INDIANA UNIVERSITY PUBLIC POLICY INSTITUTE

POLICY CHOICES *for Indiana's Future*

REPORT ON POLICY CHOICES AND OPTIONS

Commission on Energy and the Environment

February 2012

11-C40

SCHOOL OF PUBLIC AND ENVIRONMENTAL AFFAIRS

INDIANA UNIVERSITY

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ABOUT POLICY CHOICES FOR INDIANA'S FUTURE

In fall 2009, staff and faculty of the Indiana University Public Policy Institute (PPI) and the School of Public and Environmental Affairs (SPEA) began discussions regarding the critical questions that Indiana must address to secure our success now and in the future. Through the PPI Board of Advisors, work started in January 2010, on Policy Choices for Indiana's Future, a nonpartisan initiative to analyze the issues that will face the state's next legislature and governor.

As the project developed, focus began to center on the overarching idea of improving the economic health of the state, its citizens, and its businesses. Analysts began to gather data regarding the current and future economic conditions in Indiana, within the broader context of the Midwest (Illinois, Indiana, Iowa, Michigan, Minnesota, Ohio, and Wisconsin). Three key areas were identified that depend in part on our ability to:

- *develop the highly-skilled workforce necessary for economic growth in a knowledge economy,*
- *leverage the state's energy resources and assets in an environmentally responsible, productive manner, and*
- *create a balanced tax environment that allows individuals and businesses to flourish while generating the revenue required for the state to efficiently deliver the essential services necessary to keep Indiana competitive.*

Because the issues involved are large and complex, Policy Choices relied on the work of three commissions:

- *Commission on Education and Workforce Development*
- *Commission on Energy and the Environment*
- *Commission on State and Local Tax Policy*

Each commission included members of the PPI Board of Advisors and additional members from around the state selected based on their subject-matter expertise. Randall Shepard, Chief Justice of the Indiana Supreme Court, and Mark Miles, president and CEO of the Central Indiana Corporate Partnership, led the overall project.

Each commission was staffed by policy analysts from PPI and met several times through October 2011. The commissions gathered information and listened to presentations from topic area experts. Each commission developed a set of policy options to address the challenges facing our state. These options with supporting information are presented in each commission's technical report (available along with other Policy Choices work products at www.policyinstitute.iu.edu/PolicyChoices).

The goal of Policy Choices is to start the discussion among government, nonprofit, and private sector leaders about these topics now—to provide policy options for action. Recognizing that these are long-range issues, PPI will continue to analyze these questions and engage leaders, policy makers, and other partners in continuing the discussions.

COMMISSION ON ENERGY AND THE ENVIRONMENT

11-C40

EXECUTIVE SUMMARY

Determining Indiana's energy and environmental policy for the next decade is among the most important decisions that state political leaders will make in the coming years. Policy choices centered on energy and its associated environmental consequences are inextricably linked with the stewardship of the state's natural resources, its economy and will have a profound effect on Hoosiers quality of life.

This report is intended to inform decision makers about some of the choices available to them in the energy field to achieve the objectives described above. The report describes some of the benefits and disadvantages of the various alternatives discussed, but does not make recommendations as to which to choose. As such, we clearly state the report does not necessarily represent the views of any particular individual or organization who participated on the Commission. Rather, the Commission worked to provide policymakers with an understanding of key choices and the consequences of those choices in the energy and environmental field.

Policy choices, in brief

The Commission offers policy choices for state policymakers to consider in four areas of emerging technology, including:

1. Advanced biofuels
2. Electric vehicles and battery technology
3. Energy efficiency
4. Carbon capture and storage

Each policy option is presented with information about the advantages and disadvantages of adoption—critical information for policymakers to consider.

1. Advanced Biofuels

- Support university research to develop new technologies and to research the economic and policy issues associated with producing advanced biofuels in Indiana.
- Support the development of new advanced biofuels production facilities by purchasing fuel through a reverse auction.
- Make traditional and specialized economic development incentives available to firms locating new advanced biofuels facilities.
- Continue to promote ethanol and biodiesel production and flex fuel vehicle deployment.

2. Electric Vehicles and Battery Technology

Electric Vehicles

- Support in-state electric vehicle supply chains through economic development incentives.
- Support in-state purchase and use of electric vehicles.
- Support the development of an adequate recharging infrastructure.
- Encourage off-peak charging of electric vehicles.

- Encourage state and local government adoption of electric vehicles.
- Support research to develop new technologies and to research the economic and policy issues associated with manufacturing electric vehicles.

Battery Technology

- Support in-state development and manufacturing of batteries through economic development incentives.
- Support research to develop new technologies and to research the economic and policy issues associated with manufacturing batteries in Indiana.
- Support university initiatives to develop relevant curricula.
- Encourage/incent utilities to utilize used electric vehicle batteries in grid storage applications.

3. Energy Efficiency

Utility Policy

- Establish energy efficiency as a formal resource within long-term utility and energy planning.
- Address Indiana's annual energy savings goals.
    - o Monitor energy savings program efficacy and enforce program goals.
    - o Extend Indiana's annual savings goals to all electric and natural gas utilities, including municipal and co-op utilities.
    - o Raise the goals of the program.
- Make Indiana's Clean Energy Portfolio Standard mandatory.
- Track and evaluate the efficacy of demand side management programs. Strengthen programming if necessary.
- Adopt decoupling or some other form of lost revenue adjustment for Indiana's electric and natural gas utilities.
- Adopt utility performance incentives for achieving energy efficiency goals.
- Adopt time-based pricing for electricity.

Industrial Energy Efficiency

- Provide incentives for combined heat and power (CHP).
- Provide incentives for other industrial energy efficiency programs.

Building Codes

- Improve the process of adopting new building energy codes to allow the state to benefit quickly from advances in efficiency.
- Educate builders and building officials on new building codes and track compliance.

Other State Policies

- Expand state financial and information incentives to consumers for energy efficient improvements.

- Facilitate financing for energy efficiency retrofits to buildings.
- Fully implement energy efficient design standards for new state-owned building and retrofit existing buildings.
- Expand incentives for public university energy efficiency improvements.
  - o Remove bonding limits for public universities for energy efficiency improvements.
  - o Establish mechanisms to allow the reinvestment of energy efficiency savings in additional improvements.
- Encourage energy efficiency for local public buildings.
- Support research, development, and demonstration.
- Support university initiatives to develop relevant curricula.

4. Carbon Capture and Storage (CCS)

- Clarify pore space ownership.
  - o Assign pore space property rights to surface estate owners.
  - o Aggregate property rights using eminent domain with or without unitization and/or quick take provisions.
  - o Declare pore space as public domain.
  - o Make proximity payments to surface estate owners.
- Develop a regulatory framework for carbon dioxide pipelines.
  - o Establish an intrastate pipeline regulatory framework.
  - o Advocate for a federal interstate framework similar to oil pipelines.
  - o Advocate for a federal interstate framework similar to natural gas pipelines.
  - o Advocate for a hybrid regulatory framework that combines elements of the current frameworks for oil and natural gas pipelines.
  - o State government facilitation of development of pipeline network.
- Address the long-term liability of carbon storage.
  - o Advocate for expansion of federal Underground Injection Control (UIC) Program.
  - o Use current state tort and contract laws.
  - o Establish a specific state regulatory framework for liability.
- Facilitate research to establish additional carbon capture technologies.
- Facilitate investigation and evaluation of Indiana's deep subsurface geology for CO_2 storage.
- Evaluate the enhanced oil recovery opportunities located within and outside of the state.
- Provide economic development incentives to private sector CCS implementers.
- Create a state utility to develop CO_2 pipelines and/or storage facilities.

THE COMMISSION ON ENERGY AND THE ENVIRONMENT

Determining Indiana's energy and environmental policy for the next decade is among the most important decisions that state political leaders will make in the coming years. Policy choices centered on energy and its associated environmental consequences are inextricably linked with the stewardship of the state's natural resources, its economy and will have a profound effect on Hoosiers quality of life.

Options for state policymakers in this arena are conditioned by federal actions. In fact, many of the main energy policy choices are federal, not state or local. However, Indiana's leaders can enact policies to promote the state's interests while preparing for energy policies that might be implemented at the federal level. Adoption of effective state-specific energy policies will position Indiana to take advantage of future energy developments and provide the state with a head start in adapting to the new energy arena.

Three frequently cited objectives in ongoing discussions regarding federal energy policy are increasing national energy security, reducing greenhouse gas emissions and increasing job growth. Policies adopted in Indiana should seek to accomplish these objectives while stimulating the state economy, protecting the environment and promoting the well-being of the people of the state. Another consideration for state policymakers to keep in mind is the possibility of changes in budget priorities at the federal level that may alter funding levels and tax implications for various types of energy sources.

Increasing energy security for the nation and the state requires reducing our dependence on foreign oil. Means of reducing that dependence could include production of more domestic liquid fuels from alternative sources and development of an infrastructure for electric vehicles. Since Indiana is rich in coal, and biomass resources, policymakers could consider ways to promote greater domestic liquid fuel production. Indiana is also a leader in the development of the electric vehicle industry. Advancement of the infrastructure needed to support this transportation system within the state may be warranted. Another aspect of this move to energy independence may be the development of energy storage capacity.

Reducing greenhouse gas emissions will require reducing the use of fossil fuels by developing low-carbon and non-carbon sources of energy, which may include natural gas, solar, wind, hydro or other sustainable renewable sources. Additional alternatives may include coal-fueled electricity coupled with carbon capture and sequestration or expansion of the use of natural gas to produce electricity. Increased energy efficiency can reduce the need to build new energy-production facilities. Effective energy policy choices in this area would allow Indiana to be well positioned for any federal requirements restricting or placing a price on carbon emissions.

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Indiana seeks a future of increased economic growth, a healthy environment and increased well-being of its citizens while gaining maximum advantage by being an early mover in the expected new world of energy production and consumption.

The Commission and its Work

PPI leadership asked 16 volunteer experts to serve on the Energy and Environment Commission. The Commission membership reflects a broad range of expertise and experience. Biographies are provided in an appendix to this report.

The Commission co-chairs are:

- Mark Maassel, Northwest Indiana Forum (and member of the IU PPI Advisory Board)
- Dr. Wallace Tyner, Purdue University

Other members of the commission are:

- Dr. Sanya Carley, Indiana University School of Public and Environmental Affairs
- Martin Coveney, Energy Systems Network
- Dr. Greg Lindsey, University of Minnesota (and member of the IU PPI Advisory Board)
- Dr. Maureen McCann, Purdue University Energy Center
- Paul Mitchell, Energy Systems Network
- Bowden Quinn, Sierra Club Hoosier Chapter
- Darlene Radcliffe, Duke Energy
- Dr. J.C. Randolph, Indiana University Center for Research in Energy and the Environment
- Dr. Ken Richards, Indiana University Richard G. Lugar Center for Renewable Energy
- Mike Roeder, Vectren Corporation
- John Rupp, Indiana Geological Survey
- Jane Ade Stevens, Indiana Soybean Alliance and Indiana Corn Marketing Council
- Dr. Paul Sokol, Indiana University Energy Institute
- Kent Yeager, Indiana Farm Bureau, Inc.

The Commission was staffed by the Indiana University Public Policy Institute (PPI), a research organization that is part of the IU School of Public and Environmental Affairs. Commission costs were underwritten by the IU School of Public and Environmental Affairs, located at the Bloomington and Indianapolis campuses, and the Central Indiana Corporate Partnership.

The Commission staff includes:

- Jamie Palmer, Commission coordinator
- Joice Chang, Commission staff
- Tiffani Priddis, Commission intern

In addition to the internal expertise of the Commission members, the Commission relied on a number of other experts, including:

- Dr. Joan F. Brennecke, Notre Dame Energy Center
- Dr. Douglas J. Gotham, State Utility Forecasting Group, Purdue University
- Greg Noble, Indiana Soybean Alliance
- Elizabeth Baldwin, SPEA Bloomington
- Steve Schwartz, Ener1, Inc.
- Lizabeth Ardisana, THINK North America

The Commission met eight times between September 2010 and September 2011. The Commission members and staff created nine topical issue briefs over the course of the Commission's deliberations that served as the building blocks for the full Commission report. These briefs were revised iteratively over the course of the project.

Guiding Principles

Good public policy is developed when policymakers clearly understand the choices available to them and the consequences of selecting one or more of the choices. The Energy and Environment Commission focused on key areas in which the choices made by policymakers meet the following guiding principles.

1. **An issue which Indiana policymakers can impact.**

   Indiana faces many of the same issues and challenges being faced by the nation and the world. While the Commission recognized that issues within the energy and environment field are often impacted by federal action, the Commission chose to focus on those issues where Indiana policymakers can, productively and proactively, make decisions which position Indiana for a brighter future.

2. **A choice which is important to Indiana.**

   Many issues face the state. However, the Commission specifically focused on those issues which may present the biggest opportunities or risk to employment and the well-being of Hoosiers. As such, the Commission considered areas where Indiana already has strong advantages, areas critical to Indiana's economy, and areas in which substantial change could dramatically impact the state's economy.

3. **Consider the emerging technologies and issues facing Indiana.**

   Many current opportunities and risks can best be addressed through development and commercialization of technologies which are not currently in use. In part, the Commission recognized that first mover advantages can provide great benefit to Indiana. The Commission chose to focus time on these areas rather than opportunities and risks that can be addressed using current techniques. The Commission chose this focus believing that policy decisions inherently focused on emerging technologies and issues impacting the future of Indiana will have the longest lasting impact.

4. **Provide options, not recommendations, for addressing the issues.**

   The Commission believes that our role was simply to utilize the collective expertise of the members gathered in our discussions over the last year. This expertise represented many and disparate views on issues. The Commission also believes that this approach will provide policymakers with a clear view of the choices (options) available to them and the consequences of any particular decision. This choices-and-consequences approach is designed to assist policymakers in reaching an informed, thoughtful decision which appropriately balances the many factors impacting the achievement of a strong economy in which Hoosiers prosper.

POLICY CHOICES FOR ENERGY AND THE ENVIRONMENT

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1. Advanced Biofuels

Indiana has significant potential to use its agricultural resources either for biofuels or biopower. In either case, cellulosic feedstocks (corn stover, miscanthus, switchgrass, forest residues, etc.) are grown, collected and converted to usable energy.

The latter would involve using biomass as a partial substitute for coal. In states that have a Renewable Portfolio Standard (RPS), this option provides one means of reaching the RPS renewable energy target. Some utilities may have interest in this option for environmental reasons even without a RPS. The Commission's work focused on the conversion of biomass to liquid fuels.

The US EPA has established a Renewable Fuel Standard through 2022. The standard for advanced cellulosic was waived in 2010 and 2011 because these fuels are not yet commercially available. There are a number of uncertainties that currently limit the economic viability of producing these advanced fuels, including (1) future oil prices, (2) feedstock costs and availability by region, (3) conversion costs and efficiencies, (4) environmental impacts of biofuels production, and (5) government policy. These uncertainties make it extremely difficult for private firms to build the first few advanced biofuels plants, in particular.

Indiana has the potential to be a national frontrunner in the production of advanced biofuels made from cellulosic feedstock. The production of advanced cellulosic biofuels in Indiana could draw on Indiana's natural resources. Corn stover is available in the northern part of Indiana and new crops of switchgrass or miscanthus could be grown in the southern parts of the state. Indiana has the natural resource capacity to support about five cellulosic ethanol plants using corn stover.

Acting quickly, however, may be necessary to secure first mover advantages. There is more biomass available in Indiana and other agricultural states than is needed to fulfill the fuel required by the federal mandate. Facilities are being developed in other states. A commercial cellulosic ethanol plant in Kansas has broken ground, and a cellulosic add-on to an existing corn ethanol plant will be completed in Iowa in the fall of 2011.

Production facilities for these fuels provide expanded benefits for the local and state economies. Unlike other industries that must import many manufacturing components or process inputs, ethanol plants are built locally. Feedstocks also must be local. In plants using a biochemical pathway, it may be necessary to import particular enzymes.

The production of advanced biofuels has some potential environmental benefits and costs associated with the production of feedstock. The harvesting of corn stover, rather than leaving it in agricultural fields, may result in some, but not significant, loss of carbon. Miscanthus is a perennial crop that may help to reduce soil erosion and also sequester carbon. Seeded miscanthus may be considered an invasive species, but the higher yielding varieties are planted with rhizomes, and do not have this problem.

One of the promising pathways is to use biomass and coal in combination. Indiana has the potential to be a frontrunner in the production of advanced biofuels from cellulosic feedstock and coal by also drawing upon the significant deposits of coal in southwestern Indiana. Research has shown that CO_2 can be captured more cheaply in combined coal-biomass plants than in coal plants alone.

Indiana's state government has several policy options available that could be utilized to support the development and deployment of advanced biofuels.

Option 1. Support university research to develop new technologies and to research the economic and policy issues associated with producing advanced biofuels in Indiana

Indiana's universities are well positioned to conduct research to establish and improve advanced biofuels technologies, as well as provide information to policymakers on the economic and policy contexts in which these technologies will potentially be deployed. Indiana University, Purdue University, and Notre Dame have recently proposed a Future Fuels Center to research coal-biomass liquid drop-in fuels. Indiana could help to fund this research.

Research clearly can help to develop new technologies and provide supporting information on relevant economic and policy issues that will support overarching goals such as reduced dependence on foreign oil and improved environmental outcomes. It must be coupled with other efforts to result in new businesses and significant numbers of new jobs for Indiana.

Option 2. Support the development of new advanced biofuels production facilities by purchasing fuel through a reverse auction

Indiana's state government has significant purchasing power for vehicles and vehicle fuel that could be used to accomplish other policy goals. State government could utilize a reverse auction for advanced biofuels to guarantee the purchase of a certain amount of fuel. In this way, state government could underwrite part of the risk associated with early plants for drop in fuels made from cellulosic ethanol alone or in combination with coal. In this way, price policy risks are borne by government, and technology risks are borne by firms.

More analysis would be needed to design a reverse auction appropriate for Indiana conditions and markets. The design would have to assure adequate competition in the auction so that the State could be assured of getting the best price possible for the biofuel. The size of the contract also would need to be matched to the Indiana demand (busses, car pools, etc.) and to a scale of technology that can be economically viable. In other words, there must be adequate demand in the region to accommodate the plant size needed to achieve economies of scale.

Option 3. Make traditional and specialized economic development incentives available to firms locating new advanced biofuels facilities

Federal tax credits and loan guarantees may be available to incentivize the development of new advanced biofuels plants. Indiana currently has general economic development incentives, such as the Hoosier Business Investment Tax Credit (IC 6-3.1-26) that may be available to new businesses. In the past, Indiana has had specialized tax credits for corn and cellulosic ethanol production (Ethanol Production Tax Credit IC 6-3.1-28) and biodiesel production and sales (Biodiesel Production Tax Credit, Blended Biodiesel [Production] Tax Credit, Retail Sales of Blended Biodiesel Tax Credit IC 36-3.1-27). These incentives remain in state law, but are not funded. Indiana could provide additional funding for these incentives for advanced biofuels development, particularly for cellulosic biofuels plants.

Current or new state incentives could be used, in addition to federal and local incentives, to encourage the location of additional production facilities. The current and any new biofuels incentives could be made to apply both to fuels make entirely from biomass and fuels made from a combination of coal and biomass. As mentioned above, current estimates are that fuels made from a combination of coal and biomass are cheaper and produce very little GHG emissions. In addition, they make use of abundant Indiana natural resources. For the newest technologies, incentives such as these may not be substantial enough alone to offset the risk associated with building a first plant.

Option 4. Continue to promote ethanol and biodiesel production and flex fuel vehicle deployment

Indiana government and businesses already have made significant investments in encouraging ethanol and biodiesel production and the manufacture and purchase of flex fuel vehicles. The Indiana Office of Energy Development and the Indiana Department of Agriculture currently promote alternative fuel options among public and individual consumers and work to increase the retail infrastructure for those fuels.

Indiana could increase advanced biofuels consumption by augmenting the number of flex fuel vehicles and/or educating flex fuel owners about the option to utilize E85 in their vehicles.

Indiana could also expand consumption by developing and supporting a network of blender pumps in the state. This would provide consumers with more choices at the retail level as well as create a level-playing field for alternative fuels. This strategy would require a significant investment in infrastructure by local retailers and/or through public subsidies. It also requires a major expansion of flex fuel vehicles as they are the only vehicles that can take advantage of higher ethanol blends.

Indiana also could provide production tax credits for fuels produced in Indiana that would help keep prices available to consumers competitive with other fuel options. Other states, such as Minnesota, Iowa, and Nebraska, have been moving away from this strategy. This strategy has a relatively high budget cost.

2. Electric Vehicles and Battery Technology

The United States is heavily dependent on oil. The transportation sector accounts for 27 percent of the country's greenhouse gas emissions and 70 percent of its petroleum consumption. Alternative sources of energy for transportation, such as electricity, are gaining popularity in the energy and environmental policy debates. As such, alternative fuel vehicles, such as one hundred percent electric vehicles and plug-in hybrid electric vehicles (PHEVs), and the component batteries are gaining popularity in energy, economic, and environmental policy debates. For purposes of this discussion, the term "electric vehicles" (EVs) refers to both types of the aforementioned vehicles.

Although the remainder of this section focuses primarily on electric vehicles and battery technology, Indiana may be able to benefit from a broader strategy for automotive technology diversification. This would include not only EVs and batteries, but also natural gas vehicles, hybrid systems improvements, advanced biofuels (per above) and further efficiency improvements to internal combustion engines. An expanded focus on natural gas vehicles is one specific opportunity. A number of government and business fleets already have adopted this technology. Honda currently is manufacturing natural gas vehicles in Greensburg. Each of these opportunities would require an analysis similar to the one provided here for electric vehicles to identify the best opportunities and the relevant policy issues that must be addressed to implement them.

Electric Vehicles

While federal policy addresses EVs, state governments also have a role in promoting these new technologies. Indiana is aggressively trying to position itself as a leader in EVs among states such as California and Michigan. One of Governor Daniels' stated goals is to turn Indiana into "the electric vehicle state" (Eisenstein, 2010). Indiana is uniquely positioned to be a frontrunner in the manufacturing of EVs. Indiana's advantages lie in its willingness and ability to offer competitive financial incentives to attract potential manufacturers of EVs. In addition, Indiana has a substantial pool of trained labor with experience in automotive manufacturing.

THINK City has dominated the growing EV market in Indiana to date. While sales of THINK City EVs have slowed since its parent, THINK Global, entered and emerged from bankruptcy in Norway, other passenger EVs, such as the Nissan Leaf and the Chevrolet Volt, seem poised to significantly expand the number of EVs in Indiana.

Indiana's state government has several policy options that could be used to support the manufacturing and production of EVs.

Option 1. Support in-state electric vehicle supply chains through economic development incentives

With initiatives like the Energy Systems Network (ESN), Indiana is currently a leader in EVs. Indiana's government can further invigorate the EV and PHEV supply chains centered in the state through various incentives, such as tax credits and loan guarantees. For instance, the tax credits can be awarded to companies that purchase manufacturing equipment in Indiana. Currently, the Hoosier Alternative Fuel Vehicle Manufacturer Tax Credit Program provides an income tax credit up to 15 percent, as determined by the Indiana Economic Development Corporation (IEDC), of the qualified investment for the manufacture or assembly of alternative fuel vehicles (IC 6-3.1-31.9). Indiana could provide expanded funding for existing or additional economic incentives.

Given the increasing interest in EVs, Option 1 would demonstrate a collaborative commitment to energy security between government, businesses, and environmental activists. However, the economic viability of manufacturing EVs in Indiana is subject to uncertainties such as energy prices and the pace of development compared to competing technologies, such as natural gas vehicles and advanced biofuels.

Option 2. Support in-state purchase and use of electric vehicles

Several federal incentives exist to encourage the purchase and use of EVs. For example, the federal government provides a tax credit up to $7,500 for PHEVs purchased in or after 2010. Indiana could consider a variety of policy tools that may incentivize more consumers to consider EVs, including:

1. rebates;
2. feebates (combination of a rebate program that encourages a desired behavior, such as purchasing EVs, and a fee program that discourages a less desired behavior);
3. income tax credits;
4. preferential parking in places, such as malls and airports;
5. sales tax exemptions;
6. reduction in license fees for EVs;
7. exemptions from insurance surcharges; and
8. credits for electricity to the grid by car batteries.

The state also could encourage lowering the cost of electricity for owners of EVs. Currently, the Indianapolis Power & Light Company (IPL) offers special plug-in EV charging rates for residential and fleet customers. In addition, IPL provides at no cost Level 2 EV supply equipment (EVSE) and the associated metering equipment for the first 150 eligible customers to sign up for the special rate. IPL also covers the cost of a standard installation of the equipment. Indiana could collaborate with IPL and other utility companies to expand such programs so that more customers could participate.

Option 2 would undoubtedly increase the number of EVs in Indiana. An added benefit of this is that it would demonstrate to the public the viability of EVs and encourage widespread adoption of the technology. However, without sufficient recharging stations, this policy option would still not reach the intended goal.

Option 3. Support the development of an adequate recharging infrastructure

The current infrastructure is capable of supporting the recharging needs of existing EVs. However, in the long run, the availability of recharging infrastructure—both residential and public—is critical to the success of widespread deployment of EVs. To this end, the state could provide tax credits for the installation of home recharging outlets. In addition, a public network of recharging stations would be important. The existence and maintenance of an adequate recharging infrastructure depends on collaborations between local governments and the private sector. Incentives, in the form of grants, labor and service tax exemptions, and environmental regulatory exemptions, could encourage investments in more extensive recharging infrastructure.

The type of consumer who might find EVs the most attractive are urban dwellers with short commutes that live in places without garages or otherwise convenient access to electrical outlets. This may be a barrier to the widespread adoption of EVs given the inadequacies of the current residential recharging infrastructure. The state could overcome this obstacle by providing tax credits for the installation of home recharging outlets in both single family residential and multi-family residential units (e.g., apartments and condominiums). In addition, while public recharging stations are becoming available (for example, Indianapolis Power and Light installed the city's first public recharging stations in downtown Indianapolis in July 2011 and the city of Evansville installed a location in 2011 as well), the state could provide further help by offering tax credits for the costs of constructing more public recharging stations.

This is a crucial policy option; without a recharging infrastructure, the other policies would be irrelevant. An adequate recharging infrastructure would likely encourage more in-state EV and PHEV manufacturing and boost consumer confidence in EVs. A chicken-and-egg challenge remains. Consumers will not buy EVs en masse if there are no recharging stations, but companies will likely not build recharging stations if there are not enough EVs on the road. Therefore, if the state (and federal government) continues to support the development of recharging stations, it faces the uncertainty of EVs never reaching widespread deployment.

Option 4. Encourage off-peak charging of electric vehicles

By incenting EV and PHEV owners to charge their vehicles at night via reduced rates, the wide adoption of EVs should reduce or avoid the need for additional generation capacity. It also could provide a new load center for off-peak wind energy. Conceptually, the time-of-use rate may be applied specifically to the circuit from which the EV or PHEV is charging or more generally to all off-peak usage. Longer term, the "smart grid" may allow the utility to "turn off" the charging station if an EV or PHEV is charging during an exceptionally high-demand period and/or draw energy from the EV or PHEV battery. So, the EV and PHEV batteries will be not only a source of demand for electricity, but also could be a potential source of electricity during peak times.

Option 5. Encourage state and local government adoption of electric vehicles

Because EVs are still viewed as an emerging technology, public assistance may be needed for investors to overcome the financial risks between the market acceptance of EV and PHEV early adopters and its widespread commercialization. Mandates or incentives for state and municipal fleet purchases could be a cost-effective policy measure that will boost consumer confidence. Indiana has an Alternative Fuel Vehicle (AFV) Grant Program. This program provides grants to counties, cities, town, townships, or school corporations to purchase original equipment manufacturer (OEM) AFVs and for the cost of AFV conversion (which means the vehicle or engine is modified to operate using a different fuel or power source). However, only dedicated and bi-fuel liquefied petroleum gas (propane) and compressed natural gas vehicles are eligible for the program. While the program remains in state law, no funds have been appropriated since March 2011. Indiana could provide funds for this incentive and expand the definition of alternative fuel to include electricity.

Furthermore, a directive for the electrification of current government fleets will promote commercialization of EVs. In 2010, Indiana's Department of Natural Resources took delivery of 15 THINK City electric passenger cars. These vehicles are currently used in various state parks. Also in 2010, the United States Postal Service (USPS) awarded Bright Automotive, an Indiana company, a contract to retrofit a standard USPS Long Life Vehicle (LLV) with its integrated electric drive train. This type of collaboration could also occur at the state or local level. Alternatively, the state could provide incentives to local governments to purchase EVs.

An advantage of Option 4 is that it would alleviate non-government consumer anxiety about the capabilities of EVs. However, government mandates and directives may not be well-received by some constituents. This may be particularly problematic if the issues of high costs and small driving range are not resolved.

Option 6. Support research to develop new technologies and to research the economic and policy issues associated with manufacturing electric vehicles

Indiana's universities are well-positioned to expand on current research to establish and improve EV and PHEV technology, as well as provide information to policymakers on the economic and policy contexts in which technologies will potentially be deployed. Continued research—both public and private—will help develop new technologies and provide supporting information on relevant economic and policy issues that support overarching goals, such as reduced dependence on foreign fuel and improved environmental outcomes. To be most effective, however, it must also be coupled with other efforts that will lead to business growth and job creation for Indiana.

Battery Technology

Batteries are a critical component of EVs. In addition, they can be reused for electric grid storage long after they have become ineffective for EVs. The ability to store electricity on a large scale via batteries would make wind and solar energy more viable. In addition, it would increase the availability and reliability of electricity supply (e.g., matching supply with peak demand), stabilize the cost of electricity, and help reduce greenhouse emissions. State governments can play an important role in supporting the development and manufacturing of batteries.

Indiana is already gaining national attention as a leader in battery design and manufacturing with companies such as Delphi, Altair Nano, Ener1's Indiana-based EnerDel unit, and the military's battery center of excellence at NSWC Crane, as well as initiatives such as the Energy Systems Network. These entities engage in the design, development, manufacturing and/or testing of rechargeable lithium-ion batteries and battery systems for energy storage. An attractive investment climate, strong manufacturing base and extensive scientific expertise position Indiana well for additional investment in this industry. The economic viability of designing and manufacturing batteries in the state, however, is subject to variables such as energy prices and the availability of investment capital.

Indiana's state government has several policy options that could be used to support the manufacturing and production of batteries.

Option 7. **Support in-state development and manufacturing of batteries through economic development incentives**

Indiana's government can further promote the battery economy through various incentives, such as property tax exemptions, tax credits, and loan guarantees. The tax credits can be awarded to companies that purchase manufacturing equipment in Indiana or to companies based on kWh of battery capacity produced. These activities would enhance energy security and bring more jobs to Indiana.

Option 8. **Support research to develop new technologies and to research the economic and policy issues associated with manufacturing batteries in Indiana**

Indiana universities and colleges have a great deal of academic expertise on batteries, and are well-positioned to contribute to the improvement of current battery technology. In addition, there are many Indiana scholars who are available and able to provide information to state policymakers on the economic and policy contexts in which batteries are manufactured. Continued research will lead to more affordable and higher performing (in terms of energy density and storage) batteries. Some Indiana researchers are finding ways to build batteries with higher energy densities. For example, two of the promising paths Dr. Paul McGinn and his colleagues at the University of Notre Dame are pursuing include the use of polymers and the use of lithium air batteries.

Overall, research will help develop new technologies and provide supporting information on relevant economic and policy issues that support overarching goals, such as reduced dependence on foreign fuel and improved environmental outcomes. Research alone is insufficient to result in significant business growth and job creation. It must be coupled with other business development efforts to gain these benefits.

Option 9. **Support university initiatives to develop relevant curricula**

One of the ways to achieve economic growth is to support and promote university curricula that are relevant to battery technology development and manufacturing. This policy option would lay the foundation for a state economy with high-paying, high-tech jobs. In 2009, the Indiana Advanced Electric Vehicle Training and Education Consortium (I-AEVtec) received $6.1 million in stimulus money from the U.S. Department of Energy. Purdue University is the project leader, and other participating institutions include Purdue Calumet, the University of Notre Dame, IU Northwest, the IUPUI Richard G. Lugar Center for Renewable Energy, and Ivy Tech Community College. The main goal of I-AEVtec is to promote Indiana's technological edge by developing curricula that will increase the state's research and development capabilities in next-generation battery technology and fuel cells. In a similar program, Ivy Tech Community College received a $4.7M American Recovery and Reinvestment Act (ARRA) grant for its Crossroads Smart Grid Training Project. This effort will design and deliver Smart Grid curricula including modules, full courses, certificate/training programs, and refined four-year degrees in technology and engineering. The goal is to ensure Indiana's workforce has the requisite training to support the state's electric energy sector. The state of Indiana could provide additional funding to further support the development of similar curricula and training programs.

Option 10. **Encourage/incent utilities to utilize used electric vehicle batteries in grid storage applications**

The state will benefit from the development of a market for the "secondary use" of EV batteries. Since the battery represents the most significant cost element of an EV, developing a robust market for used batteries could lower the price of EVs markedly. Over time, the battery used in an EV will degrade, thereby limiting the number of miles the EV can travel on a single charge, and as a result it will need to be replaced. However, it is estimated that at the end of the batteries useful life in EVs, they will still have 70-80 percent of their original energy storage capacity. At that time the battery can still be quite useful in other applications, such as providing reserves and peak shaving for the electric grid—applications which are less constrained by weight and size.

If broadly deployed, used EV batteries can serve as an energy storage solution for the electric grid, capable of mitigating the need for peak generation, reducing transmission congestion and providing for better utilization of energy generated by renewable sources. So, a secondary market for EV batteries could benefit consumers, not only by lowering the overall cost of EVs, but also by lowering long run electricity costs. In order to support a viable secondary market for used batteries, the state should explore and ultimately adopt a legal framework that addresses crucial issues, such as ownership and liability.

3. Energy Efficiency

Improving energy efficiency across sectors has a number of potential benefits for Indiana related to the Commission's charge, including a cleaner environment, enhanced economic competitiveness, enhanced energy security, and reduced exposure to high and unpredictable energy prices. Energy efficiency is operationally attractive since improvements can be implemented quickly and at low cost relative to other energy system options. Similarly, returns on investment and ongoing savings can be realized relatively quickly.

The options presented below are organized by:

- Utility policy,
- Industrial efficiency,
- Building codes, and
- Other state policies.

Utility Policy

Option 1. Establish energy efficiency as a formal resource within long-term utility and energy planning

A number of specific policy options regarding energy efficiency are provided below. Policymakers should formalize cost effective energy efficiency improvements as an energy resource that is either comparable or prioritized over new supply-side resources for long-term utility and energy planning. Other states establish energy efficiency as first in "loading order" for utility energy planning (Molina et al., 2010). Indiana could follow similar procedures.

Option 2. Address Indiana's annual energy savings goals

States use a number of mechanisms to set energy efficiency savings targets. An Energy Efficiency Resource Standard (EERS) is a long-term energy savings target set for utilities. EERS requires that utilities or independent program administrators achieve a percentage of their energy needs through energy efficiency measures. Utilities (and independent organizations) typically administer customer-focused efficiency programs to achieve these goals. In some cases, they also may use a market-based trading system that allows utilities to purchase energy efficiency credits instead of overseeing energy efficiency savings in their own service territories.

In late 2009, the Indiana Utility Regulatory Commission (IURC) set annual savings goals for each investor-owned utility: 0.3 percent beginning in 2010, 1.1 percent beginning in 2014, and 2.0 percent beginning in 2019. The IURC also ordered electric utilities to submit three-year demand-side management (DSM) plans, including plans for meeting these energy efficiency savings goals. The order identified a failure or delay in offering the required programs as a "service deficiency", but did not include specific provisions about the consequences for noncompliance.

In 2009, Indiana utilities budgeted $13.6 million and $14.4 million for electricity and natural gas efficiency programs, respectively. Also in late 2009, the IURC ordered all jurisdictional utilities to implement five demand-side management programs:

- Residential lighting program that provides "incentives for Energy Star qualified lighting measures"
- Home energy audit program that provides "walk-through audits and direct installation of low-cost energy saving measures"
- Low-income weatherization program that provides "comprehensive energy efficiency retrofits for income qualified households"
- Energy efficient schools program that provides "information and energy efficiency kids for K-12 school building energy audits and access to prescriptive incentives available for commercial customers"

Commercial and industrial program that provides prescriptive incentives for common technologies such as T-8 and T-15 lighting, high efficiency motors and pumps and HVAC equipment."

Option 2a. Monitor energy savings program efficacy and enforce program goals

Option 2b. Extend Indiana's annual savings goals to all electric and natural gas utilities, including municipal and co-op utilities

Option 2c. Raise the goals of the program

Several sub-options are available to policymakers to address the energy savings program. Option 2a involves monitoring. Option 2b expands the program to additional utilities. To implement Option 2b, the state regulatory framework must be expanded since the IURC currently does not regulate municipal or co-op utilities. In addition, it would be crucial to evaluate whether the savings goals are achieving the overall objectives. Thus, not only would Option 2a involve assessment of the program, it would also make the program's goals enforceable by implementing noncompliance guidelines. Option 2c would go further by increasing the program's standards and imposing actual penalties, such as monetary fines, on entities that fail to meet the standards. The disadvantage with all three of these sub-options is the increase of administrative burden and costs associated with tracking and enforcing Indiana's energy efficiency goals.

Option 3. Make Indiana's Clean Energy Portfolio Standard mandatory

The majority of states have adopted a similar policy mechanism, a Renewable Portfolio Standard (RPS), which mandates that a certain percentage of total electricity must come from renewable energy by a certain end year (e.g., 25 percent renewable energy by 2025). Several states with RPS policies define energy efficiency as an eligible resource to meet their RPS energy targets.

In May 2011, Public Law 150 (SB 251) created the Clean Energy Portfolio Standard (CEPS). The program is voluntary and sets a goal of 10 percent clean energy by 2025, based on 2010 levels. Utilities must achieve 4 and 7 percent clean energy by 2013-2018 and 2019-2024, respectively, to receive financial incentives. Demand side management and energy efficiency initiatives are included in the extensive list of eligible technologies. Fifty percent of qualifying energy must come from within the state. Utilities may trade clean energy credits to comply with the portfolio mandates. The IURC must adopt rules for the program that take effect by January 1, 2012. As a practical matter, IURC also must harmonize the standard with the energy efficiency targets established for utilities in the IURC Phase II Generic Order, including establishing how activities that may qualify in both programs will be credited. Once completed, the state could monitor the effectiveness of the CPS in achieving demand side management and energy efficiency goals and adjust the policy as needed to ensure maximum effectiveness.

Of the states that have adopted some form of a RPS, Indiana's is among the minority that is voluntary. Research has shown that voluntary RPS programs are politically symbolic but largely ineffective to improve energy efficiency. Thus, this option would strengthen the current clean energy goals by making the CPS mandatory.

There are two main downsides to this policy option. First, an RPS policy may increase the cost of electricity and, thus, the price that consumers pay for electricity. Several recent studies confirm, however, that RPS policies do not necessarily raise costs; and states have experienced both increases and decreases in the price of electricity as a result of RPS policies (Carley, 2012; Wiser, Namovicz, Gielecki, & Smith, 2007; Fischer, 2006). Second, if utilities are mandated to achieve a certain percentage of their RPS goals with energy efficiency, these utilities will lose the revenue associated with the saved electricity. There are other mechanisms, however, that can help utilities capture lost revenue from energy efficiency savings, such as performance incentives and inclusion of lost revenue as part of the recovery model.

Option 4. Adopt decoupling or some other form of lost revenue adjustment for Indiana's electric utilities

Common regulatory structures do not provide economic incentives for utilities to assist their customers with energy efficiency. Typically, maximizing energy sales and profits are linked. States can adopt fixed cost recovery (referred to as a "lost revenue adjustment mechanism") to remove the disincentives inherent in the regulatory system. Decoupling is one lost revenue adjustment mechanism in which the link between a utility's revenues and sales is severed. In addition, many states have moved to a formula or revenue stabilization model to increase regulatory transparency and promote efficiency.

Decoupling has been authorized in Indiana for natural gas utilities and has saved consumers thousands in avoided natural gas costs. Indiana could make decoupling universally available to electric utilities. Decoupling has been adopted by 10-12 states, all in the last five years. Decoupling is complex to administer. The limited experience makes it difficult to assess the overall efficacy of this tool in meeting demand side management and energy efficiency goals.

The IURC also has statutory authority to allow electric utilities to collect lost revenues and has done so in a number of specific cases. Indiana also could extend other revenue adjustment mechanisms universally to electric utilities. Little research is currently available to assess the effectiveness of these other mechanisms.

Option 5. Adopt utility performance incentives for achieving energy efficiency goals

As of late 2010, Indiana had authorized performance incentives for a few electric utilities (Molina et al., 2010). In addition to fixed cost recovery, states can also adopt performance incentives to reward utilities for reaching energy efficiency program goals. While the former serves to mitigate utilities' disincentive to invest in energy efficiency, it does not necessarily provide an incentive for making such an investment. Thus, to encourage energy efficiency investments, many states have allowed utilities to earn a return on such investments on par with those in supply-side resources (e.g., new generating capacity). There are different approaches to rewarding utilities for reaching or exceeding program goals. For instance, the state could allow utilities to earn a rate of return on energy efficiency investments equal to ones in supply-side or other capital. Alternatively, the state could provide utilities with financial rewards for meeting set targets. This approach could also be balanced with financial penalties for poor performance. Overall, performance incentives have been used more frequently because they are usually seen as easier to implement than decoupling or lost revenue adjustment.

Option 6. Adopt time-based pricing for electricity

It is a basic tenet of economics that consumers make the best choices when they see the actual price of the thing that they purchase. For example, airlines often charge more for seats on a plane that is flying in the middle of the day than late in the evening. This encourages customers to use less of a limited resource (airplane seats in this case) when the maximum number of customers want those seats. This is better for the overall economy of the airline industry rather than buying more, extremely expensive, airplanes trying to fly every customer in the middle of the day while they sit empty in the evenings.

The electric utility industry shares some things in common with the airline industry. For example, power plants like airplanes are extremely expensive. Also, electricity cannot be stored for use of large numbers of customers just like airlines cannot arbitrarily add seats to a plane if an extra customer or two wants a specific flight. Thus, both industries reach limits where they simply cannot serve another customer without spending large amounts of money to buy new equipment. And, customers of both industries tend to want to use the product all at the same time. (Electric customers typically use electricity in the afternoon and early evening when lights turn on, dinner is prepared, the wash starts and so on. This is exacerbated on hot, muggy Indiana summer days when air conditioners are hard at work.)

Unlike airlines however, traditional retail pricing of electricity does not reflect the costs of providing electricity. (Sales and purchases of wholesale electricity reflect the expense of providing electricity as the supply of power plants becomes less and less. This is not typically shown in retail pricing.) Instead, electric customers see a constant price that does not change more than once a calendar quarter.

To address this issue, Indiana could adopt time-based pricing (TBP). TBP, broadly, reflects the fact that the costs of generating and providing electricity change in order to meet inter-temporal, fluctuating demand. More specifically, TBP could be in the form of block or real-time pricing. With TBP, customers would see prices as often as hourly allowing choices on when to use electricity. This option presents two separate issues – a short term issue and a longer term issue – for Indiana. In the short-term, TBP can be done at a relatively low cost by simply redesigning the prices structure (rates) that customers pay. While being relatively low cost, this option has the disadvantage of continuing to use averages. An example used in the industry many years ago was to simply price all electricity used in the summer more expensively than electricity used in the spring or fall. As the accuracy of the pricing is increased, i.e., the frequency that the price customers see is changed, the cost rises. When the pricing is changed as often as hourly, special electric metering must be installed at the customer's home.

TBP encourages customers to use electricity at periods where few others are doing so. An example is the recharging of batteries. This could be used to create an incentive for consumers to purchase electric vehicles. Electricity is quite cheap at the moment when compared to the cost of gasoline. This advantage would be enhanced if a customer could pay the actual cost of electricity used at night.

TBP is a tool that promotes the wise use of electric energy. If a customer sees the actual cost of electricity they often change their behavior. Shifting the use of electricity from periods of heavy usage to periods when usage is less, allows power plants to run at a steadier rate. It can reduce or delay the need for additional power plants This is similar to a car which gets better gas mileage when on cruise control than in the speed-up/slow-down of rush hour driving.

In the long-term, TBP pricing should send price signals to which customers respond. While customers save money, the utility also delays the need to build expensive new power plants.

Utilities have been using TBP for residential and commercial customers. In general, this is accomplished through block pricing, where the customers would pay a lower rate per kWh during periods of low demand and a higher rate per kWh during periods of high demand (typically between 12 noon and 8pm on weekdays). This arrangement would allow customers to save money, and it would also help smooth out peak load demand.

Whereas block pricing would be most appropriate for residential and commercial customers, real-time pricing could encourage load shifting at the industry level. Compared to the block approach, real-time pricing is a more sophisticated scheme. instead of facing fixed rates set in advanced, these larger customers would contend with prices that are based on either the actual market value or the utility's cost for electricity at the time it was used. In general, industrial customers think of their businesses as a process that takes in commodity inputs and generates finished products. Utilities, too, should think in terms of processes in order to maximize their industrial customers' awareness of energy efficiency, demand response, and/or renewable sources. Unlike residential and commercial customers, industrial customers already possess the physical infrastructure—such as metering—to begin facing a real-time pricing scheme. An advantage of this option is that it would reflect the true cost of peak energy to industrial customers. In addition, it would reduce the need for new generating stations to meet peak demand.

If Indiana were to choose this option, utilities would have to work with customers to create the demand and acceptance needed. To date, there has been low customer demand for this option.

Industrial Energy Efficiency

In Indiana, the industrial sector (which includes aluminum, chemicals, glass, metal casting, and steel) contributes to the state's relatively high total and per capita energy consumption. For instance, it ranks third in the United States in terms of percent of total energy consumption in industry for electricity (46 percent vs. 28 percent for the nation). Thus, there exists opportunities to improve overall industrial energy efficiency in Indiana.

The Indiana Office of Energy Development (OED) works to promote both federal and state energy efficiency programs. The OED administers a small number of programs funded by the U.S. Dept. of Energy and other federal sources. For example, the Conserving Hoosier Industrial Power (CHIP) grant program made $2.2 million available for energy efficiency upgrades to commercial or industrial facilities. Eligible project technologies included lighting, lighting controls/sensor, chillers, furnaces, boilers, heat pumps and building insulation. Eleven (11) companies received grants in mid-2010. The funds for this program came from the federal American Recovery and Reinvestment Act (ARRA).

Indiana's large industrial users typically have specific contracts with utilities that establish those firms specific load and negotiated utility rates. The industrial sector also can access energy efficiency programs offered by utilities and/or third party program administrators. These programs would typically be accessed by smaller firms that do not have the capacity to complete the energy load and efficiency analyses that larger firms do.

In addition to the above-mentioned programs, there are also federal-level energy efficiency tax incentives. However, since states are more likely to have a better understanding of the local needs, more state-level policies could be implemented to encourage energy efficiency at the industry level.

Option 7. Provide incentives for combined heat and power (CHP)

CHP is a type of industrial energy efficiency approach to generating power and thermal energy from a single fuel source with greater overall efficiency than if the two had been produced separately. In certain situations, the installation of a CHP system could increase a facility's operational efficiency and/or decrease its energy costs. For instance, it would be cost-effective for a facility with a year-round process heating load to install a CHP system. In addition, a CHP system could improve the reliability of a facility's electrical supply.

There are several current Indiana policies that indirectly support CHP. First, CHP is an eligible technology for purposes of receiving incentives under the Indiana Clean Energy Portfolio Standard. Second, CHP qualifies as an eligible technology for Indiana's electric interconnection rules. Third, CHP projects can qualify for Indiana's set-aside of allowance allocations for energy efficiency and renewable energy in its NO_x State Implementation Plan (SIP) Call trading program (which permits Indiana to allocate 1,103 tons of NO_x allowances each year for projects that reduce the consumption of electricity and other energy, or generate electricity using renewable energy).

The state of Indiana could do even more to support CHP. It could waive electric utility standby fees to encourage further CHP development. California, for example, exempts CHP from standby rates. The state could also provide direct financial incentives, such as grants, tax credits, or low-interest loans, to support CHP. For instance, in Arizona, CHP qualifies for an energy property tax exemption. Also, Connecticut provides low-interest loans for capital costs and project development costs of customer-side distributed resources, which includes CHP systems.

Option 8. Provide incentives for other industrial energy efficiency programs

The Indiana Office of Energy Development (OED) works to promote both federal and state energy efficiency programs. The OED administers a small number of programs funded by the U.S. Department of Energy and other federal sources. For example, the Conserving Hoosier Industrial Power (CHIP) grant program made $2.2 million available for energy efficiency upgrades to commercial or industrial facilities. Eligible project technologies included lighting, lighting controls/sensor, chillers, furnaces, boilers, heat pumps and building insulation. Eleven (11) companies received grants in mid-2010. The funds for this program came from the federal American Recovery and Reinvestment Act (ARRA).

The state of Indiana could provide further financial incentives to support energy efficiency at the industry level. In particular, tax incentives would encourage larger capital investments—such as retrofitting projects or development of new technologies—that might not have otherwise been pursued. Industrial improvements in energy efficiency are different than those for commercial or residential sectors. Manufacturers seek to maximize their profits. Thus, they will likely not replace a functional piece of equipment with a more energy efficient one, unless the gains from future energy savings are greater than the immediate cost of purchasing/implementing the retrofit and the lost sunk cost associated with the existing equipment. Incentives, such as loans or grants for investments in specific types of energy efficient equipment or reduced interest rate loans to defray initial capital costs, would appropriately address this issue.

State programs could also rely on non-financial incentives. Some states and localities have used zero-cost incentives to attract energy efficient industries. For instance, Arlington (Virginia) grants density and/or height bonuses to buildings that achieve LEED certification. Others offer expedited permitting for "green" industries. Another type of non-financial incentive is technical assistance. The state of Indiana could, for instance, provide energy audits to help industries identify and implement appropriate energy efficiency program. Such programs would enable industries to incorporate energy efficiency into their overall decision-making process.

Building Codes

Our nation's buildings use almost 40 percent of our energy, 73 percent of our electricity and one-eighth of our water. American homes use more than 20 percent of the energy consumed in the country and commercial buildings use about 18 percent (Molina, et al., 2010). Requiring the most up-to-date construction standards for these buildings is the easiest and most cost-effective way to reduce our energy use, save money, avoid waste and minimize pollution.

The American Recovery and Reinvestment Act of 2009 (ARRA) required states to update their building energy codes to the functional equivalent of the 2009 International Energy Conservation Code (IECC) in order to qualify for stimulus funding. ARRA also requires states to achieve a 90 percent compliance rate with the new building codes within eight years. In a letter to the Department of Energy in March 2009, Governor Daniels pledged to do what he could to get new codes adopted.

In May 2010, the most recent amendments to the Indiana Energy Conservation Code (675 IAC 19-4), containing energy construction rules for commercial buildings, went into effect. These amendments were based on ANSI/ASHRAE 90.1 2007 edition, published by the American Society of Heating, Refrigerating and Air-Conditioning

Engineers, which met the 2099 IECC requirement. While the Indiana Fire Prevention and Building Safety Commission typically utilizes review committees to recommend amendments to the national building models, at Governor Daniels' request, the commission used a streamlined procedure for this rule. Code Services staff amended the model standard and conducted a public comment process before submitting the proposed new rules to the Fire Prevention and Building Safety Commission. Using this streamlined approach, the process took 16 months from the time the commission first discussed adopting the new standard until it went into effect. However, a few months later a more efficient standard, ASHRAE 90.1 2010, became available. Currently the building commission has no plans to adopt this improved version.

Similarly, the commission is in the process of adopting a new energy section to the Indiana Residential Code that is equivalent to the 2009 IECC. However, the 2012 version of the IECC was published in July 2011, and some states, including Illinois and Minnesota, already are putting this improved code into effect.

Option 9. Improve the process of adopting new building energy codes to allow the state to benefit quickly from advances in efficiency

Model energy codes are updated on three-year cycles. Just as the American Society of Heating, Refrigerating and Air-Conditioning Engineers has adopted a 2010 version of ASHRAE 90.1 for commercial buildings, revising the 2007 standard, the International Code Council has released a 2012 version of the International Energy Conservation Code to replace the 2009 code. The goal of these organizations is to achieve 30 percent energy savings over two code cycles. ASHRAE 90.1 2010 is 30 percent more energy efficient than the 2004 version and the 2012 I.E.C.C. is 30 percent more efficient than the 2006 code.

Because of the substantial energy savings achieved by each new model code revision, Indiana could benefit greatly from quicker adoption of the new standards. To do this, state policymakers may want to consider removing the energy section from the residential code and placing it in the Indiana Energy Conservation Code along with the commercial standard. This would enable the building commission to establish an energy code review committee that could review the latest versions of both the ASHRAE standard and the residential energy conservation code, allowing for speedier adoption by the commission. Home builders and building officials may find a bifurcated residential building code a bit cumbersome, but the International Code Council publishes compact versions of the energy code for easy reference.

While making new buildings more energy efficient may add to their cost, the energy savings that result more than make up for it, resulting in an overall gain to the economy. By adopting revised energy codes on their three-year cycles, the increased cost to builders of each new code will be kept to a minimum. For example, Code Services estimated that the new residential energy code—the first energy code upgrade in almost 20 years—will increase the average cost of a new home by about $1,865. If the state had regularly updated the code to keep up with the latest improvements in homebuilding, the increased cost would have been much lower.

In other states, energy efficiency resource standards programs sometimes allow utilities to "claim savings for code enhancement activities, both for adoption and compliance." (Sciortino, et al., 2011) Overlapping policy goals and programs including establishing how activities will be credited and how activities that may qualify in multiple programs will be treated will need to be harmonized.

Option 10. Educate builders and building officials on new building codes and track compliance

As mentioned above, ARRA also requires states to achieve a 90 percent compliance rate with the new building codes within eight years. Indiana has begun the process to meet this requirement, but it will need to make significant investments and efforts in the education and training of builders and building officials to achieve this compliance rate. Policymakers may want to assign the energy code review committee the tasks of recommending improvements to education and training, and determining compliance rates.

Other State Policies

Option 11. Expand state financial and information incentives to consumers for energy efficient improvements

States can adopt rebates, loans, bond, income tax credits and deductions, and sales tax breaks to lower the cost of energy efficient products and thereby encourage individuals and businesses to purchase those products. Indiana currently uses financial incentives and other educational efforts to build awareness about energy efficient products and the importance of increasing energy efficiency in consumer homes and businesses. It could continue to offer a menu of incentive options to consumers.

Indiana has the following state incentive programs.

- The Insulation Tax Deduction (IC 6-3-2-5), created 1978, provides an income tax deduction of up to $1000 for the purchase and installation of residential insulation.
- The Solar Powered Roof Vents/Fans Deduction (IC 3-6-2-3.5), created in 2009, provides a tax deduction of up to $1,000 deduction for the purchase and installation of residential solar powered roof vents or fans. The deduction is limited to 50 percent of the cost of the equipment and installation.
- The Energy Star Heating and Cooling Equipment Credit (IC 6-3.1-31.5), created in 2007, provided a tax credit for 20 percent of the cost of Energy Star heating and cooling equipment and installation up to $100. The credit is for residential and small business owners against the adjusted gross income tax, insurance premiums tax, or financial institutions tax. The credit was set to expire when it reached $1 mil or the end of the 2010 tax year. The Indiana Department of Revenue announced on March 1, 2011, that the total credits reached $1 mil.
- The Geothermal Energy Heating or Cooling Device Deduction (IC 6-1.1-12-34), adopted in 1981 and amended in 2008, allows the owners of mobile homes or real property to deduct the marginal assessed value associated with the geothermal systems from their property taxes.
- The Solar Energy Heating or Cooling System Deduction (IC 6-1.1-12-26), adopted in 1975 and amended regularly) allows the owners of mobile homes or real property to deduct the cost of the heating or cooling unit and installation costs from their annual property taxes.

The state could evaluate the effectiveness of the Energy Star Heating and Cooling Equipment Credit program, and, in addition, it could determine whether the program should continue with funding. The state could also consider other types of incentives to encourage consumers to invest in energy efficiency improvements. For instance, under Illinois' Green Energy Loan program, business owners, nonprofit organizations, and local governments seeking loans ranging between $10,000 and $10 million for certain energy efficiency and renewable energy updates may apply for a rate reduction. Furthermore, the AlabamaSAVES program offers an energy efficiency and renewable energy revolving loan fund to in-state businesses and industries to retrofit existing facilities. (For more information on other state policies, see the Database of State Incentives for Renewables and Efficiency (DSIRE- http.//www.dsireusa.org/summarytables/finee.cfm))

Option 12. Facilitate financing for energy efficiency retrofits to buildings

While better codes will make new buildings much more energy efficient, even greater gains, both in terms of energy savings and job creation, can be achieved by retrofitting existing structures. Nationally about $5 billion a year is spent on energy retrofits to buildings, most of which are public and institutional structures. Expanding that market to more residential, commercial and industrial buildings would create hundreds of thousands of jobs. (Supple & Nix, 2010). The main reasons why building owners don't make these improvements, which can pay for themselves in energy savings over relatively short time periods, are lack of internal capital and insufficient credit to obtain financing at reasonable interest rates. Many states and localities have created innovative programs to address this problem. One approach is Property Assessed Clean Energy (PACE) programs, which tie financing for energy improvements to property assessments, allowing repayments to be passed on easily to subsequent building owners. While not currently a viable option for single-family houses, several cities (including Ann Arbor, Michigan) and counties are using PACE to help finance improvements to commercial buildings. Several models exist for these commercial programs, including owner-arranged financing that requires approval by existing mortgage holders and doesn't use bonding to raise capital. A different approach, called "on-bill financing," allows building owners to repay energy improvement loans on their utility bills. New York State recently adopted such a program, with the goals of raising $5 billion in private investment and creating more than 14,000 new jobs (Livingston, 2011). Indiana policy makers may want to consider ways to promote similar programs.

Option 13. Fully implement energy efficient design standards for new state-owned building and retrofit existing buildings

State governments can show a commitment to energy efficiency by incorporating energy efficiency measures into state facilities. The most commonly adopted measure is energy savings targets for new and existing state facilities. Another measure is a benchmarking requirement that involves "all buildings undergo[ing] an energy audit or have their energy performance tracked using a recognized tool such as EPA Energy Star Portfolio Manager. Currently, benchmarking requirements are typically voluntary rather than mandatory (Molina et al., 2010). States often accomplish building retrofits through Energy Savings Performance Contracts (ESPCs) in which a state enters into an agreement with an Energy Service Company (ESCO). The state pays the ESCO with savings from the implemented energy efficiency measures (Molina et al., 2010).

In 2008, Governor Mitch Daniels established an energy efficient state buildings initiative by executive order. The order required the Indiana Department of Administration (DOA) to develop design standards for all new state buildings that include a cost-effectiveness analysis of the building in achieving energy efficiency. The standards apply to all state agencies, departments, boards, offices, commissions, and public universities. The DOA incorporated the new requirements into Indiana's standard instructions to designers for State-owned building projects. Efficiency can be demonstrated through meeting one of the following standards.

- A rating of Silver on the USGBC LEED* rating system
- A two-globe rating on the Green Building Institute Green Globe rating system
- An EPA Energy Star building rating
- An equivalent rating under a system accredited under the American National Standards Institute (ANSI)

The order also requires that renovations or repairs of existing buildings to achieve energy efficiencies based on analyses of construction and life-cycle operating costs. Renovations are supposed to proceed in the spirit of green building guidelines (DSIRE). State policymakers have the opportunity to lead by example by ensuring the implementation of best practices for energy efficiency in state government buildings.

Option 14. Expand incentives for public university energy efficiency improvements

IC 21-34-10-7 allows state educational institutions to undertake qualified energy savings projects, contracts with energy efficiency providers, without General Assembly approval if savings are expected to equal to the annual debt service payments. The cumulative total of these bonds, however, cannot exceed $45 mil for Ivy Tech Community College and $15 mil for other institutions. These limits are quite low given the magnitude of university facilities across the state and could have the effect of impeding cost-saving investment in energy efficiencies.

Option 14a. Remove bonding limits for public universities for energy efficiency improvements

Option 14b. Establish mechanisms to allow the reinvestment of energy efficiency savings in additional improvements

Policymakers could incent additional energy efficiency investments by public universities by raising the bonding limits or creating a mechanism, such as a revolving loan fund, to allow the investment of savings into additional energy efficiency projects.

Option 15. Encourage energy efficiency for local public buildings

Local governments, including public schools and libraries, are struggling with recent revenue limits. One source of potential savings is through energy efficiency improvements to public buildings. Unfortunately, some energy efficiency improvements require a significant upfront investment in order to realize savings over time. Indiana policymakers should consider additional tools to incent energy efficiency investments by local government for new and remodeled buildings.

Indiana currently has a number of assistance programs available to local governments. The Indiana Office of Energy Development (OED) administers a number of programs, aimed at local government buildings, funded by the U.S. Department of Energy and other federal sources. Several examples are described below.

- The Community Energy Plan program provides small cities, towns, and counties with energy audits and energy plan development at no cost by third party vendors. Applications for this competitive grant program were accepted in April and May, 2011. Those communities chosen for the program will receive a comprehensive energy audit by a third party vendor. The period of performance is expected to be June to December 2011. The funds for this program come from the U.S. Department of Energy's Energy Efficiency and Conservation Block Grant (EECBG) program.

- Energy Action in Schools created Energy Action Patrols to monitor energy usage in school buildings and help recommend ways to save money on utilities. Each participating school building receives an energy audit. An adult Energy Action Leader is trained in each school, and students can join the Energy Action Patrols that will monitor energy usage in their building and make recommendations for additional savings. Energy savings are tracked. Behavioral audits are conducted twice during the school year to document energy saving practices. Ten school corporations including 49 school buildings are participating in the program. The program is administered by the National Energy Foundation, based on $60,000 grant funding from the federal State Energy Program. Duke Energy Indiana, Indianapolis Power and Light (IPL), Citizens Energy Group and Wabash Valley Power Association also have provided support.

- The Energy Efficiency for Water Treatment (EEWT) grant program offered grants up to $100,000 for replacement of water treatment pumps and motors. $350,000 is available for this program. The funds come from the U.S. Department of Energy's State Energy Program. Applicants for the program must provide a 50 percent cost match. Seven communities received grants.

IC 36-1-12.5 allows local governments to enter into guaranteed savings contracts (GSC), agreements between a qualified provider and a building owner to reduce the energy and operating costs of a building by a specified amount. The principle advantage of these agreements is that the building owner can participate in the project without a large upfront investment of capital. The savings are used to pay for the investment over a period of not more than 20 years. If the guaranteed savings are not achieved, the provider must reimburse the building owner for the difference between the guaranteed and cost savings. Utilities can offer similar programs under this statute.

Option 16. Support research, development, and demonstration

State universities and other research institutions can play an important role in developing innovations to move energy efficiency efforts forward. Research can focus on energy consumption patterns in local industries, development of new technologies, and demonstrations of new technologies. (Molina et al., 2010)

Option 17. Support university initiatives to develop relevant curricula

One of the ways to achieve economic growth is to support and promote university professional and vocational curricula that are relevant to the achievement of energy efficiencies. This policy option would help to provide the skills that are needed as energy efficiency technologies become more ubiquitous and as these technologies change.

Option 18. Track and evaluate the efficacy of energy efficiency programs. Strengthen programming if necessary

The previous options propose various mechanisms for achieving energy efficiency. The state could holistically monitor the efficacy of these programs in achieving the desired outcomes and adjust accordingly. A number of private firms, nonprofits, and universities may appropriately play a role in such a holistic evaluation effort. Such a broad monitoring initiative will need to be coordinated with the third party monitoring that has been established for particular state energy efficiency and demand management initiatives.

4. Carbon Capture and Storage

Indiana's economy has long been dominated by an energy-intensive manufacturing sector and dependent on the relatively low-cost electricity generated using coal. Even with the changes in manufacturing over the last 25 years, Indiana ranks in the top 10 states in the nation for number of manufacturing jobs. Some of the major industries within the state (e.g., steel, aluminum, automotive, refining and cement) utilize coal as an energy source in their processes directly. Additionally, over 90 percent of the electricity generated in Indiana comes from coal burning power plants (EIA, 2011). This dependence on coal provides Indiana with relatively low cost electricity, ranking it in the lowest 15 states in the nation. The abundance of manufacturing and coal-based electric generation made Indiana the second largest coal consuming state in the nation in 2009.

Indiana also has a large, robust coal mining industry with large reserves of coal located in south western region of the state. With about 2 percent of the nation's reserves, the state's mines produced approximately 35 million short tons of coal in 2010. But even with this rate of production, the state still imports more than half of the coal consumed from low sulfur western sources.

Indiana's industries and its coal based power generation release significant amounts of carbon dioxide (CO_2) as a result of their operations. With the increasing evidence of adverse impacts of global warming and the impacts of greenhouse gases (GHG), including CO_2, on the environment, Indiana's heavy dependence on coal and other fossil fuels provides the state with enormous challenges and opportunities. Analyses have shown that Indiana could be among the states most impacted as a result of any effort to control emissions of CO_2.

For Indiana to further the well-being of its citizens, it must simultaneously continue to provide low cost and reliable electricity, support the manufacturing jobs that currently utilize coal and sustain the coal mining industry, protect other industries that emit greenhouse gases, and improve on the practices that affect the environment This will require decisions about carbon management strategies including carbon capture and storage (CCS) and the use of captured carbon dioxide for enhanced oil recovery (EOR).[1] CCS is a set of practices involving capturing carbon dioxide (CO_2) from the generation system and injecting it deep underground (more than 1,000 meters below the surface) for permanent storage. Enhanced oil recovery, in this context, involves the use of CO_2 to recover oil that remains in subsurface deposits after traditional recover methods are used.

Though decisions made at the federal level will greatly influence these strategies and the prospects for CCS development within the state at this time remain uncertain, Indiana's elected leadership has numerous policy options that could prepare the state for the regulation of CO_2 emissions and implementation of CCS and EOR practices in the state. Development and deployment of CCS on a major scale within Indiana would require several key elements to assure that CCS can be carried out safely, effectively and economically. Proactive policies on CCS may provide first mover advantages to the state as well as improve the economics of deployment.

With this perspective, the Commission determined some of the key policy choices available to Indiana's elected leadership to address current technical and economic impediments to the implementation of CCS. In addition to the policy challenges associated with pore space ownership, CO_2 transport, and the long term liability of stored CO_2, Indiana's state government has several policy options availability that could be used to address the technical and economic impediments to the development and deployment of CCS.

The discussion is structured around the following issues:

- Clarify pore space ownership
- Develop a regulatory framework for carbon dioxide pipelines
- Address the long-term liability of stored CO_2
- Facilitate research to establish additional carbon capture technologies
- Facilitate investigation and evaluation of Indiana's deep subsurface geology for CO_2 storage
- Evaluate the enhanced oil recovery opportunities located within and outside of the state
- Provide economic development incentives to private sector CCS implementers
- Create a state utility to develop CO_2 pipelines and/or storage facilities

Pore Space Ownership

Option 1. Clarify pore space ownership

Porous geological formations, including saline water-filled formations, depleted oil and gas fields, and unminable coal seams currently are considered the most promising locations for CO_2 storage reservoirs. The pore system in each of these types of reservoirs is known as the pore space. The effective use of the subsurface by an entity that is planning on storing a large volume of CO_2 potentially requires the aggregation of the subsurface rights of a large numbers of landowners into a single unit for operations and management.

[1] Often, CCS refers to carbon capture and sequestration. This acknowledges that CO_2 can be removed from the environment by, for example, trees which will keep the CO_2 out of the atmosphere for many years. Storage refers to locking CO_2 into geologic formations that will keep the CO_2 out of atmosphere permanently. These papers will only consider storage.

Aggregation can be complex and costly as a result of the number of owners alone. It could be further complicated by circumstances in which the owners of the surface and subsurface estates are not the same and potentially plan competing uses such as energy resource extraction, mineral mining, natural gas storage, and geothermal energy production.

In Indiana, it is currently unclear who owns the pore space. The absence of guidance from the legislature (and the courts) creates uncertainty for surface estate owners, mineral estate owners, and CCS operators. If there were demand for the storage of CO_2 today, these activities would lead to the creation of a marketplace in which self-interested parties (i.e., pore space owners and CCS operators) allocate their respective resources (i.e., pore space and money). A continued failure to act could increase transaction costs, preclude first mover advantages, or prevent deployment altogether. Without guidance from the legislature, the resolution of the property rights issue likely will occur in the courts. Because no law exists to clarify ownership, there could be multiple competing claimants to the pore space. This likely would result in complicated and protracted lawsuits, increasing the transaction costs of CCS. The uncertainties under the market approach also are likely to increase the costs associated with identifying, negotiating, and contracting to aggregate the necessary property rights for carbon storage. In some cases property owners may deliberately hold up the process of property aggregation with the hope of gaining a higher price. One of the major consequences of holdouts is that they could drastically increase transaction costs (mostly in the form of legal actions and development delays).

A continued lack of legislative direction on ownership of pore space may lead to additional legal complications. For instance, a private firm (C12 Energy, Inc.) has begun to negotiate options contracts with surface estate owners in Illinois for the rights to the pore space beneath their land in the anticipation of the need for the pore space and that the state will clarify the ownership issue. Activity such as this may affect how courts resolve disputes resulting from legislation and/or the absence of legislation.

Given the legal uncertainties and increasing complexities, the state of Indiana could establish a legal structure for the ownership of the pore space including provisions defining the relationship of pore space owners to surface estate and mineral estate owners. The following section provides four options, as well as their attendant advantages and disadvantages.

Option 1a. Assign pore space property rights to surface estate owners

Indiana could, through legislation, assign the ownership of the pore space to the surface estate owners. Montana, North Dakota, and Wyoming have adopted this approach.[2]

One of the advantages of this option is that it is likely to be perceived as fair. The surface estate owners are easily identifiable as owners and as stakeholders. Clarity of ownership likely also reduces the uncertainty and cost of securing pore space. As with all the private ownership options, the process of identifying, negotiating, and contracting with multiple owners could be a lengthy and costly venture. Owner holdouts also could impose large transaction costs on the process.

Option 1b. Aggregate property rights using eminent domain with or without unitization and/or quick take provisions

The state could buy pore space using eminent domain. New legislative language could assign pore space ownership to surface estate owners and establish the authority of a specified state commission, agency, or public utility to use eminent domain in the context of carbon storage.

[2] The pore space ownership is severable in Montana and Wyoming. In other words, owners may sell them separately. North Dakota's statute prohibits the surface estate owners from severing their pore space interests. Illinois, Kansas, Louisiana, Oklahoma, Texas, Utah, and West Virginia acknowledge private ownership rights to the pore space without identifying the owners.

Quick-take provisions could be added to the traditional eminent domain process. Quick-take provisions would allow the state the right to immediately take possession of the property after compensating the owner at market prices, giving the state use of the pore space while ownership disputes are resolved.

Unitization provisions also could be added to the traditional eminent domain process. Unitization allows the use of eminent domain only when a significant amount of pore space (e.g., 51 percent) has been acquired through voluntary agreement. In this scenario, the remaining owners can be compelled to sell their pore space rights, via eminent domain, at market value. Currently, Wyoming has legislation allowing unitization for CO_2 storage in pore space. Indiana currently has unitization provisions for the production of oil and gas. By facilitating the aggregation of land, unitization can minimize the costs associated with minority landowners who choose to holdout.

Aggregation of rights to the pore space through eminent domain has several advantages. It would make it easier to aggregate property rights in the pore space, reducing the transaction costs associated with aggregation. It also would alleviate the holdout problem that plagues the previous two options. The additional advantage to a quick-take provision is that it would protect against high costs associated with development delays.

The overall transaction costs associated with eminent domain, however, would still be substantial; legal fees and development delays involved in eminent domain proceedings are costly. The use of eminent domain also may not be popular with surface owners, particularly in Indiana. Eminent domain has traditionally been used for government acquisition of valuable property. While the pore space (more than 1,000 meters below the surface) is arguably not valuable property, surface estate owners may still be resistant to government intrusion on their land in order to utilize the pore space.

Option 1c. Declare pore space as public domain

The state could definitively declare, through legislation or a constitutional amendment, that property rights in the pore space public domain and are not held by the surface estate owners. The state, then, would regulate activities in the pore space for the protection of public welfare. To date, no state has chosen this approach.[3]

Similar to the previous option, this approach would allow for aggregation of property rights, reduce the transaction costs associated with aggregation, and alleviate the holdout problem. Also, in the event of litigation, the state statute or constitutional amendment would provide guidance for the courts to resolve the issue of property rights in favor of carbon storage/sequestration development and deployment.

This option might be viewed as taking away some property rights from surface estate owners, and face resistance as a result. There may remain some uncertainty about how the courts would interpret such a law or amendment, especially in light of business transactions—namely, the above-mentioned options contracts—that begin to substantiate the existence of surface estate owners' property rights in the pore space. Last, depending on where the state declares its ownership of the subsurface to begin, there is a possibility that this option would interfere with the subsurface mineral estates that are currently in place.

[3] The Oklahoma Carbon Capture and Geologic Sequestration Act (2010) is a potential—albeit indirect—example of this approach. While the main purpose of the act is to protect mineral rights, it separates and protects surface and mineral interests (27A Okl. St. §3-5-105). This distinction perhaps implies that the state has, in essence, reserved the property rights to the pore space for public use.

Option 1d. Make proximity payments to surface estate owners

The state could offer a proximity payment to surface estate owners whose lands overlay the relevant pore space. Under this option, the state would again declare the pore space as public domain CCS developers would obtain the necessary permits from the appropriate state agency. Permits would require the developer to publish a map of the expected areas of the plume at x years after the first injection. Then, the state would require the developer to make a dollar-per-acre payment to any surface estate owner that completes an application and provides proof of title within the designated area. No states have adopted this option.

The advantages here are the same as the ones described in the previous option. An additional benefit is that this proximity payment option would reduce resistance, since it would assuage surface estate owners' perception that they have "lost" the property right to the pore space. Also, shifting the responsibility for making the claims for payment to the surface estate owners reduces the likelihood that small surface estate owners—for whom the transaction costs are greater than the value of the payment—would make claims.

While this option would improve economic efficiency, it is unclear whether—if challenged—the courts would support this definition of property rights. That is, the courts might find it perplexing to support on the one hand, a public definition of a property (i.e., the pore space), and on the other hand, a system that allows for compensation to surface estate owners above the designated property.

Carbon Dioxide Pipelines

Option 2. Develop a regulatory framework for carbon dioxide pipelines

Large-scale implementation of CCS scheme will require a system for transporting CO_2 from capture sites (e.g., power plants) to storage/sequestration sites. Captured CO_2 can be stored or used for enhanced oil recovery (EOR). Large-scale implementation of CCS would likely involve a series of pipelines. Under some circumstances, transporting CO_2 by ship or tanker may be more attractive than pipelines.[4] For instance, if the CO_2 has to be moved overseas or offshore, or over large distances, transportation by ship may be preferable Road/rail tankers also are technically feasible, but, compared to ships and pipelines, they are less cost effective and impractical in the event of large-scale CCS deployment. It is important to note that transportation by road/rail tankers could complement a pipeline network; they could transport CO_2 to sites that are inaccessible by pipelines or have not yet been in operation sufficiently long to justify a pipeline infrastructure investment (IPCC, 2005). The commercial use of CO_2 in the production of oil—EOR—began in 1972. Currently, there are four pipeline networks—measuring approximately 3,600 miles—in the United States for EOR (Marston & Moore, 2008).[5] No significant CO_2 pipeline infrastructure exists currently in the Midwest.

There remains much uncertainty about the location and suitability of geological formations to store CO_2. The implementation of the centralized vs. decentralized pipeline networks depends on the distance to, and the geological compatibility of, potential sites. The cost of transporting CO_2 could vary significantly depending on the selection of storage sites and other factors. A recent study concludes that 77 percent of the total CO_2 captured from major North American sources (e.g., power plants, natural gas processing plants, refineries, cement kilns, and other industrial plants) may be stored directly onsite, and that increasing the search radius to 100

[4] Because the transportation of CO_2 by ship crosses national boundaries, it is governed by various international legal conventions, such as the UN Law of the Sea Convention, the London Convention, and the Convention on Environmental Impact Assessment in a Transboundary Context.

[5] As a point of reference, about 500,000 miles of natural gas and hazardous liquid transmission pipelines currently operate across the United States.

miles around a plant could yield an additional 25 percent cost increase over onsite storage (Dooley, et al., 2004). Some analysts have suggested, at least initially, that it is preferable to store captured CO_2 in more centralized sites to reduce potential risks associated with leaks and for scale economies in large, integrated pipeline networks (Stephens & Van Der Zwaan, 2005; Deutch et al., 2007). A Massachusetts Institute of Technology (MIT) study found that because the majority of coal-fired power plants are located in regions where captured CO_2 are expected to be stored/sequestered in nearby sites, the estimated cost of transport and injection would be less than 20 percent of the total CCS cost (Deutch et al., 2007). However, the same study noted that the costs of CO_2 pipelines could be highly variable due to physical and political considerations.

The lack of a workable regulatory framework is a hurdle to CCS deployment using pipelines. The commission has identified policy options Indiana has for establishing a regulatory framework for CO_2 pipelines, as well as their advantages and limitations.

Currently, developers deal with federal regulation and a patchwork of state laws and regulations (see Table 1). No federal siting or eminent domain provisions exist for CO_2 pipelines.[6] For pipelines crossing federal lands, the U.S. Bureau of Land Management (BLM) has imposed the equivalent of common carrier obligations on the operators under the Mineral Leasing Act.[7]

The safety of CO_2 pipelines is clearly regulated. The Office of Pipeline Safety (OPS) within U.S. Department of Transportation Pipeline and Hazardous Materials Safety Administration (PHMSA) has jurisdiction to regulate various facets of safety—including design, construction, operation, maintenance, and spill response planning—of interstate CO_2 pipelines. These regulations have largely precluded states from establishing their own standards for interstate pipelines. Because of the federal preemption, states are limited to regulating the safety of intrastate pipelines.

States have adopted varied regulations regarding CO_2 pipelines. In general, these regulations address: (1) siting; (2) standards for design, installation, construction, and maintenance; (3) rate setting; (4) nondiscriminatory access requirements;[8] and (5) safety and liability.

CO_2 pipelines have been addressed in several pieces of Indiana legislation. Most recently, in May 2011, Governor Daniels signed P.L. 150-2011. This legislation includes a provision for state-issued certificates of authority for CO_2 pipelines and a provision that will grant private companies the right to exercise the power of eminent domain for the rights of way or easements to construct CO_2 pipelines in Indiana.[9] Previous legislation required,

[6] The U.S. Federal Energy Regulatory Commission (FERC) has jurisdiction to regulate the transportation and sale of natural gas in interstate commerce under the Natural Gas Act (NGA), it has specifically disclaimed jurisdiction over CO_2 pipelines. The U.S. Surface Transportation Board (STB)—an independent agency in the U.S. Department of Transportation (DOT) established in 1995—regulates certain common carrier interstate transportation. STB's predecessor, the U.S. Interstate While the U.S. Federal Energy Regulatory Commission (FERC) has jurisdiction to regulate the transportation Commerce Commission (ICC), determined that it lacked jurisdiction over CO_2 pipelines since CO_2 is a gas (and is, therefore, exempt under its authorizing statute) in 1981. Although the U.S. General Accounting Office (GAO) subsequently ruled that CO_2 pipelines are within the oversight authority of the STB, it has remained silent on the issue. To date, it has not heard a case specifically requesting it to rule on the issue of CO_2 pipeline jurisdiction. However, even if the STB were to claim jurisdiction, its reach would not extend to issues of siting, certification, or to eminent domain authority.

[7] In contrast, if a right-of-way (ROW) is granted under the Federal Land Policy and Management Act (FLPMA), the operator would not be subject to common carrier regulations. In Exxon Corp. v. Lujan, Exxon challenged the issuance of a ROW under the MLA; it argued that CO2 is a not a "natural gas" within the meaning of the MLA, and, therefore, the ROW should have been issued under the FLPMA. 970 F.2d 757 (10th Cir. 1992). The court applied the Chevron doctrine and deferred to BLM's reasonable interpretation of the MLA to cover ROW for CO2 pipelines.

[8] A "nondiscriminatory access requirement" mandates a pipeline operator to provide transportation service to any qualified entity that requests such a service.

[9] In March 2011, Kentucky passed SB50, which would: 1) allow CO_2 pipelines to be eligible for Incentives for Energy Independence Act; 2) grant companies constructing CO_2 pipelines eminent domain powers; and, 3) require said companies to obtain construction certificate from the Kentucky State Board on Electric Generation and Siting.

the Indiana Pipelines Safety Division (PSD) to provide voluntary, nonbinding guidelines for pipeline companies locating interstate pipelines "to simplify negotiations involved in establishing a price for any easement or other interest in land" (IC 8-1-22.6-8). State eminent domain legislation deems the "use of a parcel of real property to create or operate…a pipeline company" as "public use" (IC 32-24-4.5).

The state also has a role in regulating the safety of pipelines. The Indiana PSD is responsible for regulating the transportation and related pipeline facilities and their operations "to promote public safety" (IC 8-1-22.5). Also, the Indiana PSD is charged with: (1) administering and requiring compliance with federal safety standards; (2) establishing minimum state safety standards; (3) issuing a hazardous condition order if a particular pipeline facility is found to be hazardous; (4) reviewing all incidents reported involving certain accidents; and (5) keeping informed on the research and development of pipeline safety (IC 8-1-22.5). State common law or statutory tort liability are also applicable.

Given the above-discussed ambiguities of the current regulatory framework, any CCS regulatory process that takes place in Indiana should include a legislative strategy for managing the liability of CO_2 transportation. Because of the regulatory uncertainty at the federal level, taking a "wait and see" approach in the short-term could prevent adopting a framework that may later be inconsistent with federal policy. However, that benefit must be balanced with the reality that a lack of regulatory certainty may keep potential pipeline operators from investing in Indiana.

The following section assesses five state-level policy options (Table 2). Option 2a addresses intrastate pipelines; 2b through 2e assume future large-scale, integrated, interstate CO_2 pipeline infrastructure. For these options, state policy would involve extensive regulatory coordination with federal agencies as well as other states.

Table 1. Current carbon dioxide pipeline regulatory framework

	Siting (eminent domain)	Standards (design, installation, construction, replacement, maintenance, etc.)	Rate setting	Nondiscriminatory access requirements	Safety/liability
Federal		X- for interstate pipelines			X
State	?	X			X

Note: The ? denotes uncertainty as to whether or how states actually regulate siting of the pipelines.

Table 2. Potential state-level policy options for carbon dioxide pipeline regulatory framework

	Siting (eminent domain)	Standards (design, installation, construction, replacement, maintenance, etc.)	Rate setting	Nondiscriminatory access requirements	Safety/liability
Do nothing	?	Federal and state	?	?	Federal and state
Intrastate pipelines	State	State	State	?	Federal and state
Oil	State	Federal and state	Federal	Federal	Federal and state
Natural gas	Federal	Federal and state	Federal	Federal	Federal and state
Opt-in	Federal and state	Federal and state	Federal	Federal	Federal and state
Develop a network					

Note: The ? denotes ambiguity as to whether or how the policy options would be implemented.

Option 2a. Establish an intrastate pipeline regulatory framework

If the state believes that the future of CO_2 transportation will occur in on a small scale (i.e., within Indiana state boundaries), then it could establish a regulatory framework specifically for an intrastate pipeline network. The framework would include regulations on rates, safety, and siting authority. Texas and New Mexico have these regulations. For example, a section in the Texas Natural Resources Code gives an intrastate pipeline operator the option to become a common carrier (§111.001 et seq.). In this case, the operator would be subject to certain requirements (such as charging equal rates for like services), in return for certain rights (such as the statutory right of eminent domain). The state would be responsible for administering the relevant federal regulations for the safety of intrastate pipelines. Through a certification process to adopt minimum federal standards for intrastate pipelines, the state could assume regulatory and enforcement authority of the federal hazardous Liquid Pipeline Act (HLPA). In addition, the state could enter into an agreement with the OPS to oversee the safety aspects of intrastate pipelines. The state could act as agents of the OPS and participate in the oversight of interstate pipelines as well, although the OPS would remain responsible in enforcement efforts.

The main advantage of this option is that it is geographically narrower in focus, which, in turn, would allow the state to legislate on the issues of CO_2 transportation sooner. This could provide regulatory certainty and attract pipeline investors to the state. Potential developers would find legislation on siting authority and eminent domain attractive, since such clear legislative signals would likely reduce future transaction costs and lessen difficulties with property aggregation. However, the risk of adopting an extensive intrastate pipeline regulatory framework is that it might become incompatible with future federal regulations if a widespread interstate pipeline network were established. Table 2 provides a summary of regulatory elements that would be address by federal and state government for each option.

Option 2b. Advocate for a federal interstate framework similar to oil pipelines

Indiana could lobby for a regulatory model that currently exists for oil pipelines. Under this model, the state would have authority over CO_2 pipeline siting. At the federal level, the U.S. Federal Energy Regulatory Commission (FERC) would be responsible for setting rates and providing access; the OPS would oversee safety issues. Because this option would draw from a familiar regulatory framework, it might draw more support. In addition, the state's oversight over siting authority would signal regulatory certainty to potential pipeline operators. This option requires federal acquiescence. As discussed above, FERC has explicitly disclaimed jurisdiction over CO_2 pipelines.

Option 2c. Advocate for a federal interstate framework similar to natural gas pipelines

The state could lobby for a regulatory model similar to the one for natural gas pipelines. This option would involve an even larger federal role than Option 2b. Here, FERC would be authorized to site CO_2 pipelines (as it currently does for natural gas pipelines). It also would be responsible for setting transportation rates. This option would minimize the role of the state, which may be an advantage given the level of regulatory uncertainty. Also, a centralized regulatory scheme may allow for quicker and less costly aggregation of properties for interstate pipelines. However, because this would be a primarily federal-level regulatory framework, operators interested in intrastate pipelines may be hesitant to invest.

Option 2d. Advocate for a hybrid regulatory framework that combines elements of the current frameworks for oil and natural gas pipelines.

Indiana could advocate for an opt-in approach. Under this model, the state would retain its current authority to site pipelines, but developers interested in interstate pipelines could additionally choose to submit to federal siting authority. For such a developer, a federal certificate to construct interstate pipelines would, notwithstanding state law, come with federal eminent domain authority. The federal government would remain responsible for establishing transportation rates, safety requirements, and nondiscriminatory access requirements. For purely intrastate pipelines, state laws would be applicable.

One of the advantages of this option is that it would allow for some state-level policies in this issue. In addition, because it would permit intrastate pipeline developers to be subject only to state laws, it may encourage the establishment of smaller-scale pipeline networks. However, given that state and federal governments would have authority over CO_2 pipelines, this option may cause greater confusion among developers.

Option 2e. State government facilitation of development of pipeline network

Indiana could establish its own pipeline network to transport CO_2 for storage within the state or to other states in the region (e.g., Illinois, Kentucky). Instead of private companies, the state itself would facilitate, invest, and build the pipelines. The network could also be used to transport CO_2 for EOR to other parts of the country. Because this option would involve interstate pipelines, the regulatory framework would have to be drawn from Options 2c, 2d, or 2e. One of the advantages of this option is that it can more quickly realize the economies of scale, particularly in the supply of CO_2 for EOR. Also, if the state is the only investor, the process of developing and building a pipeline network could be expedited.

Long-term Liability of Carbon Storage

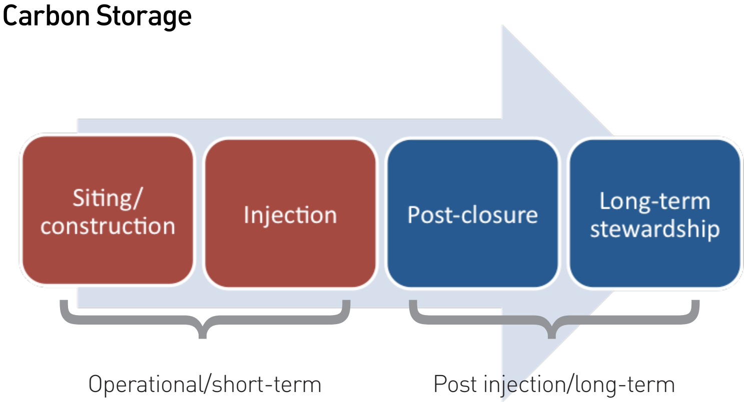
Option 3. Address the long-term liability of carbon storage

Before carbon storage can occur on a large scale, issues of operational (short-term) and post-injection (long-term) liability must be addressed. In general, the operational period refers to the construction and operational management of systems for the injection and storage of CO_2. Operational liability refers to the various risks (e.g., environmental, health, safety) related to CO_2 capture, transport, and subsurface geological storage in the short-term (see Figure 1). It would be appropriate for operators to bear the risks of CCS in the short-term as they expose stakeholders to the risks associated with the operation. The risks associated with the operation of carbon capture and storage (CCS) can be managed using policies similar to those for analogous existing activities, such as enhanced oil recovery. These policies generally include requirements for: 1) site permits; 2) monitoring, mitigation, and verification (MMV) plans; and 3) human health and environmental protection. This liability is distinct from the long-term, post-injection liability (potentially 30 years or more from the time of injection) of CO_2.

Post-injection refers to the indefinite time period after closure of the site, including the period immediately post-closure and the period of long-term stewardship. In general, there are two types of post-injection liability: 1) in situ liability; and 2) climate liability. In situ liability refers to various risks (e.g., environmental, health, safety) related subsurface geological storage in the short-term. However, the long-term nature of storage/sequestration creates potential for liability long after the initial injection, possibly after a private operator has gone out of business. This type of liability may be appropriately borne by the public and could be managed, at least in part, through state policy. Pore space plumes, and CO_2 releases, have the potential to cross state lines. If states are chosen as the regulatory platform for CCS long-term liability, some treatment of the interstate, or cross-boundary, liabilities could be necessary. Climate liability involves the control of greenhouse gas emissions, associated with leakage of CO_2, and the effects on the climate. This liability is perhaps more appropriately addressed at the federal level.

Any CCS regulatory process that takes place in Indiana should include a legislative strategy for managing the liability of CO_2 storage. In the short-term, policymakers may consider a "wait and see" approach in anticipation of specific regulations on CCS post-injection liability to take place on the federal level. The principal benefit of this approach is that it would allow state policymakers to avoid legislating on this complex topic in light of all the remaining uncertainties. If federal regulation is expected in the short-term, this option also would avoid confusion by not having two sets of laws. However, the lack of regulatory certainty may keep potential CCS operators from investing in Indiana. It also may prevent research and development or large demonstration projects from moving forward. The following section provides four state-level policy options to manage long-term in situ liability

Figure 1. Phases of Carbon Storage



Option 3a. Advocate for expansion of federal Underground Injection Control (UIC) Program

Indiana could lobby the U.S Environmental Protection Agency (EPA) to expand the Underground Injection Control (UIC) Program to explicitly include liability elements for carbon storage. The UIC Program, created under the federal Safe Drinking Water Act of 1974, currently governs most types of underground injection. While the UIC Program regulates the contamination of drinking water, it was not developed with carbon storage/sequestration in mind. It has been used to permit carbon sequestration demonstration projects, however. To address carbon storage, the program would have to expand its limited treatment to cover all the risks of carbon storage/sequestration, including harms to human health, the environment, and property. In addition, the program would need to require financial assurances in the event of operation termination. Once amended, the state would continue to have primary responsibility for implementing the requirements in its borders, consistent with EPA regulations and approval. Similar to Option 1, this approach would relieve the state of the difficult task of formulating a liability framework for carbon storage. Of course, there is no certainty that the federal government will agree to the changes to this program.

Option 3b. Use current state tort and contract laws

The state could specify, through legislation, that issues of liability related to carbon storage be addressed through existing state laws of torts and contracts. This approach would explicitly place the burden of assigning and resolving risks of operation on the private parties. Potential tort causes of action include trespass, nuisance, negligence, and strict liability. If property rights to the pore space where the CO_2 is to be stored are clearly defined, private litigation could adequately address liability issues involving issues of damages such as groundwater contamination and subsurface mineral resource contamination by CO_2. However, this approach may not appropriately address other issues, such as damages resulting from induced seismicity. Furthermore, this option likely would not be able to handle long-term issues related to damages stemming from leakage of stored carbon. For example, it would not be able to properly compensate victims of operation-related torts in the long term, especially if operators have gone out of business. Also, given that the tort system often has statutes of limitation, injured parties may not be able to bring lawsuits under some circumstances.

Option 3c. Establish a specific state regulatory framework for liability

Indiana could establish a specific carbon storage regulatory framework for liability. It would include provisions explicitly defining the roles and financial responsibility of industry and government. Many scholars advocate an arrangement in which industry is responsible for the risks in the short term, and government (the public), in the long term. The states that have adopted some form of liability regulation generally follow this pattern (e.g., North Dakota, West Virginia). In general, the long-term components of this scheme are drawn from three structural approaches.

The first approach is government-backed indemnity. An example of this is the U.S. Price-Anderson Act (42 U.S.C. §2010 et seq.), a federal policy that provides no-fault—or, strict—indemnity for the nuclear industry against liability caused by accidental releases. In addition, it mandates a system of layered risk pool. The utilities pay a premium each year for $400 million in private insurance for offsite liability coverage for each reactor unit. This is the primary insurance. The second layer requires that each reactor contribute up to $95.8 million to a fund (capped at $15 million per reactor) if an accident occurs. Last, the federal government is financially liable for all liability claims resulting from nuclear incidents involving damages in excess of the insurance pool.

The second approach is hybrid compensation. An example of this is the U.S. Superfund (42 U.S.C. §9601 et seq.). The EPA administers a fund—created through taxes levied on oil and chemical corporations—to address the investigation and cleanup of abandoned hazardous waste sites. The liable parties can then use hybrid instruments, such as risk transfer and self-insurance, to cap and manage their financial responsibilities.

The third approach could include elements of the two approaches above. It could include a component of phased liability, subjecting operators to regulations on siting, injection, and short-term (5 to 10 years) post-closure monitoring. In addition, the state could mandate some form of financial assurance from, or insurance requirements for, CCS operators. Once operators have satisfied their post-injection/post-closure requirements, the risks and responsibility of the sites would be transferred to the state. During this period, if damages arise, the state would compensate the victims; the funds may be drawn from a pool of industry financial set-asides collected during the injection period.

The third approach has the potential to be the most comprehensive and it explicitly addresses the responsibilities of long-term stewardship (including monitoring and victim compensation). This hybrid approach, in which long-term liability is transferred from industry to government, would remove some of the legal and business uncertainties and risks associated with carbon storage. However, treating short-term and long-term liability separately may be problematic. While the different phases of liability are distinct in theory, they likely overlap in reality, making it difficult to determine when long-term stewardship should begin. Further, because of the transfer of liability, the public may perceive this option negatively as a government subsidy for the industry.

Option 4. Facilitate research to establish additional carbon capture technologies

Several research institutes within the state's university system could be tasked with investigating aspects of CO_2 capture technologies. Specifically, questions on the efficiency and practicality of the capture process and the associated costs are paramount to effective deployment by the CO_2 emitters. While there are many research and development programs engaged in various aspects of evaluating materials and systems for capture, Indiana's unique strengths in science, engineering, and applied technology could be brought to bear on this challenge. The value to the state would include technical support to local industries as they work to employ the practice within the state as well as providing decision-makers information on the economic and policy aspects about the CCS practice. Such research could also potentially support the development of new facilities and the creation of additional jobs.

Option 5. Facilitate investigation and evaluation of Indiana's deep subsurface geology for CO_2 storage

Evaluating the state's subsurface carbon storage potential with the goal of identifying and characterizing the resource could remove a significant impediment to the deployment of CCS in Indiana. The resource is composed of reservoirs and seals of two general types: saline aquifers and oil and gas reservoirs. Additional potential may lie with unminable coals and gas shales. The results of such an evaluation would answer questions about volume of available pore space, permeability of rock units, and comparability of CO_2 with reservoirs and seal rocks. Additionally, the evaluation would create estimates of operational parameters that would guide operators such as injection pressures, size of the plumes, and geometry of the pressure perturbations. In the special case of reservoirs that contain oil or gas, the potential for enhanced oil or gas recovery (EOR and EGR) aided by the injection of CO_2 would be evaluated in addition to the aforementioned issues. Such evaluations could be carried out by the state's research universities, in cooperation with the state's regulatory agencies, to create a solid technical basis for permitting and operational oversight.

Option 6. Evaluate the enhanced oil recovery opportunities located within and outside of the state

A possible CO_2 reuse or value-added aspect of CCS is the potential to use the captured CO_2 for enhanced oil recovery (EOR). The state has a mature oil and gas producing industry that has been in place for more than one hundred years. Although the industry has performed waterflood or secondary recovery on these fields, two-thirds of the original oil in place (OOIP) remains in the ground. Experience in other parts of the nation have demonstrated that an additional 10 percent of the OOIP can be produced by enhanced recovery techniques using CO_2 as a medium for raising the depleted pressure of and lowering the viscosity of the oil in these mature oil reservoirs. EOR results not only in the production of additional hydrocarbons that would otherwise remain untapped, but also sequesters CO_2. Approximately half of the CO_2 injected for EOR purposes remains permanently in the reservoir while the other half is produced with the oil and recycled back in to the reservoir. In addition to enhanced oil recovery, there is also the possibility of using CO_2 to enhance the recovery of natural gas (EGR) from shale gas reservoirs located in the state. To assess the potential of producing such incremental oil and gas from reservoirs located in Indiana, the oil and gas fields could be assessed for their potential to produce additional oil. Such an assessment could be carried out by the Indiana Geological Survey in conjunction with oil and gas producing industry the utilities and the relevant regulatory entities.

Option 7. Provide economic development incentives to private sector CCS implementers

Significant financial uncertainties are likely to exist even if Indiana is able to address many of the regulatory and technical uncertainties of CCS (e.g., liability, property rights). Indiana can address these uncertainties potentially with tax and other economic development incentives, including income tax credits or deductions, price guarantees, and grant funding. Indiana could use traditional or specialized income tax credits to reduce the cost of the capital investment needed to operationalize carbon capture and/or to transport the captured CO_2 to EOR or storage sites. In addition, the state also could offer price guarantees for the products produced from facilities with carbon capture technology. For example, in 2010, the Indiana Finance Authority entered into a 30-year contract with Indiana Gasification, Inc., to purchase the syngas produced at the coal gasification plant in Rockport. When sold on the market, "if contract prices are lower than market prices, the savings will be split between the company and ratepayers. If contract prices are higher than market prices, ratepayers would be protected by $150 million set aside by the company to cover higher prices." (Associated Press, 2010) The state owes nothing if the plant is not completed. The state also could provide grant funding to offset the costs associated with pilot or demonstration projects.

Option 8. Create a state utility to develop CO_2 pipelines and/or storage facilities

State government has the option to participate directly in the development of CCS by creating a state utility. The recommendations from the Indiana CCS Summit in 2008, suggests that the utility could have a role in siting and/or operating CO_2 pipelines and/or CO_2 storage. By doing so, state government may be able to overcome impediments that keep the private sector from investing in these activities, including holdouts. For storage, it clearly locates the long-term liability for stored CO_2 with a government entity. Pursuing such a direct role in pipelines or storage may encounter political opposition as the costs and risks are substantial and prevailing political preferences are for providing incentives to rather than supplanting the role of the private sector.

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APPENDIX A. COMMISSION BIOGRAPHIES

Dr. Sanya Carley is an Assistant Professor in the School of Public and Environmental Affairs at Indiana University. Her research focuses on energy policy and electricity technology innovation policy; and she teaches classes on energy economics and policy, and energy analysis and markets. Her recent research fits within three categories: the effectiveness of state energy policy incentives and regulatory efforts to alter electricity generation portfolios; the emerging field of energy-based economic development; and public perceptions of emerging energy technologies.

Dr. Carley also has over seven years of evaluation and statistical consulting experience with the World Bank, RTI International, ARCeconomics, the Nicholas Institute, and the Wisconsin Public Utility Institute. She earned her Ph.D. in Public Policy in 2010 from the University of North Carolina at Chapel Hill. She holds master's degrees in Energy Policy and Urban and Regional Planning, with a focus on economic development, from the University of Wisconsin-Madison, and bachelor's degrees in Economics and Sustainable Development from Swarthmore College.

Martin Coveney is Vice President of Energy Systems Network (ESN), a nonprofit industry-driven economic organization focused on the development of energy technology in the "clean tech" sector, where he is responsible for project and program management. Prior to joining ESN, Martin served in various executive finance roles for Exelon Corporation, the largest electric generator and operator of the largest nuclear fleet in the United States. Before his work at Exelon, Martin worked in various finance and regulatory roles for Ameritech, now AT&T.

Martin holds a BBA from the University of Notre Dame, an MBA from the Indiana University Kelly School of Business, and is a Chartered Financial Analyst.

Dr. Greg Lindsey is Associate Dean of the Hubert H. Humphrey Institute of Public Affairs at the University of Minnesota. He specializes in environmental planning and management and has worked in the areas of water resources management, land use, transportation, and recreation, including a series of studies of the use urban greenways.

Dr. Lindsey earned his doctorate and a master's degree from the Department of Geography and Environmental Engineering at the Johns Hopkins University. He also received a master's degree in geography and environmental studies from Northeastern Illinois University. His bachelor's degree is in urban planning from the University of Illinois.

Dr. Lindsey has published articles in the Journal of the American Planning Association, Journal of Environmental Planning and Management, Journal of Physical Activity and Health, Professional Geographer, Journal of Recreation and Park Administration, Landscape and Urban Planning, Journal of Urban Design, and the Journal of Water Resources Planning and Management.

Mark T. Maassel is a member of the IU PPI Advisory Board and served as a co-chair of the Energy and Environment Commission. He currently is the President and CEO of the North West Indiana Forum, a regional business organization focused on creating high paying jobs while also enhancing the environment.

Maassel recently left the law Firm of Krieg DeVault. Krieg DeVault is a law firm with approximately 130 attorneys whose practices cover a wide range of legal issues. At Krieg DeVault, he was a member of the Alternative Energy, Business and Government Affairs practice groups.

Prior to joining Krieg DeVault, Maassel served as the President of Northern Indiana Public Service Company (NIPSCO) and several smaller companies owned by NiSource, a Fortune 500 energy company. On a combined basis, these companies had annual revenues of over $2 billion. In these roles he was responsible for maintaining strong relationships in NIPSCO's marketplace, particularly in the regulatory, legislative, and public affairs areas.

Prior to these roles, he held positions as Vice President, Regulatory and Governmental Policy; Vice President, Marketing and Sales; Vice President of Electric Service and Sales for NIPSCO; Director of the Central Region for NIPSCO; and Manager of Environmental Programs at NIPSCO as well as numerous engineering positions during his 30 year career. In these roles, he has been involved in virtually all aspects of NIPSCO's business.

Industry affiliations included the following.

- Edison Electric Institute Board of Directors
- Indiana Energy Association Board of Directors
- Gas Technology Institute Board of Directors
- American Gas Association – Numerous committees, including chair
- Operations Technology Development Corp. Board, including chair
- North American Energy Standards Board, including chair
- National Petroleum Council's Coordinating Subcommittee for Natural Gas

Community Organizations included the following.

- State Workforce Innovations Council (Gubernatorial appointment)
- Indiana Humanities Council (Gubernatorial appointment)
- IVY Tech Community College Foundation Board, including chair
- United Way Regional Leadership Giving Circle Chair
- 2008 Porter County United Way Campaign Co - Chair
- Porter County Community Foundation Board and Resource Development Chair
- Crisis Center Board of Directors and Vice President
- Purdue Technology Center Board
- Valparaiso Community Schools Board of Education
- Calumet College of St. Joseph Board of Trustees
- Northwest Indiana Forum Board, including chair
- Trinity Lutheran Church, Valparaiso
- Numerous fundraisers for American Heart Association, Juvenile Diabetes Research Foundation, American Cancer Society

Other Boards include.

- Porter Hospital Board
- Neosphere

Maassel has received various honors and awards including a Sagamore of the Wabash, the Valparaiso Distinguished Community Leader Award and was inducted into the Northwest Indiana Business and Industry Hall of Fame.

Maassel earned a bachelor's degree in civil engineering with high distinction from the University of Minnesota and a juris doctorate degree with high honors from the Chicago Kent College of Law at the Illinois Institute of Technology. He is a registered professional engineer and a member of the American Bar Association and the Indiana State Bar Association, Utility Law Section.

Dr. Maureen McCann obtained an undergraduate degree in Natural Sciences from the University of Cambridge, UK, in 1987, and then a Ph.D. in Botany at the John Innes Centre, Norwich UK, a government-funded research institute for plant and microbial sciences. She stayed at the John Innes Centre for a post-doctoral, partly funded by Unilever, and then as a project leader with my own group from 1995, funded by The Royal Society. In January 2003, Dr. McCann moved to Purdue University as an Associate Professor, and is currently a Professor and Assistant head in the Department of Biological Sciences. Since August 2010, she has been the Director of Purdue's Energy Center, a broad community of scientists and engineers engaged in energy sciences.

The goal of Dr. McCann's research is to understand how the molecular machinery of the plant cell wall contributes to cell growth and specialization, and thus to the final stature and form of plants. The cell wall is a highly organized composite of many different polysaccharides, proteins, and aromatic substances. However, it has been difficult to ascribe specific functions to these molecules. She and her fellow scientists aim to define the relationship between genetically-defined changes in plant cell wall-related proteins (biosynthetic, hydrolytic, and structural) and cell wall molecular architecture and structural properties. Plant cell walls are the source of lignocellulosic biomass, an untapped and sustainable resource for biofuels production with the potential to reduce oil dependence, improve national security, and boost rural economies. Dr. McCann also leads an interdisciplinary team of biologists, chemists and chemical engineers in a DOE-funded Energy Frontier Research Center focused on developing technologies for the direct catalytic conversion of biomass to biofuels.

Paul J. Mitchell is President and CEO of Energy Systems Network (ESN), a consortium of companies and institutions focused on the development of Indiana's energy technology "cleantech" sector. ESN provides project development and coordination for joint ventures and cooperative partnerships between network members who are seeking to commercialize new energy technologies in a diversity of cleantech markets including advanced technology vehicles, distributed power generation, advanced biofuels, renewable energy, and energy efficiency.

ESN member companies/institutions include, among others. Duke Energy, IBM, Cummins, Delphi, Allison Transmission, Navistar, Nissan, Smart, THINK, Remy, ITOCHU, SAIC, Rolls Royce, BAE, Indianapolis Power & Light, Simon Property Group, I-Power, Brevini, EnerDel, GridPoint, Bright Automotive, Midwest ISO, PJM, Rocky Mountain Institute, Purdue University, University of Notre Dame, Ivy Tech Community College, and Naval Surface Warfare Center Crane.

Prior to joining ESN, Mr. Mitchell served in the Office of Governor Daniels where he was Policy Director for Economic Development, Workforce, & Energy. In this capacity he oversaw legislation, policy, and program development for the Indiana Economic Development Corporation, Indiana Department of Workforce Development, and Indiana Department of Labor, and acted as Governor's liaison to the Indiana Utility Regulatory Commission and Office of Utility Consumer Counselor. During his tenure with the Governor's Office, Mr. Mitchell also led the formation of and directed the Indiana Office of Federal Grants and Procurement.

A native of West Lafayette, Indiana he holds a Master of Public Affairs from the Indiana University School of Public and Environmental Affairs in Bloomington, where he graduated as valedictorian.

Bowden Quinn is conservation program coordinator for the Sierra Club Hoosier Chapter. He works on two of the Club's national energy campaigns. Rebuilding America through Better Energy Codes and the Beyond Coal Campaign. He also works on water quality issues and is a former member of the Indiana Water Pollution Control Board. He has a law degree from the Chicago-Kent College of Law with a certificate in energy and environmental law. He worked for the Grand Calumet Task Force, a grassroots environmental organization in Northwest Indiana, from 1994 to 2002 and has lived in Indianapolis for the past eight years.

Darlene Radcliffe is currently the Director of Environmental Technology and Fuel Policy at Duke Energy. In that capacity, she works on a broad range of environmental policy issues including climate change and specifically looks for ways to develop and deploy new technologies that will benefit the environment, meet compliance requirements and produce the most reliable, lowest cost energy possible. One of her major areas of concentration is the development and construction of a 618 MW class integrated gasification combined cycle plant for electricity production in Edwardsport, Indiana. Another major focus is the development of carbon capture and sequestration technology and related policy. She was the project manager for Duke Energy's Phase II carbon sequestration project at the East Bend Generating Station in Kentucky as part of one of the DOE's Regional Carbon Sequestration Partnerships. She serves on the Midwestern Governor's Association Carbon Capture and Sequestration Task Force as well as a variety of national industry organizations.

She has a B.A. in Psychology and Anthropology and a Master of Environmental Science from Miami University.

Dr. J.C. Randolph is Professor of Environmental Science in the School of Public and Environmental Affairs (SPEA) at Indiana University, Bloomington. Since 2008 he has been Director of the Center for Research in Energy and the Environment. Dr. Randolph has held several administrative positions at Indiana University including Director of Environmental Science Programs and Chair of the SPEA Faculty in Environmental Science and Policy (1977-1986), SPEA Associate Dean for Research and External Programs (1986-1989), Director of the Midwestern Regional Center of the National Institute for Global Environmental Change (1990-2006), Director of the Ph.D. in Environmental Science program (2000-2007),and Director of the M.S. in Environmental Science program (2004-2008). He has been at Indiana University since 1973 when he came from the Environmental Sciences Division of the Oak Ridge National Laboratory. He received a B.S. degree in biology and a M.S. degree in ecology from the University of Texas at Austin, and a Ph.D. degree in ecology from Carlton University, Ottawa, Canada.

His research interests are in ecosystem ecology and natural resources management with an emphasis on forests and agriculture. Much of his current research concerns the ecological aspects of energy production, distribution, and use, including climate change effects on Midwestern agriculture and forests. He also studies carbon dynamics of temperate deciduous forests at the AmeriFlux site in south-central Indiana and has worked in tropical forests in eastern Brazil, Venezuela, Costa Rica, Guatemala, and Honduras. He has been actively involved in the applications of geographic information systems and of remote sensing in natural resources and environmental management.

Dr. Randolph has 35 years of experience in large, multi-investigator, and often multi-institutional projects such as. (1) Center for the Study of Institutions, Population, and Environmental Change. Dr. Elinor Ostrom and Dr. Emilio Moran, Co-directors. National Science Foundation, 1996–2006; (2) Analysis of Carbon Dynamics at the Morgan-Monroe State Forest (MMSF) AmeriFlux Site, U.S. Department of Energy, 1996–2006; (3) Integrated Assessment of Economic Adaptation Strategies for Climate Change, Impacts on Midwestern Agriculture, U.S. Environmental Protection Agency, Co-principal investigator with Dr. Otto Doering, Purdue University, 1996–2002; (5) State Electric Utility Forecasting Project, Indiana Utility Regulatory Commission, Dr. Otto Doering, Purdue University, Project director, 1985–1992; (6) Ohio River Basin Energy Study, Principal investigator for terrestrial ecology and land-use sections, Dr. James Stukel, University of Illinois, Champaign-Urbana, Project director, U.S. Environmental Protection Agency, 1975–1980.

He has been heavily involved with several government agencies and professional organizations including: 1) several review panels for the National Science Foundation, U.S. Environmental Protection Agency, and U.S. Department of Energy, 2) serving as chair of the Transportation, Energy and Environment Committee of the Indiana Corporation for Science and Technology, the Indiana Energy Development Board, and the Midwest Universities Energy Consortium, and 3) serving as chair of Applied Ecology Section, International Affairs Section, Public Affairs Committee, Corporate Awards Committee, and as a member of the ESA Council of the Ecological Society of America.

Dr. Ken Richards is Associate Professor at the School of Public and Environmental Affairs and Affiliated Associate Professor at the Maurer School of Law, Bloomington, where he teaches courses on public law and administration, environmental and cost-benefit economics, energy and climate change law and policy, and applied math at the School of Public and Environmental Affairs and the Maurer School of Law. His research focuses on two areas: environmental policy design and implementation and climate change policy. He is currently on leave at the University of Oxford where he serves as the James Martin Senior Visiting Fellow for the Oxford Martin School.

Dr Richards holds a Ph.D. in Public Policy from the Wharton School and a JD from the Law School, University of Pennsylvania. He holds an MSCE in Urban and Regional Planning and a BSCE in Environmental Engineering from Northwestern University, and a B.A. in Botany and Chemistry from Duke University. He serves as Associate Director for the Richard G. Lugar Center for Renewal Energy, and Associate Director for the Center for Research on Energy and the Environment. He has served as an economist at the Council of Economic Advisers, the U.S. Department of Agriculture's Economic Research Service, and the U.S. Department of Energy's Pacific Northwest National Laboratory. He also served as national energy planner for the Cook Islands from 1984 to 1986.

Mike Roeder is in his 10th year with Vectren Corporation, an energy holding company headquartered in Evansville, Indiana. Mike serves as the company's principal spokesperson and government affairs representative. Mike also is the chairman of the Vectren Employee PAC and is actively involved in many public affairs issues in Indiana, Ohio and Washington, D.C.

Prior to his current role, he served as director of government affairs leading legislative efforts and as the director of corporate communications for Vectren where he led public affairs, internal/external communications, advertising, and media activities. The University of Southern Indiana and Ball State University graduate previously worked with local elected officials as communications director for the Indiana Association of Cities and Towns where he wrote and designed member communications, and lobbied for the trade association. He also previously served state elected officials as a public information officer for the Indiana House of Representatives.

Mike has chaired the Ohio Gas Association Legislative Committee and is active with the Indiana Energy Association lobbyist group. He currently serves on the American Gas Association and Edison Electric Institute's government affairs committees. He is a board member of AGA's GASPAC committee, and previously chaired the AGA public relations committee. He also serves on the boards of the Indiana Sports Corporation Presidents' Council, the Government Affairs committee of the Chamber of Commerce of Southwestern Indiana, the Evansville Convention and Visitors' Bureau, and the Newburgh Sea Creatures.

Mike and his wife Lee Ann have three boys and reside in Newburgh, Indiana. Mike enjoys politics and golf.

John A. Rupp area of expertise is in energy resource geology, subsurface geology and geological sequestration. He holds M.S. degree (1980) in exploration geology from Eastern Washington University and a B S. degree (1978) in geology from the University of Cincinnati. Prior to joining the Indiana Geological Survey at Indiana University as a research scientist in 1982, he was an exploration geologist with Salisbury and Dietz in Washington State and a production geologist with Exxon Company USA working the Permian Basin and Rocky Mountain region. He is currently a senior Research Scientist in the Subsurface Geology Section at the Indiana Geological Survey, the associate Director for Science at the Center for Research on Energy and the Environment and an adjunct in the School of Public and Environmental Affairs.

His research in the last five years has focused on understanding the geological constraints of reservoirs and seals for geologic carbon sequestration, the characterization of coals for coal bed methane and underground coal gasification, and the evolution the gas in coals and shales.

He currently serves on the Committee Technology and Production Committee of the Interstate Oil and Gas Compact Commission, Advisory Board of the American Association of Petroleum Geologists, Midwestern

Governor's Association Carbon Capture and Sequestration Task Force, and Governor's Interagency Council on Energy. Additionally he serves as project director for Indiana on two of the DOE's Regional Carbon Sequestration Partnerships: the seven-state Midwest Regional Carbon Sequestration Partnership (MRCSP) and the three-state Midwestern Geological Sequestration Consortium (MGSC) for assessing the geological carbon sequestration of the state within these regions.

Dr. Paul Sokol is Professor of Physics at Indiana University, Bloomington. He received his B.S. in Physics from the State University of New York at Buffalo (1977) and his Ph.D. from The Ohio State University (1981) and carried out postdoctoral work at the University of Illinois at Urbana Champaign. He was Assistant and Associate Professor of Physics at Harvard University from 1984-1988 before joining the Physics Department at Penn State University. He joined Indiana University in 2004 as Professor of Physics.

Sokol is a condensed matter experimentalist specializing in x-ray and neutron scattering. His research interests include the microscopic dynamics of quantum systems such as helium and hydrogen with a particular emphasis on superfluidity, phase transitions and structure of classical liquids and solids confined in nanoporous materials, and energy storage materials such as carbon nanomaterials, hydrides and clathrates. He also has an interest in the development of advanced facilities and detectors for radiation effects, space applications, neutron scattering and neuroscience. Sokol is the author of over 100 scientific publications and numerous conference proceedings. These activities have been funded by the NSF, DOC, DOD, DOE and NASA.

Sokol has held several leadership positions. He was the principal investigator for the development team of the Cold Neutron Chopper Spectrometer at the Spallation Neutron Source. He was also director of the Indiana University Cyclotron Facility where he oversaw the construction and FDA approval of the Midwest Proton Radiotherapy Institute and the development of the Low Energy Neutron Source. Currently, Sokol is the director of the Low Energy Neutron Source as well as the first director of the Indiana University Energy Institute. He also serves as a Special Advisor to the Vice Provost for Research.

Jane Ade Stevens is CEO and Executive Director of the Indiana Soybean Alliance, Indiana Corn Marketing Council, and Indiana Corn Growers Association. Before moving into the CEO role, Stevens was on staff as the senior director of programming. Prior to her work with Indiana's corn and soybean programs, she had her own public relations and association management services company, Stevens & Associates Inc., with her husband, Roger. Her vast agriculture experience includes work within the beef, pork, dairy and sheep industries. She also worked for Indiana Farm Bureau, Elanco, and in Washington, D.C., at the U.S. Department of Agriculture for Assistant Secretary Jim Moseley.

In 2011 Stevens received the Purdue University Agriculture Alumni Certificate of Distinction. She currently sits on the board of directors for Qualisoy, Center for Food Integrity, Fair Oaks Pork Experience Project and the Center Agriculture, Science and Heritage. She also serves on Purdue University's College of Agriculture Dean's Advisory Council.

Stevens grew up on a grain and livestock farm in Tippecanoe County and graduated from Purdue University. She lives in Indianapolis, Indiana, with her husband, Roger.

Dr. Wallace E. Tyner served as the co-chair of the Energy and Environment Commission. Dr. Tyner is an energy economist and James and Lois Ackerman Professor of Agricultural Economics, Purdue University. He received his B.S. degree in chemistry (1966) from Texas Christian University, and his M.A. (1972) and Ph.D. (1977) degrees in economics from the University of Maryland. Professor Tyner's research interests are in the area of energy, agriculture, and natural resource policy analysis and structural and sectoral adjustment in developing economies. He has over 200 professional papers in these areas including three books and 70+ journal papers, published abstracts, and book chapters. His past work in energy economics has encompassed oil, natural gas, coal, oil shale, biomass, ethanol from agricultural sources, and solar energy. His current research focuses on renewable energy policy issues and climate change. He teaches a graduate course in benefit-cost analysis, which incorporates risk into the economic and financial analysis of investment projects. In 4 of the past 6 years, his students have received the department's outstanding thesis award. In June 2007, Senator Richard G. Lugar of Indiana named Tyner an "Energy Patriot" for his work on energy policy analysis. In 2009 he received the Purdue College of Agriculture Outstanding Graduate Educator award and was part of a group that received the College Team award for multidisciplinary research on biofuels. He is currently a member of the National Academy of Sciences Committee on Economic and Environmental Impacts of Biofuels.

Kent Yeager is the director of Indiana Farm Bureau's Public Policy Team and has been in that position since May of 1996. Kent returned to Indiana Farm Bureau in 1996 after serving for three years as state executive director of the U.S. Department of Agriculture's Farm Service Agency. Prior to his 1993 appointment to the FSA position, he was a field representative and national affairs assistant for IFB.

For more than twenty years Kent was a farmer and community volunteer. He was an active volunteer in Farm Bureau and many other organizations including service on the board of directors of the Indiana Corn Growers Association, the Indiana Soybean Growers Association, the Southern Indiana Rural Development Project and Purdue CARET (Council for Agricultural Research, Extension and Teaching).

In 1983, Kent was named Indiana's Conservation Farmer, and was chairman of the Indiana Farm Bureau Young Farmer Committee in 1984. He was named to the original Indiana Commission for Agriculture and Rural Development and was elected twice to the Harrison County Council. Kent was the first person to be named an Honorary Commissioner of Agriculture in Indiana and received Indiana's Sagamore of the Wabash in 1996.

Kent and his wife, Joy, live in the home where he was raised. The house, near Mauckport, Indiana, is more than 130 years old and the farm has been in the Yeager family since before the home was built. They are the parents of three adult children and are active members of St. Joseph Catholic Church in Corydon.

ABOUT PPI

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