CONFIDENTIAL

TOOLS FOR THE ROAD:

HELPING OHIO MANUFACTURERS ASSESS AND BENEFIT FROM GOVERNMENT ENERGY POLICIES AND PROGRAMS

Report (Task 3) Prepared

for

Ohio University Voinovich School

and

The Ohio Manufacturers' Association

Project on Ohio Energy and Manufacturing in the 21st Century

by

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Overview

Although passage of national climate change legislation appears unlikely, at least at this time, Ohio manufacturers remain concerned about energy markets and shifting policies that affect the supply and costs of energy. Of particular concern is what the mix of energy supplies will be in the State over the coming decades, and the uncertainties associated with volatile energy markets and changing government energy and environmental policies—and what the implications will be for Ohio's manufacturing sector as it also confronts increasing competition in global markets.

Highly energy-intensive industry sectors—primary metals, chemicals, paper, non-metallic mineral products—are especially sensitive to volatile energy prices, though, a number of relatively low-energy-consuming sectors—auto, machinery, fabricated metal products, food processing—also view energy as an increasingly important cost factor affecting their bottom-lines.[1] Having access to an affordable and reliable supply of energy therefore is an increasingly important goal of manufacturers. For example, the Ohio Manufacturers' Association (OMA) has adopted a statement of energy principles[2] that emphasizes maintaining predictable, stable energy pricing through effective energy rate design and a modernized energy infrastructure to help maximize energy supplies and stabilize energy pricing and stability.

Ohio manufacturers similarly worry about excessive environmental regulations and shifting energy policies that can affect their profitability and hamper their ability to plan. Such concerns, in fact, have played a role in their resistance to initiatives support growth in clean (non-fossil-fuel) energy alternatives or even to invest in energy saving measures and technologies in their own production operations.

Nevertheless, the development of non-fossil-fuel alternative energy technologies, and the diffusion energy-efficient technologies and practices, present potentially significant economic opportunities for many manufacturers, with the ancillary benefit of curtailing greenhouse-gas emissions and providing other environmental benefits. For example, OMA recognizes that environmental sustainability requirements can create profitable new market opportunities—indeed, many Ohio manufacturers are already engaged in these markets.[3] In addition, Ohio's considerable, traditional manufacturing capabilities could enable it to be a global leader in energy technology innovation, advanced manufacturing and transportation logistics.

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1 As reflected in interviews with OMA members, summarized in: Ohio University Voinovich School (OU). "Part 2: The Voice of Ohio Manufacturers." *Advanced Energy Manufacturing Policy Study Study.* Prepared for The Ohio Manufacturers' Association, 2011.

2 See OU, "Part 1: OMA's Energy Statement of Principles," *Advanced Energy Manufacturing Policy Study.* Prepared for The Ohio Manufacturers' Association, 2011.

3 See OU, "Part 2: The Voice of Ohio Manufacturers." and OU, Part 4: "An Industrial Energy Efficiency Roadmap for Ohio Manufacturers: Potential, Barriers and Opportunities.'' [Prepared by Joel S. Yudken, High Road Strategies, LLC) *Advanced Energy Manufacturing Policy Study.* Prepared for The Ohio Manufacturers' Association, 2011.

As summarized in Ohio University Voinovich School of Leadership and Public Affairs policy paper prepared for OMA, "policies benefitting Ohio manufacturers in terms of stable energy costs, reliable supplies of energy, streamlined regulations and available financing will help get Ohio's manufacturers back on the right track. Ultimately, the development of a clear, consistent energy policy at both the state and federal levels will reduce this uncertainty and promote much-needed growth in manufacturing to compete on a global scale." [4]

Advanced Energy Manufacturing Project. This paper is one of several products produced by the Voinovich School, in project working with OMA over the last eight months, in to help "articulate a path forward for Ohio manufacturers to take advantage of new and emerging opportunities in advanced energy manufacturing." Specifically, the Voinovich School team[5]:

- Working with a small group of OMA members and staff, developed an Energy Statement of Principles to inform decisions associated with various energy and environmental public policies. The objective is to guide manufacturing leaders in advocating and advancing policies that help manufacturers achieve their corporate goals with respect to energy use and costs, while also supporting environmental sustainability.
- Conducted interviews with executives from thirty OMA member firms that explored how they used energy, and their views on a wide range of energy issues, including energy management, price sensitivity, external challenges, market opportunities and policy solutions. The goal is to help OMA and its members engage on energy issues with a consistent and powerful voice representing their diverse interests.
- Outlined a number of potential policy actions at the state level to address manufacturers' energy needs and concerns while promoting Ohio's competitiveness. This framework was drawn up in recognition that a clear, consistent energy policy at both the state and federal levels is needed to reduce the uncertainties associated with energy supplies and markets, while also promoting growth in Ohio's manufacturing sector to compete on a global scale.
- Conducted a review of the most recent research studies, analyses, and data on industrial energy-efficiency (IEE) potential, barriers and opportunities in Ohio. The findings were summarized in an IEE "roadmap" for Ohio manufacturers, to help them identify potential cost-effective IEE gains; assess barriers that limit their ability to realize this potential; and, identify and evaluate opportunities in the private and public sectors for overcoming these barriers.
- Produced a related document to help Ohio manufacturers identify which energy efficiency opportunities—especially financing and technical assistance options—are the most strategically valuable to them.

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[4] See OU, "Part 3: Course Corrections in Policy," *Advanced Energy Manufacturing Policy Study.* Prepared for The Ohio Manufacturers' Association, 2011.

[5] Ohio University Voinovich School. *Ohio University Proposal to Conduct an Advanced Energy Manufacturing Policy Study.* Submitted to Ohio Manufacturers' Association, 2011.

In short, the Voinovich School working jointly with OMA has produced an initial set of resources for Ohio manufacturers to improve their understanding and to responses to energy-related opportunities and challenges—especially as they confront new opportunities (e.g., new shale gas supplies) and challenges (e.g., EPA greenhouse gas regulations), as well as uncertain energy markets.

New Tools for Effective Energy Policies. However, much more can be done to provide OMA and its members with tools that can both

(i) greatly sharpen their ability to evaluate and formulate better responses to energy policy options—i.e., assess the impacts and opportunities for manufacturers in particular, and Ohio's economy in general, and

(ii) enable them to more effectively access and take advantage of state and federal energy-related policies and programs aimed at helping manufacturers achieve higher levels of energy efficiency and reduce their carbon footprints.

Towards those ends, the Voinovich School team proposes a three-part follow-on project that builds on the recently completed work of the Voinovich School-OMA project described above, and the preceding joint initiative of the Ohio University Voinovich School and The Ohio State University ("OU-OSU Project")—*Assuring Ohio's Competitiveness in a Carbon Constrained World*—funded by a grant from the Ohio Department of Development (ODOD).

Specifically, the Voinovich School will work with OMA to develop the following resources:

1. An *Ohio Energy Policy and Manufacturing Competitiveness (EPMC) Evaluation Tool* that will provide OMA and its members an easy to use, interactive, expandable, and empirically-grounded, analytical capacity for evaluating the potential impacts and implications for Ohio manufacturers of state and federal energy policies and regulations. It would essentially be a refinement and extension of the Dynamic Energy-Economic Policy Simulation (DEEPS) modeling tool developed by the OU-OSU Project, tailored to the concerns of Ohio's manufacturers.[6] This System-Dynamics-based modeling tool and methodology would enable comparisons of the potential economic costs and gains associated with different policy alternatives. In addition, it would enable assessments of how potential shifts in energy supply markets affect Ohio's *manufacturing* sector, as well as Ohio's economy, as a whole. Other modeling platforms and tools also would be explored.

2. *Technical Assistance Tools for the Low-Carbon Road,* an online resource that can guide OMA members in the use of tools and resources available from federal, state and private sector sources, which can help Ohio manufacturers introduce cost-effective IEE and other low-carbon energy measures into their operations. In the Voinovich School interviews, several large corporations noted their participation in

[6] Threshold-21 (T21) is a national development planning model created by project partner the Millennium Institute.

federal energy efficiency programs.[7] However, may Ohio manufacturers are not aware of the large amount of technical and financial assistance resources available to them through state and federal programs that can help them achieve energy savings and reduce their reliance on fossil-fuels. These tools could be especially helpful for small and mid-sized manufacturers (SMMs) who often lack the technical expertise, personnel and resources to make energy efficiency improvements even if they are aware of them.

3. *Industrial Energy-Efficiency Investment Tool,* a web-based analytical resource designed to guide OMA members in evaluating the cost-effectiveness of potential investments in energy-efficient technologies, equipment and processes in manufacturing operations. The tool would be constructed using system dynamics modeling,

These tools and the methodology for developing them are described below.

I. Ohio Energy Policy and Manufacturing Competitiveness (EPMC) Evaluation Tool

Ohio manufacturers have consistently identified the uncertainty associated with both government energy and environmental policies and volatile energy markets as among their greatest concerns, affecting their planning and investment decisions. In the Voinovich School interviews, OMA members emphasized the importance of clear, stable energy policies at both the state and federal levels that would reduce uncertainty, and called for well-designed government programs (tax incentives, grants, low-income loans) that lessen the risk of undertaking energy projects.[8] Correspondingly they cite predictable, stable energy pricing and a modernized energy infrastructure that maximizes energy supplies and stabilizes energy pricing and reliability as top energy policy principles that they support.[9]

To-date, the Voinovich School team has provided OMA a preliminary policy framework, insights and guidance to better assess and address the uncertainties associated the costs and benefits tied to energy supply options in general, and clean energy (non-fossil fuel) supplies and policies, in particular. Building on this and prior work, the Voinovich School now proposes to develop powerful, easy to use, analytical tools that could help Ohio manufacturers achieve greater clarity about the potential impacts and opportunities from current and future proposed energy policies. These same tools could also provide insights about how potential shifts in energy markets could affect both the state's manufacturing sector, and the Ohio economy as a whole. A key value that these kind tools can provide, is that they can help manufacturers adopt new "mental models" that addresses barriers to investing in industrial energy efficiency and clean energy opportunities.

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[7] These include U.S. Department of Energy's (DOE) Save Energy Now Program (recently renamed Better Buildings, Better Plants Program) and The U.S. Environmental Protection Agency's (EPA) ENERGY STAR Partnership Program.

[8] See OU, "Part 2: The Voice of Ohio Manufacturers-*Summary*."

[9] See OU, "Part 1: OMA's Energy Statement of Principles."

Policy Framework. Exhibit 1 presents a logic model that shows the complex linkages and causal relationships between energy and environmental policies, business strategies and decisions, and energy, economic and environmental outputs of the Ohio economy. The model revolves around business strategies and decisions—which reflect business goals, behavior (or culture) and internal organizational and behavioral barriers—in response to competitive market pressures (including in energy markets) and government policies and regulations.

Government policies can influence business strategies and decisions, addressing barriers to realize energy opportunities, affecting energy supply and demand across industrial sectors. External technological and market factors also must be considered in understanding business actions—i.e., why they succeed or fail in achieving business energy goals.

This is a complex system requiring sophisticated analytical tools to evaluate the impacts and implications of alternative energy policy options and energy supply changes. Fortunately, the DEEPS/Threshold-21 (T21) Ohio system dynamics-based model developed by the OU-OSU project provides an excellent foundation for developing a new operational modeling tool to carry out such evaluations.

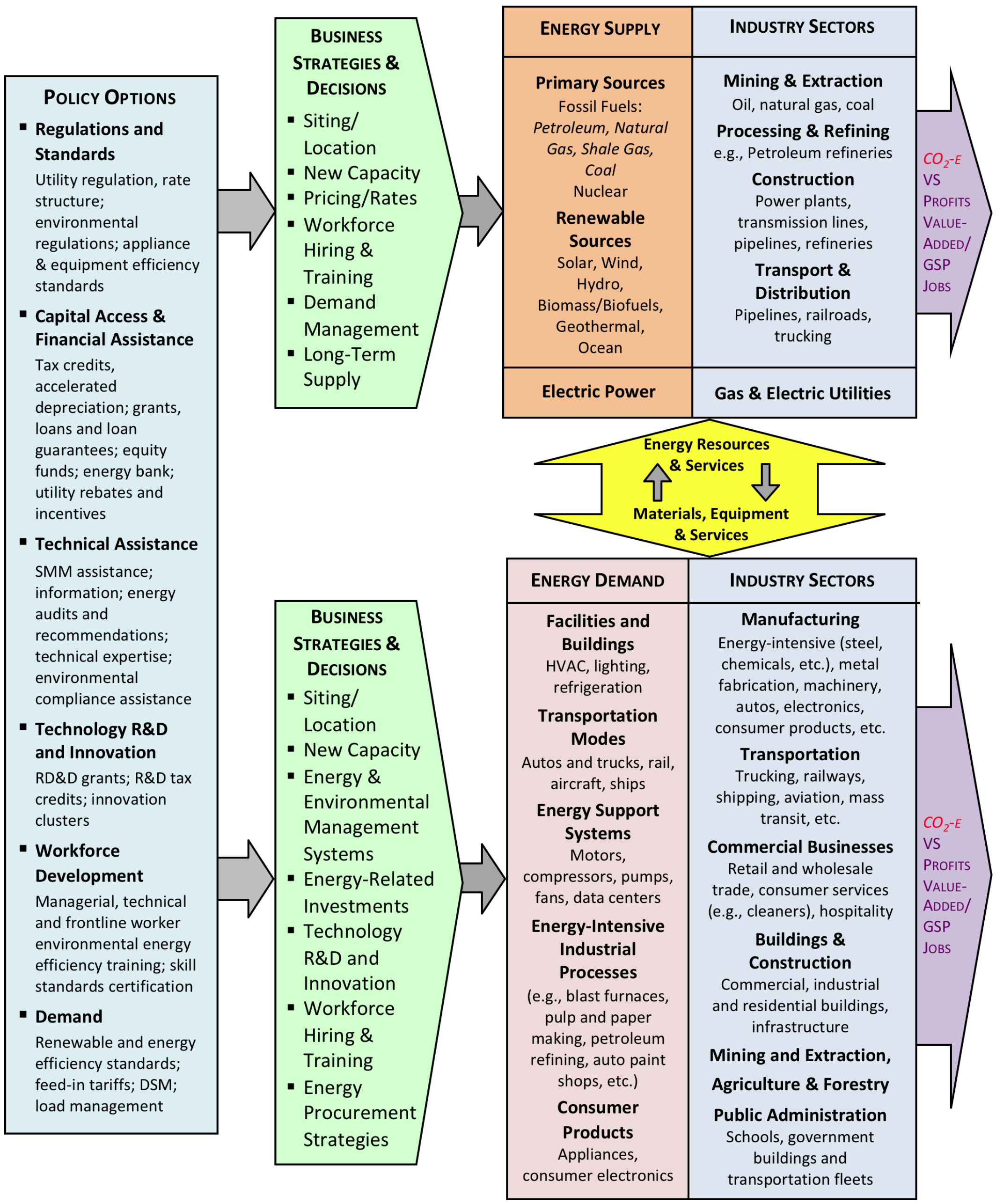
EPMC Evaluation Tool. As noted above, the new Energy Policy and Manufacturing Competitiveness (EPMC) Evaluation Tool will build upon, expand and extend the DEEPS/T21 Ohio model developed in the OU-OSU project. The model will dynamically simulate the linkages between policies, business behavior, energy markets and demand, industrial activities (including energy use) and economic and business outcomes, with a special focus on the manufacturing sector and industries within that sector. Although primarily a macro-model, the EPMC evaluation tool would include modules enabling evaluation of policy options and energy supply shifts and their impacts (e.g., on production costs, profits and operating revenue) on key manufacturing industries in Ohio (e.g., iron and steel, auto manufacturing, paper, fabricated metal products, petroleum refining, chemical manufacturing industries).

Exhibit 2 shows a schematic of the EMPC, illustrating the underlying System Dynamics-based model and user-friendly interface of the Evaluation Tool. (The schematic is only meant to be suggestive of what the actual modeling tool and interface might look like.)

Specifically, the EPMC tool would be designed to enable the following two types of analysis:

1. *Policy impact and opportunity analysis*. It would assess and compare the impacts of different energy (and, if desired, GHG emissions) policies and the economic opportunities that might be created for Ohio manufacturers—i.e., what synergies could be created that supports economic growth (increased returns, jobs). It also could evaluate measures for mitigating adverse impacts from energy and emissions policies, as well as opportunities for energy savings or new energy markets.

Exhibit 1: Energy-Economic Strategy and Policy Framework for Ohio

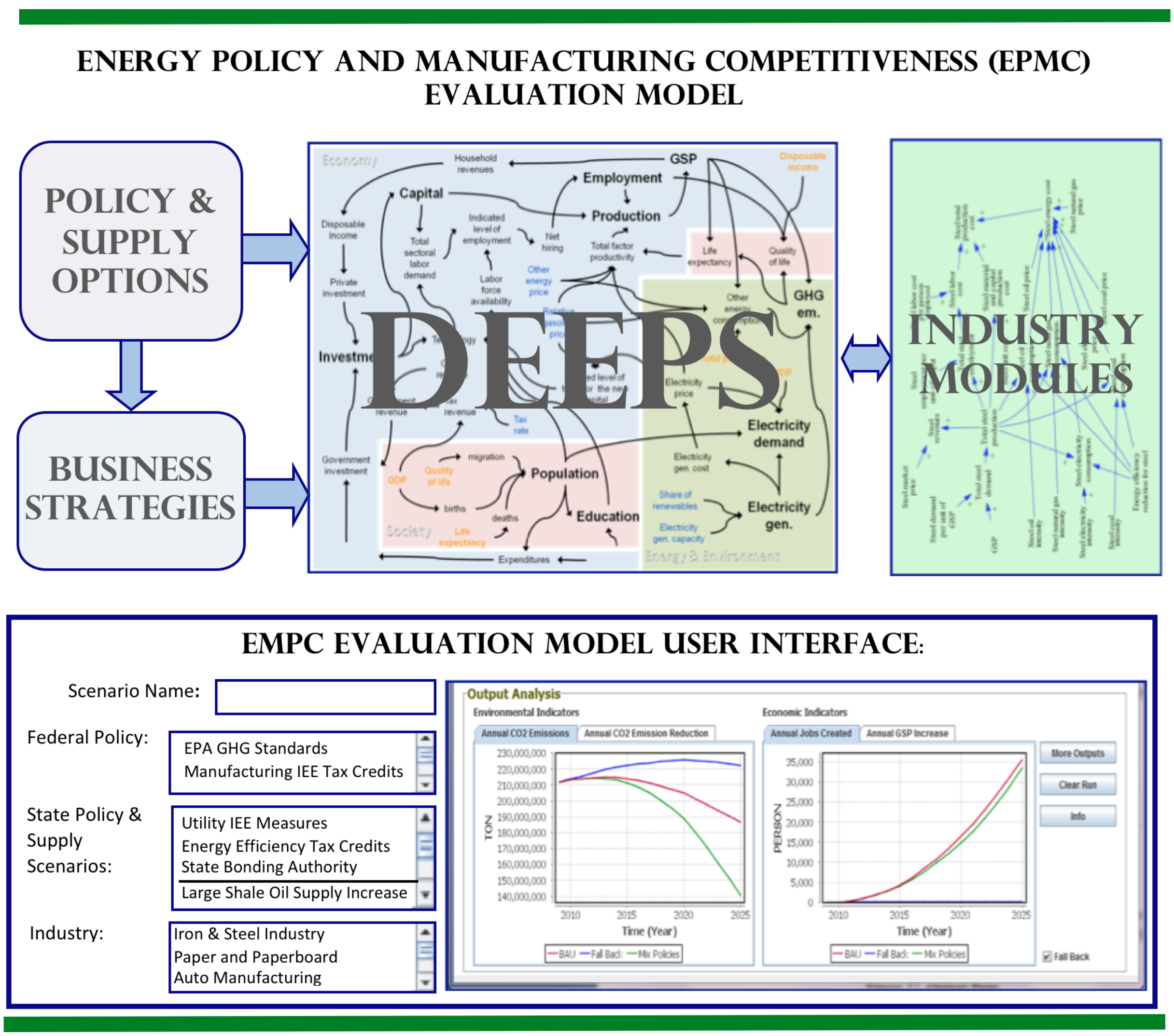


2. *Supply-side analysis*. It also would be able to evaluate the impacts on the economy, and specifically, manufacturing industries, resulting from potential major projected changes in energy supply and large energy price changes (e.g., in the electrical sector), including shifts in energy mix (e.g., increases in renewable energy share of electricity generation; new shale gas production).

The EPMC tool would have several important characteristics that would make it a useful and usable resource for OMA and its members:

- It would be analytically robust and empirically-grounded
- It would have an easy to use, understandable and accessible interface
- It would be interactive—allowing for real-time interactions with stakeholders/users to examine results, trace causal affects, and test out alternative assumptions, goals and options
- It would be transparent, flexible and expandable
- It could be placed onto the OMA website, allowing OMA staff and members to run online evaluation simulations.

Exhibit 2: EPMC Evaluation Tool Model and User Interface



Tool Development. The primary work in the new project would be to reconfigure and extend the DEEPS/T-21 Ohio model to carry out these simulations and quantitative analyses, and to analyze the results.[10] The principal challenges in developing the EPMC modeling tool include the following:

- Although the original policy options that the current DEEPS model is designed to simulate would be retained in the new model, the EPMC model will be tailored to evaluate a range of a number of other energy policy (such as SB 221 utility incentives for IEE) and energy supply options. For example:
  - the EPMC tool will be able to compare/contrast fossil fuel (natural gas, coal) and clean energy (CE) alternatives
  - it could also include extensions that link energy efficiency potential, internal business behavioral barriers, and policy opportunities—for example, it might be able show the effect of certain policy options (e.g., investment tax credits) on reducing business barriers to investments in energy efficiency or clean energy technologies (e.g., high hurdle rates, ROI requirements), resulting in energy savings and improvements for manufacturers.
- To enable sector level modeling analysis, the EPMC model will require modifications and addition of new modules to the DEEPS model that enable simulations at a greater level of industrial *disaggregation*—modeling the manufacturing sector as a whole and selected manufacturing industries, down to the 4- and 6-digit NAICS level—than currently exists
- The EPMC model may also require enhancements that expand elements that are not fully developed in DEEPS, such as accounting for greater stocks of natural resources (which are important for energy-intensive manufacturing industries), labor markets, and capital and financial markets
- The data requirements for the EPMC model, especially at the desired levels of industrial and geographical disaggregation (e.g., for 4- to 6-digit industries at the state level) for purposes of this tool—especially financial, production output, production expenditures (materials, labor, energy, capital expenditures) and energy consumption data[11]—will present new challenges and require additional work in data collection, collating and processing
- An easy to use, user-friendly front-end interface (e.g., some form of dashboard) will need to be developed and incorporated into the modeling tool—especially if it is desired to make the tool web-enabled—to enable OMA staff and members to access and use the EPMC tool to examine different policy and energy supply scenarios. The user would be able to select policy or supply scenarios, industries,

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[10] This work will require the services of the Millennium Institute and its current top modeler, Dr. Andrea Bassi.

[11] This require data collected from federal and state government sources as well as from private industrial sources.

Stakeholder Modeling Sessions. The Voinovich School team will seek to engage stakeholders (OMA staff and members) in the EPMC model design and development process throughout the project. As model development proceeds, the stakeholders will be given real-time demonstrations to illustrate the model capabilities—how it operates and the kinds of results it can provide and address stakeholder concerns. This also will enable the stakeholders to evaluate and provide feedback to the modeling process, to make it more realistic, improve assumptions and other model elements as they are developed. It especially will be important to engage OMA and members to identify the set of energy policy and energy supply scenarios that Ohio manufacturers would like to see evaluated by the EPMC tool, and therefore built into the final model. In addition, stakeholder feedback on the user interface (both stand-alone and online) will be critical to ensure ease of use and to evaluate the usefulness of the tool to OMA's members.

User Training. The EPMC tool will be designed to have a reasonably easy to use user interface—requiring no modeling expertise or even substantive energy and manufacturing expertise to be applied to energy policy and supply issues confronting Ohio manufacturers. Nevertheless, training would be made available for OMA staff, members and others desiring to obtain a deeper understanding of the model's internal structure and operation, and more advanced features, including how to configure and evaluate a wider range of scenarios.

Other Modeling Tools. The EPMC Evaluation Tool, like its DEEPS predecessor, uses a System Dynamics simulation methodology, which enables the integrated evaluation of policy options relating to a variety of issues that arise in complex social, managerial, economic, and ecological systems. As noted in the OU-OSU Project report, System Dynamics enables "a policy assessment methodology with a proven framework than can integrate empirical data, causal relationships, subjective judgments, and detailed rigorous mathematical models." In addition, by incorporating "causality and feedback loops in the analytical framework, the SD-based model provides deeper insights than are possible" with other modeling frameworks (such as, parameter based optimization and econometric frameworks).[12]

Nevertheless, it may be worthwhile to examine other modeling approaches capable of evaluating energy-economic systems at regional and sectoral levels, most notably regional economic development input-output (I/O) modeling platforms, such as IMPLAN ((IMpact analysis for PLANning) and REMI (Regional Economic Models, Inc). I/O models depict the inter-industry relations of an economy, that is, how the output of one industry is an input to each other industry. Each industry in the economy is both a customer of other industries' outputs as well as a supplier of inputs to industries.

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[12] Joseph Fiksel, Andrea Bassi, et al. "Chapter 9: Task 5: Development of a Two-Tiered Economic Analysis Based Upon Energy-Economic Policy Model." In Ohio University and The Ohio State University (OU-OSU), *Assuring Ohio's Competitiveness in a Carbon-Constrained World: A Collaboration between Ohio University and The Ohio State University*. Ohio University and The Ohio State University. Prepared for the Ohio Department of Development, 2011: 48.

Although they lack the dynamic character of SD models, I/O models do allow rapid computation and flexibility in computing the effects of changes in demand. They are commonly used to study regional economies within a nation, and in national and regional economic planning. Other important applications include measuring the economic impacts of public investments or programs, studying targeted industry clusters, and other issues such as energy use and policies. Hence, I/O models could be useful for examining energy policy issues at the regional and manufacturing industry levels, perhaps as a supplement to the SD-based EPMC Evaluation Tool.

II. Technical Assistance Tools for the Low-Carbon Road

A valuable service that OMA could provide its members is access to information and guidance to identify and take advantage of IEE and other low-carbon energy opportunities. This includes both public and private sector technical assistance and financial resources to adopt cost-effective IEE measures and technologies into their operations. Not only would it direct Ohio manufacturers to who and where these resources can be found, but also guide them on how to obtain and use the resources to achieve their energy goals.

OMA recognizes that improving industrial energy efficiency needs to be an important goal, and essential for increasing their members' competitiveness. Many if not most OMA members have engaged in efforts to reduce their energy use—and some also want to reduce their carbon footprint. According to the Voinovich School interviews with OMA members, many companies have established detailed energy goals, such as specific timeframes, benchmarks, measureable targets, implementation plans and communications strategies. Most of the respondent companies reported that they have some form of energy management plan. Energy-intensive manufacturers especially have adopted strategies to improve their energy efficiency—they are more likely to have specific targets, goals and objectives to reduce energy use in their operations, and some reported that they already are working on a second round of energy goals.[13]

IEE Potential and Barriers. Despite these gains, there remains substantial potential for improving the energy efficiency of manufacturers in Ohio—to save energy consumed by their facilities, equipment, industrial heat and power, and industrial production processes.[14] However, most companies confront financial, managerial, technological, and organizational barriers that limit their ability and motivation to invest in IEE opportunities. Small and mid-sized manufacturers (SMMs) in particular face more obstacles than larger firms—the latter more frequently institute energy management plans than their smaller counterparts. SMMs often lack the technical expertise, personnel and resources to make IEE improvements even if they are aware of their potential.

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13 See OU, "Part 2: The Voice of Ohio Manufacturers."

14 See OU, Part 4: "An Industrial Energy Efficiency Roadmap;" See also: Joel S. Yudken. "Chapter 2: Task 2: Part 2: Risks and Opportunities for Ohio's Manufacturing Sector in a Carbon Constrained World." In OU-OSU, *Assuring Ohio's Competitiveness.*

Indeed, large, multinational manufacturing firms are more likely to engage in and take advantage of government energy programs than SMMs. For example, some larger OMA members firms in the Voinovich interviews have participated in programs such as the Department of Energy's *Save Energy Now* program (which requires a commitment to reduce their energy intensity by 25 percent by 2025) and the Environmental Protection Agency's *Energy Star Program* (which helps companies develop and refine corporate energy-management programs). Many, if not most, manufacturers, especially smaller firms, however, probably are not even aware of these programs, or of the considerable amount of other technical and financial assistance resources available to them through state and federal programs that can help them achieve energy savings and reduce their reliance on fossil-fuels—and how they can benefit from these programs.

Technical Assistance Tools. The Voinovich School team therefore proposes to work with OMA staff and members to design and develop an online, searchable low-carbon energy technical assistance resource, that can be made available on the OMA website, to provide this service. This easy to use, web-based tool would be designed to help manufacturers:

- Identify and access no-or-low cost sources of technical assistance that can:[15]
  - (i) Conduct energy assessments and analyses that identify energy waste and inefficiencies in their operations
  - (ii) Identify and recommend IEE measures (technologies, processes, practices) that could reduce these losses and produce energy savings
  - (iii) Assess internal barriers in their operations to realizing these gains
  - (iv) Help in the development of energy management systems at the plant and company levels, including support for implementing ISO 50001, the world's first global energy management system standard
  - (v) Provide software tools, technical expertise, training and guidance for addressing these internal barriers to introducing cost-effective IEE measures into their plants.
- Guide manufacturers in their efforts to identify and obtain external sources of financial assistance for implementing IEE improvements. This can include:[16]
  - (i) Grants, loans, loan guarantees and other direct sources of financing for IEE and other low-carbon energy projects
  - (ii) Tax credits and incentives
  - (iii) Funding for R&D and technology innovation in IEE and low-carbon energy products (e.g., SBIR; equity financing; venture capital).

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[15] See OU, Part 4: "An Industrial Energy Efficiency Roadmap."

[16] See OU, "Part 5: "Financing Comprehensive Energy Management.'' [Prepared by Mark Shanahan] *Advanced Energy Manufacturing Policy Study Study*

OMA's new low-carbon energy technical assistance website would also point manufacturers to relevant workforce development and training resources (e.g., Manufacturing Skill Standards Council's Green Production certification;[17] how to gain access to the latest new IEE and low-carbon innovations and products; qualified technical experts and consultants; case studies and best practices; workshops, conferences and webinars; and publications, guides, and other resources.

As schematically illustrated in Exhibit 3, federal, state, and local government programs provide a large number of technical/financial assistance resources to help manufacturers implement IEE and low-carbon options for a range of industrial system types and energy sources. Many of these resources also are available from by private and non-governmental organizations and other types of providers—including utilities, non-profit organizations, financial institutions, universities and community colleges, business organizations, and regional organizations. The OMA online technical assistance resource would enable Ohio manufacturers to search this database to identify which resource types are being offered by different programs and sponsors that fit their industrial system and energy consumption needs.

Exhibit 3—Technical Assistance Resource Database Structure

Region	Program Sponsor	Resource Type	Industrial System Type	Energy Type
National Ohio County/City	Federal State Local Utility Nonprofit Other	Energy Assessments Energy Analysis Grants Incentive Rate Program Loans Other Rebates Renewable Energy Credits Tax Incentive Programs R&D and Technology Training	All Industrial Types Industrial Systems/General Industrial System/Process-Specific Lighting Building Systems HVAC Load Management Energy Sources	All Energy Types Natural Gas Electric Renewable Other

Examples of program sponsors and programs that provide one or more types of technical/financial assistance resources include:

- *Federal agencies and programs* providing technical and financial assistance, R&D and technology innovation and other support include:
  - U.S. Department of Energy (Advanced Manufacturing Office, Better Buildings, Better Plants Program (formerly Save Energy Now LEADER), Industrial Assessment Centers (IACs), Clean Energy Application Centers; State Energy Program);

[17] See www.msscusa.org.

  - Environmental Protection Agency (ENERGY STAR Partnership);
  - National Institute of Standards and Technology (NIST)/Hollings Manufacturing Extension Partnership (MEP);
  - The Department of Labor, Economic Development Administration, U.S. Department of Agriculture and Department of Defense also have energy-related programs that could benefit or impact manufacturers.
- *Ohio agencies and programs* such as:
  - Ohio Department of Development (ODOD)/Ohio Energy Resources Division (Ohio Energy Efficiency Program for Manufacturers)
  - Ohio Advanced Energy Fund; Ohio Bipartisan Job Stimulus Program; Ohio Energy Gateway Fund, etc.); Ohio Air Quality Development Authority (OAQDA); and
  - Ohio Third Frontier Program
- *Ohio's electric power and natural gas public utilities* (e.g., FirstEnergy, AEP, Dayton Power and Light, American Municipal Power, Duke Energy, Vectren Energy Delivery of Ohio), which provide rebates and technical assistance implementing energy efficiency upgrades (created in response to SB 221)
- *Academic institutions* such as Ohio's colleges and universities and/or the University Clean Energy Alliance of Ohio administer programs providing financial and technical assistance to manufacturers, funded by Federal programs and by utilities, respectively. The IACs (e.g., University of Dayton in Ohio) and Clean Energy Application Centers also are university based.

The Department of Energy (DOE)'s Advanced Manufacturing Office website offers a similar database resource that allows users to search a state incentives and resource database.[18] The Ohio version would be tailored to Ohio's situation, and extended to other kinds of resources, and perhaps searchable by counties and cities within Ohio, as well as by industry sector and company size—i.e., special resources for energy-intensive and for small and mid-sized manufacturers.

TA Resource User Guide. Along with helping OMA design and develop this resource, the Voinovich School team would produce an online guide (downloadable) to help users navigate the low-carbon energy technical assistance website and use its various information tools—i.e., help them find, evaluate and access the resources they need to meet their energy goals.

III. Industrial Energy Efficiency (IEE) Investment Tool

As a supplement to the EPMC Evaluation Tool and/or Technical Assistance Tool for the Low-Carbon Road, or as a stand-alone product, the Voinovich School team proposes to develop a web-based, configurable, analytical tool designed to guide OMA members in

[18] See http://www1.eere.energy.gov/industry/states/state_activities/incentive_search.aspx.

evaluating the cost-effectiveness of potential investments in energy-efficient technologies, processes and practices in their manufacturing operations. The tool would be constructed using system dynamics modeling, and designed to evaluate and compare cost savings from different kinds of IEE improvements (e.g., new boilers; CHP systems; new industry-specific process technologies).

The value to OMA members of having such a tool would be that they would be able visualize how investing in new IEE improvements in their plants might affect their costs and bottom-line—for both good for bad. It might help change their mental models about the potential cost-effective opportunities associated with low-carbon energy use and efficiencies possible for their own production facilities.

This would be a unique tool. The DOE has software tools that allow estimates of costs and benefits of introducing new energy savings technologies into their operations—which OMA members should explore. This tool, however, would allow a much more rapid, preliminary evaluation of various possibilities based on their own situations, before they attempt more sophisticated assessments of energy use and alternative IEE technology investments using DOE tools.

Tool Configuration Options. As suggested in Exhibit 4, users will have a menu and dashboard user interface that will allow them to select or configure a number of IEE investment scenarios, production inputs, and desired outputs to be viewed (including intermediate causal linkages, if desired).

Exhibit 4—Menu of Input, Investment Options and Output Variables for IEE Investment Tool

<table>
<tr><th>Industry Sector</th><th>Energy Inputs (H&P)</th><th>Energy Prices</th><th>IEE Investments</th><th>Production Variables</th></tr>
<tr><td rowspan="3">Generic manufacturing
Aluminum
Auto manufacturing
Cement
Chemical manufacturing
Chlor-alkali
Fabricated Metal Products
Iron and Steel
Lime
Machinery
Nitrogenous fertilizer
Paper and paperboard
Petrochemicals
Plastics</td><td>Coal
Coke
Distillate Fuel Oil
Electricity
Natural Gas
NGL/LPG
Other
Residual Fuel Oil</td><td>Coal
Coke
Distillate Fuel Oil
Electricity
Natural Gas
Other
Petroleum
Residual Fuel Oil</td><td rowspan="3">CHP/Waste heat recovery
Industrial boilers
Industry Specific Processes
Motor systems
Other industrial systems (general)
Building systems
HVAC
Lighting
Refrigeration</td><td>Production output
Labor costs
Material costs
New capital costs</td></tr>
<tr><th>Energy Inputs (Feedstock)</th><th>Other Energy Variables</th><th>Output Variables</th></tr>
<tr><td>Coal & Coke
Natural Gas
NGL/LPG
Other
Petroleum</td><td>Internally Generated Electricity
Internally Generated Steam
Waste heat
Recovered heat</td><td>Energy savings
Total energy costs
Payback period
ROI</td></tr>
</table>

The tool would be designed to allow users to configure the modeling inputs and investment scenarios based on realistic assumptions and using data based on their own facilities or industries (if they know this information), or examine a range of hypothetical investment scenarios for "typical" plants and production activities in their industries—or both.

- *Realistic IEE investment analysis.* Manufacturers will be able to select a number of different IEE applications, enter realistic data representative of their own production facilities or industries, if known—e.g., purchased energy quantities consumed, energy prices, production cost variables (labor, materials, capital expenditures), production outputs, internally generated electricity and steam, waste heat, recovered waste heat, equipment vintage, and production product prices—or select predetermined scenarios in the model, approximating their situations. The user would be able to view real-time outputs—such as energy costs, energy shares of total production costs, energy savings, payback periods and ROIs—as charts and/or data tables, comparing outputs associated with different alternative investment scenarios and business-as-usual (BAU) scenario.
- *Hypothetical industry-based analysis*. Alternatively, the user could select in the menu and/or vary dashboard values for a range of IEE improvements—CHP/waste heat recovery, replacement of motors, new industrial boilers, building systems, HVAC, etc.—tailored to different industry sectors, known energy flows (e.g., from the DOE), cost structures, for "typical" facilities in those industries. The user would be able to view real-time outputs—energy costs, energy shares of total production costs, energy savings, payback periods and ROIs—as charts and/or data tables, comparing outputs associated with alternative investment scenarios and business-as-usual (BAU) scenario.

Underlying Model Development. The IEE assessment tool will be developed using a System Dynamics modeling platform (Vensim™), which has the capability and flexibility to simulate a wide-range of customizable options and provide an easy-to-use interface—web-based or standalone (i.e., on a CD). Exhibit 5 shows simplified schematics of the underlying model structure (not all variables are shown), for illustrative purposes.

Exhibit 5a illustrates the interface between energy supply and energy consumption in a typical production facility. It has several features:

– It shows that in typical manufacturing facilities energy use can be divided into energy used in production facilities (building systems, HVAC, lighting, refrigeration, etc.), in production activities (motors, compressed air systems, fans, pumps, boilers, etc.) and in industry-specific processes (iron and steel blast furnaces, pulping and drying in paper making, smelting and melting in aluminum manufacturing, etc.)

– In each case, externally generated purchased electricity (generated using a variety of energy sources, including nuclear, renewables, coal, natural gas, and petroleum fuels) and energy fuels burned internally to produce heat (and also internally generated electricity and steam, not shown in Exhibit 5a) used onsite (in industrial boilers)

Exhibit 5a: IEE Investment Model Schematic

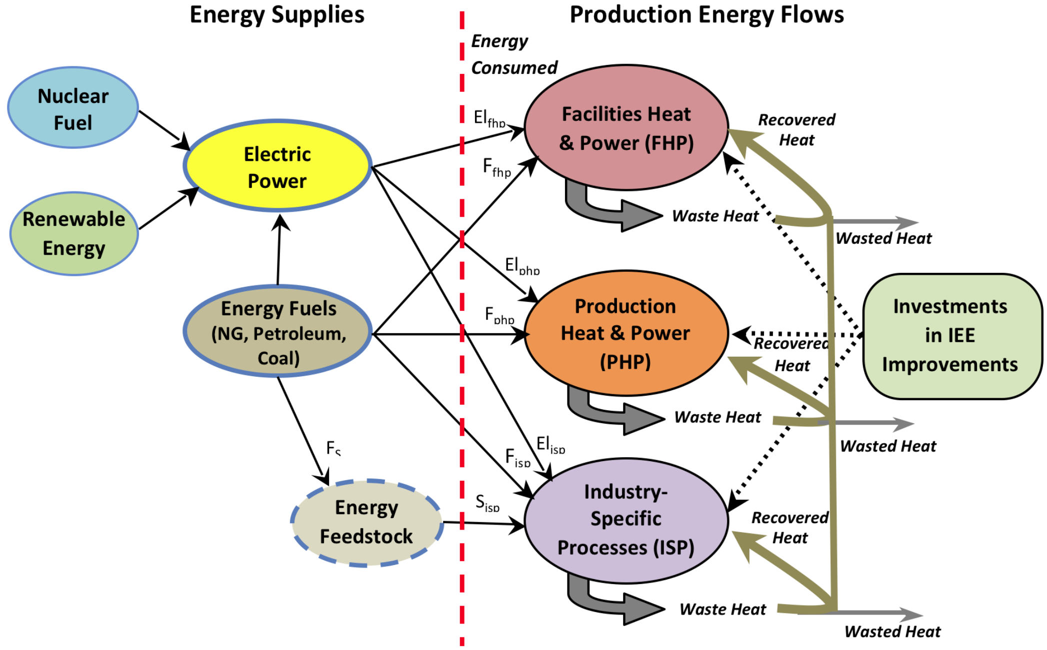
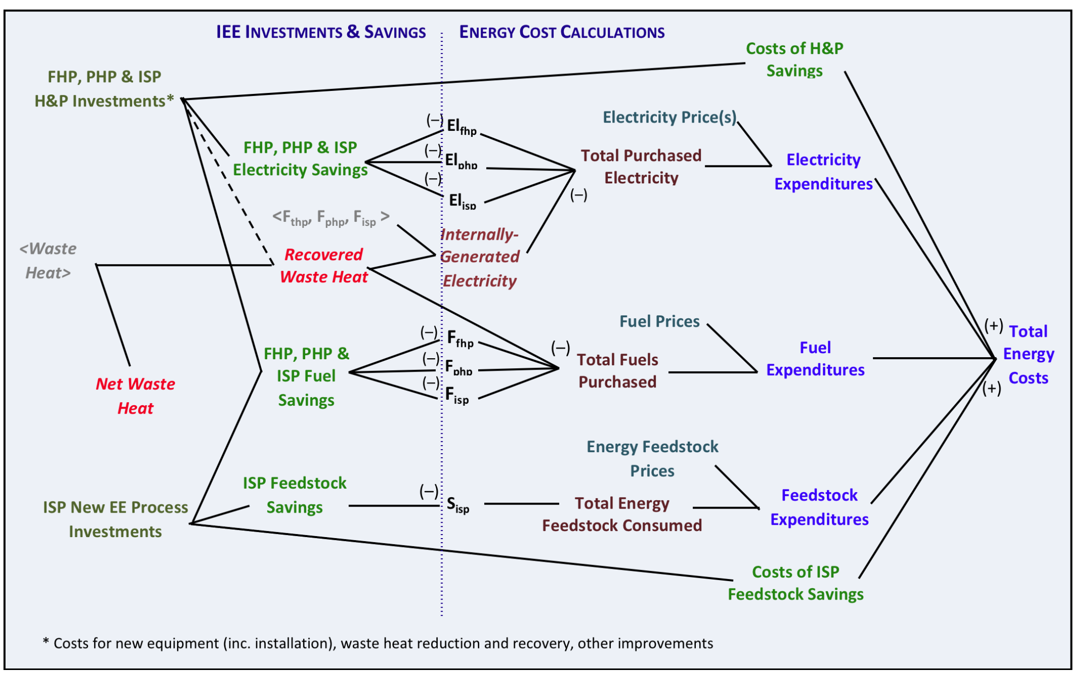


Exhibit 5b: Partially Operationized IEE Investment Model



El_{fhp} = Electricity Consumed by Facilities

El_{php} = Electricity Consumed by Production

El_{isp} = Electricity Consumed by Industry-Specific Processes

F_{fhp} = Fuels Consumed by Facilities H&P

F_{php} = Fuels Consumed by Production H&P

F_{isp} = Fuels Consumed by Industry-Specific Processes (H&P)

F_S = Fuel Demand for Feedstock = S_{isp} = Energy Feedstock Consumed by Industry-Specific Processes

- Externally purchased energy fuels also is consumed as production feedstock in industrial specific processes—such as coal and coke, natural gas, and petroleum used in iron and steel making, petrochemicals, petroleum refining, respectively
- Investments in IEE improvements can be applied to achieve energy saving gains in each major energy consumption area—i.e,. facilities heat and power, production heat and power, and industry-specific processes
- Waste heat from each of these areas is represented, as is recovered heat that can be recycled through a plant and used in any of these areas (not just the area where it is produced).

Exhibit 5b illustrates how the tool model presented in Exhibit 5a might be operationalized using a System Dynamics modeling platform. (This is an oversimplified portrayal compared to how it might be shown using an actual System Dynamics platform.):

Energy Cost Calculations (Right-Hand Side):

- Shows the energy cost calculations for total electricity, fuel sources (for heat and power) and energy feedstock consumption costs, and total energy costs
- These calculations factor in deductions for recovered waste heat—reducing quantities and costs of purchased fuels used to generate heat for all production activities and quantities and costs of purchased electricity by amounts of internally generated electricity.
- The exhibit and calculations do not show energy consumption quantities and cost deductions that might be associated with internal steam generation (which could be subsumed by heat generation costs tied to burning of fuels in production plants)—but the model could be expanded or elaborated to include these calculations.

IEE Investments and Savings (Left-Hand Side):

- The left-hand side illustrates how IEE investments and savings could be applied to reduce energy consumption and costs of a production plant
- Heat and power IEE investments would entail introducing new equipment and processes that reduce demand for fuels and electricity by facilities and production activities and processes, and/or improve the efficiencies of recovering and utilizing waste heat used internally for heat and electric power generation.
- New IEE process investments applied to industry-specific processes—e.g., substituting a more efficient production process for existing systems—could reduce consumption of feedstock as well as heat and power energy consumption in a plant
- The new IEE investment costs (for energy savings in facilities heat and power, production heat and power, industry-specific processes) would be added to the sum of net electricity, fuel, and feedstock expenditures to product total energy costs
- The model would allow comparison of total energy costs for a BAU case where new investments are assumed to be zero with different IEE investment scenarios selected by

the tool users, which would produce a range of energy savings (types, quantities, expenditures)

- A bell and whistle might be incorporation into the model information about equipment vintage—i.e., for selected kinds of energy consuming equipment (boilers, motors)—users might have an option of including information about age of equipment, expected lifetime, and related data that could affect the timing of IEE investments in more energy-efficient replacement equipment.

Outputs and Other Calculations (not shown in exhibit)

- The outputs could include net savings (BAU – investment scenario), payback period (total new investment costs divided by annual net energy cost savings), and return on investments (cost savings over a specific period of time divided by total investment costs, or similar calculation)
- The calculated total energy costs (BAU and investment scenarios) could be incorporated into a larger module of the model that includes inputs of other production costs, such as materials, labor, and new capital expenditures, to show how changes in energy costs (energy savings) might affect a plant's (or industry's) overall production cost structures—outputs might include production costs and impacts on operating revenues for BAU and investments scenarios.

The work involved in developing this tool that would be undertaken by the Voinovich School team (suitable modelers, such as the Millennium Institute, would be recruited to carry out the technical side of the modeling work) will include development and configuration of the model, collection, processed and inputting of data for typical models and industries, and the design and implementation of a user interface. OMA staff and members will be consulted along the way to ensure the design and configuration of the tool reflects their actual needs and is appropriately user friendly.