

GLIMPSE:

An integrated assessment model-based tool for
coordinated energy and environmental planning

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Foreword

- Objective of this presentation
 - Introduce the GLIMPSE project and demonstrate its use
 - The demo will walk through an application, giving a sense of both user-friendliness and capabilities
- Intended audience
 - State modelers and analysts interested in tools for facilitating longterm energy and air quality planning
- Additional contributors
 - EPA: Chris Nolte, Tai Wu, and Carol Lenox
 - ORISE participants and fellows: Wenjing Shi, Yang Ou, Samaneh Babaei, and Troy Hottle
- Disclaimers
 - While this material has been cleared for presentation, it does not necessarily reflect the views or policy of the U.S. EPA
 - Results are provided for illustrative purposes only

Abbreviations

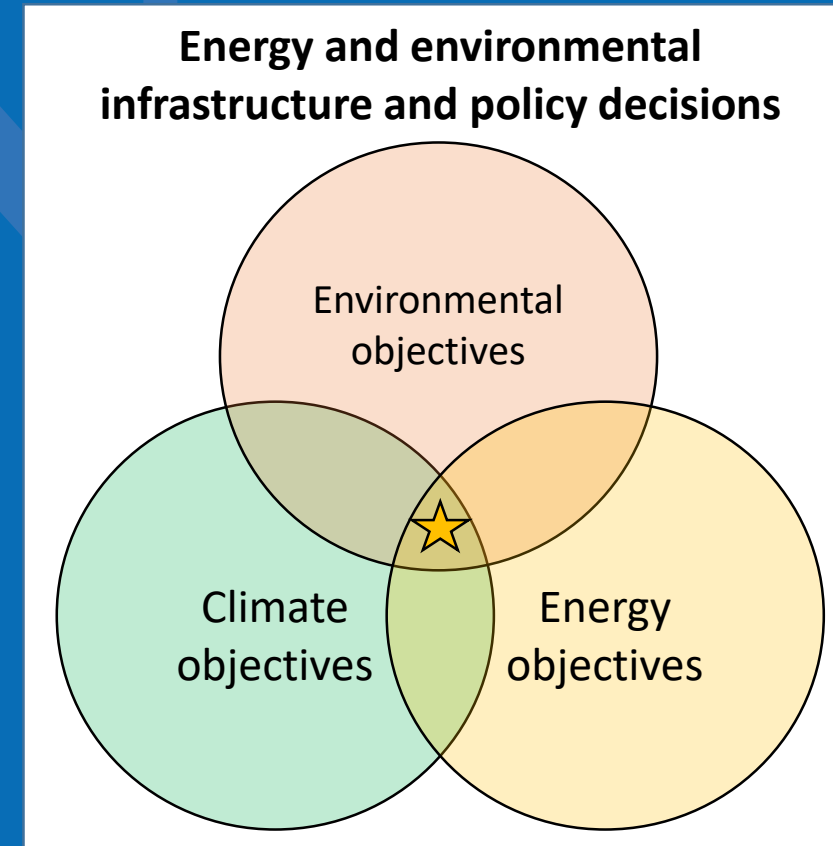
- Greenhouse gases
 - CO₂ – carbon dioxide
 - CH₄ – methane
- Traditional air pollutants
 - NO_x – nitrogen oxides
 - SO₂ – sulfur dioxide
 - CO – carbon monoxide
 - PM – particulate matter
 - PM_{2.5} – PM with a diameter less than 2.5 microns
 - O₃ - ozone
- Policies and regulations
 - CAFE – Corporate Vehicle Efficiency Standard
 - CSAPR – Cross-State Air Pollution Rule
 - RES – Renewable Electricity Standard
- Modeling
 - IAM – Integrated Assessment Model
 - GCAM – Global Change Assessment Model
 - MOVES – MOBILE Vehicle Emissions Simulator
 - IPM – Integrated Planning Model
 - NONROAD – Nonroad mobile source model
- Energy and technologies
 - EGU – Electricity generating unit
 - NG – natural gas
 - BEV – battery electric vehicle
 - FCEV – fuel cell electric vehicle
 - PV - photovoltaic

Outline

- GLIMPSE project objectives
- Background: GCAM and GCAM-USA
- GLIMPSE activities
- Demonstration
- Next steps

GLIMPSE project objectives

- Develop model-based tools for long-term environmental and energy planning
 - Evaluate scenarios (exploring assumptions: technology, policy, socioeconomic, ...)
 - Understand tradeoffs among policy options
 - Identify cost-effective, robust management strategies
- Support decisions at various geo-political scales
 - National
 - Regional
 - State
- Desired attributes
 - Low-cost or free, open source
 - Easy to use
 - Executes on desktop computer
 - Relatively quick

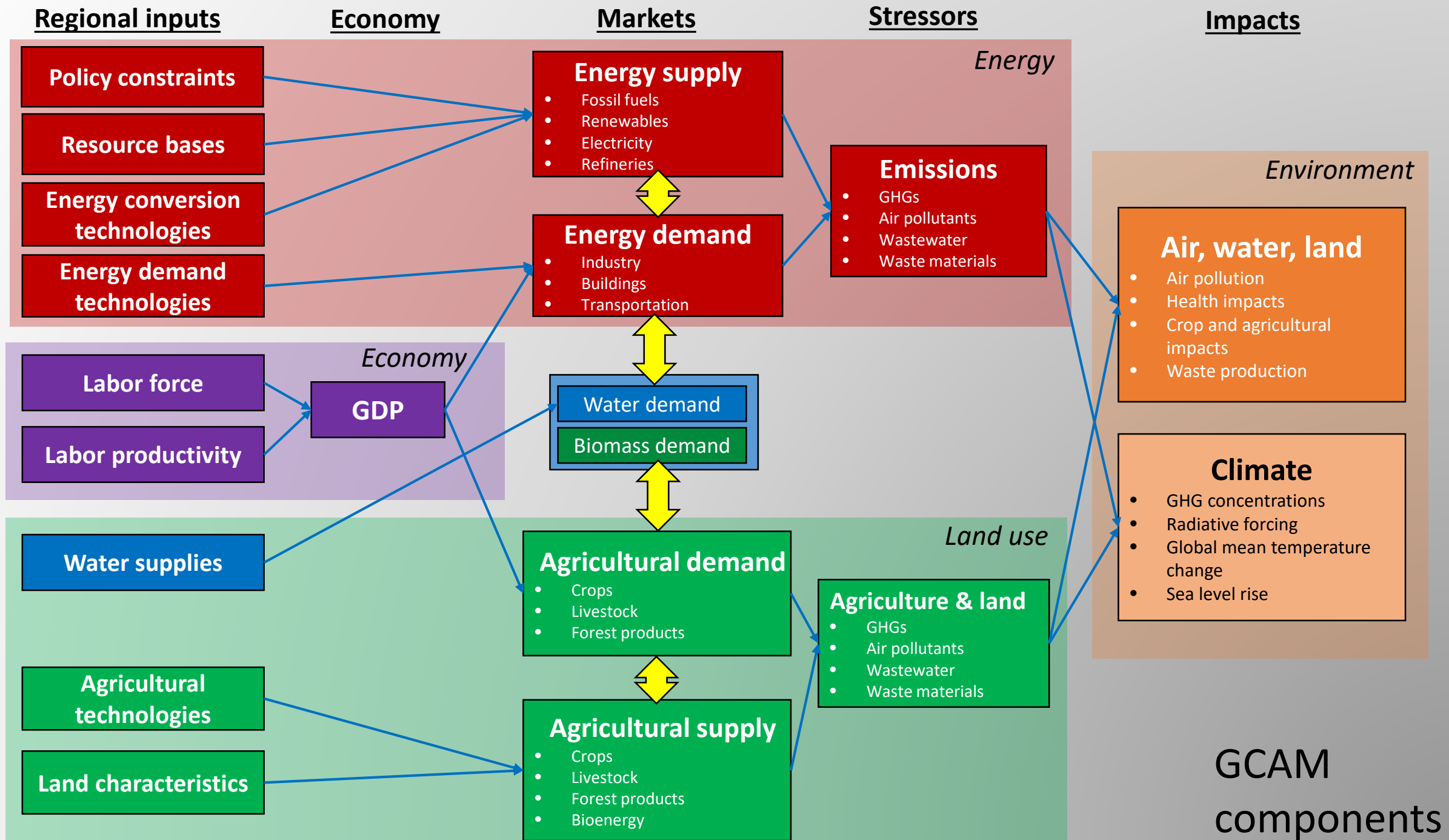


Background

- Several years ago, we learned about PNNL's development of GCAMUSA, a state-level variant of the Global Change Assessment Model (GCAM)
- GCAM:
 - A technology-rich Integrated Assessment Model (IAM)
 - IAMs simulate interactions among human and earth systems
 - Major systems represented in GCAM:



- 30 years of applications, predominantly related to climate change mitigation
- Estimates greenhouse gas (GHG) emissions, but also NO_x, SO₂, CO, PM, NH₃ and other air pollutants
- Global coverage, 32 regions; Time horizon of 2010-2100 in 5 yr steps
- Public domain, open source, requires no proprietary software to run, free
- Runtime of <<1 hour on a typical desktop computer

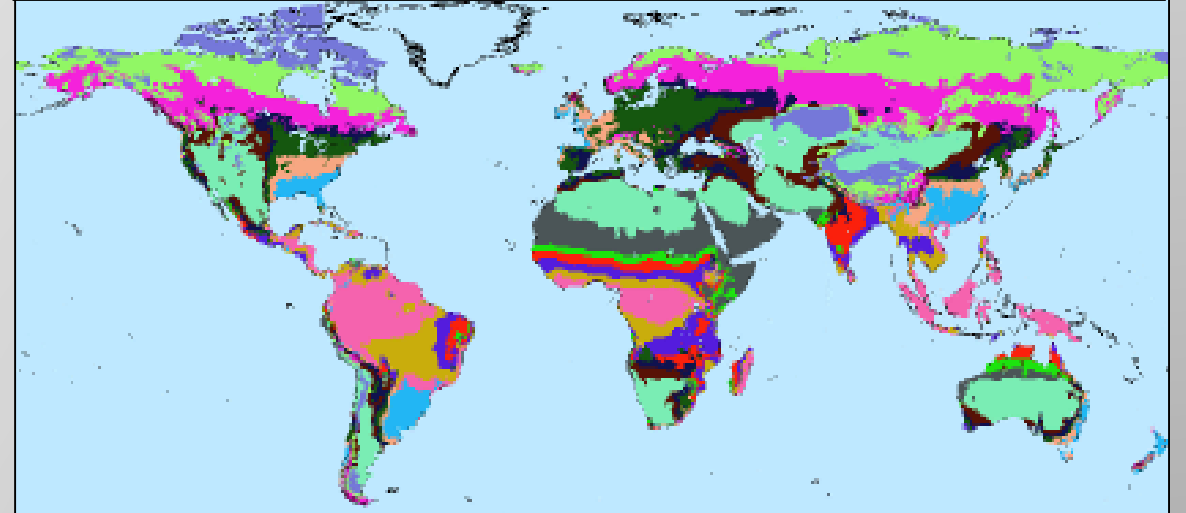


Temporal and spatial resolution

32 economic and energy regions



283 agriculture and land use regions



233 water basins

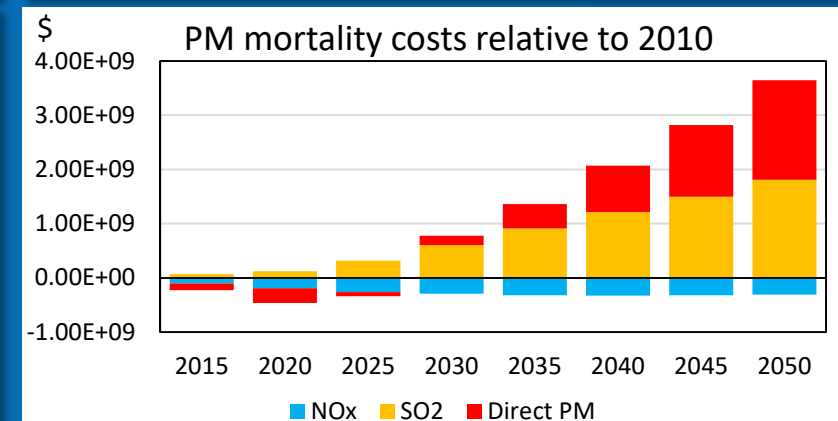
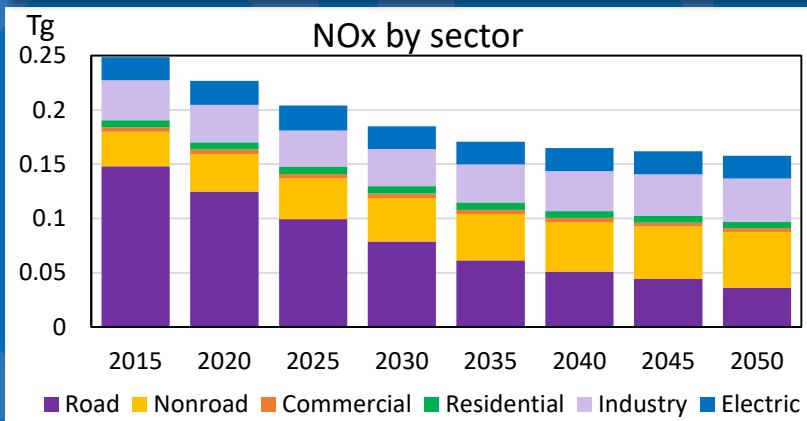
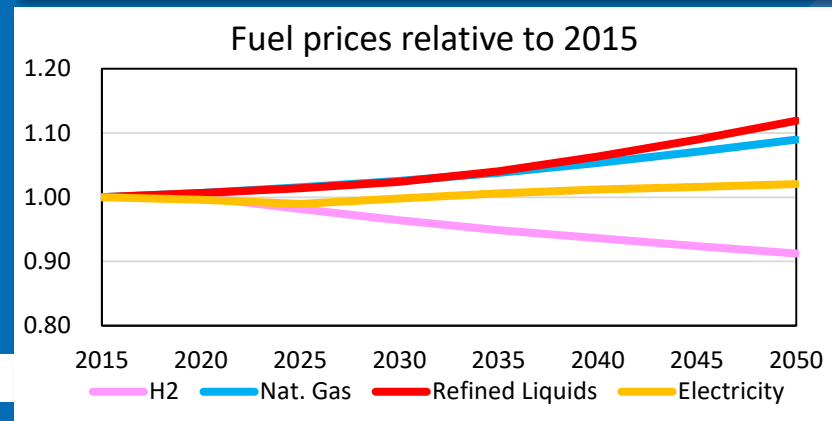
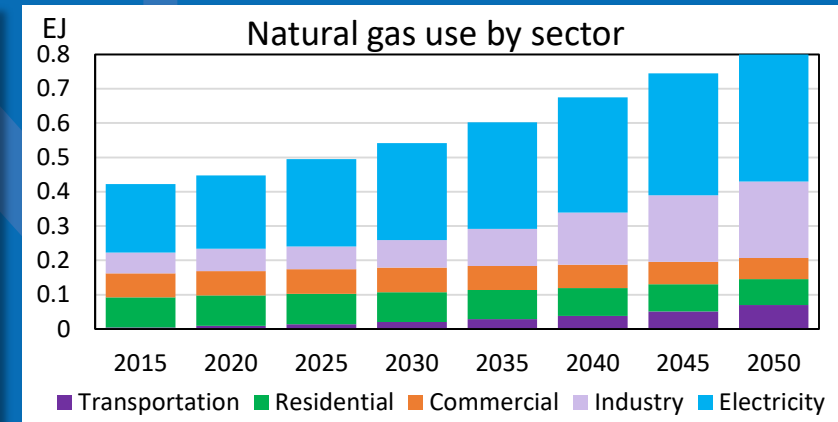
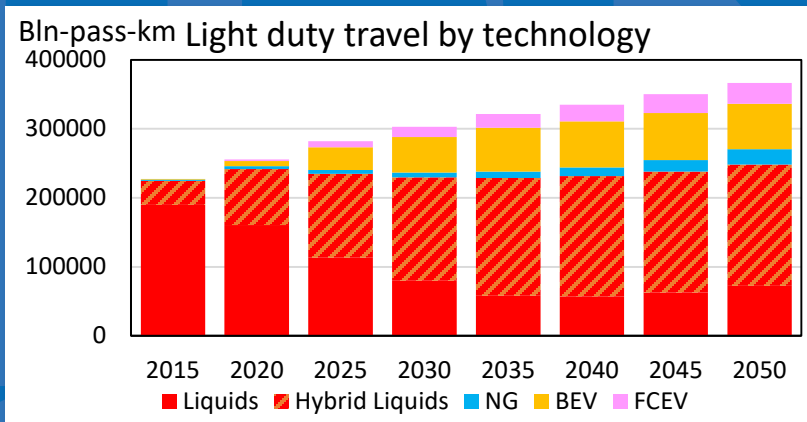
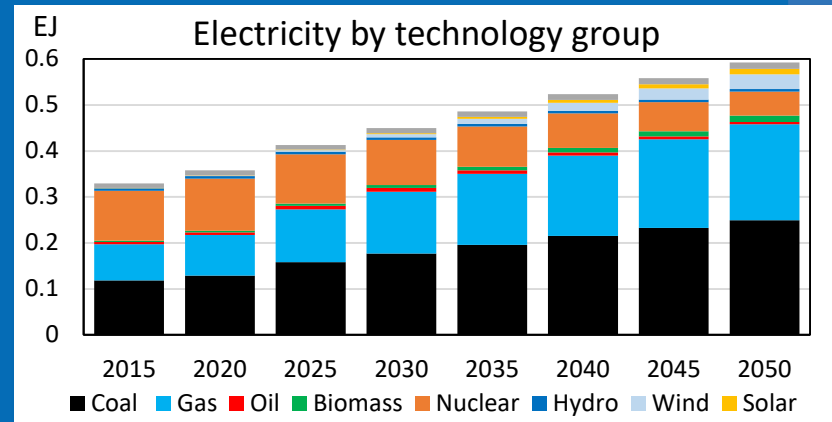


1990 to 2100
5-yr time steps

Background, cont'd

- GCAM-USA:
 - Shares the same code as GCAM
 - Energy system represented at the state level

Example state-level outputs for a scenario of the future (these are for Virginia):



Questions addressed by GCAM-USA

- How would these outputs change if a state, region or the US ...
 - incentivizes vehicle electrification or increases CAFE targets?
 - adopts new biofuel targets?
 - implements a new renewable electricity standard (RES)?
 - sets a target CO₂ reduction goal?
 - implements energy efficiency measures?
- Other things that could be examined include:
 - which technological pathways cost-effectively meet multi-pollutant goals
 - whether or not existing coal and nuclear plant lifetimes are extended
 - implications of wide-spread adoption of advanced technologies
 - effects of drastically lower costs for solar PV, wind, stationary battery storage, or electric vehicles.

GLIMPSE activities

GCAM-USA

Improvements to model

Regulatory representations

- CSAPR
- CAFE
- State-level RES

Emission factors from
MOVES, IPM, NONROAD

Partnering with others

EPA program office beta-testers
of graphical interface

Beginning collaboration with
EPA Region 1 to explore
regional application:

- pathways for meeting state-level air
quality, energy and climate targets

Graphical interface

Developed “Scenario Builder”
to facilitate running the model
and managing results

Modifying existing output tools
for visualizing and analyzing
results

Applications

Effects of alternative population
growth and migration patterns
on energy and emissions

Health effects of alternative
energy pathways

Technology assessment

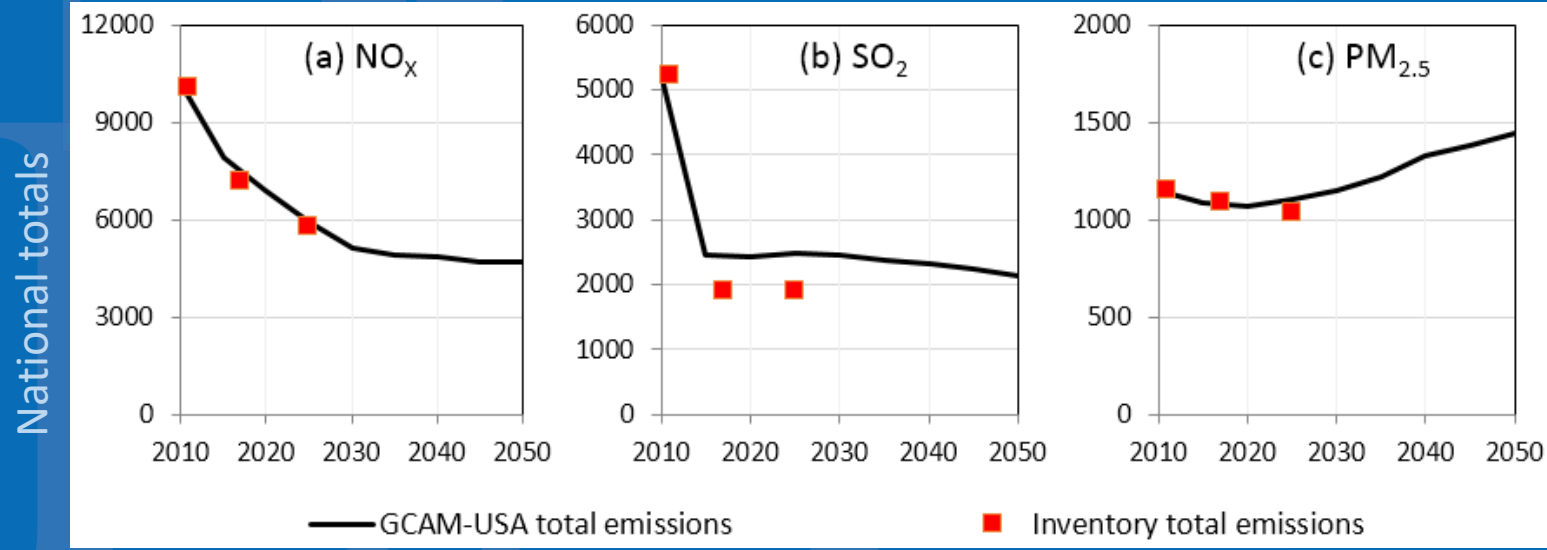
Other activities

Model evaluation: Comparing
national-, state-, and sector-level
emission outputs with the NEI and
EPA projections

Adding impact factors: PM
mortality costs, O₃ damage to
timber and crops, N deposition

Comparison of GCAM-USA emission outputs and EPA inventories

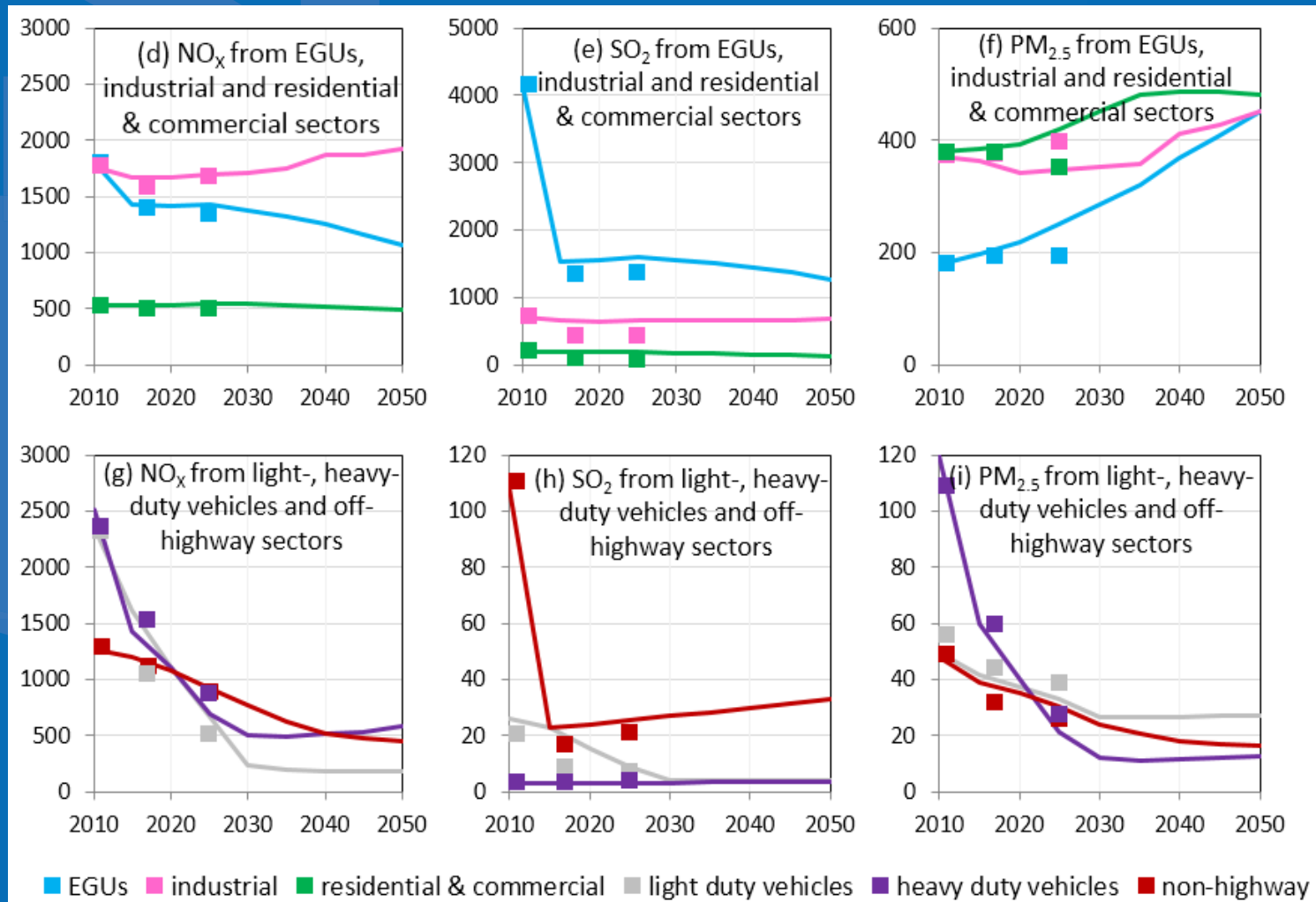
National totals by pollutant



GCAM-USA: Solid lines
EPA inventories: Dots

Comparison of GCAM-USA emission outputs and EPA inventories

National sectoral totals



GCAM-USA: Solid lines
EPA inventories: Dots

Projecting emissions

2010 to 2050 emissions growth and control factors for NO_x

GCAM-USA results can be processed to produce state-, pollutant-, source-category specific growth factors suitable for air quality modeling.

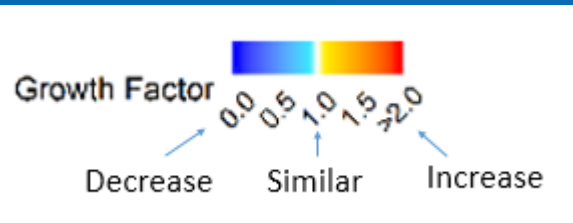
Here, we compare Reference Case factors with those of an alternative energy scenario.

| | | Reference Case | | | Alternative scenario | | |
|-------------|---------------|----------------|------|------|----------------------|------|------|
| Sector | Fuel | CA | OH | TX | CA | OH | TX |
| Electric | Biomass | 0.32 | 6.69 | 0.57 | 0.41 | 5.47 | 0.83 |
| | Coal | 0.20 | 0.43 | 0.33 | 0.17 | 0.35 | 0.32 |
| | Gas | 1.54 | 0.50 | 0.57 | 1.50 | 0.83 | 0.58 |
| | Oil | 1.33 | 1.15 | 1.03 | 1.13 | 0.83 | 1.00 |
| Industrial | Coal | 1.39 | 1.08 | 2.61 | 0.86 | 0.67 | 1.28 |
| | Gas | 1.15 | 0.83 | 1.61 | 1.04 | 0.81 | 1.42 |
| | Oil | 0.79 | 0.52 | 1.47 | 0.72 | 0.50 | 0.96 |
| | Refineries | 0.54 | 0.54 | 0.53 | 0.53 | 0.53 | 0.52 |
| Commercial | Biomass | 1.39 | 0.80 | 1.67 | 1.24 | 0.73 | 1.47 |
| | Gas | 1.44 | 0.70 | 1.44 | 1.39 | 0.69 | 1.38 |
| | Oil | 1.26 | 0.67 | 1.47 | 1.18 | 0.64 | 1.38 |
| Residential | Gas | 1.33 | 0.79 | 1.35 | 1.29 | 0.77 | 1.30 |
| | Oil | 1.61 | 0.88 | 1.73 | 1.54 | 0.85 | 1.64 |
| | Wood | 1.31 | 0.99 | 1.74 | 1.14 | 0.88 | 1.50 |
| Mobile | LDV | 0.06 | 0.04 | 0.06 | 0.06 | 0.04 | 0.06 |
| | HDV | 0.26 | 0.22 | 0.33 | 0.26 | 0.22 | 0.33 |
| | Aircraft | 1.31 | 0.63 | 1.37 | 1.28 | 0.62 | 1.34 |
| | Marine & rail | 1.03 | 0.22 | 0.60 | 0.93 | 0.21 | 0.65 |

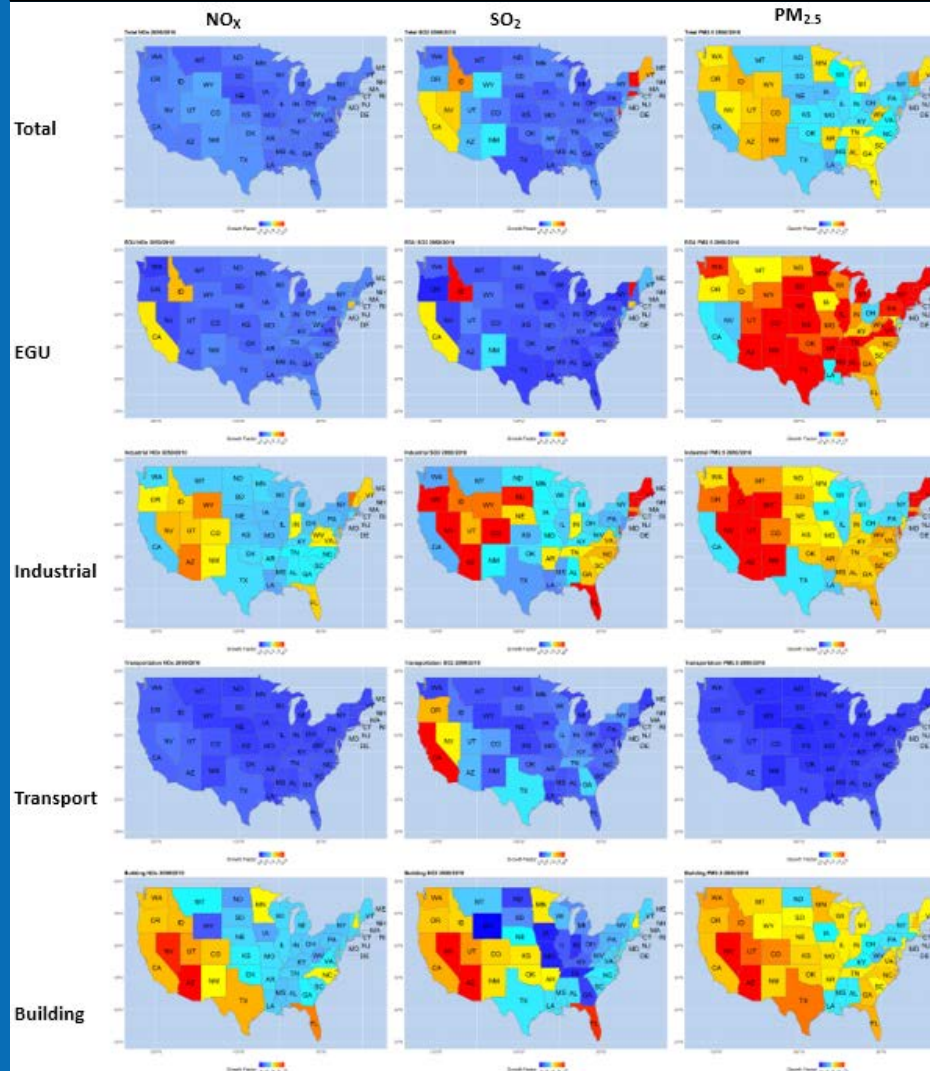
Projecting emissions

State-level 2010 to 2050 growth and control factors

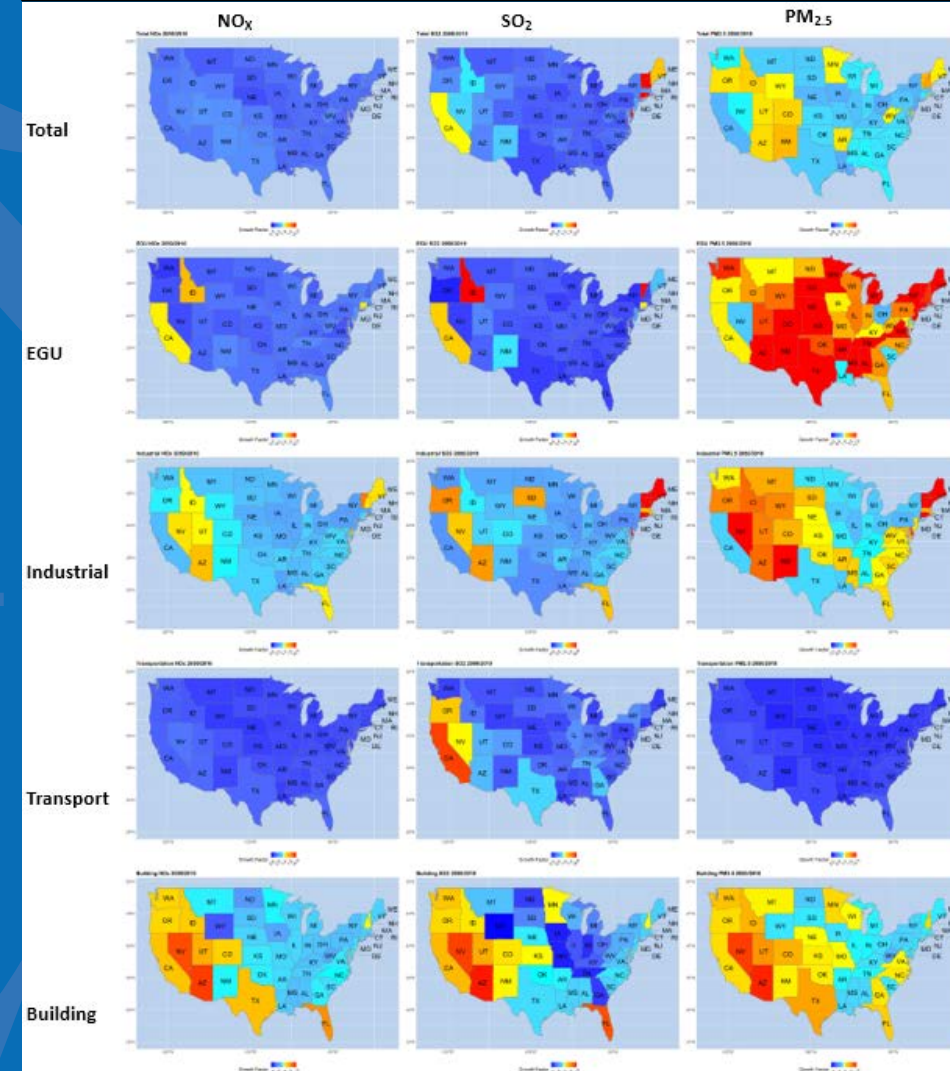
Examining growth and control factors geographically provides some insights into state and regional trends.



Reference case



Alternative scenario

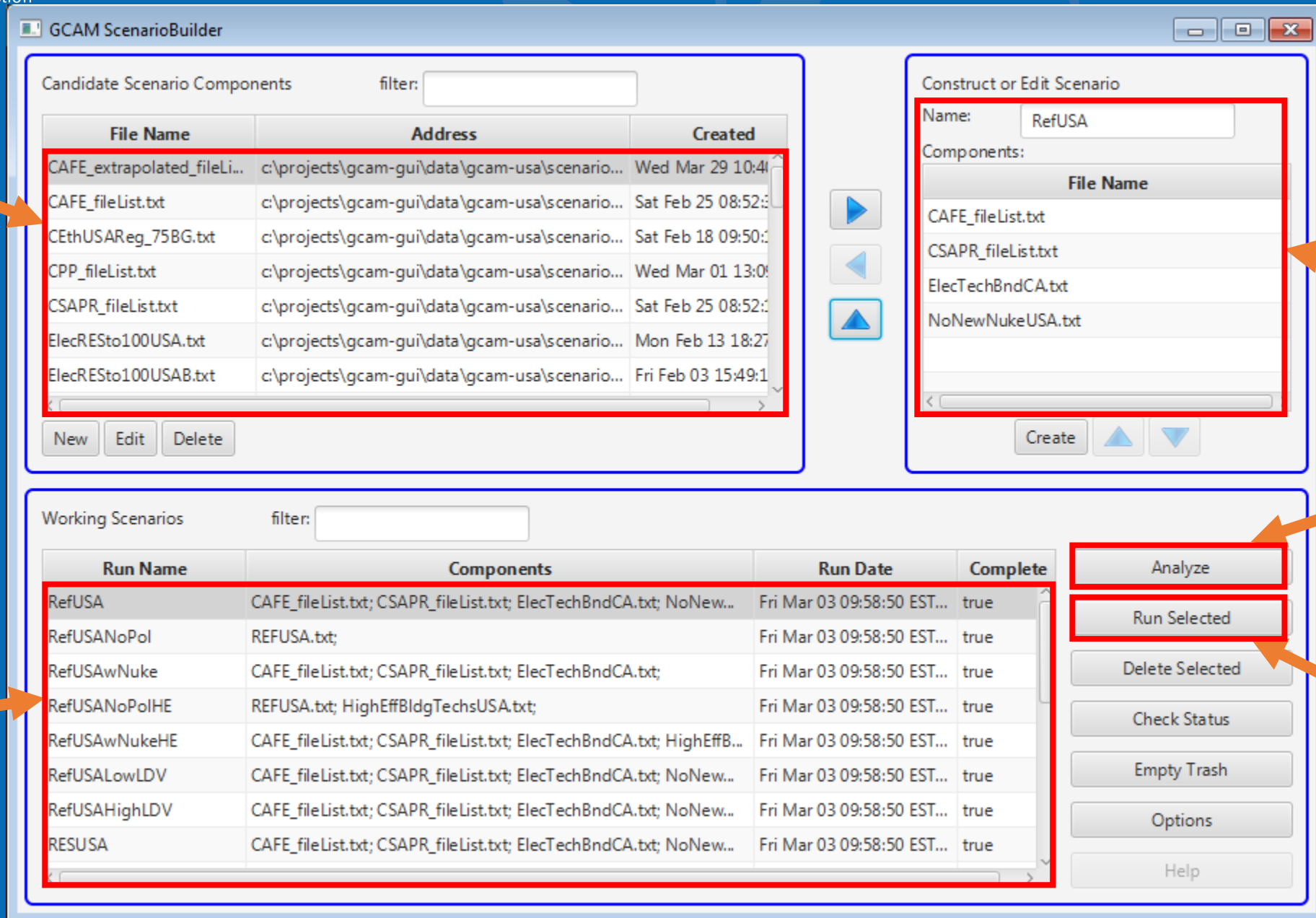


Application: Renewable Electricity Standard (RES)

Hypothetical RES target - percent of electricity generated from new capacity added in that year, applied to each state in the US:

| | | |
|------|---|-----|
| 2020 | - | 30% |
| 2030 | - | 40% |
| 2040 | - | 50% |
| 2050 | - | 60% |

GLIMPSE Scenario Builder



The screenshot shows the GLIMPSE Scenario Builder application window. It is divided into three main sections: 'Candidate Scenario Components', 'Construct or Edit Scenario', and 'Working Scenarios'. Annotations with arrows point to specific features in each section.

Candidate Scenario Components

| File Name | Address | Created |
|-----------------------------|--|--------------------|
| CAFE_extrapolated_fileLi... | c:\projects\gcam-gui\data\gcam-usa\scenario... | Wed Mar 29 10:41 |
| CAFE_fileList.txt | c:\projects\gcam-gui\data\gcam-usa\scenario... | Sat Feb 25 08:52:5 |
| CEthUSAReg_75BG.txt | c:\projects\gcam-gui\data\gcam-usa\scenario... | Sat Feb 18 09:50:5 |
| CPP_fileList.txt | c:\projects\gcam-gui\data\gcam-usa\scenario... | Wed Mar 01 13:08 |
| CSAPR_fileList.txt | c:\projects\gcam-gui\data\gcam-usa\scenario... | Sat Feb 25 08:52:5 |
| ElecRESto100USA.txt | c:\projects\gcam-gui\data\gcam-usa\scenario... | Mon Feb 13 18:27 |
| ElecRESto100USAB.txt | c:\projects\gcam-gui\data\gcam-usa\scenario... | Fri Feb 03 15:49:1 |

Construct or Edit Scenario

Name: RefUSA

Components:

| File Name |
|--------------------|
| CAFE_fileList.txt |
| CSAPR_fileList.txt |
| ElecTechBndCA.txt |
| NoNewNukeUSA.txt |

Working Scenarios

| Run Name | Components | Run Date | Complete |
|---------------|---|----------------------------|----------|
| RefUSA | CAFE_fileList.txt; CSAPR_fileList.txt; ElecTechBndCA.txt; NoNew... | Fri Mar 03 09:58:50 EST... | true |
| RefUSANoPol | REFUSA.txt; | Fri Mar 03 09:58:50 EST... | true |
| RefUSAwNuke | CAFE_fileList.txt; CSAPR_fileList.txt; ElecTechBndCA.txt; | Fri Mar 03 09:58:50 EST... | true |
| RefUSANoPolHE | REFUSA.txt; HighEffBldgTechsUSA.txt; | Fri Mar 03 09:58:50 EST... | true |
| RefUSAwNukeHE | CAFE_fileList.txt; CSAPR_fileList.txt; ElecTechBndCA.txt; HighEffB... | Fri Mar 03 09:58:50 EST... | true |
| RefUSALowLDV | CAFE_fileList.txt; CSAPR_fileList.txt; ElecTechBndCA.txt; NoNew... | Fri Mar 03 09:58:50 EST... | true |
| RefUSAHighLDV | CAFE_fileList.txt; CSAPR_fileList.txt; ElecTechBndCA.txt; NoNew... | Fri Mar 03 09:58:50 EST... | true |
| RESUSA | CAFE_fileList.txt; CSAPR_fileList.txt; ElecTechBndCA.txt; NoNew... | Fri Mar 03 09:58:50 EST... | true |

Annotations:

- Scenario building blocks:** Points to the 'Candidate Scenario Components' table.
- Creating a scenario:** Points to the 'Construct or Edit Scenario' panel.
- Analysis of results:** Points to the 'Analyze' button.
- One-click scenario execution:** Points to the 'Run Selected' button.
- Library of scenarios:** Points to the 'Working Scenarios' table.

GCAM ScenarioBuilder

Candidate Scenario Components filter:

| File Name | Address | Created |
|-----------------------------|--|--------------------|
| CAFE_extrapolated_fileLi... | c:\projects\gcam-gui\data\gcam-usa\scenario... | Wed Mar 29 10:41 |
| CAFE_fileList.txt | c:\projects\gcam-gui\data\gcam-usa\scenario... | Sat Feb 25 08:52:5 |
| CEthUSAREg_75BG.txt | c:\projects\gcam-gui\data\gcam-usa\scenario... | Sat Feb 18 09:50:1 |
| CPP_fileList.txt | c:\projects\gcam-gui\data\gcam-usa\scenario... | Wed Mar 01 13:08 |
| CSAPR_fileList.txt | c:\projects\gcam-gui\data\gcam-usa\scenario... | Sat Feb 25 08:52:5 |
| ElecRESto100USA.txt | c:\projects\gcam-gui\data\gcam-usa\scenario... | Mon Feb 13 18:27 |
| ElecRESto100USAB.txt | c:\projects\gcam-gui\data\gcam-usa\scenario... | Fri Feb 03 15:49:1 |

New Edit Delete

Construct or Edit Scenario

Name:

Components:

| File Name |
|--------------------|
| CAFE_fileList.txt |
| CSAPR_fileList.txt |
| ElecTechBndCA.txt |
| NoNewNukeUSA.txt |

Create

Existing Scenarios filter:

| Run Name | Components | Run Date | Complete |
|---------------|---|----------------------------|----------|
| RefUSA | CAFE_fileList.txt; CSAPR_fileList.txt; ElecTechBndCA.txt; NoNew... | Fri Mar 03 09:58:50 EST... | true |
| RefUSANoPol | REFUSA.txt; | Fri Mar 03 09:58:50 EST... | true |
| RefUSAwNuke | CAFE_fileList.txt; CSAPR_fileList.txt; ElecTechBndCA.txt; | Fri Mar 03 09:58:50 EST... | true |
| RefUSANoPolHE | REFUSA.txt; HighEffBldgTechsUSA.txt; | Fri Mar 03 09:58:50 EST... | true |
| RefUSAwNukeHE | CAFE_fileList.txt; CSAPR_fileList.txt; ElecTechBndCA.txt; HighEffB... | Fri Mar 03 09:58:50 EST... | true |
| RefUSALowLDV | CAFE_fileList.txt; CSAPR_fileList.txt; ElecTechBndCA.txt; NoNew... | Fri Mar 03 09:58:50 EST... | true |
| RefUSAHighLDV | CAFE_fileList.txt; CSAPR_fileList.txt; ElecTechBndCA.txt; NoNew... | Fri Mar 03 09:58:50 EST... | true |
| RESUSA | CAFE_fileList.txt; CSAPR_fileList.txt; ElecTechBndCA.txt; NoNew... | Fri Mar 03 09:58:50 EST... | true |

Analyze

Run Selected

Delete Selected

Check Status

Empty Trash

Options

Help

New Scenario Component

Preset

Tech Bound

XML List

Component:

Action: Emission Cap (Mt)

Sector: System Wide

Parameter: NOx

Populate:

Type: Initial w/% Growth

Start Year: 2020

End Year: 2100

Initial Amount:

Growth (%):

Values: Populate Delete Clear

| Year | Value |
|---------------------|-------|
| No content in table | |

Add

Applied to:

▶

☐ world

Save

Close

New Scenario Component

PresetTech BoundXML List

Component:

Action:

Emission Cap (Mt)

Sector:

Emission Cap (Mt)

Parameter:

Emission Tax (\$/t)

Populate:

Renewable Elec Std (%)

Type:

Cell Ethanol Shock (EJ)

Initial w/% Growth

Start Year:

2020

End Year:

2100

Initial Amount:

Growth (%):

Values:

PopulateDeleteClear

| Year | Value |
|---------------------|-------|
| No content in table | |

Add

Applied to:

▶

☐ world

SaveClose

New Scenario Component

Preset

Tech Bound

XML List

Component:

Action: Renewable Elec Std (%)

Sector: Electric Sector

Parameter: N/A

Populate:

Type: Initial w/% Growth

Start Year: 2020

End Year: 2100

Initial Amount:

Growth (%):

Values:

Populate

Delete

Clear

| Year | Value |
|---------------------|-------|
| No content in table | |

Add

Applied to:

world

Save

Close

New Scenario Component

Preset Tech Bound XML List

Component:

Action: Renewable Elec Std (%)

Sector: Electric Sector

Parameter: N/A

Populate:

Type: Initial w/% Growth

Start Year: Initial w/% Growth

End Year: Initial w/Delta

Initial Amount: Initial and Final

Growth: Table w/% Change

Table w/Delta

Values: Populate Delete Clear

| Year | Value |
|---------------------|-------|
| No content in table | |

Applied to:

world

Add

Save Close

New Scenario Component

PresetTech BoundXML List

Component:

Action:Renewable Elec Std (%)

Sector:Electric Sector

Parameter:N/A

Populate:

Type:Initial and Final

Start Year:2020

End Year:2100

Initial Amount:

Final Amount:

Values:PopulateDeleteClear

| Year | Value |
|---------------------|-------|
| No content in table | |

Add

Applied to:

▶

☐ world

SaveClose

New Scenario Component

Preset

Tech Bound

XML List

Component:

Action: Renewable Elec Std (%)

Sector: Electric Sector

Parameter: N/A

Populate:

Type: Initial and Final

Start Year: 2020

End Year: 2050

Initial Amount:

Final Amount:

Values:

Populate

Delete

Clear

| Year | Value |
|---------------------|-------|
| No content in table | |

Add

Applied to:

world

Save

Close

New Scenario Component

Preset Tech Bound XML List

Component:

Action: Renewable Elec Std (%)

Sector: Electric Sector

Parameter: N/A

Populate:

Type: Initial and Final

Start Year: 2020

End Year: 2050

Initial Amount: 30

Final Amount:

Values: Populate Delete Clear


| Year | Value |
|---------------------|-------|
| No content in table | |

Applied to:

▶ ☐ world

Add

Save Close



New Scenario Component

Preset

Tech Bound

XML List

Component:

Action: Renewable Elec Std (%)

Sector: Electric Sector

Parameter: N/A

Populate:

Type: Initial and Final

Start Year: 2020

End Year: 2050

Initial Amount: 30

Final Amount: 60

Values:

Populate

Delete

Clear

| | Value |
|---------------------|-------|
| No content in table | |

Add

Applied to:

▶

☐ world

Save

Close

New Scenario Component

Preset Tech Bound XML List

Component:

Action: Renewable Elec Std (%)

Sector: Electric Sector

Parameter: N/A

Populate:

Type: Initial and Final

Start Year: 2020

End Year: 2050

Initial Amount: 30

Final Amount: 60

Values: Populate Delete Clear

| Year | Value |
|------|-------|
| 2020 | 30.00 |
| 2025 | 35.00 |
| 2030 | 40.00 |
| 2035 | 45.00 |
| 2040 | 50.00 |
| 2045 | 55.00 |
| 2050 | 60.00 |
| | |
| | |
| | |

Applied to: ☐ world

Save Close

New Scenario Component

Preset

Tech Bound

XML List

Component:

Action: Renewable Elec Std (%)

Sector: Electric Sector

Parameter: N/A

Populate:

Type: Initial and Final

Start Year: 2020

End Year: 2050

Initial Amount: 30

Final Amount: 60

Values:

Populate

Delete

Clear

| Year | Value |
|------|-------|
| 2020 | 30.00 |
| 2025 | 35.00 |
| 2030 | 40.00 |
| 2035 | 45.00 |
| 2040 | 50.00 |
| 2045 | 55.00 |
| 2050 | 60.00 |
| | |
| | |
| | |

<

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Add

Applied to:

world

USA

AL

AK

AZ

AR

CA

CO

CT

DE

DC

FL

GA

HI

Save

Close

New Scenario Component

Preset Tech Bound XML List

Component:

Action: Renewable Elec Std (%)

Sector: Electric Sector

Parameter: N/A

Populate:

Type: Initial and Final

Start Year: 2020

End Year: 2050

Initial Amount: 30

Final Amount: 60

Values: Populate Delete Clear

| Year | Value |
|------|-------|
| 2020 | 30.00 |
| 2025 | 35.00 |
| 2030 | 40.00 |
| 2035 | 45.00 |
| 2040 | 50.00 |
| 2045 | 55.00 |
| 2050 | 60.00 |
| | |
| | |
| | |
| | |

Applied to:

- world
 - ☒ USA
 - ☒ AL
 - ☒ AK
 - ☒ AZ
 - ☒ AR
 - ☒ CA
 - ☒ CO
 - ☒ CT
 - ☒ DE
 - ☒ DC
 - ☒ FL
 - ☒ GA
 - ☒ HI

Save Close

GCAM ScenarioBuilder

Candidate Scenario Components

filter:

| File Name | Address | Created |
|-----------------------|--|-----------------------|
| SysTaxCO2Reg2.txt | c:\projects\gcam-gui\data\gcam-usa\scenario... | Mon Feb 13 18:28:02 |
| SysTaxCO2Reg_NE20... | c:\projects\gcam-gui\data\gcam-usa\scenario... | Wed May 10 14:51:01 |
| TechBnd_CA_HFCV.txt | c:\projects\gcam-gui\data\gcam-usa\scenario... | Tue Mar 28 10:33:13 |
| TechBnd_CA_LDVCon... | c:\projects\gcam-gui\data\gcam-usa\scenario... | Tue Mar 28 11:28:22 |
| TechBnd_CA_LDVEon... | c:\projects\gcam-gui\data\gcam-usa\scenario... | Tue Mar 28 10:31:41 |
| TechBnd_USA_LDVEo... | c:\projects\gcam-gui\data\gcam-usa\scenario... | Fri Apr 28 08:04:38 E |
| ElecRES_USA_30-60_... | C:\Projects\GCAM-GUI\data\GCAM-USA\Scen... | Wed May 17 08:21:41 |

New

Edit

Delete

Construct or Edit Scenario

Name:

Components:

| File Name |
|---------------------|
| No content in table |

Create

▲

▼

Working Scenarios

filter:

| Run Name | Components | Run Date | Complete |
|------------------|---|----------------------------|----------|
| RefUSA | CAFE_fileList.txt; CSAPR_fileList.txt; ElecTechBndCA.txt; NoNew... | Mon May 01 16:26:06 E... | true |
| RefUSANoPol | REFUSA.txt; | Fri Mar 03 09:58:50 EST... | true |
| RefUSANoPolwNuke | CAFE_fileList.txt; CSAPR_fileList.txt; ElecTechBndCA.txt; | Fri Mar 03 09:58:50 EST... | true |
| RefUSANoPolHE | REFUSA.txt; HighEffBldgTechsUSA.txt; | Fri Mar 03 09:58:50 EST... | true |
| RefUSAwNukeHE | CAFE_fileList.txt; CSAPR_fileList.txt; ElecTechBndCA.txt; HighEffB... | Fri Mar 03 09:58:50 EST... | true |
| RefUSALowLDV | CAFE_fileList.txt; CSAPR_fileList.txt; ElecTechBndCA.txt; NoNew... | Fri Mar 03 09:58:50 EST... | true |
| RefUSAHighLDV | CAFE_fileList.txt; CSAPR_fileList.txt; ElecTechBndCA.txt; NoNew... | Fri Mar 03 09:58:50 EST... | true |
| RESUSA | CAFE_fileList.txt; CSAPR_fileList.txt; ElecTechBndCA.txt; NoNew... | Fri Mar 03 09:58:50 EST... | true |

Analyze

Run Selected

Delete Selected

Check Status

Empty Trash

Options

Help

GCAM ScenarioBuilder

Candidate Scenario Components

filter:

| File Name | Address | Created |
|-----------------------|--|-----------------------|
| SysTaxCO2Reg2.txt | c:\projects\gcam-gui\data\gcam-usa\scenario... | Mon Feb 13 18:28:02 |
| SysTaxCO2Reg_NE20... | c:\projects\gcam-gui\data\gcam-usa\scenario... | Wed May 10 14:51:0 |
| TechBnd_CA_HFCV.txt | c:\projects\gcam-gui\data\gcam-usa\scenario... | Tue Mar 28 10:33:13 |
| TechBnd_CA_LDVCon... | c:\projects\gcam-gui\data\gcam-usa\scenario... | Tue Mar 28 11:28:22 |
| TechBnd_CA_LDVEon... | c:\projects\gcam-gui\data\gcam-usa\scenario... | Tue Mar 28 10:31:41 |
| TechBnd_USA_LDVEo... | c:\projects\gcam-gui\data\gcam-usa\scenario... | Fri Apr 28 08:04:38 E |
| ElecRES_USA_30-60_... | C:\Projects\GCAM-GUI\data\GCAM-USA\Scen... | Wed May 17 08:21:4 |

New

Edit

Delete

Construct or Edit Scenario

Name:

Components:

File Name

No content in table

Create

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Working Scenarios

filter:

| Run Name | Components | Run Date | Complete |
|---------------|---|----------------------------|----------|
| RefUSA | CAFE_fileList.txt; CSAPR_fileList.txt; ElecTechBndCA.txt; NoNew... | Mon May 01 16:26:06 E... | true |
| RefUSANoPol | REFUSA.txt; | Fri Mar 03 09:58:50 EST... | true |
| RefUSAwNuke | CAFE_fileList.txt; CSAPR_fileList.txt; ElecTechBndCA.txt; | Fri Mar 03 09:58:50 EST... | true |
| RefUSANoPolHE | REFUSA.txt; HighEffBldgTechsUSA.txt; | Fri Mar 03 09:58:50 EST... | true |
| RefUSAwNukeHE | CAFE_fileList.txt; CSAPR_fileList.txt; ElecTechBndCA.txt; HighEffB... | Fri Mar 03 09:58:50 EST... | true |
| RefUSALowLDV | CAFE_fileList.txt; CSAPR_fileList.txt; ElecTechBndCA.txt; NoNew... | Fri Mar 03 09:58:50 EST... | true |
| RefUSAHighLDV | CAFE_fileList.txt; CSAPR_fileList.txt; ElecTechBndCA.txt; NoNew... | Fri Mar 03 09:58:50 EST... | true |
| RESUSA | CAFE_fileList.txt; CSAPR_fileList.txt; ElecTechBndCA.txt; NoNew... | Fri Mar 03 09:58:50 EST... | true |

Analyze

Run Selected

Delete Selected

Check Status

Empty Trash

Options

Help

GCAM ScenarioBuilder

Candidate Scenario Components

filter:

| File Name | Address | Created |
|-----------------------|--|-----------------------|
| SysTaxCO2Reg2.txt | c:\projects\gcam-gui\data\gcam-usa\scenario... | Mon Feb 13 18:28:02 |
| SysTaxCO2Reg_NE20... | c:\projects\gcam-gui\data\gcam-usa\scenario... | Wed May 10 14:51:0 |
| TechBnd_CA_HFCV.txt | c:\projects\gcam-gui\data\gcam-usa\scenario... | Tue Mar 28 10:33:13 |
| TechBnd_CA_LDVCon... | c:\projects\gcam-gui\data\gcam-usa\scenario... | Tue Mar 28 11:28:22 |
| TechBnd_CA_LDVEon... | c:\projects\gcam-gui\data\gcam-usa\scenario... | Tue Mar 28 10:31:41 |
| TechBnd_USA_LDVEo... | c:\projects\gcam-gui\data\gcam-usa\scenario... | Fri Apr 28 08:04:38 E |
| ElecRES_USA_30-60_... | C:\Projects\GCAM-GUI\data\GCAM-USA\Scen... | Wed May 17 08:21:4 |

New

Edit

Delete

Construct or Edit Scenario

Name:

Components:

| File Name |
|--------------------|
| CAFE_fileList.txt |
| CSAPR_fileList.txt |
| ElecTechBndCA.txt |
| NoNewNukeUSA.txt |

Create

Working Scenarios

filter:

| Run Name | Components | Run Date | Complete |
|---------------|---|----------------------------|----------|
| RefUSA | CAFE_fileList.txt; CSAPR_fileList.txt; ElecTechBndCA.txt; NoNew... | Mon May 01 16:26:06 E... | true |
| RefUSANoPol | REFUSA.txt; | Fri Mar 03 09:58:50 EST... | true |
| RefUSAwNuke | CAFE_fileList.txt; CSAPR_fileList.txt; ElecTechBndCA.txt; | Fri Mar 03 09:58:50 EST... | true |
| RefUSANoPolHE | REFUSA.txt; HighEffBldgTechsUSA.txt; | Fri Mar 03 09:58:50 EST... | true |
| RefUSAwNukeHE | CAFE_fileList.txt; CSAPR_fileList.txt; ElecTechBndCA.txt; HighEffB... | Fri Mar 03 09:58:50 EST... | true |
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| RESUSA | CAFE_fileList.txt; CSAPR_fileList.txt; ElecTechBndCA.txt; NoNew... | Fri Mar 03 09:58:50 EST... | true |

Analyze

Run Selected

Delete Selected

Check Status

Empty Trash

Options

Help

GCAM ScenarioBuilder

Candidate Scenario Components

filter:

| File Name | Address | Created |
|-----------------------|--|-----------------------|
| SysTaxCO2Reg2.txt | c:\projects\gcam-gui\data\gcam-usa\scenario... | Mon Feb 13 18:28:02 |
| SysTaxCO2Reg_NE20... | c:\projects\gcam-gui\data\gcam-usa\scenario... | Wed May 10 14:51:0 |
| TechBnd_CA_HFCV.txt | c:\projects\gcam-gui\data\gcam-usa\scenario... | Tue Mar 28 10:33:13 |
| TechBnd_CA_LDVCon... | c:\projects\gcam-gui\data\gcam-usa\scenario... | Tue Mar 28 11:28:22 |
| TechBnd_CA_LDVEon... | c:\projects\gcam-gui\data\gcam-usa\scenario... | Tue Mar 28 10:31:41 |
| TechBnd_USA_LDVEo... | c:\projects\gcam-gui\data\gcam-usa\scenario... | Fri Apr 28 08:04:38 E |
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New

Edit

Delete

Construct or Edit Scenario

Name:

Comp

| File Name |
|---------------------------------|
| CAFE_fileList.txt |
| CSAPR_fileList.txt |
| ElecTechBndCA.txt |
| NoNewNukeUSA.txt |
| ElecRES_USA_30-60_2020-2050.txt |

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Working Scenarios

filter:

| Run Name | Components | Run Date | Complete |
|---------------|---|----------------------------|----------|
| RefUSA | CAFE_fileList.txt; CSAPR_fileList.txt; ElecTechBndCA.txt; NoNew... | Mon May 01 16:26:06 E... | true |
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| RESUSA | CAFE_fileList.txt; CSAPR_fileList.txt; ElecTechBndCA.txt; NoNew... | Fri Mar 03 09:58:50 EST... | true |

Analyze

Run Selected

Delete Selected

Check Status

Empty Trash

Options

Help

GCAM ScenarioBuilder

Candidate Scenario Components

filter:

| File Name | Address | Created |
|----------------------|--|-----------------------|
| SysTaxCO2Reg2.txt | c:\projects\gcam-gui\data\gcam-usa\scenario... | Mon Feb 13 18:28:02 |
| SysTaxCO2Reg_NE20... | c:\projects\gcam-gui\data\gcam-usa\scenario... | Wed May 10 14:51:0 |
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| TechBnd_CA_LDVCon... | c:\projects\gcam-gui\data\gcam-usa\scenario... | Tue Mar 28 11:28:22 |
| TechBnd_CA_LDVEon... | c:\projects\gcam-gui\data\gcam-usa\scenario... | Tue Mar 28 10:31:41 |
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Edit

Delete

Construct or Edit Scenario

Name:

Components:

| File Name |
|---------------------------------|
| CAFE_fileList.txt |
| CSAPR_fileList.txt |
| ElecTechBndCA.txt |
| NoNewNukeUSA.txt |
| ElecRES_USA_30-60_2020-2050.txt |

Create

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| Run Name | Components | Run Date | Complete |
|---------------|---|----------------------------|----------|
| RefUSA | CAFE_fileList.txt; CSAPR_fileList.txt; ElecTechBndCA.txt; NoNew... | Mon May 01 16:26:06 E... | true |
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| RefUSAwNukeHE | CAFE_fileList.txt; CSAPR_fileList.txt; ElecTechBndCA.txt; HighEffB... | Fri Mar 03 09:58:50 EST... | true |
| RefUSALowLDV | CAFE_fileList.txt; CSAPR_fileList.txt; ElecTechBndCA.txt; NoNew... | Fri Mar 03 09:58:50 EST... | true |
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Candidate Scenario Components

filter:

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|-----------------------|--|-----------------------|
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| ElecRES_USA_30-60_... | C:\Projects\GCAM-GUI\data\GCAM-USA\Scen... | Wed May 17 08:21:4 |

New

Edit

Delete

Construct or Edit Scenario

Name:

Components:

| File Name |
|---------------------------------|
| CAFE_fileList.txt |
| CSAPR_fileList.txt |
| ElecTechBndCA.txt |
| NoNewNukeUSA.txt |
| ElecRES_USA_30-60_2020-2050.txt |

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Working Scenarios

filter:

| Run Name | Components | Run Date | Complete |
|---------------|---|----------------------------|----------|
| RefUSA | CAFE_fileList.txt; CSAPR_fileList.txt; ElecTechBndCA.txt; NoNew... | Mon May 01 16:26:06 E... | true |
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| RefUSALowLDV | CAFE_fileList.txt; CSAPR_fileList.txt; ElecTechBndCA.txt; NoNew... | Fri Mar 03 09:58:50 EST... | true |
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| RESUSA | CAFE_fileList.txt; CSAPR_fileList.txt; ElecTechBndCA.txt; NoNew... | Fri Mar 03 09:58:50 EST... | true |

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GCAM ScenarioBuilder

Candidate Scenario Components

filter:

| File Name | Address | Created |
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| SysTaxCO2Reg2.txt | c:\projects\gcam-gui\data\gcam-usa\scenario... | Mon Feb 13 18:28:02 |
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New

Edit

Delete

Construct or Edit Scenario

Name:

Components:

| File Name |
|---------------------------------|
| CAFE_fileList.txt |
| CSAPR_fileList.txt |
| ElecTechBndCA.txt |
| NoNewNukeUSA.txt |
| ElecRES_USA_30-60_2020-2050.txt |

Create

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Working Scenarios

filter:

| Run Name | Components | Run Date | Complete |
|---------------|---|----------------------------|----------|
| RefUSA | CAFE_fileList.txt; CSAPR_fileList.txt; ElecTechBndCA.txt; NoNew... | Mon May 01 16:26:06 E... | true |
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| RefUSAwNuke | CAFE_fileList.txt; CSAPR_fileList.txt; ElecTechBndCA.txt; | Fri Mar 03 09:58:50 EST... | true |
| RefUSANoPolHE | REFUSA.txt; HighEffBldgTechsUSA.txt; | Fri Mar 03 09:58:50 EST... | true |
| RefUSAwNukeHE | CAFE_fileList.txt; CSAPR_fileList.txt; ElecTechBndCA.txt; HighEffB... | Fri Mar 03 09:58:50 EST... | true |
| RefUSALowLDV | CAFE_fileList.txt; CSAPR_fileList.txt; ElecTechBndCA.txt; NoNew... | Fri Mar 03 09:58:50 EST... | true |
| RefUSAHighLDV | CAFE_fileList.txt; CSAPR_fileList.txt; ElecTechBndCA.txt; NoNew... | Fri Mar 03 09:58:50 EST... | true |
| RESUSA | CAFE_fileList.txt; CSAPR_fileList.txt; ElecTechBndCA.txt; NoNew... | Fri Mar 03 09:58:50 EST... | true |

Analyze

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Options

Help

GCAM ScenarioBuilder

Candidate Scenario Components

filter:

| File Name | Address | Created |
|-----------------------|--|-----------------------|
| SysTaxCO2Reg2.txt | c:\projects\gcam-gui\data\gcam-usa\scenario... | Mon Feb 13 18:28:02 |
| SysTaxCO2Reg_NE20... | c:\projects\gcam-gui\data\gcam-usa\scenario... | Wed May 10 14:51:0 |
| TechBnd_CA_HFCV.txt | c:\projects\gcam-gui\data\gcam-usa\scenario... | Tue Mar 28 10:33:13 |
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| ElecRES_USA_30-60_... | C:\Projects\GCAM-GUI\data\GCAM-USA\Scen... | Wed May 17 08:21:4 |

New

Edit

Delete

Construct or Edit Scenario

Name:

Components:

| File Name |
|---------------------------------|
| CAFE_fileList.txt |
| CSAPR_fileList.txt |
| ElecTechBndCA.txt |
| NoNewNukeUSA.txt |
| ElecRES_USA_30-60_2020-2050.txt |

Create

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Working Scenarios

filter:

| Run Name | Components | Run Date | Complete |
|---------------|---|----------------------------|----------|
| RefUSA | CAFE_fileList.txt; CSAPR_fileList.txt; ElecTechBndCA.txt; NoNew... | Mon May 01 16:26:06 E... | true |
| RefUSANoPol | REFUSA.txt; | Fri Mar 03 09:58:50 EST... | true |
| RefUSAwNuke | CAFE_fileList.txt; CSAPR_fileList.txt; ElecTechBndCA.txt; | Fri Mar 03 09:58:50 EST... | true |
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| RefUSAwNukeHE | CAFE_fileList.txt; CSAPR_fileList.txt; ElecTechBndCA.txt; HighEffB... | Fri Mar 03 09:58:50 EST... | true |
| RefUSALowLDV | CAFE_fileList.txt; CSAPR_fileList.txt; ElecTechBndCA.txt; NoNew... | Fri Mar 03 09:58:50 EST... | true |
| RefUSAHighLDV | CAFE_fileList.txt; CSAPR_fileList.txt; ElecTechBndCA.txt; NoNew... | Fri Mar 03 09:58:50 EST... | true |
| RESUSA | CAFE_fileList.txt; CSAPR_fileList.txt; ElecTechBndCA.txt; NoNew... | Fri Mar 03 09:58:50 EST... | true |

Analyze

Run Selected

Delete Selected

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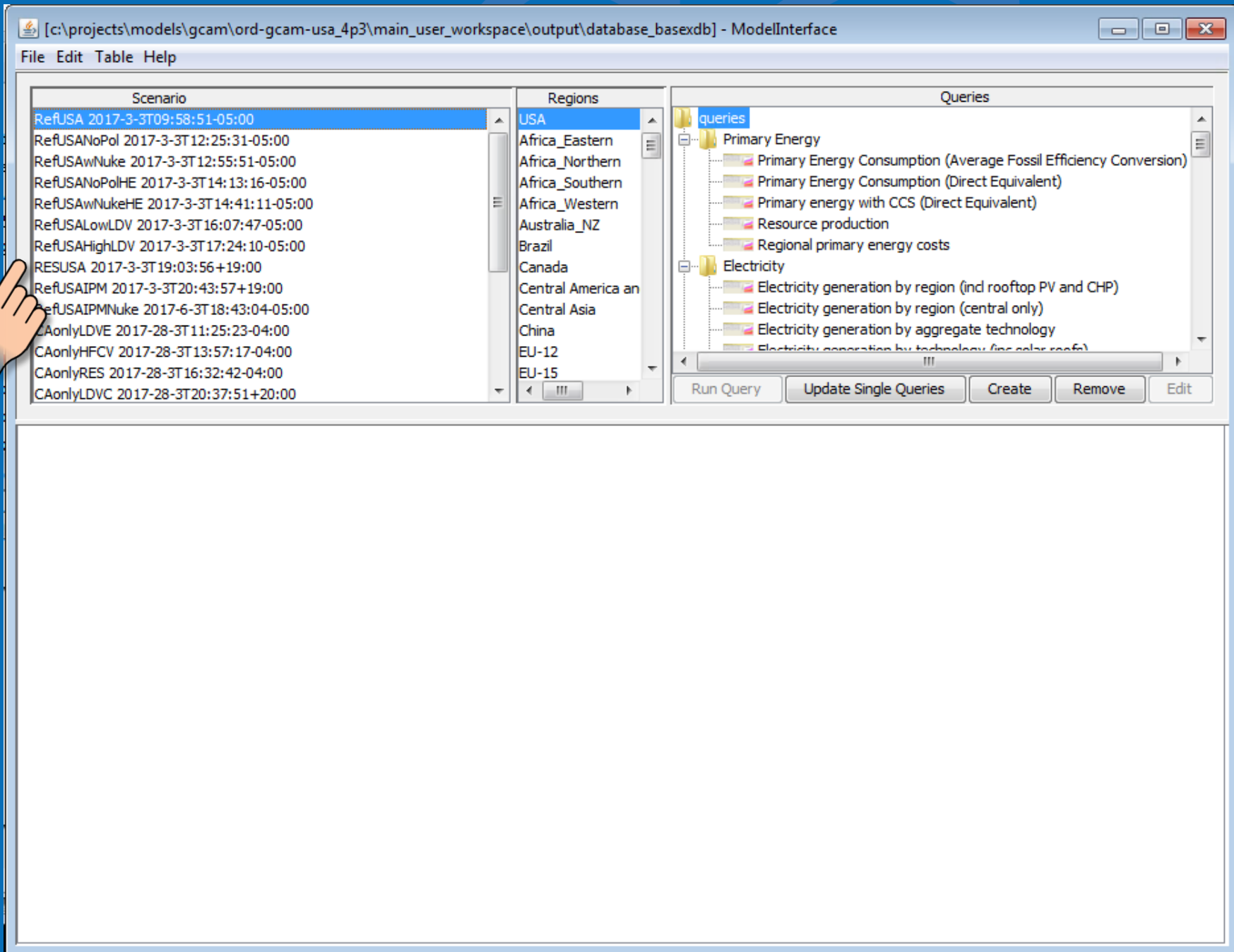
GLIMPSE Enhanced ModelInterface

The screenshot displays the GLIMPSE Enhanced ModelInterface software window. The interface is divided into several panes:

- Scenarios in results database:** A list of scenarios on the left, including RefUSA, RefUSANoPol, RefUSANuke, RefUSANukeHE, RefUSALowLDV, RefUSAHighLDV, RESUSA, RefUSAIPM, RefUSAIPMNuke, CAonlyLDVE, CAonlyHFCV, CAonlyRES, and CAonlyDVC.
- Modeled regions:** A list of regions in the center, including USA, Africa_Eastern, Africa_Northern, Africa_Southern, Africa_Western, Australia_NZ, Brazil, Canada, Central America an, Central Asia, China, EU-12, and EU-15.
- Query results:** A table at the bottom showing electricity generation by aggregate technology for various scenarios and regions. The table has columns for scenario, region, technology, and years from 1990 to 2095, along with units.
- Query visualization:** A chart on the right titled "Electricity generation by aggregate technology" showing output (EJ) over time (Year).
- List of scenario outputs that can be queried:** A tree view on the right showing queries such as Primary Energy, Electricity, and Electricity generation by region.

Annotations with arrows point to these specific features:

- Scenarios in results database
- Modeled regions
- Query results
- Query visualization
- List of scenario outputs that can be queried



[c:\projects\models\gcam\ord-gcam-usa_4p3\main_user_workspace\output\database_basexdb] - ModelInterface

File Edit Table Help

| Scenario | Regions | Queries |
|---------------------------------------|-----------------------------------|---|
| RefUSA 2017-3-3T09:58:51-05:00 | USA | queries |
| RefUSANoPol 2017-3-3T12:25:31-05:00 | Africa_Eastern | Primary Energy |
| RefUSAwNuke 2017-3-3T12:55:51-05:00 | Africa_Northern | Primary Energy Consumption (Average Fossil Efficiency Conversion) |
| RefUSANoPolHE 2017-3-3T14:13:16-05:00 | Africa_South | Primary Energy Consumption (Direct Equivalent) |
| RefUSAwNukeHE 2017-3-3T14:41:11-05:00 | Africa_Western | Primary energy with CCS (Direct Equivalent) |
| RefUSALowLDV 2017-3-3T16:07:47-05:00 | Australia | Resource production |
| RefUSAHighLDV 2017-3-3T17:24:10-05:00 | Brazil | Regional primary energy costs |
| RESUSA 2017-3-3T19:03:56+19:00 | Canada | Electricity |
| RefUSAIPM 2017-3-3T20:43:57+19:00 | Central America and the Caribbean | Electricity generation by region (incl rooftop PV and CHP) |
| RefUSAIPMNuke 2017-6-3T18:43:04-05:00 | Central Asia | Electricity generation by region (central only) |
| CAonlyLDVE 2017-28-3T11:25:23-04:00 | China | Electricity generation by aggregate technology |
| CAonlyHFCV 2017-28-3T13:57:17-04:00 | EU-12 | Electricity generation by technology (incl solar roofs) |
| CAonlyRES 2017-28-3T16:32:42-04:00 | EU-15 | |
| CAonlyLDVC 2017-28-3T20:37:51+20:00 | | |


Run Query Update Single Queries Create Remove Edit

[c:\projects\models\gcam\ord-gcam-usa_4p3\main_user_workspace\output\database_basexdb] - ModelInterface

File Edit Table Help

| Scenario | Regions | Queries |
|---------------------------------------|-----------|---|
| RefUSA 2017-3-3T09:58:51-05:00 | Argentina | queries |
| RefUSANoPol 2017-3-3T12:25:31-05:00 | Colombia | Primary Energy |
| RefUSAwNuke 2017-3-3T12:55:51-05:00 | AL | Primary Energy Consumption (Average Fossil Efficiency Conversion) |
| RefUSANoPolHE 2017-3-3T14:13:16-05:00 | AK | Primary Energy Consumption (Direct Equivalent) |
| RefUSAwNukeHE 2017-3-3T14:41:11-05:00 | AZ | Primary energy with CCS (Direct Equivalent) |
| RefUSALowLDV 2017-3-3T16:07:47-05:00 | AR | Resource production |
| RefUSAHighLDV 2017-3-3T17:24:10-05:00 | CA | Regional primary energy costs |
| RESUSA 2017-3-3T19:03:56+19:00 | CO | Electricity |
| RefUSAIPM 2017-3-3T20:43:57+19:00 | CT | Electricity generation by region (incl rooftop PV and CHP) |
| RefUSAIPMNuke 2017-6-3T18:43:04-05:00 | DE | Electricity generation by region (central only) |
| CAonlyLDVE 2017-28-3T11:25:23-04:00 | DC | Electricity generation by aggregate technology |
| CAonlyHFCV 2017-28-3T13:57:17-04:00 | FL | Electricity generation by technology (incl solar roofs) |
| CAonlyRES 2017-28-3T16:32:42-04:00 | GA | |
| CAonlyLDVC 2017-28-3T20:37:51+20:00 | | |

Run Query Use Queries Create Remove Edit




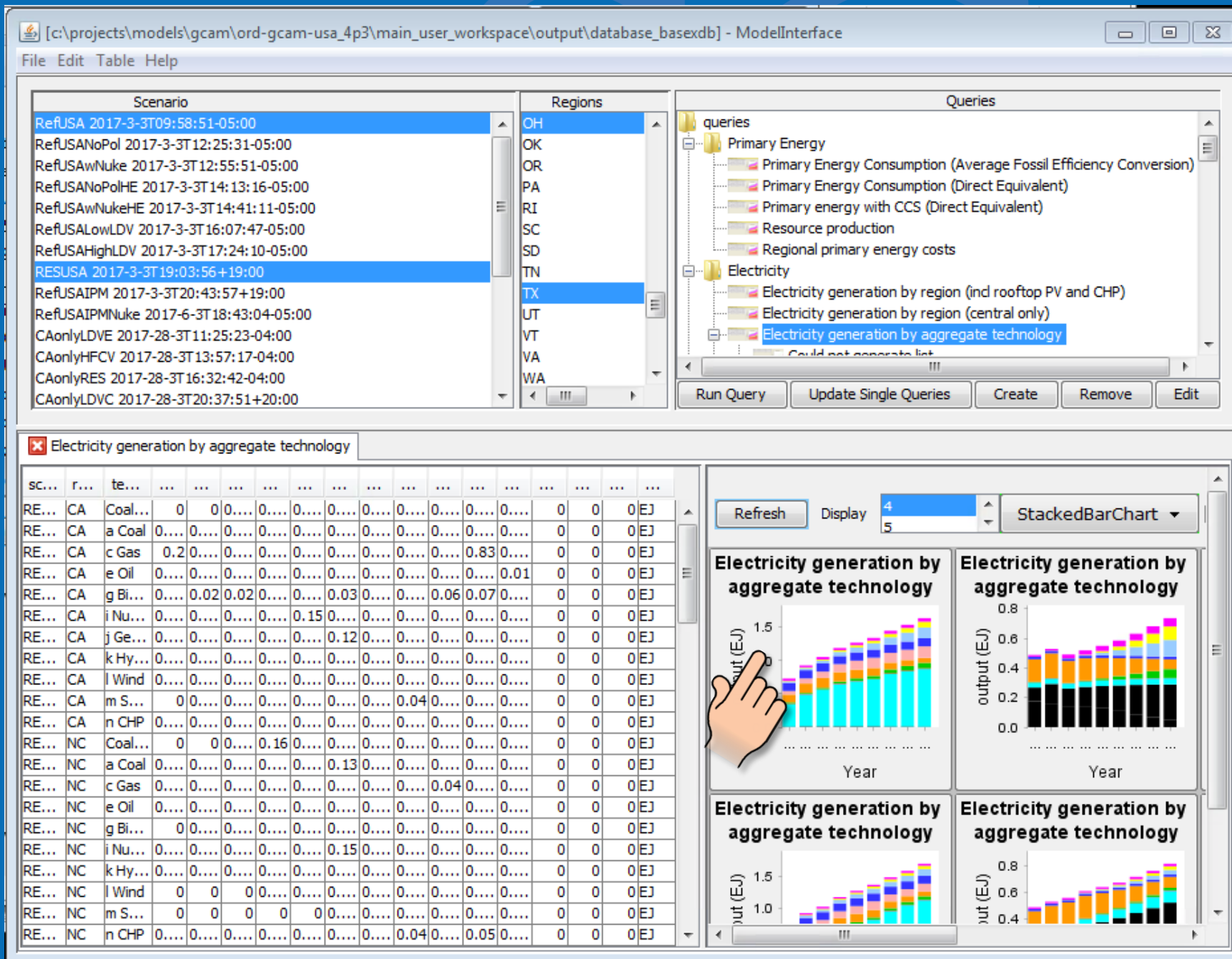
[c:\projects\models\gcam\ord-gcam-usa_4p3\main_user_workspace\output\database_basexdb] - ModelInterface

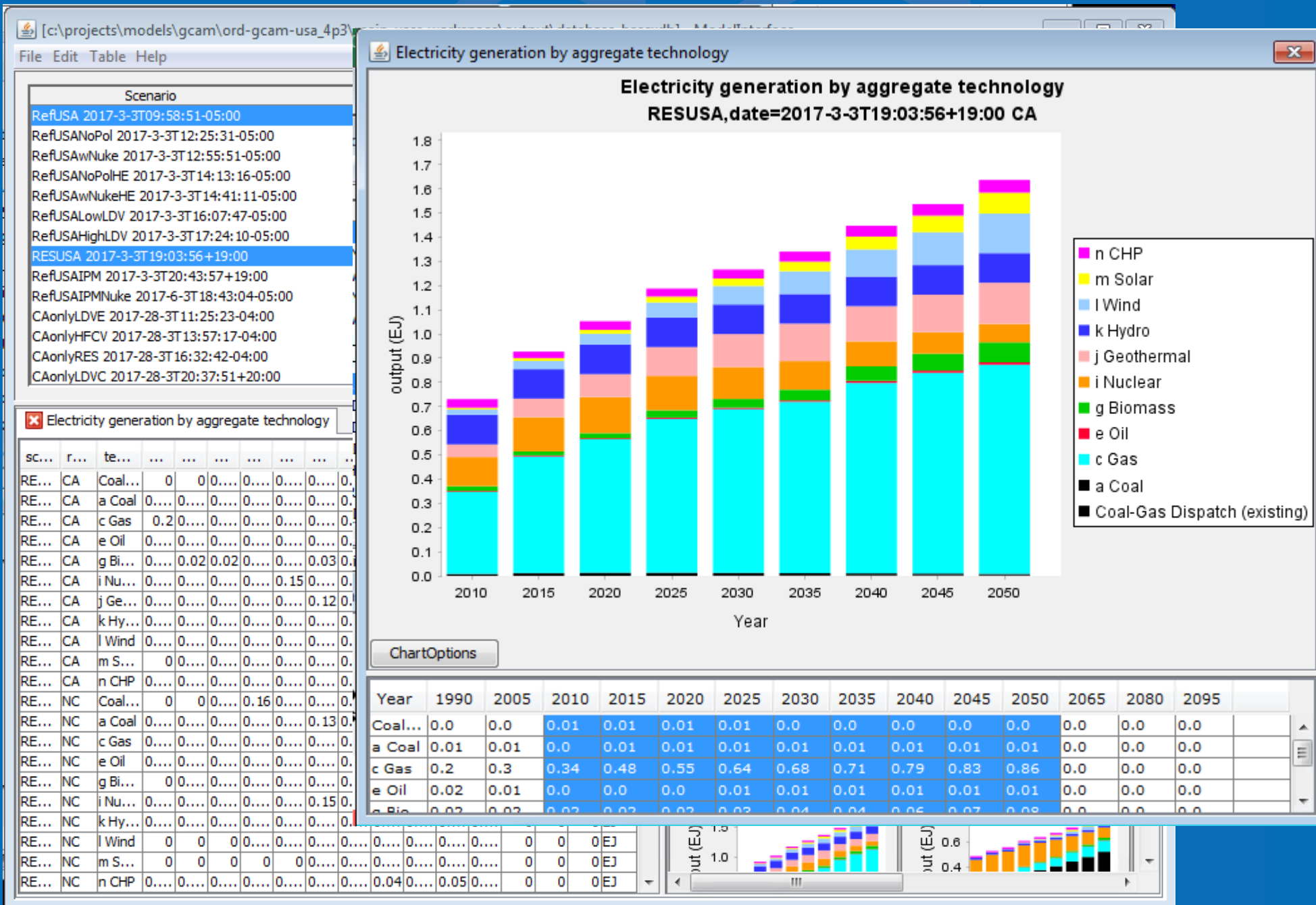
File Edit Table Help

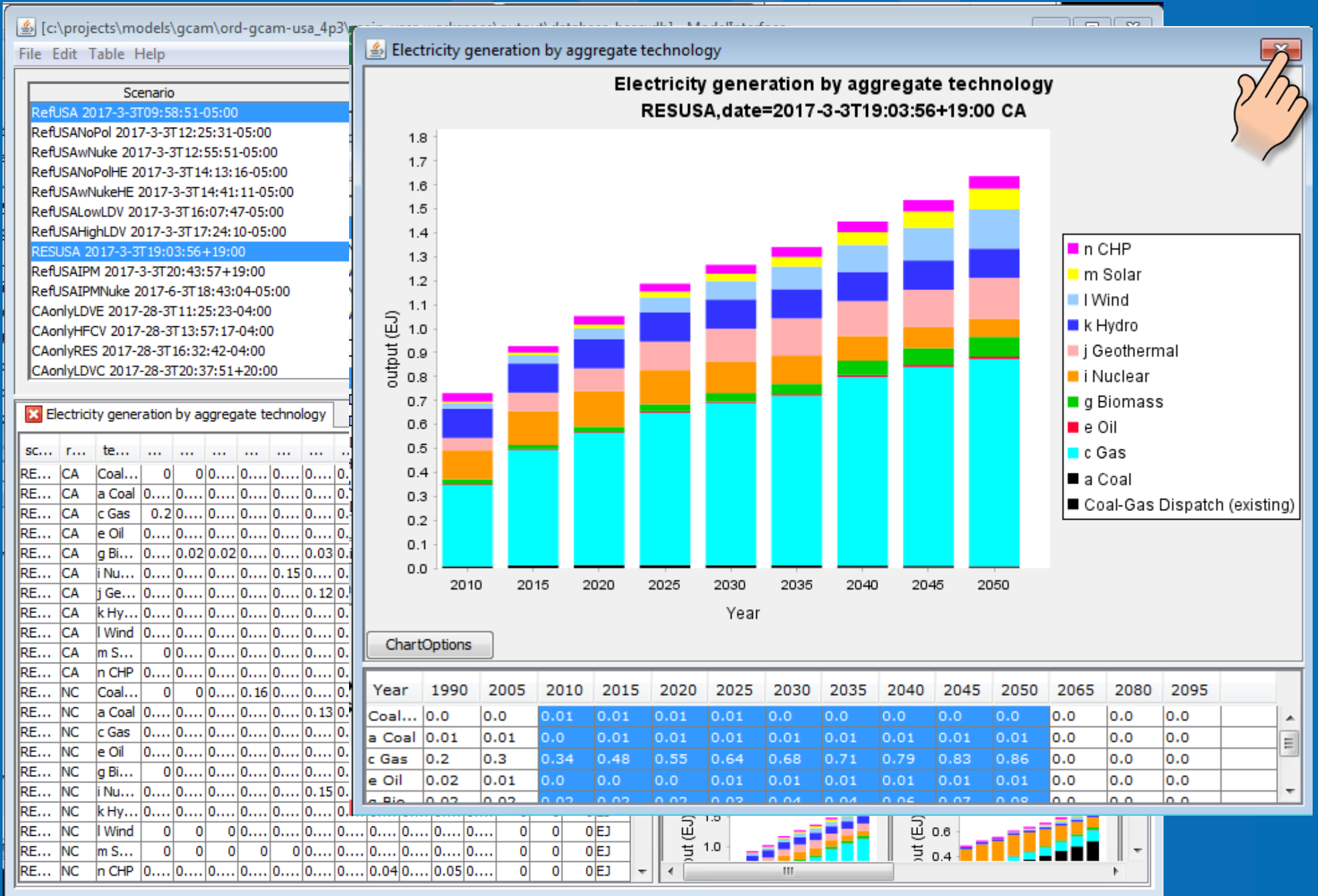
| Scenario | Regions | Queries |
|---------------------------------------|-----------|---|
| RefUSA 2017-3-3T09:58:51-05:00 | Argentina | queries |
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| RefUSAHighLDV 2017-3-3T17:24:10-05:00 | CA | Regional primary energy costs |
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| RefUSAIPM 2017-3-3T20:43:57+19:00 | CT | Electricity generation by region (ind rooftop PV and CHP) |
| RefUSAIPMNuke 2017-6-3T18:43:04-05:00 | DE | Electricity generation by region (central only) |
| CAonlyLDVE 2017-28-3T11:25:23-04:00 | DC | Electricity generation by aggregate technology |
| CAonlyHFCV 2017-28-3T13:57:17-04:00 | FL | Could not generate list |
| CAonlyRES 2017-28-3T16:32:42-04:00 | GA | |
| CAonlyLDVC 2017-28-3T20:37:51+20:00 | | |

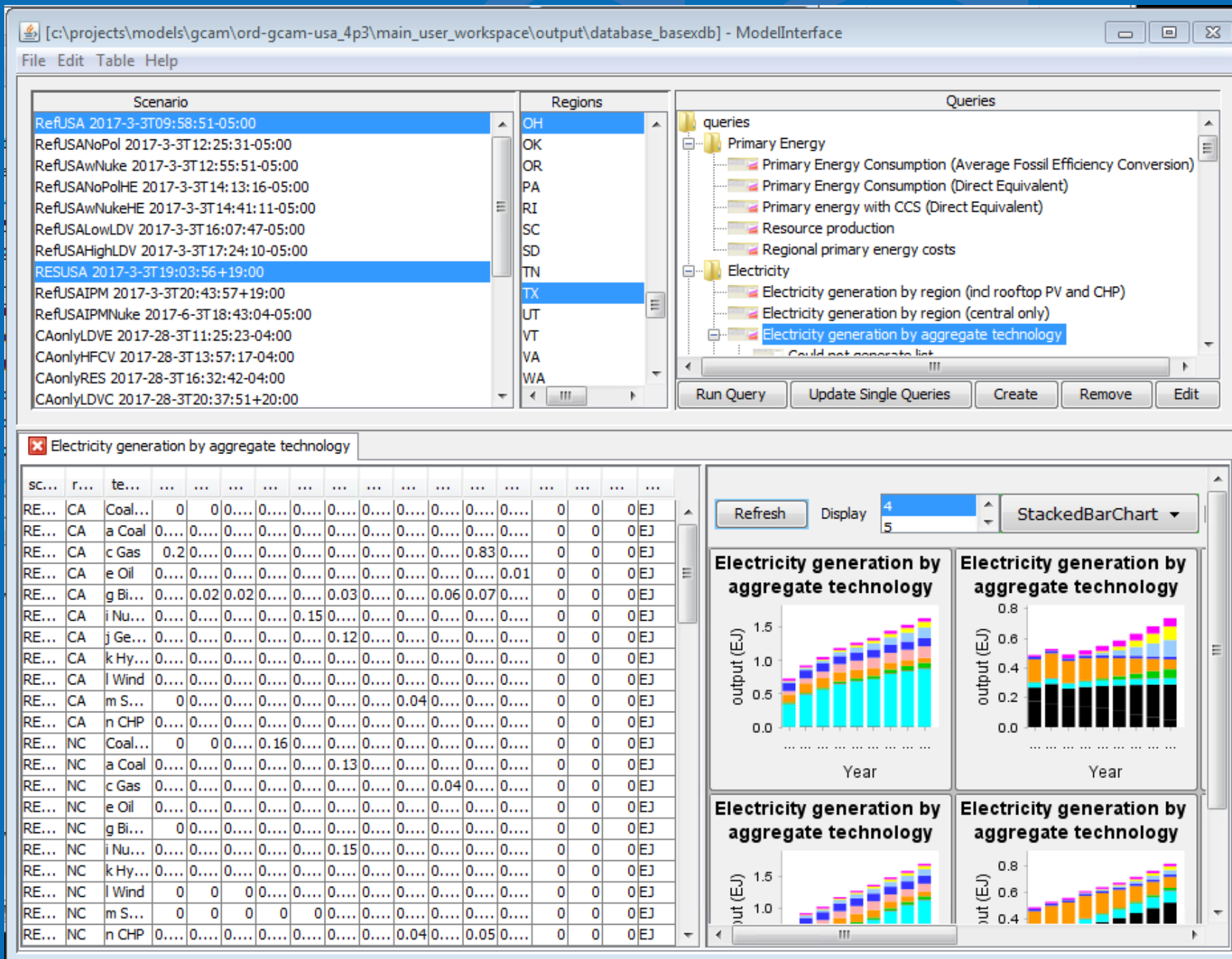
Run Query Update Single Queries Create Remove Edit

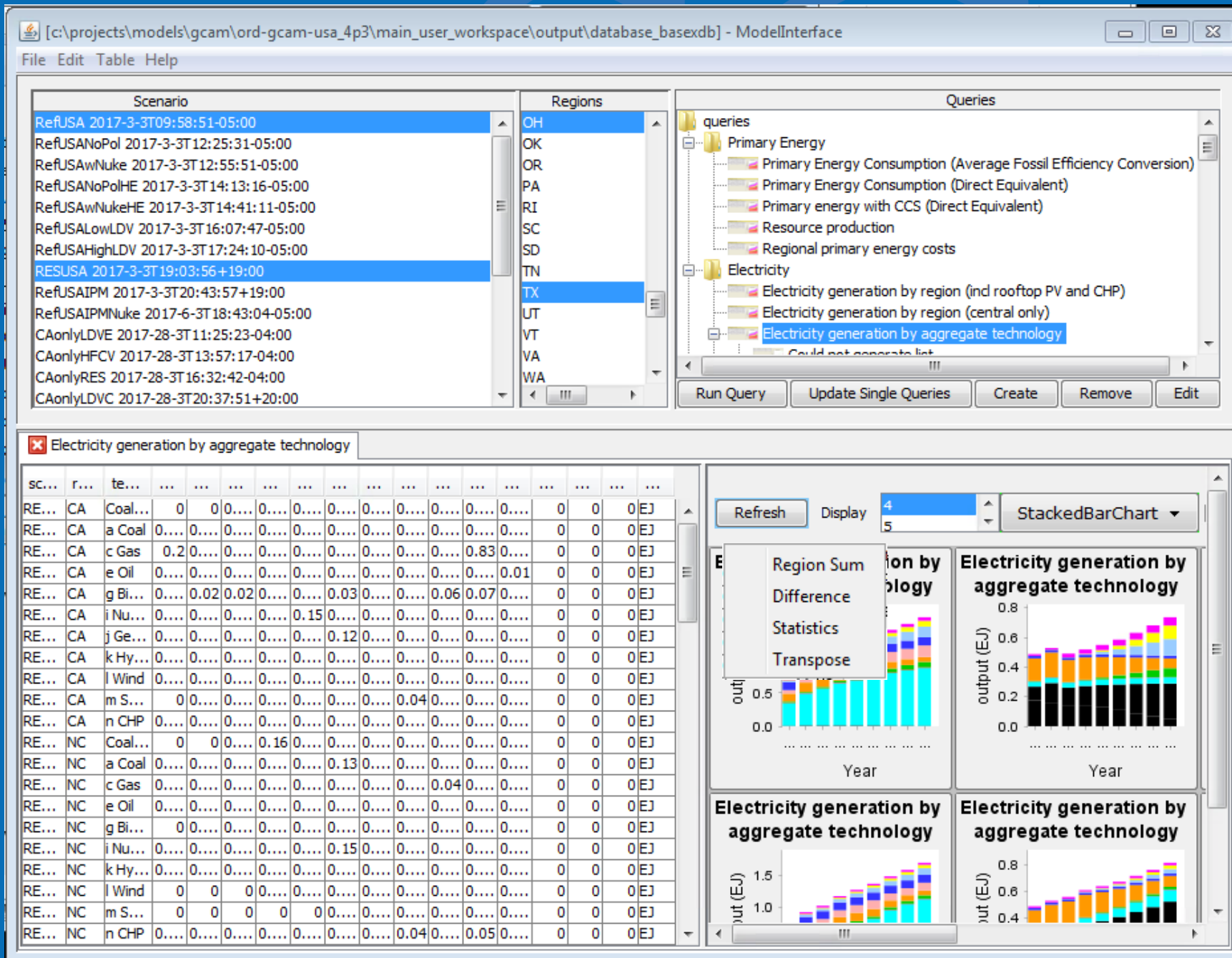


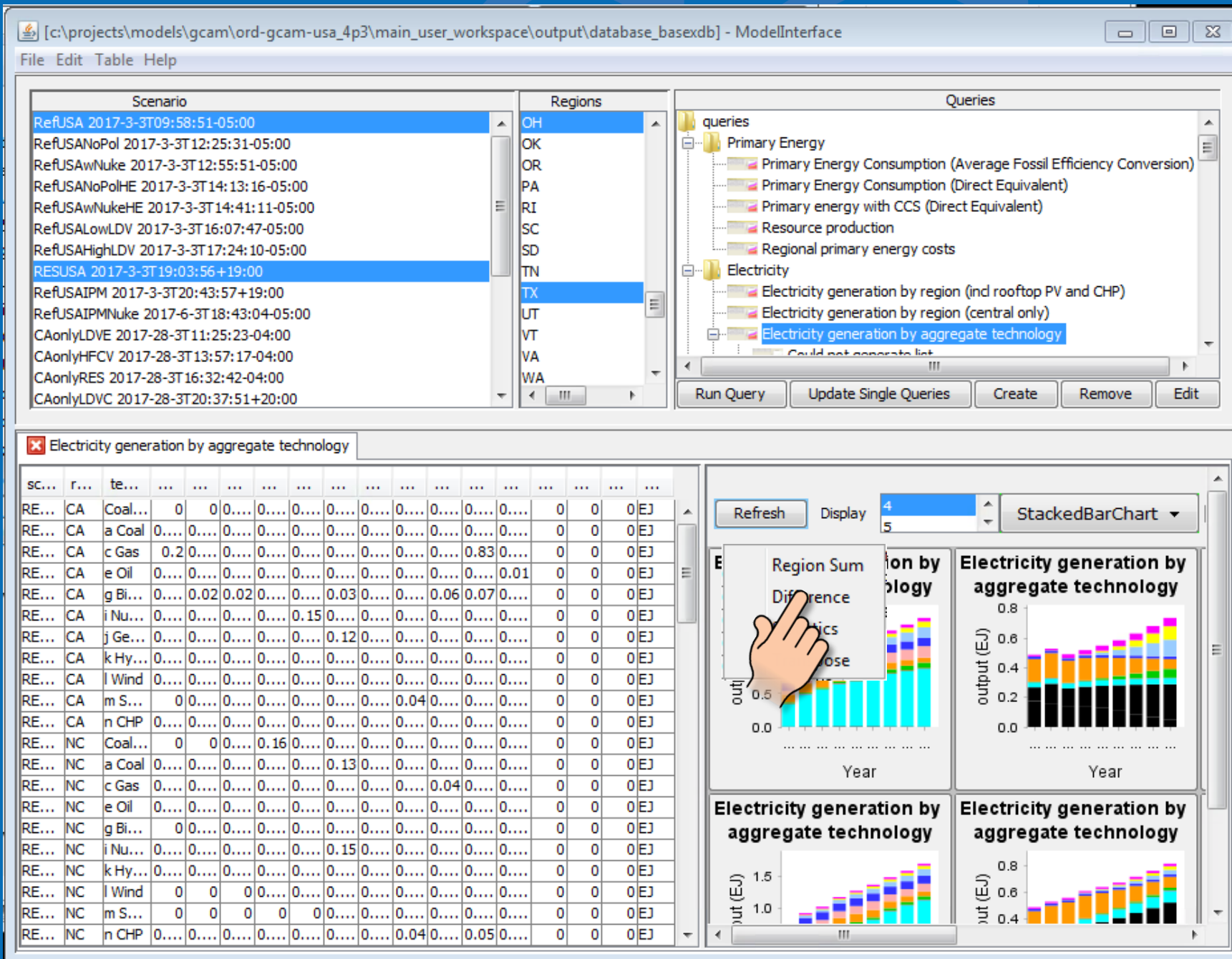


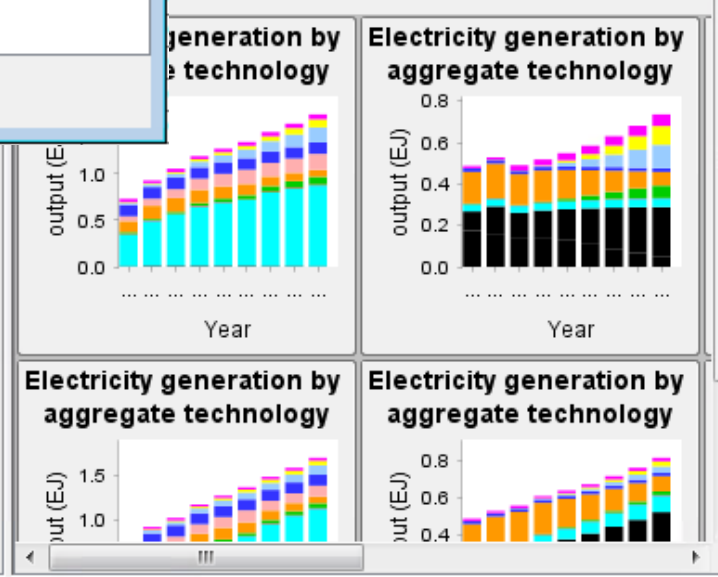


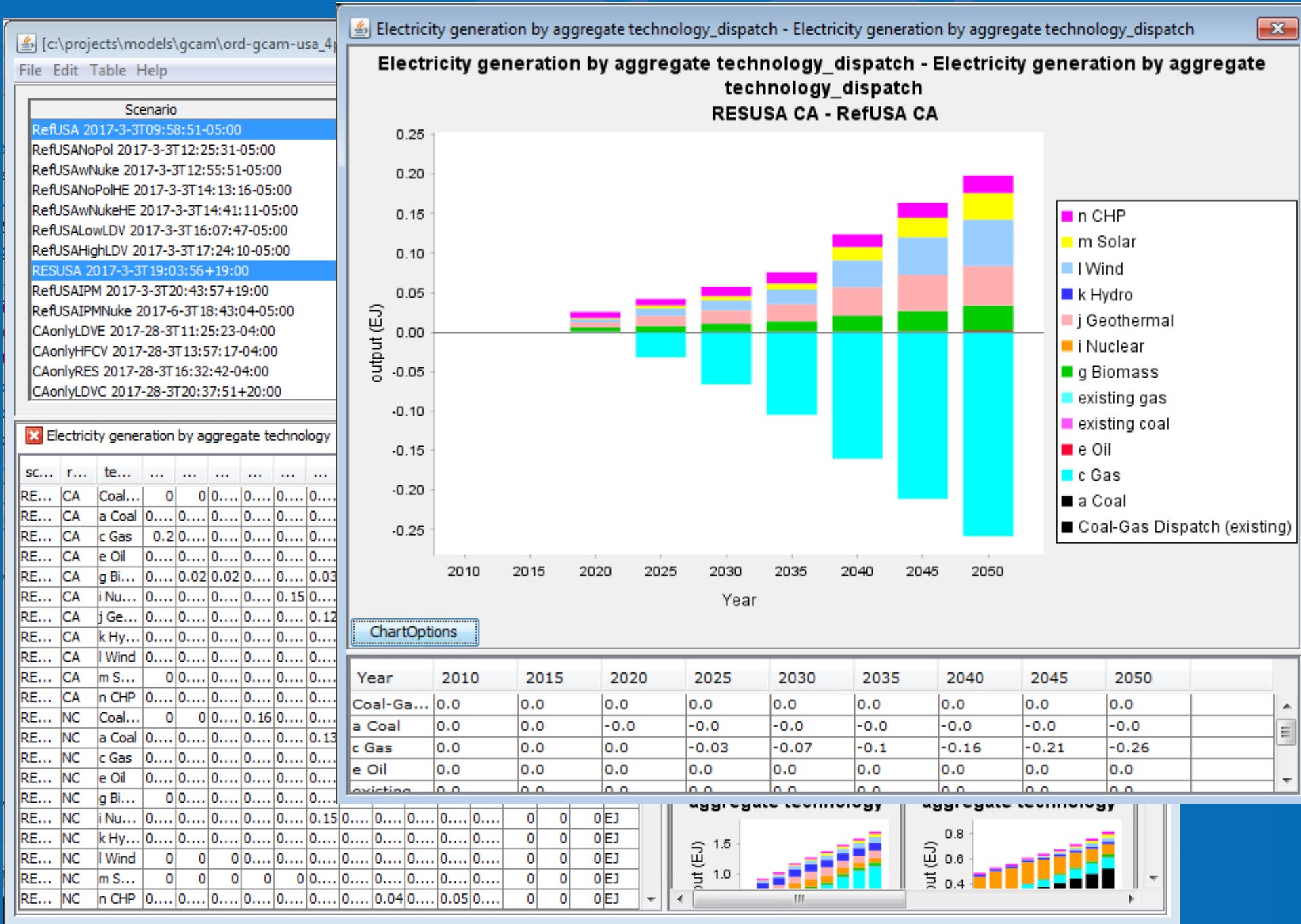








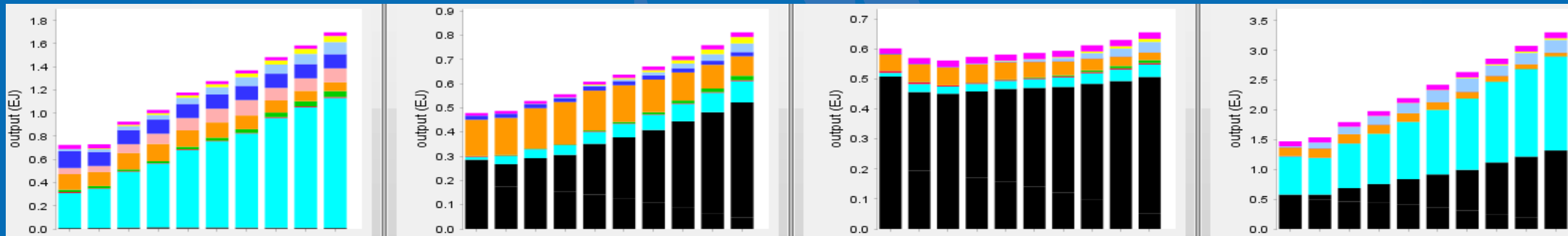




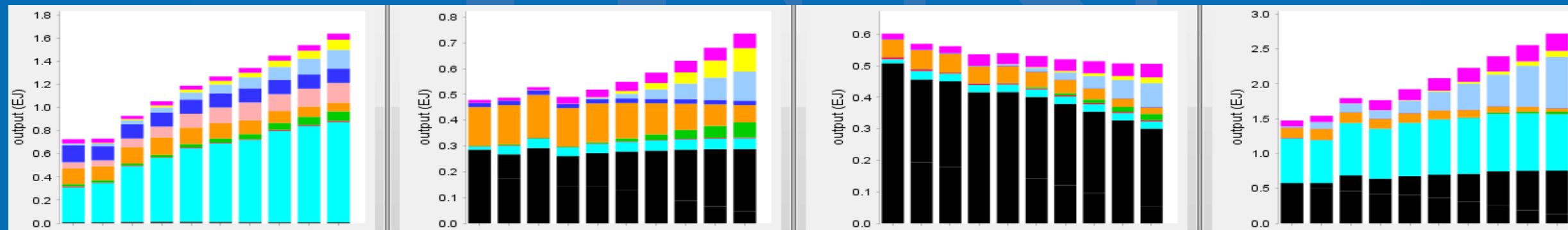
Application: Renewable Electricity Standard

State-level electricity production (2005-2050) by aggregated technology

Reference



RES Constraint



California

North Carolina

Ohio

Texas



Application: Renewable Electricity Standard

Relative to reference case value in that year

Change in
CO₂

Change in
elect

Change in
PM mortality
costs

Increased PM mortality relative to reference largely from:

- Increased biomass for electricity

Other factors:

- Industrial fuel switching in response to electricity and natural gas prices changes
- Minor increase in utilization of refined petroleum products for electricity production

| | 2005 | 2010 | 2015 | 2020 | 2025 | 2030 | 2035 | 2040 | 2045 | 2050 |
|---|------|------|------|------|------|------|------|------|------|------|
| California | 0% | 0% | 0% | 1% | 1% | 0% | 0% | 0% | -1% | -1% |
| Mortality relative to largely from: biomass for electricity | | | 0% | -3% | -6% | -6% | -7% | -7% | -7% | -8% |
| | | | 0% | -3% | -3% | -5% | -7% | -9% | -12% | -15% |
| | | | 0% | -3% | -5% | -6% | -8% | -10% | -12% | -13% |
| | | | | | | | | | | |
| | | | | | | | | | | |
| S: fuel switching in response to and natural gas prices changes ease in utilization of refined products for electricity | | | 2015 | 2020 | 2025 | 2030 | 2035 | 2040 | 2045 | 2050 |
| | | | 0% | 6% | 7% | 7% | 8% | 8% | 7% | 7% |
| | | | 0% | 10% | 15% | 15% | 15% | 14% | 14% | 14% |
| | | | 0% | 9% | 8% | 7% | 6% | 5% | 5% | 4% |
| | | | 0% | 12% | 15% | 16% | 17% | 17% | 18% | 18% |
| | | | | | | | | | | |
| | | | 2015 | 2020 | 2025 | 2030 | 2035 | 2040 | 2045 | 2050 |
| California | 0% | 0% | 0% | 2% | 3% | 5% | 6% | 7% | 8% | 9% |
| North Carolina | 0% | 0% | 0% | 1% | 1% | 3% | 4% | 6% | 7% | 6% |
| Ohio | 0% | 0% | 0% | 3% | 4% | 3% | 2% | 0% | -3% | -6% |
| Texas | 0% | 0% | 0% | -4% | -5% | -7% | -9% | -11% | -13% | -15% |

Application: Renewable Electricity Standard

Relative to

Change in
CO₂

Change in
elect

Change in
PM mortality
costs

Increased PM mortality relative to reference largely from:

- Increased biomass for electricity

Other factors:

- Industrial fuel switching in response to electricity and natural gas prices changes
- Minor increase in utilization of refined petroleum products for electricity production

Supporting state-level decision making:

Results like these help inform the process and point to important questions to ask:

- Is the amount of biomass increase indicated practical?
- Are there measures in place or that could be taken to avoid this PM health disbenefit?
- Could disbenefits be avoided if the RES were structured differently?

| | 2005 | 2010 | 2015 | 2020 | 2025 | 2030 | 2035 | 2040 | 2045 | 2050 |
|----------------|------|------|------|------|------|------|------|------|------|------|
| California | 0% | 0% | 0% | 2% | 3% | 5% | 6% | 7% | 8% | 9% |
| North Carolina | 0% | 0% | 0% | 1% | 1% | 3% | 4% | 6% | 7% | 6% |
| Ohio | 0% | 0% | 0% | 3% | 4% | 3% | 2% | 0% | -3% | -6% |
| Texas | 0% | 0% | 0% | -4% | -5% | -7% | -9% | -11% | -13% | -15% |

Next steps

- Continue to foster existing partner relationships
 - EPA Program Offices and Region 1
- Seek out additional partners
 - beta testers for the model and GUI?
 - analyses with EPA regions and states?
- Explore other uses
 - classroom setting, university research projects?
- Applications
 - emission projections, technology assessment, population growth and migration patterns...?
- New GCAM-USA features
 - PNNL: industrial sector improvements, time slices (seasonal day and night)
 - ORD: air pollutant controls from CoST?

Questions?

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