

# Integration of GCAM-USA into GLIMPSE: Update and demonstration

Dan Loughlin, Chris Nolte and Tai Wu U.S. EPA Office of Research and Development

Wenjing Shi and Yang Ou Fellows, Oak Ridge Institute for Science and Engineering

> Steve Smith and Catherine Ledna Joint Global Change Research Institute Pacific Northwest National Laboratory

GCAM Community Modeling Meeting Joint Global Change Research Institute, College Park, MD October 13, 2016

# 

# Forward

# Objectives of this presentation

- Describe enhancements to GCAM-USA to support environmentalclimate-energy decision support
- Demonstrate Scenario Builder and Enhanced Model Interface graphical user interface components

# Intended audience

- The Global Change Assessment Model (GCAM) modeling community

# Acknowledgments

 The GLIMPSE team includes the authors, as well as Samaneh Babaee, Raj Bhander, Troy Hottle, and Carol Lenox

# Disclaimers

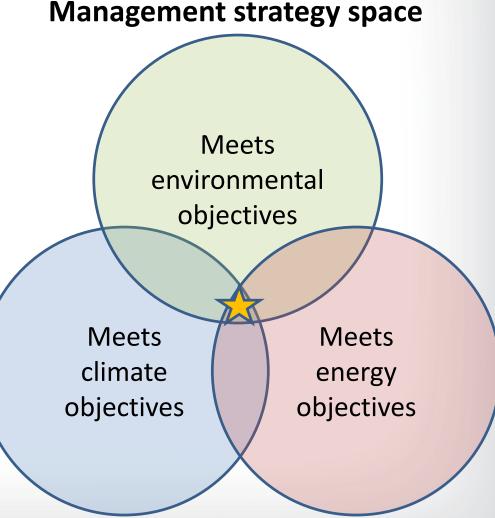
- The views expressed in this presentation are those of the author and do not necessarily represent the views or policies of the U.S. Environmental Protection Agency.
- All results are provided for illustrative purposes only.

# **ORD's GLIMPSE project**

## **Develop decision support** tools for:

EPA

- Evaluating how candidate management strategies meet environmental, climate and energy objectives
- Characterizing tradeoffs among objectives
- Identifying strategies that efficiently meet all objectives



# GCAM-USA activities in 2016

# • GCAM-USA is being enhanced by:

**S**EPA

- harmonizing emission factors with U.S. estimates
- incorporating characterizations of air pollutant controls
- including representations of U.S. regulations
  - CAFE, CSAPR, CPP, NSPSs, RPSs
- enhancing the industrial sector representation
  - regionality, source categories
- prototyping decision support tools
  - Scenario Builder (front-end)
  - Enhanced Model Interface (back-end)

# **SEPA**

# **Evaluation of emissions**

SO<sub>2</sub> emissions (tons x1000) NOx emissions (tons x1000) GCAM-USA (lines) vs. EPA 2011eh platform (squares) GCAM-USA (lines) vs. EPA 2011eh platform (squares) 5000 6000 FGUs EGUs industrial industrial 5000 residential&commercial 4000 residential&commercial on-road on-road 4000 off-highway off-highway 3000 3000 2000 2000 1000 1000 0 0 2010 2015 2020 2025 2030 2010 2015 2020 2030 2025

- Off-highway NOx is low relative to the inventory, but this could be because of discrepancies in what is being compared
- Industrial sector SO2 from GCAM-USA are two times higher than the inventory. A hypothesis we are testing is that offroad mobile emissions included GCAM's industrial sector may not reflect mobile source fuel sulfur content limits. We also need to examine the assumed mix of industrial boilers, turbines, and engines in GCAM-USA.

# **Decision Support System** integration

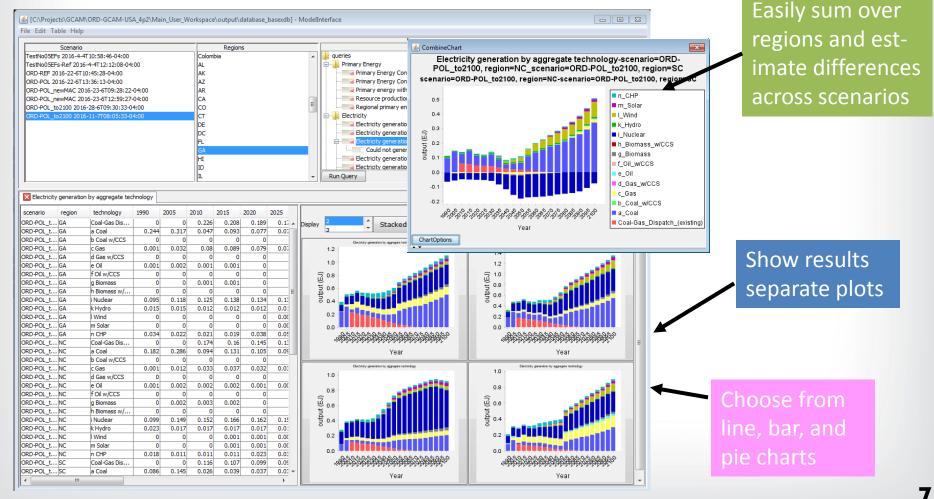
#### Scenario Builder: Managing scenarios Creating a new scenario - 0 % GCAM-USA Scenario Creator from existing Library of Candidate Scenario Components filter: Construct or Edit Scenario components Name: CO2CapNE\_update File Name Address Created scenario Components: 2CapNortheast.txt C:\Projects\GCAM-GUI\io\ScenarioComponen... Mon Oct 26 16:49:54 .. File Name components CO2CapUSA.txt C:\Projects\GCAM-GUI\io\ScenarioComponen... Mon Oct 26 16:47:41 . CO2CapNortheast.txt CO2TaxNortheast.txt C:\Projects\GCAM-GUI\io\ScenarioComponen... Mon Oct 26 16:35:14 . CO2TaxUSA.txt C:\Projects\GCAM-GUI\io\ScenarioComponen... Mon Oct 26 16:33:19 .. SolarPVSubsidyUSA.txt C:\Projects\GCAM-GUI\io\ScenarioComponen... Mon Oct 26 16:53:27 ... C:\Projects\GCAM-GUI\io\ScenarioComponen... Mon Oct 26 16:52:17 ... SolarPVSubsidyWest.... Run Create New Edit Delete Working Scenarios filter: Run Name Components Run Date Analyze Management CO2TaxUSA Mon Oct 26 16:57:34 EDT 2015 CO2TaxUSA.txt: CO2TaxNortheast CO2TaxNortheast.txt; Mon Oct 26 16:57:34 EDT 2015 and execution CO2CapUSA Mon Oct 26 16:57:34 EDT 2015 CO2CapUSA.txt; of scenarios CO2CapNortheast Mon Oct 26 16:57:34 EDT 2015 CO2CapNortheast.txt; SolarPVSubsidyWest SolarPVSubsidyWest.txt; Mon Oct 26 16:57:34 EDT 2015 SolarPVSubsidvUSA SolarPVSubsidyUSA.txt; Mon Oct 26 16:57:34 EDT 2015

**SEPA**

# **Decision Support System** integration

## **Enhancements to the Model Interface**

**SEPA**



# **SEPA**

# Management strategy levers

# Types

- Air pollutant taxes or caps\*
- GHG taxes or caps\*
- CAFE standard<sup>+</sup>
- Renewable Electricity Standard<sup>+</sup>
- Technology subsidies
- Forced technology penetration
- High-efficiency technology end-use requirements

# Geographic application

- Global, global region, or national\*
- Group of states or individual state\*



# Demo

9

| andidate Scenario Com  | iponents filter:  |                        |  | Construct or Edit Sc   | enario                  |  |
|--|---|------------------------|--|--|-------------------------|--|
| File Name  | Address   | Created                |  | Name:  |                         |  |
| 30pctCO2RdxUSA.txt   | c:\projects\gcam-gui\version\gcam-core\ic   | \s Mon Feb 08 14:57:30 |  | Components:  | File Name               |  |
| 40pctCO2RdxUSA.txt   | c:\projects\gcam-gui\version\gcam-core\ic   | \s Mon Feb 08 14:57:45 |  |  | rite Name               |  |
| 50pctCO2RdxUSA.txt   | c:\projects\gcam-gui\version\gcam-core\ic   | \s Mon Feb 08 14:57:55 |  |  |                         |  |
| 60pctCO2RdxUSA.txt   | c:\projects\gcam-gui\version\gcam-core\ic   | \s Mon Feb 08 14:58:04 |  |  |                         |  |
| 70pctCO2RdxUSA.txt   | c:\projects\gcam-gui\version\gcam-core\ic   | \s Mon Feb 08 14:58:14 |  | No co  | content in table        |  |
| 80pctCO2RdxUSA.txt   | c:\projects\gcam-gui\version\gcam-core\ic   | \s Mon Feb 08 14:58:23 |  |  |                         |  |
|  |   |                        |  |  |                         |  |
| New Edit Delete  |   | \s Mon Feb 08 14:58:32 |  | RunCr  | eate                    |  |
| New Edit Delete  | filter:   | >×                     |  |  |                         |  |
| Vorking Scenarios<br>Run Name  | filter:   | >×                     |  | Run Date   | eate                    |  |
| New Edit Delete Vorking Scenarios Run Name Ref4p2  | filter:<br>Compor<br>Reference4p2.txt;  | >×                     | Mon Feb 08   |  |                         |  |
| New Edit Delete Vorking Scenarios Run Name Ref4p2 30pctCO2RdxUSA   | filter:   | → ×                    | Mon Feb 08<br>Mon Feb 08   | Run Date<br>14:04:24 EST 2016  | Analyze                 |  |
| New Edit Delete  | filter:<br>Compor<br>Reference4p2.txt;<br>30pctCO2RdxUSA.txt;   | → ×                    | Mon Feb 08<br>Mon Feb 08<br>Mon Feb 08                             | Run Date<br>14:04:24 EST 2016<br>15:01:31 EST 2016   | Analyze<br>Run Selected |  |
| New Edit Delete<br>Vorking Scenarios<br>Run Name<br>Ref4p2<br>30pctCO2RdxUSA<br>40pctCO2RdxUSA<br>50pctCO2RdxUSA | filter:<br>Compor<br>Reference4p2.txt;<br>30pctCO2RdxUSA.txt;<br>40pctCO2RdxUSA.txt;                        | → ×                    | Mon Feb 08<br>Mon Feb 08<br>Mon Feb 08<br>Mon Feb 08               | Run Date<br>14:04:24 EST 2016<br>15:01:31 EST 2016<br>15:01:31 EST 2016                      | Analyze<br>Run Selected |  |
| New Edit Delete Vorking Scenarios Run Name Ref4p2 30pctCO2RdxUSA 40pctCO2RdxUSA                                  | filter:<br>Compor<br>Reference4p2.txt;<br>30pctCO2RdxUSA.txt;<br>40pctCO2RdxUSA.txt;<br>50pctCO2RdxUSA.txt; | → ×                    | Mon Feb 08<br>Mon Feb 08<br>Mon Feb 08<br>Mon Feb 08<br>Mon Feb 08 | Run Date<br>14:04:24 EST 2016<br>15:01:31 EST 2016<br>15:01:31 EST 2016<br>15:01:31 EST 2016 | Analyze<br>Run Selected |  |

## Scenario Builder graphical interface

| Candidate Scenario Cor  | mponents filter:  |   |  | Construct or Edit Sce  | enario                  |
|---|---|---|--|--|-------------------------|
| File Name   | Address   | Created   |  | Name:  |                         |
| 30pctCO2RdxUSA.txt  | c:\projects\gcam-gui\version\gcam-core\io\s   | Mon Feb 08 14:57:30                                       |  | Components:  | ile Name                |
| 40pctCO2RdxUSA.txt  | c:\projects\gcam-gui\version\gcam-core\io\s   | jects\gcam-gui\version\gcam-core\io\s Mon Feb 08 14:57:45 |  |  |                         |
| 50pctCO2RdxUSA.txt  | c:\projects\gcam-gui\version\gcam-core\io\s   | Mon Feb 08 14:57:55                                       |  |  |                         |
| 60pctCO2RdxUSA.txt  | c:\projects\gcam-gui\version\gcam-core\io\s   | Mon Feb 08 14:58:04                                       |  |  |                         |
| 70pctCO2RdxUSA.txt  | c:\projects\gcam-gui\version\gcam-core\io\s   | Mon Feb 08 14:58:14                                       |  | No co  | ntent in table          |
| 80pctCO2RdxUSA.txt  | c:\projects\gcam-gui\version\gcam-core\io\s   | Mon Feb 08 14:58:23                                       |  |  |                         |
|   |   |   |  |  |                         |
| K C Edit Delete   |   | Mon Feb 08 14:58:32                                       |  | RunCre   | eate                    |
| Edit Delete   | e filter:   | > ×   |  |  |                         |
| Run Name  | e filter:   | > ×   |  | Run         Cree           Run Date         []           14:04:24 EST 2016         []        | Analyze                 |
| Ref4p2  | e filter:   | > ×   | Mon Feb 08   | Run Date   |                         |
| Edit Delete<br>ng Scenarios<br>Run Name<br>Ref4p2<br>30pctCO2RdxUSA   | e<br>filter:<br>Component<br>Reference4p2.txt;  | > ×   | Mon Feb 08<br>Mon Feb 08   | Run Date<br>14:04:24 EST 2016  | Analyze                 |
| Ref4p2<br>30pctCO2RdxUSA  | e<br>filter:<br>Component<br>Reference4p2.txt;<br>30pctCO2RdxUSA.txt;                             | > ×   | Mon Feb 08<br>Mon Feb 08<br>Mon Feb 08                             | Run Date<br>14:04:24 EST 2016<br>15:01:31 EST 2016   | Analyze<br>Run Selected |
| K Edit Delete<br>N Edit Delete<br>N Scenarios<br>Run Name<br>Ref4p2<br>30pctC02RdxUSA<br>40pctC02RdxUSA<br>50pctC02RdxUSA | e<br>filter:<br>Component<br>Reference4p2.txt;<br>30pctC02RdxUSA.txt;<br>40pctC02RdxUSA.txt;      | > ×   | Mon Feb 08<br>Mon Feb 08<br>Mon Feb 08<br>Mon Feb 08               | Run Date<br>14:04:24 EST 2016<br>15:01:31 EST 2016<br>15:01:31 EST 2016                      | Analyze<br>Run Selected |
| Ing Scenarios   | e filter: Component Reference4p2.txt; 30pctC02RdxUSA.txt; 40pctC02RdxUSA.txt; 50pctC02RdxUSA.txt; | > ×   | Mon Feb 08<br>Mon Feb 08<br>Mon Feb 08<br>Mon Feb 08<br>Mon Feb 08 | Run Date<br>14:04:24 EST 2016<br>15:01:31 EST 2016<br>15:01:31 EST 2016<br>15:01:31 EST 2016 | Analyze<br>Run Selected |

## Creating a new scenario component

| 💷 New Scenario ( | Component            |   |  |
|------------------|----------------------|---|--|
| Preset Custon    | n                    |   |  |
| Component:       |                      | Values: Populate Delete Clear Applied to: |  |
| Action:          | Emission Cap (Mt) 🔹  | Year Value world                          |  |
| Sector:          | System Wide 🔹        |   |  |
| Parameter:       | CO2 ~                |   |  |
|                  |                      |   |  |
| Populate:        |                      |   |  |
| Туре:            | Initial w/% Growth 🔹 |   |  |
| Start Year:      | 2020                 | No content in table                       |  |
| End Year:        | 2100                 |   |  |
| Initial Amount:  |                      |   |  |
| Growth (%):      |                      |   |  |
|                  |                      |   |  |
|                  |                      |   |  |
|                  |                      | Add                                       |  |
|                  |                      | Save                                      |  |

## New Scenario Component window

| 📃 New Scenario ( | Component            |   | - • • |
|------------------|----------------------|---|-------|
| Preset Custon    | n                    |   |       |
| Component:       |                      | Values: Populate Delete Clear Applied to: |       |
| Action:          | Emission Cap (Mt)    | Year Value world                          |       |
| Sector:          | System Wide          |   |       |
| Parameter:       | CO2                  |   |       |
|                  |                      |   |       |
| Populate:        |                      |   |       |
| Туре:            | Initial w/% Growth 🔹 |   |       |
| Start Year:      | 2020                 | No content in table                       |       |
| End Year:        | 2100                 |   |       |
| Initial Amount:  |                      |   |       |
| Growth (%):      |                      |   |       |
|                  |                      |   |       |
|                  |                      |   |       |
|                  |                      | Add                                       |       |
|                  |                      | Save                                      |       |

## Choosing the type of the component

| 💷 New Scenario ( | Component              |   | - • • |
|------------------|------------------------|---|-------|
| Preset Custon    | n                      |   |       |
| Component:       |                        | Values: Populate Delete Clear Applied to: |       |
| Action:          | Emission Cap (Mt) 🛛 👻  | Year Value  world                         |       |
| Sector:          | Emission Cap (Mt)      |   |       |
| Parameter:       | Emission Tax (\$/t)    |   |       |
|                  | Renewable Elec Std (%) |   |       |
| Populate:        | CAFE (MPG)             |   |       |
| Туре:            | Initial w/% Growth 👻   |   |       |
| Start Year:      | 2020                   | No content in table                       |       |
| End Year:        | 2100                   |   |       |
| Initial Amount:  |                        |   |       |
| Growth (%):      |                        |   |       |
|                  |                        |   |       |
|                  |                        |   |       |
|                  |                        | Add                                       |       |
|                  |                        | Save Close                                |       |

Menu of component types (to be expanded)

| New Scenario Component         |   |  |
|--------------------------------|---|--|
| Preset Custom                  |   |  |
| Component:                     | Values: Populate Delete Clear Applied to: |  |
| Action: Emission Tax (\$/t) -  | Year Value I world                        |  |
| Sector: Emission Cap (Mt)      |   |  |
| Parameter: Emission Tax (\$/t) |   |  |
| Renewable Elec Std (%)         |   |  |
| Populate AFE (MPG)             |   |  |
| Type: Initial w/% Growth 👻     |   |  |
| Start Year: 2020               | No content in table                       |  |
| End Year: 2100                 |   |  |
| Initial Amount:                |   |  |
| Growth (%):                    |   |  |
|                                |   |  |
|                                |   |  |
|                                | Add                                       |  |
|                                | Save Close                                |  |

Choosing to apply an emission tax

| New Scenario    | Component             |   |  |
|-----------------|-----------------------|---|--|
| Preset Custor   | m                     |   |  |
| Component:      |                       | Values: Populate Delete Clear Applied to: |  |
| Action:         | Emission Tax (\$/t) 🔹 | Year Value world                          |  |
| Sector:         | System Wide 👻         |   |  |
| Parameter:      | CO2 -                 |   |  |
|                 |                       |   |  |
| Populate:       |                       |   |  |
| Туре:           | Initial w/% Growth 🔹  |   |  |
| Start Year:     | 2020                  | No content in table                       |  |
| End Year:       | 2100                  |   |  |
| Initial Amount: |                       |   |  |
| Growth (%):     |                       |   |  |
|                 |                       |   |  |
|                 |                       |   |  |
|                 |                       | Add                                       |  |
|                 |                       | Save Close                                |  |

Applied system-wide to CO2

| 💷 New Scenario | Component             |   |        |
|----------------|-----------------------|---|--------|
| Preset Custo   | om                    |   |        |
| Component:     |                       | Values: Populate Delete Clear Applied to: |        |
| Action:        | Emission Tax (\$/t) 🔹 | Year Value world                          |        |
| Sector:        | System Wide 🔹         |   |        |
| Parameter:     | CO2 -                 |   |        |
|                |                       |   |        |
| Populate:      |                       |   |        |
| Туре:          | Initial w/% Growth 🔹  |   |        |
| Start Yea      | 2020                  | No content in table                       |        |
| End Yea        | 2100                  |   |        |
| Initial Amount | t:                    |   |        |
| Growth (%):    |                       |   |        |
|                |                       |   |        |
|                |                       |   |        |
|                |                       | Add                                       |        |
|                |                       | Save                                      |        |
|                |                       |   | 001010 |

Defining the tax magnitude and timing

| 💷 New Scenario ( | Component             |   |  |
|------------------|-----------------------|---|--|
| Preset Custon    | n                     |   |  |
| Component:       |                       | Values: Populate Delete Clear Applied to: |  |
| Action:          | Emission Tax (\$/t) 🔹 | Year Value world                          |  |
| Sector:          | System Wide 👻         |   |  |
| Parameter:       | CO2 ~                 |   |  |
|                  |                       |   |  |
| Populate:        |                       |   |  |
| Type:            | Initial w/% Growth 👻  |   |  |
| Start Year:      | Initial w/% Growth    | No content in table                       |  |
| End Year:        | Initial w/Delta       |   |  |
| Initial Amount:  | Initial and Final     |   |  |
| Growth (%):      | Table w/% Change      |   |  |
|                  | Table w/Delta         |   |  |
|                  |                       |   |  |
|                  |                       | Add                                       |  |
|                  |                       | Save Close                                |  |

## Options

| 🔜 New Scenario | Component           |   |   |       |
|----------------|---------------------|---|---|-------|
| Preset Custo   | m                   |   |   |       |
| Component:     |                     |   | Values: Populate Delete Clear Applied to: |       |
| Action:        | Emission Tax (\$/t) | • | Year Value world                          |       |
| Sector:        | System Wide         | • |   |       |
| Parameter:     | CO2                 | • |   |       |
|                |                     |   |   |       |
| Populate:      |                     | _ |   |       |
| Туре:          | Initial and Final   | - |   |       |
| Start Year:    | Initial w/% Growth  |   | No content in table                       |       |
| End Year:      | Initial w/Delta     |   |   |       |
| Initial Amount | Initial and Final   |   |   |       |
| Growth         | Table w/% Change    |   |   |       |
| 5              | able w/Delta        |   |   |       |
|                |                     |   |   |       |
|                |                     |   | Add                                       |       |
|                |                     |   |   |       |
|                |                     |   | Save Close                                | 00000 |

#### Selecting starting and ending tax – Intermediate values are interpolated

| 💷 New Scenario ( | Component             |   | - • • |
|------------------|-----------------------|---|-------|
| Preset Custon    | n                     |   |       |
| Component:       |                       | Values: Populate Delete Clear Applied to: |       |
| Action:          | Emission Tax (\$/t) 🔹 | Year Value world                          |       |
| Sector:          | System Wide 🔹         |   |       |
| Parameter:       | CO2 -                 |   |       |
|                  |                       |   |       |
| Populate:        |                       |   |       |
| Туре:            | Initial and Final 🔹   |   |       |
| Start Year:      | 2020                  | No content in table                       |       |
| End Year:        | 2100                  |   |       |
| Initial Amount:  |                       |   |       |
| Final Amount:    |                       |   |       |
|                  |                       |   |       |
|                  |                       |   |       |
|                  |                       | Add                                       |       |
|                  |                       | Save Close                                |       |

| 💷 New Scenario  | Component             |         |          |             |       |    |             | - • • |
|-----------------|-----------------------|---------|----------|-------------|-------|----|-------------|-------|
| Preset Custor   | n                     |         |          |             |       |    |             |       |
| Component:      |                       | Values: | Populate | Delete      | Clear |    | Applied to: |       |
| Action:         | Emission Tax (\$/t) 🔹 | Year    |          | Valu        | e     |    | world       |       |
| Sector:         | System Wide 🔹         |         |          |             |       |    |             |       |
| Parameter:      | CO2 ~                 |         |          |             |       |    |             |       |
|                 |                       |         |          |             |       |    |             |       |
| Populate:       |                       |         |          |             |       |    |             |       |
| Туре:           | Initial and Final 🔹   |         |          |             |       |    |             |       |
| Start Year:     | 2020                  |         | No con   | tent in tab | e     |    |             |       |
| End Year:       | 2100                  |         |          |             |       |    |             |       |
| Initial Amount: | 50                    |         |          |             |       |    |             |       |
| Final Amount:   | 500                   |         |          |             |       |    |             |       |
| S.F.            |                       |         |          |             | Ad    | bb |             |       |
|                 |                       |         | Sa       | ve Clos     | e     |    |             |       |

#### Tax increases linearly from \$50/tCO2 in 2020 to \$500/tCO2 in 2100

| 💷 New Scenario ( | Component           |   |                  |              |             |  |
|------------------|---------------------|---|------------------|--------------|-------------|--|
| Preset Custon    | n                   |   |                  |              |             |  |
| Component:       |                     |   | Values: Populate | Delete Clear | Applied to: |  |
| Action:          | Emission Tax (\$/t) | - | Sh               | Value        | world       |  |
| Sector:          | System Wide         | - | /20              | 50.00        |             |  |
| Parameter:       | CO2                 | - | 2025             | 78.12        |             |  |
|                  |                     |   | 2030             | 106.25       |             |  |
| Populate:        |                     |   | 2035             | 134.38       |             |  |
| Туре:            | Initial and Final   | - | 2040             | 162.50       |             |  |
| Start Year:      | 2020                |   | 2045             | 190.62       |             |  |
| End Year:        | 2100                |   | 2050             | 218.75       |             |  |
| Initial Amount:  |                     |   | 2055             | 246.88       |             |  |
|                  |                     |   | 2060             | 275.00       |             |  |
| Final Amount:    | 500                 |   | 2065             | 303.12       |             |  |
|                  |                     |   | 2070             | 331.25       |             |  |
|                  |                     |   | 2075             | 250.28 ~     |             |  |
|                  |                     |   |                  | Add          |             |  |
|                  |                     |   |                  |              |             |  |
|                  |                     |   | Si               | Close        |             |  |

## Populating the table of values

| 🖳 New Scenario ( | Component           |   |                 |                |                                 |
|------------------|---------------------|---|-----------------|----------------|---------------------------------|
| Preset Custon    | n                   |   |                 |                |                                 |
| Component:       |                     |   | Values: Populat | e Delete Clear | Applied to:                     |
| Action:          | Emission Tax (\$/t) | - | Year            | Value          | x world                         |
| Sector:          | System Wide         | - | 2020            | 50.00          | USA                             |
| Parameter:       | CO2                 | • | 2025            | 78.12          | Canada                          |
|                  |                     |   | 2030            | 106.25         | EU-15                           |
| Populate:        |                     |   | 2035            | 134.38         | Europe_Non_EU                   |
| Туре:            | Initial and Final   | - | 2040            | 162.50         | European Free Trade Association |
| Start Year:      | 2020                |   | 2045            | 190.62         | Japan                           |
|                  |                     | _ | 2050            | 218.75         | Australia_NZ                    |
| End Year:        | 2100                | _ | 2055            | 246.88         | Central Asia                    |
| Initial Amount:  | 50                  |   | 2060            | 275.00         | Russia                          |
| Final Amount:    | 500                 |   | 2065            | 303.12         | China                           |
|                  |                     |   | 2070            | 331.25         | Middle East                     |
|                  |                     |   | 2075            | 250.28 ~       | Africa_Eastern                  |
|                  |                     |   |                 | Add            |                                 |
|                  |                     |   |                 |                |                                 |
|                  |                     |   |                 | Save Close     |                                 |

## Selecting to which regions the tax is applied

#### New Scenario Component Preset Custom Values: Component: Populate Delete Clear Applied to: Emission Tax (\$/t) Action: Ŧ Year Value • world System Wide 50.00 Sector: Ŧ 2020 USA $\checkmark$ 2025 78.12 Canada CO2 V Ŧ Parameter: 106.25 EU-15 2030 V Europe\_Non\_EU 2035 134.38 Populate: European Free Trade Association 2040 162.50 Initial and Final Type: Ŧ Japan 2045 190.62 Start Year: 2020 Australia\_NZ 218.75 2050 End Year: 2100 Central Asia 2055 246.88 Initial Amount: 50 Russia 275.00 2060 China Final Amount: 500 2065 303.12 Middle East 331.25 2070 Africa\_Eastern 250.28 ~ 2075 1 5 Add Save Close

#### - -New Scenario Component Preset Custom Values: Component: Populate Delete Clear Applied to: Emission Tax (\$/t) Action: Ŧ Year Value • world System Wide 50.00 Sector: Ŧ 2020 USA $\checkmark$ 2025 78.12 Canada CO2 Ŧ Parameter: 106.25 EU-15 2030 V Europe\_Non\_EU 2035 134.38 Populate: European Free Trade Association 2040 162.50 Initial and Final Type: Ŧ Japan 2045 190.62 Start Year: 2020 Australia\_NZ 218.75 2050 End Year: 2100 Central Asia 246.88 2055 Initial Amount: 50 Russia 275.00 2060 China Final Amount: 500 2065 303.12 Middle East 331.25 2070 Africa\_Eastern 250.28 ~ 2075 1 5 Add Close Save

Saving the scenario component

| andidate Scenario Con  | mponents filter:   |                       |  | Construct or Edit Sce  | enario                  |  |  |  |
|--|--|-----------------------|--|--|-------------------------|--|--|--|
| File Name  | Address  | Created               |  | Name:  |                         |  |  |  |
| 50pctCO2RdxUSA.txt   | c:\projects\gcam-gui\version\gcam-core\io\   | Mon Feb 08 14:57:55   |  | Components:  | ile Name                |  |  |  |
| 50pctCO2RdxUSA.txt   | c:\projects\gcam-gui\version\gcam-core\io\   | Mon Feb 08 14:58:04   |  |  |                         |  |  |  |
| 70pctCO2RdxUSA.txt   | c:\projects\gcam-gui\version\gcam-core\io\   | Mon Feb 08 14:58:14   |  |  |                         |  |  |  |
| 80pctCO2RdxUSA.txt   | c:\projects\gcam-gui\version\gcam-core\io\   | Mon Feb 08 14:58:23   |  |  |                         |  |  |  |
| 90pctCO2RdxUSA.txt   | c:\projects\gcam-gui\version\gcam-core\io\   | No co                 | ntent in table                           |  |                         |  |  |  |
| Reference4p2.txt   | c:\projects\gcam-gui\version\gcam-core\io\   | Mon Feb 08 13:56:54   |  |  |                         |  |  |  |
| SysTaxCO2Reg.txt   | C:\Projects\GCAM-GUI\version\GCAM-Core\  | i Mon Oct 03 21:55:07 |  | Run Cre  | ate 🔺 🔻                 |  |  |  |
| SysTaxCO2Reg.txt<br>New Edit Delete<br>Vorking Scenarios   |  | i Mon Oct 03 21:55:07 |  | RunCre   | ate 🔺 🔻                 |  |  |  |
| New Edit Delete  | •  | > ``                  |  | Run Cre  | eate                    |  |  |  |
| New Edit Delete  | filter:  | > ``                  | Mon Feb                                  |  |                         |  |  |  |
| New Edit Delete<br>Vorking Scenarios<br>Run Name   | filter:  | > ``                  |  | Run Date   | Analyze<br>Run Selected |  |  |  |
| New Edit Delete<br>Vorking Scenarios<br>Run Name<br>Ref4p2   | filter:<br>Compone<br>Reference4p2.txt;  | > ``                  | Mon Feb                                  | Run Date<br>08 14:04:24 EST 2016   | Analyze                 |  |  |  |
| New Edit Delete<br>Vorking Scenarios<br>Run Name<br>Ref4p2<br>30pctCO2RdxUSA                                     | filter:<br>Compone<br>Reference4p2.txt;<br>30pctCO2RdxUSA.txt;   | > ``                  | Mon Feb<br>Mon Feb                       | Run Date<br>08 14:04:24 EST 2016<br>08 15:01:31 EST 2016   | Analyze<br>Run Selected |  |  |  |
| New Edit Delete<br>Vorking Scenarios<br>Run Name<br>Ref4p2<br>30pctCO2RdxUSA                                     | filter:<br>Compone<br>Reference4p2.txt;<br>30pctCO2RdxUSA.txt;<br>40pctCO2RdxUSA.txt;                        | > ``                  | Mon Feb<br>Mon Feb<br>Mon Feb            | Run Date<br>08 14:04:24 EST 2016<br>08 15:01:31 EST 2016<br>08 15:01:31 EST 2016   | Analyze<br>Run Selected |  |  |  |
| New Edit Delete<br>Vorking Scenarios<br>Run Name<br>Ref4p2<br>30pctCO2RdxUSA<br>40pctCO2RdxUSA<br>50pctCO2RdxUSA | filter:<br>Compone<br>Reference4p2.txt;<br>30pctCO2RdxUSA.txt;<br>40pctCO2RdxUSA.txt;<br>50pctCO2RdxUSA.txt; | > ``                  | Mon Feb<br>Mon Feb<br>Mon Feb<br>Mon Feb | Run Date           08 14:04:24 EST 2016           08 15:01:31 EST 2016           08 15:01:31 EST 2016           08 15:01:31 EST 2016 | Analyze<br>Run Selected |  |  |  |

| andidate Scenario Cor  | mponents filter:  |                        |  | Construct or Edit Sce   | nario                   |  |
|--|---|------------------------|--|---|-------------------------|--|
| File Name  | Address   | Created                |  | Name:   |                         |  |
| 50pctCO2RdxUSA.txt   | c:\projects\gcam-gui\version\gcam-core\io   | s Mon Feb 08 14:57:55  |  | Components:<br>File Name  |                         |  |
| 60pctCO2RdxUSA.txt   | c:\projects\gcam-gui\version\gcam-core\io   | s Mon Feb 08 14:58:04  |  | SysTaxCO2Reg.txt  |                         |  |
| 70pctCO2RdxUSA.txt   | c:\projects\gcam-gui\version\gcam-core\io   |                        |  |   |                         |  |
| 80pctCO2RdxUSA.txt   | c:\projects\gcam-gui\version\gcam-core\io   |                        |  |   |                         |  |
| 90pctCO2RdxUSA.txt   | c:\projects\gcam-gui\version\gcam-core\io   | s Mon Feb 08 14:58:32  |  |   |                         |  |
| Reference4p2.txt   | c:\projects\gcam-gui\version\gcam-core\io   |                        |  |   |                         |  |
|  |   |                        |  |   |                         |  |
| SysTaxCO2Reg.txt   |   | \i Mon Oct 03 21:55:07 |  | K CRun Cre  | ate 🔺 🔻                 |  |
| New Edit Delete  | filter:   | > ``                   |  | Run Cre   |                         |  |
| New Edit Delete Vorking Scenarios Run Name   | filter:   | > ``                   |  | Run Cre   | ate                     |  |
| New Edit Delete Vorking Scenarios Run Name Ref4p2  | filter:<br>Compon<br>Reference4p2.txt;  | > ``                   | Mon Feb 08   | Run Cre   |                         |  |
| New Edit Delete Vorking Scenarios Run Name   | filter:   | > ``                   | Mon Feb 08<br>Mon Feb 08   | Run Cre<br>Run Date<br>14:04:24 EST 2016  | Analyze                 |  |
| New Edit Delete Vorking Scenarios Run Name Ref4p2 30pctCO2RdxUSA   | filter:<br>Compon<br>Reference4p2.txt;<br>30pctCO2RdxUSA.txt;   | > ``                   | Mon Feb 08<br>Mon Feb 08<br>Mon Feb 08                             | Run Cre<br>Run Date<br>14:04:24 EST 2016<br>15:01:31 EST 2016   | Analyze<br>Run Selected |  |
| New Edit Delete Vorking Scenarios Run Name Ref4p2 30pctCO2RdxUSA 40pctCO2RdxUSA                                  | filter:<br>Compon<br>Reference4p2.txt;<br>30pctC02RdxUSA.txt;<br>40pctC02RdxUSA.txt;                        | > ``                   | Mon Feb 08<br>Mon Feb 08<br>Mon Feb 08<br>Mon Feb 08               | Run Cre<br>Run Date<br>14:04:24 EST 2016<br>15:01:31 EST 2016<br>15:01:31 EST 2016                      | Analyze<br>Run Selected |  |
| New Edit Delete<br>Vorking Scenarios<br>Run Name<br>Ref4p2<br>30pctCO2RdxUSA<br>40pctCO2RdxUSA<br>50pctCO2RdxUSA | filter:<br>Compon<br>Reference4p2.txt;<br>30pctC02RdxUSA.txt;<br>40pctC02RdxUSA.txt;<br>50pctC02RdxUSA.txt; | > ``                   | Mon Feb 08<br>Mon Feb 08<br>Mon Feb 08<br>Mon Feb 08<br>Mon Feb 08 | Run Cre<br>Run Date<br>14:04:24 EST 2016<br>15:01:31 EST 2016<br>15:01:31 EST 2016<br>15:01:31 EST 2016 | Analyze<br>Run Selected |  |

## Selecting which components to include in the scenario

| GCAM-USA Scenario C   | reator                                      |                     |                              |                 |
|-----------------------|---|---------------------|------------------------------|-----------------|
| andidate Scenario Con | nponents filter:                            |                     | Construct or Edit Sc         | enario          |
| File Name             | Address                                     | Created             | Name: Test                   |                 |
| 0pctCO2RdxUSA.txt     | c:\projects\gcam-gui\version\gcam-core\io\s | Mon Feb 08 14:57:55 | Company                      | File Name       |
| 0pctCO2RdxUSA.txt     | c:\projects\gcam-gui\version\gcam-core\io\s | Mon Feb 08 14:58:04 | SysTaxCO2_eg.txt             | ne Name         |
| 0pctCO2RdxUSA.txt     | c:\projects\gcam-gui\version\gcam-core\io\s | Mon Feb 08 14:58:14 | - Oystance - cynn            |                 |
| 0pctCO2RdxUSA.txt     | c:\projects\gcam-gui\version\gcam-core\io\s | Mon Feb 08 14:58:23 |                              |                 |
| 0pctCO2RdxUSA.txt     | c:\projects\gcam-gui\version\gcam-core\io\s | Mon Feb 08 14:58:32 |                              |                 |
| eference4p2.txt       | c:\projects\gcam-gui\version\gcam-core\io\s | Mon Feb 08 13:56:54 |                              |                 |
| ysTaxCO2Reg.txt       | C:\Projects\GCAM-GUI\version\GCAM-Core\i    | Mon Oct 03 21:55:07 |                              |                 |
| New Edit Delete       | filter:                                     |                     | Run Cr                       | eate            |
| Run Name              | Component                                   | s                   | Run Date                     | Analyze         |
| Ref4p2                | Reference4p2.txt;                           |                     | Mon Feb 08 14:04:24 EST 2016 | Run Selected    |
| 0pctCO2RdxUSA         | 30pctCO2RdxUSA.txt;                         |                     | Mon Feb 08 15:01:31 EST 2016 | Kun Selected    |
| 0pctCO2RdxUSA         | 40pctCO2RdxUSA.txt;                         |                     | Mon Feb 08 15:01:31 EST 2016 | Delete Selected |

| nempe          | hererenee perso,    | 111011100 00 1410424 201 2010 | Run Selected    |
|----------------|---------------------|-------------------------------|-----------------|
| 30pctCO2RdxUSA | 30pctCO2RdxUSA.txt; | Mon Feb 08 15:01:31 EST 2016  | Kun Selected    |
| 40pctCO2RdxUSA | 40pctCO2RdxUSA.txt; | Mon Feb 08 15:01:31 EST 2016  | Delete Selected |
| 50pctCO2RdxUSA | 50pctCO2RdxUSA.txt; | Mon Feb 08 15:01:31 EST 2016  |                 |
| 60pctCO2RdxUSA | 60pctCO2RdxUSA.txt; | Mon Feb 08 15:01:31 EST 2016  |                 |
| 70pctCO2RdxUSA | 70pctCO2RdxUSA.txt; | Mon Feb 08 15:01:31 EST 2016  |                 |
| 80pctCO2RdxUSA | 80pctCO2RdxUSA.txt; | Mon Feb 08 15:01:31 EST 2016  | Options         |
| < [            |                     | ) >                           | Help            |

## Naming the scenario

| andidate Scenario Cor   | mponents filter:  |                     |  | Construct or Edit Sce   | nario                   |  |  |
|---|---|---------------------|--|---|-------------------------|--|--|
| File Name   | Address   | Created             |  | Name: Test  |                         |  |  |
| 50pctCO2RdxUSA.txt  | c:\projects\gcam-gui\version\gcam-core\io\s   | Mon Feb 08 14:57:55 |  | Components:   | le Name                 |  |  |
| 50pctCO2RdxUSA.txt  | c:\projects\gcam-gui\version\gcam-core\io\s   | Mon Feb 08 14:58:04 |  | SysTaxCO2Reg.txt  |                         |  |  |
| 70pctCO2RdxUSA.txt  | c:\projects\gcam-gui\version\gcam-core\io\s   | Mon Feb 08 14:58:14 |  | by staxe of 2 meg. at   |                         |  |  |
| 80pctCO2RdxUSA.txt  | c:\projects\gcam-gui\version\gcam-core\io\s   | Mon Feb 08 14:58:23 |  |   |                         |  |  |
| 90pctCO2RdxUSA.txt  | c:\projects\gcam-gui\version\gcam-core\io\s   |                     |  |   |                         |  |  |
| Reference4p2.txt  | c:\projects\gcam-gui\version\gcam-core\io\s   |                     |  |   |                         |  |  |
| SysTaxCO2Reg.txt  | C:\Projects\GCAM-GUI\version\GCAM-Core\i  | Mon Oct 03 21:55:07 |  |   |                         |  |  |
| New Edit Delete   |   | > ``_               | J  | Run Cre   | ate 🔺 🔻                 |  |  |
| Vorking Scenarios   | filter:   | > ``                | ]  | Run Cre   |                         |  |  |
| Vorking Scenarios<br>Run Name   | filter:   | nts                 |  | Run Crea  | ate 🔺 🔻                 |  |  |
| Vorking Scenarios<br>Run Name<br>Ref4p2   | filter:<br>Compone<br>Reference4p2.txt;   | nts                 | Mon Feb 08   | Run Crea<br>Run Date<br>3 14:04:24 EST 2016   |                         |  |  |
| Vorking Scenarios<br>Run Name<br>Ref4p2<br>30pctCO2RdxUSA   | filter:<br>Compone<br>Reference4p2.txt;<br>30pctCO2RdxUSA.txt;  | nts                 | Mon Feb 08<br>Mon Feb 08   | Run Crei<br>Run Date<br>3 14:04:24 EST 2016<br>3 15:01:31 EST 2016  | Analyze<br>Run Selected |  |  |
| Vorking Scenarios<br>Run Name<br>Ref4p2<br>30pctCO2RdxUSA<br>40pctCO2RdxUSA                                     | filter:<br>Compone<br>Reference4p2.txt;<br>30pctCO2RdxUSA.txt;<br>40pctCO2RdxUSA.txt;   | nts                 | Mon Feb 08<br>Mon Feb 08<br>Mon Feb 08   | Run Cree<br>Run Date<br>3 14:04:24 EST 2016<br>3 15:01:31 EST 2016<br>3 15:01:31 EST 2016   | Analyze                 |  |  |
| Vorking Scenarios<br>Run Name<br>Ref4p2<br>30pctCO2RdxUSA<br>40pctCO2RdxUSA<br>50pctCO2RdxUSA                   | filter: Compone<br>Reference4p2.txt;<br>30pctCO2RdxUSA.txt;<br>40pctCO2RdxUSA.txt;<br>50pctCO2RdxUSA.txt;                           | nts                 | Mon Feb 08<br>Mon Feb 08<br>Mon Feb 08<br>Mon Feb 08                             | Run Cree<br>Run Date<br>3 14:04:24 EST 2016<br>3 15:01:31 EST 2016<br>3 15:01:31 EST 2016<br>3 15:01:31 EST 2016                        | Analyze<br>Run Selected |  |  |
| Vorking Scenarios<br>Run Name<br>Ref4p2<br>30pctCO2RdxUSA<br>40pctCO2RdxUSA<br>50pctCO2RdxUSA<br>60pctCO2RdxUSA | filter:<br>Compone<br>Reference4p2.txt;<br>30pctCO2RdxUSA.txt;<br>40pctCO2RdxUSA.txt;<br>50pctCO2RdxUSA.txt;<br>60pctCO2RdxUSA.txt; | nts                 | Mon Feb 08<br>Mon Feb 08<br>Mon Feb 08<br>Mon Feb 08<br>Mon Feb 08               | Run Cree<br>Run Date<br>3 14:04:24 EST 2016<br>3 15:01:31 EST 2016<br>3 15:01:31 EST 2016<br>3 15:01:31 EST 2016<br>3 15:01:31 EST 2016 | Analyze<br>Run Selected |  |  |
| Vorking Scenarios<br>Run Name<br>Ref4p2<br>30pctCO2RdxUSA<br>40pctCO2RdxUSA<br>50pctCO2RdxUSA                   | filter: Compone<br>Reference4p2.txt;<br>30pctCO2RdxUSA.txt;<br>40pctCO2RdxUSA.txt;<br>50pctCO2RdxUSA.txt;                           | nts                 | Mon Feb 08<br>Mon Feb 08<br>Mon Feb 08<br>Mon Feb 08<br>Mon Feb 08<br>Mon Feb 08 | Run Cree<br>Run Date<br>3 14:04:24 EST 2016<br>3 15:01:31 EST 2016<br>3 15:01:31 EST 2016<br>3 15:01:31 EST 2016                        | Analyze<br>Run Selected |  |  |

Running scenario "Test"

| Candidate Scenario Cor  | mponents filter:  |                       | Co   | nstruct or Edit   | Scenario                |
|---|---|-----------------------|--|---|-------------------------|
| File Name   | Address   | Created               |  | me: Te  | est                     |
| 50pctCO2RdxUSA.txt  | c:\projects\gcam-gui\version\gcam-core\io\!   | s Mon Feb 08 14:57:55 |  | mponents:   | File Name               |
| 60pctCO2RdxUSA.txt  | c:\projects\gcam-gui\version\gcam-core\io\  | s Mon Feb 08 14:58:04 | Sv Sv  | sTaxCO2Reg.t  |                         |
| 70pctCO2RdxUSA.txt  | c:\projects\gcam-gui\version\gcam-core\io\!   | s Mon Feb 08 14:58:14 |  |   |                         |
| 80pctCO2RdxUSA.txt  | c:\projects\gcam-gui\version\gcam-core\io\  | s Mon Feb 08 14:58:23 |  |   |                         |
| 90pctCO2RdxUSA.txt  | c:\projects\gcam-gui\version\gcam-core\io\:   | s Mon Feb 08 14:58:32 |  |   |                         |
| Reference4p2.txt  | c:\projects\gcam-gui\version\gcam-core\io\:   | s Mon Feb 08 13:56:54 |  |   |                         |
| SysTaxCO2Reg.txt  | C:\Projects\GCAM-GUI\version\GCAM-Core\   | i Mon Oct 03 21:55:07 |  |   |                         |
| New Edit Delete   |   | >>                    |  | Run   | Create 🔺 🔻              |
| Vorking Scenarios   | filter:   | >                     |  |   |                         |
| Vorking Scenarios<br>Run Name   | filter:   | ents                  | Run D  | ate   | Analyze                 |
| Vorking Scenarios<br>Run Name<br>Ref4p2   | filter:<br>Compone<br>Reference4p2.txt;   | ents                  | Mon Feb 08 14:04   | ate<br>:24 EST 2016   | Analyze                 |
| Vorking Scenarios<br>Run Name<br>Ref4p2<br>30pctCO2RdxUSA   | filter:<br>Compone<br>Reference4p2.txt;<br>30pctCO2RdxUSA.txt;  | ents                  |  | ate<br>:24 EST 2016<br>:31 EST 2016   | Analyze                 |
| Vorking Scenarios<br>Run Name<br>Ref4p2<br>30pctCO2RdxUSA<br>40pctCO2RdxUSA                                     | filter:<br>Compone<br>Reference4p2.txt;   | ents                  | Mon Feb 08 14:04<br>Mon Feb 08 15:01   | ate<br>:24 EST 2016<br>:31 EST 2016<br>:31 EST 2016   | Analyze<br>Run Selected |
| Vorking Scenarios<br>Run Name<br>Ref4p2<br>30pctCO2RdxUSA<br>40pctCO2RdxUSA<br>50pctCO2RdxUSA                   | filter: Compone<br>Reference4p2.txt;<br>30pctCO2RdxUSA.txt;<br>40pctCO2RdxUSA.txt;  | ents                  | Mon Feb 08 14:04<br>Mon Feb 08 15:01<br>Mon Feb 08 15:01   | ate<br>:24 EST 2016<br>:31 EST 2016<br>:31 EST 2016<br>:31 EST 2016                                 | Analyze<br>Run Selected |
| Vorking Scenarios<br>Run Name<br>Ref4p2<br>30pctCO2RdxUSA<br>40pctCO2RdxUSA<br>50pctCO2RdxUSA<br>50pctCO2RdxUSA | filter:<br>Compone<br>Reference4p2.txt;<br>30pctCO2RdxUSA.txt;<br>40pctCO2RdxUSA.txt;<br>50pctCO2RdxUSA.txt;                        | ents                  | Mon Feb 08 14:04<br>Mon Feb 08 15:01<br>Mon Feb 08 15:01<br>Mon Feb 08 15:01                     | ate<br>:24 EST 2016<br>:31 EST 2016<br>:31 EST 2016<br>:31 EST 2016<br>:31 EST 2016                 | Analyze<br>Run Selected |
| Vorking Scenarios   | filter:<br>Compone<br>Reference4p2.txt;<br>30pctCO2RdxUSA.txt;<br>40pctCO2RdxUSA.txt;<br>50pctCO2RdxUSA.txt;<br>60pctCO2RdxUSA.txt; | ents                  | Mon Feb 08 14:04<br>Mon Feb 08 15:01<br>Mon Feb 08 15:01<br>Mon Feb 08 15:01<br>Mon Feb 08 15:01 | ate<br>:24 EST 2016<br>:31 EST 2016<br>:31 EST 2016<br>:31 EST 2016<br>:31 EST 2016<br>:31 EST 2016 | Analyze<br>Run Selected |

## Invoking the Enhanced Model Interface to view results

#### 🛃 [C:\Projects\GCAM\GCAM\_4p2\Main\_User\_Workspace\output\database\_basexdb] - ModelInterface



File Edit Table Help

| Scenario                               | Regions                       | Queries  |
|--|-------------------------------|--|
| Ref4p2 2016-8-2T14:04:25-05:00         | USA                           | 🔺 📗 queries 🔺  |
| 30pctCO2RdxUSA 2016-8-2T15:01:32-05:00 | Africa_Eastern                | 🔲 🖨 Primary Energy 📰   |
| 40pctCO2RdxUSA 2016-8-2T15:46:21-05:00 | Africa_Northern               | Primary Energy Consumption (Average Fossil Efficiency Conversion)  |
| 50pctCO2RdxUSA 2016-8-2T16:16:28-05:00 | Africa_Southern               | E Primary Energy Consumption (Direct Equivalent)                   |
| 60pctCO2RdxUSA 2016-8-2T16:51:10-05:00 | Africa_Western                |  |
| 70pctCO2RdxUSA 2016-8-2T17:12:26-05:00 | Australia_NZ                  |  |
| 80pctCO2RdxUSA 2016-8-2T17:39:01-05:00 | Brazil                        | Regional primary energy costs                                      |
| Reference 2016-9-8T08:47:31-04:00      | Canada                        | Electricity  |
| Test 2016-3-10T21:58:08+20:00          | Central America and Caribbean |  |
|  | Central Asia                  | Electricity generation by region (central only)                    |
|  | China                         |  |
|  | EU-12                         | Electricity generation by aggregate technology_dispatch            |
|  | EU-15                         |  |
|  | Europe_Eastern                | Run Query     Update Single Queries     Create     Remove     Edit |
| J                                      | Europe Non EU                 | epode Single Queres Create Reinove Luit                            |

#### Enhanced Model Interface, showing scenarios that have been run, regions, and outputs



File Edit Table Help

|              |   |                       |          |       |       |            |        |       |       |                               |           |  |                   |             |                                 | Quarter                                    |  |
|--------------|---|-----------------------|----------|-------|-------|------------|--------|-------|-------|-------------------------------|-----------|--|-------------------|-------------|---------------------------------|--|--|
|              | Scen  |                       |          |       |       |            | egions |       |       |                               | ۱h        |  |                   |             |                                 | Queries                                    |  |
|              |   | 14:04:25-05:00        |          |       | USA   |            |        |       |       | <u> </u>                      |           | quer   | es<br>Primary Ene |             |                                 | <u>^</u>                                   |  |
|              |   | 2016-8-2T15:01:32-0   |          |       |       | ca_Eastern |        |       |       |                               |           | _  |                   |             |                                 |  |  |
|              |   | 2016-8-2T15:46:21-0   |          |       |       | ca_Norther |        |       |       |                               |           |  |                   |             |                                 | ion (Average Fossil Efficiency Conversion) |  |
|              |   | 2016-8-2T16:16:28-0   |          |       |       | ca_Southe  |        |       |       | =                             |           | Primary Energy Consumption (Direct Equivalent) |                   |             |                                 |  |  |
| 60pctC0      | 02RdxUSA                                      | 2016-8-2T16:51:10-0   | 5:00     |       |       | ca_Wester  | n      |       |       |                               |           |  |                   |             |                                 |  |  |
| 70pctC0      | 02RdxUSA                                      | 2016-8-2T17:12:26-0   | 5:00     |       | Aus   | tralia_NZ  |        |       |       |                               |           |  |                   |             |                                 |  |  |
| 80pctC0      | 80pctCO2RdxUSA 2016-8-2T17:39:01-05:00 Brazil |                       |          |       |       |            |        |       | 11    | Regional primary energy costs |           |  |                   |             |                                 |  |  |
| Test 20      | Test 2016-4-10T07:44:25-04:00 Canada          |                       |          |       |       |            |        |       | Ш     | 🚊 🚺 E                         | ectricity |  |                   |             |                                 |  |  |
|              | Central America and Caribbean                 |                       |          |       |       |            |        |       |       | Ш                             |           | 📲 Electr                                       | icity gener       | ation by re | egion (incl rooftop PV and CHP) |  |  |
|              | Central Asia                                  |                       |          |       |       |            |        |       |       | Ш                             |           | 🛛 a Electr                                     | icity gener       | ation by re | egion (central only)            |  |  |
|              |   |                       |          |       | Chir  | na         |        |       |       |                               | Ш         |  | 📲 Electr          | icity gener | ation by ag                     | ggregate technology                        |  |
|              |   |                       |          |       | EU-   | 12         |        |       |       |                               | Ш         |  |                   |             | enerate list                    |  |  |
|              |   |                       |          |       | EU-   | 15         |        |       |       |                               |           |  | Electr            | icity gener | ation by a                      | ggregate technology_dispatch               |  |
|              |   |                       |          |       | Euro  | ope_Easter | m      |       |       |                               |           |  | · · · ·           |             |                                 |  |  |
|              |   |                       |          |       |       | one Non F  |        |       |       | Ψ.                            |           |  | uery              |             | Update S                        | Single Queries Create Remove Edit          |  |
|              |   |                       |          |       |       |            |        |       |       |                               | $\sim$    | 16   |                   |             |                                 |  |  |
| Elect        | ricity gener                                  | ation by aggregate te | chnology |       |       |            |        |       |       |                               | Ϊ         | In   | <b>`</b>          |             |                                 |  |  |
|              |   |                       |          |       |       |            |        |       |       | ——(`                          |           | - /  | /                 |             |                                 |  |  |
| scenario     |   | n technology          | 1990     | 2005  | 2010  | 2015       | 2020   | 2025  | 2030  | 2035                          | 20        |  | 2045              | 2050        | 2055                            |  |  |
| Test,date    | e= USA  | a Coal                | 6.029    | 7.68  | 7.105 |            | 8.118  | 7.949 |       |                               |           | p.274  | 5.301             | 4.302       |                                 | Display 1 LineChart - Same Scale           |  |
| 11 · · · · · | e= USA  | b Coal w/CCS          | 0        | _     | 0     | -          | _      | 0.021 |       | 0.23                          |           | 0.493  | 0.82              | 1.212       | 1.626                           | 2 *  |  |
| <u> </u>     | e= USA  | c Gas                 | 1.026    | 2,569 | 3.385 | 3.88       | 3.934  | 4.09  |       | 4.346                         |           | 4.416  | 4.334             | 4.178       | 3.989                           |  |  |
| Test,date    | e= USA  | d Gas w/CCS           | 0        | 0     | 0     | 0          | 0      | 0.041 | 0.149 | 0.344                         |           | 0.669  | 1.036             | 1.434       | 1.826                           |  |  |
| Test,date    | e= USA  | e Oil                 | 0.451    | 0.455 | 0.145 | 0.111      | 0.103  | 0.104 | 0.102 | 0.098                         |           | 0.098  | 0.098             | 0.104       | 0.106                           |  |  |
| Test,date    | e= USA  | f Oil w/CCS           | 0        | 0     | 0     | 0          | 0      | 0.013 | 0.033 | 0.062                         |           | 0.11   | 0.165             | 0.243       | 0.323                           |  |  |
| Test,date    | e= USA  | g Biomass             | 0.079    | 0.111 | 0.115 | 0.064      | 0.084  | 0.118 | 0.158 | 0.195                         |           | 0.233  | 0.257             | 0.27        | 0.263                           | Electricity generation by aggregate        |  |
| Test,date    | e= USA  | h Biomass w/          | 0        | 0     | 0     | 0          | 0      | 0.008 | 0.035 | 0.1                           |           | 0.234  | 0.423             | 0.686       | 0.988                           | technology                                 |  |
| Test,date    | e= USA  | i Nuclear             | 2.201    | 2.919 | 3.02  | 3.213      | 3.199  | 3.282 | 3.542 | 3.969                         |           | 4.665  | 5.342             | 6.04        | 6.737                           |  |  |
| Test,date    | e= USA  | j Geothermal          | 0.058    | 0.06  | 0.063 | 0.117      | 0.141  | 0.208 | 0.327 | 0.477                         |           | 0.613  | 0.74              | 0.795       | 0.795                           | 10   |  |
| Test,date    | := USA  | k Hydro               | 0.983    | 0.982 | 0.945 | 0.954      | 0.964  | 0.974 | 0.984 | 0.994                         |           | 0.998  | 1.003             | 1.007       | 1.011                           |  |  |
| Test.date    | = USA   | l Wind                | 0.011    | 0.064 | 0.343 | 0.458      | 0.503  | 0.631 | 0.911 | 1.358                         |           | 1.751  | 2,452             | 3.294       | 4.079                           |  |  |
| <u> </u>     | = USA   | m Solar               | 0.002    |       | 0.014 |            | 0.035  |       |       | 0.205                         |           | 0.35   | 0.51              | 0.705       | 0.907                           | H G  |  |
| <u> </u>     | = USA   | n CHP                 | 0.689    |       | 0.538 | 0.485      | 0.654  | 0.826 | 0.931 | 0.988                         |           | 0.976  | 0.945             | 0.91        | 0.815                           |  |  |
| Corporte     |   | in shi                | 0.005    | 0.022 | 0.000 | 0, 100     | 0.001  | 0.020 | 0.001 | 0.000                         |           | 5.570  | 01010             | 0.91        | 0.013                           | tin 6<br>dtn 4                             |  |
|              |   |                       |          |       |       |            |        |       |       |                               |           |  |                   |             |                                 |  |  |
|              |   |                       |          |       |       |            |        |       |       |                               |           |  |                   |             |                                 |  |  |
|              |   |                       |          |       |       |            |        |       |       |                               |           |  |                   |             |                                 |  |  |
|              |   |                       |          |       |       |            |        |       |       |                               |           |  |                   |             |                                 | 060606060606060606060                      |  |
|              |   |                       |          |       |       |            |        |       |       |                               |           |  |                   |             |                                 | ~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~     |  |
|              |   |                       |          |       |       |            |        |       |       |                               |           |  |                   |             |                                 |  |  |
|              |   |                       |          |       |       |            |        |       |       |                               |           |  |                   |             |                                 | Year                                       |  |
|              |   |                       |          |       |       |            |        |       |       |                               |           |  |                   |             |                                 |  |  |
|              |   |                       |          |       |       |            |        |       |       |                               |           |  |                   |             |                                 |  |  |
|              |   |                       |          |       |       |            |        |       |       |                               |           |  |                   |             |                                 |  |  |
| •            |   |                       |          |       |       |            |        |       |       |                               |           |  |                   |             | P.                              | L  |  |
|              |   |                       |          |       |       |            |        |       |       |                               | -         |  |                   | _           |                                 |  |  |

#### Electricity production by technology for Test

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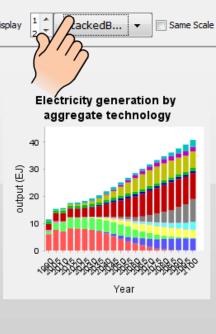
File Edit Table Help

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| Scenario                               | Regions                       |          | Queries   |
|--|-------------------------------|----------|---|
| Ref4p2 2016-8-2T14:04:25-05:00         | USA                           | *        | 📔 queries 🔺   |
| 30pctCO2RdxUSA 2016-8-2T15:01:32-05:00 | Africa_Eastern                |          | 🚊 🕒 Primary Energy  |
| 40pctCO2RdxUSA 2016-8-2T15:46:21-05:00 | Africa_Northern               |          | Primary Energy Consumption (Average Fossil Efficiency Conversion) |
| 50pctCO2RdxUSA 2016-8-2T16:16:28-05:00 | Africa_Southern               | =        | Primary Energy Consumption (Direct Equivalent)                    |
| 60pctCO2RdxUSA 2016-8-2T16:51:10-05:00 | Africa_Western                |          | Primary energy with CCS (Direct Equivalent)                       |
| 70pctCO2RdxUSA 2016-8-2T17:12:26-05:00 | Australia_NZ                  |          | Resource production   |
| 80pctCO2RdxUSA 2016-8-2T17:39:01-05:00 | Brazil                        |          | Regional primary energy costs                                     |
| Test 2016-4-10T07:44:25-04:00          | Canada                        |          | 🚊 🔒 Electricity   |
|  | Central America and Caribbean |          | Electricity generation by region (incl rooftop PV and CHP)        |
|  | Central Asia                  |          | Electricity generation by region (central only)                   |
|  | China                         |          | 🛱 🛲 Electricity generation by aggregate technology                |
|  | EU-12                         |          | Could not generate list.  |
|  | EU-15                         |          | Electricity generation by aggregate technology_dispatch           |
|  | Europe_Eastern                |          | Run Query Update Single Queries Create Remove Edit                |
| I                                      | Europe Non El                 | <b>T</b> |   |

#### Electricity generation by aggregate technology

| scenario   | region | technology   | 1990  | 2005  | 2010  | 2015  | 2020   | 2025  | 2030  | 2035  | 2040  | 2045  | 2050  | 2055  |            |             |
|------------|--------|--------------|-------|-------|-------|-------|--------|-------|-------|-------|-------|-------|-------|-------|------------|-------------|
| Test,date= | USA    | a Coal       | 6.029 | 7.68  | 7.105 | 8.216 | 8.118  | 7.949 | 7.634 | 7.051 | 6.274 | 5.301 | 4.302 | 3.396 | Display 1  | $^{\wedge}$ |
| Test,date= | USA    | b Coal w/CCS | 0     | 0     | 0     | 0     | 0      | 0.021 | 0.088 | 0.23  | 0.493 | 0.82  | 1.212 | 1.626 | 2          | $\sqrt{6}$  |
| Test,date= | USA    | c Gas        | 1.026 | 2.569 | 3.385 | 3.88  | 3.934  | 4.09  | 4.257 | 4.346 | 4.416 | 4.334 | 4.178 | 3.989 |            | ] / [       |
| Test,date= | USA    | d Gas w/CCS  | 0     | 0     | 0     | 0     | 0      | 0.041 | 0.149 | 0.344 | 0.669 | 1.036 | 1.434 | 1.826 |            |             |
| Test,date= | USA    | e Oil        | 0.451 | 0.455 | 0.145 | 0.111 | 0.103  | 0.104 | 0.102 | 0.098 | 0.098 | 0.098 | 0.104 | 0.106 |            |             |
| Test,date= | USA    | f Oil w/CCS  | 0     | 0     | 0     | 0     | 0      | 0.013 | 0.033 | 0.062 | 0.11  | 0.165 | 0.243 | 0.323 |            | 1           |
| Test,date= | USA    | g Biomass    | 0.079 | 0.111 | 0.115 | 0.064 | 0.084  | 0.118 | 0.158 | 0.195 | 0.233 | 0.257 | 0.27  | 0.263 | E          | lectri      |
| Test,date= | USA    | h Biomass w/ | 0     | 0     | 0     | 0     | 0      | 0.008 | 0.035 | 0.1   | 0.234 | 0.423 | 0.686 | 0.988 |            | aggre       |
| Test,date= | USA    | i Nuclear    | 2.201 | 2.919 | 3.02  | 3.213 | 3, 199 | 3.282 | 3.542 | 3.969 | 4.665 | 5.342 | 6.04  | 6.737 |            |             |
| Test,date= | USA    | j Geothermal | 0.058 | 0.06  | 0.063 | 0.117 | 0.141  | 0.208 | 0.327 | 0.477 | 0.613 | 0.74  | 0.795 | 0.795 | 40         | -           |
| Test,date= | USA    | k Hydro      | 0.983 | 0.982 | 0.945 | 0.954 | 0.964  | 0.974 | 0.984 | 0.994 | 0.998 | 1.003 | 1.007 | 1.011 |            |             |
| Test,date= | USA    | l Wind       | 0.011 | 0.064 | 0.343 | 0.458 | 0.503  | 0.631 | 0.911 | 1.358 | 1.751 | 2.452 | 3.294 | 4.079 | <u></u> 30 | -           |
| Test,date= | USA    | m Solar      | 0.002 | 0.004 | 0.014 | 0.027 | 0.035  | 0.058 | 0.111 | 0.205 | 0.35  | 0.51  | 0.705 | 0.907 | Ŭ<br>Ŭ     |             |
| Test,date= | USA    | n CHP        | 0.689 | 0.522 | 0.538 | 0.485 | 0.654  | 0.826 | 0.931 | 0.988 | 0.976 | 0.945 | 0.91  | 0.815 | 10 th      |             |



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#### Changing the thumbnail display type

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Year

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File Edit Table Help

| Scenario                               | Regions                       | Queries  |   |  |  |  |  |  |
|--|-------------------------------|----------|---|--|--|--|--|--|
| Ref4p2 2016-8-2T14:04:25-05:00         | USA                           | <b>^</b> | 📔 queries 🔺   |  |  |  |  |  |
| 30pctCO2RdxUSA 2016-8-2T15:01:32-05:00 | Africa_Eastern                |          | 📄 🌗 Primary Energy 📃  |  |  |  |  |  |
| 40pctCO2RdxUSA 2016-8-2T15:46:21-05:00 | Africa_Northern               |          |   |  |  |  |  |  |
| 50pctCO2RdxUSA 2016-8-2T16:16:28-05:00 | Africa_Southern               | =        |   |  |  |  |  |  |
| 60pctCO2RdxUSA 2016-8-2T16:51:10-05:00 | Africa_Western                |          | Primary energy with CCS (Direct Equivalent)   |  |  |  |  |  |
| 70pctCO2RdxUSA 2016-8-2T17:12:26-05:00 | Australia_NZ                  |          | Resource production<br>Regional primary energy costs  |  |  |  |  |  |
| 80pctCO2RdxUSA 2016-8-2T17:39:01-05:00 | Brazil                        |          |   |  |  |  |  |  |
| Test 2016-4-10T07:44:25-04:00          | Canada                        |          | 🚊 🔒 Electricity   |  |  |  |  |  |
|  | Central America and Caribbean |          | Electricity generation by region (incl rooftop PV and CHP)  |  |  |  |  |  |
|  | Central Asia                  |          | Electricity generation by region (central only)   |  |  |  |  |  |
|  | China                         |          | Electricity generation by aggregate technology Could not generate list. Electricity generation by aggregate technology_dispatch |  |  |  |  |  |
|  | EU-12                         |          |   |  |  |  |  |  |
|  | EU-15                         |          |   |  |  |  |  |  |
|  | Europe_Eastern                |          | Run Query Update Single Queries Create Remove Edit  |  |  |  |  |  |
| J                                      | Europe Non El                 | Ψ.       | Create Relifove Edit  |  |  |  |  |  |

#### Electricity generation by aggregate technology

| scenario   | region | technology   | 1990  | 2005  | 2010  | 2015  | 2020   | 2025  | 2030  | 2035  | 2040  | 2045  | 2050  | 2055  |  |
|------------|--------|--------------|-------|-------|-------|-------|--------|-------|-------|-------|-------|-------|-------|-------|--|
| Fest,date= | . USA  | a Coal       | 6.029 | 7.68  | 7.105 | 8.216 | 8.118  | 7.949 | 7.634 | 7.051 | 6.274 | 5.301 | 4.302 | 3.396 | 6 Display <sup>1</sup> _ StackedB □ Same Sca |
| est,date=  | . USA  | b Coal w/CCS | 0     | 0     | 0     | 0     | 0      | 0.021 | 0.088 | 0.23  | 0.493 | 0.82  | 1.212 | 1.626 |  |
| est,date=  | . USA  | c Gas        | 1.026 | 2.569 | 3.385 | 3.88  | 3.934  | 4.09  | 4.257 | 4.346 | 4.416 | 4.334 | 4.178 | 3.989 | 9  |
| est,date=  | . USA  | d Gas w/CCS  | 0     | 0     | 0     | 0     | 0      | 0.041 | 0.149 | 0.344 | 0.669 | 1.036 | 1.434 | 1.826 | 6  |
| est,date=  | . USA  | e Oil        | 0.451 | 0.455 | 0.145 | 0.111 | 0.103  | 0.104 | 0.102 | 0.098 | 0.098 | 0.098 | 0.104 | 0.106 | 6  |
| est,date=  | . USA  | f Oil w/CCS  | 0     | 0     | 0     | 0     | 0      | 0.013 | 0.033 | 0.062 | 0.11  | 0.165 | 0.243 | 0.323 |  |
| est,date=  | . USA  | g Biomass    | 0.079 | 0.111 | 0.115 | 0.064 | 0.084  | 0.118 | 0.158 | 0.195 | 0.233 | 0.257 | 0.27  | 0.263 | 3 Electricity generation by                  |
| est,date=  | . USA  | h Biomass w/ | 0     | 0     | 0     | 0     | 0      | 0.008 | 0.035 | 0.1   | 0.234 | 0.423 | 0.686 | 0.988 | aggregate technology                         |
| est,date=  | . USA  | i Nuclear    | 2.201 | 2.919 | 3.02  | 3.213 | 3, 199 | 3.282 | 3.542 | 3.969 | 4.665 | 5.342 | 6.04  | 6.737 | 7  |
| est,date=  | . USA  | j Geothermal | 0.058 | 0.06  | 0.063 | 0.117 | 0.141  | 0.208 | 0.327 | 0.477 | 0.613 | 0.74  | 0.795 | 0.795 | 5 40   |
| est,date=  | . USA  | k Hydro      | 0.983 | 0.982 | 0.945 | 0.954 | 0.964  | 0.974 | 0.984 | 0.994 | 0.998 | 1.003 | 1.007 | 1.011 |  |
| est,date=  | . USA  | l Wind       | 0.011 | 0.064 | 0.343 | 0.458 | 0.503  | 0.631 | 0.911 | 1.358 | 1.751 | 2.452 | 3.294 | 4.079 | 9 💮 30 -                                     |
| est,date=  | . USA  | m Solar      | 0.002 | 0.004 | 0.014 | 0.027 | 0.035  | 0.058 | 0.111 | 0.205 | 0.35  | 0.51  | 0.705 | 0.907 |  |
| est,date=  | . USA  | n CHP        | 0.689 | 0.522 | 0.538 | 0.485 | 0.654  | 0.826 | 0.931 | 0.988 | 0.976 | 0.945 | 0.91  | 0.815 | 9 (ĵ 30 -<br>7 U)<br>5 Ind 20                |
|            |        |              |       |       |       |       |        |       |       |       |       |       |       |       |  |

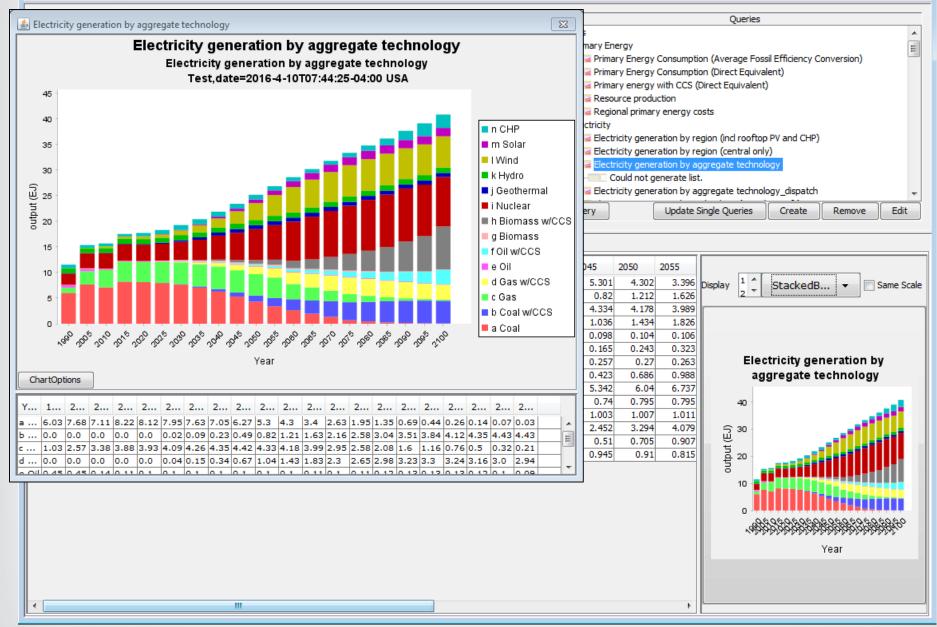
#### Clicking on the thumbnail...

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File Edit Table Help

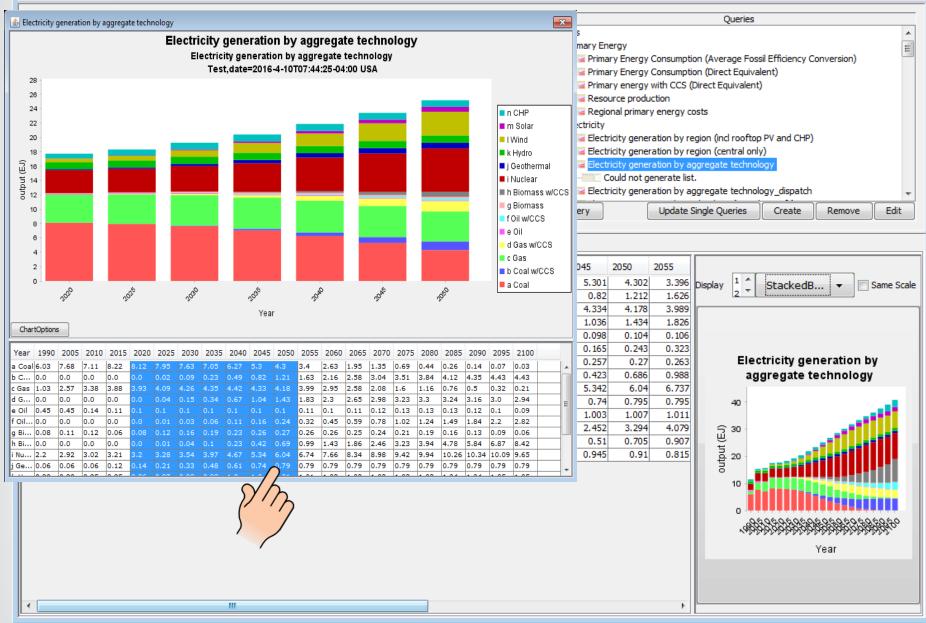


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[C:\Projects\GCAM\GCAM\_4p2\Main\_User\_Workspace\output\database\_basexdb] - ModelInterface

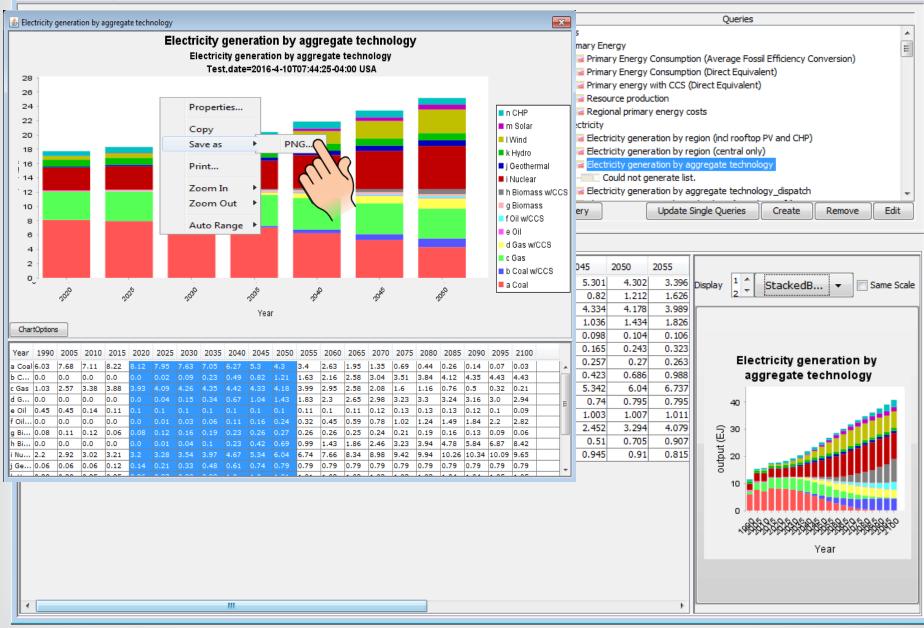
File Edit Table Help



#### You can highlight which data to show on the graphic

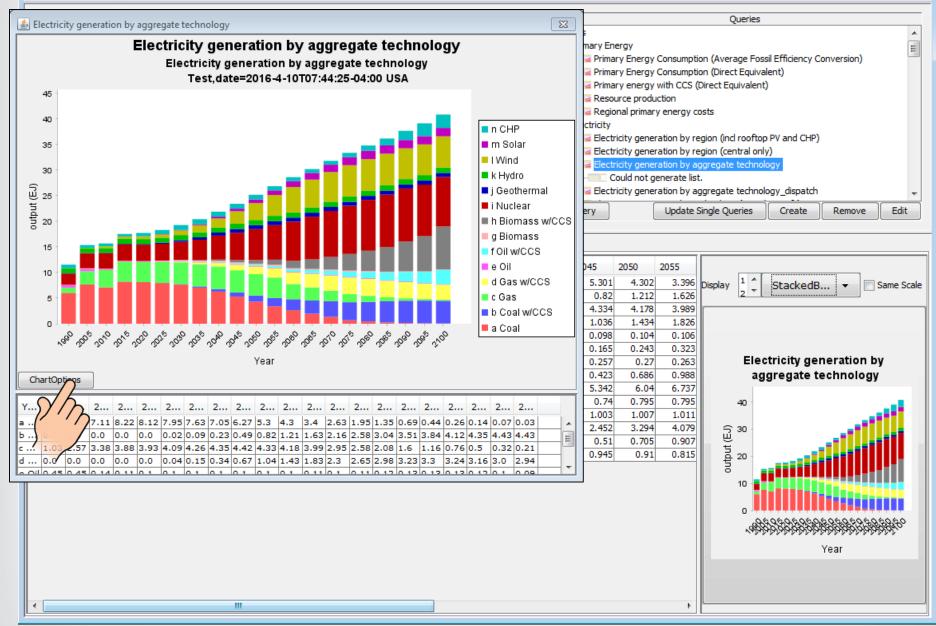


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#### And save the graphic as a png file

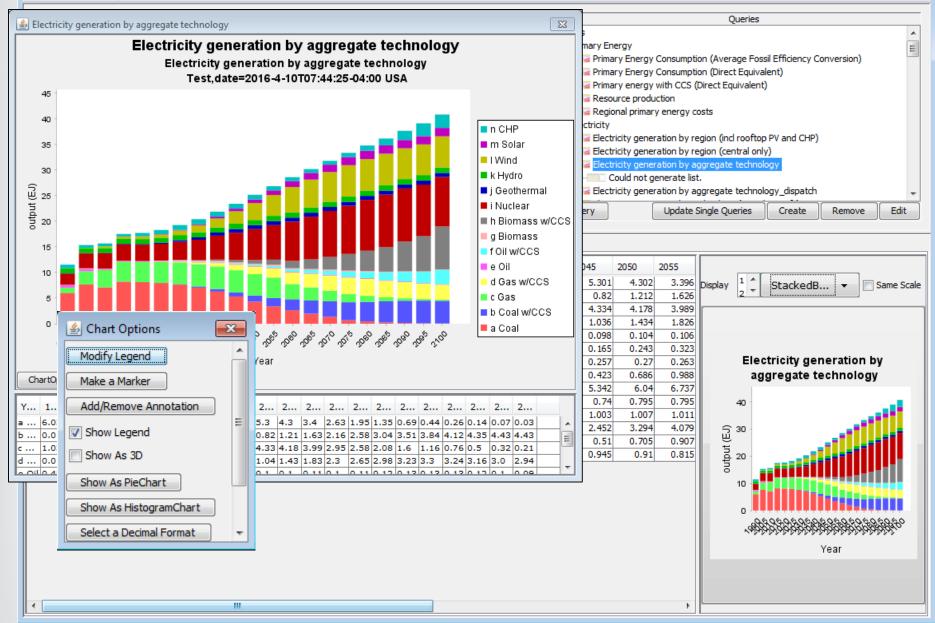
File Edit Table Help



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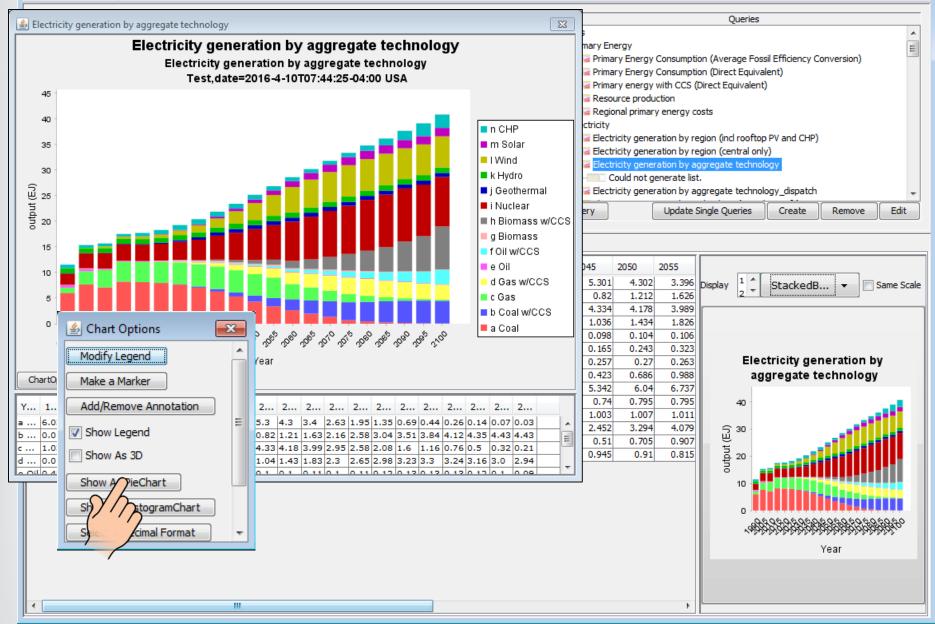
#### Plots support additional functions

File Edit Table Help



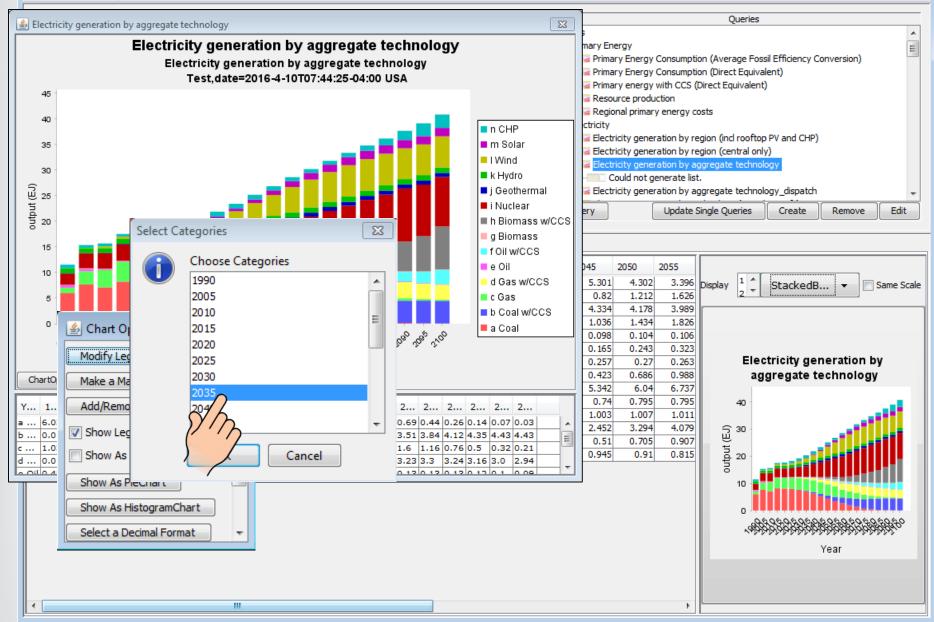
#### Plots support additional functions

File Edit Table Help



Plots support additional functions

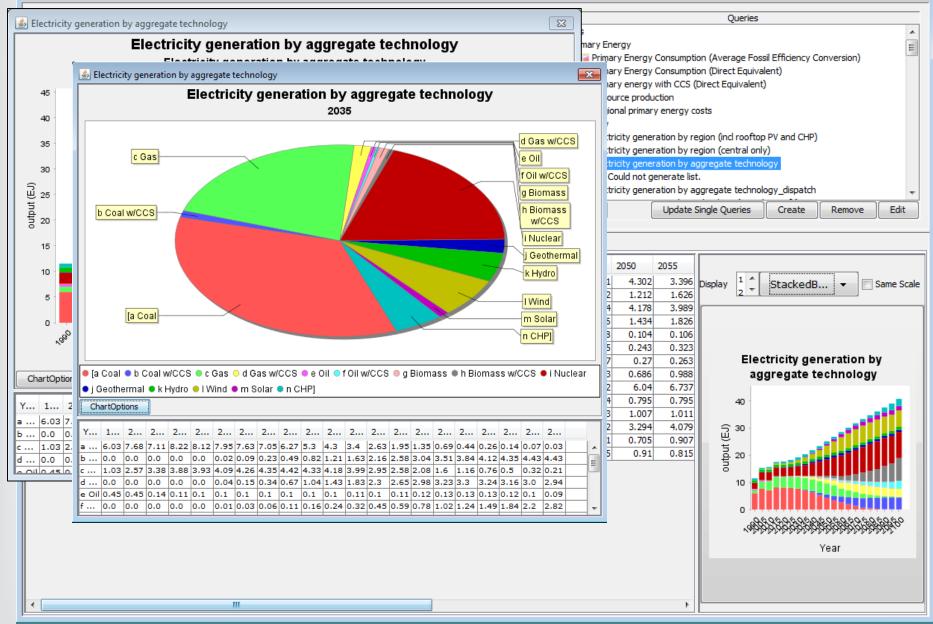
File Edit Table Help



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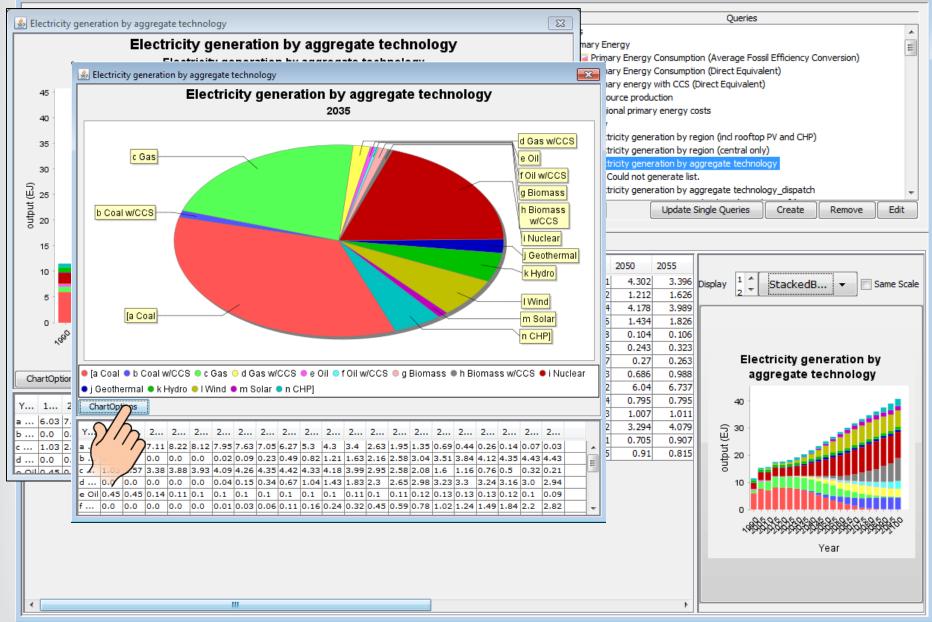
#### Plots support additional functions

File Edit Table Help



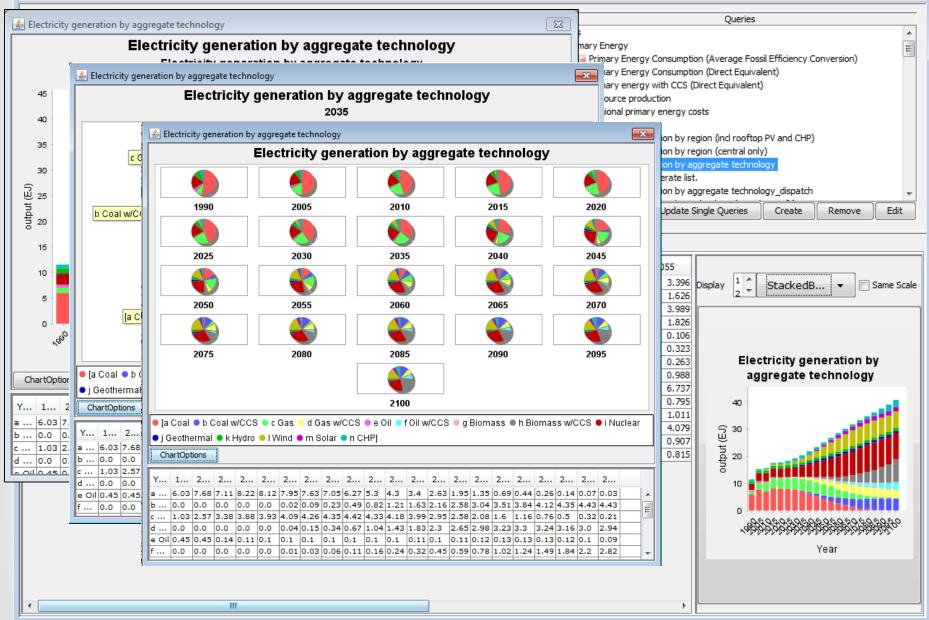
Plots support additional functions, such as year-specific pie charts

File Edit Table Help



Plots support additional functions, such as year-specific pie charts

File Edit Table Help



- C X

Plots support additional functions, such as year-specific pie charts and multiple pie charts

#### 

File Edit Table Help

| Scenario                               | Regions                       | Queries   |
|--|-------------------------------|---|
| Ref4p2 2016-8-2T14:04:25-05:00         | USA 🔺                         | 📔 queries 🔹   |
| 30pctCO2RdxUSA 2016-8-2T15:01:32-05:00 | Africa_Eastern                | 📄 📲 Primary Energy  |
| 40pctCO2RdxUSA 2016-8-2T15:46:21-05:00 | Africa_Northern               | Primary Energy Consumption (Average Fossil Efficiency Conversion) |
| 50pctCO2RdxUSA 2016-8-2T16:16:28-05:00 | Africa_Southern               | Primary Energy Consumption (Direct Equivalent)                    |
| 60pctCO2RdxUSA 2016-8-2T16:51:10-05:00 | Africa_Western                | Primary energy with CCS (Direct Equivalent)                       |
| 70pctCO2RdxUSA 2016-8-2T17:12:26-05:00 | Australia_NZ                  |   |
| 80pctCO2RdxUSA 2016-8-2T17:39:01-05:00 | Brazil                        | Regional primary energy costs                                     |
| Test 2016-4-10T07:44:25-04:00          | Canada                        | 🚊 📲 Electricity   |
|  | Central America and Caribbean | Electricity generation by region (ind rooftop PV and CHP)         |
|  | Central Asia                  | Electricity generation by region (central only)                   |
|  | China                         | Electricity generation by aggregate technology                    |
|  | EU-12                         | Could not generate list.  |
|  | EU-15                         | Electricity generation by aggregate technology_dispatch           |
|  | Europe_Eastern                | Run Query Update Single Queries Create Remove Edit                |
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|    | Scenario                              | Regions                       | Queries   |
|----|---------------------------------------|-------------------------------|---|
|    | Ref4p2 2016-8-2T14:04:25-05:00        | USA                           | Jueries A   |
|    | 3/tCO2RdxUSA 2016-8-2T15:01:32-05:00  | Africa_Eastern                | 🗐 🖳 Primary Energy  |
| Н  | ctCO2RdxUSA 2016-8-2T15:46:21-05:00   | Africa_Northern               | Primary Energy Consumption (Average Fossil Efficiency Conversion) |
| )) | O2RdxUSA 2016-8-2T16:16:28-05:00      | Africa_Southern               | Primary Energy Consumption (Direct Equivalent)                    |
| [  | O2RdxUSA 2016-8-2T16:51:10-05:00      | Africa_Western                | Primary energy with CCS (Direct Equivalent)                       |
|    | CO2RdxUSA 2016-8-2T17:12:26-05:00     | Australia_NZ                  | Resource production   |
|    | opctCO2RdxUSA 2016-8-2T17:39:01-05:00 | Brazil                        |   |
|    | Test 2016-4-10T07:44:25-04:00         | Canada                        | Electricity   |
|    |                                       | Central America and Caribbean | Electricity generation by region (incl rooftop PV and CHP)        |
|    |                                       | Central Asia                  | Electricity generation by region (central only)                   |
|    |                                       | China                         | Electricity generation by aggregate technology                    |
|    |                                       | EU-12                         | Could not generate list.  |
|    |                                       | EU-15                         | Electricity generation by aggregate technology_dispatch           |
|    |                                       | Europe_Eastern                | Run Query Update Single Queries Create Remove Edit                |
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## We can also view and compare multiple scenarios

#### 

#### File Edit Table Help

| The Earce I | able Help    |                   |         |       |       |               |            |        |       |       |                |             |                     |  |
|-------------|--------------|-------------------|---------|-------|-------|---------------|------------|--------|-------|-------|----------------|-------------|---------------------|--|
|             | Scenario     |                   |         |       |       |               | legions    |        |       |       | -              |             |                     | Queries  |
| Ref4p2 201  |              |                   |         |       |       | SA .          | legions    |        |       |       |                | eries       |                     | Quenes   |
|             |              | 6-8-2T15:01:32-05 | 5:00    |       |       | rica_Easter   |            |        |       | -     |                | Primary En  | erav                | =  |
|             |              | 6-8-2T15:46:21-05 |         |       |       | rica_Laste    |            |        |       |       |                |             |                     | Imption (Average Fossil Efficiency Conversion)   |
|             |              | 6-8-2T16:16:28-05 |         |       |       | rica_North    |            |        |       |       |                |             |                     | Imption (Direct Equivalent)  |
|             |              | 6-8-2T16:51:10-05 |         |       |       | rica_30001    |            |        |       | E     |                |             |                     | CCS (Direct Equivalent)  |
|             |              | 6-8-2T17:12:26-05 |         |       |       | istralia NZ   |            |        |       |       |                |             | urce production     | Co (Direct Equivalent)   |
|             |              | 6-8-2T17:12:26-05 |         |       |       | azil          |            |        |       |       |                |             | and primary energy  | av ceste   |
|             |              |                   | 5:00    |       |       | azii<br>anada |            |        |       |       |                | Electricity | nai prinai y ener   | gy costs   |
| Test 2016-  | 4-10T07:44   | :25-04:00         |         |       |       | entral Amer   |            |        |       |       |                |             | isity concration    | by region (incl rooftop PV and CHP)  |
|             |              |                   |         |       |       | entral Amer   | ica anu ca | nobean |       |       |                |             |                     | by region (central only)   |
|             |              |                   |         |       |       | ina Asia      |            |        |       |       |                |             |                     | by aggregate technology  |
|             |              |                   |         |       |       | ina<br>1-12   |            |        |       |       | 11 7           |             | ould not generation |  |
|             |              |                   |         |       |       | -12<br> -15   |            |        |       |       |                |             | -                   | by aggregate technology_dispatch   |
|             |              |                   |         |       |       |               |            |        |       |       |                |             |                     |  |
|             |              |                   |         |       |       | rope_East     |            |        |       | -     | R              | Query       | Update              | e Single Queries Create Remove Edit  |
|             |              |                   |         |       |       |               |            |        |       |       | N              | 2           |                     |  |
| Electricity | v generation | by aggregate tec  | hnology |       |       |               |            |        |       |       | $\mathcal{V}'$ | 5           |                     |  |
|             | y generation | rby aggregate tee |         |       |       |               |            |        |       |       | (* ·           | 1/          |                     |  |
| scenario    | region       | technology        | 1990    | 2005  | 2010  | 2015          | 2020       | 2025   | 2030  | 2035  | 2040           | 2045        | 2050 205            |  |
| 30pctCO2R   | . USA        | a Coal            | 6.029   | 7.68  | 7.105 |               | 8.788      |        |       |       | 6.#32          |             | 6.049               | Display 1 🔶 LineChart 👻 🗌 Same Sca   |
| 30pctCO2R   |              | b Coal w/CCS      | 0       | 0     | 0     | - v           | 0          | 0.001  | 0.129 |       | 0.441          |             | 0.775               |  |
| 30pctCO2R   |              | c Gas             | 1.026   | 2.569 | 3.385 | 3.88          | 4.276      | 4.045  |       |       | 4.451          |             | 4.609               | Electricity generation by  |
| 30pctCO2R   |              | d Gas w/CCS       | 0       | 0     | 0     | -             | 0          | 0.002  | 0.175 |       | 0.599          |             | 1.034               | aggregate technology   |
| 30pctCO2R   |              | e Oil             | 0.451   | 0.455 | 0.145 |               | 0.107      | 0.106  | 0.107 | 0.101 | 0.099          |             | 0.102               | aggregate technology   |
| 30pctCO2R   |              | f Oil w/CCS       | 0       | 0     | 0     | -             | 0          |        |       |       | 0.087          |             | 0.128 (             |  |
| 30pctCO2R   |              | g Biomass         | 0.079   | 0.111 | 0.115 |               | 0.071      | 0.114  | 0.153 |       | 0.218          |             | 0.295 (             | 8  |
| 30pctCO2R   |              | h Biomass w/      | 0       | 0     | 0     | -             | 0          | -      | 0.061 | 0.129 | 0.203          |             | 0.355               | 1 S  |
| 30pctCO2R   |              | i Nuclear         | 2.201   | 2.919 | 3.02  |               | 3.303      |        | 3.534 |       | 4.433          |             | 5.288               | 2°   |
| 30pctCO2R   |              | j Geothermal      | 0.058   | 0.06  | 0.063 |               | 0.161      | 0.164  | 0.32  |       | 0.577          |             | 0.77                | E a a a a a a a a a a a a a a a a a a a  |
| 30pctCO2R   |              | k Hydro           | 0.983   | 0.982 | 0.945 |               | 0.964      |        |       |       | 0.998          |             | 1.007               | B ATTACK AND AND A |
| 30pctCO2R   |              | l Wind            | 0.011   | 0.064 | 0.343 |               | 0.542      |        | 0.909 |       | 1.604          |             | 2.708               | 2  |
| 30pctCO2R   |              | m Solar           | 0.002   | 0.004 | 0.014 |               | 0.039      | 0.046  | 0.115 |       | 0.318          |             | 0.586 (             |  |
| 30pctCO2R   |              | n CHP             | 0.689   | 0.522 | 0.538 | 0.485         | 0.512      |        | 0.983 | 0.99  | 0.959          |             | 0.948 (             | 060606060606060606060  |
| Test,date=  |              | a Coal            | 6.029   | 7.68  | 7.105 |               | 8,118      | 7.949  | 7.634 |       | 6.274          |             | 4.302               | ~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~   |
| Test,date=  |              | b Coal w/CCS      | 0       | 0     | 0     | -             | 0          |        | 0.088 | 0.23  | 0.493          |             | 1.212               | Year   |
| Test,date=  |              | c Gas             | 1.026   | 2.569 | 3.385 |               | 3.934      |        | 4.257 | 4.346 | 4.416          |             | 4.178               |  |
| Test,date=  |              | d Gas w/CCS       | 0       | 0     | 0     | -             | 0          | 0.041  | 0.149 |       | 0.669          |             | 1.434               | Electricity generation by  |
| Test,date=  |              | e Oil             | 0.451   | 0.455 | 0.145 |               | 0.103      |        | 0.102 |       | 0.098          |             | 0.104               | aggregate technology   |
| Test,date=  |              | f Oil w/CCS       | 0       | 0     | 0     |               | 0          | 0.013  | 0.033 |       | 0.11           |             | 0.243               |  |
| Test,date=  |              | g Biomass         | 0.079   | 0.111 | 0.115 |               | 0.084      | 0.118  | 0.158 | 0.195 | 0.233          |             | 0.27                | 10 -   |
| Test,date=  |              | h Biomass w/      | 0       | 0     | 0     | -             | 0          |        | 0.035 |       | 0.234          |             | 0.686               |  |
| Test,date=  |              | i Nuclear         | 2.201   | 2.919 | 3.02  |               | 3.199      | 3.282  |       |       | 4.665          |             | 6.04                |  |
| Test,date=  | . USA        | j Geothermal      | 0.058   | 0.06  | 0.063 | 0.117         | 0.141      | 0.208  | 0.327 | 0.477 | 0.613          | 0.74        | 0.795               |  |
|             |              |                   |         |       |       |               |            |        |       |       |                |             | P                   |  |

## When multiple scenarios and/or regions are selected, graphics for each are created

File Edit Table Help

| Scenario                               | Regions                       |   | Queries   |
|--|-------------------------------|---|---|
| Ref4p2 2016-8-2T14:04:25-05:00         | USA                           | * | 🔰 queries 🔹   |
| 30pctCO2RdxUSA 2016-8-2T15:01:32-05:00 | Africa_Eastern                |   | 🚊 📲 Primary Energy  |
| 40pctCO2RdxUSA 2016-8-2T15:46:21-05:00 | Africa_Northern               |   | Primary Energy Consumption (Average Fossil Efficiency Conversion) |
| 50pctCO2RdxUSA 2016-8-2T16:16:28-05:00 | Africa_Southern               | = |   |
| 60pctCO2RdxUSA 2016-8-2T16:51:10-05:00 | Africa_Western                |   | Primary energy with CCS (Direct Equivalent)                       |
| 70pctCO2RdxUSA 2016-8-2T17:12:26-05:00 | Australia_NZ                  |   |   |
| 80pctCO2RdxUSA 2016-8-2T17:39:01-05:00 | Brazil                        |   | Regional primary energy costs                                     |
| Test 2016-4-10T07:44:25-04:00          | Canada                        |   | 🚊 📲 Electricity   |
|  | Central America and Caribbean |   | Electricity generation by region (incl rooftop PV and CHP)        |
|  | Central Asia                  |   | Electricity generation by region (central only)                   |
|  | China                         |   | Electricity generation by aggregate technology                    |
|  | EU-12                         |   | Could not generate list.  |
|  | EU-15                         |   | Electricity generation by aggregate technology_dispatch           |
|  | Europe_Eastern                | _ | Run Query Update Single Queries Create Remove Edit                |
| J                                      | Europe Non El                 | • |   |

#### 🔀 Electricity generation by aggregate technology

| scenario   | region | technology   | 1990  | 2005  | 2010  | 2015  | 2020  | 2025  | 2030  | 2035  | 2040  | 2045             |   |
|------------|--------|--------------|-------|-------|-------|-------|-------|-------|-------|-------|-------|------------------|---|
| 30pctCO2R  | USA    | a Coal       | 6.029 | 7.68  | 7.105 | 8.216 | 8.788 | 8.114 | 7.506 | 7.121 | 6.832 | 6.4 🔺            | Display 1 StackedBarChart - Same Scale              |
| 30pctCO2R  | USA    | b Coal w/CCS | 0     | 0     | 0     | 0     | 0     | 0.001 | 0.129 | 0.273 | 0.441 | 0.5              |   |
| 30pctCO2R  | USA    | c Gas        | 1.026 | 2.569 | 3.385 | 3.88  | 4.276 | 4.045 | 4.162 | 4.267 | 4.451 | 4.5              |   |
| 30pctCO2R  | USA    | d Gas w/CCS  | 0     | 0     | 0     | 0     | 0     | 0.002 | 0.175 | 0.368 | 0.599 | 0.8              |   |
| 30pctCO2R  | USA    | e Oil        | 0.451 | 0.455 | 0.145 | 0.111 | 0.107 | 0.106 | 0.107 | 0.101 | 0.099 | 0.0              |   |
| 30pctCO2R  | USA    | f Oil w/CCS  | 0     | 0     | 0     | 0     | 0     | 0     | 0.04  | 0.062 | 0.087 | 0.1              |   |
| 30pctCO2R  | USA    | g Biomass    | 0.079 | 0.111 | 0.115 | 0.064 | 0.071 | 0.114 | 0.153 | 0.181 | 0.218 | 0.2              |   |
| 30pctCO2R  | USA    | h Biomass w/ | 0     | 0     | 0     | 0     | 0     | 0     | 0.061 | 0.129 | 0.203 | 0.               | Electricity generation by Electricity generation by |
| 30pctCO2R  | USA    | i Nuclear    | 2.201 | 2.919 | 3.02  | 3.213 | 3.303 | 3.121 | 3.534 | 3.932 | 4.433 | 4.8              |   |
| 30pctCO2R  | USA    | j Geothermal | 0.058 | 0.06  | 0.063 | 0.117 | 0.161 | 0.164 | 0.32  | 0.468 | 0.577 | 0.6              | aggregate technology aggregate technology           |
| 30pctCO2R  | USA    | k Hydro      | 0.983 | 0.982 | 0.945 | 0.954 | 0.964 | 0.974 | 0.984 | 0.994 | 0.998 | 1.0 <sub>E</sub> | S   |
| 30pctCO2R  | USA    | l Wind       | 0.011 | 0.064 | 0.343 | 0.458 | 0.542 | 0.547 | 0.909 | 1.34  | 1.604 | 2.1              |   |
| 30pctCO2R  | USA    | m Solar      | 0.002 | 0.004 | 0.014 | 0.027 | 0.039 | 0.046 | 0.115 | 0.203 | 0.318 | 0.4              | 5 <sup>20</sup> 5 <sub>20</sub>                     |
| 30pctCO2R  | USA    | n CHP        | 0.689 | 0.522 | 0.538 | 0.485 | 0.512 | 0.884 | 0.983 | 0.99  | 0.959 | 0.9              |   |
| Test,date= | USA    | a Coal       | 6.029 | 7.68  | 7.105 | 8.216 | 8.118 | 7.949 | 7.634 | 7.051 | 6.274 | 5.3              |   |
| Test,date= | USA    | b Coal w/CCS | 0     | 0     | 0     | 0     | 0     | 0.021 | 0.088 | 0.23  | 0.493 | 0.               |   |
| Test,date= | USA    | c Gas        | 1.026 | 2.569 | 3.385 | 3.88  | 3.934 | 4.09  | 4.257 | 4.346 | 4.416 | 4.3              |   |
| Test,date= | USA    | d Gas w/CCS  | 0     | 0     | 0     | 0     | 0     | 0.041 | 0.149 | 0.344 | 0.669 | 1.0              | Year Year   |
| Test,date= | USA    | e Oil        | 0.451 | 0.455 | 0.145 | 0.111 | 0.103 | 0.104 | 0.102 | 0.098 | 0.098 | 0.0              |   |
| Test,date= | USA    | f Oil w/CCS  | 0     | 0     | 0     | 0     | 0     | 0.013 | 0.033 | 0.062 | 0.11  | 0.1              |   |
| Test,date= | USA    | g Biomass    | 0.079 | 0.111 | 0.115 | 0.064 | 0.084 | 0.118 | 0.158 | 0.195 | 0.233 | 0.2              |   |
| Test,date= | USA    | h Biomass w/ | 0     | 0     | 0     | 0     | 0     | 0.008 | 0.035 | 0.1   | 0.234 | 0.4              |   |
| Test,date= | USA    | i Nuclear    | 2.201 | 2.919 | 3.02  | 3.213 | 3.199 | 3.282 | 3.542 | 3.969 | 4.665 | 5.3              |   |
| Test,date= | USA    | j Geothermal | 0.058 | 0.06  | 0.063 | 0.117 | 0.141 | 0.208 | 0.327 | 0.477 | 0.613 | 0. 🖵             |   |
| T          | LICA.  | In the same  | 0.000 | 0.000 | 0.045 | 0.054 | 0.004 | 0.074 | 0.004 | 0.004 | 0.000 | 10               |   |
|            |        |              |       |       |       |       |       |       |       |       |       |                  |   |

## We can change the display type to facilitate comparison

File Edit Table Help

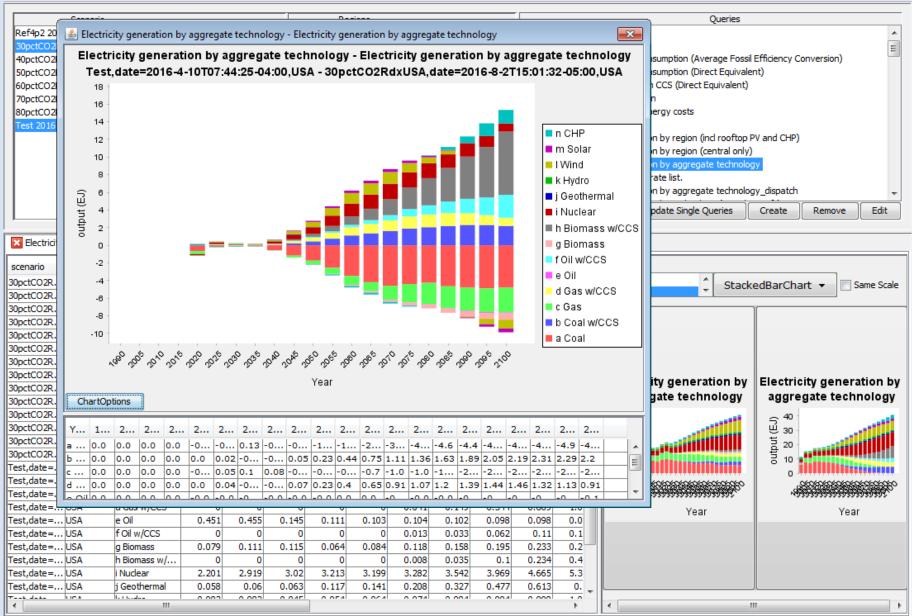
| Scenario                               | Regions                       |   | Queries   |
|--|-------------------------------|---|---|
| Ref4p2 2016-8-2T14:04:25-05:00         | USA                           | * | 🔒 queries 🔹   |
| 30pctCO2RdxUSA 2016-8-2T15:01:32-05:00 | Africa_Eastern                |   | 🚊 📲 Primary Energy  |
| 40pctCO2RdxUSA 2016-8-2T15:46:21-05:00 | Africa_Northern               |   | Primary Energy Consumption (Average Fossil Efficiency Conversion) |
| 50pctCO2RdxUSA 2016-8-2T16:16:28-05:00 | Africa_Southern               | = |   |
| 60pctCO2RdxUSA 2016-8-2T16:51:10-05:00 | Africa_Western                |   |   |
| 70pctCO2RdxUSA 2016-8-2T17:12:26-05:00 | Australia_NZ                  |   |   |
| 80pctCO2RdxUSA 2016-8-2T17:39:01-05:00 | Brazil                        | - | Regional primary energy costs                                     |
| Test 2016-4-10T07:44:25-04:00          | Canada                        |   | Electricity   |
|  | Central America and Caribbean |   | Electricity generation by region (incl rooftop PV and CHP)        |
|  | Central Asia                  |   | Electricity generation by region (central only)                   |
|  | China                         |   | Electricity generation by aggregate technology                    |
|  | EU-12                         |   | Could not generate list.  |
|  | EU-15                         |   | Electricity generation by aggregate technology_dispatch           |
|  | Europe_Eastern                |   | Run Query Update Single Queries Create Remove Edit                |
| J                                      | Europe Non Ell                | Ŧ |   |

#### Electricity generation by aggregate technology

| scenario   | region | technology              | 1990  | 2005  | 2010  | 2015  | 2020  | 2025  | 2030  | 2035  | 2040  | 2045 |     |   |
|------------|--------|-------------------------|-------|-------|-------|-------|-------|-------|-------|-------|-------|------|-----|---|
| 30pctCO2R  | USA    | a Coal                  | 6.029 | 7.68  | 7.105 | 8.216 | 8.788 | 8.114 | 7.506 | 7.121 | 6.832 | 6.4  |     | Display 1 StackedBarChart 🗸 🗖 Same Sca    |
| 30pctCO2R  | USA    | b Coal w/CCS            | 0     | 0     | 0     | 0     | 0     | 0.001 | 0.129 | 0.273 | 0.441 | 0.5  | ٦Ľ  |   |
| 30pctCO2R  | USA    | c Gas                   | 1.026 | 2.569 | 3.385 | 3.88  | 4.276 | 4.045 | 4.162 | 4.267 | 4.451 | 4.5  | Uh  | ) (                                       |
| 30pctCO2R  | USA    | d Gas w/CCS             | 0     | 0     | 0     | 0     | 0     | 0.002 | 0.175 | 0.368 | 0.599 | 0.8  |     |   |
| 30pctCO2R  | USA    | e Oil                   | 0.451 | 0.455 | 0.145 | 0.111 | 0.107 | 0.106 | 0.107 | 0.101 | 0.099 | 0.0  |     | Region Sum                                |
| 30pctCO2R  | USA    | f Oil w/CCS             | 0     | 0     | 0     | 0     | 0     | 0     | 0.04  | 0.062 | 0.087 | 0.1  |     |   |
| 30pctCO2R  | USA    | g Biomass               | 0.079 | 0.111 | 0.115 | 0.064 | 0.071 | 0.114 | 0.153 | 0.181 | 0.218 | 0.2  |     | Difference                                |
| 30pctCO2R  | USA    | h Biomass w/            | 0     | 0     | 0     | 0     | 0     | 0     | 0.061 | 0.129 | 0.203 | 0.   |     | Ele Statistic by Electricity generation b |
| 30pctCO2R  | USA    | i Nuclear               | 2.201 | 2.919 | 3.02  | 3.213 | 3.303 | 3.121 | 3.534 | 3.932 | 4.433 | 4.8  |     |   |
| 30pctCO2R  | USA    | j Geothermal            | 0.058 | 0.06  | 0.063 | 0.117 | 0.161 | 0.164 | 0.32  | 0.468 | 0.577 | 0.6  |     | aggregation in aggregate technology       |
| 30pctCO2R  | USA    | k Hydro                 | 0.983 | 0.982 | 0.945 | 0.954 | 0.964 | 0.974 | 0.984 | 0.994 | 0.998 | 1.0  |     |   |
| 30pctCO2R  | USA    | l Wind                  | 0.011 | 0.064 | 0.343 | 0.458 | 0.542 | 0.547 | 0.909 | 1.34  | 1.604 | 2.1  |     |   |
| 30pctCO2R  | USA    | m Solar                 | 0.002 | 0.004 | 0.014 | 0.027 | 0.039 | 0.046 | 0.115 | 0.203 | 0.318 | 0.4  |     | 5 20 5 20 5 20 5 20 5 20 5 20 5 20 5 20   |
| 30pctCO2R  | USA    | n CHP                   | 0.689 | 0.522 | 0.538 | 0.485 | 0.512 | 0.884 | 0.983 | 0.99  | 0.959 | 0.9  |     |   |
| Test,date= | USA    | a Coal                  | 6.029 | 7.68  | 7.105 | 8.216 | 8.118 | 7.949 | 7.634 | 7.051 | 6.274 | 5.3  |     |   |
| Test,date= | USA    | b Coal w/CCS            | 0     | 0     | 0     | 0     | 0     | 0.021 | 0.088 | 0.23  | 0.493 | 0.   |     | 0403004030303030303030                    |
| Test,date= | USA    | c Gas                   | 1.026 | 2.569 | 3.385 | 3.88  | 3.934 | 4.09  | 4.257 | 4.346 | 4.416 | 4.3  |     |   |
| Test,date= | USA    | d Gas w/CCS             | 0     | 0     | 0     | 0     | 0     | 0.041 | 0.149 | 0.344 | 0.669 | 1.0  |     | Year Year                                 |
| Test,date= | USA    | e Oil                   | 0.451 | 0.455 | 0.145 | 0.111 | 0.103 | 0.104 | 0.102 | 0.098 | 0.098 | 0.0  |     |   |
| Test,date= | USA    | f Oil w/CCS             | 0     | 0     | 0     | 0     | 0     | 0.013 | 0.033 | 0.062 | 0.11  | 0.1  |     |   |
| Test,date= | USA    | g Biomass               | 0.079 | 0.111 | 0.115 | 0.064 | 0.084 | 0.118 | 0.158 | 0.195 | 0.233 | 0.2  | 1   |   |
| Test,date= | USA    | h Biomass w/            | 0     | 0     | 0     | 0     | 0     | 0.008 | 0.035 | 0.1   | 0.234 | 0.4  |     |   |
| Test,date= | USA    | i Nuclear               | 2.201 | 2.919 | 3.02  | 3.213 | 3.199 | 3.282 | 3.542 | 3.969 | 4.665 | 5.3  |     |   |
| Test,date= | USA    | j Geothermal            | 0.058 | 0.06  | 0.063 | 0.117 | 0.141 | 0.208 | 0.327 | 0.477 | 0.613 | 0.   | - 1 |   |
| <b>⊤</b> ⊾ | LICA.  | liter e catalana<br>III | 0.002 | 0.000 | 0.045 | 0.054 | 0.004 | 0.074 | 0.004 | 0.004 | 0.000 | 1    |     | •   |

## And automatically show differences

File Edit Table Help



Here is the resulting difference plot for electricity production between two scenarios

#### 

File Edit Table Help

| Scenario                               | Regions                       | Queries  |
|--|-------------------------------|--|
| Ref4p2 2016-8-2T14:04:25-05:00         | USA                           | 🔺 🎍 queries 🔹  |
| 30pctCO2RdxUSA 2016-8-2T15:01:32-05:00 | Africa_Eastern                | 👘 🌐 Primary Energy 📰   |
| 40pctCO2RdxUSA 2016-8-2T15:46:21-05:00 | Africa_Northern               | Primary Energy Consumption (Average Fossil Efficiency Conversion)  |
| 50pctCO2RdxUSA 2016-8-2T16:16:28-05:00 | Africa_Southern               | Primary Energy Consumption (Direct Equivalent)                     |
| 60pctCO2RdxUSA 2016-8-2T16:51:10-05:00 | Africa_Western                | Primary energy with CCS (Direct Equivalent)                        |
| 70pctCO2RdxUSA 2016-8-2T17:12:26-05:00 | Australia_NZ                  | Resource production  |
| 80pctCO2RdxUSA 2016-8-2T17:39:01-05:00 | Brazil                        | Regional primary energy costs                                      |
| Test 2016-4-10T07:44:25-04:00          | Canada                        | 🚊 📲 Electricity  |
|  | Central America and Caribbean | Electricity generation by region (ind rooftop PV and CHP)          |
|  | Central Asia                  | Electricity generation by region (central only)                    |
|  | China                         | Electricity generation by aggregate technology                     |
|  | EU-12                         | Could not generate list.   |
|  | EU-15                         | Electricity generation by aggregate technology_dispatch            |
|  | Europe_Eas                    | Run Query     Update Single Queries     Create     Remove     Edit |
| J                                      | Europe Non                    | Run Query     Update Single Queries     Create     Remove     Edit |
|  |                               |  |
|  |                               |  |

### Another options is to view multiple regions simultaneously

#### 

File Edit Table Help

|             | Scenario     |                 |          |       |       | R           | legions    |          |       |       |            |                     | Queries  |
|-------------|--------------|-----------------|----------|-------|-------|-------------|------------|----------|-------|-------|------------|---------------------|--|
| Ref4p2 201  | 16-8-2T14:04 | 1:25-05:00      |          |       | US    | SA          |            |          |       |       | - 🔝 o      | queries             | A  |
| 30pctCO2R   | dxUSA 2016   | -8-2T15:01:32-0 | 5:00     |       | Af    | rica_Easter |            |          |       |       | <b>İ</b> . | 📗 Primary Ene       | ergy   |
| 40pctCO2R   | dxUSA 2016   | -8-2T15:46:21-0 | 5:00     |       | Af    | rica_North  | ern        |          |       |       |            | Primar              | ry Energy Consumption (Average Fossil Efficiency Conversion) |
| 50pctCO2R   | dxUSA 2016   | -8-2T16:16:28-0 | 5:00     |       | Af    | rica South  | ern        |          |       | =     |            |                     | ry Energy Consumption (Direct Equivalent)                    |
| 60pctCO2R   | dxUSA 2016   | -8-2T16:51:10-0 | 5:00     |       | Af    | rica Weste  | ern        |          |       | -     |            |                     | ry energy with CCS (Direct Equivalent)                       |
| 70pctCO2R   | dxUSA 2016   | -8-2T17:12:26-0 | 5:00     |       | Au    | ustralia NZ |            |          |       |       |            |                     | urce production  |
| 80pctCO2R   | dxUSA 2016   | -8-2T17:39:01-0 | 5:00     |       |       | azil        |            |          |       |       |            | Regio               | nal primary energy costs                                     |
| Test 2016-4 | 4-10T07:44:  | 25-04:00        |          |       | Ca    | anada       |            |          |       |       | <u> </u>   | Electricity         |  |
|             |              |                 |          |       |       | entral Amer | ica and Ca | aribbean |       |       |            | Electri             | icity generation by region (incl rooftop PV and CHP)         |
|             |              |                 |          |       |       | entral Asia |            |          |       |       |            |                     | icity generation by region (central only)                    |
|             |              |                 |          |       |       | nina        |            |          |       |       |            |                     | icity generation by aggregate technology                     |
|             |              |                 |          |       |       | J-12        |            |          |       |       |            |                     | ould not generate list.                                      |
|             |              |                 |          |       |       | J-15        |            |          |       |       |            |                     | icity generation by aggregate technology_dispatch            |
|             |              |                 |          |       |       | rope East   | ern        |          |       |       |            | <u> </u>            |  |
|             |              |                 |          |       |       | rope_Last   | FU         |          |       | -     | R          | un Cery             | Update Single Queries Create Remove Edit                     |
|             |              |                 |          |       |       |             |            |          |       |       |            | $\Delta \setminus $ |  |
| Electricity | y generation | by aggregate te | chnology |       |       |             |            |          |       |       |            | $\gamma_{1}$        |  |
|             |              |                 |          |       |       | _           |            |          |       |       |            | $( \cdot \cdot )$   |  |
| scenario    | region       | technology      | 1990     | 2005  | 2010  | 2015        | 2020       | 2025     | 2030  | 2035  | 2040       |                     |  |
| Test,date=  | . Africa_E   | a Coal          | 0.001    | 0.002 | 0.003 | 0.011       | 0.016      | 0.02     | 0.025 | 0.031 | 0.0        | 38 0.04 -           | Display 2 StackedBarChart - Same                             |
| Test,date=  | . Africa_E   | c Gas           | 0        | 0     | 0     | 0.005       | 0.008      | 0.011    | 0.015 | 0.021 | 0.0        | 28 0.0 =            | 3  |
| Test,date=  | . Africa_E   | e Oil           | 0.008    | 0.027 | 0.037 | 0.091       | 0.113      | 0.14     | 0.17  | 0.209 | 0.2        | .54 0.32            | Electricity generation by Electricity generation             |
| Test,date=  |              |                 | 0.001    | 0.001 | 0.001 | 0.004       | 0.007      | 0.01     | 0.015 | 0.022 | 0.         | 03 0.04             |  |
| Test,date=  | . Africa_E   | i Nuclear       | 0        | 0     | 0     | 0.002       | 0.002      | 0.007    | 0.018 | 0.035 | 0.0        | 56 0.08             | aggregate technology aggregate technolo                      |
| Test,date=  | . Africa_E   | j Geothermal    | 0.001    | 0.004 | 0.005 | 0.02        | 0.029      | 0.039    | 0.05  | 0.062 | 0.         | 07 0.07             |  |
| Test,date=  | . Africa_E   | k Hydro         | 0.022    | 0.035 | 0.054 | 0.071       | 0.089      | 0.106    | 0.123 | 0.141 | 0.1        | .75 0.20            |  |
| Test,date=  | . Africa_E   | l Wind          | 0        | 0     | 0     | 0.01        | 0.02       | 0.035    | 0.057 | 0.09  | 0.1        | .33 0.1             | 54 52  |
| Test,date=  | . Africa_E   | m Solar         | 0        | 0     | 0     | 0.008       | 0.016      | 0.024    | 0.036 | 0.053 | 0.0        | 78 0.10             | (rg) 1 1 2 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1                   |
| Test,date=  | . Africa_E   | n CHP           | 0        | 0     | 0     | 0           | 0.001      | 0.002    | 0.004 | 0.006 | 0.0        | 09 0.01             |  |
| Test,date=  | . Africa_N   | a Coal          | 0.008    | 0.047 | 0.04  | 0.055       | 0.068      | 0.077    | 0.087 | 0.095 | 0.1        | .02 0.10            | 30303030303030300, 000303030303030303030                     |
| Test,date=  | . Africa_N   | c Gas           | 0.136    | 0.482 | 0.636 | 0.805       | 0.958      | 1.092    | 1.222 | 1.342 | 1.4        | 36 1.51             | ······································                       |
| Test,date=  | . Africa_N   | e Oil           | 0.118    | 0.127 | 0.2   | 0.252       | 0.277      | 0.31     | 0.332 | 0.347 | 0.3        | 55 0.36             | Year Year  |
| Test,date=  | . Africa_N   | g Biomass       | 0        | 0     | 0     | 0.001       | 0.003      | 0.005    | 0.008 | 0.011 | 0.0        | 14 0.01             | lean lean  |
| Test,date=  |              |                 | 0        | 0     | 0     | 0.001       | 0.002      | 0.006    | 0.014 | 0.025 | 0.0        | 36 0.04             | Electricity generation by Electricity generation             |
| Test,date=  | . Africa_N   | j Geothermal    | 0        | 0     | 0     | 0.007       | 0.016      | 0.026    | 0.036 | 0.046 | 0.0        | 54 0.05             | aggregate technology aggregate technolc                      |
| Test,date=  |              |                 | 0.041    | 0.052 | 0.06  | 0.063       | 0.066      | 0.069    | 0.072 | 0.075 | 0.0        | 81 0.08             |  |
| Test,date=  | . Africa_N   | l Wind          | 0        | 0.003 | 0.008 | 0.018       | 0.03       | 0.047    | 0.068 | 0.094 | 0.1        | .14 0.13            |  |
| Test,date=  | . Africa_N   | m Solar         | 0        | 0     | 0     | 0.005       | 0.013      | 0.024    | 0.038 | 0.057 | 0.0        | 78 0.09             |  |
| Test,date=  | . Africa_N   | n CHP           | 0        | 0     | 0     | 0           | 0          | 0        | 0.001 | 0.001 | 0.0        | 01 0.00             | output 5   |
| Test,date=  | . Africa_S   | a Coal          | 0.022    | 0.02  | 0.018 | 0.054       | 0.083      | 0.105    | 0.129 | 0.158 | 0.1        | 93 0.24             |  |
| Test,date=  | . Africa_S   | c Gas           | 0        | 0.004 | 0.006 | 0.023       | 0.038      | 0.052    | 0.068 | 0.089 | 0.1        | 16 0.15             | 0  |
| Test,date=  | . Africa_S   | e Oil           | 0.003    | 0.007 | 0.009 | 0.049       | 0.075      | 0.099    | 0.125 | 0.155 | 0.1        | .92 0.24            |  |
| Test,date=  | . Africa_S   | g Biomass       | 0        | 0     | 0     | 0           | 0          | 0.001    | 0.001 | 0.002 | 0.0        | 03 0.00 -           | . 20202020202020202020202020202020202020                     |
| •           | _            |                 |          |       |       |             |            |          |       |       |            | +                   | ۰ III - ۲  |

When you select multiple regions, each gets its own figure.

#### 

File Edit Table Help

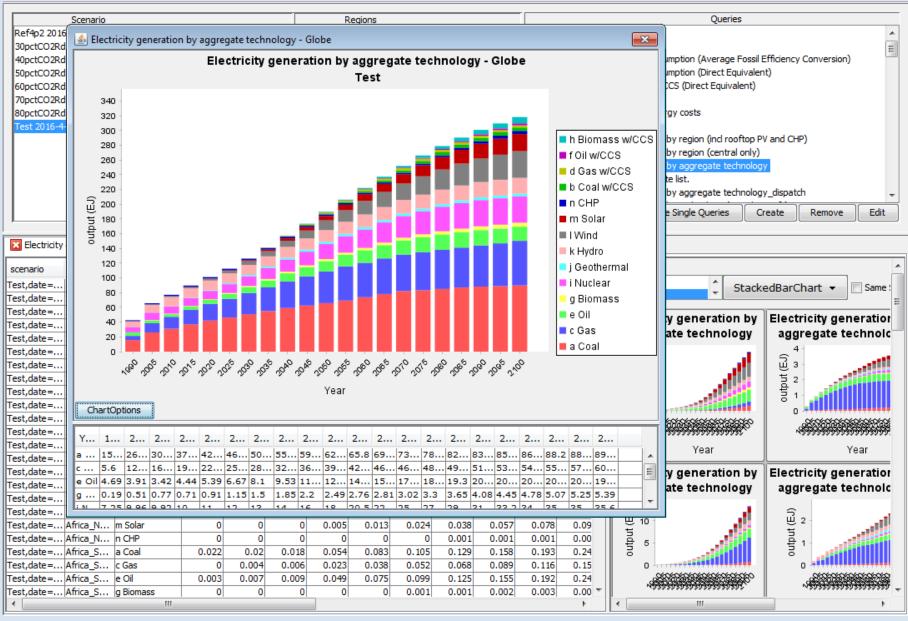
| Scenario                               | Regions                       | Queries  |    |
|--|-------------------------------|--|----|
| Ref4p2 2016-8-2T14:04:25-05:00         | USA                           | 🔺 🌗 queries  |    |
| 30pctCO2RdxUSA 2016-8-2T15:01:32-05:00 | Africa_Eastern                | 🔲 🚊 Primary Energy   | =  |
| 40pctCO2RdxUSA 2016-8-2T15:46:21-05:00 | Africa_Northern               |  |    |
| 50pctCO2RdxUSA 2016-8-2T16:16:28-05:00 | Africa_Southern               | Primary Energy Consumption (Direct Equivalent)                   |    |
| 60pctCO2RdxUSA 2016-8-2T16:51:10-05:00 | Africa_Western                | Primary energy with CCS (Direct Equivalent)                      |    |
| 70pctCO2RdxUSA 2016-8-2T17:12:26-05:00 | Australia_NZ                  | Resource production  |    |
| 80pctCO2RdxUSA 2016-8-2T17:39:01-05:00 | Brazil                        | Regional primary energy costs                                    |    |
| Test 2016-4-10T07:44:25-04:00          | Canada                        | 🚊 🖓 📙 Electricity  |    |
|  | Central America and Caribbean | Electricity generation by region (ind rooftop PV and CHP)        |    |
|  | Central Asia                  | Electricity generation by region (central only)                  |    |
|  | China                         | Electricity generation by aggregate technology                   |    |
|  | EU-12                         | Could not generate list.   |    |
|  | EU-15                         | Electricity generation by aggregate technology_dispatch          | -  |
|  | Europe_Eastern                | Run Query     Update Single Queries     Create     Remove     Ed | i+ |
| J                                      | Europe Non El l               | ✓ Run Query Update Single Queries Create Remove Ed               | n. |

#### Electricity generation by aggregate technology

| scenario   | region   | technology   | 1990  | 2005  | 2010  | 2015  | 2020  | 2025  | 2030  | 2035  | 2040  | 2045   |   |
|------------|----------|--------------|-------|-------|-------|-------|-------|-------|-------|-------|-------|--------|---|
| Test,date= | Africa_E | a Coal       | 0.001 | 0.002 | 0.003 | 0.011 | 0.016 | 0.02  | 0.025 | 0.031 | 0.038 | 0.04 🔺 | Display 2 StackedBarChart - Same  |
| Test,date= | Africa_E | c Gas        | 0     | 0     | 0     | 0.005 | 0.008 | 0.011 | 0.015 | 0.021 | 0.028 | 0.0 =  |   |
| Test,date= | Africa_E | e Oil        | 0.008 | 0.027 | 0.037 | 0.091 | 0.113 | 0.14  | 0.17  | 0.209 | 0.254 | 0.32   | Electricity generation by Electricity generation  |
| Test,date= | Africa_E | g Biomass    | 0.001 | 0.001 | 0.001 | 0.004 | 0.007 | 0.01  | 0.015 | 0.022 | 0.03  | 0.04   |   |
| Test,date= | Africa_E | i Nuclear    | 0     | 0     | 0     | 0.002 | 0.002 | 0.007 | 0.018 | 0.035 | 0.056 | 0.08   | 3,  |
| Test,date= | Africa_E | j Geothermal | 0.001 | 0.004 | 0.005 | 0.02  | 0.029 | 0.039 | 0.05  | 0.062 | 0.07  | 0.07   | Region Sym  |
| Test,date= | Africa_E | k Hydro      | 0.022 | 0.035 | 0.054 | 0.071 | 0.089 | 0.106 | 0.123 | 0.141 | 0.175 | 0.20   | Difference Difference   |
| Test,date= | Africa_E | l Wind       | 0     | 0     | 0     | 0.01  | 0.02  | 0.035 | 0.057 | 0.09  | 0.133 | 0.1    |   |
| Test,date= | Africa_E | m Solar      | 0     | 0     | 0     | 0.008 | 0.016 | 0.024 | 0.036 | 0.053 | 0.078 | 0.10   | Statistic Statistic   |
| Test,date= | Africa_E | n CHP        | 0     | 0     | 0     | 0     | 0.001 | 0.002 | 0.004 | 0.006 | 0.009 | 0.01   |   |
| Test,date= | Africa_N | a Coal       | 0.008 | 0.047 | 0.04  | 0.055 | 0.068 | 0.077 | 0.087 | 0.095 | 0.102 | 0.10   |   |
| Test,date= | Africa_N | c Gas        | 0.136 | 0.482 | 0.636 | 0.805 | 0.958 | 1.092 | 1.222 | 1.342 | 1.436 | 1.51   | · · · · · · · · · · · · · · · · · · ·   |
| Test,date= | Africa_N | e Oil        | 0.118 | 0.127 | 0.2   | 0.252 | 0.277 | 0.31  | 0.332 | 0.347 | 0.355 | 0.36   | Year Year   |
| Test,date= | Africa_N | g Biomass    | 0     | 0     | 0     | 0.001 | 0.003 | 0.005 | 0.008 | 0.011 | 0.014 | 0.01   |   |
| Test,date= | Africa_N | i Nuclear    | 0     | 0     | 0     | 0.001 | 0.002 | 0.006 | 0.014 | 0.025 | 0.036 | 0.04   | Electricity generation by Electricity generatio   |
| Test,date= | Africa_N | j Geothermal | 0     | 0     | 0     | 0.007 | 0.016 | 0.026 | 0.036 | 0.046 | 0.054 | 0.05   | aggregate technology aggregate technol  |
| Test,date= | Africa_N | k Hydro      | 0.041 | 0.052 | 0.06  | 0.063 | 0.066 | 0.069 | 0.072 | 0.075 | 0.081 | 0.08   |   |
| Test,date= | Africa_N | l Wind       | 0     | 0.003 | 0.008 | 0.018 | 0.03  | 0.047 | 0.068 | 0.094 | 0.114 | 0.13   | <u><u><u></u></u> <u></u> <u></u> <u></u> <u></u> <u></u> <u></u></u>   |
| Test,date= | Africa_N | m Solar      | 0     | 0     | 0     | 0.005 | 0.013 | 0.024 | 0.038 | 0.057 | 0.078 | 0.09   |   |
| Test,date= | Africa_N | n CHP        | 0     | 0     | 0     | 0     | 0     | 0     | 0.001 | 0.001 | 0.001 | 0.00   | output 5-   |
| Test,date= | Africa_S | a Coal       | 0.022 | 0.02  | 0.018 | 0.054 | 0.083 | 0.105 | 0.129 | 0.158 | 0.193 | 0.24   | 5   |
| Test,date= | Africa_S | c Gas        | 0     | 0.004 | 0.006 | 0.023 | 0.038 | 0.052 | 0.068 | 0.089 | 0.116 | 0.15   |   |
| Test,date= | Africa_S | e Oil        | 0.003 | 0.007 | 0.009 | 0.049 | 0.075 | 0.099 | 0.125 | 0.155 | 0.192 | 0.24   |   |
| Test,date= | Africa_S | g Biomass    | 0     | 0     | 0     | 0     | 0     | 0.001 | 0.001 | 0.002 | 0.003 | • 0.00 | ~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~  |
| •          |          | 111          |       |       |       |       |       |       |       |       |       | P.     | ۰ III + I |

You can create aggregate regions by summing over the model regions...

File Edit Table Help



This shows global totals, but you can sum across any aggregate

# SEPA Lessons learned and next steps

# Lessons:

- GCAM-USA is a complex modeling system and its use has required building expertise in R, C++, xml, MS Visual Studio
- However, it appears the paradigm of integrating GCAM-USA into the GLIMPSE framework is very workable and has value to our partners

# Next steps:

- Continue harmonizing emission factors
  - rail and marine shipping, industrial, other pollutants
- Improving policy levers
  - Renewable electricity standards applicable to both new and old generation
  - End-use efficiency standards
- Internal Beta test of Scenario Builder and Enhanced Model Interface in late 2016
- External Beta test of Scenario Builder and Enhanced Model Interface in 2017?



# **Questions?**

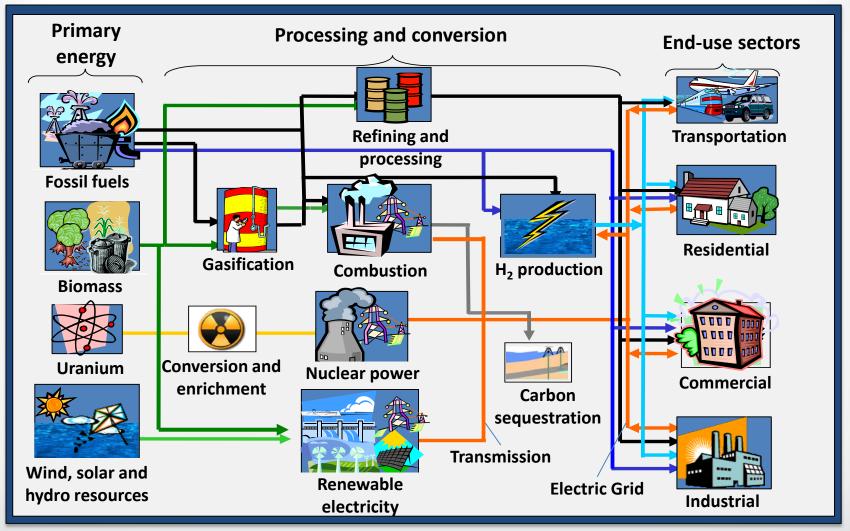
Contact information:

Dan Loughlin, U.S. EPA, ORD – <u>loughlin.dan@epa.gov</u> Chris Nolte, U.S. EPA, ORD – <u>nolte.chris@epa.gov</u>

# Background The energy system

# **Components of the energy system**

**SEPA**





## **Background**

# **Energy and the environment**

# Energy system contributions to environmental concerns:

# Air quality<sup>1</sup>

- Photochemical smog: 92% of nitrogen oxide (NOx) emissions\*
- Acid rain: 90% of sulfur dioxide (SO<sub>2</sub>) emissions\*

# Climate change<sup>2</sup>

- Greenhouse gas emissions: 95% of carbon dioxide  $(CO_2)$  emissions\*
- Major source of short-lived climate pollutants (e.g., black carbon, methane)

# Water

- Demands: electricity production accounts for 45% of U.S. water withdrawals<sup>3</sup>
- Pollution:
  - wastewater from fuel extraction and processing, seepage from waste
  - eutrophication from N deposition, acidification from S and N deposition
  - heat pollution from cooling water discharge

# Waste production

– Mine tailings, combustion residues, agricultural wastes

| *Percentage of U.S.<br>anthropogenic emissions from<br>the energy system in 2014 |
|--|
| <sup>I</sup> EPA trends report   |
| <sup>2</sup> EPA 2016 GHG Inventory  |
| <sup>3</sup> Maupin et al., 2014 (USGS)  |