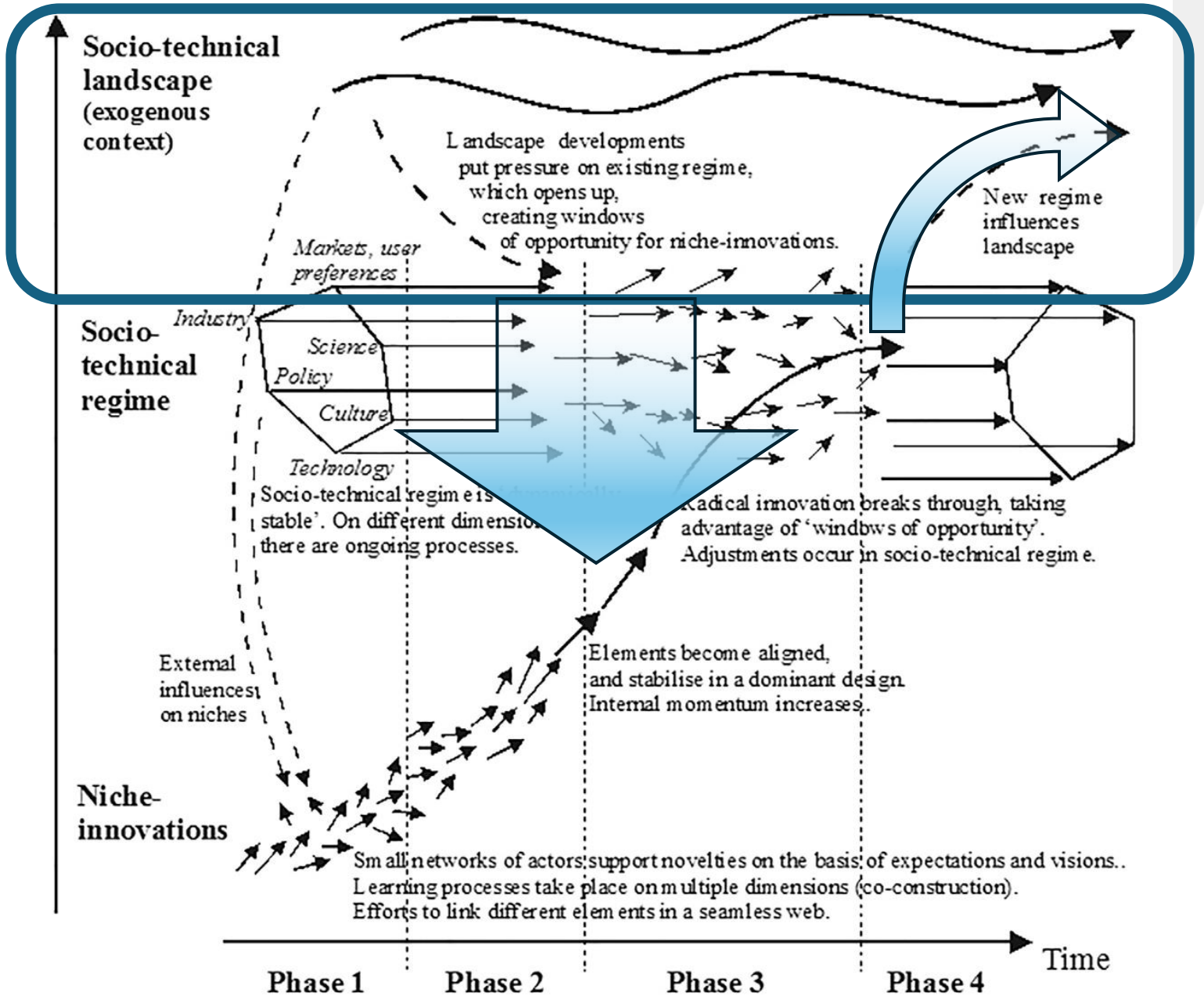
Landscape Pressures

- UNFCC Paris Agreement
- Infrastructure Investment & Jobs Act
- Inflation Reduction Act
- Justice40 Initiative
- Industry cost & technology trends
- Preferences, governance, & culture



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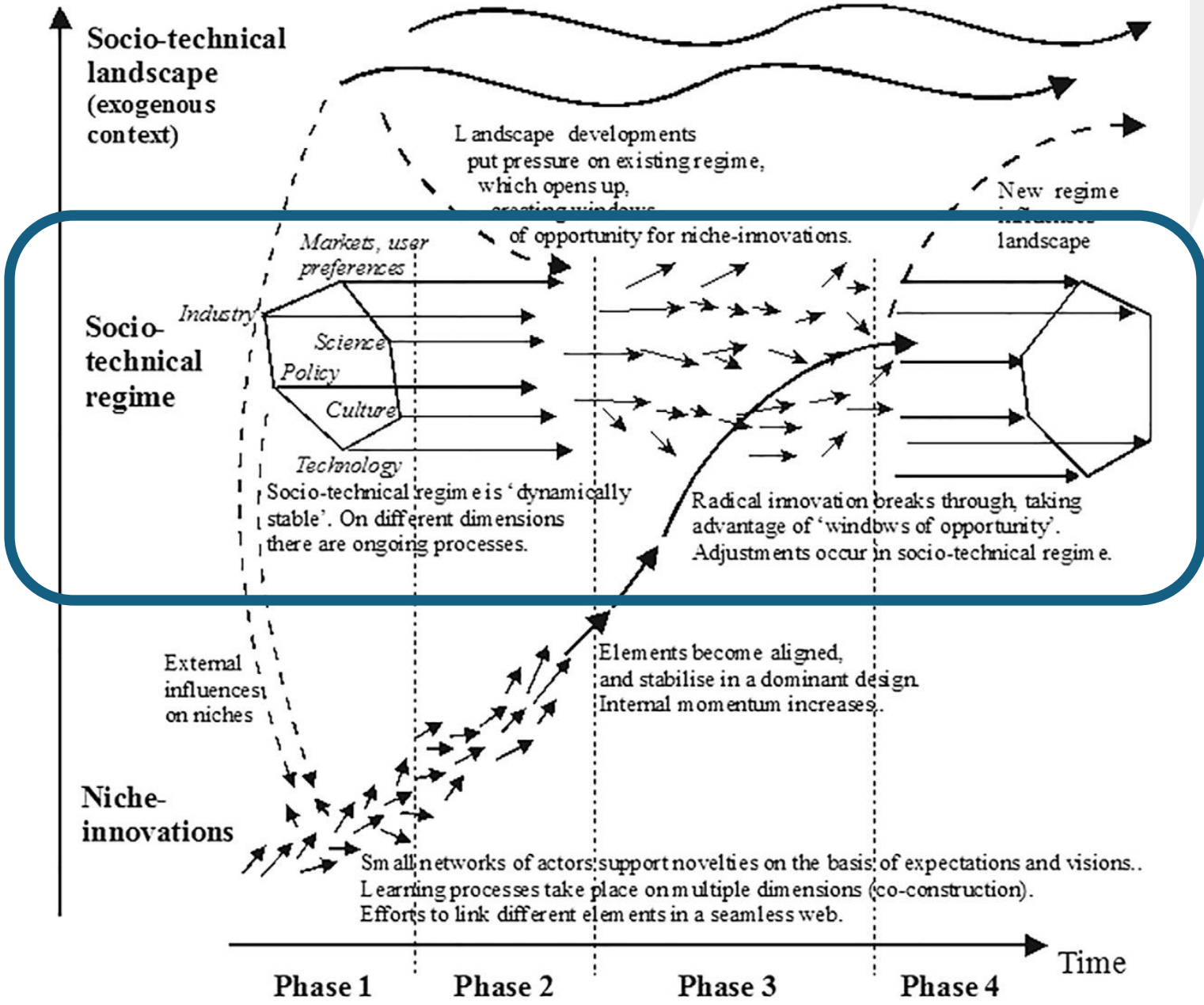
Socio-technical Regime

- Vermont Comprehensive Energy Plan (90 x 2050)
  - ➢ 1998
    - ➢ 2011
      - ➢ 2016
        - ➢ 2022



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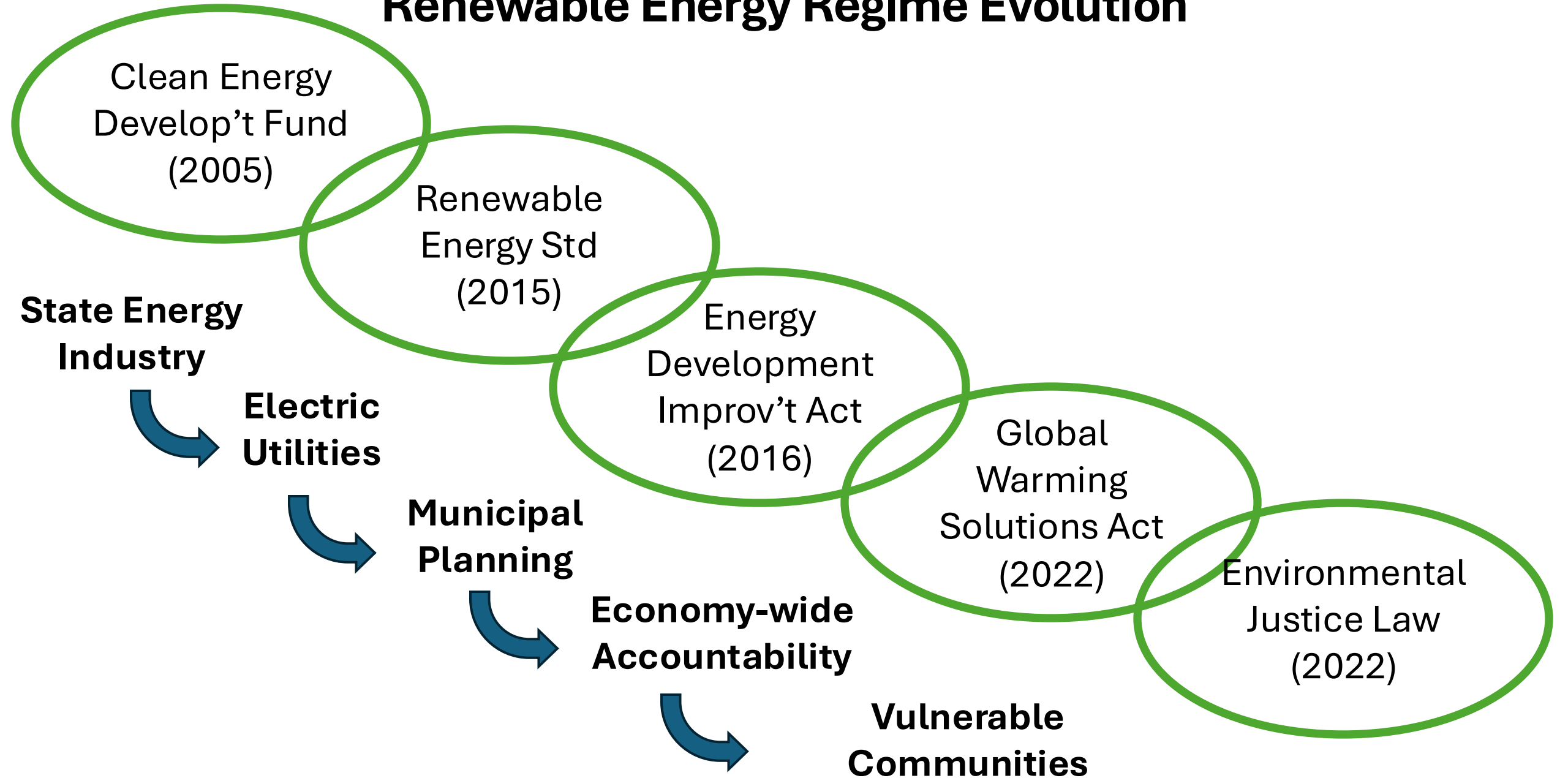
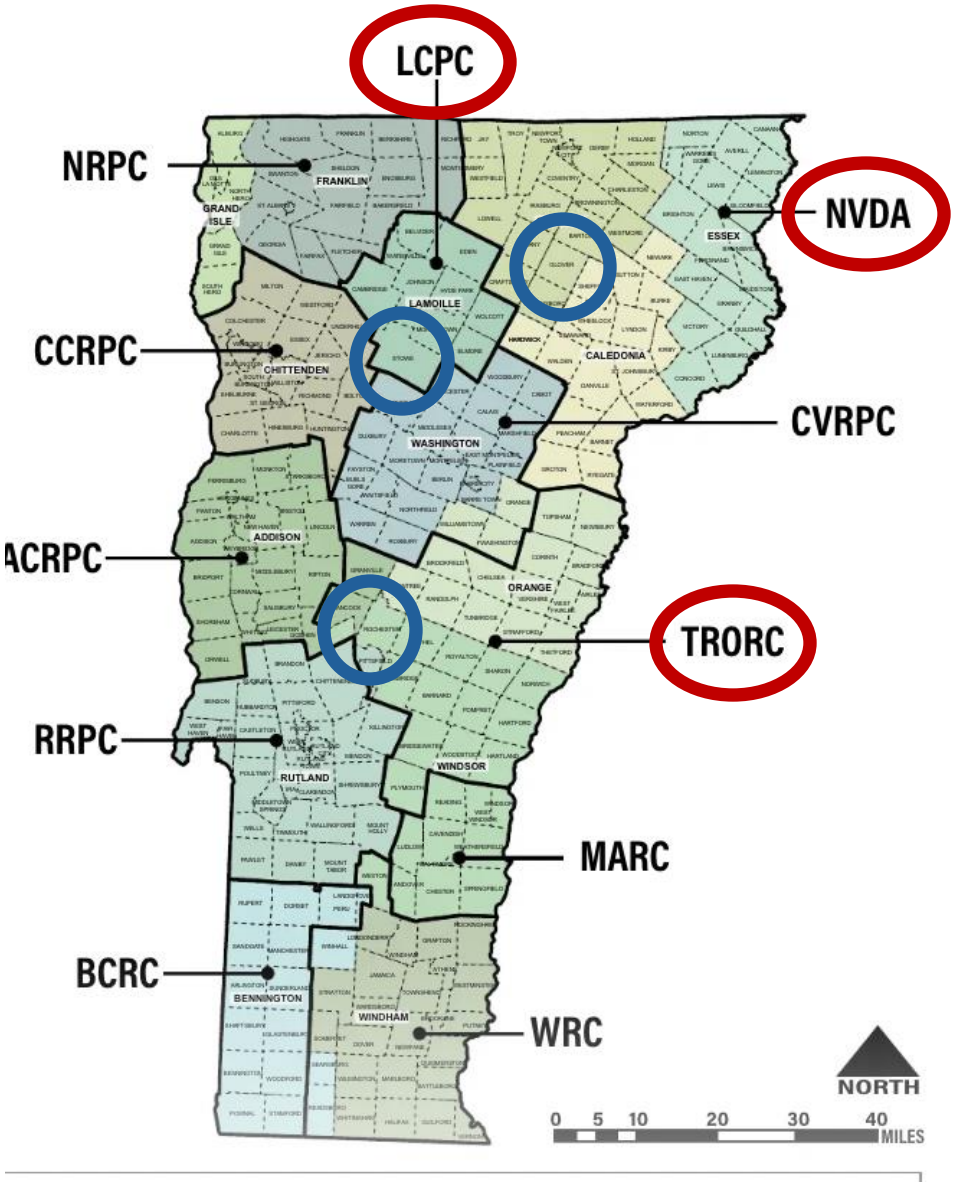
Renewable Energy Regime Evolution



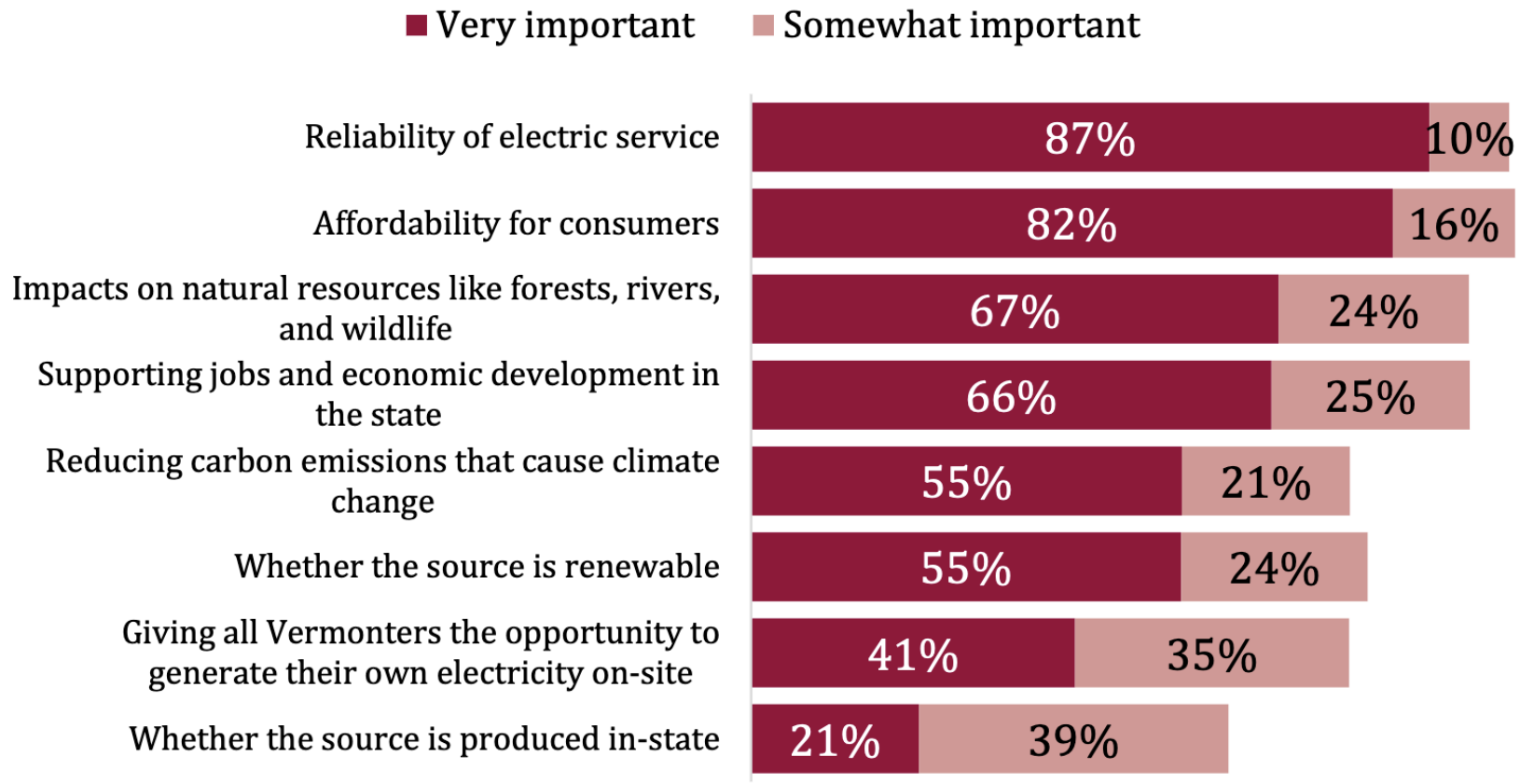
Energy Development Improvement Act (2016)



Regional & Local Energy Planning

- 11 Regional Planning Commission energy plans
- 110 of 253 municipalities with "enhanced" town energy plans
  - Stowe
  - Glover
  - Rochester

Renewable Energy Standard (2017 → 2024)

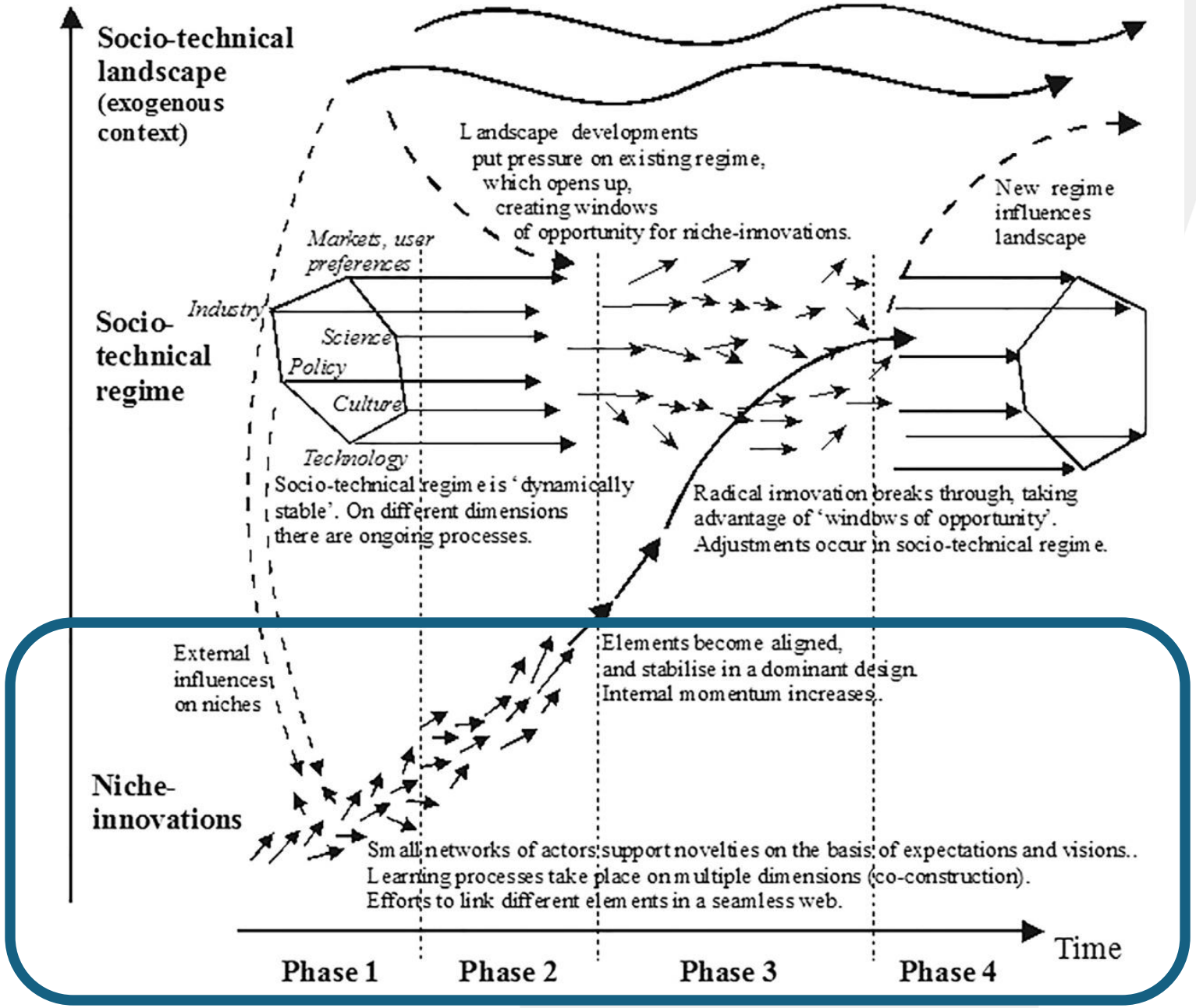


Q: How important should each of the following be when considering how Vermont gets its electricity?

Vermont Department of Public Service,
"Vermont Weighs In: Public Opinion on Renewable Electricity," October 3, 2023

Niche Innovations

- Regional and Town Energy Plans
- Town Energy Committees
- Vermont Energy & Climate Action Network



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Interviews and Meetings

Goals:

1. Explore the **energy needs** at the town level in Vermont, including household, business, and local government goals.
2. Gauge the perceived **opportunities** and **obstacles** at local scales associated with a statewide transition to renewable energy.
3. Identify the most **contentious issues** and **priorities** for local energy planning to be explored further in the energyshed project.

Interviews and Meetings

Priorities and Challenges:

1. Weatherization → old housing stock, high energy burdens
2. Transportation → rural living and land-use planning
3. Heat Pumps → back-up heat and 100-amp panels
4. Community Solar → grid capacity and net metering laws

Interviews and Meetings

Governance and Community Capacity:

1. Building social “infrastructure”
2. Education and energy system awareness
3. Electric utilities as “gate keepers”
4. Town selectboards as “conservative”
5. Barriers to low-income households

Interviews and Meetings

Community Energy Scenarios:

1. Affordability, affordability, affordability
2. Diversity of energy sources
3. Local self-reliance vs. imported electricity
4. Overcoming grid capacity constraints
5. Workforce development

Household Surveys

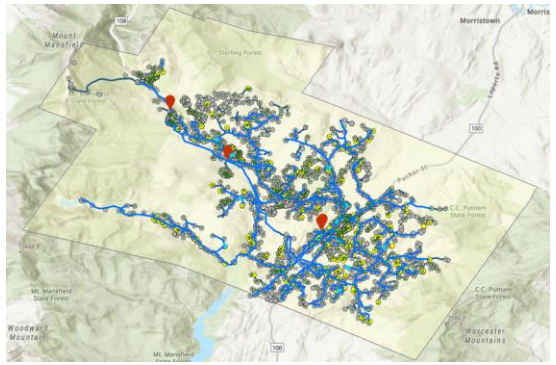
1. Household energy use and expenditure
2. Household renewable energy adoption
3. Community renewable energy perceptions and participation
4. Town energy planning and infrastructure development

Do you feel adequately represented in decisions about energy infrastructure in your area? 50% YES 29% NO 21% UNSURE

Do you participate in decision making processes for energy infrastructure that affects you? 23% YES 74% NO 3% UNSURE

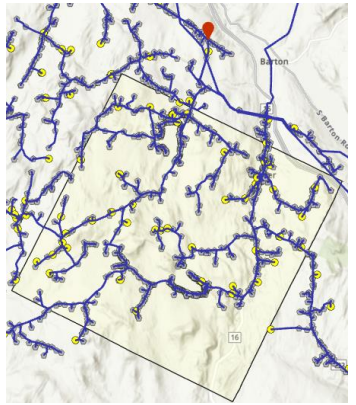
Energyshed Model Development

- Develop web-based tool to visualize and manage local and regional tradeoffs
  - ➢ Economic – costs, jobs, income
  - ➢ Environmental – GHG emissions
  - ➢ Social – energy burden, justice, governance
  - ➢ Grid performance – reliability and resilience

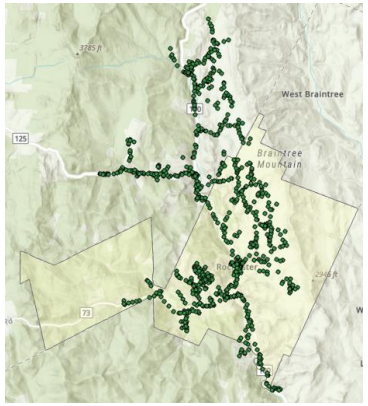


Stowe, VT

- Simulate potential impacts of Town Energy Plans
  - ➢ Increased renewable generation & energy storage
  - ➢ Heating/cooling electrification
  - ➢ Transportation electrification
  - ➢ Weatherization/energy conservation

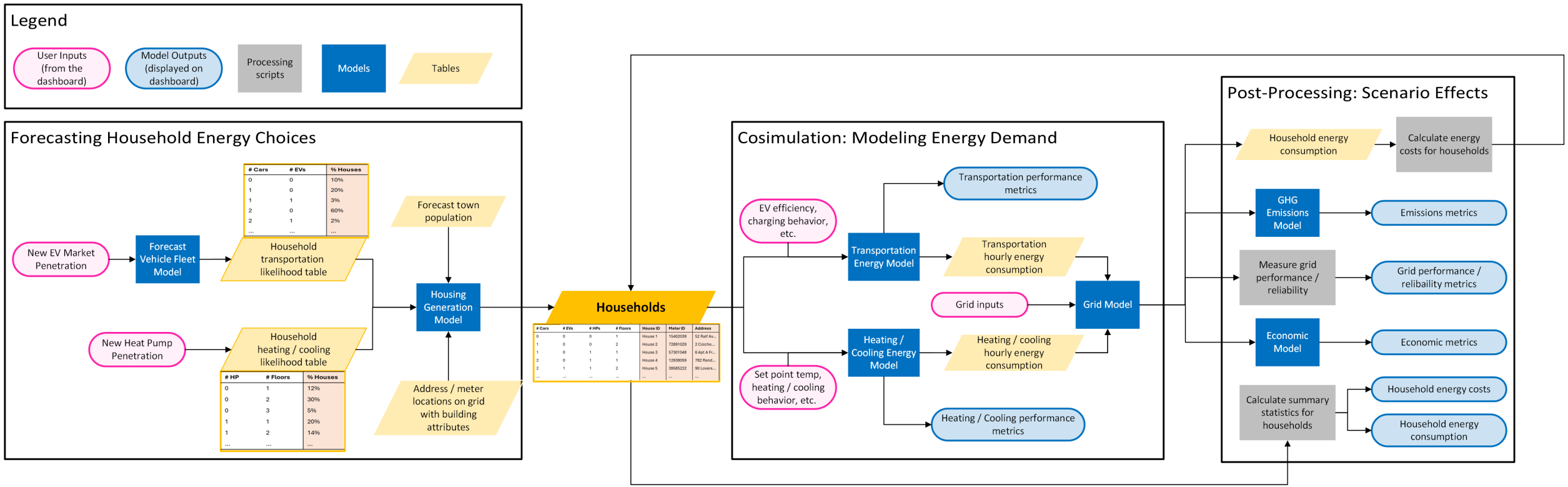


Glover, VT

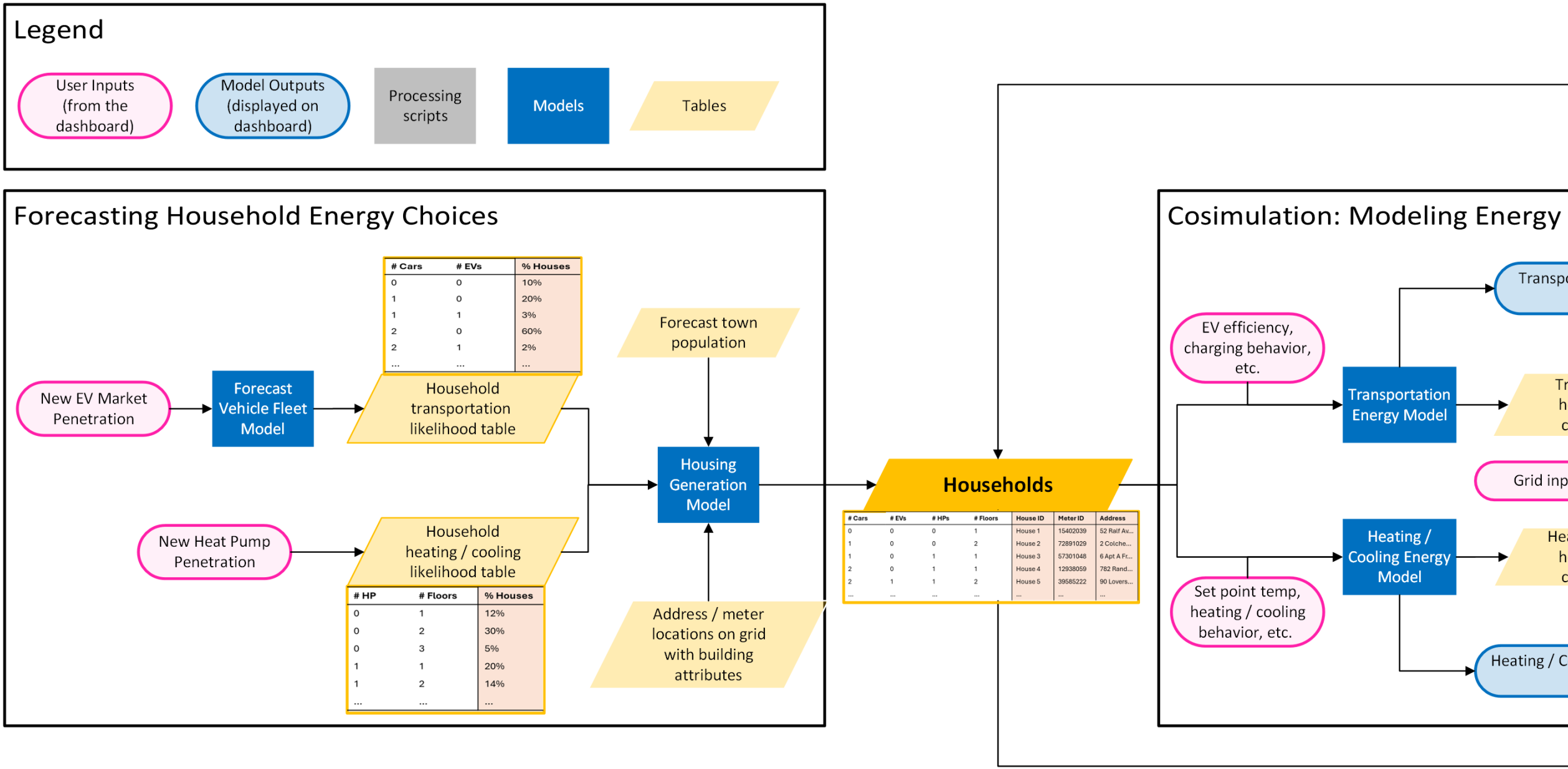


Rochester, VT

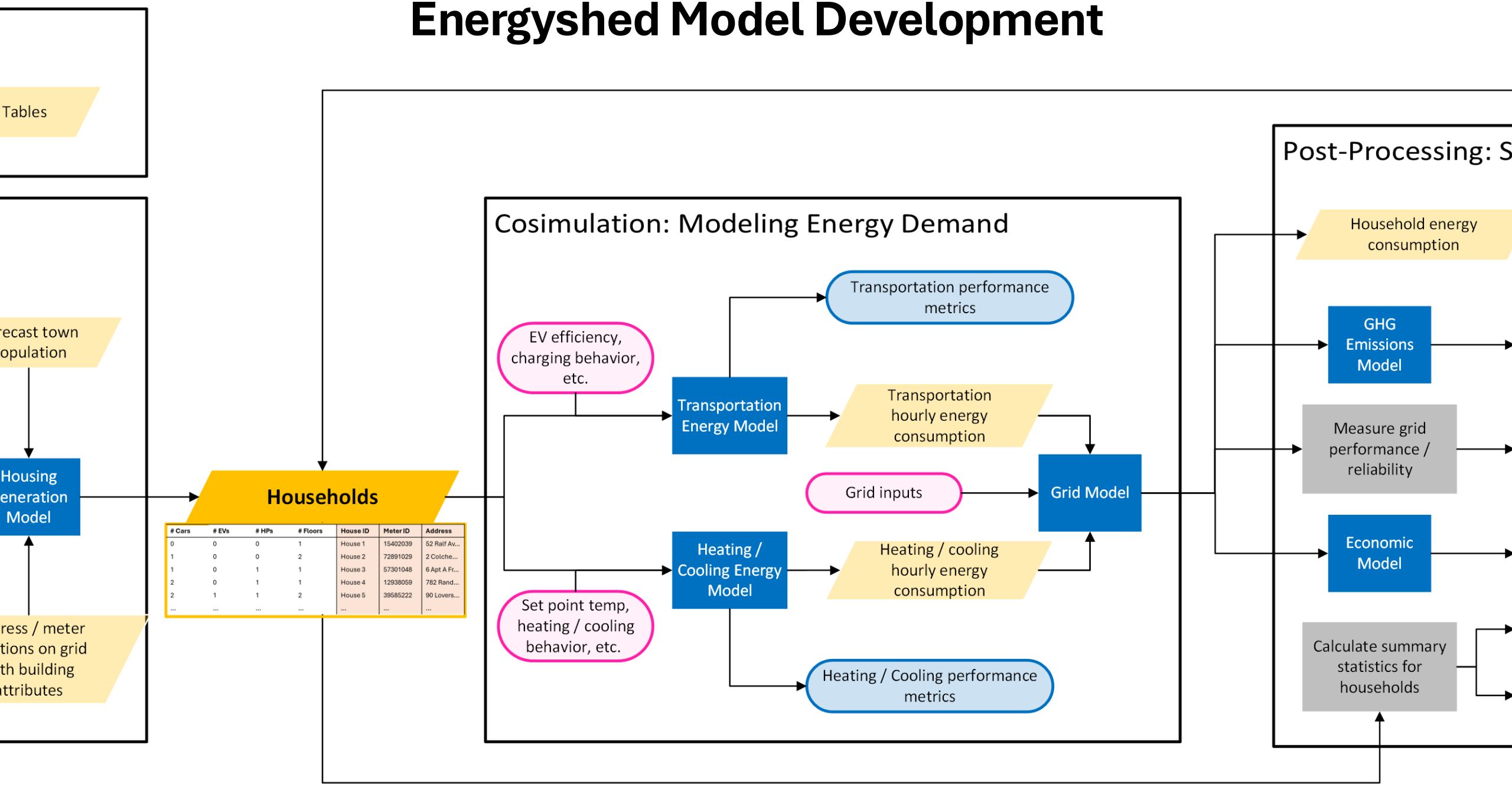
Energyshed Model Development



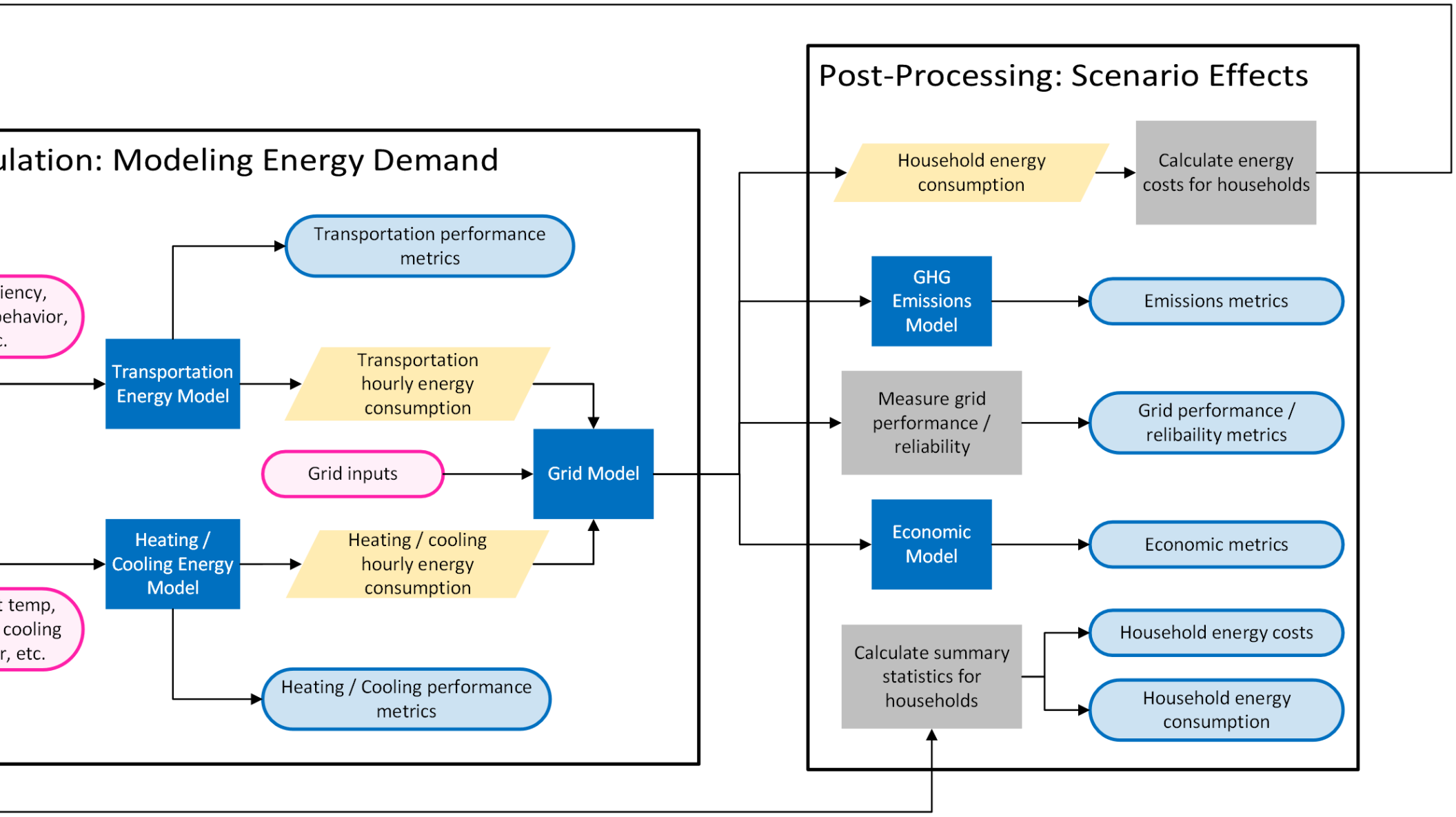
Energyshed Model Development



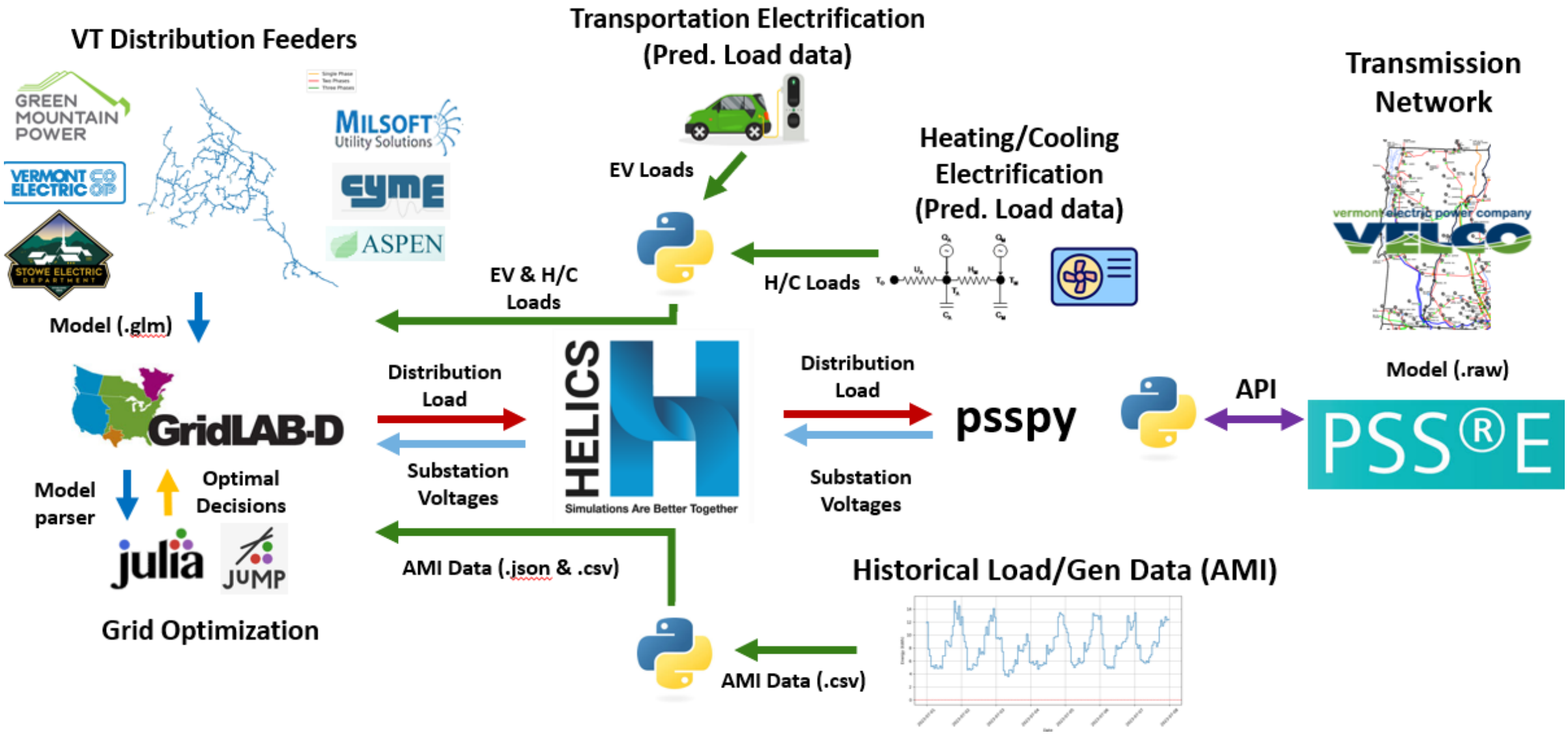
Energyshed Model Development



Energyshed Model Development



Grid Model


VT Distribution Feeders
GREEN MOUNTAIN POWER
VERMONT CO-OP ELECTRIC
STOWE ELECTRIC DEPARTMENT
MILSOFT Utility Solutions
cyme
ASPEN
Model (.glm)
GridLAB-D
Model parser
Optimal Decisions
julia
JUMP
Grid Optimization
Transportation Electrification (Pred. Load data)
EV Loads
Heating/Cooling Electrification (Pred. Load data)
H/C Loads
EV & H/C Loads
Distribution Load
Substation Voltages
HELICS
Simulations Are Better Together
AMI Data (.json & .csv)
Distribution Load
Substation Voltages
psspy
API
Transmission Network
vermont electric power company
VELCO
Model (.raw)
PSS®E
Historical Load/Gen Data (AMI)
AMI Data (.csv)

Economic Model

Glover Town Energy Plan

↓

Household Weatherization Targets

↓

Upfront Capital Investment

↓

Direct, Indirect, & Induced Impacts on Town Scale Income and Employment

WEATHERIZATION	2025	2025	2050
Households	501	531	563
% Weatherized	18%	30%	30%
# Weatherized	92	160	171

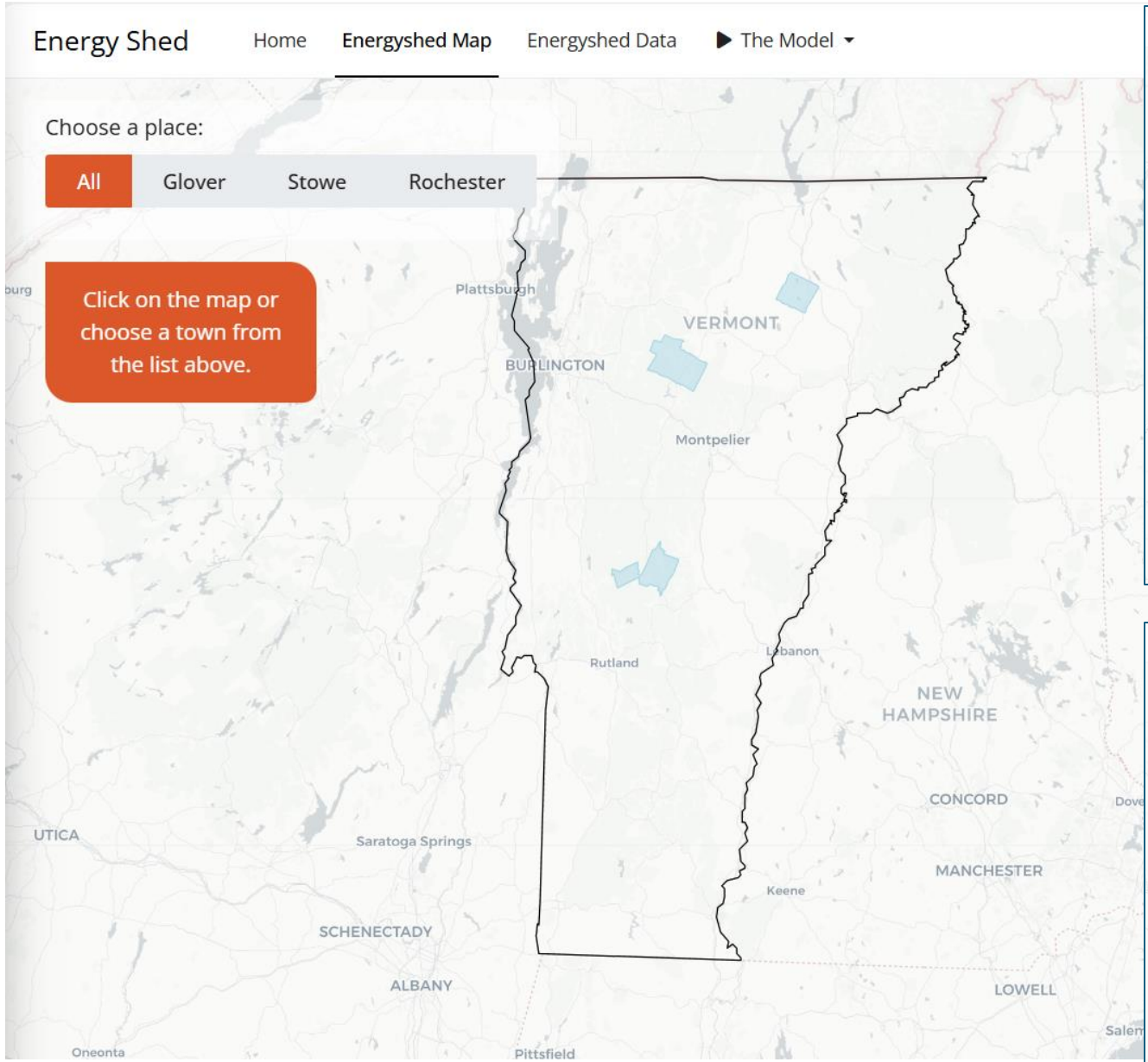
↓

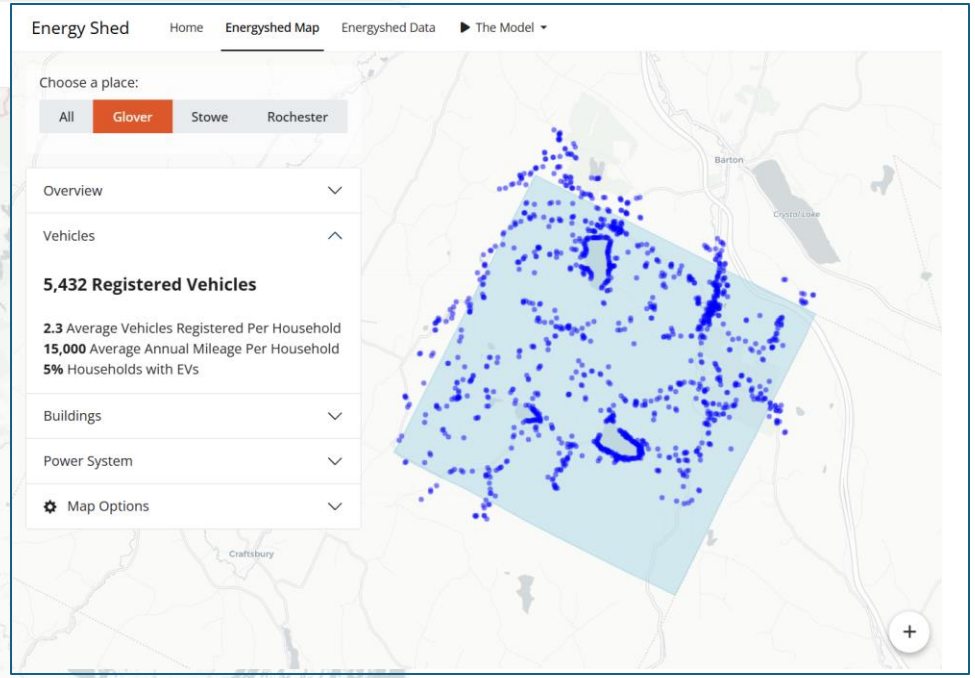
$10,000 per household

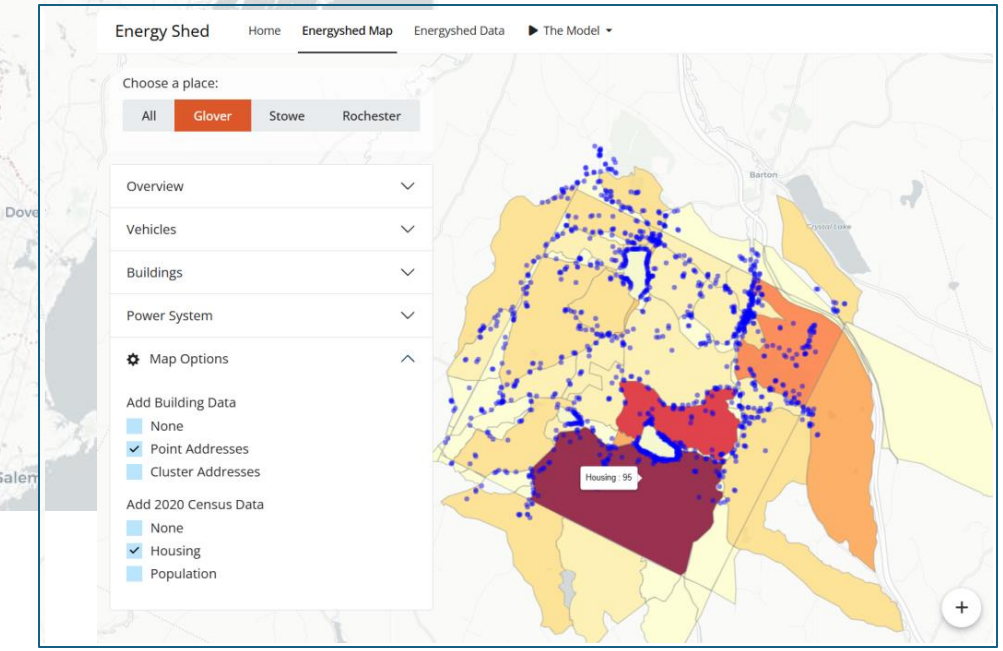
↓

Base Case	Local Impact	Hyper Local Impact

+ significance of co-benefits


Energy Shed
Home
Energyshed Map
Energyshed Data
The Model
Choose a place:
All
Glover
Stowe
Rochester
Click on the map or choose a town from the list above.
Plattsburgh
VERMONT
BURLINGTON
Montpelier
Rutland
Lebanon
NEW HAMPSHIRE
CONCORD
MANCHESTER
Keene
UTICA
Saratoga Springs
SCHENECTADY
ALBANY
LOWELL
Pittsfield
Oneonta


Energy Shed
Home
Energyshed Map
Energyshed Data
The Model
Choose a place:
All
Glover
Stowe
Rochester
Overview
Vehicles
5,432 Registered Vehicles
2.3 Average Vehicles Registered Per Household
15,000 Average Annual Mileage Per Household
5% Households with EVs
Buildings
Power System
Map Options
Barton
Crystal Lake
Craftsbury


Energy Shed
Home
Energyshed Map
Energyshed Data
The Model
Choose a place:
All
Glover
Stowe
Rochester
Overview
Vehicles
Buildings
Power System
Map Options
Add Building Data
None
Point Addresses
Cluster Addresses
Add 2020 Census Data
None
Housing
Population
Housing : 95
Barton
Crystal Lake

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