

Regional Air Quality Management in Response to Global Change

Tools for Supporting Decision-Makers

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**CCSP Workshop: Climate Science in Support of Decision Making
Arlington, VA, November 14-16, 2005**

EPA-ORD Program Objectives

EPA's Role in the Climate Change Science Program:

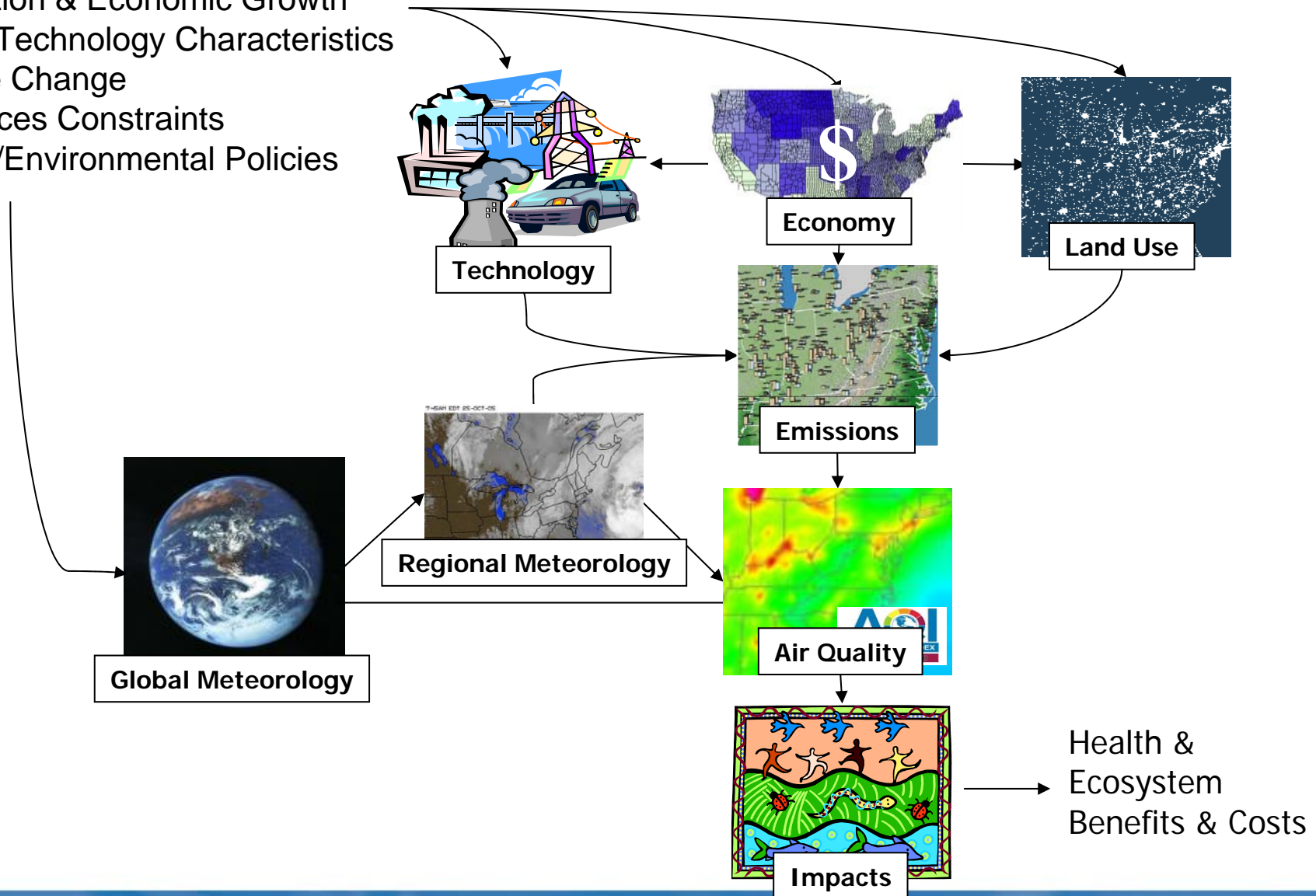
1. Assess the impacts of global change on *air quality*
2. Develop tools to assist EPA, regional, state, and local decision-makers in developing cost-effective, robust adaptation strategies

- Focus on Year 2050
- Consider factors such as:
 - Population growth and redistribution
 - Economic growth
 - Land use change
 - Resource constraints
 - Technology and fuel use changes
 - Climate changes (temperature, precipitation, solar isolation)
 - Current and expected national, regional, and state actions

Scenario Assumptions

Population & Economic Growth
Future Technology Characteristics
Climate Change
Resources Constraints
Energy/Environmental Policies

Modeling Process



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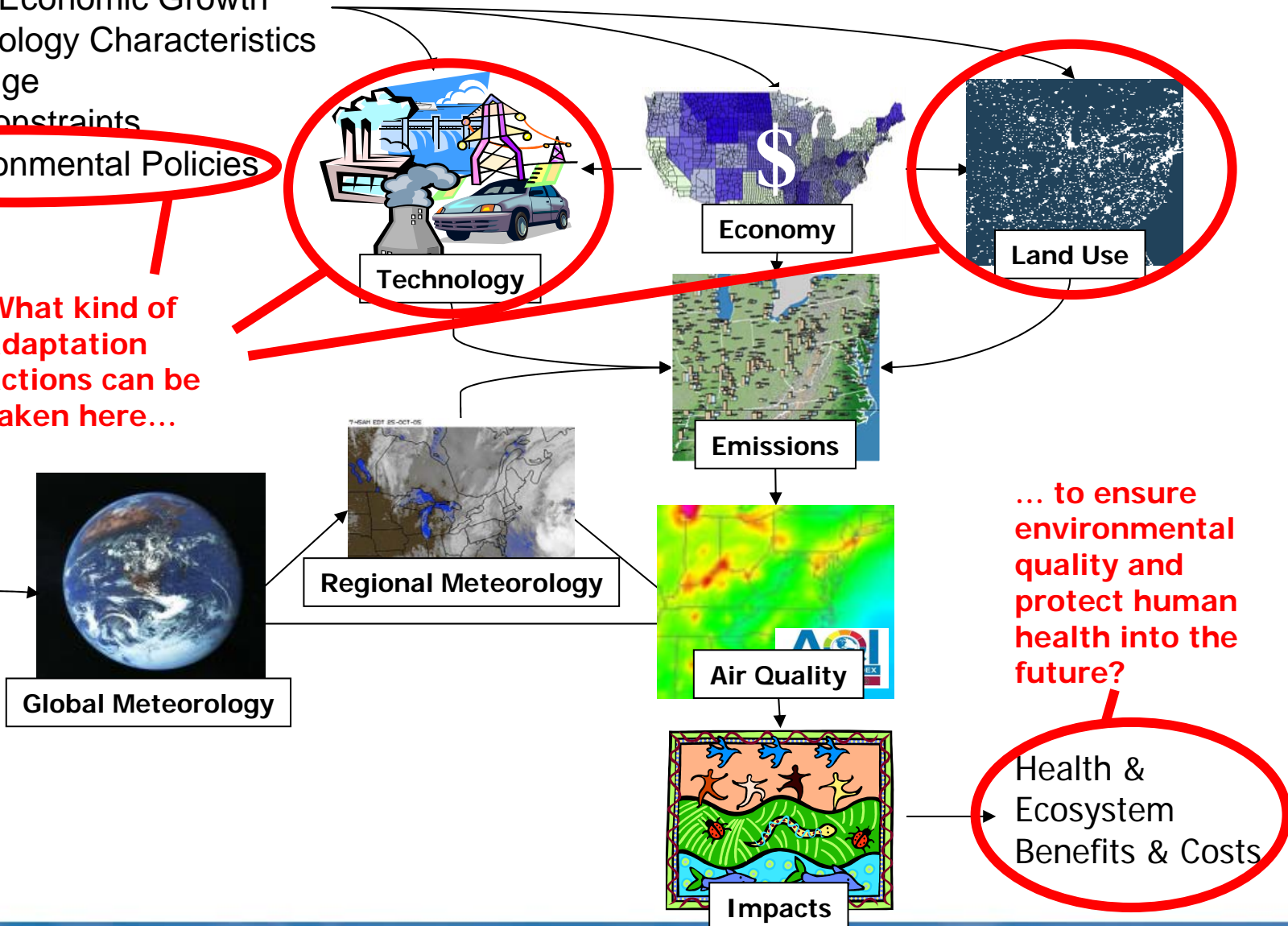
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Scenario Assumptions

- Population & Economic Growth
- Future Technology Characteristics
- Climate Change
- Resources Constraints
- Energy/Environmental Policies**

Modeling Process

What kind of adaptation actions can be taken here...

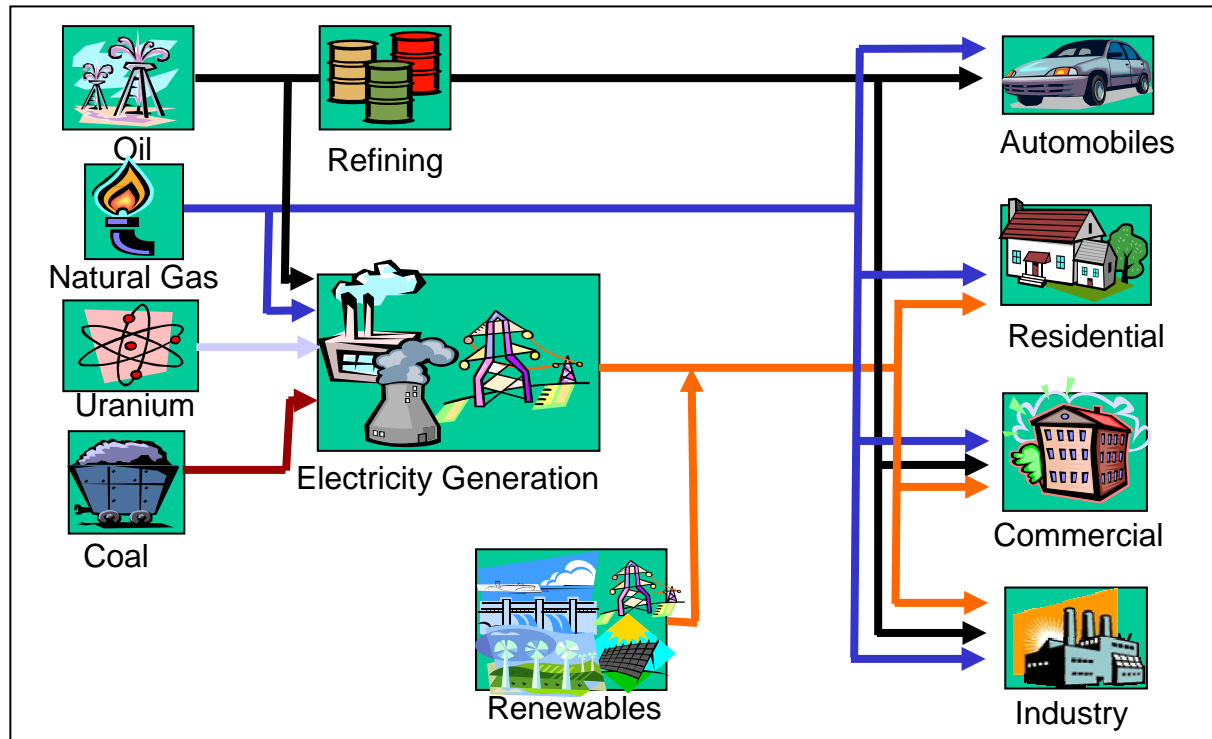


... to ensure environmental quality and protect human health into the future?

Health & Ecosystem Benefits & Costs

Why Energy and Air Quality?

Today's Energy System



Air Pollution

Contribution to anthropogenic emissions:

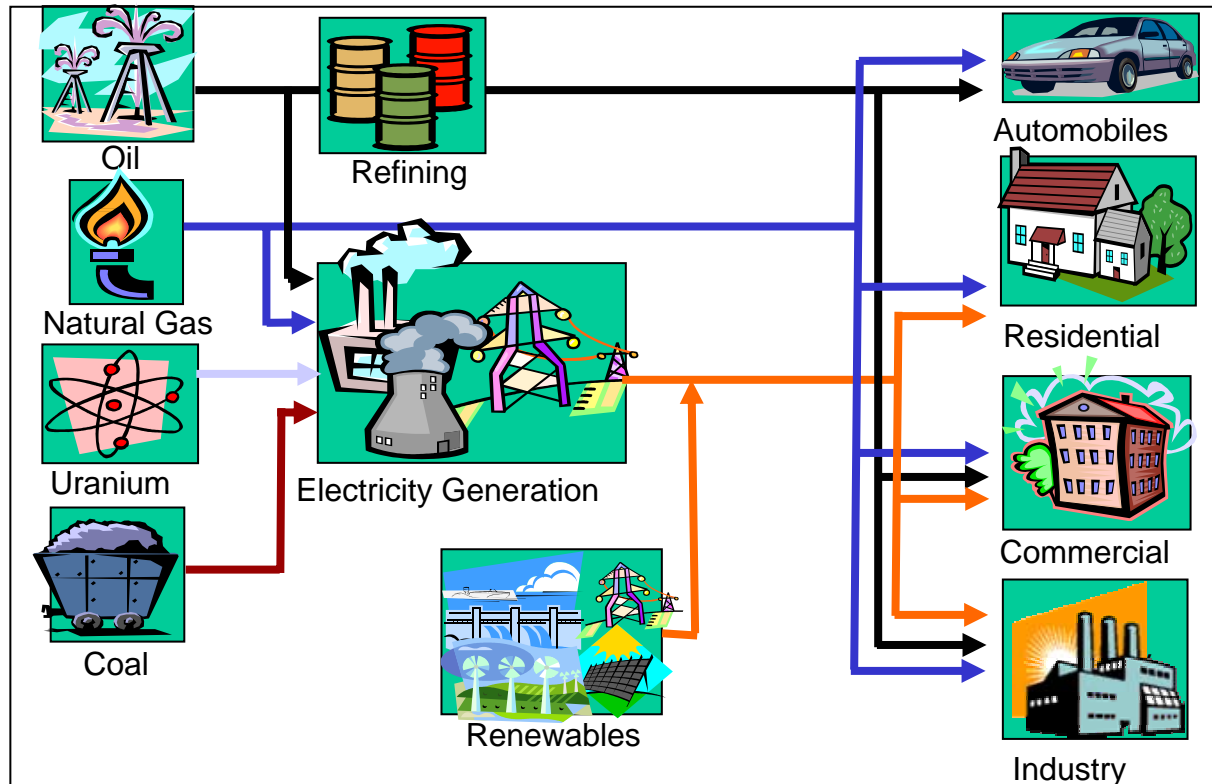
NO_x ~ 95%
SO_x ~ 89%
CO ~ 95%
NH₄ ~ 62%
Hg ~ 87%

Air Quality Concerns:

Ozone
PM_{2.5}
Acid deposition
Toxics

Why Energy and Air Quality?

Tomorrow's Energy Demands with Today's Technologies



Air Pollution

Demands: +

Emissions:

NO_x

SO_x

CO

NH₄

Hg

Temperature: +

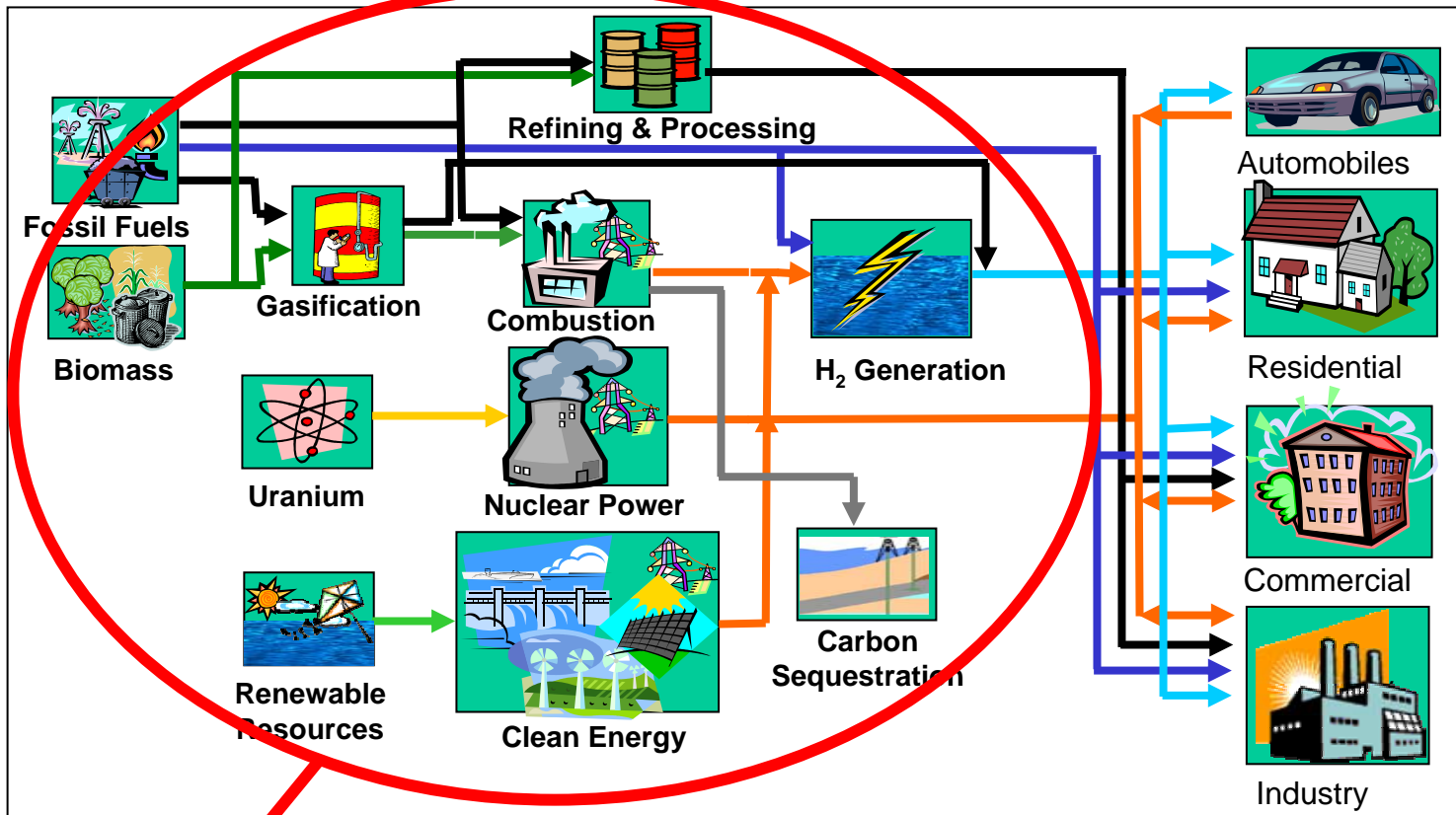
Air Quality ↓

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Why Energy and Air Quality?

Tomorrow's Energy Demands with New Technologies



Air Pollution

Demands: +

Emissions:

NO_x
SO_x
CO +/-?
NH₄
Hg

Temperature: +

Air Quality

Regional planning decisions can influence the energy system and therefore impact air quality...

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Adaptation in Regional Context

User:

State or regional air quality planner

Goal:

Evaluate actions for maintaining or improving ambient air quality under various global change scenarios

Options:

Smart growth programs

Renewable energy subsidies

Light duty vehicle feebates

Heavy duty vehicle and fleet programs

Energy efficiency programs

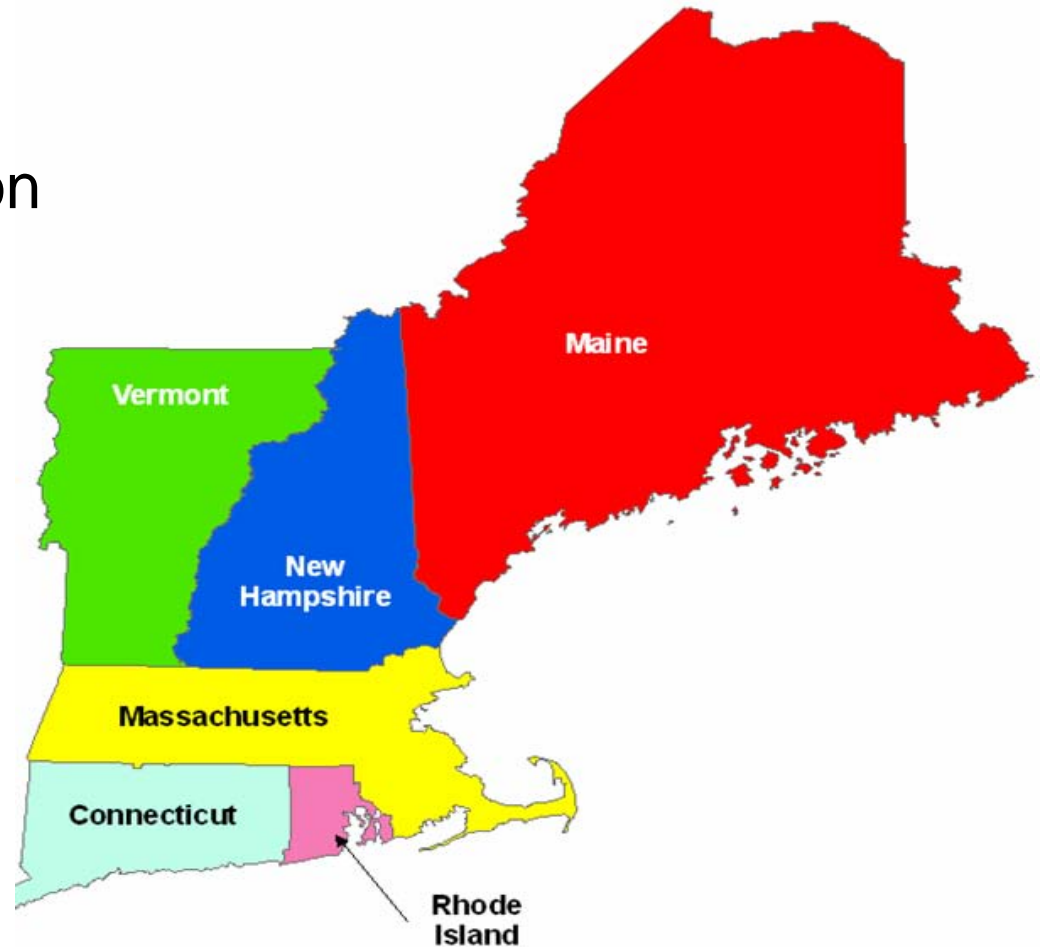
Example: Northeast States for Coordinated Air Use Management (NESCAUM)

A Regional Energy/Emissions Model

Pilot Study:

6-state New England region

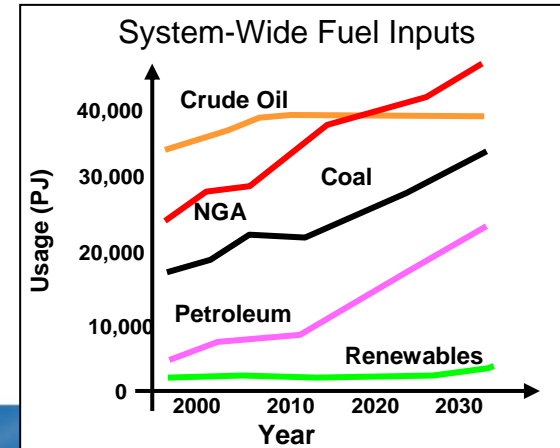
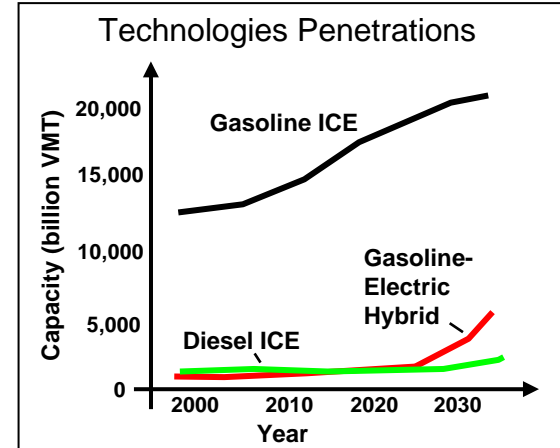
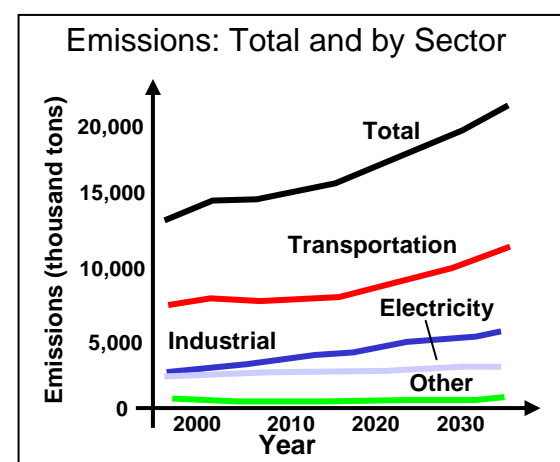
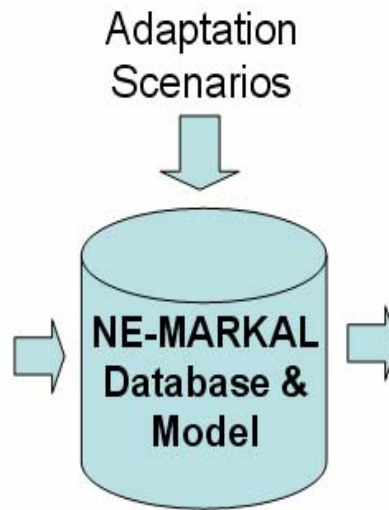
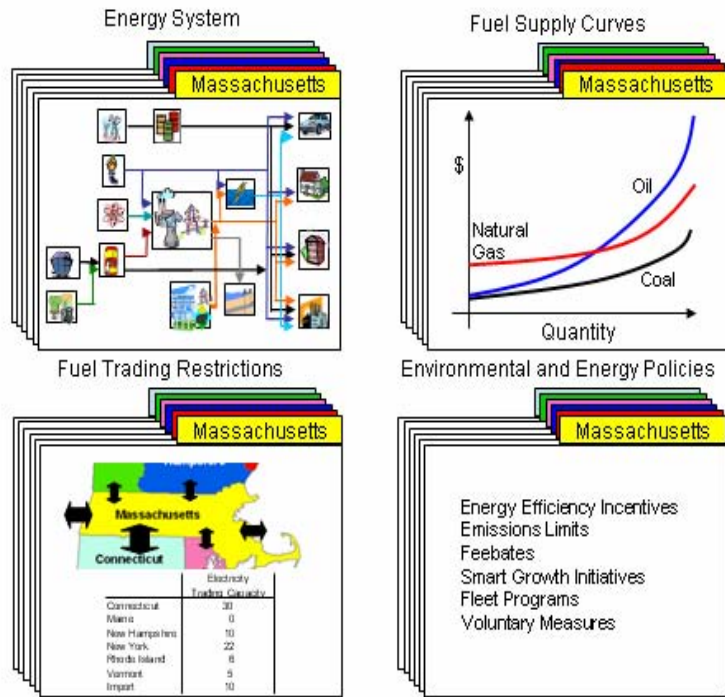
Collaboration with
NESCAUM



EPA has funded tool development

Pilot Study

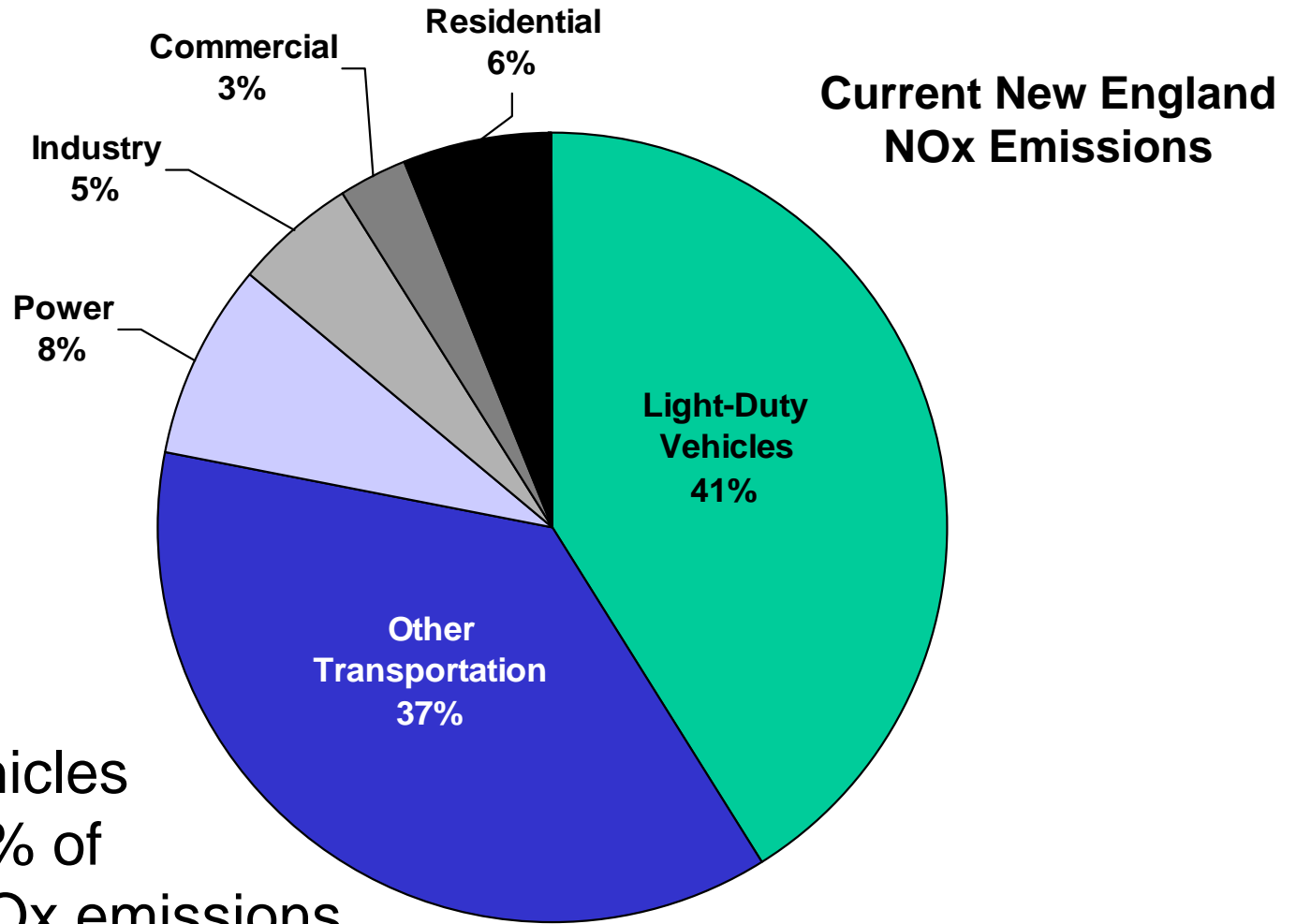
NESCAUM's Energy/Emissions Model: NE-MARKAL



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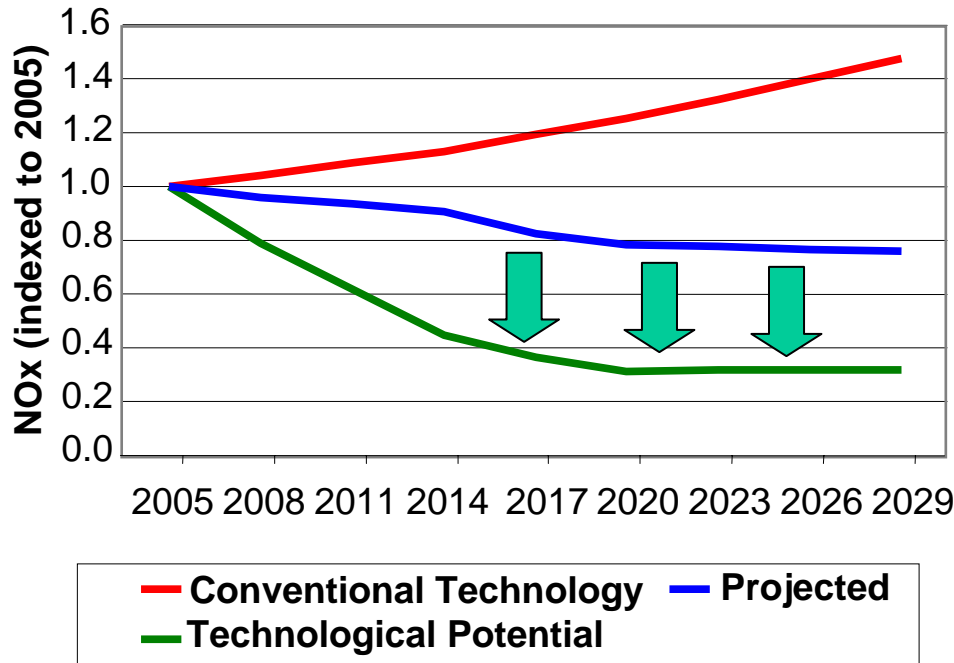
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Example NE-MARKAL Application by NESCAUM



Example NE-MARKAL Application by NESCAUM

Projections of Light Duty NOx Emissions



Light duty emissions are expected to decline based on technological progress

How can a *feebate* encourage further reductions?

Illustrative Results... Please do not cite.

Example Application

Feebate: A revenue-neutral policy in which rebates are given on fuel-efficient car purchases and fees are charged on non-fuel efficient vehicles

Example:

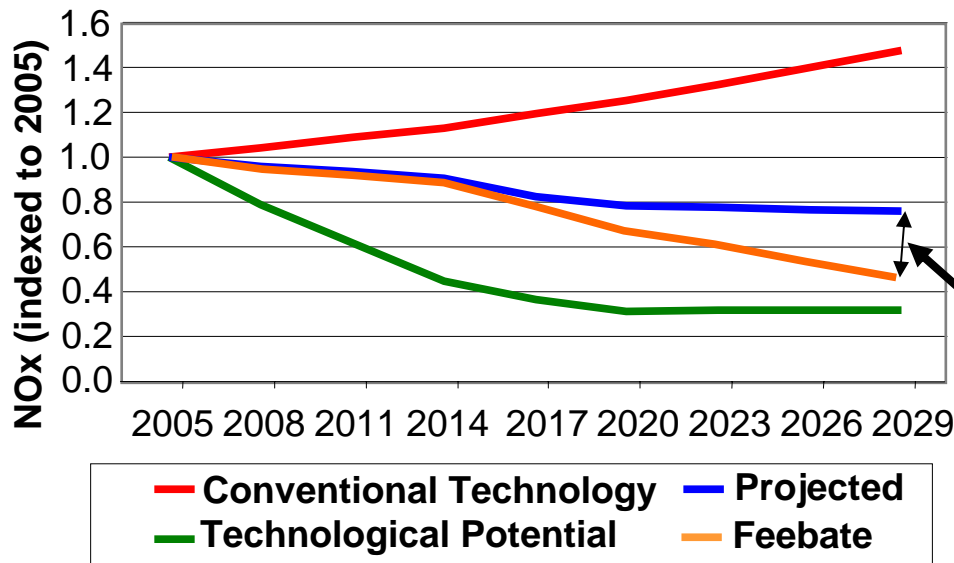
Vehicle Type	MPG	Fee/Rebate
Large SUV	13	(\$3,290)
Large 2WD Pickup	18	(\$1,150)
Mid-size Family Sedan	24	\$ 140
Car-Based Hybrid SUV	31	\$1,180
Compact Sedan	33	\$1,370
Compact Hybrid	47	\$2,280

A feebate is modeled...

Illustrative Results... Please do not cite.

Example Application

Projections of Light Duty NOx Emissions



Additional improvements due to increased penetration of hybrids and advanced gasoline-ICEs technologies.

Illustrative Results... Please do not cite.

Tool Development Criteria

Operational on desktop computer

User-friendly

By decision-maker or analyst

Design:

Leverage existing EPA (ORD &OAR) and public domain tools

MIMS – Multimedia Integrated Modeling System

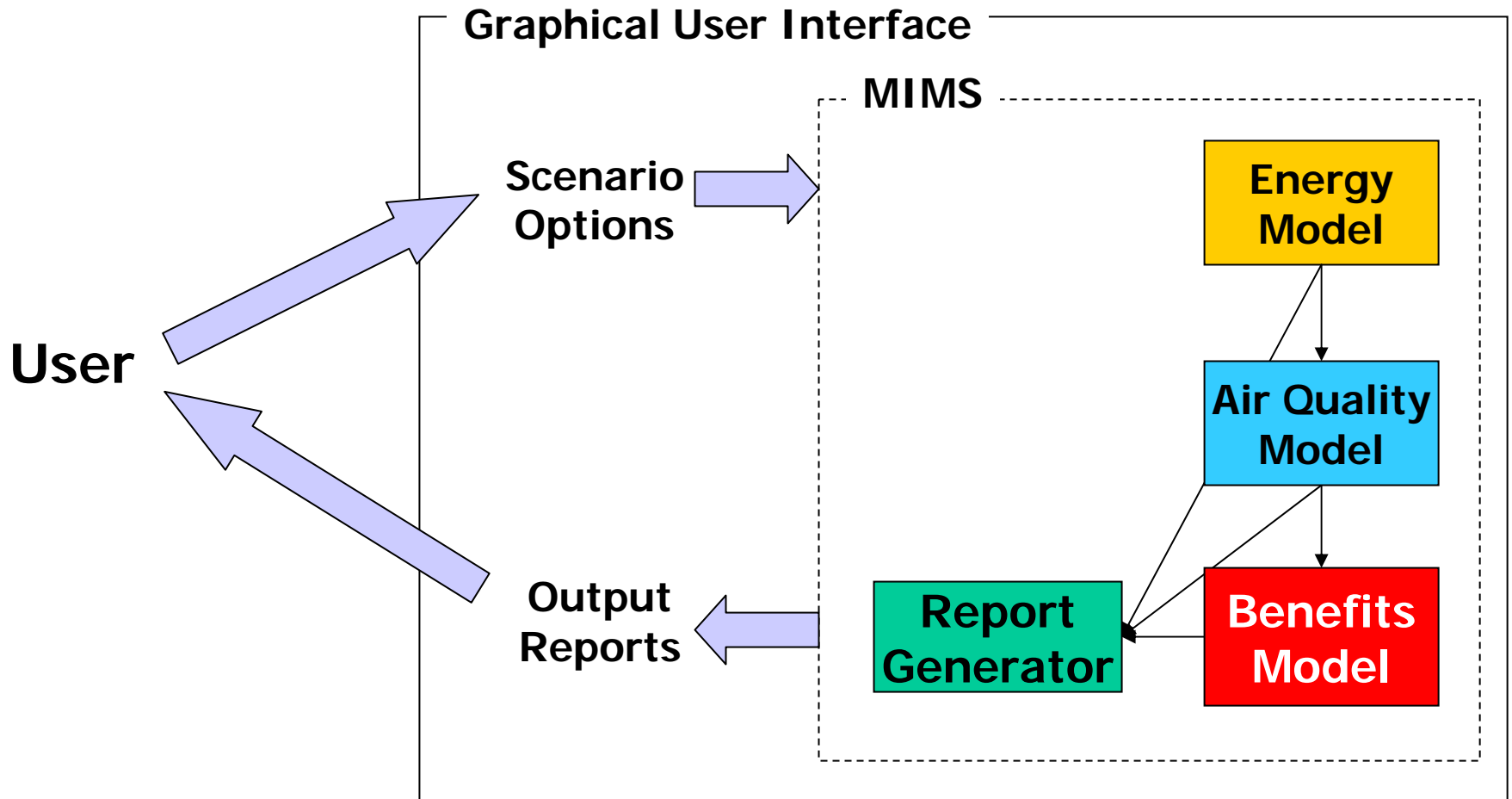
RSM – Response Surface Model

VPA – Visual Policy Analyzer

BenMAP – Benefits analysis and mapping program

MARKAL – MARKet ALocation energy system model

Tool Components



Prototype Decision Support Tool

Scenario Run MARKAL RSM VPA

File Scenario View Help

Key Inputs and Outputs

Vehicle Efficiencies Response Surface Misc Benefits Outputs

General Emissions Fuel Costs Vehicle Costs

Name: BASE_CAIR

MARKAL Directory: 1\AnswerV5\Gams_WrkPRD [Browse]

Working Directory: rking\Scenarios\BASE_CAIR [Browse]

Solution Mode: Optimize

Modeling Flow

- Energy Modeling
 - Evaluate Energy System: MARKAL
 - Post Process MARKAL: MARKAL_PostProc
- Data Analysis
- Air Quality Modeling
 - Pre-Process: RSM_PreProc
 - Run: Response Surface Model
 - Post-Process: RSM_PostProc
- Benefits Modeling
 - Run: BenMAP

Viewers for Model Outputs: Tables

The image shows a screenshot of the 'Scenario Run MARKAL RSM VPA' software interface. A window titled 'Analysis Engine Table Application' is open, displaying a table of model outputs. The table has 9 rows and 8 columns, with the following data:

Row	YEAR	DiscountR...	GSLCostIncrea...	DSLCostIncrea...	NGACostIncrea...	SystemNGAIcrea...	H2F
1	1995	5.00E-02	0.00E00	0.00E00	0.00E00	0.00E00	
2	2000	5.00E-02	0.00E00	0.00E00	0.00E00	0.00E00	
3	2005	5.00E-02	0.00E00	0.00E00	0.00E00	0.00E00	
4	2010	5.00E-02	0.00E00	0.00E00	0.00E00	0.00E00	
5	2015	5.00E-02	0.00E00	0.00E00	0.00E00	0.00E00	
6	2020	5.00E-02	0.00E00	0.00E00	0.00E00	0.00E00	
7	2025	5.00E-02	0.00E00	0.00E00	0.00E00	0.00E00	
8	2030	5.00E-02	0.00E00	0.00E00	0.00E00	0.00E00	
9	2035	5.00E-02	0.00E00	0.00E00	0.00E00	0.00E00	

The table viewer window also shows the file name 'c:\Projects\Working\markal_out_BASE_CAIR_Optimize.csv' and a 'Full Description' button. The status bar at the bottom of the window indicates '9 rows : 226 columns'.

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Analysis Engine

Scenario Run MARKAL RSM

File Scenario View Help

Key Inputs and Outputs

Vehicle Efficiencies Respo

General Emission

MARKAL Output LST Filename

MARKAL Output ANT Filename

MARKAL Output Summary File

Vehicle MPG Filename

Emissions Bin Filename

RSM Output Filename

VPA Input Factors Filename

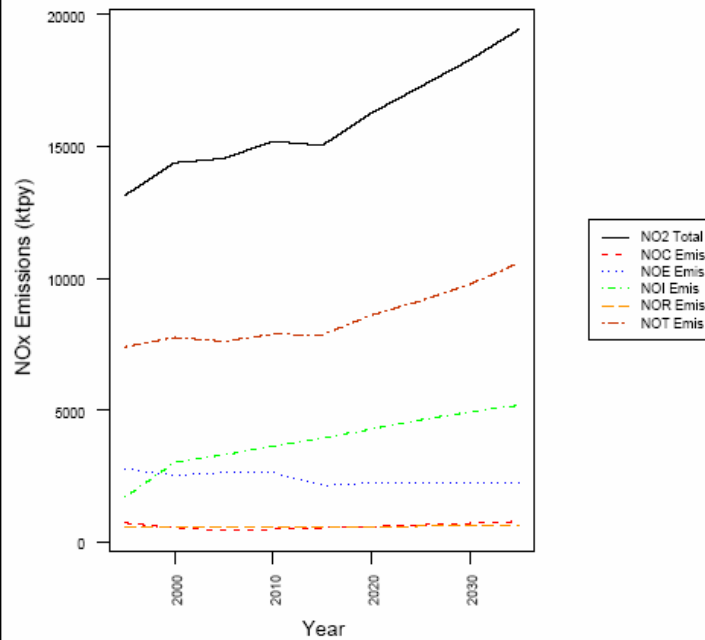
BenMAP Filename

Rows: 220 Columns

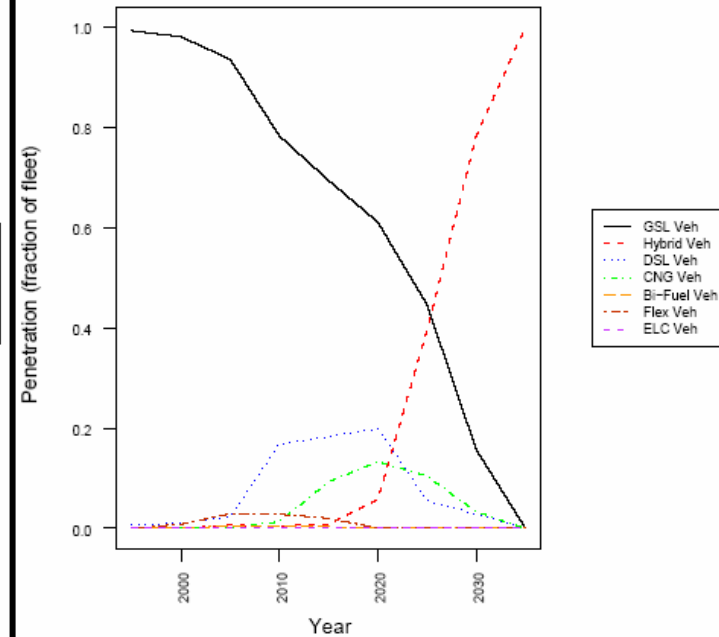
Footer

Build

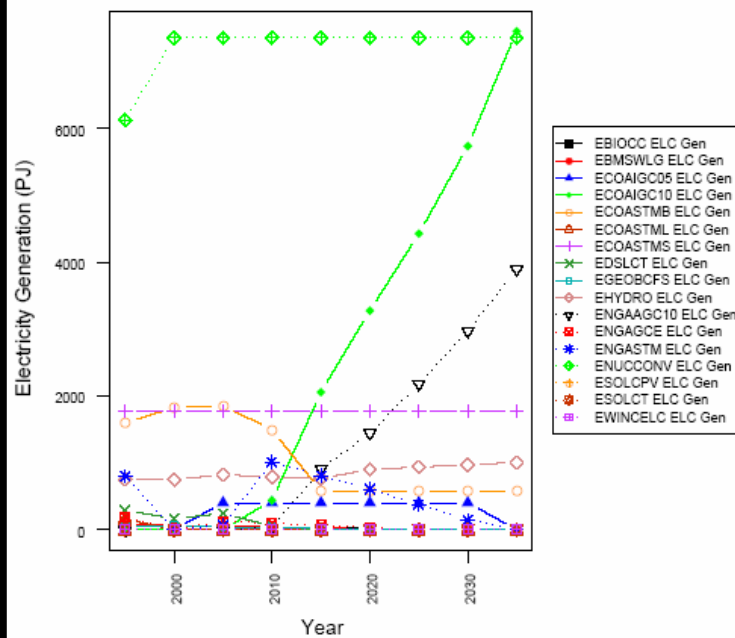
Total and Sectoral NOx Emissions



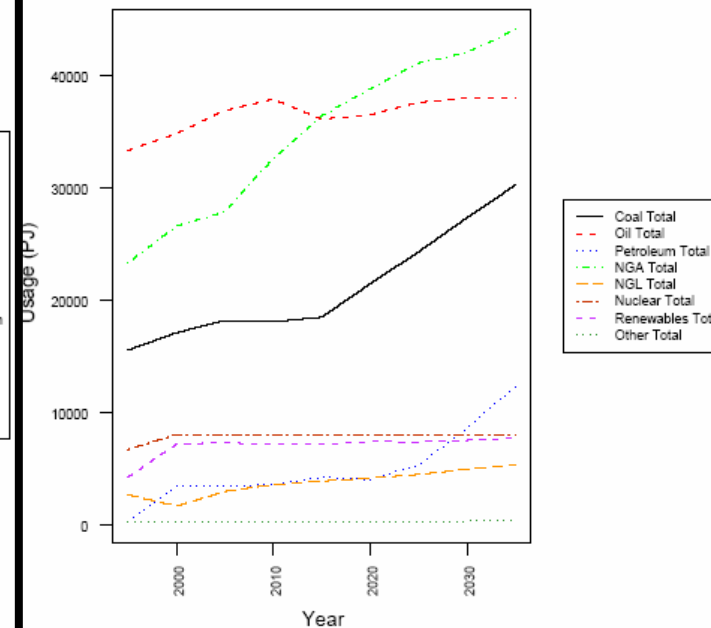
Light Duty Vehicle Penetrations



Electricity Generation by Technology



Fuel Use by Type



Viewers for Model Outputs: RSM

Scenario Run MARKAL RSM VPA

Visual Policy Analyzer - Model_stat1hr.def

File View Window Help

Key Inputs and Outputs

Vehicle Efficiencies Respo
General Emission

MARKAL Output LST Filename

MARKAL Output ANT Filename

MARKAL Output Summary File

Vehicle MPG Filename

Emissions Bin Filename

RSM Output Filename

VPA Input Factors Filename

BenMAP Filename

Non-road VOC in nonattainment areas: 1.03

Non-road VOC in attainment areas: 1.03

Area VOC in NA areas: 1.03

Area VOC in attainment areas: 1.03

Non-road NOx in NA areas: 1.03

Non-road NOx in attainment areas: 1.03

EGU NOx in nonattainment areas: 1.20

EGU NOx in attainment areas: 1.20

Non-EGU NOx in NA areas: 1.05

Non-EGU NOx in attainment areas: 1.05

On-road VOC in NA areas: 1.20

On-road VOC in attainment areas: 1.20

On-road NOx in NA areas: 1.20

On-road NOx in attainment areas: 1.20

Model_avg8hr.def

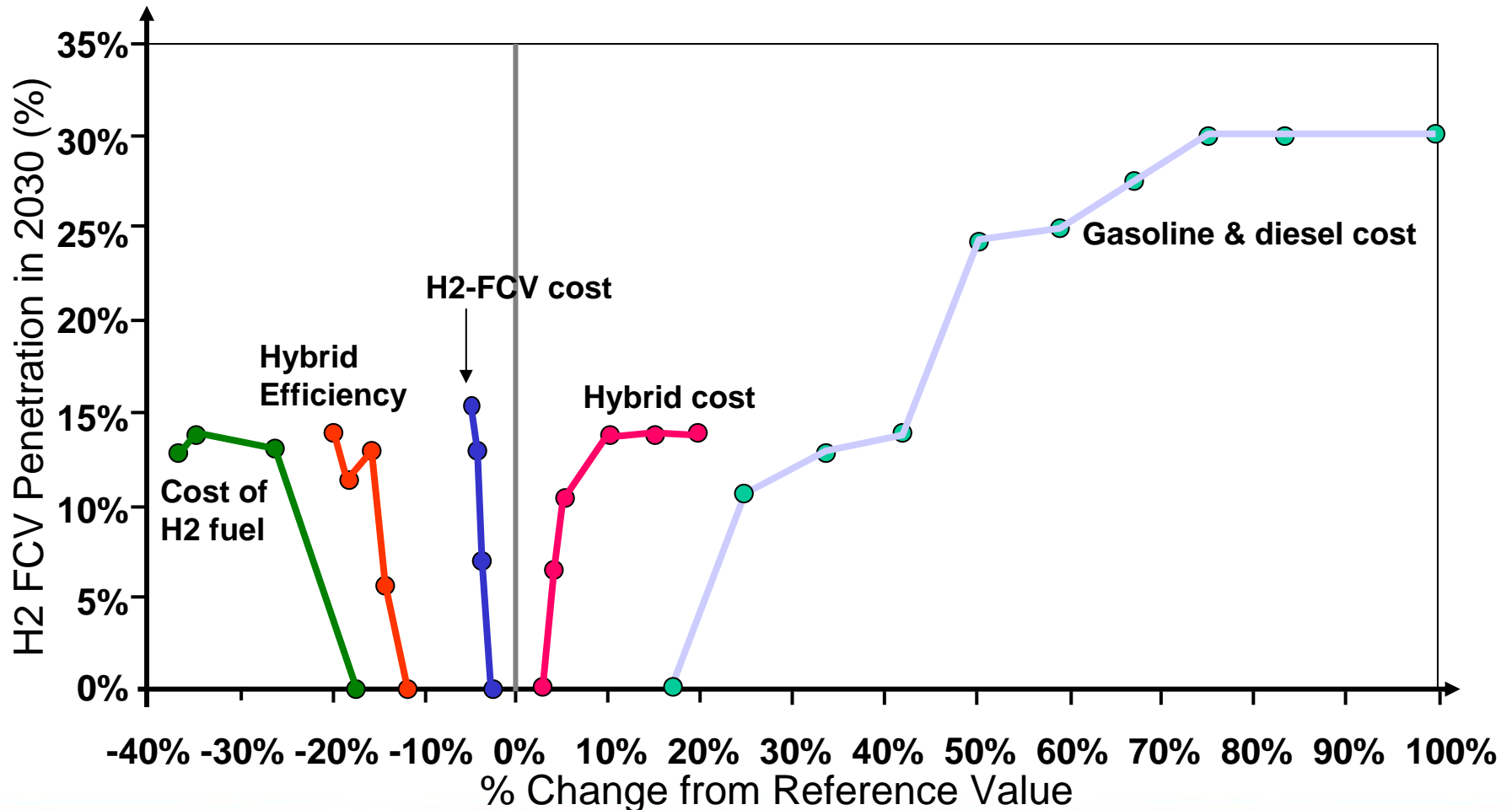
Model_stat1hr.def

Legend:

22.25 37.29 52.32 67.35 82.39 97.42
(ug/m3)

Parametric Sensitivity Analysis

Understand model responses to stimuli



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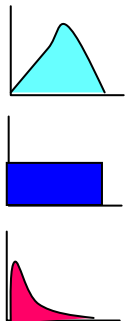
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Sensitivity and Uncertainty Analysis

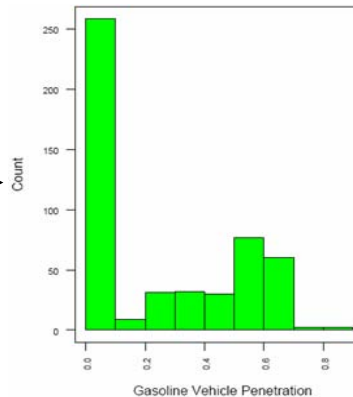
Monte Carlo Simulation

Characterize uncertainty in model results
Identify key relationships among inputs and outputs

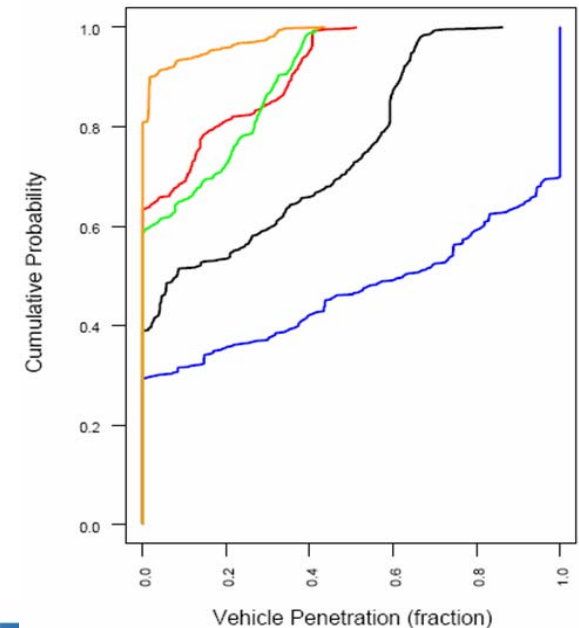
inputs



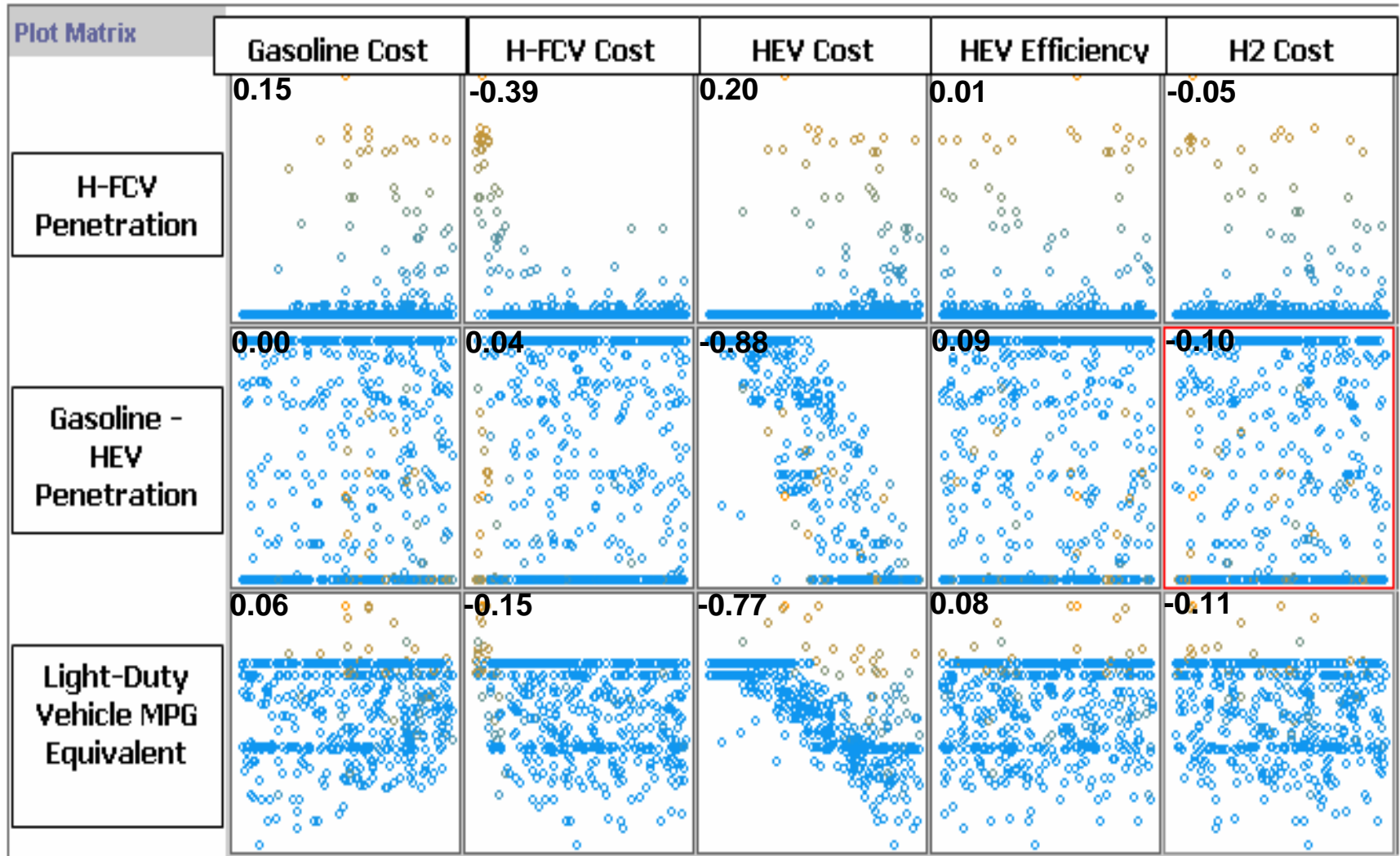
outputs



Iterate



Global Sensitivity Analysis



Ongoing and Future Activities

- Tailor for NESCAUM use
 - Integrate NE-MARKAL and BenMAP
 - Improve graphical user interface to facilitate policy analyses of interest to regional decision-makers
- Work with NESCAUM to test and evaluate the design
- Learn from experience and work with NESCAUM and other regions to develop/apply next generation decision support tools.