



INTRODUCTION TO REMI E3⁺
ENERGY, ENVIRONMENT & ECONOMY

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Presented by Regional Economic Models, Inc.

About REMI

REMI's 38-year history of rigorous academic research and software development has led to the development of the the industry standard in macroeconomic research methodology:

Input-Output

Close analysis of inter-industry relationships

Econometrics

Advanced statistical analyses underpinning the model

General Equilibrium

Estimate of long-run stability of the economy allows for analysis of policy decisions

Economic Geography

Effects of geographic concentration of labor and industry

**Integrated REMI
economic modelling
approach**

What is E3+?



E3+ is the leading off-the-shelf solution for analyzing the macroeconomic and demographic impacts of any environmental or energy initiative

CADMUS



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Prior Relevant Analyses

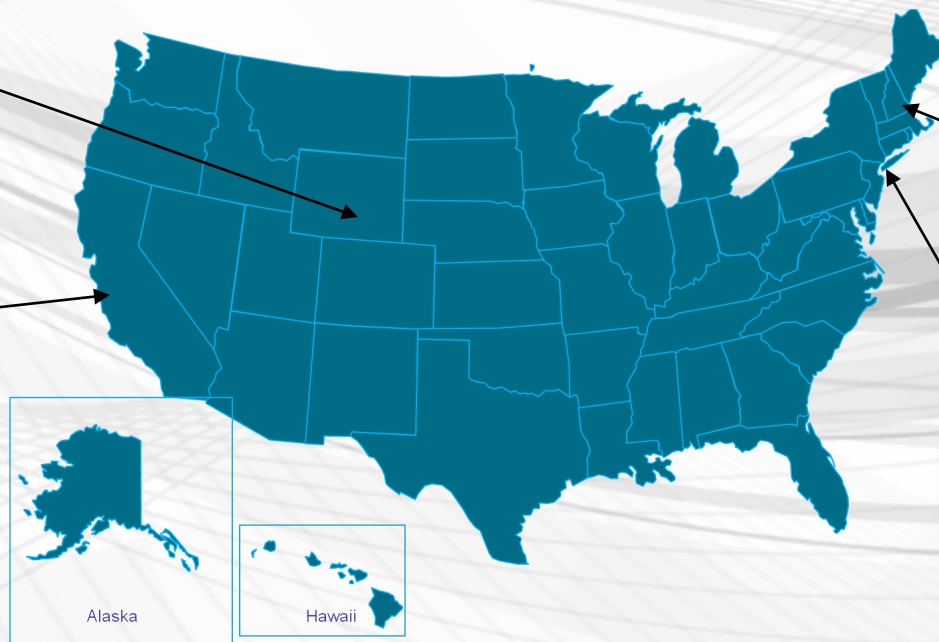
REMI is the industry leader for regional macroeconomic and demographic analyses of energy and environmental issues.

Wyoming:

Impacts of the ZEPHYR power transmission line

California:

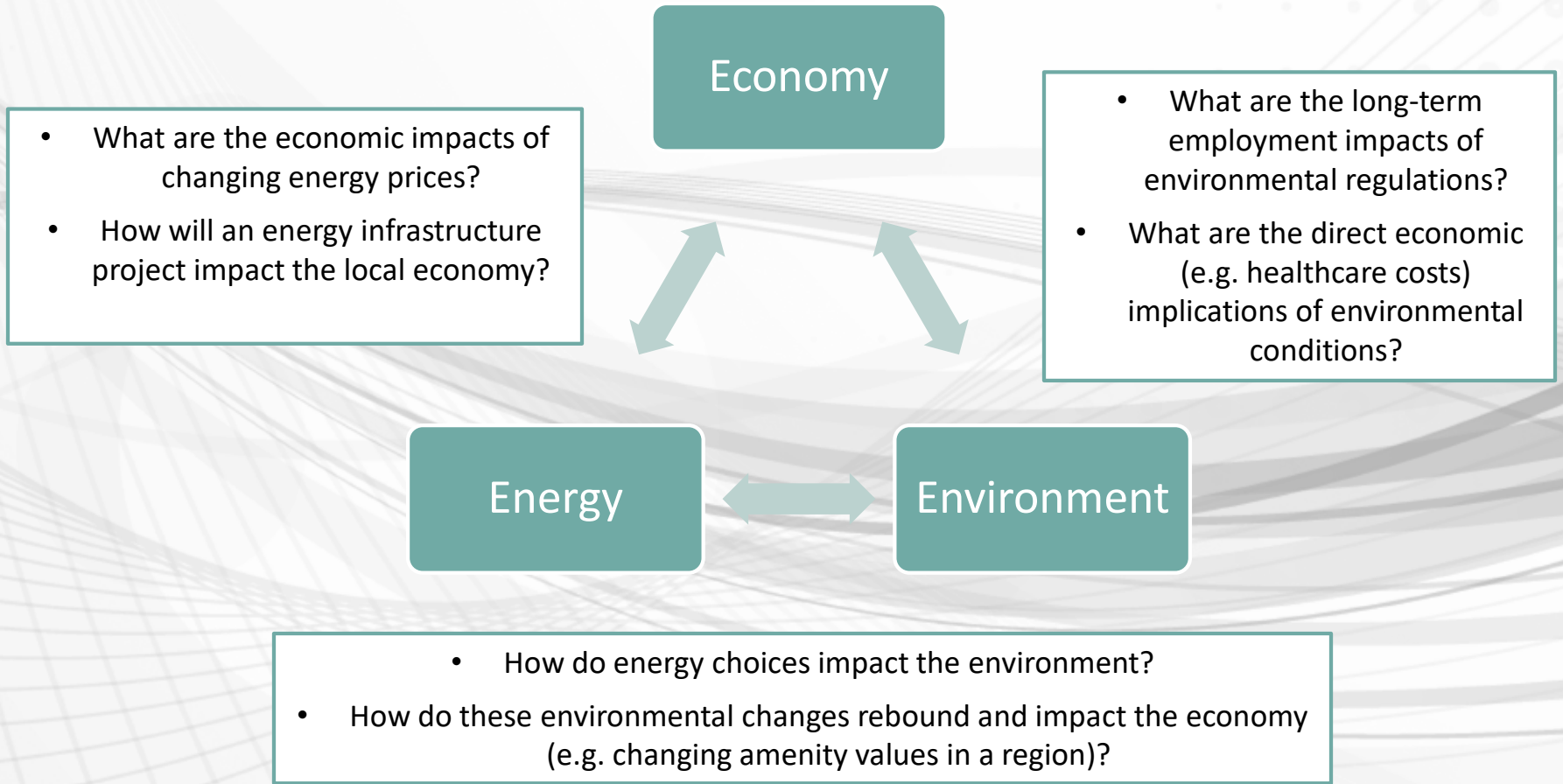
Impacts of CAFE emissions standards



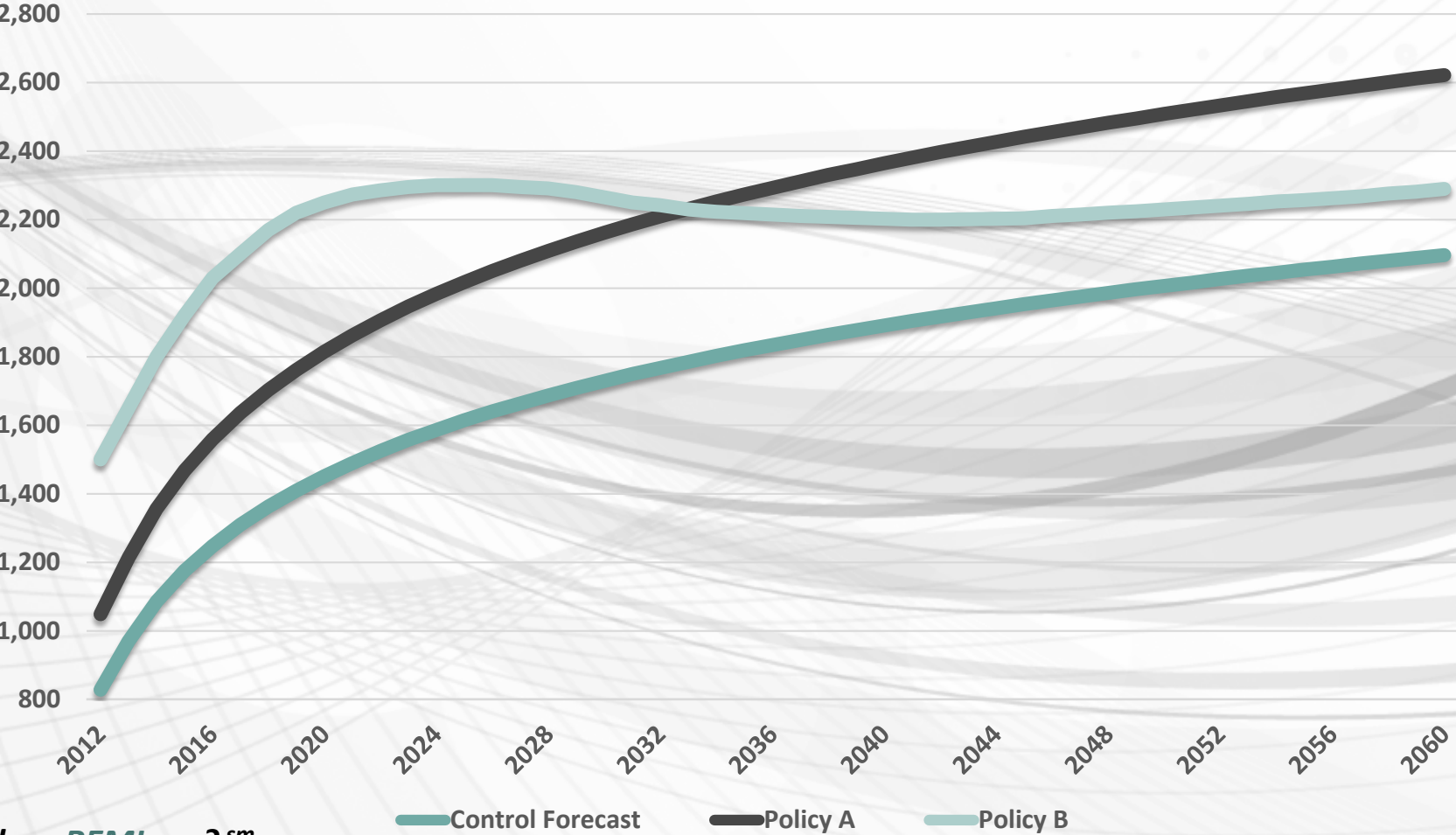
New Hampshire:
Merrimack Valley energy reliability project

NYC:
Energy Efficiency Programs analysis (NYSERDA)

Energy, Environment & Economic Linkages



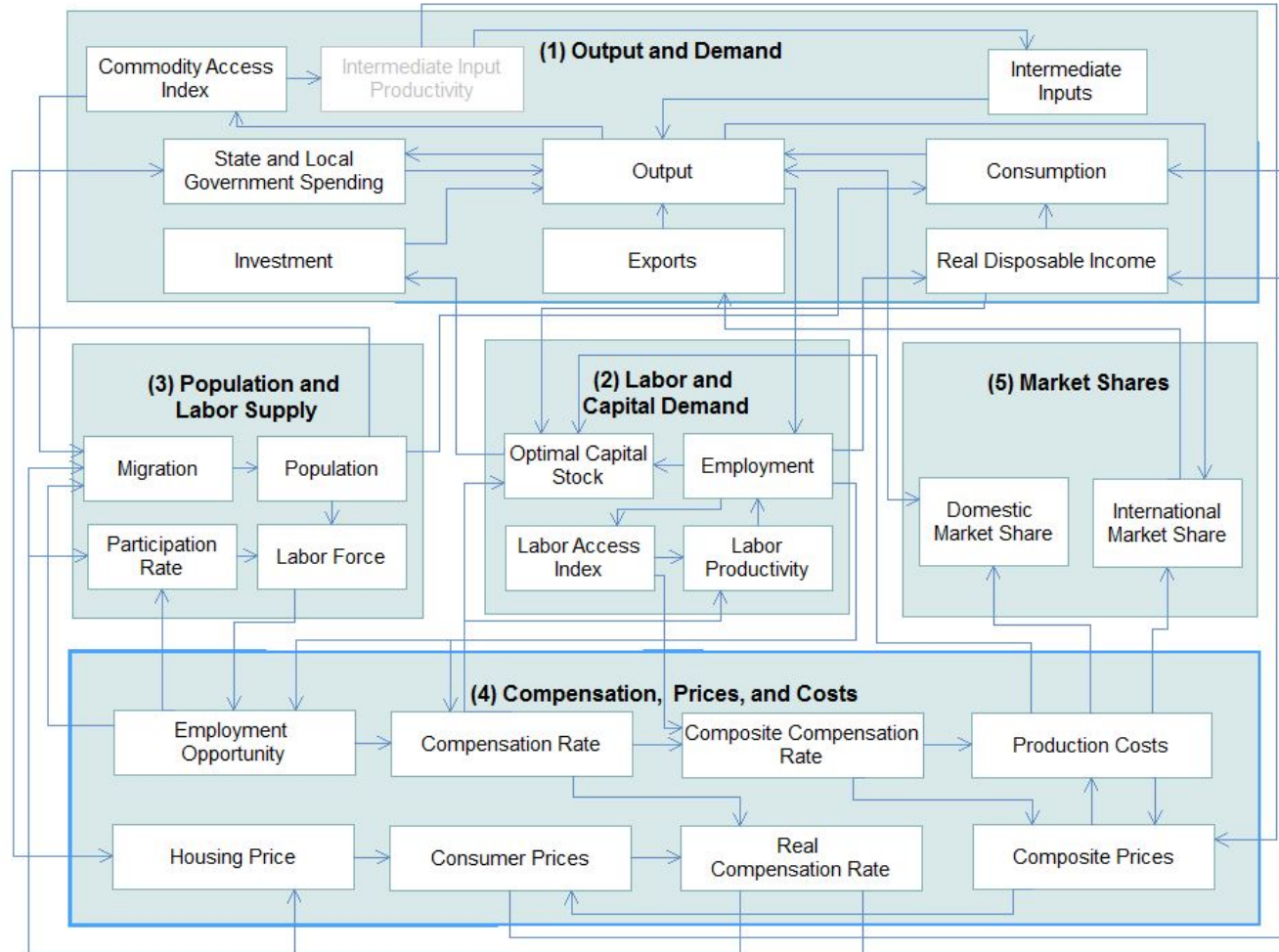
Dynamic Modeling



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Control Forecast Policy A Policy B

Model Linkages



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New Aspects Unique with E3+

Specific analysis of Energy and Environment related policies including:

1. Translator variables for electrical, solar, wind, and nuclear power plant construction and operations and maintenance
2. Energy Consumption and Carbon Dioxide Emissions Module
3. Resilience Module
4. Carbon Tax scenario
5. Social cost policy variable associated with five types of emissions
6. Allows for integration with third-party energy models

Translators in the E3+ Model

- The model can distribute spending on **construction and operations and maintenance** of a electrical power plant across 160 industries
- Based on studies and data from several sources, including:
 - ▣ National Renewable Energy Laboratory
 - ▣ Energy Information Administration



Accounts for:
Nuclear, Solar, Natural Gas, Coal, and
Wind Energy

REMI E3+ Emissions Module

- Dynamic Carbon Footprint
 - Forecast results include Energy Consumption and Carbon Dioxide Emissions
- Uses EIA data to generate parameters that are applied to economic impact results
 1. Btus consumed by sector and source
 2. CO2 emissions by sector and source
 3. Residential, Industrial, Commercial, and Transportation sectors



Resiliency Module in the E3+ Model

- ❑ E3+ can now produce an automatic calculation discussing resiliency through a forecast's “Resiliency Report”
 - ❑ This compares a no-action baseline disaster scenario to an a resilience investment scenario
- ❑ The model produces a **Resilience Loss Reduction Potential** figure:

$$RLRP = \frac{\textit{Avoided Losses}}{\textit{Maximum Potential Losses}}$$

Dynamic Carbon Footprint- A Hypothetical E3+ Application

Inputs:

New Renewable Energy Developments with Retirement of Coal Plant & Direct Energy Cost Changes

Model Responses

Relative Output

Change in output of supply chain and other industries

Business & consumer responses to change in energy prices

Relative Employment

Change in employment, different industry impacts

Change in employment from consumer spending responses

Dynamic Carbon Footprint

Increase in carbon emissions for travel in service industries

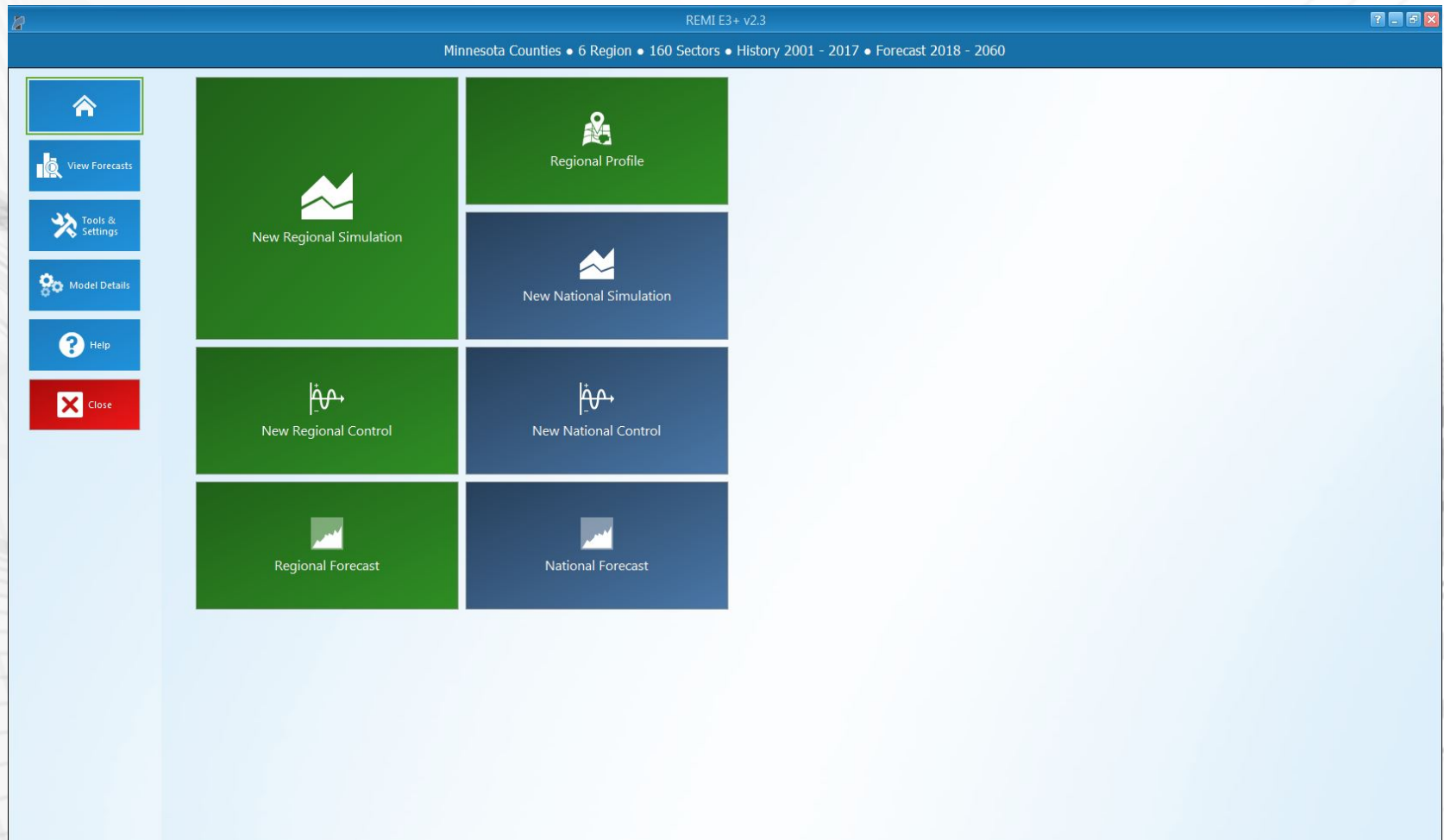
Decrease carbon emissions in manufacturing industries



Model Demonstration

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New Simulations and Controls



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Inputs

The screenshot shows the 'Regional Simulation 1' software interface. At the top, there is a blue header bar with the title 'Regional Simulation 1' and window control icons. Below the header is a navigation bar with a 'Save Forecast' button and a breadcrumb trail 'Start'. The main content area is divided into three columns: 'Featured', 'Variables', and 'Topics & Scenarios'. The 'Featured' column contains tiles for 'Energy Prices and Demand', 'Power Plant Construction', 'Power Plant Operation & Maintenance', 'Social Costs', and 'Carbon Tax'. The 'Variables' column has a 'Favorites' tile with a star icon, a 'Full List' tile with a book icon, a large 'Model Linkages' tile with a blue background and text 'Display a block diagram of the model structure. Clicking on an area of the diagram will show the policy variables related to that area.', and a 'Model Blocks' tile with a group of people icon and the text 'Population and Labor Supply'. The 'Topics & Scenarios' column contains a grid of tiles: 'Industries' (factory icon), 'Business Costs' (calculator icon), 'Consumer Prices' (dollar sign icon), 'More Topics' (dollar sign icon), 'Base Realignment and Closure' (ship icon), 'Higher Education' (graduation cap icon), 'Minimum Wage' (cans icon), and 'More Scenarios' (document icon).

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Energy Prices and Demand

The screenshot shows a software window titled "Regional Simulation 1". The interface includes a top navigation bar with buttons for "Select Inputs", "Inputs List", "Forecast Options", and "Results". Below this is a breadcrumb trail: "Start > Energy Prices and Demand". A sidebar on the left lists four menu items, each with a representative image and a green header:

- Energy Prices by Fuel Type** (Residual): Image of an oil pumpjack at sunset.
- Energy Prices by Fuel Sector** (Residential): Image of a suburban residential street.
- Fuel Demand** (Electricity): Image of high-voltage power lines.
- Production Cost** (NaturalGas): Image of a gas burner with blue flames.

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Power Plant Construction

The screenshot displays a software window titled "Regional Simulation 1". The interface includes a top navigation bar with buttons for "Save Forecast", "Select Inputs", "Inputs List", "Forecast Options", and "Results". Below this is a breadcrumb trail: "Start > Power Plant Construction". The main content area is titled "Power Plant Construction" and features a grid of seven options, each with a representative image and a text label:

- Coal-Fired Plant Construction (Image: Coal power plant with smokestacks)
- Wind Farm-Offshore Construction (Image: Offshore wind turbines)
- Natural Gas-Fired Plant Construction (Image: Natural gas pipeline)
- Wind Farm-Onshore Construction (Image: Onshore wind turbines)
- Nuclear Plant Construction (Image: Nuclear cooling towers)
- Custom Power Plant Construction (Image: Industrial machinery)
- Solar Farm Construction (Image: Solar panels)

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Operation and Maintenance

The screenshot displays a software window titled "Regional Simulation 1". The interface includes a top navigation bar with the following elements:

- Save Forecast (button)
- Select Inputs (button)
- Inputs List (button)
- Forecast Options (button)
- Results (button)

The breadcrumb path is: Start > Power Plant Operation & Maintenance

The main content area is titled "Power Plant Operation & Maintenance" and contains the following options:

- Coal-Fired Plant O&M (Image: Coal-fired power plant)
- Wind Farm-Offshore O&M (Image: Offshore wind turbines)
- Natural Gas-Fired Plant O&M (Image: Natural gas pipeline)
- Wind Farm-Onshore O&M (Image: Onshore wind turbines)
- Nuclear Plant O&M (Image: Nuclear power plant cooling towers)
- Custom Power Plant O&M (Image: Industrial power plant machinery)
- Solar Farm O&M (Image: Solar panels)

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Inputs

Heating Switch Electric to Natural Gas

Save Forecast Import Export Print Tools

Select Inputs **Inputs List** Forecast Options Results

Policy Variable Inputs

Active	Edit	Group	Ac	View	Category	Detail	Region	Units	2018	2019	2020	2021	2022	2023	2024	2025	2026	2027	2028
<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	Residential Heating Switch from Electric to Gas																	
<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	Consumer Spending	Electricity			Washington County	Nominal \$ (M)		0	0	-40	-40	-40	-40	-40	-40	-40	-40	-40
<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	Consumer Spending	Natural gas			Washington County	Nominal \$ (M)		0	0	10	10	10	10	10	10	10	10	10
<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	Consumer Spending	Details (73)			Washington County	Nominal \$ (M)		0	0	30	30	30	30	30	30	30	30	30

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Energy Consumption Tab

Heating Switch Electric to Natural Gas

Save Forecast | Master Selection | Export Results | Select Inputs | Inputs List | Forecast Options | Results

Search Result Tables

Energy Consumption

Region	Category	Comparison Type	Forecast										Comparison Forecast					
Washington County	Energy Consumption	% Change	Heating Switch Electric to Natural Gas										Standard Regional Control					
Details	Fuel Type	Units	2018	2019	2020	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030	2031	2032	2033
Residential	Total	Percent	0.000%	0.000%	-0.663%	-0.561%	-0.492%	-0.447%	-0.414%	-0.390%	-0.388%	-0.385%	-0.388%	-0.396%	-0.399%	-0.401%	-0.403%	-0.403%
	Petroleum	Percent	0.000%	0.000%	+0.259%	+0.245%	+0.234%	+0.224%	+0.215%	+0.206%	+0.198%	+0.191%	+0.183%	+0.176%	+0.169%	+0.163%	+0.157%	+0.157%
	Natural Gas	Percent	0.000%	0.000%	+11.302%	+11.148%	+10.957%	+10.740%	+10.492%	+10.227%	+9.966%	+9.706%	+9.448%	+9.206%	+8.972%	+8.740%	+8.521%	+8.311%
	Coal	Percent	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Commercial	Total	Percent	0.000%	0.000%	-19.432%	-18.902%	-18.359%	-17.816%	-17.268%	-16.732%	-16.247%	-15.771%	-15.303%	-14.864%	-14.441%	-14.028%	-13.636%	-13.266%
	Petroleum	Percent	0.000%	0.000%	-0.211%	-0.167%	-0.081%	-0.079%	-0.070%	-0.059%	-0.047%	-0.037%	-0.027%	-0.019%	-0.013%	-0.008%	-0.004%	0.000%
	Natural Gas	Percent	0.000%	0.000%	-0.196%	-0.291%	-0.314%	-0.303%	-0.277%	-0.246%	-0.215%	-0.186%	-0.161%	-0.139%	-0.121%	-0.105%	-0.091%	-0.079%
	Coal	Percent	0.000%	0.000%	-0.129%	-0.200%	-0.219%	-0.213%	-0.195%	-0.173%	-0.151%	-0.131%	-0.113%	-0.097%	-0.084%	-0.073%	-0.063%	-0.053%
Industrial	Total	Percent	0.000%	0.000%	+0.089%	+0.071%	+0.062%	+0.059%	+0.058%	+0.057%	+0.057%	+0.057%	+0.057%	+0.056%	+0.055%	+0.054%	+0.053%	+0.053%
	Petroleum	Percent	0.000%	0.000%	+0.005%	+0.000%	-0.002%	-0.002%	-0.001%	0.000%	+0.001%	+0.001%	+0.002%	+0.002%	+0.002%	+0.002%	+0.002%	+0.002%
	Natural Gas	Percent	0.000%	0.000%	+0.005%	+0.001%	+0.000%	+0.000%	+0.000%	+0.001%	+0.002%	+0.002%	+0.003%	+0.003%	+0.003%	+0.003%	+0.003%	+0.003%
	Coal	Percent	0.000%	0.000%	+0.003%	-0.003%	-0.005%	-0.005%	-0.004%	-0.003%	-0.001%	0.000%	+0.000%	+0.001%	+0.001%	+0.001%	+0.002%	+0.002%
Transportation	Total	Percent	0.000%	0.000%	+0.235%	+0.221%	+0.210%	+0.200%	+0.191%	+0.183%	+0.176%	+0.169%	+0.162%	+0.156%	+0.150%	+0.144%	+0.139%	+0.139%
	Petroleum	Percent	0.000%	0.000%	+0.237%	+0.223%	+0.212%	+0.202%	+0.193%	+0.184%	+0.177%	+0.171%	+0.164%	+0.158%	+0.152%	+0.146%	+0.141%	+0.141%
	Natural Gas	Percent	0.000%	0.000%	-0.003%	-0.012%	-0.015%	-0.014%	-0.012%	-0.009%	-0.006%	-0.006%	-0.005%	-0.006%	-0.007%	-0.009%	-0.011%	-0.011%
	Coal	Percent	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Total	Total	Percent	0.000%	0.000%	+0.003%	-0.007%	-0.010%	-0.010%	-0.009%	-0.008%	-0.007%	-0.006%	-0.005%	-0.004%	-0.004%	-0.004%	-0.004%	-0.004%
	Petroleum	Percent	0.000%	0.000%	-0.054%	-0.040%	-0.029%	-0.023%	-0.019%	-0.017%	-0.020%	-0.023%	-0.028%	-0.034%	-0.042%	-0.046%	-0.046%	-0.046%
	Natural Gas	Percent	0.000%	0.000%	+0.198%	+0.184%	+0.173%	+0.164%	+0.156%	+0.150%	+0.144%	+0.138%	+0.133%	+0.127%	+0.122%	+0.117%	+0.113%	+0.113%
	Coal	Percent	0.000%	0.000%	+8.412%	+8.240%	+8.063%	+7.872%	+7.665%	+7.450%	+7.236%	+7.038%	+6.841%	+6.663%	+6.490%	+6.322%	+6.162%	+6.003%
Total	Electricity	Percent	0.000%	0.000%	-11.783%	-11.386%	-11.010%	-10.649%	-10.287%	-9.935%	-9.634%	-9.341%	-9.057%	-8.793%	-8.551%	-8.311%	-8.084%	-7.871%

Energy Consumption

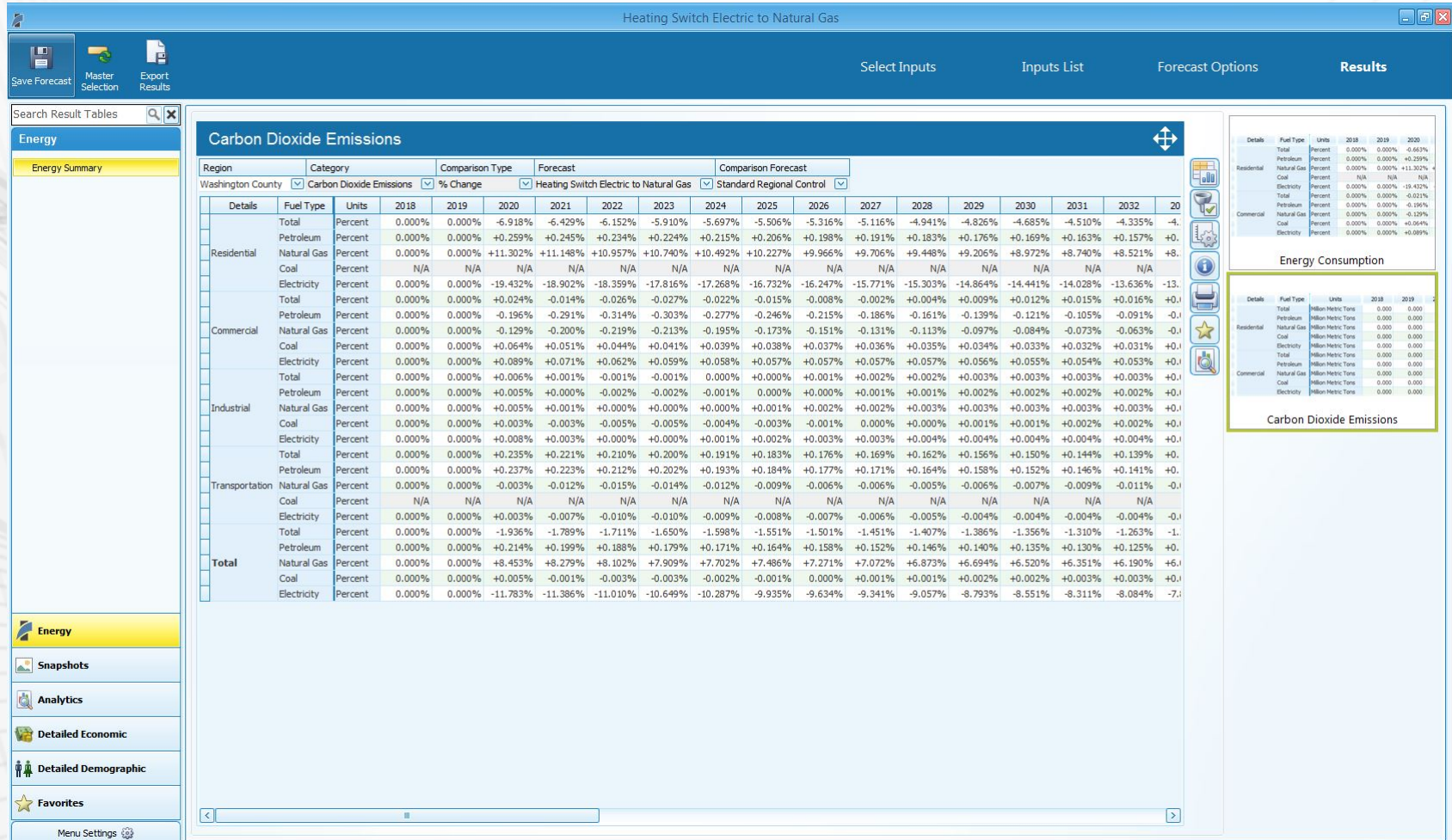
Details	Fuel Type	Units	2018	2019	2020
Residential	Total	Percent	0.000%	0.000%	-0.037%
	Petroleum	Percent	0.000%	0.000%	+0.013%
	Natural Gas	Percent	0.000%	0.000%	+0.027%
	Coal	Percent	N/A	N/A	N/A
Commercial	Total	Percent	0.000%	0.000%	-0.003%
	Petroleum	Percent	0.000%	0.000%	-0.013%
	Natural Gas	Percent	0.000%	0.000%	+0.008%
	Coal	Percent	0.000%	0.000%	+0.002%

Carbon Dioxide Emissions

Details	Fuel Type	Units	2018	2019
Residential	Total	Million Metric Tons	0.000	0.000
	Petroleum	Million Metric Tons	0.000	0.000
	Natural Gas	Million Metric Tons	0.000	0.000
	Coal	Million Metric Tons	0.000	0.000
Commercial	Total	Million Metric Tons	0.000	0.000
	Petroleum	Million Metric Tons	0.000	0.000
	Natural Gas	Million Metric Tons	0.000	0.000
	Coal	Million Metric Tons	0.000	0.000

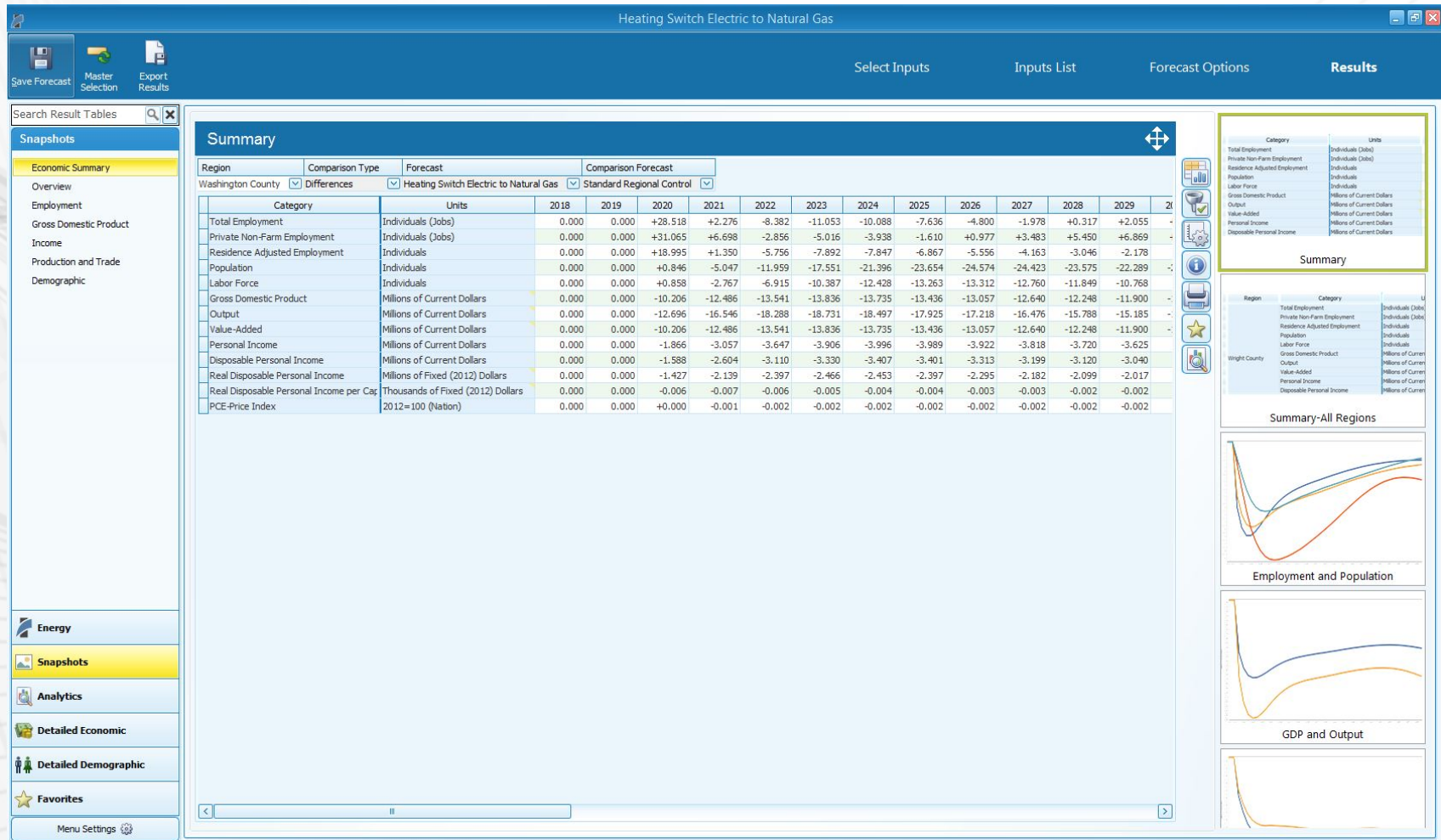
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Carbon Emissions



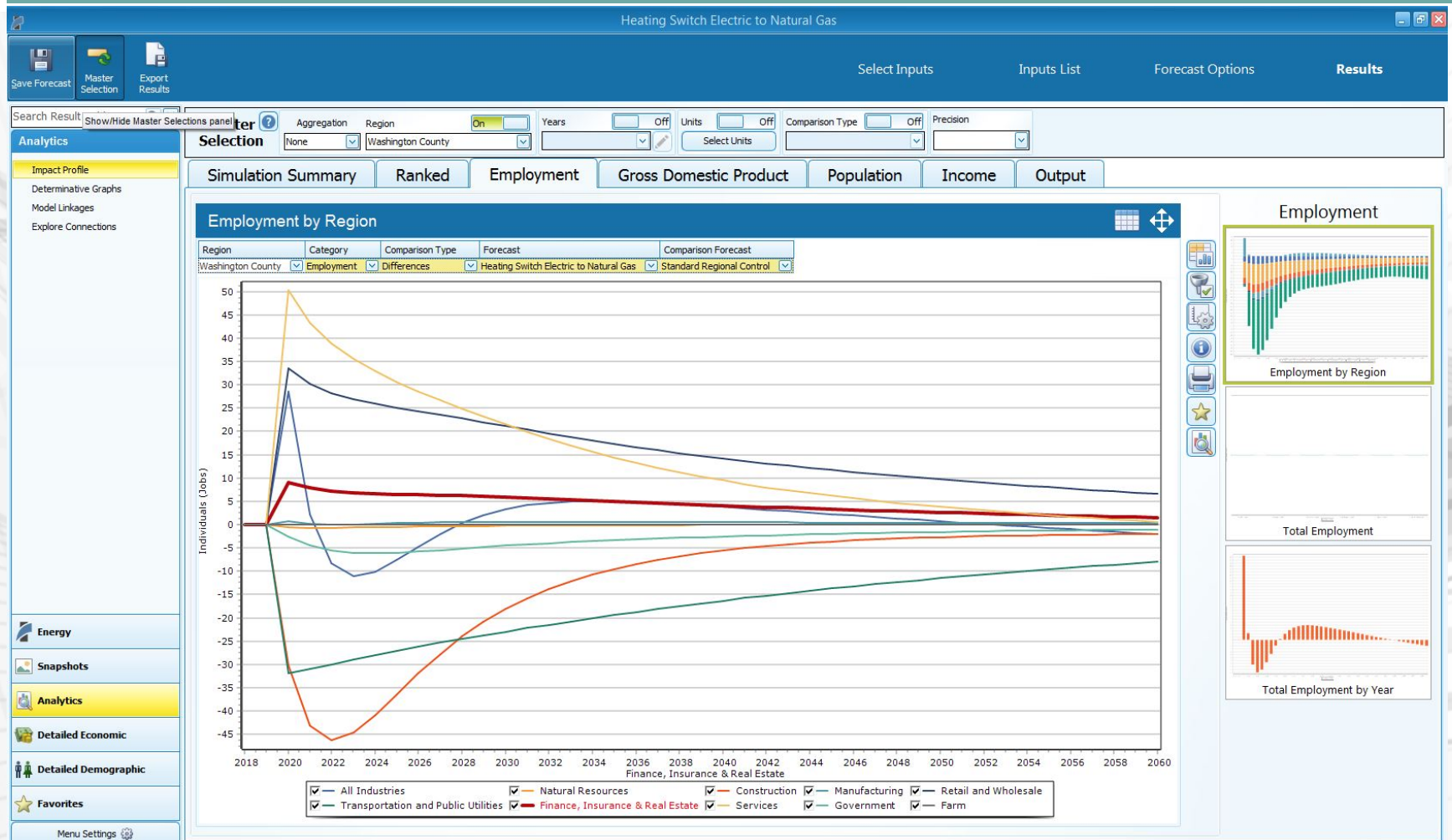
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Economic Summary



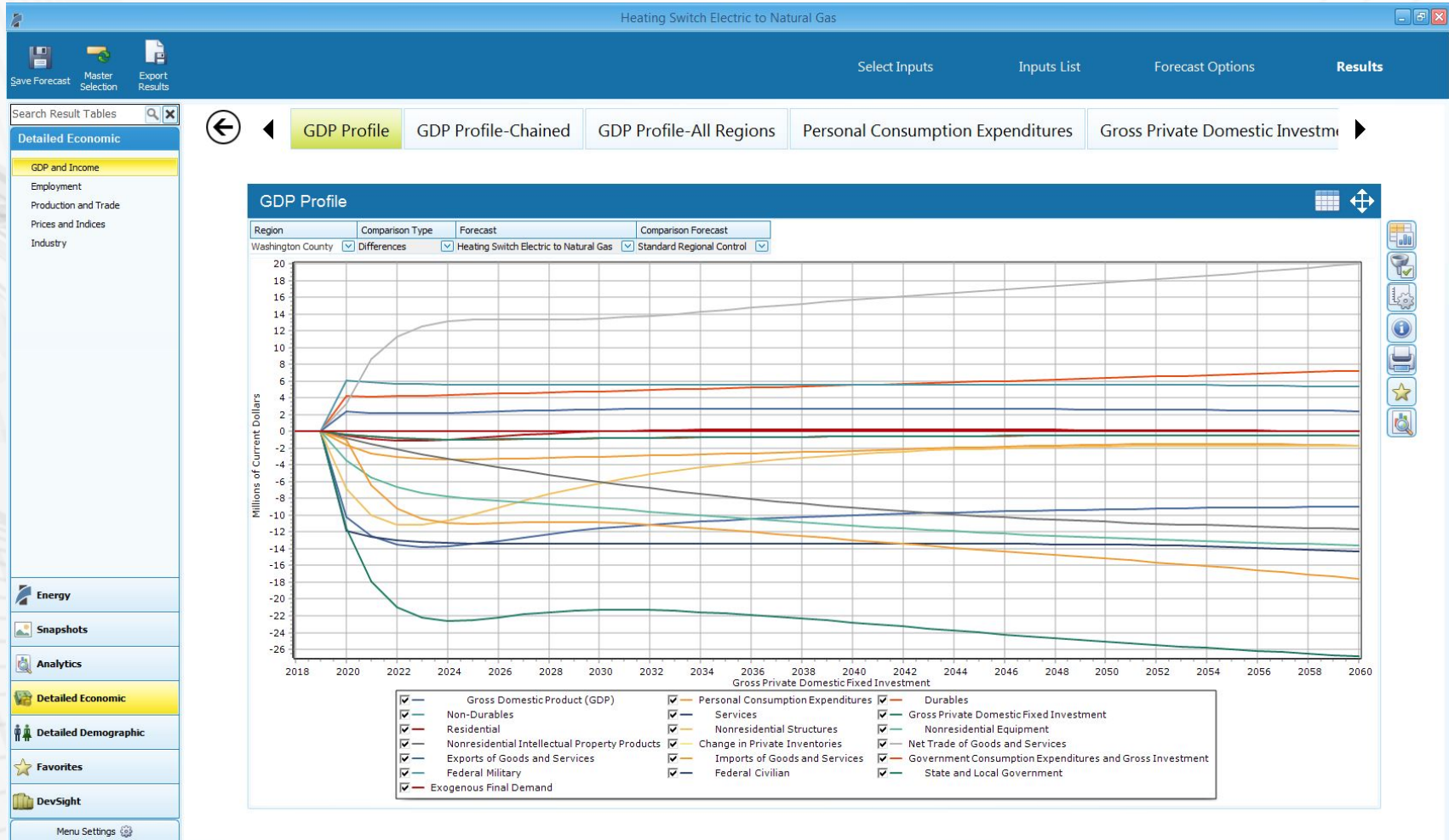
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Employment by Industry



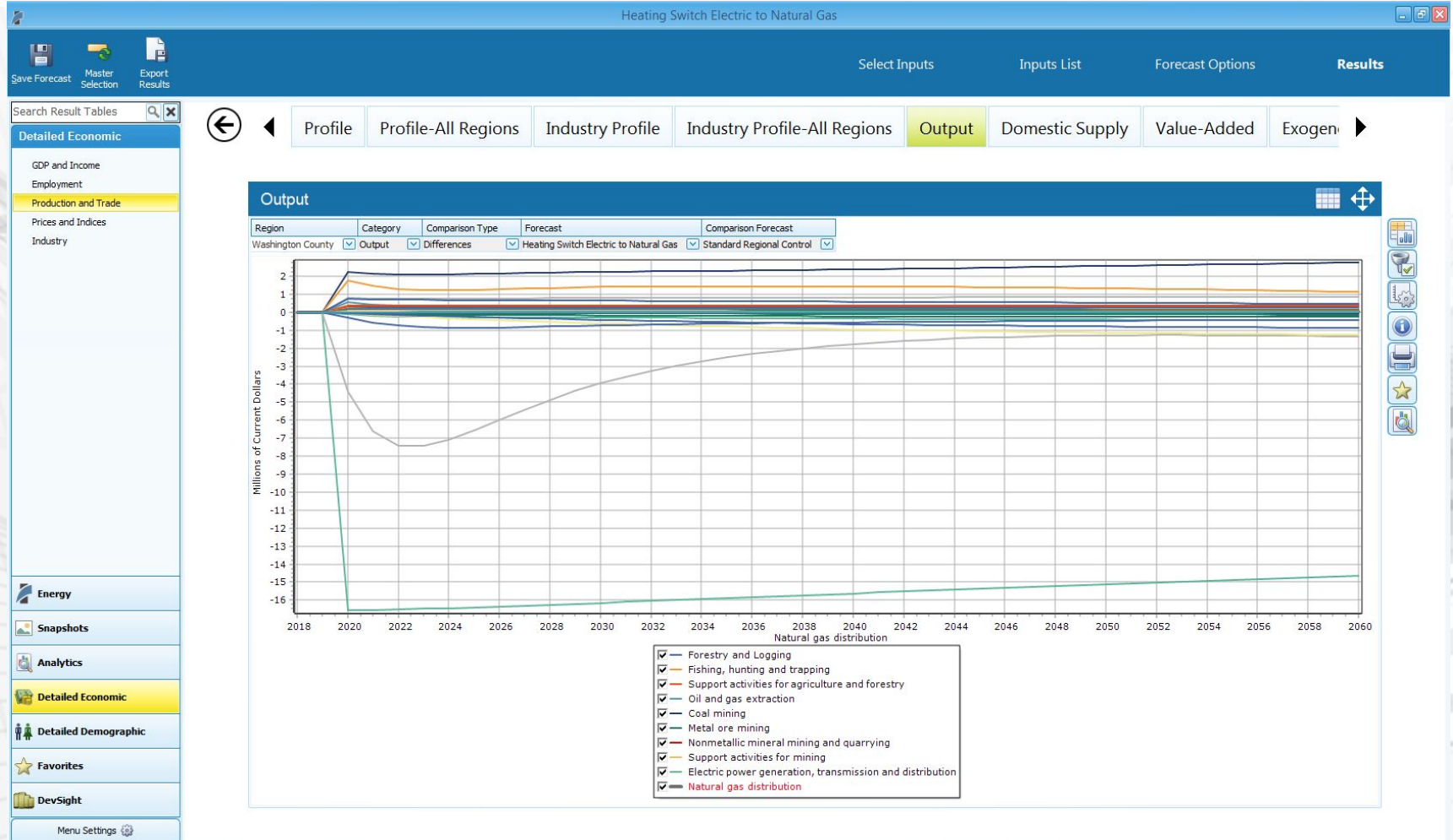
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GDP by Components



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Output by Industry



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Average Annual Wage Rate

Heating Switch Electric to Natural Gas

Save Forecast Master Selection Export Results Select Inputs Inputs List Forecast Options Results

Search Result Tables

DevSight

Demographics

Economics

← Employment Exports to Multiregions Employment Exports to Rest of Nation Employment Exports to Rest of World Employment →

Average Annual Wage Rate

Region	Category	Comparison Type	Forecast															
Washington County	Average Annual Wage Rate	Levels	Heating Switch Electric to Natural Gas	Industries	Units	2018	2019	2020	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030
	Utilities	Millions of Current Dollars			0.099	0.102	0.106	0.110	0.115	0.119	0.123	0.127	0.131	0.136	0.140	0.145	0.149	
	Electric power generation, transmission	Millions of Current Dollars			0.101	0.104	0.108	0.112	0.117	0.121	0.125	0.130	0.134	0.139	0.143	0.148	0.152	
	Natural gas distribution	Millions of Current Dollars			0.104	0.108	0.113	0.119	0.125	0.130	0.136	0.142	0.148	0.154	0.161	0.167	0.174	
	Construction	Millions of Current Dollars			0.041	0.043	0.044	0.046	0.048	0.050	0.052	0.054	0.056	0.058	0.060	0.062	0.064	
	Retail trade	Millions of Current Dollars			0.023	0.023	0.025	0.026	0.027	0.028	0.030	0.031	0.032	0.034	0.035	0.037	0.038	
	Transportation and warehousing	Millions of Current Dollars			0.028	0.029	0.031	0.032	0.033	0.035	0.036	0.037	0.039	0.040	0.041	0.043	0.044	
	Real estate and rental and leasing	Millions of Current Dollars			0.005	0.006	0.006	0.006	0.006	0.006	0.007	0.007	0.007	0.007	0.008	0.008	0.008	
	Real estate	Millions of Current Dollars			0.005	0.005	0.005	0.005	0.006	0.006	0.006	0.006	0.006	0.007	0.007	0.007	0.007	
	State and Local Government	Millions of Current Dollars			0.050	0.052	0.053	0.054	0.055	0.057	0.058	0.060	0.061	0.063	0.064	0.066	0.068	

Energy

Snapshots

Analytics

Detailed Economic

Detailed Demographic

Favorites

DevSight

Menu Settings

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