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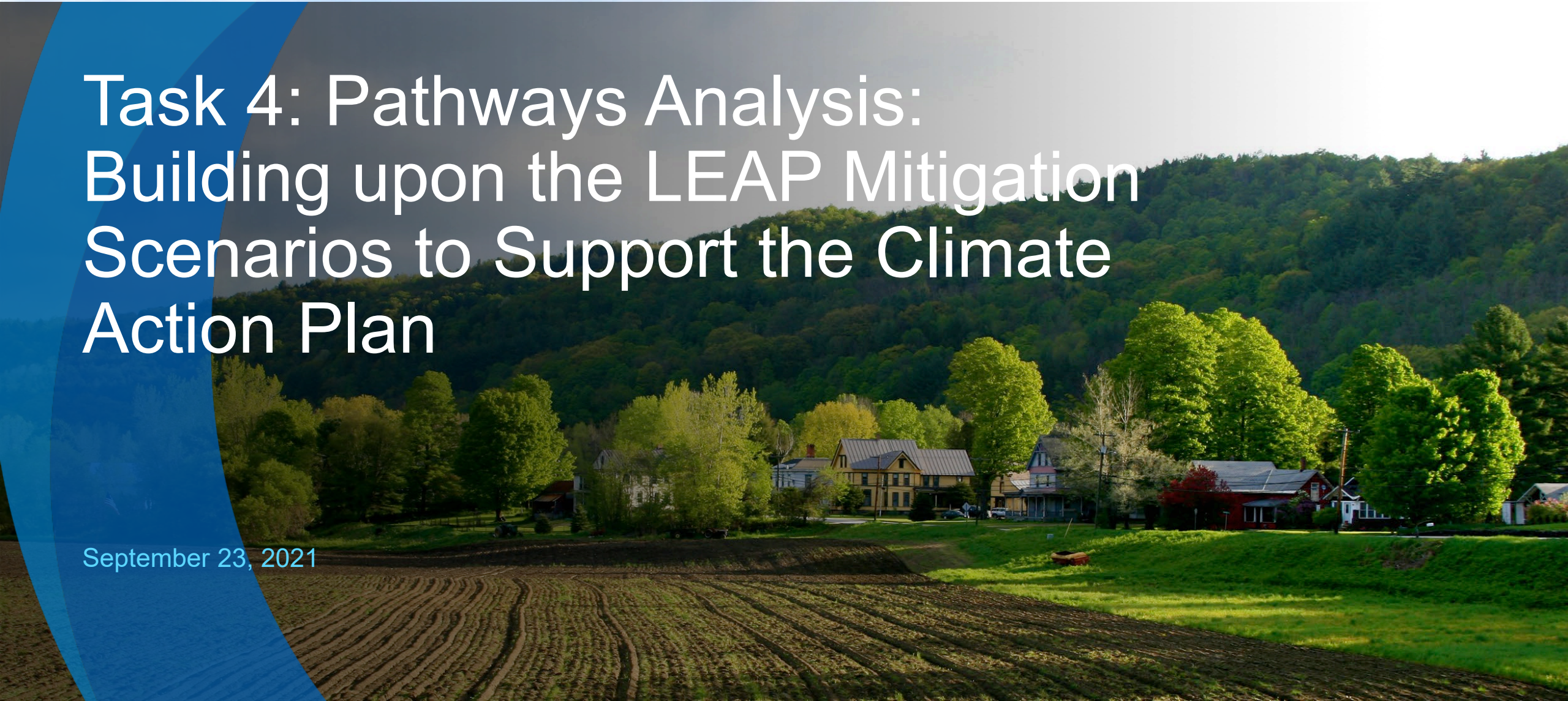
Task 4: Pathways Analysis: Building upon the LEAP Mitigation Scenarios to Support the Climate Action Plan



September 23, 2021

Analyze and Build Upon the Analyses Completed by the State and Stockholm Environment Institute

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Pathways Analysis

Task 4a

Initial Pathways Analysis (Sept. 30)

Recommendations and Excel table:

- Sectoral, jurisdictional and existing climate initiatives
- Impact of the VCC recommended strategies on emissions reductions
- Preliminary 2025, 2030 and 2050 pathway recommendations and corresponding LEAP inputs

Task 4b

Draft and Final Pathways Report and Executive Summary (Nov. 30)

- 2025 Pathway: Immediate and short-term policies, programs, and initiatives to meet reduction targets.
- 2030 Pathway: Additional policies, programs, and initiatives to be advanced this decade to meet reduction targets.
- 2050 Pathway: Strategic framework for additional activities necessary to achieve 2050 emissions targets.

Deliverables

50-page report, 10-page Executive Summary

Approach to Pathways Analyses

Assess and Build upon existing model

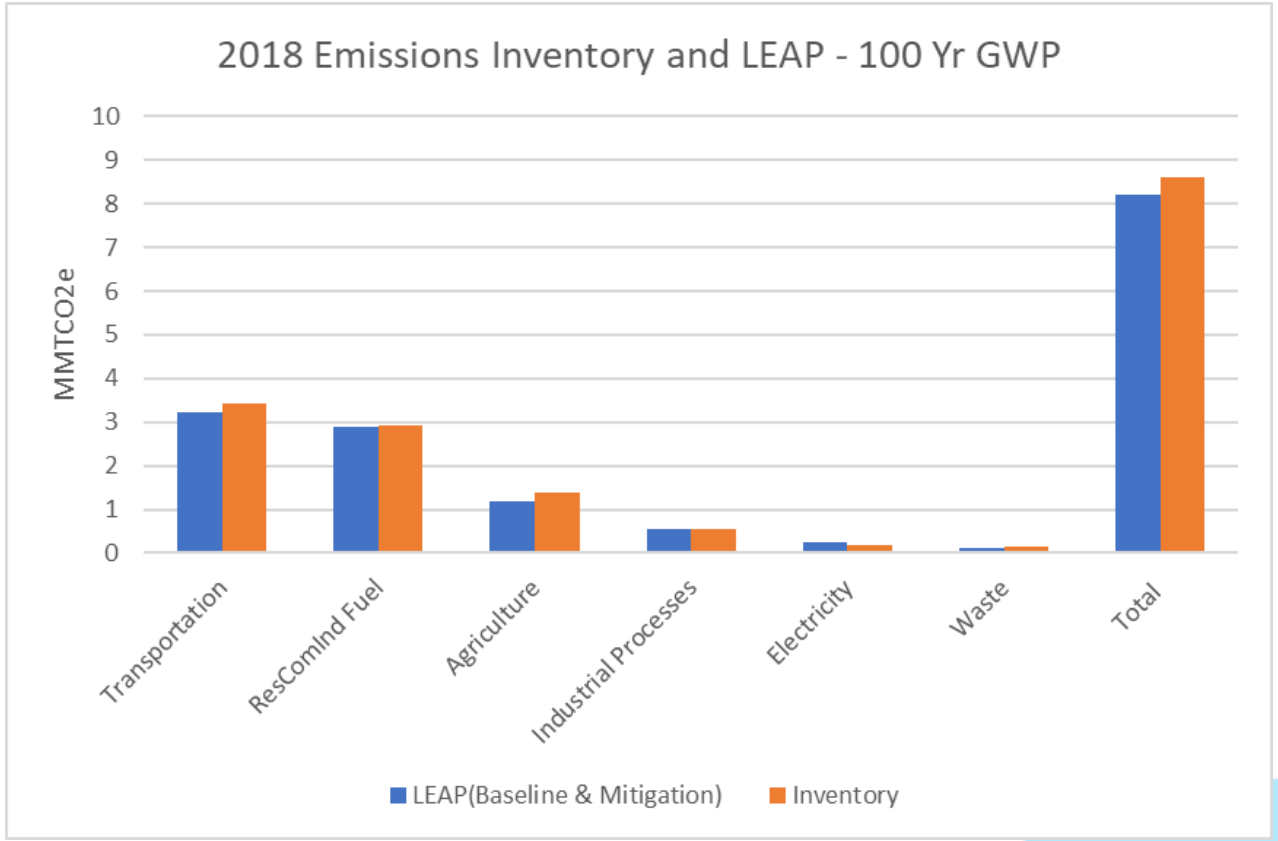
Synthesize Climate Council Pathways and Mitigation Pathways

Identify:

- Gaps in existing analyses
- Additional strategies, measures or categories
- Review assumptions and inputs
  - Depth and pace of emissions reductions
  - Costs and performance
- Supporting policies and initiatives

Critical Questions

- Is the modeling consistent with inventory?
- Do the Scenarios meet GWSA reduction targets? - Yes
- Does the sector meet target reductions? (generally, Yes)
- By what means.. (e.g. electric vehicles w some biofuels for transport)
- Is there Consistency and/or Gaps with x-sector expectations?
- What are the Cadmus team recommendations to revise and build on the model?



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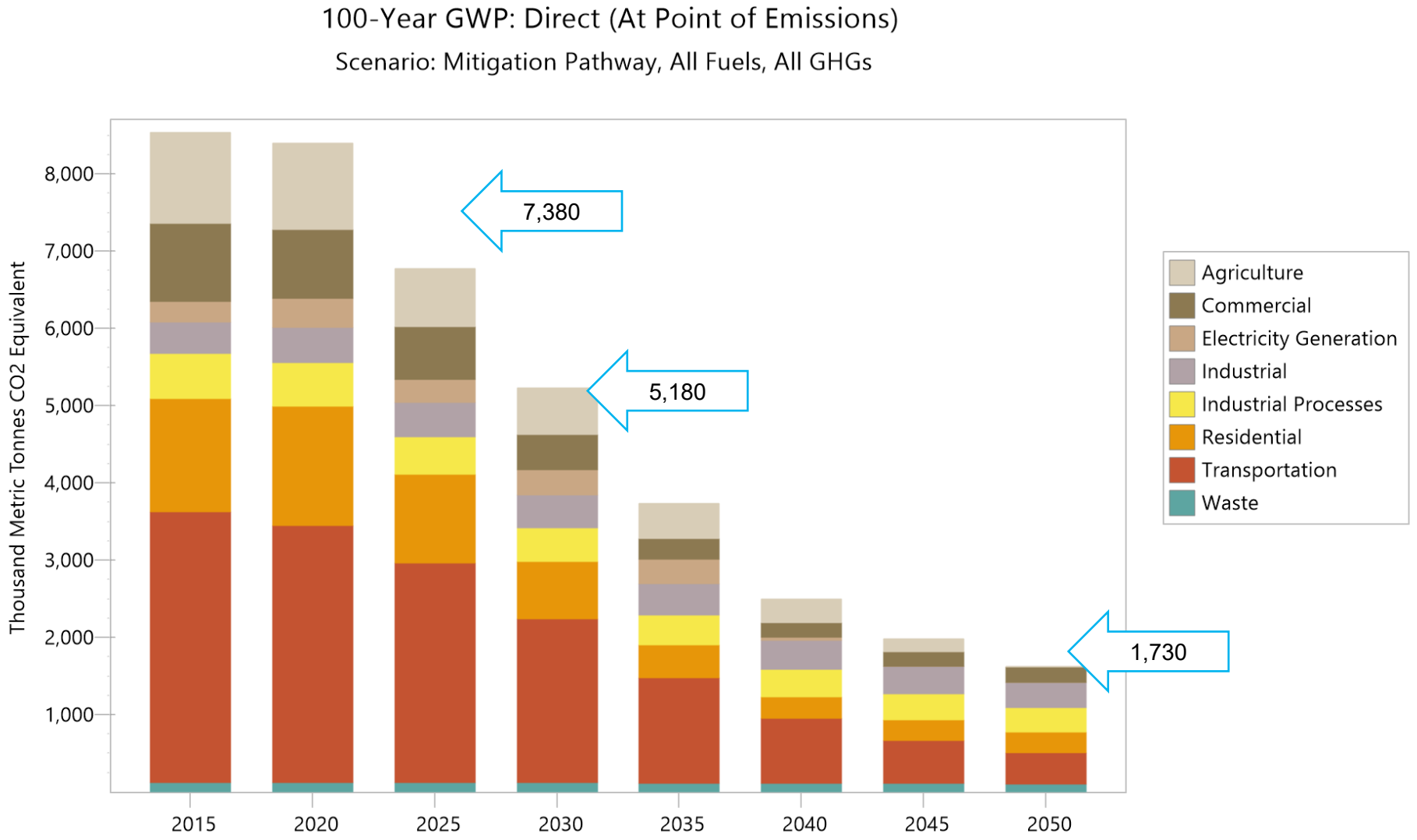
Mitigation Scenario 1.63 Meets GWSA Targets



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Sector Modeling
Transportation

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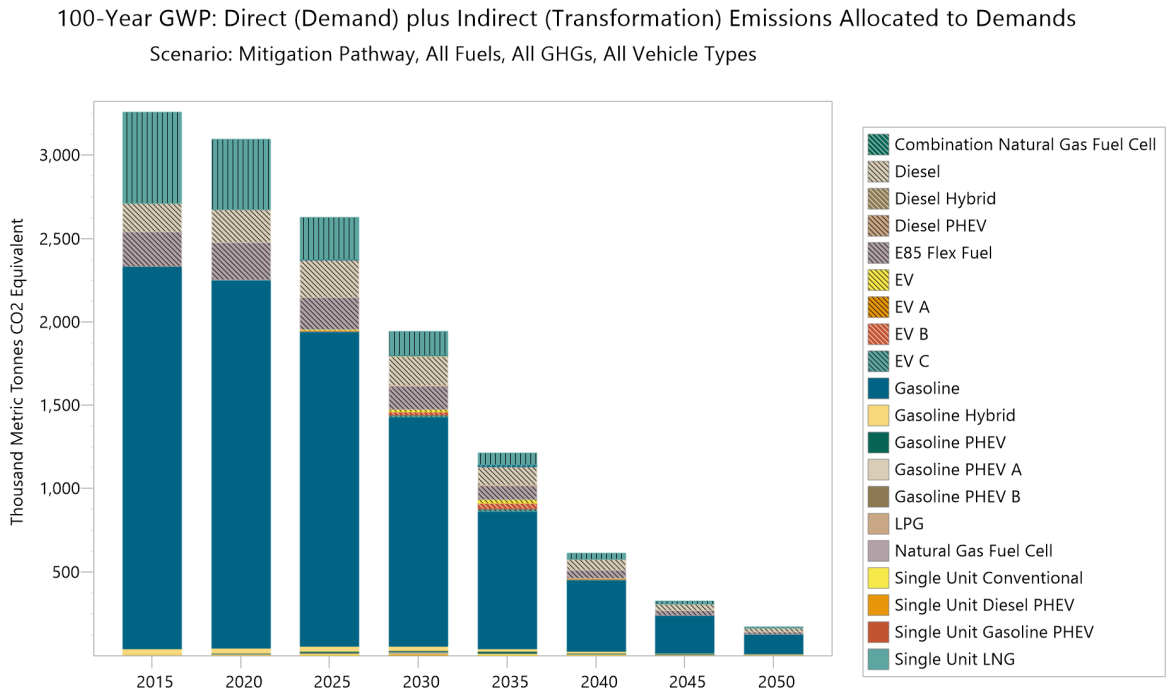
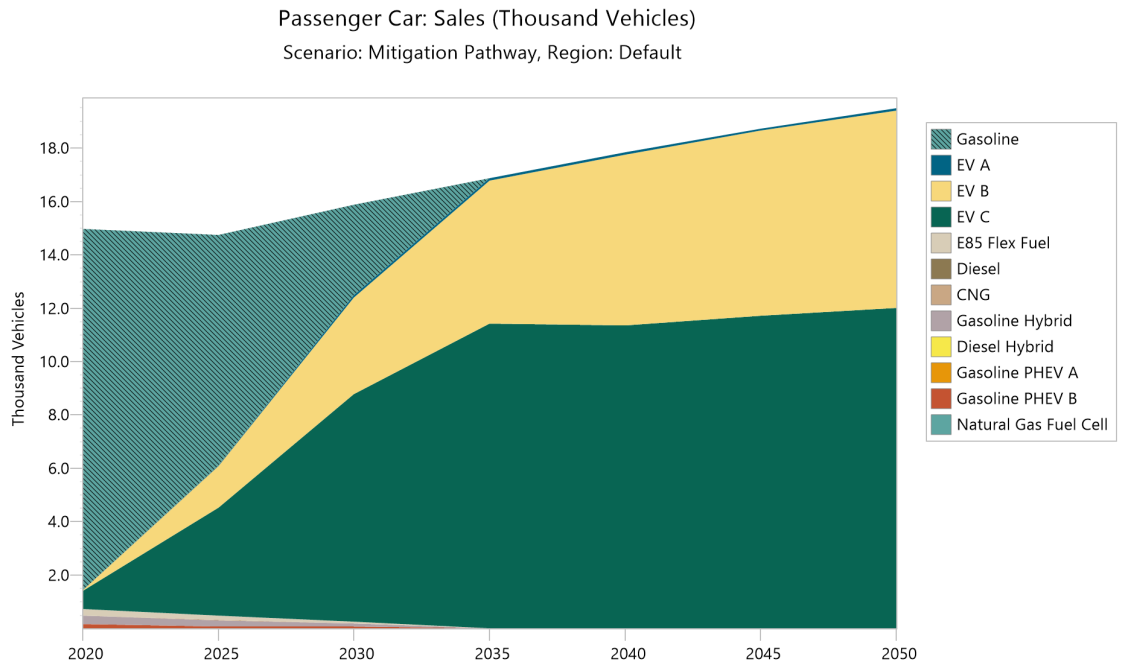
Transport Sector – v1.63 Snapshot





Emissions reductions from 2020 by 2030 36%, and by 2050 87%.

Primarily from EV adoption, ICE phase out of new sales by 2032.

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Transport Recommendations

1. Add Elements that impact vehicle and passenger miles travelled:
    a) Densification/smart growth
    b) Transit
    c) Travel demand management
    d) Bike/Pedestrian
2. Vehicle charging infrastructure – number and costs by type
3. Modify profile of cost declines for electric vehicles/crossover
4. Biodiesel 100 viability and conversion costs for cold operations

Transport: Consistency/Gaps with Committee Priorities

Modeling (existing and w recommendations) provides analytic support for participation in Transportation Climate Initiative, and associated initiatives such as:

- Replace your Ride
- Transit
- Smart growth and other TDM,and
- Feebates

Complementary supporting analyses (e.g on customer financial incentives/adoption rates, and public costs of initiatives under consideration) to be included in Pathways Analysis Deliverable.

Source TCI-P updates program webinar, March 2021

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Sector Modeling
Buildings

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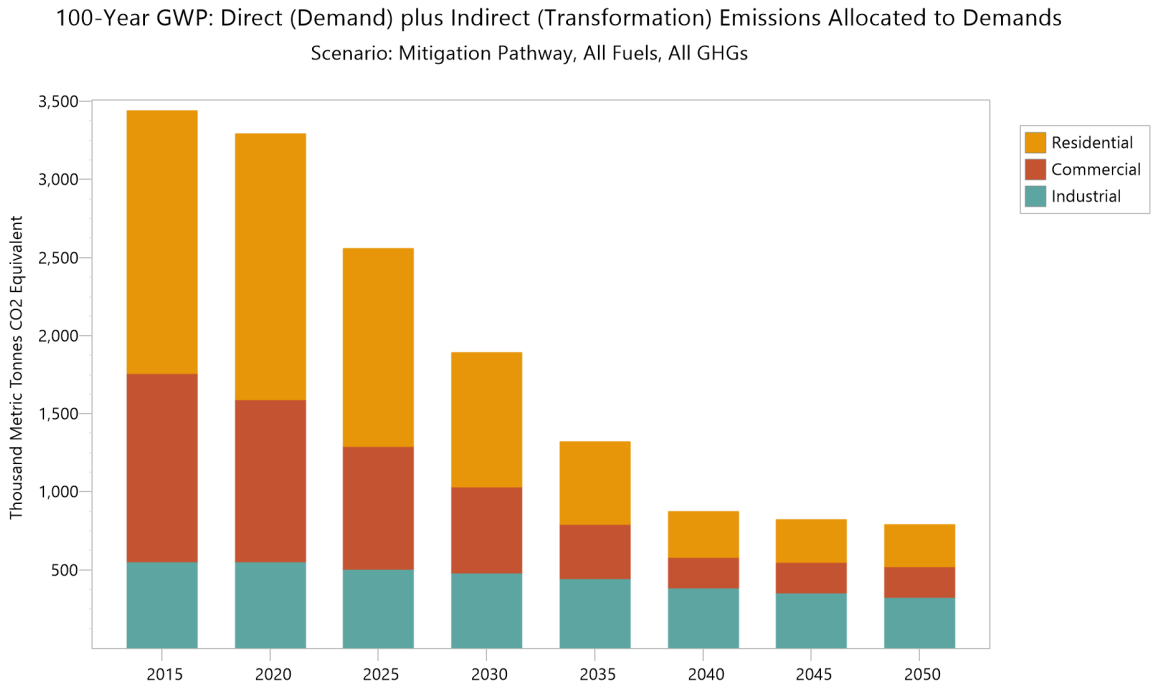
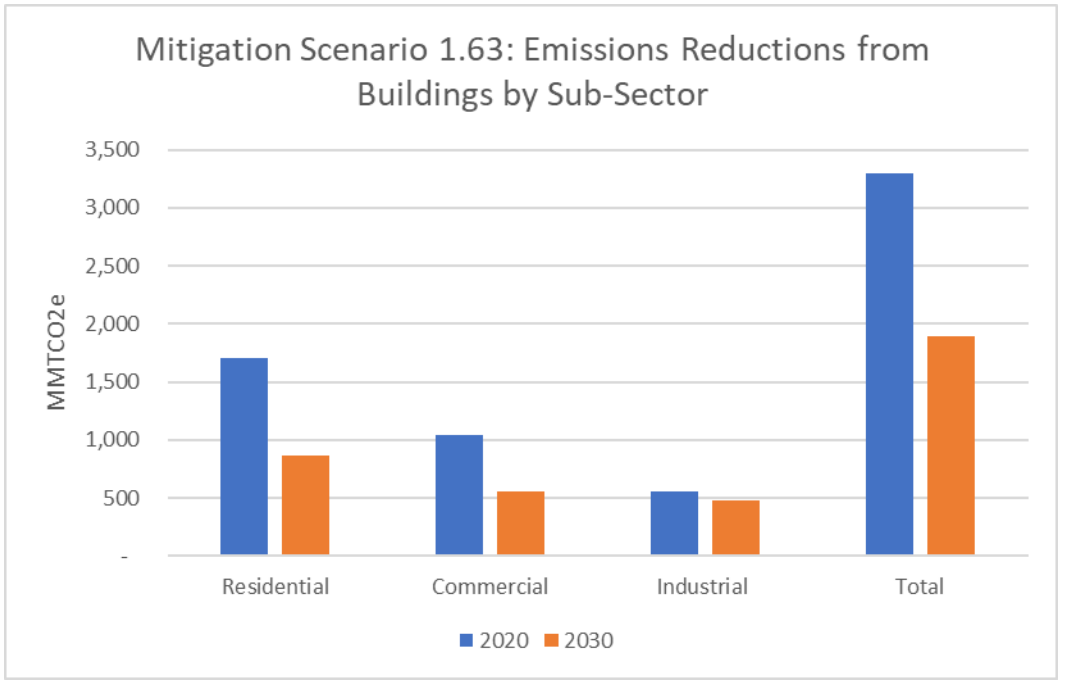
Buildings Sector – v. 1.63 Snapshot





Emissions reductions from 2020 to 2030 42%, and by 2050 76%.

~60% from residential, 33% Commercial, 7% Industrial

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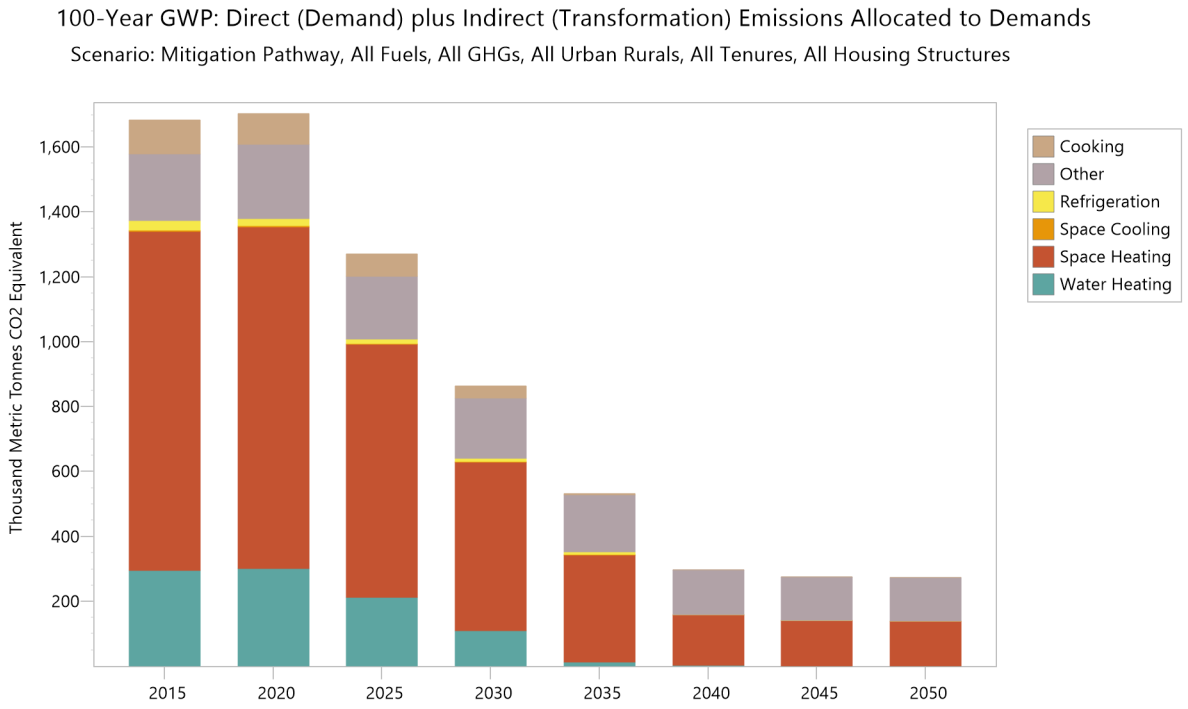
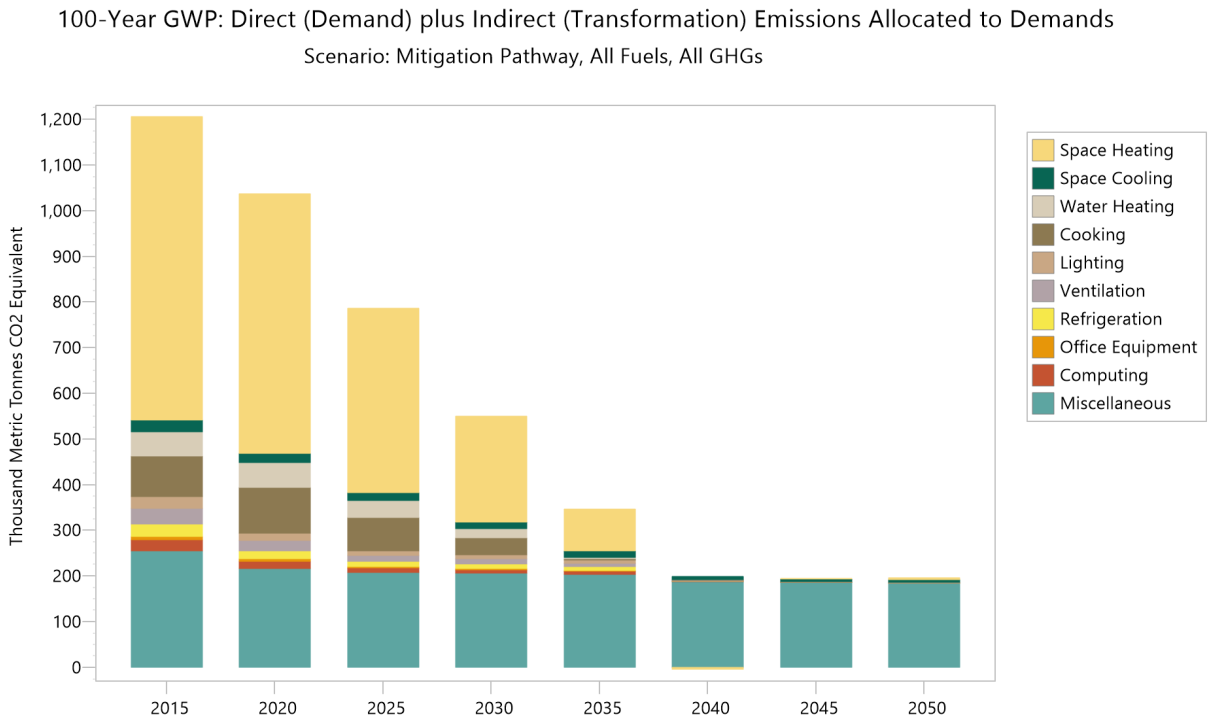
Buildings Sector – v. 1.63 Snapshot





Residential, primarily space heating –

Heat pumps, shell efficiency, phase out of water and cooking fossil .

Commercial, primarily space heating

Heat pumps, phase out of water and cooking fossil .

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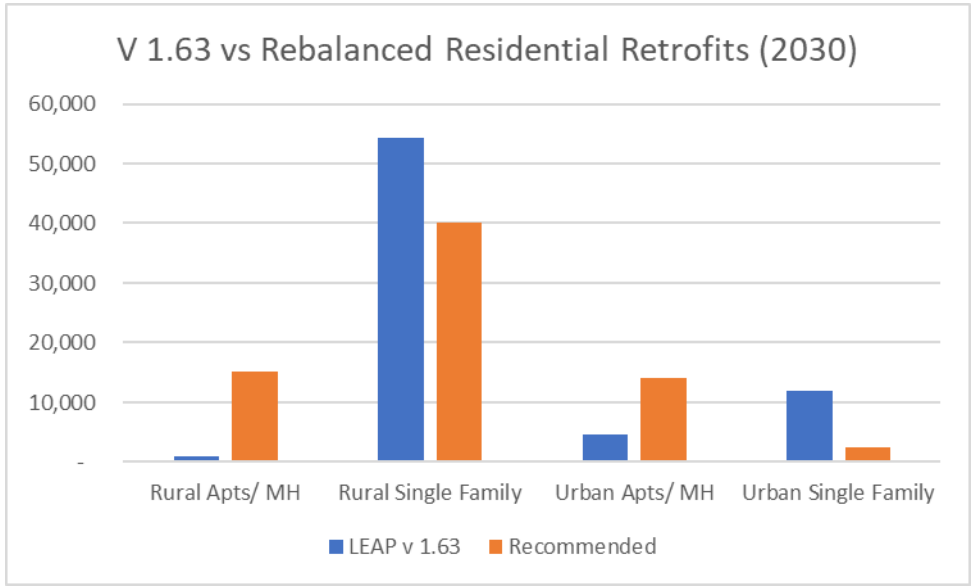
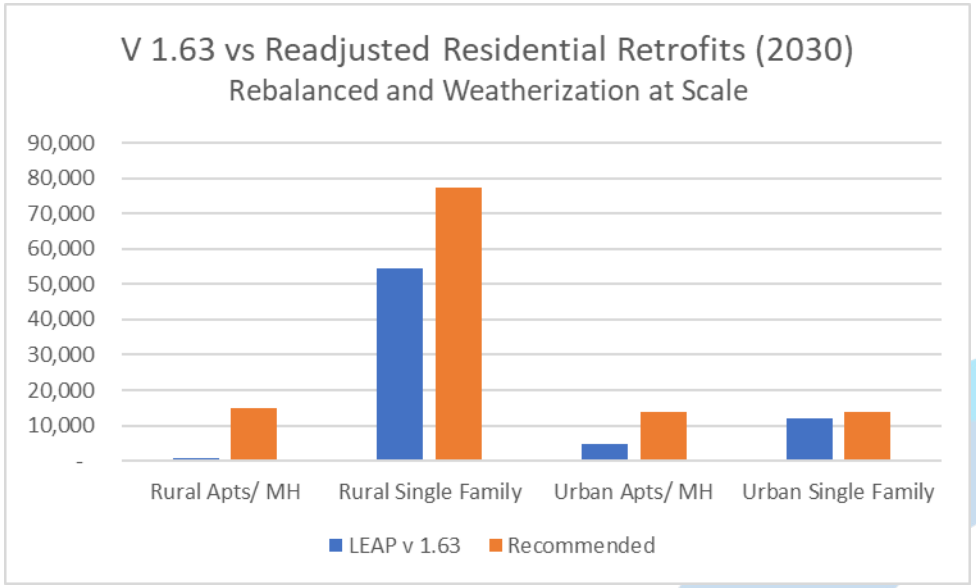
Building Sector Recommendations

1. Rebalance Weatherization Portfolio
   a) Increase apartments and mobile homes
   b) Add mobile homes to urban
   c) Add “Wx at Scale” scenario with 120,000 units by 2030





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Building Sector Recommendations

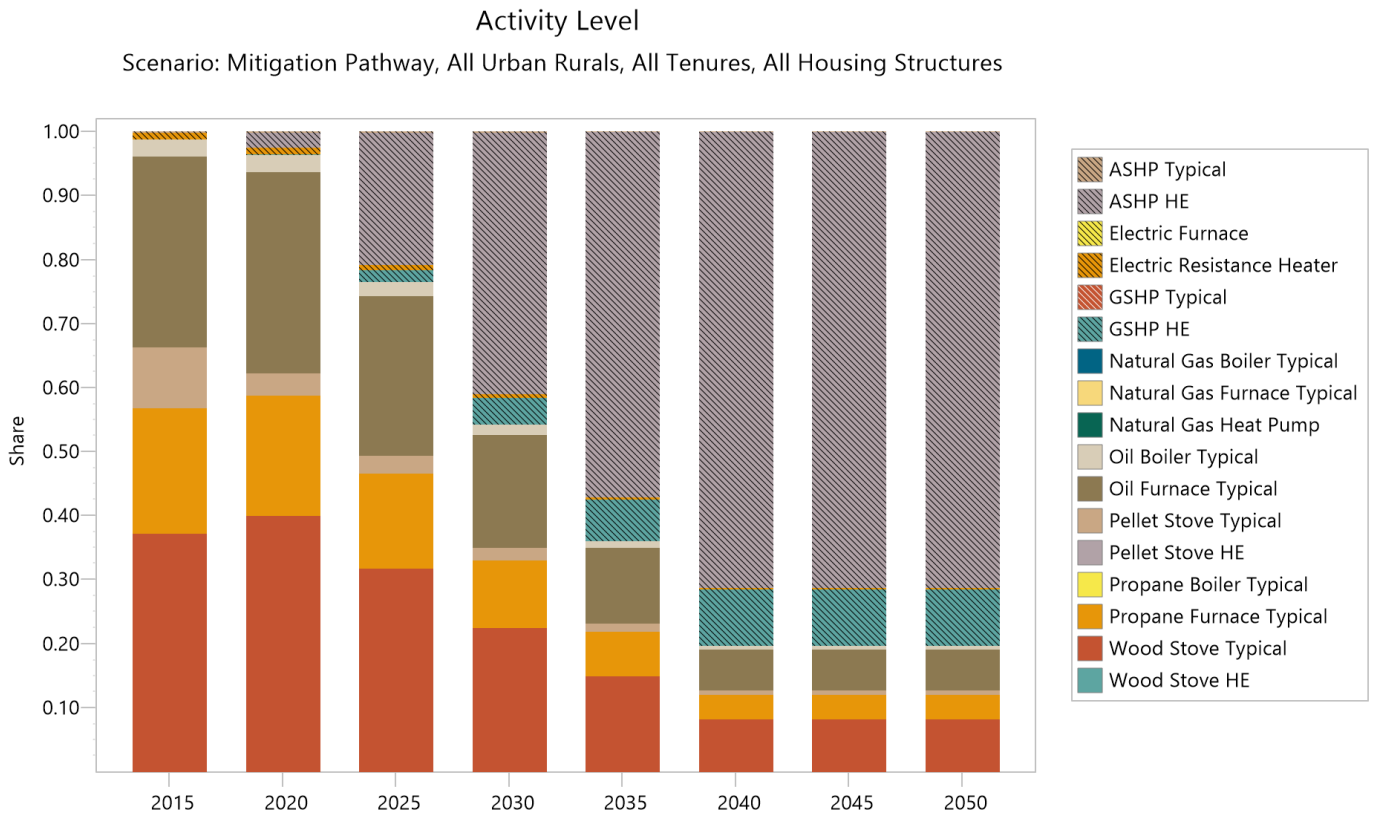
2. Reflect greater variety for residential heat pumps

Include centrally ducted systems (applicable for roughly 30% households with forced air systems)

Single head systems w cost of $6,100 serving 40% of heating load,

Two head system costing $7,000 and meeting 66% of heating load,

Centrally ducted system costing $8,500 and meets 100% of load.



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Buildings Additional Recommendations

3. **Residential new construction**
   - Net zero code improvements reduce useful energy intensity for space heating per unit, more than off-setting larger buildings.
   - 23% reduction in UEUI by 2025, and 52% reduction by 2030

4. **Timing for water and cooking fossil fuel phase outs**
   - Shift phase out to 2040. This would allow for all new sales to be electric starting in 2025 and turnover with 15-year measure-life.

5. **Advanced wood heating**
   - Higher uptake of advanced wood heating systems in the biofuel focused scenario.

6. **District heating**
   - Delivered fuel cost per MMBtu to off-set commercial and possible apartment 5+ loads.
   - Based on general characteristics (fuel type and cost per MMBtu) for systems similar in scale to Burlington and Montpelier

7. **Commercial**
   - Higher share for GSHP, revise final energy intensities for wood boilers and stoves

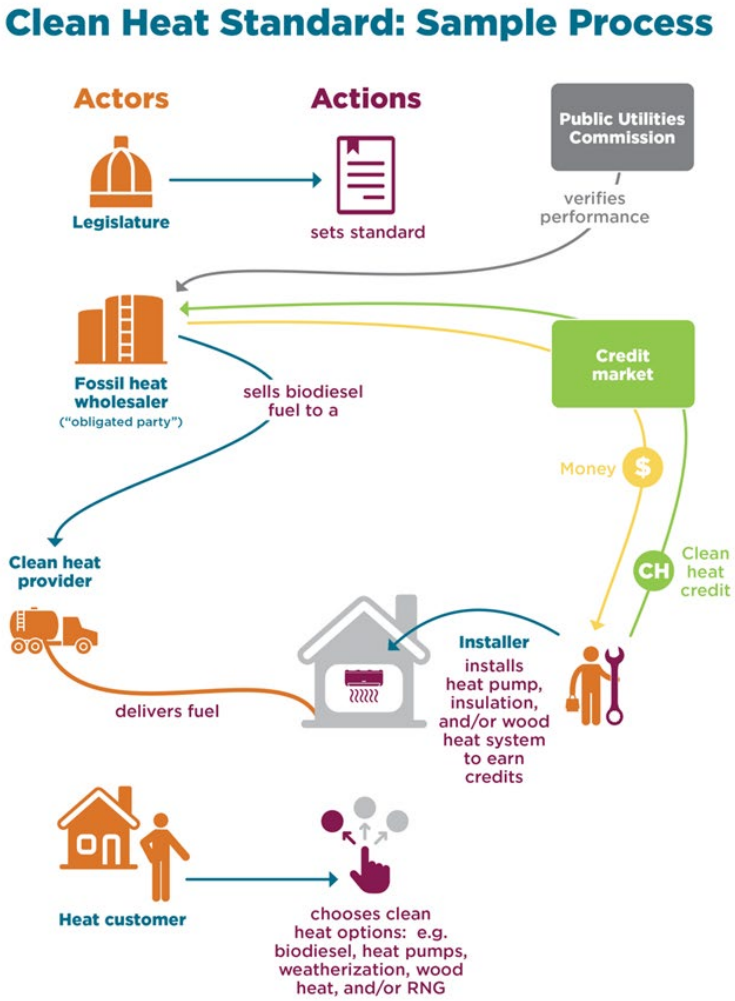
8. **Industrial**
   - Strategic electrification and process efficiency options.

Buildings: Consistency/Gaps with Committee Priorities

Modeling (existing and w recommendations) provides analytic support evaluation of:

- Clean Heat Standard,
- Rental Efficiency Initiative,
- Weatherization at scale,
- Fossil cooking and water heating phase out,
- Net zero new construction standards for residential and commercial.

- Need additional analysis for industrial strategic electrification and process efficiency.



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Sector Modeling
Non-Energy

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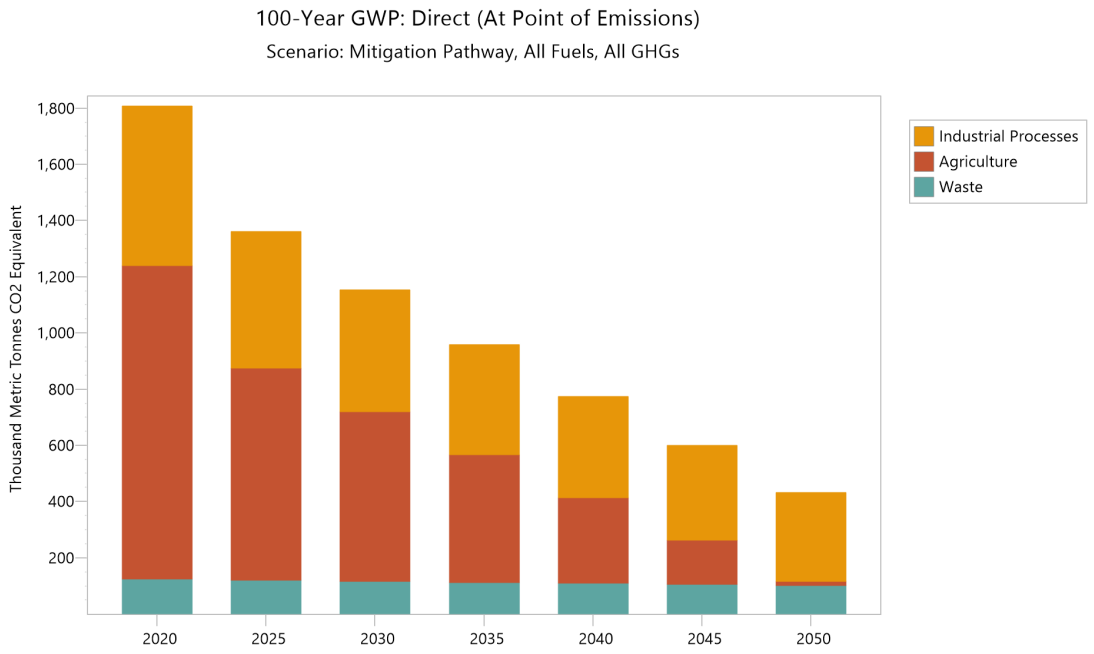
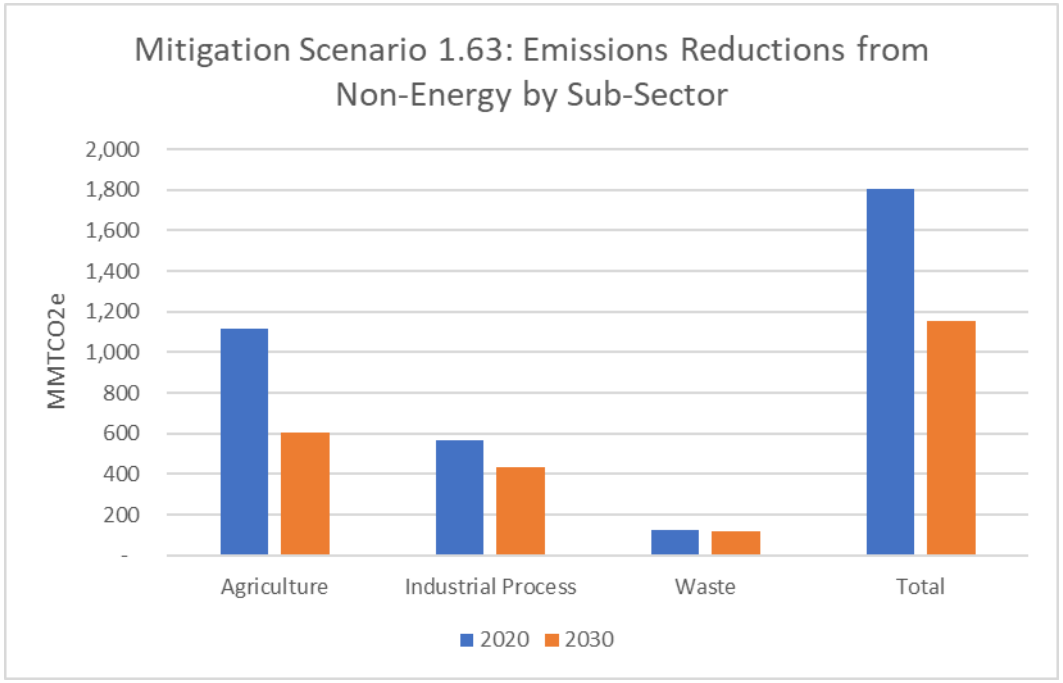
Non-Energy Sector – v. 1.63 Snapshot





Emissions reductions from 2020 to 2030 47%, and by 2050 76%.

~80% from Agriculture, 20% Industrial Process

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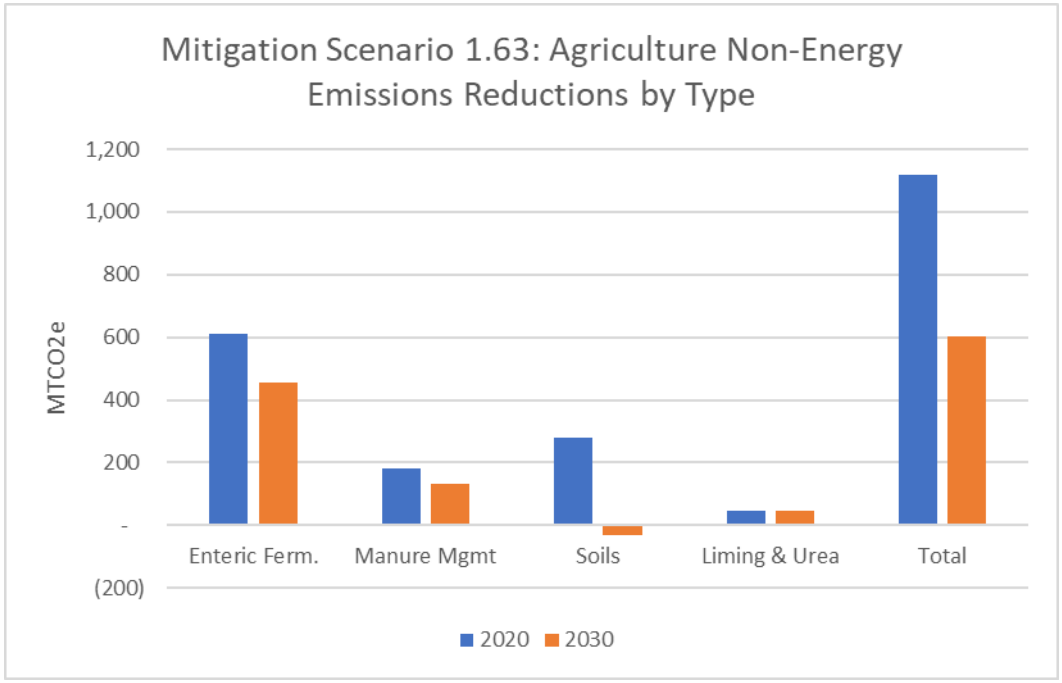
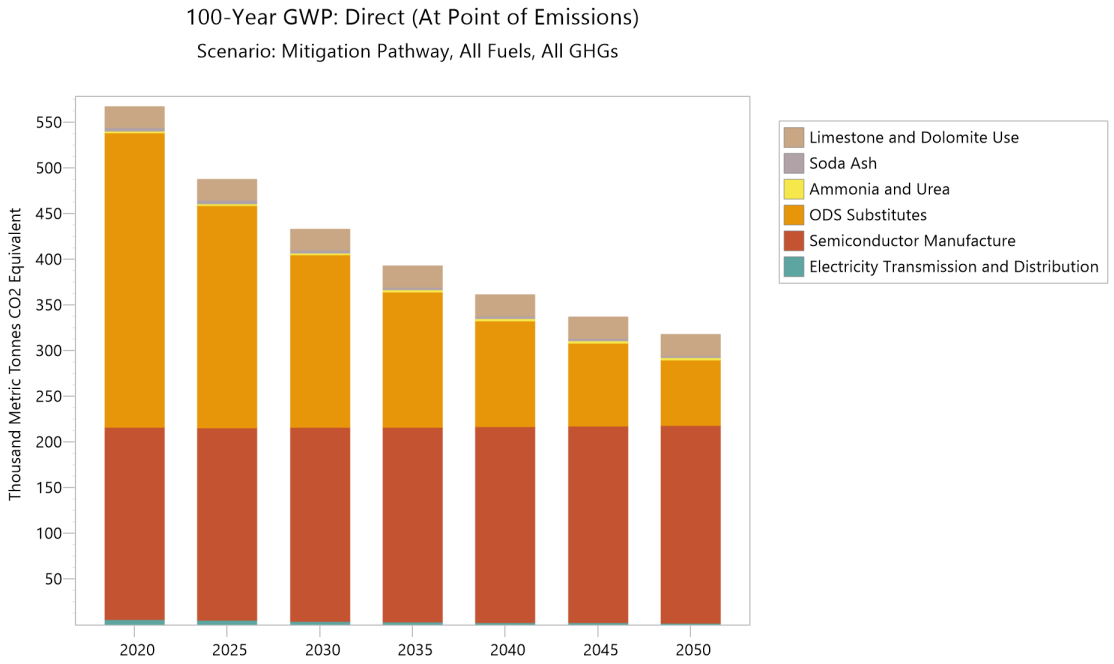
Non-Energy Sector – v. 1.63 Snapshot





Agriculture, 80% of reductions from soils, they become net sink

Enteric fermentation and Manure management also have significant declines before 2030.

Industrial Process - All reductions are ODS substitutes

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Agriculture Non-Energy Recommendations

Agricultural Soil Management - the existing 1% rate of increased agricultural soil sequestration may be high given range of rates in literature.

- This rate offsets soil direct and indirect resulting in soils becoming net sink by 2030. The rate may decline in later years as carbon content increases, rather than being steady.
- Based on data and research gaps we also recommend a sensitivity case with 0 increase in ag soil sequestration – accompanied by further research

Enteric Fermentation - 30% reduction by 2025 is too rapid.

- We recommend modification to reflect 50% adoption of the improved practices by 2035, resulting in a 20% reduction, and 75% adoption and 30% reduction by 2040.

Manure Management - 30% reduction by 2025 is too rapid.

- Shift to reach 30% by 2030.
- Livestock population directly linked to growth in human population, investigate alternative
- Reference to cow power for costs and adoption potential.

Industrial Process Non-Energy Recommendations

Ozone Depleting Substitutes - Reductions are consistent with annual levels from refrigerant management initiative.

- Characterize average cost based on demand resource plan estimates.
- Validate pace of continued reductions through 2050.

Semi-Conductor Manufacturing

- Consider modifying current growth which is proportional to state population.
- Recommend including some reductions, Process reductions of 40% by 2025 (appears to already be met) and 50% by 2030 which would be 179,000 MTCO2e– based on the earliest historical year (2011) of direct reporting.

Non-Energy: Consistency/Gaps with Committee Priorities

Modeling (existing and w recommendations) provides analytic support evaluation of:

- Soil management practices and initiatives – note that a zero increase in soil uptake is sensitivity.
- Enteric fermentation and manure management – note emissions reductions will likely be delayed from current.
- Refrigerant management
- Consideration of targets for Semi- Conductor manufacturing
- Costs and additional research necessary in several categories.

Sector Modeling
Electricity

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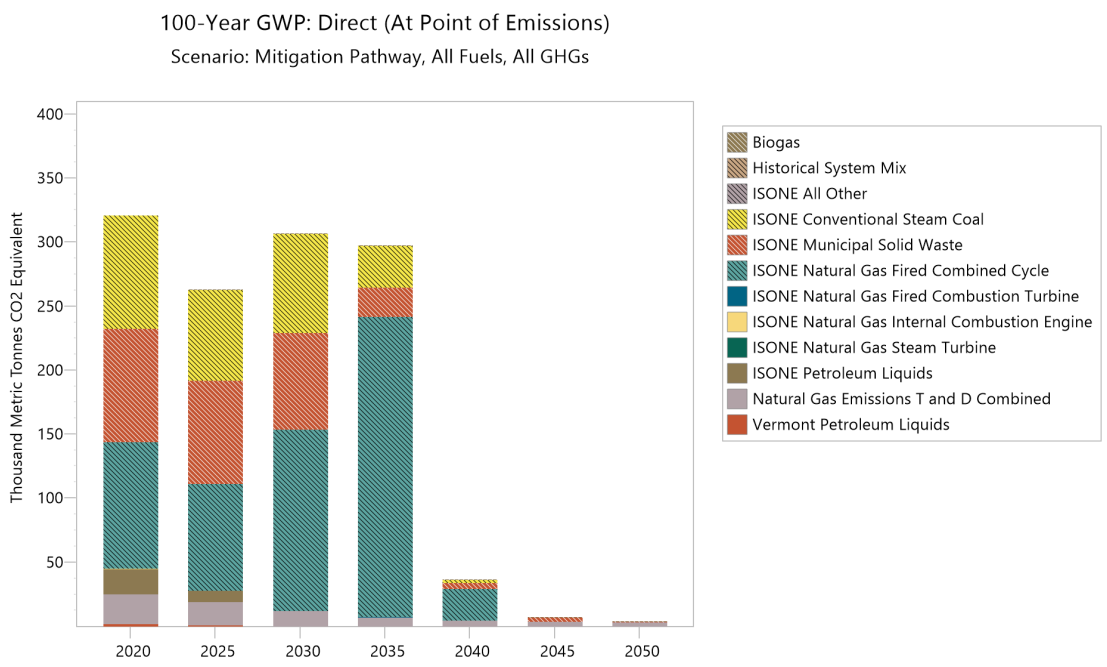
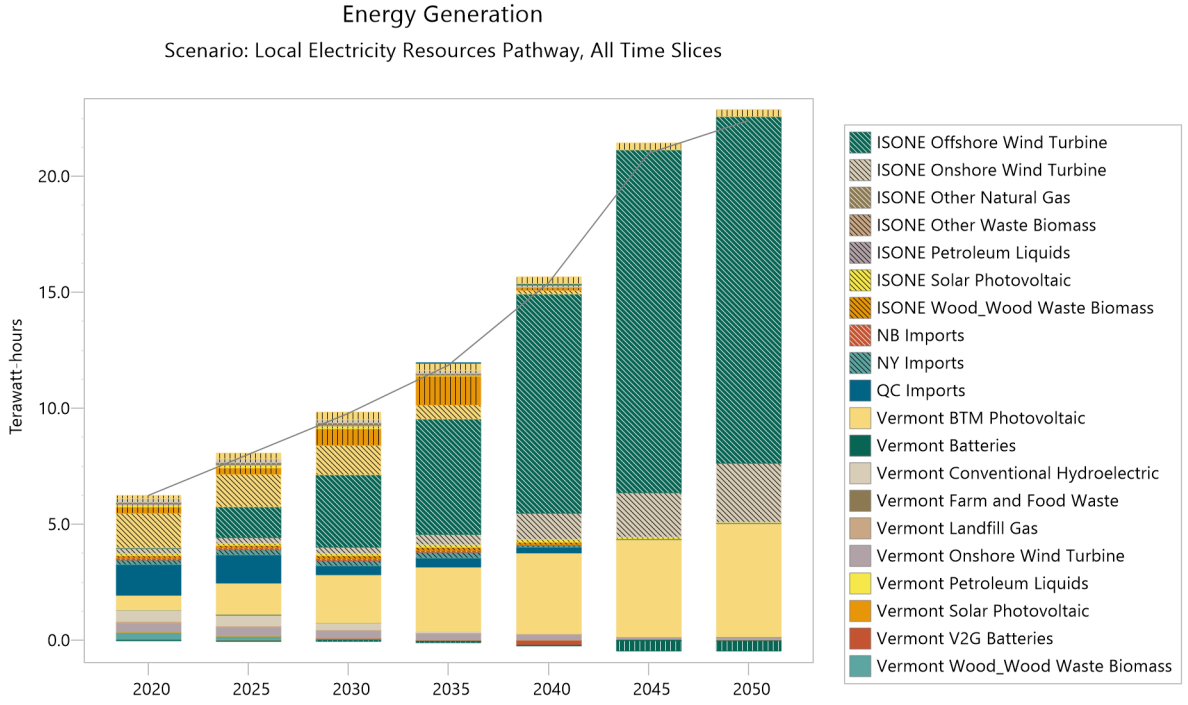
Electricity Sector – v. 1.63 Snapshot





Emissions from Electric Grid decline as gas, remaining coal and solid waste phase out by 2040.

Growth in Generation and capacity. Generation 6,300 GWh in 2020 → 9,700 GWh by 2030 and 25,800 GWh by 2050. Installed capacity 2.6 GW in 2020 to 4.2 GW in 2030 and 12.7 GW by 2050.

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Electricity Recommendations

Transmission and distribution system upgrades

- Aggregate level of $84/kW for T&D upgrades.

Managed charging and flexible load

- Examine mitigation scenario with and without managed charging

Equity and inclusion

- Electric sector initiatives related to income class and geographic inclusivity. Electrification for all, community solar, etc.

Electricity: Consistency/Gaps with Committee Priorities

Modeling (existing and w recommendations) provides analytic support evaluation of:

- Expansion of RES from 75% to 100% after 2032
- Greater emphasis of in state electric resources
- Emphasize that CAP is not a substitute for more detailed electric sector planning.

Observations and Next Steps

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Observations

Vermont level of analysis and modeling is admirable

Tale of two states.

Discussion and Framing of Varied Approach by Sector

Clean Heat Standard Credits – Cap and Invest TCI-P.

Timeline

Project Tasks & Deliverables	9-Aug	16-Aug	23-Aug	30-Aug	6-Sep	13-Sep	20-Sep	27-Sep	4-Oct	11-Oct	18-Oct	25-Oct	1-Nov	8-Nov	15-Nov
Task 4. Research and Recommend Pathways for Achieving the 2020, 2030, and 2050 GWSA Targets															
Pathway Analysis															
Sector Kickoff Meetings															
Review SEI CEP Model															
Review CSM Pathways															
Pathway LEAP review															
CEP and CAP Analysis CSM presentation															
Sector Analysis Meetings															
LEAP Pathway Integration															
CAP Analysis CSM Presentation															
Draft recommendations															
VCC Presentation															
IMPLAN analysis															
Final recommendations															

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Questions and Discussion

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Thank You!

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