Regional Economic Impact Assessment of Climate Change Legislation: A Case for Michigan

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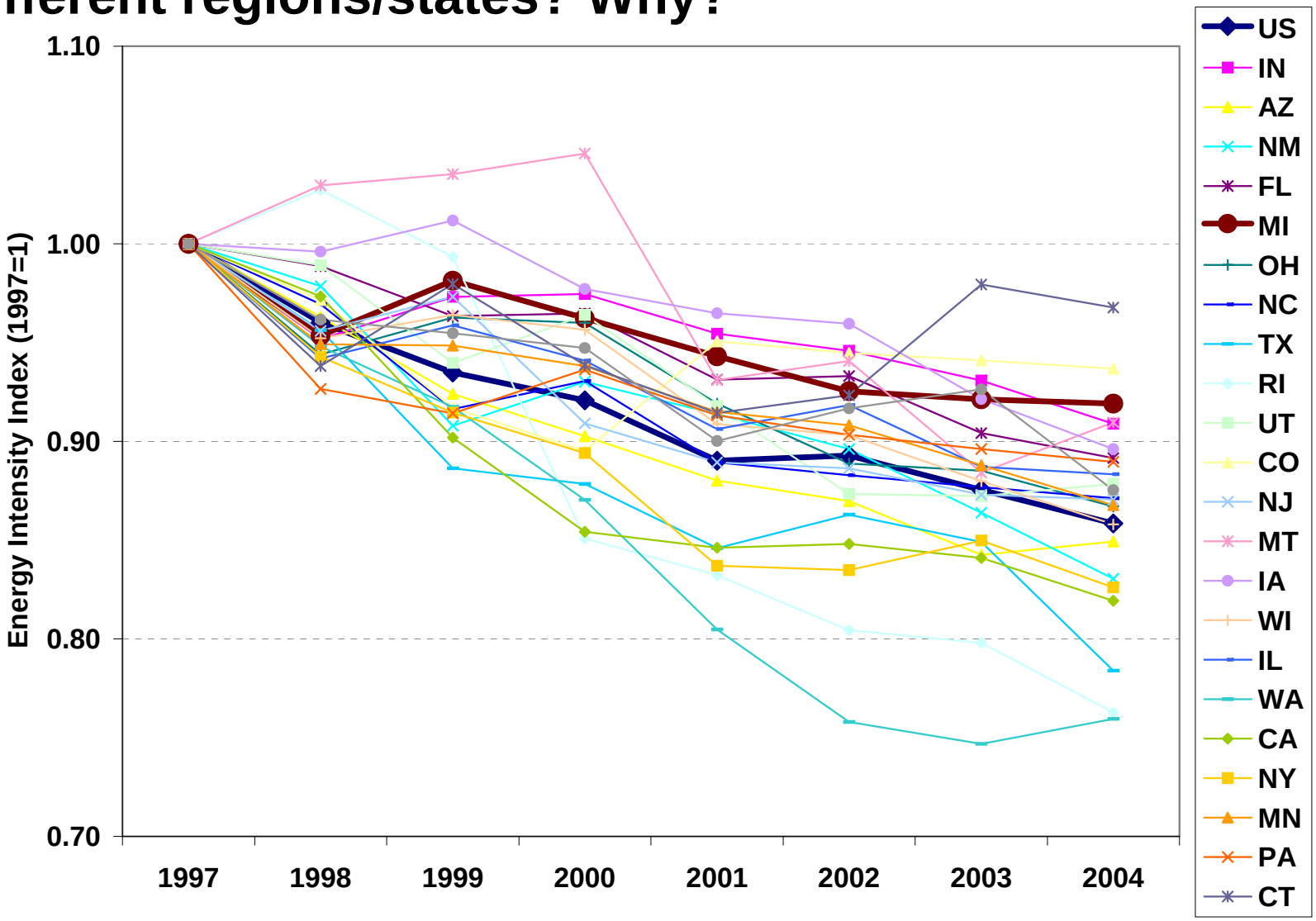
Talk outline

- **Why do some states/regions have different energy use patterns?**
  - Economic structure of the state
  - Demographic patterns
  - Production technology
- **How do we capture regional differences?**
- **What kind of a model is needed to inform implementation of climate policies?**
- **What approaches and tools are available for performing regional analysis**
  - Input-output modeling
  - CGE modeling
  - CRA's integrated modeling approach
- **Analysis of two federal GHG emissions policies using MRN-NEEM**
  - Stringent Cap and Trade Program
  - Moderate Cap and Trade with a Safety Valve Program
- **Impact on the State of Michigan**

Outline

- **Regional variations in economic impacts of climate policies**
- **Capturing the regional effects**
  - Selecting the appropriate model
  - Approaches and tools for regional analysis
- **MRN-NEEM Multi-Region National Model**
- **Example of a regional analysis of climate policies**
  - Analysis of two federal GHG emissions policies using MRN-NEEM
  - Impact on the State of Michigan

Energy policy will have different resulting impacts on different regions/states? Why?



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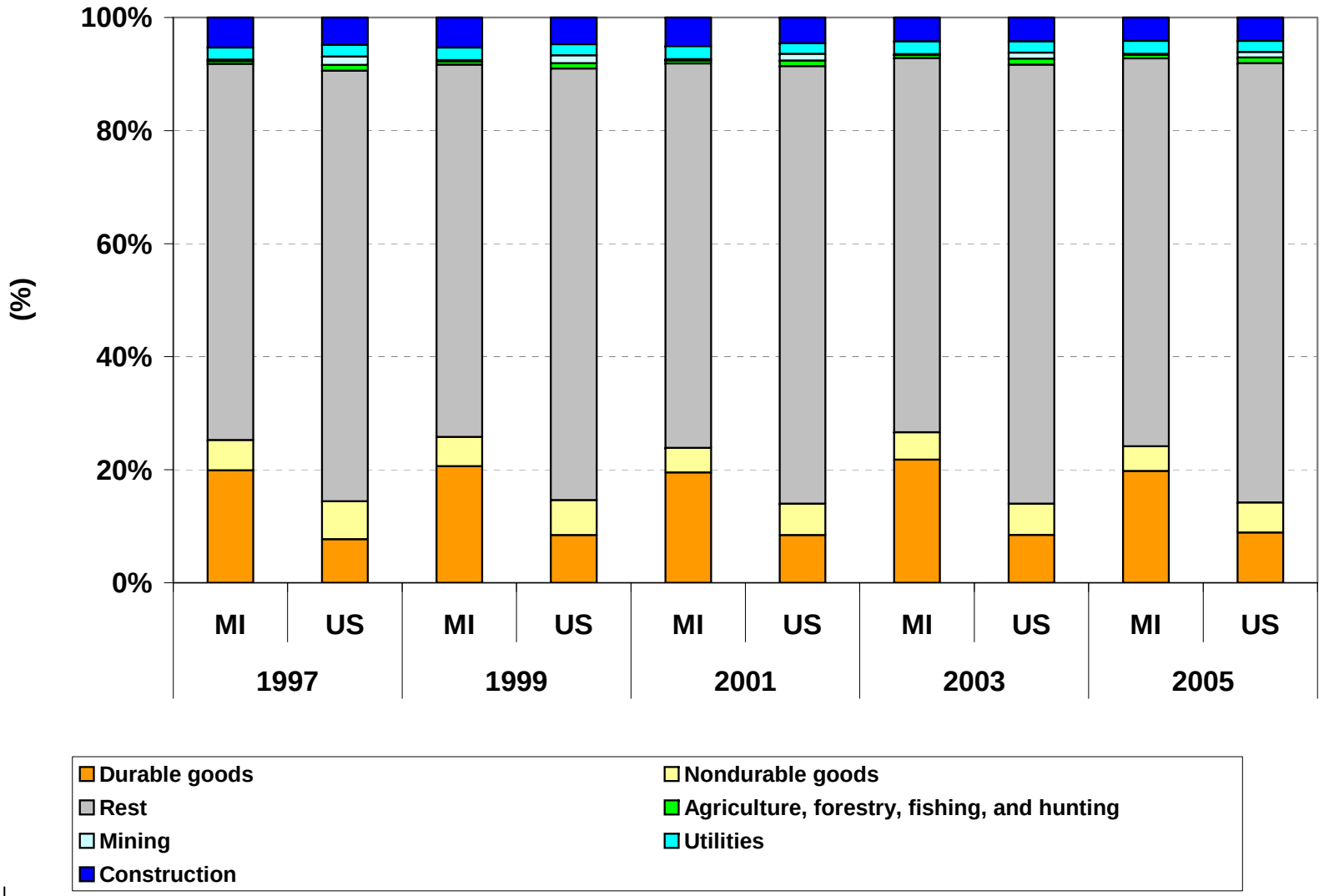

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There is need to perform analysis at regional level

- **Types of models and tools used to perform regional analysis**
  - Regionalized input-output based modeling
    - Multipliers or Regional Purchase Coefficients (RPCs) used to estimate the response in economic behavior to a policy change
    - Multiplier-based analysis lacks demand response feedbacks, substitutability of inputs, and is often static in nature
    - Although simple to model, results would not accurately reflect the true cost of the policy
    - Examples: IMPLAN model, REMI model
  - CGE modeling
    - Most appropriate economic tool to perform regional analysis of climate policies
    - Based on sound micro-economic foundations representing effects on cost of production, regional supply and demand balances, and consumer welfare
    - Captures general equilibrium and ripple effects throughout the economy
    - Developments in future technologies can be represented explicitly

What Kind of Modeling Capabilities are Required?

- **Sound treatment of economic decisions and markets**
  - Household and business decisions based on rational economic calculations
  - Complete accounting for factor inputs so that all costs are accounted for
  - Supply and demand equilibrium that supports efficient use of limited resources, unless there are specific market failures represented in the model
- **Detail sufficient to differentiate the impacts of alternative policy approaches**
  - Detailed representation of the electricity sector (the sector subject to the most complex and critical regulatory interventions)
  - Explicit representation of electricity, fuel, and other trade with the rest of the United States
  - Ability to determine effects and costs of measures within the model, rather than as externally imposed assumptions about costs and energy savings
- **Impossibility of outsmarting agents about future price trends and policy decisions**

MRN-NEEM is such a framework that integrates a technology rich bottom-up model with a comprehensive top-down CGE framework

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MRN-NEEM: MRN Overview

- **MRN is CRA's Multi-Region National model**
  - One of a set of CGE models developed at CRA
  - Current CRA team: Tom Rutherford, Paul Bernstein, Sugandha Tuladhar, David Montgomery, Anne Smith
- **MRN data**
  - New IMPLAN data including 2002 input-output matrices and trade flow data
  - EIA state-level energy production, consumption and price data
  - Capability of analyzing California in relation to U.S. economy and energy markets
- **Key economic mechanisms included in MRN model**
  - Possibility of premature retirement of capital
  - Impacts on government budgets, tax interaction and "double dividend" effects
  - Improvement in technology over time or in response to policies to represent technology breakthroughs
  - Sufficiently long time horizon to capture anticipation of future policies
- **Linkage to NEEM**
  - Replaced typical CES representation of electricity production function with a detailed electric power sector model because top-down models cannot capture decisions about what kind of technology to use for future generation capacity
  - Iteration between models to obtain consistent solutions for prices and quantities

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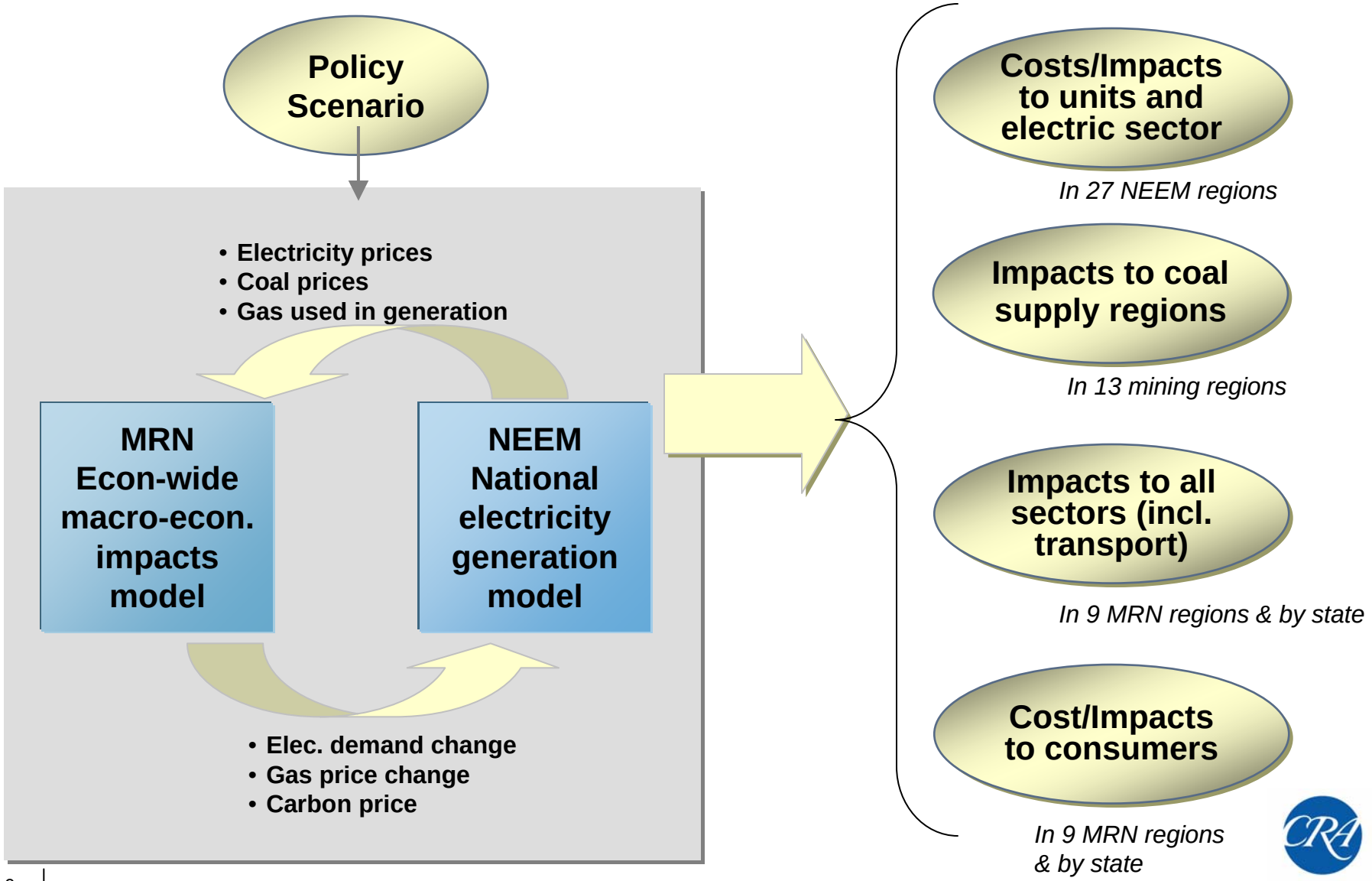
Integration of MRN and NEEM Provides a Unique Capability for Analysis of GHG Policy Impacts



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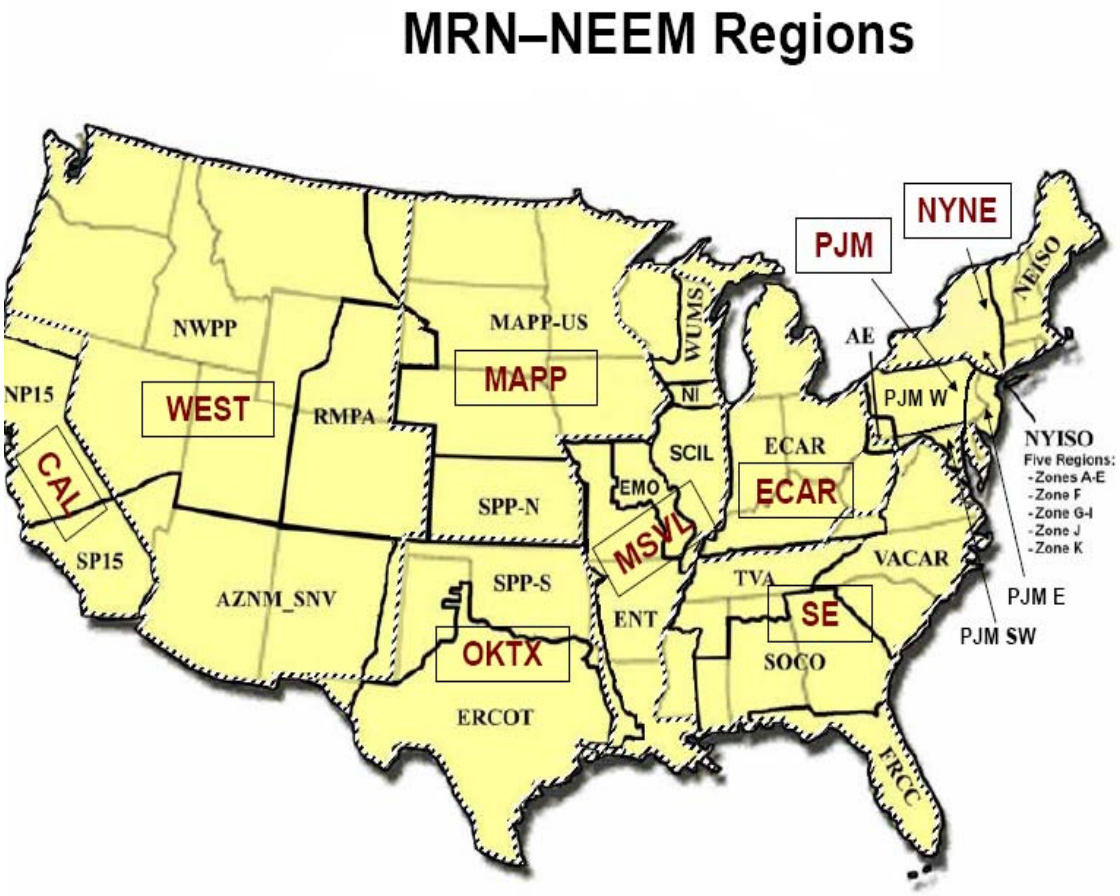
MRN Regional Coverage: 10 Region

MRN Region	States
NYNE	MA, ME, NH, NY, RI, VT, CT
PJME	PA, MD, DC, NJ, DE
CALI	CA
WEST	WA, OR, AK, HI, ID, MT, NV, UT, CO, WY, AZ, NM
SEST	MS, GA, AL, TN, VA, SC, NC, FL
OKTX	TX, OK
MAPP	ND, SD, NE, KS, MN
MSVL	IA, MO, AR, LA, WI, IL
ECRR	IN, OH, KY, WV
MIST	MI



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MRN Sectoral Coverage: 11 Industrial Sectors

*** Energy Sectors**

1	COL	Coal
2	CRU	Natural Gas and Crude
3	ELE	Electric Generation
4	GAS	Natural Gas Distribution
5	OIL	Refined Petroleum

*** General Sectors**

6	AGR	Agriculture
7	CNS	Construction
8	DWE	Owner-occupied dwellings
9	MIN	Metal and Nonmetal Mining
10	M_V	Motor Vehicles -- SIC 371
11	SRV	Services
12	TRN	Transportation Services

*** MECS Energy Sectors**

13	ALU	Aluminum
14	CHM	Chemicals
15	COM	Computer and Electronic Products
16	ELQ	Electrical Equipment and Appliances
17	FAB	Fabricated Metal Products
18	FOO	Food and Kindred Products
19	I_S	Iron and Steel
20	MAC	Machinery
21	MSC	Miscellaneous Manufacturing
22	OPM	Other Primary Metals
23	PAP	Paper and Pulp Mills
24	PRN	Printing and Related Support
25	RUB	Plastics and Rubber
26	SCG	Nonmetallic Mineral Products
27	TEX	Textiles and Apparel and Leather
28	TRQ	Transportation Equipment
29	WOO	Wood Products and Furniture

Energy	COL	Coal extraction
	CRU	Natural Gas extraction
	ELE	Electric Generation
	GAS	Natural Gas Distribution
	OIL	Refined Petroleum
Non-energy	AGR	Agriculture
	M_V	Motor Vehicles Manufacturing
	EIS	Energy intensive sectors
	TRN	Transportation Services
	SRV	Services
	MAN	Manufactured and processed goods

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MRN Inputs Based on Public Macroeconomic Data

Data	Source
Input-output tables of US economy at state level	IMPLAN *
Energy flows and prices	EIA
Tax rate and revenue data	National Bureau of Economic Research's TAXSIM model
Forecasts of energy prices and quantities	EIA (AEO)

*** CRA corrects IMPLAN's regional economic data to make them usable for energy analysis**

- Raw IMPLAN data are inconsistent with energy quantities and prices reported by EIA
- CRA modifies the IMPLAN energy accounts to match EIA's state-level energy data

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MRN-NEEM: NEEM Overview

- **CRA's North American Electricity and Environment Model (NEEM) is designed to model:**
  - Decisions about the timing and mix of new generating capacity
  - Retirement and mothball decisions
  - Environmental compliance decisions for SOx, NOx and Hg including pollution control retrofits and choice of emission controls for new units
  - Fuel choice in new units and fuel switching in existing units
  - Dispatch decisions (20 period load duration curve)
- **NEEM models the US electric power system and portions of the Canadian system**
  - Fundamental geographical structure is determined by transmission interfaces - 28 NERC regions/sub-regions
  - Additional geographic structure within regions to reflect environmental regulations, usually along state boundaries
  - Operates over a 45 year time horizon matching MRN
- **NEEM is one of the leading electric power models nationwide**
  - Designed by Ira Shavel, who also created the IPM model used by EPA for similar purposes
  - NEEM, IPM and NEMS have been accepted as the most comprehensive modeling frameworks for analysis of impacts of 3P and 4P regulations on the power sector
  - NEEM has capabilities and features beyond those of other models

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Regional Analysis of Nationwide Climate Policies

- **Two generic federal climate change policies selected**
  1. Stringent policy
  2. Moderate policy with a safety valve

- **These two broad policies bracket most of the climate change bills that have been proposed in the US Congress over the past couple of years.**

- **We look at economic impacts of these comprehensive national policies on the state of Michigan**

Nationwide Climate Change Policies Analyzed

	Stringent Cap and Trade Policy	Moderate Cap and Trade Policy with Safety Valve
Model Proposed Legislation	Safe Climate Act (Waxman)	NCEP Proposal (Bingaman)
Target Emissions	2009 level by 2010 2% annual cuts from 2011-2020 1990 level by 2020 5% annual cuts from 2021 80% below 1990 level by 2050	2006 level by 2020 15% below 2006 level by 2030
Safety Valve	None	Raising the starting price of a safety value to $10 per ton of carbon-dioxide equivalent emissions Increasing the rate of escalation in the safety-value price to 5 percent per year in real terms
Banking	Yes	Yes
Allowance Allocation	Free, based on size of region's economy	Free, based on size of region's economy
Offsets	Yes	Yes
Alternative Transportation Fuel	Available	Available
Other Regulatory or Transportation Subsidies	None	None

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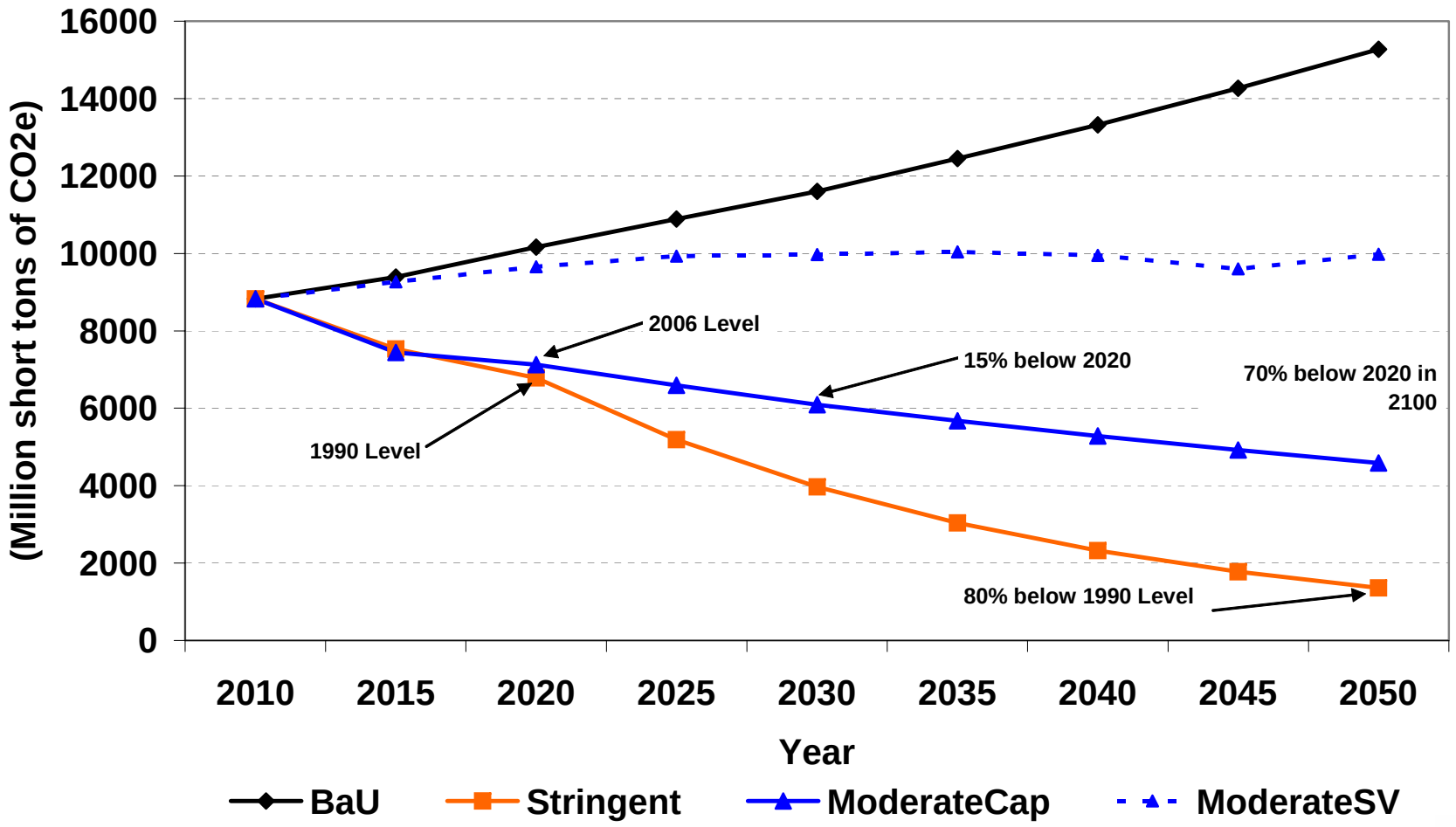
Total Emissions – Baseline and Cap



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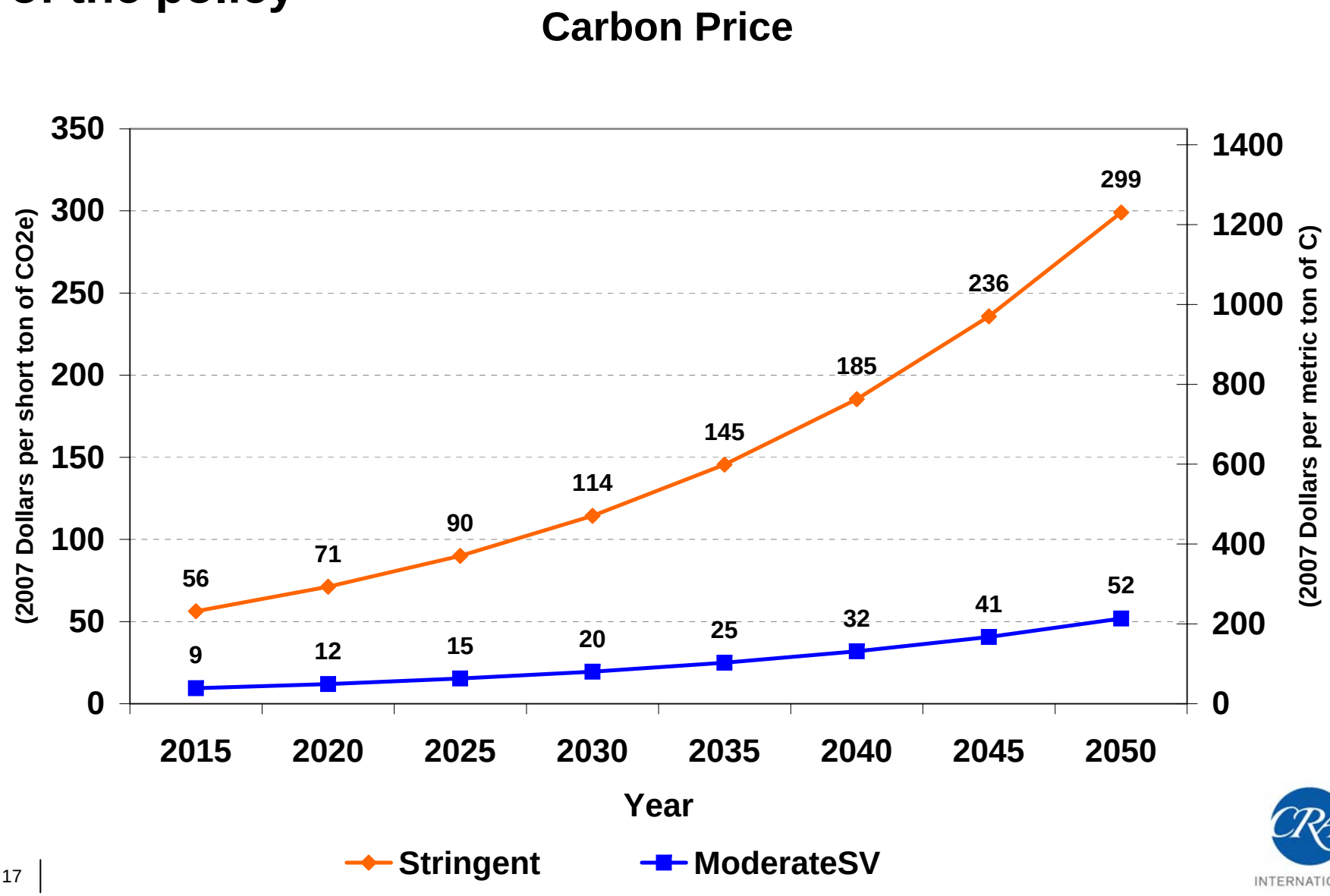
Carbon Price depends on Policy design and stringency of the policy



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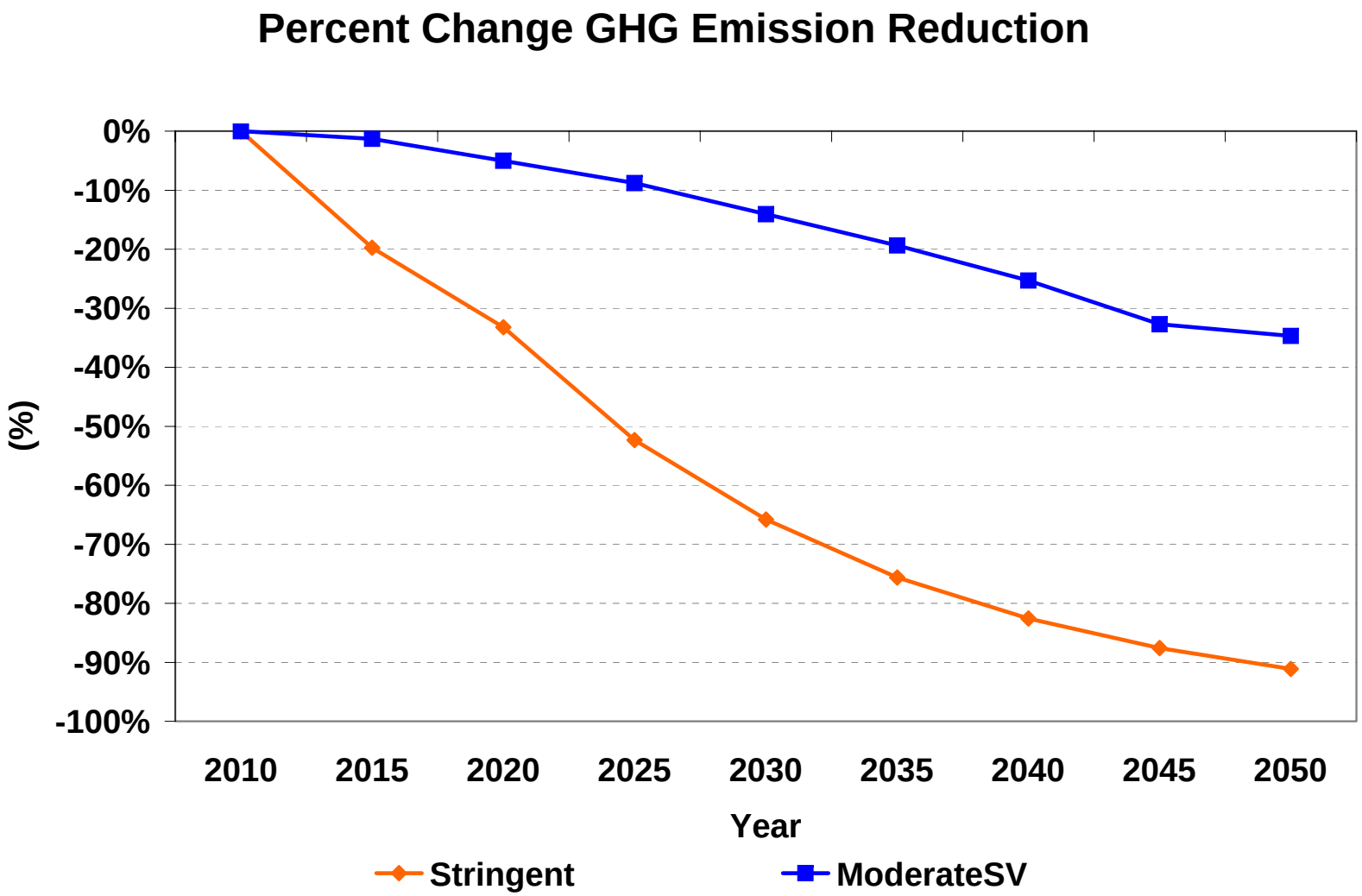
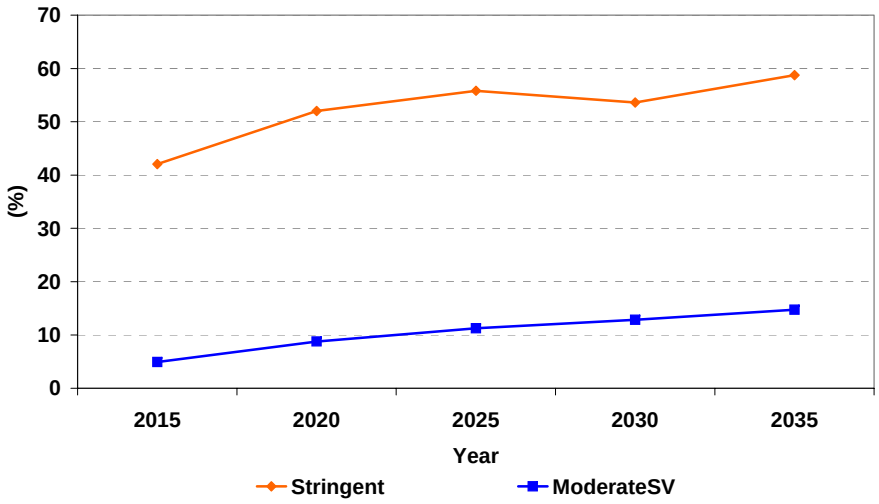
Stringent policy causes much greater reduction in emissions from the baseline

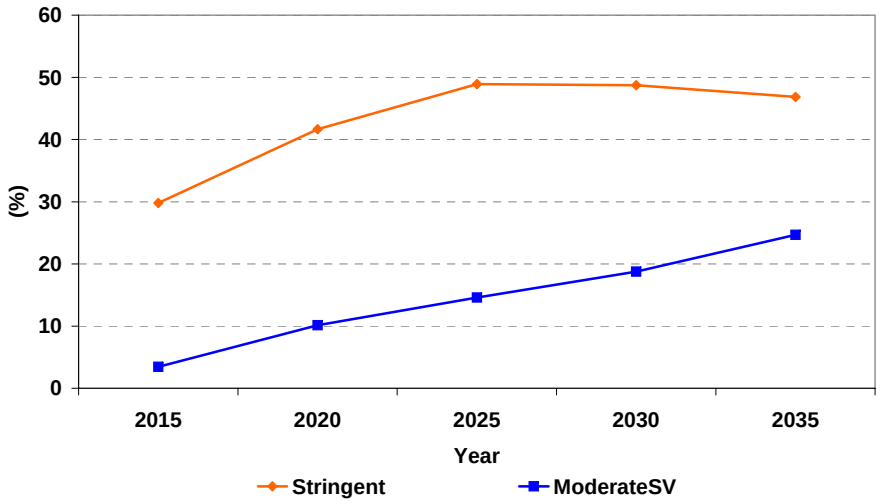


Carbon price leads to higher energy costs for Michigan

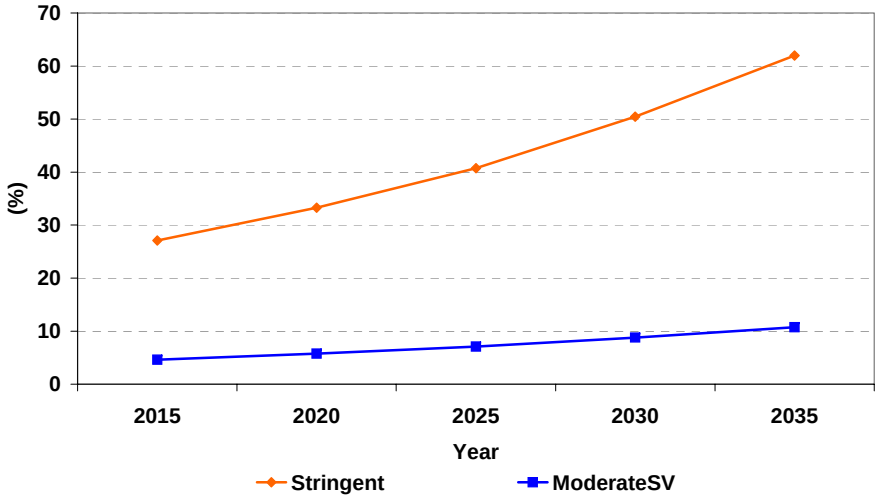
Percent Change in Residential Natural Gas Price



Percent Change in Residential Electricity Price



Percent Change in Residential Refined Petroleum Product Price



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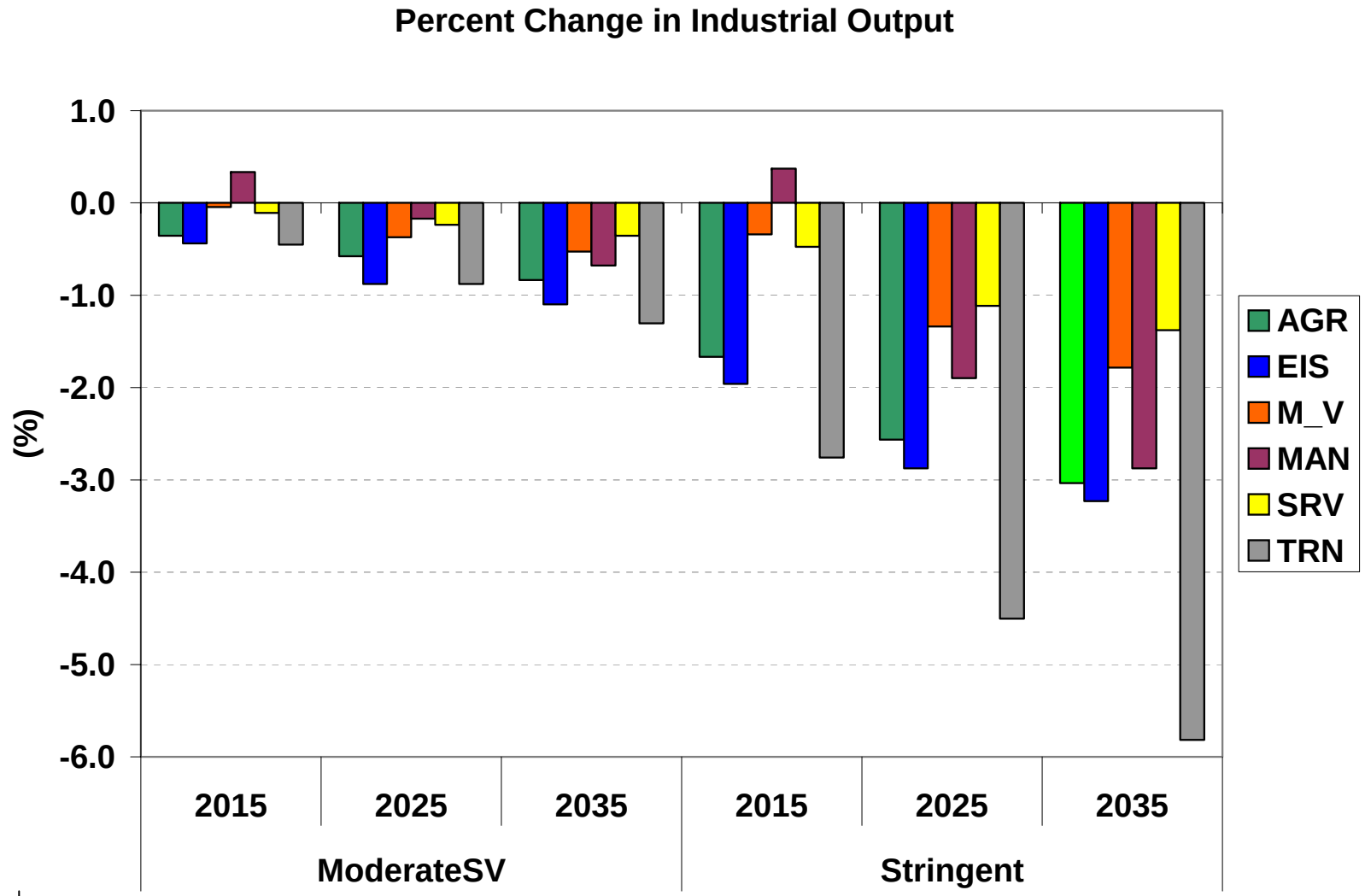
Higher energy costs leads to higher cost of production and hence lower industrial output in Michigan



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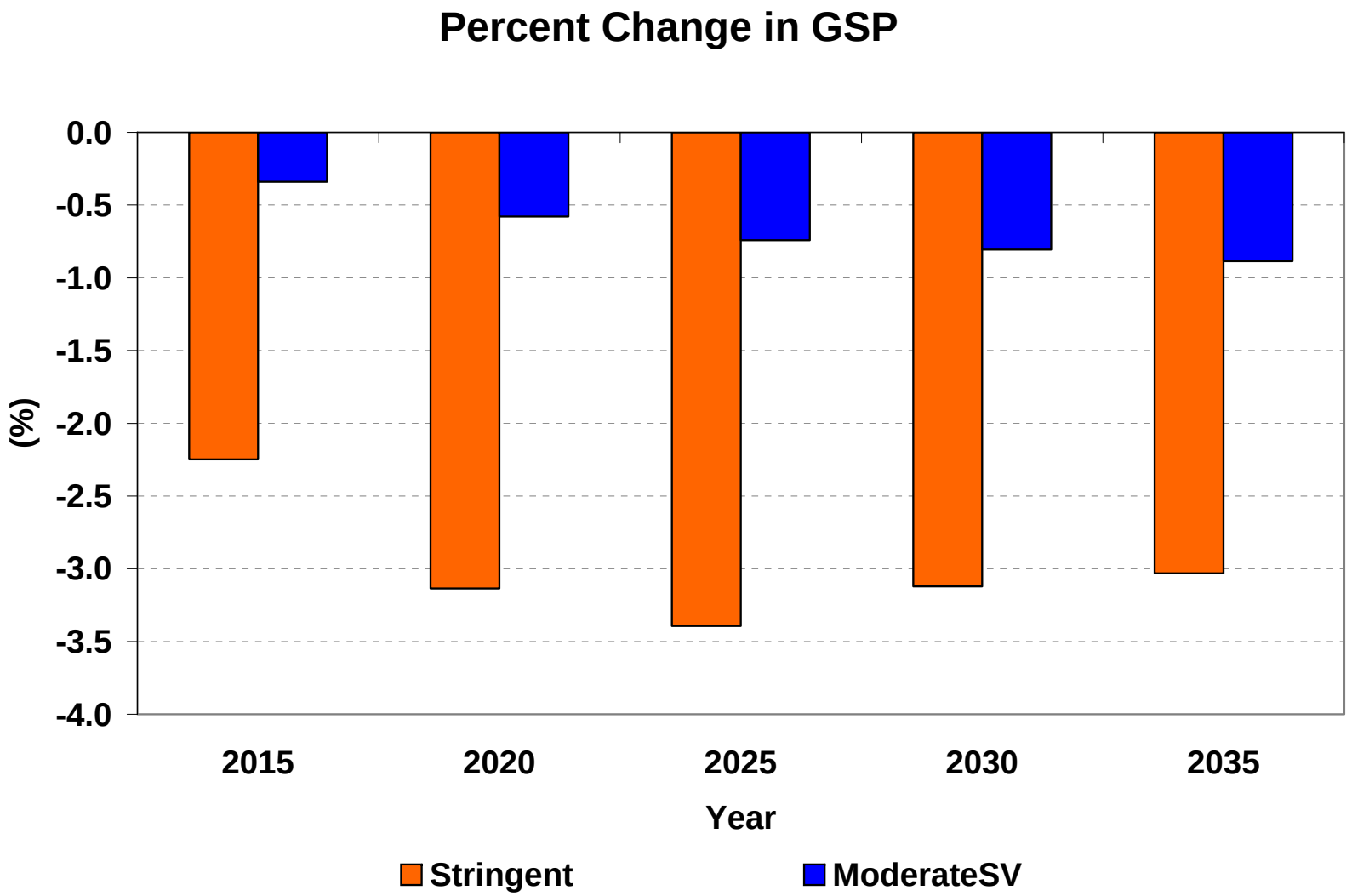
Reduction in industrial output leads to lower GSP and lower income sources



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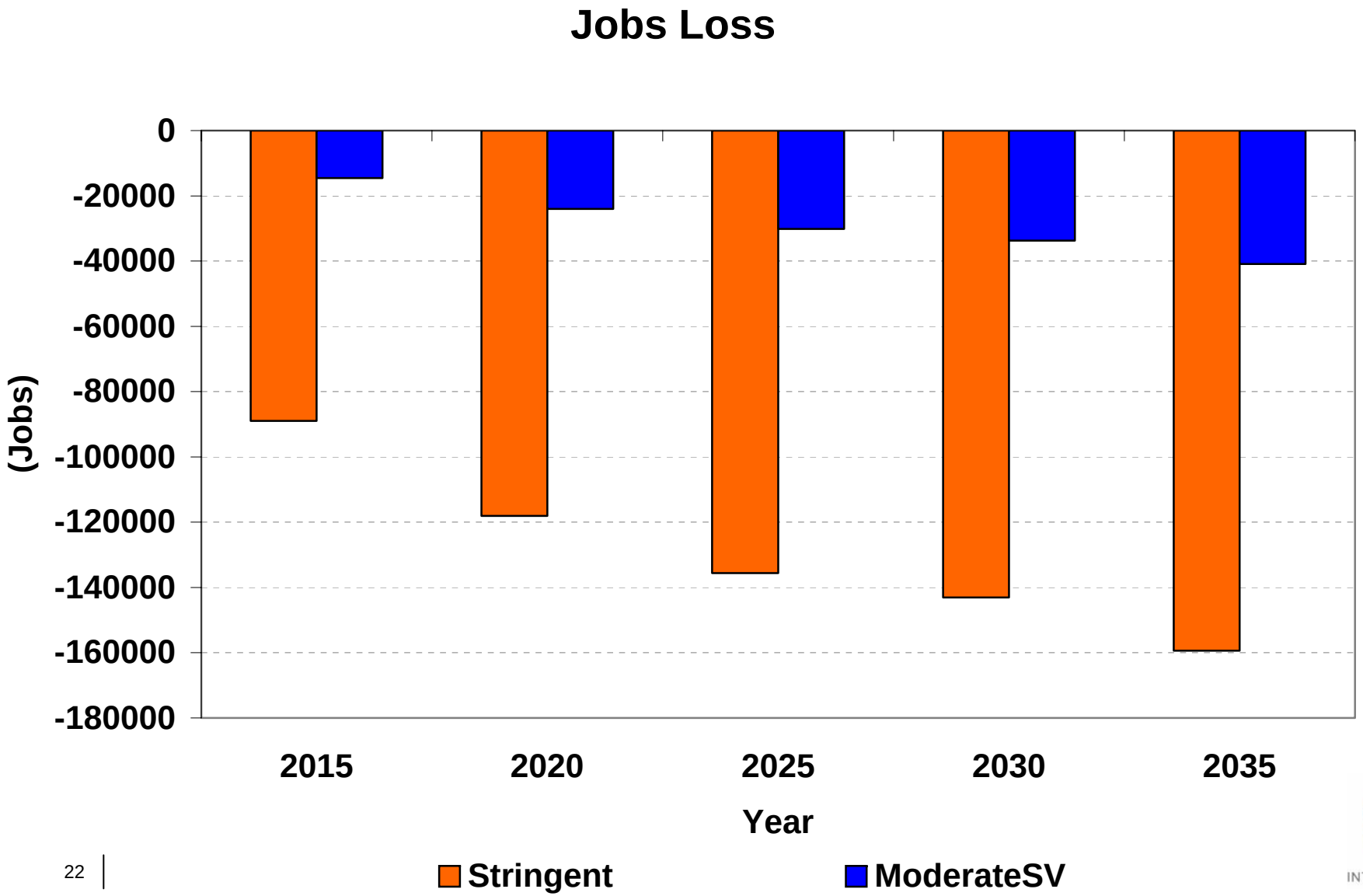
Loss of jobs are large under stringent policy for the state of Michigan



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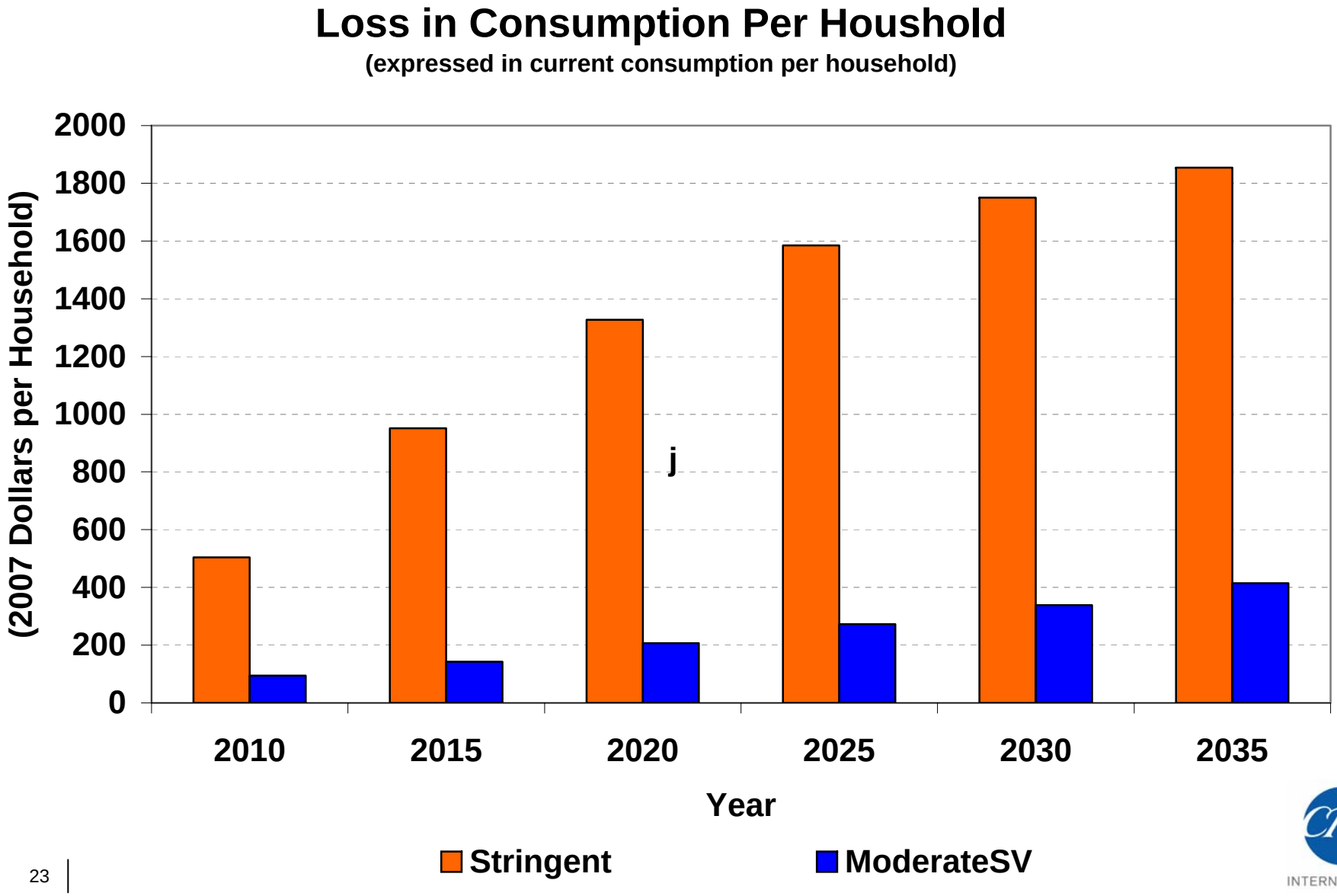
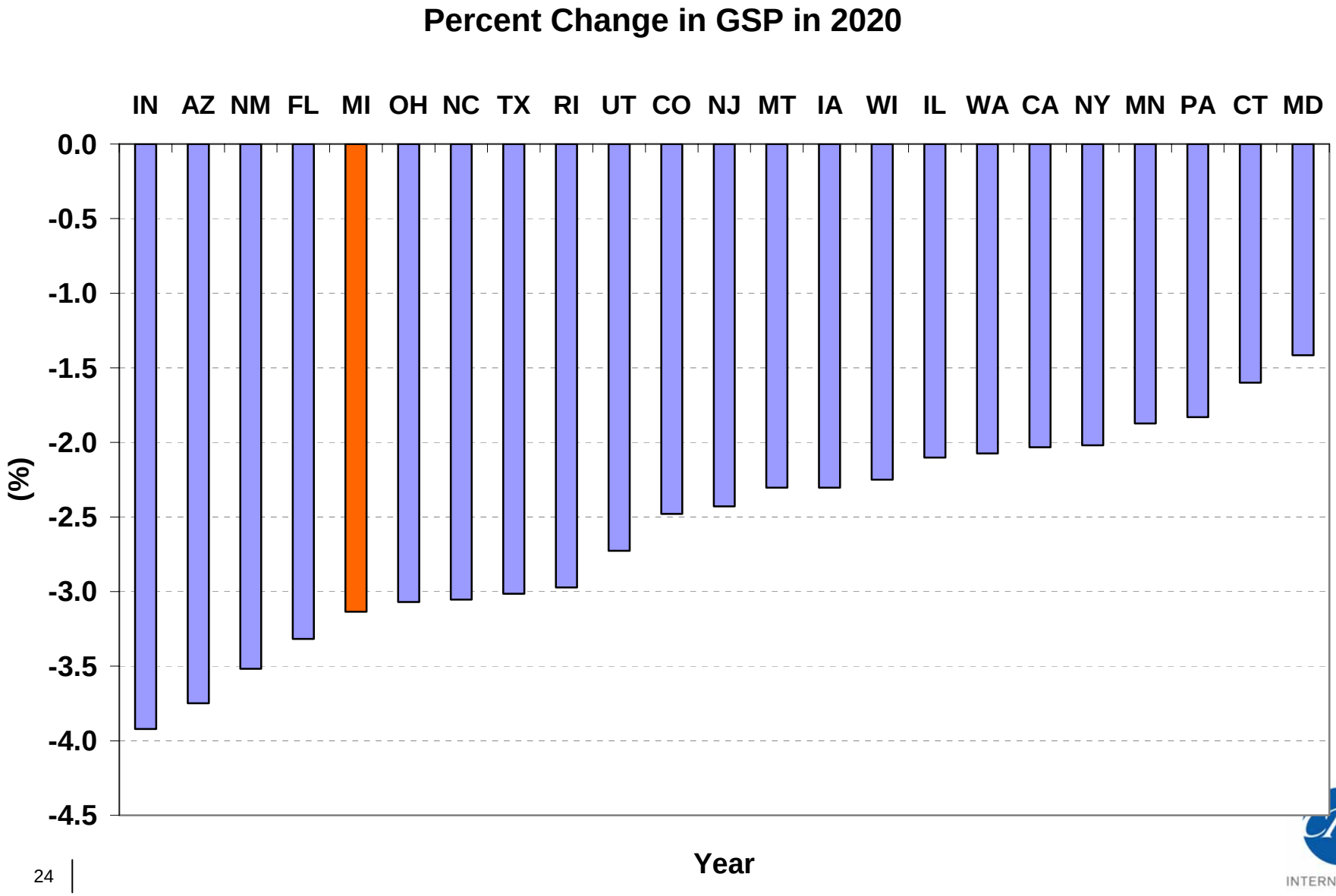
There will be a cost: Cost per household



Michigan compared to some selected states



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Conclusion and climate policy implications for Michigan

- **There is a cost of climate change legislation for Michigan**
- **Key industrial sectors are impacted by climate policies**
- **The cost depends upon stringency of the policy and policy design options chosen**
  - Economy-wide policies were modeled in order to put a uniform price on carbon with no sector-specific regulations
  - Inclusion of CAFE standards that cause larger reductions in new car sales would have even greater impacts on Michigan
- **All states are not impacted equally**
  - The degree of impact varies widely across states depending on their mix of industry and sources of energy
  - Regional model suited to capture regional heterogeneity
- **Safety valve is an important policy design element, particularly for MI, to avoid high costs**

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