A NUCLEAR GAMBLE:

Why Nuclear Power is a Bad Bet for Iowans

Iowa PIRG Education Fund

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Executive Summary

Nuclear power is among the most costly approaches to solving Iowa's energy problems. Fearing the many significant financial risks of new nuclear projects, private investors have stayed away. As a result, utilities and nuclear proponents are now asking Iowa citizens and businesses to pay more on their electricity bills to make the construction of a new nuclear reactor possible.

This would be a bad deal for Iowans. A new reactor project would force Iowans to pay a lot more now for uncertain results in the future. A new reactor would come without a guarantee of final cost, and without a guarantee that the reactor would ever deliver electricity at all.

A smarter investment lies in renewable energy options – such as energy efficiency and wind power. Per dollar of investment, these technologies deliver far more energy than nuclear power. By directing our resources towards the most cost-effective solutions, we can make greater progress toward a secure, reliable and safe supply of electricity to power Iowa's economy.

Nuclear power is expensive, with cost estimates on the rise.

- Iowa's largest utility, MidAmerican Energy, anticipates that construction costs for a new 540 megawatt nuclear reactor in Iowa would range between $1-3 billion. MidAmerican calculates that a project on this scale would increase customers' electricity bills by 10 to 30 percent – or $13.30 to $40.00 per month for a typical Iowa family.
- The design of MidAmerican's proposed nuclear reactors has not been finalized, and is still undergoing review by the U.S. Nuclear Regulatory Commission (NRC). As a result, MidAmerican's cost estimate for new nuclear reactors is speculative. Since 2005, cost estimates for building a new nuclear reactor have more than tripled.
- If delays and cost escalation drive up the price tag during construction, Iowa's ratepayers would be stuck with the bill. Nuclear power already has a long history of cost overruns. Of 75 nuclear reactors completed between 1966 and 1986, the average reactor cost more than triple its original construction budget. Later-built reactors came in as much as 1,200 percent over-budget. New reactors are not immune – the French government-owned nuclear giant Areva is currently three and a half years behind schedule and 75 percent over budget on a new reactor project in Finland.

Previous failed investments in nuclear power have made private investors wary.

- Nuclear power has historically proven to be a risky investment. Of the 253 nuclear power reactors approved and funded in the United States, only 52 percent were ever completed. Of those, 21 percent were permanently and prematurely closed due to reliability or cost concerns.
- In addition to out-of-control construction costs, many of these investments failed because the electricity demand the plants were built to serve never materialized.
- Similar conditions exist today. Because of the lingering impacts of the financial crisis, and because of increasing efforts to improve energy efficiency, electricity demand overall has been leveling off. Nationally, the Electrical Power Research Institute shows factory and business electricity demand growing at only 0.7 percent annually, which is far lower than the average of 2.5 percent a year over the past four decades. In an era of increasing efficiency, households are anticipated to show a gradual decline in energy use by 0.5 percent annually over the next ten years – reducing the need for any new nuclear reactors.

MidAmerican Energy's proposal to have Iowa's citizens and businesses carry the financial risk of building a new reactor would be a bad deal.

- MidAmerican Energy is currently working to charge customers up-front to finance reactor construction.
- This charge would come without any guarantee of final cost, and without even a guarantee that the plant would ever deliver electricity at all.
- Decision makers in Florida, who authorized utilities to charge customers up-front to finance reactor construction in 2006, expressed regret after numerous rate hike requests by utility company Progress Energy.

Energy efficiency and renewable energy offer more cost-effective and less risky options to power Iowa's economy.

- Iowa has huge potential to increase its energy efficiency. If Iowa follows through on plans to reduce electricity usage by 1.5 percent annually, by 2030, electricity consumption will fall nearly 30 percent below forecast levels, greatly reducing the need for any new nuclear reactors.
- In 2010, MidAmerican Energy's efficiency program delivered actual, real electricity savings for a cost of just 5 cents per kWh. In comparison, electricity from a new reactor would cost as much as 10 to 30 cents per kWh and it would not be available until the end of the decade.
- Similarly, Iowa has huge renewable energy resources. Iowa is already the second largest producer of wind energy nationally with 4,375 megawatts of installed wind capacity. With over 20 percent of all the electricity generated in the state from wind turbines, Iowa ranks first in the nation for percentage of total energy produced from wind power, and second in the world.
- Still, Iowa has barely scratched the surface of its wind energy resources. An estimated 75 percent of Iowa is suitable for wind energy development with an estimated total wind resource of 570,000 megawatts. The Iowa Wind Energy Association has set a goal of producing 20,000 megawatts of installed wind energy by 2030, reducing the need for any new nuclear reactors.

Iowa energy policy should prioritize clean energy solutions – technologies that deliver safe, reliable and secure electricity supplies at a reasonable cost. Iowa's leaders should:

- **Protect citizens from unnecessary risks and costs** by requiring any company proposing to build a new nuclear reactor to demonstrate that nuclear power generation would be more cost-effective than other ways to meet electricity demand, including energy efficiency.
- **Ensure that energy companies and their shareholders, not ratepayer or taxpayers, bear all the financial risks associated with building a new nuclear power plant.**
- **Provide full opportunity for public input** at every key point in the process of developing any new nuclear reactor.
- **Speed energy efficiency efforts** by raising the energy efficiency resource standard goals to reach 2 percent energy reduction below forecasted levels per year by 2020.
- **Expand renewable electricity production** to ensure that 30 percent of Iowa's electricity supply comes from renewable resources by 2025.

The High Cost of Nuclear Power

In 2003, a group of experts at the Massachusetts Institute of Technology and Harvard evaluated the future of nuclear power. They concluded that, "today, nuclear power is not an economically competitive choice."[i] Without new policies offering financial support to the nuclear industry, the MIT researchers predicted, "nuclear power faces stagnation and decline."[ii]

The Estimated Cost of Building a Nuclear Power Plant Has Skyrocketed

In the early 2000s, nuclear industry executives estimated that construction costs for building a new nuclear reactor could approach $1,500 per kilowatt (kW) of power generating capacity, plus finance costs.[iii] At that price, they maintained that nuclear power would be competitive with most competing power generation technologies, including coal and natural gas.

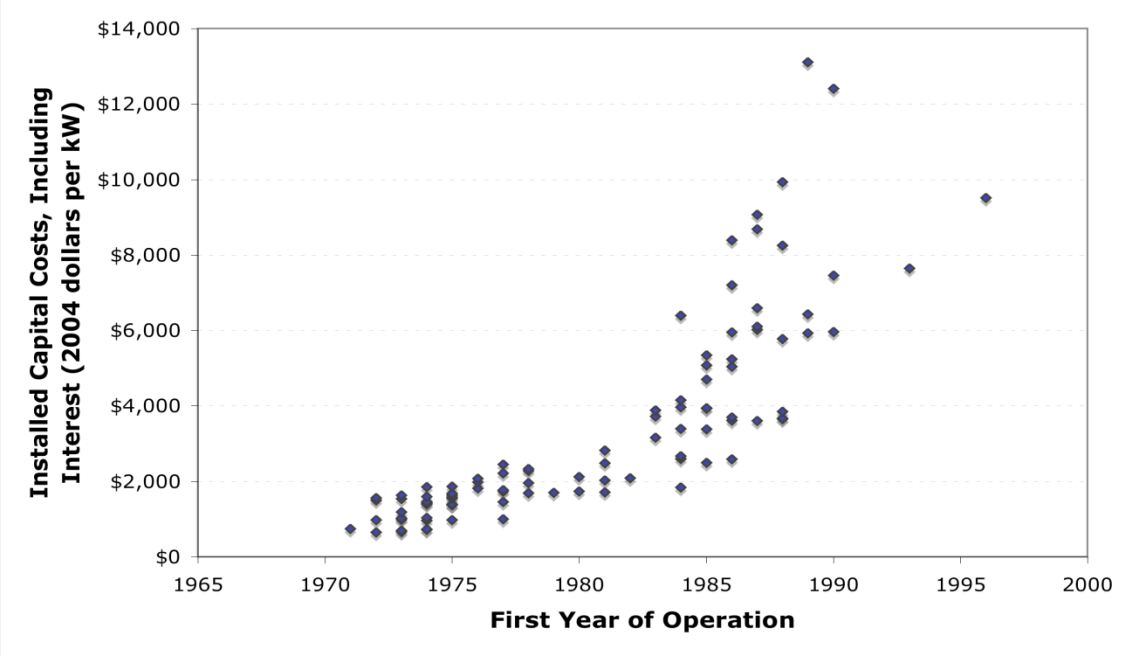
However, that estimate now appears wildly optimistic. During the last wave of nuclear power plant construction in the United States, capital costs far exceeded this benchmark. Since 2005, the anticipated cost of a new nuclear power plant has more than tripled.

Costs Escalated Rapidly During the Last Wave of Reactor Construction

Economists commonly expect that new products and technologies will become cheaper over time, as companies gain experience and develop economies of scale.

However, in the case of the last generation of nuclear power in the United States, the opposite proved to be true. The first nuclear reactors ever built were among the least expensive, while costs spiraled wildly out of control in the final decades of reactor construction. (See Figure 1.) For plants beginning operation in the late 1970s and onward, inflation-adjusted capital costs escalated from just under $2,000 per kW to more than $10,000 per kW (in 2004 dollars).

Figure 1: Actual Capital Costs of Completed U.S. Nuclear Reactors (in 2004 Dollars)[iv]



In 1973, the beginning of the Arab oil embargo, the United States entered a period of economic turbulence that increased the cost of power plant construction, while simultaneously reducing demand for power.[v] As power companies began to realize that predictions for future electricity demand were greatly overestimated, and as construction costs escalated, executives canceled more than 100 reactor projects, some in the middle of construction.[vi]

Complicating the situation, in 1979, a reactor at Three Mile Island in Pennsylvania suffered a partial meltdown, turning the tide of public opinion against nuclear power. Construction times for reactors built after 1979 extended up to 10 to 15 years and beyond, greatly increasing finance costs for reactor owners. Finally, many reactor projects suffered from quality control problems during construction.[vii]

Today, the nuclear industry promises that new, standardized designs and technological advances will enable reactor construction to proceed without the delays and cost-overruns of the past, while maintaining an adequate margin of safety.[viii] However, recent cost escalation, construction delays, and fallout from the collapse of the U.S. financial system suggest that a new generation of nuclear reactors would suffer from the same problems as the last.

The Anticipated Cost for Building a New Nuclear Reactor Has More than Tripled

In June 2007, a group of nuclear experts assembled by the Keystone Center published a re-evaluation of the cost of building a new reactor, taking into account the effects of rising prices for important commodities like steel and concrete.[ix] The group found that the probable cost of a new reactor had risen from $3,600 to $4,000 per kW (in 2007 dollars).[x]

If anything, the Keystone estimate was too low. That same month, UniStar Nuclear submitted a proposal to build a new reactor at Calvert Cliffs in Maryland, pegging the cost at about $4,300 per kW.[xi]

Moody's Investment Service, a credit rating agency advising Wall Street investors, felt that industry cost estimates were still falling short. In October 2007, Moody's estimated that a new reactor could actually cost as much as $6,000 per kW on the high end.[xii]

By early 2008, power companies were developing cost estimates that exceeded even the most pessimistic limit of Moody's projections. For example:

- In February 2008, FPL Group projected that an expanded reactor system at Turkey Point in Florida could cost about $4,200 to $6,100 per kW.[xiii]
- In March 2008, Progress Energy estimated that two nuclear reactors in Levy County, Florida would cost roughly $6,300 per kW – not including the cost of upgraded transmission lines.[xiv]

By May 2008, costs showed no sign of decreasing. *The Wall Street Journal* reported:

> "Estimates released in recent weeks by experienced nuclear operators – NRG Energy Inc., Progress Energy Inc., Exelon Corp., Southern Co. and FPL Group Inc. – "have blown by our highest estimate" of costs computed just eight months ago, said Jim Hempstead, a senior credit officer at Moody's Investors Service credit-rating agency in New York."[xv]

In June 2008, staff at the Federal Energy Regulatory commission estimated that building a new 1,000 megawatt (MW) reactor could cost up to $7.5 billion.[xvi] At that cost, analysts at Moody's calculate that reactor

owners would have to sell power in the market at 15 cents per kWh (without transmission and distribution costs) in order to achieve a 10 percent return on the investment. [xvii]

Cost Projections for New Nuclear Reactors in Iowa

Hopes that a new generation of nuclear reactors could avoid the high construction costs that plagued the industry in the past appear to be overly optimistic. In attempt to reduce the size and improve on the safety of nuclear power generation, some utilities have begun development of new nuclear reactor designs. However, even when reviewing the potential for new nuclear reactor technology, Moody's most recent review of the economic competitiveness of nuclear power in comparison to energy efficiency programs and national renewable standards led them to identify investment in nuclear power as a "bet-the-farm" risk.[xviii]

Regardless, MidAmerican Energy has already begun plans to build the first model of a new nuclear reactor design in Iowa – and has actively pursued legislation that would allow them to preemptively fund the planning, licensing, and construction of the plant through a long-term utility rate increase. The favored nuclear reactor design by NuScale is still under review by the Nuclear Regulatory Commission (NRC), and has not yet gone through the regulatory or certification process.

NuScale's proposed nuclear reactor design links 12 individual reactors that operate in similar fashion to their large counterparts, generating only 45 megawatts of electricity each, to eventually produce 540-megawatts. NuScale cites a simplification of the manufacturing and construction process that would cut construction time, and cost.[xix]

Even using a smaller design, NuScale's low estimates put overall costs at $4,000 per KW.[xx] MidAmerican Energy's own cost estimates ranged between $1,800-$5,500 per KW, which would translate to a 10-30 percent increase in consumer electricity bills – or $13.30 to $40.00 per month for a typical Iowa family.[xxi]

However, particularly with this kind of new technology, it is difficult to predict exactly what one of these nuclear power plants should cost because the expenses are largely determined by labor, materials, and litigation – variables that will all change over the course of the decade it takes to build a nuclear plant.

Nuclear Costs Have Risen Faster Than Other Generation Technologies

While anticipated costs for building power plants of all stripes are rising, nuclear costs have risen faster than other generation technologies.

According to Cambridge Energy Research Associates (CERA), a firm that tracks capital costs for building new power plants, the cost of building a new power facilities fueled by coal, gas, or wind climbed by approximately 80 percent from 2000 to 2007.[xxii] However, the anticipated cost of building a new nuclear reactor rose more than twice as fast as these competing technologies, expanding by 185 percent over the same period of time.[xxiii]

All power plants are affected to some degree by changes in prices for key commodities like steel, concrete and copper, and by factors such as currency exchange rates. However, commodity prices make up only about 5 percent of the total cost of a nuclear reactor.[xxiv]

Much more significantly, the nuclear industry faces an acute shortage of workers qualified to build nuclear facilities and limited manufacturing capacity for specialized nuclear components.[xxv] No American company has ordered a new nuclear power plant since 1973. As a result, domestic manufacturing capability for nuclear

reactor parts has withered and trained personnel are scarce.[xxvi] While the United States had 900 certified nuclear component suppliers two decades ago, today there are fewer than 200.[xxvii] In addition, only two metal foundries in the world are currently capable of forging heavy nuclear reactor vessels – and they are located in Japan and France.[xxviii]

NuScale's new nuclear reactor design will face additional costs and challenges while going through the development process, and gaining the certification required by the NRC.[xxix] In fact, NuScale already terminated operations once due to financial difficulties in 2010, only to resume in late 2011. In addition, both the nuclear industry and MidAmerican Energy will have to win over decision makers and communities in the face of shifting public perception following the nuclear disaster in Fukushima, Japan.

A History of Cost Overruns and Construction Delays

"Nobody has ever overestimated the construction cost of a nuclear power plant at the pre-construction stage."

- Dr. Paul Joskow, Massachusetts Institute of Technology, May 19, 2006[xxx]

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AREVA, the French government-owned nuclear developer, provides an example of what could occur should MidAmerican Energy choose to build a new nuclear power plant in Iowa - even with new design.

Greenpeace activists on a crane at the heart of the Olkiluoto 3 nuclear reactor site in Finland to protest at alleged safety problems. Photograph: Greenpeace/Reuters

AREVA is currently building a new reactor in Finland.[xxxi] The reactor is the first of its kind in the world; incorporating advanced design features the industry had hoped would keep construction costs in check. However, the project has suffered from numerous delays and cost overruns, much like past nuclear reactor construction. The project is now over three years behind schedule.[xxxii]

AREVA started construction on the project before the design was finalized and approved by regulators. What followed included thousands of defects and a variety of costly mistakes.[xxxiii] Welds for the reactor's steel liner were flawed, and had to be redone. Water coolant pipes were revealed as unusable, and concrete poured in the foundation was suspect – with too much moisture content to meet safety requirements.[xxxiv] Analysts estimated that delays added nearly $3.5 billion to the cost of the plant – over 75 percent above original estimates.[xxxv] When *Washington Monthly* editor Mariah Blake visited the site in November 2008, someone had scrawled the word "*Titanic*" on the steel interior of the containment building.[xxxvi]

Delays continue to mount and the final price tag is unknown, but it is likely to exceed $6 billion.[xxxvii] AREVA and the Finnish utility TVO are locked in a dispute over who will be responsible for the cost overruns.[xxxviii] Meanwhile, a coalition of Finnish industries estimates that the delays will indirectly cost electricity users $4 billion in higher power bills.[xxxix]

The Finnish reactor is not the only nuclear project behind schedule. A second AREVA reactor being built in France is now reportedly nine months behind schedule, even though construction began barely a year ago.[xl] Project coordinators now admit that the project is already 20 percent over budget.[xli]

A new generation of nuclear reactors in the United States would likely face similar difficulties. Despite the fact that national expertise in manufacturing and building nuclear plants has withered in the last few decades and component supply bottlenecks are developing, power companies are still counting on quick and efficient construction. Recent reactor proposals estimate construction durations of five to six years – faster than 80 to 90 percent of all reactors completed during the last wave of reactor construction in the United States.[xlii]

According to Jim Harding, a nuclear energy expert who participated in the Keystone study, while many of these proposals put forward relatively high construction cost estimates, "none could be called 'worst case'."[xliii]

Further complicating matters are possible delays at the Nuclear Regulatory Commission (NRC). Facing a large volume of reactor applications – coupled with a lack of qualified staff – the NRC is outsourcing application reviews to third-party contractors.[xliv] Moreover, the NRC is reviewing and certifying five new reactor designs – with probable delays caused by ongoing design modifications and revisions.

The Risk of Financial Investment

MidAmerican Energy and its partners are not relying on private lenders to finance their new nuclear reactor project. Private lenders are wary of the substantial risk that the investment could fail, given that no one has any certainty what the proposed reactors will end up costing or how long they will take to build. Moreover, there is a large risk that anticipated electricity demand might not materialize.

The cautionary tale of the original effort to build the nation's existing fleet of nuclear reactors perfectly illustrates why private investors are looking towards more reliable options. Of 75 nuclear reactors completed between 1966 and 1986, the average reactor cost more than triple its original construction budget.[xlv] In 1985, *Forbes magazine* wrote, "the failure of the U.S. nuclear power program ranks as the largest managerial disaster in business history, a disaster on a monumental scale."[xlvi]

Little over half of the 253 nuclear plants proposed and funded in the U.S. ever reached operation. Of those that were built, 21 percent were permanently and prematurely closed due to reliability or cost problems, while another 27 percent have completely failed for a year or more at least once.[xlvii] Of the projects that were completed, the spiraling cost of one nuclear reactor led to the first major utility company bankruptcy since the Great Depression, when the Public Service Company of New Hampshire succumbed to the billions of dollars of unexpected costs it had incurred in building the Seabrook reactor.[xlviii]

President Obama's push for a "nuclear revolution" has raised the question of whether or not private investors would forgive the failures of the past, and reinvest in nuclear power with the promise of government loan guarantees. However, conditions for private investment in large, lengthy projects has only worsened, and the appeal of newer, cost-effective and renewable energy options has only grown.

The Impact of the 2008 Financial Crisis

The financial crisis that developed in September 2008 has appeared to have little effect on price escalation for new nuclear plants, but it has created new obstacles and risks.

Despite depressed economic conditions, investment analysts at Standard & Poor's found no fundamental changes in the factors driving nuclear costs upward. In October 2008, the credit rating agency issued a report entitled, "Construction Costs to Soar for New U.S. Nuclear Power Plants."[xlix] Soon after, Duke Energy doubled the expected construction costs of its proposed Lee Nuclear Station, reaching about $6,300 per kW.[l] That same month, *Platts Nucleonics Week* interviewed experts and industry officials, describing the anticipated impact of the financial crisis on global nuclear revival as "moderate," foreseeing possible benefits in easing the supply chain or credit crunch due to an economic slowdown.[li]

However, the financial crisis has contributed to a slackening in demand for electricity and higher costs for capital. If these conditions persist, utilities could find investments in new nuclear power plants more difficult to justify or to finance. The situation is eerily reminiscent of the conditions that sank the last wave of U.S. nuclear power plant construction.

"Even before the scale of the impact of the financial crisis began to be appreciated the cracks in the nuclear renaissance were becoming clear. The [reactor] designs were unproven; costs were escalating sharply; obtaining finance was problematic; and [there were] skills shortages and component supply bottle-necks. The financial crisis has done nothing to lessen these concerns."

-Steven Thomas, University of Greenwich Business School, February 11, 2009[lii]

Drop in Electricity Use Increases the Risk that New Nuclear Plants Will Not Be Needed

In 2008, utility companies noticed an exceptional decline in electricity consumption.[liii] While the economic crisis likely contributed to the drop in energy demand, utility executives have also expressed concern that the trend marks a deeper shift in consumption patterns.[liv]

More recently, the Electric Power Research Institute released a study predicting a gradual annual decline in residential demand in the U.S. by 0.5 percent a year. While overall demand, including factories and businesses, is still expected to grow, the predicted annual rate is only 0.7 percent through 2035 – well below the average of 2.5 percent a year the past four decades.[lv]

In Iowa, the EIA projects an increase in energy consumption by 28% over the 30-year span between 2005 and 2035. This is a reduction from the 40% growth in energy consumption that took place in Iowa between 1985 and 2005.[lvi]

If the trend holds, utilities run the risk of building too much generating capacity, burdening customers and shareholders with unnecessary costs. Michael Morris, the chief executive at American Electric Power, sounded a cautionary note. Quoted in the *Wall Street Journal*, he warned, "The message is, be cautious about what you build, because you may not have the demand [to justify the expense]."[lvii]

Shifting the Financial Risk Onto Consumers

"You can't expect the consumer to take on all the risk and pay for it in higher bills."

– David Springe, President of the National Association of State Utility Consumer Advocates[lviii]

Jeffrey Immelt, CEO of General Electric, told an audience at Dartmouth College in New Hampshire that the future of nuclear generation will be limited without government intervention, because of high construction and insurance costs.[lix]

In recognition of this fact, nuclear power companies have pursued a variety of subsidies and policy changes that shift risks that private investors are unwilling to cover onto taxpayers and customers instead – all while limiting public involvement in the regulatory process.

From the beginning, U.S. taxpayers have been instrumental in financing the deployment of nuclear technology. From 1950 to 1999, the federal government subsidized nuclear power to the tune of $145 billion.[lx]

Despite this massive level of historical support, the nuclear industry still requires assistance in order to have a chance at competing in the electricity market. In other words, although nuclear technology is already mature, it is too uneconomic to secure private investment. As a result, utilities like MidAmerican Energy are asking their customers to shoulder a significant share of the risk.

Charging Consumers Up Front

Traditionally, Iowa law requires that utility companies carry the costs of power plant development themselves, charging customers only after a plant is finished and able to deliver electricity.[lxi] However, utilities wishing to build nuclear power plants like MidAmerican Energy are now reaching into their customers' pockets much earlier, creating special charges to help finance new nuclear plants before construction begins – with no guarantee of final cost, or even a guarantee that the plant will ever deliver electricity at all.

With the force of MidAmerican Energy behind it, a Nuclear Construction Work in Progress (CWIP) bill proposal was brought before the Iowa General Assembly in early 2011 that contained language specifically altering the ratemaking principles for the development and construction of nuclear power plants. The CWIP proposal included stringent protections for any utility company pursuing nuclear power generation. However, there was little protection for consumers in the event MidAmerican Energy's plans followed in the steps of nuclear development in the past.

Elements of concern to consumers within the Nuclear CWIP legislation included[lxii]:

- The ability of utilities to preemptively recover in rates all expenses and costs including, but not limited to, ongoing operations and maintenance, decommissioning funding and site restoration, construction, licensing and taxes.
- Specific allowance of utilities to recover all preconstruction and construction costs incurred even if the utility cancels or fails to complete the construction of the nuclear plant, with no possibility of refund to ratepayers.
- Permission to recover in rate increases the net book value of any retired generating facility, like a coal plant, in anticipation of the nuclear plant.
- Restriction of the ability for consumers to collect refund on revenues already collected in the case of a lawsuit that modifies or cancels the ratemaking principle.

Iowa is not the first state to entertain nuclear CWIP legislation. For example, in 2009 Florida regulators began allowing Progress Energy to start billing customers up front for the planning, development, and construction of two nuclear power plants in Levy County. As a result, Florida customers were anticipated to pay more than $100 per year in higher electricity bills, even though the plant will not deliver electricity until 2016 at the

earliest. Progress Energy CEO Jeff Lyash estimated that customers' monthly bills could increase 3 to 4 percent a year beyond that, with a potential to spike as plant construction intensifies.[lxiii]

In early 2011, Senator Mike Fasano, a self-proclaimed conservative, pro-business legislator representing Florida State Senate District 11, wrote a letter publically withdrawing his original support for the Florida CWIP bill he helped to pass in 2006. In his letter, he said[1]:

Allowing utilities to charge customers for new power plant construction work in progress will hurt already strapped customers with possibly large increases in their electricity bills. According to Progress Energy filings with the Florida Public Service Commission, the average Progress customer could see an estimated increase of nearly $50 per month by 2020 from the Levy capital additions. […]

I believe that it is inherently unfair for utilities to ask their customers, our constituents, to front the costs of massive and expensive construction projects that are not even guaranteed to be completed. These risky investments ought to be the responsibility of utility shareholders and their investment partners, not the average ratepayer that is already struggling to pay their monthly utility bill or keep their business afloat.

Other utilities turning to their customers for advance loans are primarily located in the southern United States. South Carolina Electric & Gas plans to phase in a 37 percent rate hike to help cover the finance costs for a new reactor.[lxiv] Santee Cooper, a publically owned South Carolina utility, is following suit.[lxv] Ameren has requested a rate increase in Missouri, which critics allege is linked to an effort to overturn a law preventing utilities from charging consumers up-front for new power plant construction.[lxvi] The utility claims that unless the law is repealed, it will not be able to afford to construct a new reactor.[lxvii] Georgia Power has dispatched its lobbyists to Atlanta to win approval for charging $1.6 billion in financing costs to its customers during the proposed construction of two new reactors at the Votgle nuclear power plant – a plant that exceeded its original construction budget by 1,200 percent.[lxviii]

The Dollar for Dollar Benefit of a Clean Energy Portfolio

Expanding nuclear power is not the only option to address Iowa's energy needs. We could also continue in our efforts to create an innovative, new electricity system based on highly efficient and targeted use of power, generated by a diverse set of modular, clean and widely distributed resources.

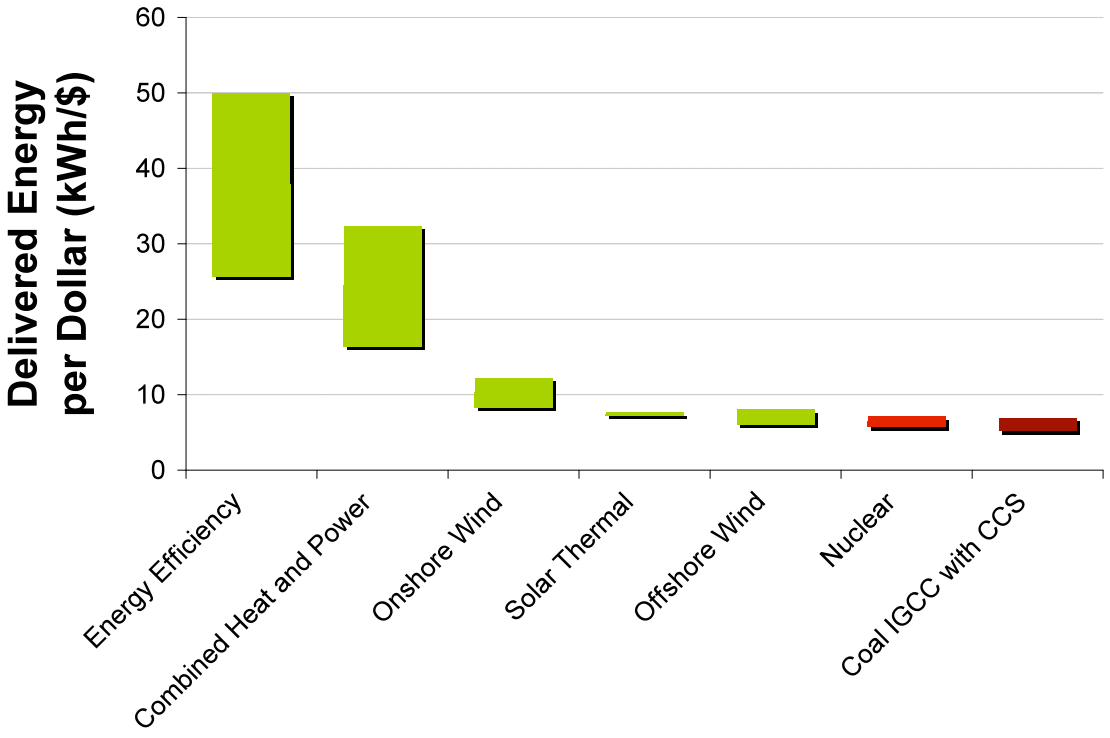
This course would include highly efficient homes, businesses and factories – improving the reliability of electricity service while minimizing investment in expensive infrastructure. In addition, this course would further build Iowa's capacity to generate electricity from renewable sources of energy – like wind.

These clean energy solutions can deliver more power per dollar of investment than a new generation of nuclear power plants. Average estimates for the cost of power from a new nuclear reactor are 300 percent higher than the cost of reducing the same amount of energy used through energy efficiency efforts. Nuclear power is more than 200 percent costlier than combined heat and power technologies, and more than 50 percent more expensive than new onshore wind power.

The cost advantages clean energy has over nuclear power are likely to become even more pronounced over time. According to Moody's Investor Service, "…nuclear generation has a fixed design where construction costs are rising rapidly, while other renewable technologies are still experiencing significant advancements in terms of energy conversion efficiency and cost reductions."[lxix]

As a result, investments in nuclear power could be more profitably directed into more cost-effective energy efficiency and renewable energy programs.

Figure 2: Electricity Delivered to the Consumer per Dollar of Investment (Levelized) – A Comparison of Select Low-Carbon Energy Technologies



This figure presents the amount of electricity delivered to the consumer per dollar of investment in different energy technologies, with the investment per unit of energy production "levelized" (or averaged) over the lifetime of the technology to enable meaningful comparison. Each bar represents the range between high and low productivity estimates, accounting for differences in the technology used, variability in the quality of the natural resource, and the precision of cost estimates. Values for energy efficiency, combined heat and power, nuclear and coal are not specific to any particular location. Wind energy estimates represent the average resource for the U.S. as a whole. Estimates for solar thermal represent typical resources in the southwestern United States. (IGCC with CCS stands for integrated gasification combined cycle with carbon capture and sequestration, a potential method of producing effectively low carbon electricity from coal.)

Iowa Has Enormous Clean Energy Potential

Iowa has enormous potential to save electricity through energy efficiency, and to generate electricity through clean and renewable resources, from recycling waste energy to tapping into wind power. Iowa's potential resources vastly exceed our annual electricity needs, and represent the equivalent of dozens of nuclear reactors.

Vast "strategic reserves" of energy efficiency exist within Iowa's homes, businesses and industrial facilities. For example, any light fixtures give off excess heat; air fans operate without the benefit of efficient motors; weaknesses in building insulation allow indoor heat to escape. Opportunities to improve energy efficiency also

include combined heat and power (CHP) technology, which captures waste heat from electricity generation and puts it to use.[lxx] Similarly, waste heat from industrial processes can be used to generate pollution-free electricity.[lxxi] Altogether, John "Skip" Laitner, director of the American Council for an Energy Efficient Economy (ACEEE), testified to the Iowa State Senate Commerce Committee in 2011 an estimate that Iowa could cost effectively reduce its overall energy consumption by 20 to 30 percent or more over the next 20 to 25 years.[lxxii]

Iowa is already the second largest producer of wind energy nationally, with 4,375 megawatts of installed wind capacity. Just this past year, in 2011, Iowa began producing over 20% of all the electricity in the state from wind turbines – making it the first in the nation for percentage of energy produced, and second in the world.[lxxiii] Even so, Iowa still has vast, untapped reserves of wind power. An estimated 75% of Iowa is suitable for wind energy development with an estimated total wind resource of 570,000 megawatts. The Iowa Wind Energy Association has set a goal of producing 20,000 megawatts of installed wind energy by 2030 – an increase equivalent to nearly 30 small nuclear reactors.

Clean Energy Solutions Cost Less Than Nuclear Power

As noted earlier, Moody's May 2008 cost estimate for nuclear power implies that reactor owners would have to sell electricity at an average of 15 cents per kWh over the life of the plant in order to earn adequate profit. Even the most optimistic estimates by MidAmerican Energy range from 10-12 cents per kWh.

Vast amounts of clean energy are available for far less.

Increasing Efficiency is the Cheapest Source of Electricity

Improving the energy efficiency of our economy is the cheapest and fastest way to address America's energy problems.

Saving energy through efficiency measures is much cheaper than generating and delivering electricity. In leading states, energy efficiency supplies most new electricity needs – cutting projected consumption by 1 to 2 percent each year at an average cost of 3 cents per kWh.[lxxiv] In comparison a typical American family pays more than 10 cents per kWh for electricity. [lxxv]

Goals of energy-efficiency resource standards in the Midwest*

State	Targets for energy-use reduction
Illinois	For electric, gradual ramp-up that reaches 2.0% by 2015; for natural gas, cumulative energy savings of 8.6% by 2020
Indiana	1.1% by 2014 and 2.0% by 2019 (electric)
Iowa	1.5% (electric and natural gas)
Michigan	Gradual ramp-up that reaches 1.0% by 2012 for electric and 0.75% for natural gas
Minnesota	1.5% by 2010 (electric and natural gas)
Ohio	Gradual ramp-up that reaches 2.0% by 2019
Wisconsin	1.5% by 2014 for electric and 1.0% by 2014 for natural gas

Source: American Council for an Energy-Efficient Economy

Analyses of future energy efficiency potential typically find available resources with average levelized costs of around 4 cents per kWh in the residential sector and 2 cents per kWh or less in the commercial and industrial sectors.[lxxvi] For example, recent studies of energy efficiency potential in Maryland and Florida found that the state could reduce electricity consumption by as much as 30 percent below forecast levels by 2025, at average cost of around 3 cents per kWh.[lxxvii] Studies by the electric power industry concur. For example, Commonwealth Edison calculated that an aggressive efficiency program in Illinois could save more than 1,000 GWh of electricity per year at a cost of only 2.5 cents per kWh.[lxxviii] Moreover, as the scale and scope of energy efficiency programs increase, they tend to become even more cost effective.[lxxix]

Iowa utilities currently administer energy efficiency programs under a regulated structure with oversight by the Iowa Utilities Board. Iowa code 476.6.16 mandates that all electric and natural gas utilities that are required to be rate-regulated must offer energy efficiency programs through cost-effective energy efficiency plans. Particularly since 2000, Iowa has renewed and increased commitment to energy efficiency programs. Beginning in 2008, Iowa Code instructed investor-owned utilities to annually submit plans to achieve a goal of 1.5% annual electricity and natural gas savings.

In MidAmerican Energy's most recent energy efficiency program report, the average levelized cost for both residential and non-residential programs was $0.05 cents per kWh. In the collective evaluation of all energy efficiency goals and programs with the Iowa Utilities Board, a report presented to the Iowa General Assembly estimated that the aggregate cost-effectiveness numbers of the goals and programs amount to a Societal Benefit-Cost ratio of 1.32. In other words, the energy efficiency programs will provide Iowans with benefits that are estimated to be 32 percent greater than the costs.[lxxx]

Reducing energy waste through Combined Heat and Power

Combined heat and power and recycled energy technologies are also extremely cost-effective sources of electricity. Recycled energy technologies can generate electricity for about 3 cents per kWh.[lxxxi] Combined cycle industrial heat and power installations can generally produce power for 4.5 to 5.5 cents per kWh, including credit for the value of useful heat that the generators also produce.[lxxxii] And smaller building-scale CHP technology can deliver electricity for less than 6 cents per kWh, again counting the value of the useful heat also produced by the generator.

For example, Beloit Memorial Hospital in Beloit, Wisconsin, installed a CHP system while upgrading its electrical distribution system in the 1990s. The CHP technology allows the hospital to provide its own electricity, and heat for internal hospital systems, at between 1.8 and 2.3 cents per kWh (2002 dollars).[lxxxiii]

CHP systems can significantly reduce energy bills. For example, San Mateo Community College District in California installed two combined heat and power units to generate electricity and heat for two of its campuses. Coupled with several energy efficiency upgrades, the combined heat and power system reduced the district's electricity usage by more than 50 percent and cut energy bills by more than $1 million per year.[lxxxiv]

Energy efficiency and combined heat and power have the added advantage of saving or generating energy near where it will be used. This avoids the added cost for transmitting and distributing electricity from a central power plant, which can exceed 2 cents per kWh. In addition, saving or generating energy locally minimizes electricity losses that can occur while transporting electricity from a distant power plant.

Energy from a new nuclear reactor would be – at best – two to five times more expensive than both energy efficiency and combined heat and power energy sources.

Large Amounts of Wind Energy Can be Delivered in Iowa for Less Cost Than Nuclear Power

Since nuclear reactors can take a decade or more to construct, new nuclear power cannot be obtained today in the United States at any price. However, many other energy technologies are available now that can deliver cost-effective reductions in pollution. Iowa has already been established as a global leader in wind power technology, and is currently producing the vast majority of materials to continue developing wind power potential.

The Iowa Energy Center estimates the levelized commercial cost of onshore wind energy in Iowa to be between $0.05-$0.07 per kWh. As our technology and our capacity to install wind turbines has improved, our costs associated with developing wind energy have diminished. MidAmerican Energy quoted an optimistic levelized cost of $0.10 per kWh for nuclear power.

Advancing Wind Technology

The municipal utilities located in Iowa have begun the testing and analysis of our ability to store compressed air and energy produced by wind turbines underground. The Iowa Stored Energy Park (ISEP) will use the energy from wind facilities to store air in an underground geologic structure during intermittent periods of low customer electric demand and high wind. This project promises to offer a large and economical grid-scale alternative that would make renewable wind energy dependable and dispatchable on-demand. ISEP will be located in central Iowa, and is expected to produce commercial electricity by 2015.

Similar technology is already being used for a 110 MW facility in Alabama, and a 290 MW facility in Germany.

The benefits, and the low cost of wind power has not been lost on the utility companies in Iowa. MidAmerican Energy actually produces the largest total amount of wind energy in the country. Warren Buffett, owner of MidAmerican Energy through Berkshire Hathaway, wrote in a recent letter to shareholders, "MidAmerican Energy will have 2,909 megawatts of wind generation in operation by the end of 2011, more than any other regulated electric utility in the country. The total amount that MidAmerican has invested or committed to wind is $5.4 billion."[lxxxv]

MidAmerican Energy's total investment in wind breaks down to $1,856 per kilowatt, which they have turned around to produce wind energy at roughly $0.05 per kWh. They are optimistically anticipating the new proposed nuclear reactors to cost between $1-3 billion for 540 megawatts of power. If we take their average prediction at $2 billion, their investment in new nuclear power would cost $3,703 per kilowatt and it will cost a minimum of $0.10 per kWh to produce energy if the plant reaches operation.

Iowa's Investment in Wind Energy Has Generated Economic Development and Job Creation

Beyond providing a clean, safe and cost-effective means of energy production, Iowa's investment in wind energy has generated benefits for the state in economic development and job creation. Investment in wind power has proven to be an investment in jobs in operations and maintenance, construction, manufacturing and many support sectors. In addition, wind power projects produce lease payments for landowners and increase the tax base of communities.

The wind industry in Iowa is estimated to have generated over $5 billion for Iowa's economy, and currently employs over 3,000 full time workers.[lxxxvi] This is in part due to the manufacturing boom that wind power has brought to Iowa. With at least nine Iowa manufacturers supplying turbines, towers, and blades to the wind industry, Iowa has attracted more major wind manufacturing than any other state. The state-wide Renewable

Angie Rose / Iowa Lakes Community College via AP

Portfolio Standards enacted in 1983, which required that a certain amount of electricity come from renewable energy, laid the foundation for the growth of wind as one of the fastest growing manufacturing industries in Iowa.

In comparison, as mentioned earlier, the nuclear industry faces an acute shortage of workers qualified to build nuclear facilities and limited manufacturing capacity for specialized nuclear components.[lxxxvii] Due to the specific skill set required to work in the nuclear industry, it is likely that few of the workers hired would be from within Iowa. Also, with the highly specialized manufacturing capability necessary to produce a nuclear reactor, much of the money invested in new nuclear power plants in would be invested either out of state or outside of the U.S.

Conclusions and Recommendations

Nuclear power is one of the least cost-effective ways to address Iowa's energy problems. In comparison, other low-carbon energy sources – including energy efficiency, wind power, and combined heat and power – deliver more results for every dollar of investment.

This fact has important implications for Iowa's energy policy. By directing resources toward the most cost-effective solutions, we can make greater progress toward a secure, reliable and safe supply of electricity to power Iowa's economy.

Iowa should reform its energy policy to prioritize clean energy solutions – technologies that deliver safe, reliable and secure electricity supplies at a reasonable cost. Iowa's leaders should:

- **Protect citizens from unnecessary risks** by requiring any company proposing to build a new nuclear reactor to demonstrate that nuclear power generation would be more cost-effective than other ways to meet electricity demand, including energy efficiency, before allowing construction to proceed. Evaluations of cost-effectiveness should be conducted by an unbiased, independent, reputable agency and be available for public review.
- **Ensure that energy companies and their shareholders, not ratepayers or taxpayers bear all of the financial risks** associated with building a new nuclear power plant. In particular, regulators should not allow consumers to be charged up-front to finance the construction of a new nuclear reactor.
- **Provide full opportunity for public input** at every key point in the process of developing any new nuclear reactor.
- **Continue state tax credits that promote the development and growth of the wind power industry**, and provide further incentives for research and development of new wind generation technologies.
- **Speed energy efficiency efforts by raising the energy efficiency resource standard** goals to reach 2% by 2020. Energy efficiency programs across the country have proven effective in saving substantial amounts of electricity and natural gas, saving consumers money, reducing energy prices, eliminating the need to build expensive new nuclear power plants, creating jobs, and improving local economies.
- **Expand renewable energy production** to ensure that 30% of Iowa's electricity supply comes from renewable resources by 2025, as well as expand analogous policies to promote clean energy at the state level.

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